Appendix 22

Traffic impact assessment study

REPORT

Ichthys Gas Field Development Project

Traffic Impact Assessment Study





Prepared for

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Level 22, 100 St George's Terrace
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Glossary

B Double - a commercial vehicle with a prime mover and at least two trailers (using B couplings between trailers - a full turntable coupling similar to that on the prime mover of an articulated truck).

Commercial Vehicles - any vehicle above 4.5 tonnes gross vehicle mass.

Control Delay – the additional travel time experienced by a vehicle at an intersection that is controlled such as a red light at traffic signals.

Degree of Saturation – the ratio of arrival (demand) flow rate to capacity during a given flow period.

Effective Intersection Capacity - this is the total number of vehicles that can pass through an intersection in a given period of time (typically one hour is used). The capacity of each left, through and right turn is calculated for each approach to the intersection and this depends primarily on the number of lanes and the signal phasing for the intersection (how much time each turn gets a green light).

Intersection - a place at which two roads meet or cross.

Level of Service – an index of the operational performance of traffic on a given traffic lane, carriageway, road or intersection, based on service measures such as speed, travel time, delay and degree of saturation during a given flow period.

Midblock - the section of a road between intersections.

Road Train - a truck with a prime mover and at least two trailers (using A couplings between trailers - a simple A-frame arrangement on a tow bar).

Seagull Intersection - a t-intersection where the right turn out of the side road gives way to oncoming traffic from the right and is provided with an acceleration lane in the median to merge into the traffic stream approaching from the left.

T-Intersection – an intersection where two roads meet (whether or not at right angles) and one of the roads ends.

95% Queue length - the length of queue (measured in metres) that will be exceeded only 5% of the time. Typically at a signalised intersection, this will be one cycle every hour (a cycle is one complete set of individual red and green lights on every approach).

Executive Summary

URS has been engaged by INPEX, Browse Ltd. (INPEX) to prepare a traffic impact assessment for the proposed Ichthys Gas Field Development Project planned for Blaydin Point in Darwin Harbour, Northern Territory. This study focuses on the traffic generated by the onshore LNG processing plant development, including the onshore pipeline and rock armouring, for both the construction and ongoing operation phases.

This traffic impact assessment will form part of a wider environmental impact statement for the Project.

The scope of this report is to:

- Describe the existing traffic patterns on the road network surrounding the site, including peak volumes and directions and determine any changes to these patterns due to the construction and ongoing operations of the proposed development (refer to Sections 3 and 4 of this report);
- Determine the road improvement options required to maintain an appropriate level of service on the road network during the INPEX construction period, taking into account ongoing background traffic growth and road network improvements that will occur through government and other private sector investment (refer to Section 5 of this report);
- Identify commuting options for the construction period (refer to Section 5 of this report); and
- Identify issues relating to on-site traffic requirements including access to the site from the surrounding arterial roads and internal road requirements, parking and access requirements (refer to Section 6 of this report).

The greatest traffic impact of the LNG plant development at Blaydin Point will occur during the construction period of the development. It is expected that peak construction activity will occur during 2013 and traffic generated during this phase will consist of construction related commercial vehicle movements and employee transport between the site and the accommodation facilities.

It is estimated that 2015 is the date of completion for the construction period, and the commencement of the operation period and as such, background traffic has been analysed for that year.

The SIDRA modelling package was used to analyse both the existing and future performance of the road network including predicted traffic volumes associated with the proposed development during construction.

The Degree of Saturation (DoS) and 95% Queue Length for each approach of the intersections has been used as a guide to determine the performance of the road network. Generally a DoS of 0.95 or below is considered acceptable in a congested urban road network, although often intersections will be shown to be operating at capacity in existing conditions. Queue lengths (length which have a probability of being exceeded only 5% of the time) are used to determine lengths of dedicated turn lanes when preparing functional designs.

A summary of the SIDRA analysis is shown in Tables E-1 and E-2.

It should be noted that the model does not take into account the influence of the new Tiger Brennan Drive extension project which is anticipated to be completed in 2010. If this project is completed prior to the development of the LNG facilities, the results of the modelling will change due to a shift in the usage of roads affected by the new Tiger Brennan Drive. Overall, the network should operate more efficiently if this occurs and therefore the analysis in this report is considered conservative and actual conditions should be better than those reported.

Executive Summary

From the analysis, the proposed development is not expected to create an overall significant incremental adverse impact on the operation of the road network when compared to the operation arising from background traffic growth. However, it should be recognised that there are a number of key intersections that will be congested by the time construction reaches its peak, due to background traffic growth in Darwin, driven by the on-going increase in population (and the distribution of this population in the satellite suburbs). The roadworks required to mitigate the traffic impact of the development are therefore localised and limited to two signalised intersections.

The proposed location of the employee housing accommodation facilities is within Howard Springs encompassing contiguous land portion 2819 , part portion 2818 and part location 273. The major implication presented by the proposed site is the impact on the capacity of the Stuart Highway/Lambrick Avenue intersection during the AM peak period. This site would also require the construction of a new intersection on Howard Springs Road for access to the facilities. It is recommended that infrastructure upgrades required to achieve acceptable road network operating performance be identified for these road works.

The use of over dimension vehicles may also require that some localised road upgrades are undertaken such as shoulder strengthening or drop kerbing along the selected route.

It is recommended that the following issues should be considered in the planning of the INPEX LNG development;

Employee Transport

- Bus transport to support the majority of the construction workforce transport requirements to the site will minimise car impact
- Some employees will travel to and from site by car
- Appropriate on site provision for parking and manoeuvring of vehicles at the employee accommodation facilities should be incorporated into their design
- The intersection at which the accommodation facilities join the road network will require detailed design and traffic management plans for construction to minimise impact on the existing road network
- Upgrading of the Stuart Highway/Lambrick Avenue intersection may be required.

Construction Transport

- The use of oversize vehicles will require traffic management plans and permits, additionally movement of oversize vehicles on the road system may require road improvements or alterations such as the removal of structures to allow the vehicles through.

LNG Site

- Appropriate on site provision for limited parking and manoeuvring of vehicles at the LNG plant site should be incorporated into their design
- Consideration of offsite maintenance and parking for commercial vehicles and buses will minimise parking requirements for the LNG plant site.
- Circulation routes with designated bus stops within the LNG plant site for employee buses will enable efficient traffic flow through the site

Other

- Investigate minimising construction and personnel movements during peak hours where possible
- The use of unsealed roads should be avoided

Table E-1 Summary of SIDRA Analysis: Degree of Saturation

	2008 Conditions	2013 Background Traffic Growth	2013 including Generated Construction Traffic	2015 Background Traffic Growth	Intersection Movement Causing DoS	Comment
Elrundie Avenue/Wishart Road/Hedley Place/University Avenue (AM peak)	0.48	0.77	0.82	0.93	Northbound Elrundie Ave: left turn into Wishart Road (inbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Berrimah Road/Wishart Road (PM peak)	0.86	0.90	0.91	0.93	More than one intersection movement Southbound Berrimah Rd: left turn into Wishart Rd (outbound); and Northbound Berrimah Rd: right turn into Wishart Rd (outbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Elrundie Avenue/Chung Wah Terrace (PM peak)	0.07	0.09	0.17	0.09	Northbound Elrundie Ave: right (outbound) turn into Chiung Wah Tce	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Stuart Highway/Berrimah Road (PM peak)	0.89	1.00	1.00	1.03	More than one intersection movement Southbound Vanderlin Dve: right turn into Stuart Highway (inbound); Eastbound Stuart Highway: through movement (outbound); and Northbound Berrimah Rd: right turn into Stuart Highway (outbound)	Generated traffic creates incremental impact. Intersection operating above capacity without impact of generated traffic by 2015.

Executive Summary

	2008 Conditions	2013 Background Traffic Growth	2013 including Generated Construction Traffic	2015 Background Traffic Growth	Intersection Movement Causing DoS	Comment
Stuart Highway/Lambrick Avenue (AM peak)	0.82	0.96	1.06	1.05	More than one intersection movement Southwest-bound Howard Springs Rd: right turn into Stuart Highway (inbound); Southwest-bound Howard Springs Rd: through movement; and Northwest-bound Stuart Highway: through movement (inbound)	Generated traffic increases degree of saturation. Intersection operating above capacity without impact of generated traffic by 2015.
Stuart Highway/Temple Terrace (PM peak)	0.76	0.90	0.90	0.89	Southeast-bound Stuart Highway: through movement (outbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Channel Island Road/Wickham Point Road (AM peak)	0.04	0.11	0.19	0.06	Northwest-bound Channel Island Road turning right into Wickham Point Road (outbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Stuart Highway/Jenkins Road (PM peak)	0.11	0.11	0.15	0.16	Northbound Stuart Highway: through movement (inbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.

Table E-2 Summary of SIDRA Analysis: 95% Queue Length (m)

	2008 Conditions	2013 Background Traffic Growth	2013 including Generated Construction Traffic	2015 Background Traffic Growth	Intersection Movement Causing 95% Queue Length	Comment
Elrundie Avenue/Wishart Road/Hedley Place/University Avenue (AM peak)	38	114	114	114	Northbound Elrundie Ave: left turn into Wishart Road (inbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Berrimah Road/Wishart Road (PM peak)	228	324	378	364	Southbound Berrimah Rd: left turn into Wishart Rd (outbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Elrundie Avenue/Chung Wah Terrace (PM peak)	No more than 1 car	No more than 1 car	No more than 1 car	No more than 1 car	Northbound Elrundie Ave: through movement (inbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Stuart Highway/Berrimah Road (PM peak)	284	469	495	557	Eastbound Stuart Highway: through movement (outbound)	Generated traffic creates incremental impact. Intersection operating above capacity without impact of generated traffic by 2015.
Stuart Highway/Lambrick Avenue (AM peak)	195	556	791	802	Northwest-bound Stuart Highway: through movement (inbound)	Generated traffic increases queue length. Intersection operating above capacity without impact of generated traffic by 2015.
Stuart Highway/Temple Terrace (AM peak)	109	214	294	292	Northwest-bound Stuart Highway: through movement (inbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.

Executive Summary

	2008 Conditions	2013 Background Traffic Growth	2013 including Generated Construction Traffic	2015 Background Traffic Growth	Intersection Movement Causing 95% Queue Length	Comment
Channel Island Road/Wickham Point Road (PM peak)	0	0	0	0	-	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Stuart Highway/Jenkins Road (PM peak)	0	0	0	0	-	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.

Introduction Section 1

1.1 Background

URS has been engaged by INPEX Browse, Ltd. (INPEX) to prepare a traffic impact assessment for Darwin for the proposed Ichthys Gas Field Development Project (the Project) whose onshore processing plant is planned for Blaydin Point in Darwin Harbour. This study focuses on the traffic generated by the development of the onshore facilities, including the installation of the subsea and onshore gas export pipeline and associated rock-armouring, for both the construction and operations phases.

INPEX proposes to develop the natural gas and associated condensate contained in the Ichthys Field situated about 220 km off Western Australia's Kimberley coast and about 820 km west-south-west of Darwin. The field encompasses an area of 800 km^2 in water depths ranging from 235 to 275 m.

The two reservoirs which make up the field are estimated to contain 12.8 tcf (trillion cubic feet) of sales gas and 527 MMbbl (million barrels) of condensate. INPEX proposes to process the reservoir fluids to produce liquefied natural gas (LNG), liquefied petroleum gases (LPGs) and condensate for export to overseas markets.

For the Project, the company plans to install offshore extraction facilities at the field and a subsea gas pipeline from the field to onshore facilities at Blaydin Point. A two-train LNG plant, an LPG fractionation plant, a condensate stabilisation plant and a product loading jetty will be constructed at Blaydin Point. Around 85% of the condensate will be extracted and exported directly from the offshore facilities while the remaining 15% will be processed at and exported from Blaydin Point.

In May 2008 INPEX referred its proposal to develop the Ichthys Field to the Commonwealth's Department of the Environment, Water, Heritage and the Arts and the Northern Territory's Department of Natural Resources, Environment and the Arts. The Commonwealth and Northern Territory ministers responsible for environmental matters both determined that the Project should be formally assessed at the environmental impact statement (EIS) level to ensure that potential impacts associated with the Project are identified and appropriately addressed.

Assessment will be undertaken in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) and the *Environmental Assessment Act* (NT). It was agreed that INPEX should submit a single EIS document to the two responsible government departments in the Northern Territory and the Commonwealth for assessment.

URS Australia Pty Ltd (URS) was commissioned to carry out environmental work associated with INPEX's preparation of the Project EIS and this technical report, assessing the Project's traffic impact, was prepared in part fulfilment of that commission.

Figure 1.1 shows the location of the proposed site and the associated road network and population centres.

Section 1 Introduction

Figure 1-1 Location Map

1.2 Project Objectives and Scope

1.2.1 Objectives

The objectives of this study are to:

- Identify and describe any impacts of traffic resulting from the construction and operation of the onshore LNG processing plant and associated works on the surrounding road network and local community
- Determine on-site traffic operational requirements and propose associated commuting options
- Propose management and mitigation measures which will minimise any adverse impacts to permit the local community to function adequately during the construction and operation phases

1.2.2 Scope

The scope of this study report is:

- Describe the existing traffic patterns on the road network surrounding the site, including peak volumes and directions and determine any changes to these patterns due to the construction and ongoing operations of the proposed development (refer to Sections 3 and 4 of this report).
- Determine the road improvement options required to maintain an appropriate level of service on the road network during the INPEX construction period, taking into account ongoing background traffic growth and road network improvements that will occur through government and other private-sector investment (refer to Section 5 of this report).
- Identify commuting options for the construction period (refer to Section 5 and 6 of this report).
- Identify issues relating to on-site traffic requirements including access to the site from the surrounding arterial roads and internal road requirements, parking and access requirements (refer to Section 6 of this report).

Section 2 Base Case Proposal

The below sections outline the assumptions made for this report. These are based on information provided by INPEX (August to October, 2008). It should be noted that three different components of the development proposal are relevant to the traffic impact assessment;

- Construction and operation activity on the processing site itself
- Traffic generated by a dedicated accommodation facility associated with the development
- Locations of sources of construction materials

2.1 Proposed Construction Schedule

Based on the information provided by INPEX (August to October, 2008), the following schedule will be used for the basis of analysis:

- The construction phase runs from late 2009 through to mid 2015
- The peak of activity for the construction phase is anticipated to occur over 2013
- The operations phase will commence in approximately July 2015

2.2 Location of Facilities and Access

The proposed LNG processing facilities will be located on Blaydin Point in Darwin Harbour. An existing LNG processing plant is located adjacent to Blaydin Point on the western side of the Middle Arm peninsula. Wickham Point Road provides access to this existing plant and will also provide the main access into the new development at Blaydin Point.

The existing LNG processing plant, along with the Channel Island Power station, are the only significant sources of traffic in the immediate area of the proposed location of the new plant.

Accommodation facilities will be established in Section 2819 and 2818, Howard Springs, to provide dedicated housing for the construction workforce. This site is bounded by Howard Springs Road, Stow Road and Whitewood Road. This site has been expanded recently to include a proportion of an adjacent block of land.

An estimated 2,500 people will be working on the site at the peak of the construction phase, with significantly fewer people required during the operational phase.

All proposed granite and hornsel quarries to supply this development are located within Mt Bundy, approximately 100km southeast of Darwin along the Stuart and Arnhem Highways. The sandstone quarry is located in Katherine, 330km south of Darwin along the Stuart Highway.

A locality map of the proposed development and proposed accommodation facilities is provided in Figure 2.1

Proposed Site Access

The proposed access to the development site is an existing unsealed road intersecting with Wickham Point Road, as indicated in Figure 2.1.

Accommodation Facilities Connection to Existing Road Network

The proposed location for the accommodation facilities will require the construction of a new intersection at the point where the facilities connect to the existing road network. It is proposed that this intersection should be designed to minimise impact on the existing road network and hence are not critical to the overall impact on the existing road network.

Detailed traffic studies and traffic management plans will need to be developed for the construction of this intersection.

2.3 Construction Activity

Data has been provided to URS by INPEX detailing the anticipated construction related traffic for use in the traffic impact assessment. It should be noted that this data specifies that all commercial vehicles used during construction will be B-Doubles or similar. Assessment of the road network has been based on this assumption.

It should be noted that the use of road trains for large construction projects is common in the Northern Territory and that these road trains have significantly different impacts on the road network due to their size and restricted access to certain roads. If road trains are to be used for the INPEX development, further analysis of the network would be necessary.

Refer to Table 4.1 for a summary of the traffic volumes generated by construction activity as provided by INPEX. Note that further detail on Construction Traffic is available in section 4.2

2.4 Workforce

During construction, site works are expected to occur over a six-day week, with work on some Sundays as required to support the schedule. Construction will occur over a 10 hour period on work days, with hours of work ranging between 6:00am and 6:00pm. In addition to this, some site works may be required at night; however personnel movements would be significantly lower in comparison to day-time operations.

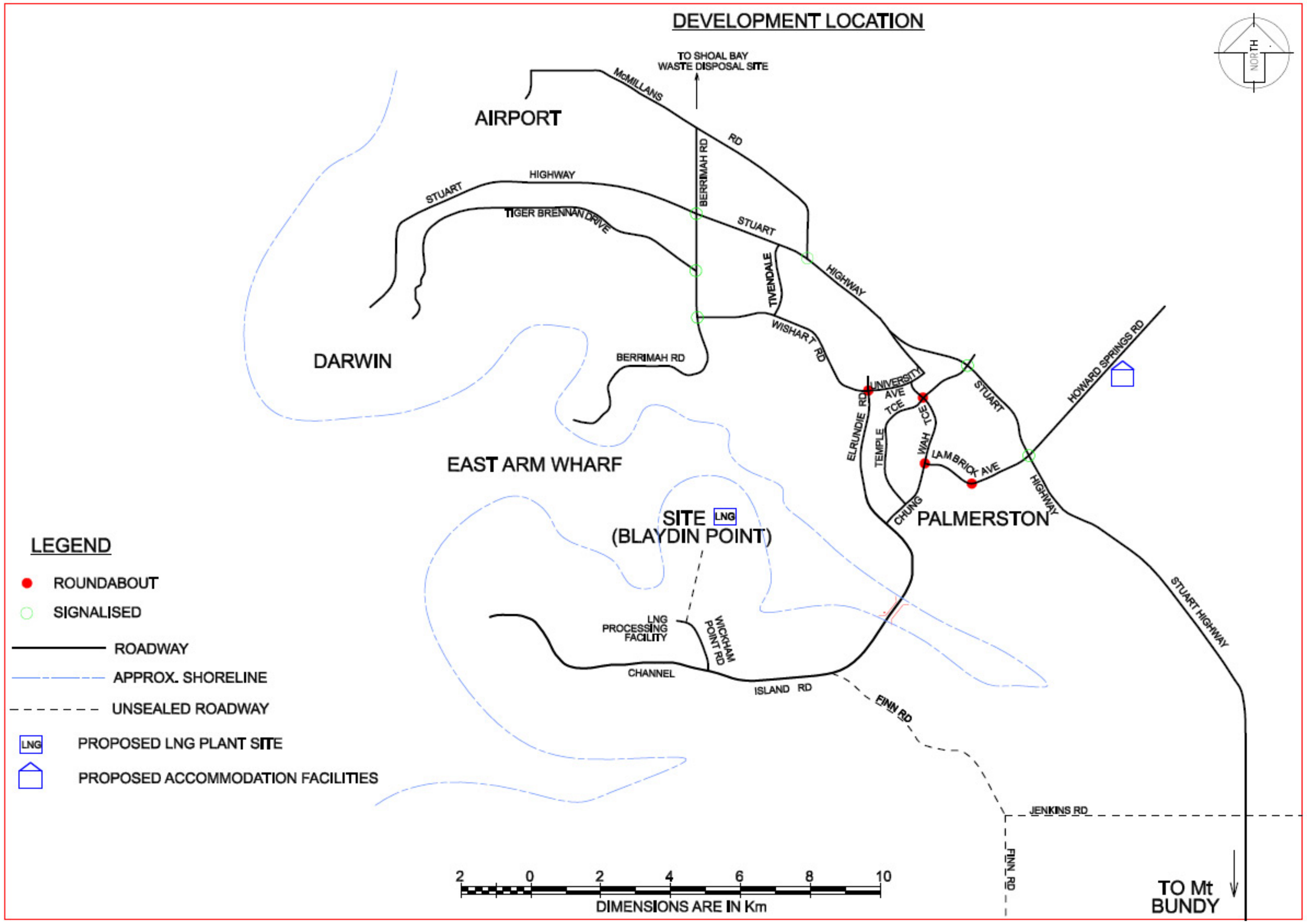
2.5 Relevant Sections of the Road Network

Given the location of the processing site, proposed accommodation facilities sites and sources of construction materials, the following roads are considered relevant to this traffic impact assessment;

- Stuart Highway
- Channel Island Road/Elrundie Avenue
- Chung Wah Terrace
- Lambrick Avenue
- Berrimah Road
- Tiger Brennan Drive
- Wishart Road
- Tivendale Road

Base Case Proposal

Figure 2-1 Development Location and Road Network



Existing Conditions Section 3

This section identifies the existing 2008 road network, public transport services, proposed roadworks and accident data. The existing and future performance of this network is assessed in Section 5 of this report.

3.1 Existing Road Network

Darwin has a well defined road network, with the Stuart Highway providing an east – west spine through the city from the CBD to Palmerston, then continuing south into the Territory. There is a parallel arterial road to the south of Stuart Highway, Tiger Brennan Drive, which provides an alternative connection between Darwin and Berrimah while Wishart Road continues this alternate route between Berrimah and Palmerston. A number of north-south arterial roads connect Stuart Highway and Tiger Brennan Drive and then extend further north and/or south into the urban areas of Darwin and Palmerston.

Details on the key arterial roads in Darwin relevant to the development site are provided in this section.

The road network is indicated in Figure 2-1.

Stuart Highway

The Stuart Highway is the major highway access to Darwin and the surrounding area, identified as National Highway Route 1. The highway is dual carriageway with a minimum of two lanes in each direction running from the Darwin CBD east and then south, skirting the northern and eastern edges of Palmerston and continuing on to Katherine to the south.

Within the Darwin CBD area, the highway has parking within the median, which then reduces to a grassed or dirt median as the road extends south.

Major intersections within the Darwin and Palmerston area;

- Westralia Street – Signalised intersection
- Goyder Road – Seagull intersection
- Parap Road – Signalised intersection
- Woolner Road – Signalised intersection
- Bagot Road – Elevated roadway and signalised intersection
- Billeroy Road – Signalised intersection
- Hook Road – Signalised intersection
- Amy Johnson Avenue – Signalised intersection
- Berrimah Road – Signalised intersection
- McMillans Road – Signalised intersection
- Roystonea Avenue – Unsignalised interchange/merge
- Temple Terrace –Signalised intersection
- Lambrick Avenue – Signalised intersection

The speed limit on Stuart Highway is 60km/hr near the Darwin CBD, increasing to 100km/hr near Berrimah Road and then dropping back to 80km/hr in the vicinity of Palmerston.

Traffic volumes provided by Territory Asset Management Services (TAMS) are highest near the Darwin central business district with 2007 data showing 26,591 vehicles per day (vpd) when measured as Annual Average Daily Traffic (AADT). Traffic volumes decrease to around 17,000 vpd as Stuart Highway passes the Palmerston area.

Traffic counts from 2008 provided by TAMS show that between 12% and 17% of vehicles using Stuart Highway to the south of Palmerston were commercial vehicles.

Channel Island Road/Elrundie Avenue

Channel Island Road is a rural, single carriageway road with one lane in each direction. Originating on Channel Island, offshore to the west of the proposed development, the road extends east and then north, connecting the Island to the Palmerston area. It also forms part of the main route to the existing LNG plant located on Middle Arm Peninsula on which the new development is located, via Wickham Point Road. Channel Island Road changes name to Elrundie Avenue at the intersection with Chung Wah Terrace in Palmerston.

A single carriageway bridge crosses the Elizabeth River to connect Middle Arm Peninsula to Palmerston. The bridge has a single lane in each direction and a raised pedestrian footpath on the southbound side with no shoulders. Permanent safety barriers are fixed to either side of the bridge. A rail bridge runs parallel to the northbound lane but is not connected structurally to the road bridge.

There are very few intersections along Channel Island Road until it changes to Elrundie Avenue which then terminates with a major roundabout at the intersection with University Avenue and Wishart Road. This multilane roundabout is large enough to accommodate road train turning movements when utilising both lanes.

The only signalised intersection is a midblock pedestrian operated crossing connecting the suburbs of Driver with Marlow Lagoon.

Channel Island Road has priority at all intersections along its entire length and ranges in speed limit from 80km/hr near residential areas in Palmerston, to 90km/hr in the transition zone between urban and rural areas, and continues at 100km/hr in undeveloped rural areas.

This road is the main route between the proposed development site and the Darwin/Palmerston area and will carry all traffic bound for the development. Daily traffic volumes on the road in the vicinity of Palmerston during 2007 were around 8,500 vpd AADT.

Traffic counts from 2008 show that 13% of vehicles using Elrundie Avenue near Palmerston were commercial vehicles, increasing to 15% on Channel Island Road to the south of the Elizabeth River Bridge.

Palmerston Road Network

Palmerston is a satellite city with a network of curvilinear collector and local roads, and intersections with Stuart Highway to the east. The satellite city houses around 26% of the Darwin region population and is serviced by a large shopping complex and bus terminal on the corner of Chung Wah and Temple Terraces.

Chung Wah Terrace is the major collector road running north/south through the satellite city, connecting to Channel Island Road and feeding traffic to local roads. It is dual carriageway north of Lambrick Avenue with two lanes in each direction separated by a median. South of Lambrick Avenue, it is a single carriageway with one lane in each direction with an occasional painted median. There is limited private driveway access to the road. The speed limit is 60km/hr in residential areas and 80km/hr elsewhere.

Lambrick Avenue intersects both Chung Wah Terrace and Stuart Highway, providing a main connector between the satellite city and Stuart Highway. This road is single carriageway with one lane in each direction. In residential areas the road has a speed limit of 70km/hr increasing to 100km/hr in undeveloped areas.

Local road connections to the Stuart Highway do not allow traffic to turn right and head south on the Highway and therefore Lambrick Avenue and Temple Terrace are the primary access for Palmerston traffic to turn right onto the highway and head south.

No road train access is allowed into the Palmerston area. Road trains must use Tivendale Road to the north in order to access a route between Channel Island Road and Stuart Highway as advised by the Northern Territory Department of Planning and Infrastructure (DPI). The major collector roads in Palmerston have been designed to accommodate 9m articulated commercial vehicles such as B-doubles and single buses, but may not be able to accommodate large articulated buses. These roads are available for use by commercial vehicles as shown by the existing commercial vehicle volumes before.

Daily traffic volumes on the main collector roads within the Palmerston area were around 5,000-7,000 vpd AADT in 2007 with up to 15% commercial vehicles, whilst local roads had a lower level of commercial vehicles at 5%.

Berrimah Road

Berrimah Road runs in a north-south direction, intersecting the three main east-west routes in the region (Stuart Highway, Tiger Brennan Drive and Wishart Road). It provides a key link between the Darwin International Airport, Stuart Highway and East Arm Wharf. The road is a single carriageway with a single lane in each direction and an asphalt median to accommodate right turning traffic at intersections. The speed limit varies, from 60km/hr near East Arm Port, to 80km/hr near Stuart Highway. A 40km/hr school zone exists from 7am until 5pm on school days, to the south of Stuart Highway.

The northern section of Berrimah Road runs past both schools and heavy commercial and industrial zones, which in turn has led to commercial vehicles utilising the road as well as school related traffic.

Signalised intersections control traffic at the intersections with the Stuart Highway and Tiger Brennan Drive and Wishart Road (the alternate, parallel route to the Stuart Highway from Darwin CBD).

There is a steep gradient on the section of road directly to the north of Tiger Brennan Drive.

As the road approaches the wharf to the south, the road widens to dual carriageways with two lanes in each direction, with a truck passing/turning/parking zone and weighbridge facilities within the median. A rail level crossing also exists at the entrance to the wharf area.

The road condition is poor in some parts however it is currently undergoing major redevelopment, which is outlined in Section 3.3.

Daily traffic volumes in 2007 were around 4,000 vpd AADT on the southern section of road (which provides access to the East Arm Wharf), however much higher volumes use Berrimah Road as a connection between Tiger Brennan Drive and Wishart Road. Traffic volume survey data is not available for this section, but it can be inferred from other nearby traffic counts that this volume is in the order of 8,000 vpd to 10,000 vpd AADT.

Traffic counts for 2008 showed that 28% of vehicles using Berrimah Road south of Wishart Road were commercial vehicles.

Tiger Brennan Drive/Wishart Road

Tiger Brennan Drive and Wishart Road provide the main alternate east-west route to Stuart Highway, from Darwin to Palmerston. This route services both cars and commercial vehicles and includes a dog-leg movement from Tiger Brennan Drive into Berrimah Road and onto Wishart Road. Speed limits vary from 100km/hr in undeveloped and heavy commercial/industrial zones, to 60km/hr as Tiger Brennan Drive approaches Darwin CBD.

The current arrangement is a single carriageway with single lanes in each direction for both Tiger Brennan Drive and Wishart Road. However, upgrade works are currently underway as outlined in Section 3.3.

Wishart Road intersects Elrundie Avenue at the double lane roundabout in Palmerston and includes two rail crossings between Berrimah Road and the roundabout.

As one of the main routes between Palmerston and the Darwin CBD, Tiger Brennan Drive has relatively high daily traffic volumes. Counts from 2007 show a traffic volume of over 18,000 vpd AADT for the western section of the road near the CBD, decreasing to around 8,500 vpd AADT near the intersection with Berrimah Road. Wishart Road had a 2007 AADT volume of 11,000 vpd.

Tivendale Road

Tivendale Road is the designated road train route linking Channel Island Road to Stuart Highway, via Elrundie Avenue and Wishart Road. Tivendale Road is single carriageway, single lane each direction and has unsignalised intersections with both Wishart Road and Stuart Highway. A rail crossing exists directly north of the intersection with Wishart Road.

The road condition is generally a mix of poor and good sections, with some pot holes and patching evident and no shoulders in some sections. However, Tivendale Road has been identified as a possible redevelopment project in the future as outlined in Section 3.3.

Daily traffic volumes for 2007 were not available for Tivendale Road, although it should be noted that this road is expected to have a high percentage of commercial vehicle traffic, as it forms part of the designated road train route.

3.2 Public Transport

Darwin and Palmerston's primary mode of public transport is the bus network. Bus services are divided between three key locations – Darwin city centre, the Northern suburbs (Casuarina) and Palmerston. Furthermore, services are separated into three categories – suburban services, loop services and rural services.

The current suburban routes operate on a regular urban timetable with additional weekday express services;

- 3 services between Darwin and Casuarina;
- 2 services between Casuarina and Palmerston;
- 2 services between Darwin and Palmerston;
- 1 service between Darwin and Royal Darwin Hospital;

- 1 service between Leanyer and Darwin; and
- 1 service between Karama and Darwin.

The current loop services operate on a regular urban timetable and consist of;

- 5 services within the Northern suburbs;
- 1 service within Darwin city centre; and
- 6 services within Palmerston.

The current regional services (that go beyond Palmerston) operate two daily services in each peak direction on school days, with one service only during school holidays. The routes consist of;

- 2 services between Palmerston and Noonamah;
- 2 services between Palmerston and Humpty Doo; and
- 1 service between Palmerston and Bees Creek.

There are currently no services along Channel Island Road in close proximity to the location of the development.

3.3 Proposed Roadworks

The Northern Territory DPI has a number of proposed roadworks that are currently in either planning or construction and which will increase road capacity and therefore may influence the impact of the traffic generated by the development. The following roadworks are relevant to this study;

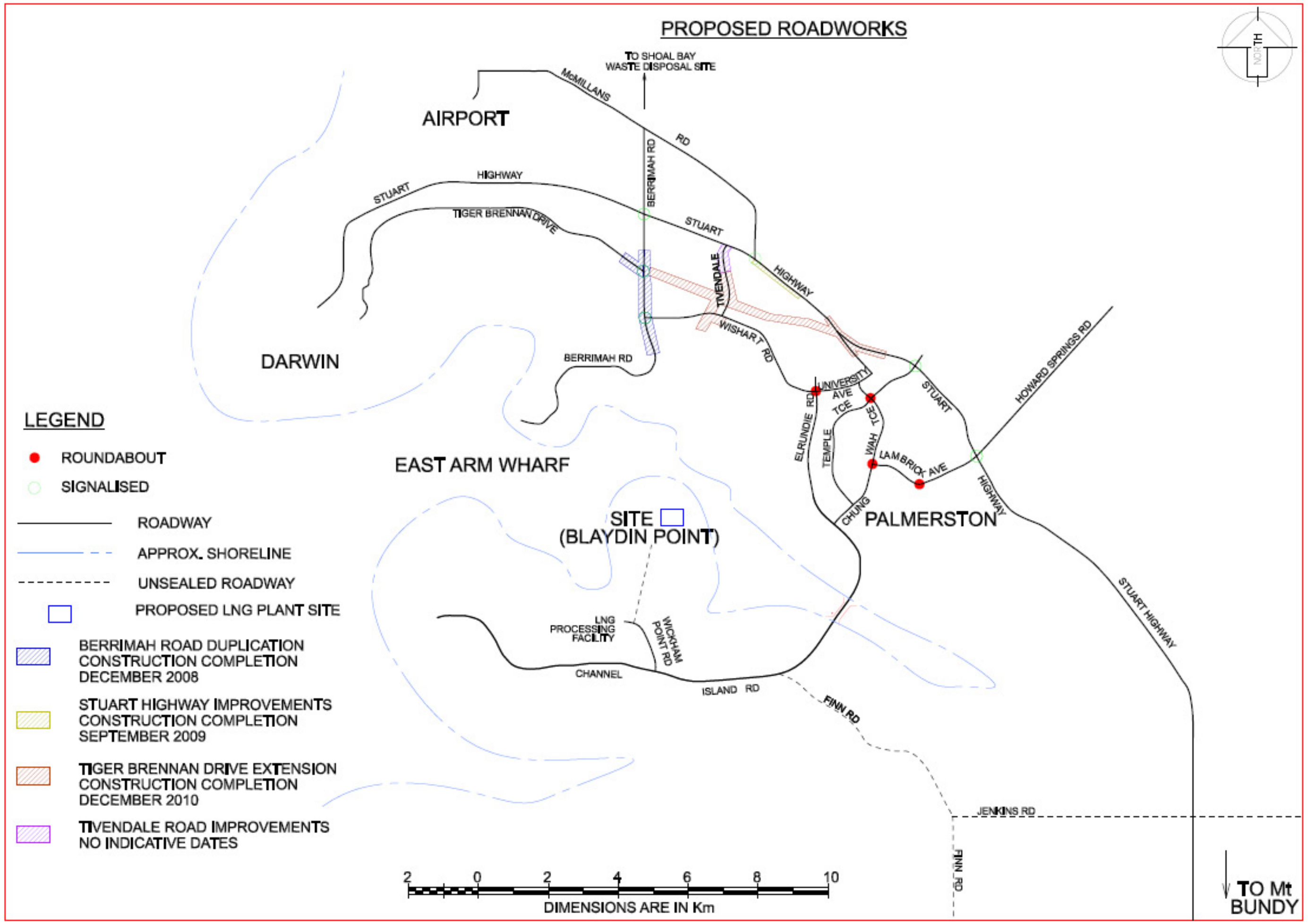
- Current construction works for the duplication of Berrimah Road including upgraded intersections at Tiger Brennan Drive and Wishart Road and widening of Tiger Brennan Drive to two lanes in each direction near the intersection: planned construction completion early 2009;
- The extension of Tiger Brennan Drive to the east from Berrimah Road, including construction of a new grade separated interchange at Stuart Highway: currently in conceptual planning stage with construction due for completion in 2010;
- Improvements to the inbound lanes of the Stuart Highway between Deviney Road and McMillans Road: planned completion 2009 dry season; and
- Realignment of Tivendale Road, with improved signalised intersections with Wishart Road, the new Tiger Brennan Drive and Stuart Highway: no proposed dates at present.

The locations of these roadworks are shown in Figure 3-1. Conceptual designs for the proposed Tiger Brennan Drive and Berrimah Road upgrades have been provided by Northern Territory DPI and are reproduced in Appendix A.

The impact of these proposed roadworks will depend on the timing of construction of both the roadworks and the proposed development.

It is anticipated that further roadworks will take place during the construction phase of the Project – however such information is unavailable at the time of this impact assessment. The basis for the traffic analysis used in this report is discussed in Sections 4 and 5.

Figure 3-1 Proposed Roadworks



3.4 Existing Road Accident Data (2003 to 2008)

Road accident data provided by Northern Territory DPI has been analysed along the routes proposed to be utilised by the traffic generated by the development. In order to provide a clear understanding of the road accident data, the analysis has been separated into two broad categories – accident data collected from intersections, and accident data collected within specified 'midblocks' (ie. sections of road between intersections). A standard analysis period of five years (2003 to 2008) has been adopted.

3.4.1 Intersections

The data for the following intersections have been analysed to determine what type of vehicle crash, the time of day it occurred and the severity of the accident:

- Elrundie Avenue / Wishart Road / University Avenue / Hedley Place;
- Berrimah Road / Wishart Road;
- Chung Wah Terrace / Lambrick Avenue;
- Elrundie Avenue / Chung Wah Terrace;
- Tiger Brennan Drive / Berrimah Road;
- Stuart Highway / Berrimah Road;
- Stuart Highway / Lambrick Avenue; and
- Stuart Highway / Temple Terrace.

Accident Type

Table 3-1 outlines the classification of the type of accidents at the intersections outlined above. The shaded cells indicate the most common type of accident to occur at the intersection. As can be clearly seen, the most common type of vehicle accident at nearly all intersections was either an Angle Collision or a Rear End. The Elrundie Avenue / Chung Wah Terrace T-intersection was the only intersection to go against this trend (with the most common accident being the vehicle running off the road) – however it should be noted that this intersection has very low accident data when compared to all others

Section 3 Existing Conditions

Table 3-1 Accident Type at Intersections (2003 to 2008)

	Total Accidents	Overturned	Fell Off Motorcycle	Ran Off Road	Hit Pedestrian	Hit Fixed Object	Hit Other Object	Hit Parked Vehicle	Angle Collision	Rear End	Head On	Side Swipe	Hit Cattle/Buffalo	Hit Horse/Camel	Hit Other Animal	Other Accident	Hit Light Pole	Hit Power Pole	Unknown
Elrundie Avenue / Wishart Road / University Avenue / Hedley Place	**18**	1	1	3		2	2		3	5	1								
Berrimah Road / Wishart Road	**22**	1		1		1			1	15		1				2			
Chung Wah Terrace / Lambrick Avenue	**22**		1	3			2		10		3	3							
Elrundie Avenue / Chung Wah Terrace	**3**			2					1										
Tiger Brennan Drive / Berrimah Road	**17**			5		1			3	8									
Stuart Highway / Berrimah Road	**24**	1	1			1			8	8		5							
Stuart Highway / Lambrick Avenue	**16**			1					7	6		2							
Stuart Highway / Temple Terrace	**24**			1			1		1	19							1		1

Source – Northern Territory Department of Infrastructure

Time of Accidents

The data for all intersections has been compiled into 3 hour intervals to determine whether the time of day (i.e. peak traffic periods) is relative to the number of accidents occurring. Table 3-2 has been split between AM and PM 3-hour intervals, with the shaded cells highlighting the most common interval for vehicle accidents to occur.

The table identifies that there is no clear relationship suggesting that the number of accidents increases in the morning and afternoon peak periods. However, the data does show that the majority of accidents occur between 6am and 9pm, with a notable reduction in the number of accidents between 9pm and 6am (with the 3am – 6am interval experiencing the least number of accidents).

Table 3-2 Accident Time at Intersections (2003 to 2008)

	Total Accidents	0:00 – 3:00	3:01 – 6:00	6:01 – 9:00	9:01 – 12:00	12:01 – 15:00	15:01 – 18:00	18:01 – 21:00	21:01 – 23:59
Elrundie Avenue / Wishart Road / University Avenue / Hedley Place	**18**	2	2	4		3	3	3	1
Berrimah Road / Wishart Road	**22**	2		8	1	2	7	1	1
Chung Wah Terrace / Lambrick Avenue	**22**	3		1	1	2	8	6	1
Elrundie Avenue / Chung Wah Terrace	**3**			1					2
Tiger Brennan Drive / Berrimah Road	**17**	2		3	1	4	6		1
Stuart Highway / Berrimah Road	**24**	1	1	3	4	7	5	3	
Stuart Highway / Lambrick Avenue	**16**		2	2	1	2	2	5	2
Stuart Highway / Temple Terrace	**24**	1		8	4	4	5	2	

Source – Northern Territory Department of Infrastructure

Severity of Accidents

The available data has identified that no fatal accidents have occurred at these intersections since 2003. The majority of classifications identified that either no injury was sustained in the accident, individuals suffered minor injuries that did not require treatment, or were otherwise treated at the accident location.

3.4.2 Midblocks

The data for the following 'midblock' sections have been analysed to determine what type of vehicle crash, the time of day it occurred and the accident and fatality rates of accidents:

- Channel Island Road
  - Whole length
- Elrundie Avenue
  - Whole length
- Chung Wah Terrace
  - Elrundie Avenue – Lambrick Avenue
  - Lambrick Avenue – University Avenue
- Lambrick Avenue
  - Whole length
- University Avenue
  - Elrundie Avenue – Chung Wah Terrace
  - Chung Wah Terrace – Stuart Highway
- Wishart Road
  - Tivendale Road – Elrundie Avenue
  - Tivendale Road – Berrimah Road
- Berrimah Road
  - Stuart Highway – Tiger Brennan Drive
  - Tiger Brennan Drive – Wishart Road
  - South of Wishart Road
- Tiger Brennan Drive
  - Amy Johnson Avenue – Berrimah Road
  - Woolner Road – Amy Johnson Avenue
  - McMinn Street – Woolner Road

- Stuart Highway
  - Goyder Road – Smith Street
  - Ross Smith Avenue – Goyder Road
  - Ross Smith Avenue – Bagot Road
  - Bagot Road – Amy Johnson Avenue
  - Amy Johnson Avenue – Vanderlin Drive
  - Vanderlin Drive – McMillans Road
  - McMillans Road – University Avenue
  - University Avenue – Lambrick Avenue

These midblocks are identified as being incorporated within the routes expected to be used by traffic generated by the development.

Each midblock identifies a length of the particular road between two major intersecting roads. Therefore, each midblock specified also incorporates minor intersections along its length. As such, data was separated between accidents occurring at these minor intersections from those that only occurred purely in a midblock location. This was done as the type of accident occurring at minor intersections was anticipated to be different to accident characteristics along midblock locations with no intersecting road.

Table 3-3 summarises the data for the specified midblocks and accident type and count has been separated between minor intersections and midblock.

Table 3-3(a) Road Accident Data at Midblocks (2003 to 2008)

	Channel Island Road	Elrundie Avenue	Chung Wah Terrace		Lambrick Avenue	University Avenue		Wishart Road	
	Whole length	Whole length	Elrundie Avenue – Lambrick Avenue	Lambrick Avenue – University Avenue	Whole length	Elrundie Avenue – Chung Wah Terrace	Chung Wah Terrace – Stuart Highway (via Roystonea)	Tivendale Road – Elrundie Avenue	Tivendale Road – Berrimah Road
Traffic Volume (vpd) – AADT	596	9241	1944	N/A	5470	N/A	N/A	12381	7065
Distance (km)	19	4.9	2.2	2.8	3.2	1.3	1.6	3.8	2.3
Total number of accidents	16	52	5	122	24	31	37	53	38
Accident Count – **Midblock**	14	13	3	30	10	10	2	18	38
Most common accident type (count) - **Midblock**	Ran off road (7)	Ran off road (7)	Overturned (1), Ran off road (1), Rear end (1)	Ran off road (15)	Side swipe (3)	Hit parked car (3)	Ran off road (1), Rear end (1)	Ran off road (7)	Rear end (22)
Accident Count – **Minor Intersections**	2	39	2	92	14	21	35	35	-
Most common accident type (count) – **Minor Intersections**	Ran off road (1), Rear end (1)	Angle collision (23)	Rear end (1), Other (1)	Angle collision (27)	Ran off road (5)	Ran off road (8)	Rear end (17)	Rear end (12)	-
AM interval with most accidents (number)	0601-0900 (3)	0601-0900 (12)	0301-0600 (1)	0601 – 0900 (15)	000 – 0300 (6)	000 – 0300 (5), 0901 – 1200 (5)	0601 – 0900 (7)	0601 – 0900 (16)	0601 – 0900 (16)
PM interval with most accidents (number)	2101-2359 (4)	1501 - 1800 (14)	1801 – 2100 (2)	1501 – 1800 (37)	1501 – 1800 (5), 1801 – 2100 (5)	1501 – 1800 (7)	1501 – 1800 (19)	1501 – 1800 (16)	1501 – 1800 (7)
Number of fatalities	3			2				3	1
Accident Rate per annum - TOTAL (accidents / million vehicle km)	**0.830**	**0.674**	**0.687**	**N/A**	**0.805**	**N/A**	**N/A**	**0.661**	**1.37**
Fatality Rate per annum – TOTAL (fatalities / million vehicle km)	0.156	0	0	N/A	0	N/A	N/A	0.037	0.036

Source – Northern Territory Department of Infrastructure

Table 3-3(b) Road Accident Data at Midblocks (2003 to 2008)

	Berrimah Road			Tiger Brennan Drive			Stuart Highway							
	Stuart Highway – Tiger Brennan Drive	Tiger Brennan Drive – Wishart Road	South of Wishart Road	Amy Johnson Avenue – Berrimah Road	Woolner Road – Amy Johnson Avenue	McMinn Street – Woolner Road	Smith Street – Goyder Road	Goyder Road – Ross Smith Avenue	Ross Smith Avenue – Bagot Road	Bagot Road – Amy Johnson Avenue	Amy Johnson Avenue – Vanderlin Drive	Vanderlin Drive – McMillans Road	McMillans Road – Roystonea Avenue	Roystonea Avenue – Lambrick Avenue
Traffic Volume (vpd) – AADT	9963	12790	3481	7658	11336	16823	24564	N/A	18194	19312	24452	25554	N/A	15971
Distance (km)	1.8	1.3	5.6	3.5	5.7	2.5	2.4	1.0	0.94	5.6	1.8	3.4	4.0	5.4
Total number of accidents	23	8	15	42	93	73	275	140	52	180	29	112	89	162
Accident Count - **MIDBLOCK**	9	8	14	16	40	23	110	57	12	59	11	49	28	91
Most common accident type (count) - **MIDBLOCK**	Rear end (3)	Ran off road (2), Angle collision (2)	Overturned (4)	Ran off road (4)	Rear end (13)	Ran off road (9)	Rear end (40)	Rear end (24)	Rear end (7)	Rear end (21)	Rear end (10)	Rear end (16)	Rear end (16)	Rear end (51)
Accident Count – **Minor Intersections**	14	-	1	26	53	50	165	83	40	121	18	63	61	71
Most common accident type (count) – **Minor Intersections**	Angle collision (5)	-	Fell off motorcycle (1)	Rear end (10)	Rear end (25)	Angle collision (18)	Rear end (57)	Rear end (67)	Rear end (20)	Rear end (60)	Rear end (7)	Rear end (27)	Rear end (34)	Rear end (40)
AM interval with most accidents (number)	0901 – 1200 (3)	000 – 300 (3)	0301 – 0600 (3)	0601 – 0900 (7)	0601 – 0900 (22)	0601 – 0900 (9)	0601 – 0900 (45)	0601 – 0900 (21)	000 – 0300 (9)	0901 – 1200 (31)	0601 – 0900 (4)	0601 – 0900 (20)	0601 – 0900 (22)	0601 – 0900 (52)
PM interval with most accidents (number)	1201 – 1500 (8)	1201 - 1500 (2)	1501 – 1800 (5)	1501 – 1800 (11)	1501 – 1800 (29)	1501 – 1800 (22)	1501 – 1800 (57)	1501 – 1800 (38)	1501 – 1800 (16)	1501 – 1800 (53)	1501 – 1800 (13)	1501 – 1800 (34)	1501 – 1800 (27)	1501 – 1800 (43)
Number of fatalities					2	4	4	2	1	1			3	
Accident Rate per annum - TOTAL (accidents / million vehicle km)	**0.753**	**0.282**	**0.452**	**0.920**	**0.845**	**1.02**	**2.74**	**N/A**	**1.79**	**0.977**	**0.387**	**0.757**	**N/A**	**1.10**
Fatality Rate per annum – TOTAL (fatalities / million vehicle km)	0	0	0	0	0.018	0.056	0.040	N/A	0.034	0.005	0	0	N/A	0

Source – Northern Territory Department of Infrastructure

Stuart Highway

The analysis of accident data clearly illustrates a higher number of accidents along Stuart Highway both at midblock locations and at minor intersections compared with the other sites analysed. The most common type of accident recording for all lengths along Stuart Highway was identified as Rear End. The AM interval with most accidents occurring was mainly 6am – 9am, and the PM interval being 3pm – 6pm (both reflecting the anticipated AM and PM peak periods).

Stuart Highway carries a significantly larger amount of traffic volume when compared to all other midblocks analysed, however some sections also reflect the highest accident rates. In particular, Smith Street – Goyder Road, Ross Smith Avenue – Bagot Road and Roystonea Avenue – Lambrick Avenue where each respective accident rate per annum was 2.74, 1.79 and 1.10 accidents / million vehicle km since 2003. These values reflect three out of the top four accident rates identified from all midblocks analysed suggesting that Stuart Highway still experiences more accidents even though volumes for each road length has been taken into account.

The highest fatality per annum rate along Stuart Highway was 0.040 fatalities / million vehicle km. These fatality rates reflect a much lower value than those analysed at other locations.

Midblocks around Palmerston

The midblocks categorised within Palmerston are along Channel Island Road, Elrundie Avenue, Chung Wah Terrace, Lambrick Avenue and University Avenue.

Channel Island Road is the longest midblock analysed and has the lowest traffic volume and produces a comparable accident rate per annum (0.830 accidents / million vehicle km) in respect to all roads analysed. However, this 19 km section of road has the highest fatality rate. In the period 2003 to 2008 there were a total of 16 accidents which included 3 fatalities, resulting in the highest fatality rate analysed at 0.156 fatalities / million vehicle km per annum compared with an overall average of 0.021 for the roads analysed. Furthermore, 25% of all accidents recorded occurred between 9pm and midnight – the only midblock to record this as the PM interval with highest number of accidents.

Elrundie Avenue has a relatively low accident rate with no fatalities recorded in the period 2003-2008. Elrundie Avenue incorporates many intersecting roads, and therefore the majority of accidents at minor intersections being Angle Collisions, with midblock accidents being mainly Ran Off Road.

Chung Wah Terrace (Elrundie Avenue – Lambrick Avenue) records the lowest number of accidents with no fatalities. Due to the small sample size it is difficult to find any accident relationship within this midblock.

The midblock analysis for Lambrick Avenue was the only section to have Side Swipe as the most common accident type. Furthermore, the most common accident type at minor intersections was Ran Off Road. The accident rate is around average for all lengths analysed and Lambrick Avenue has no recorded fatalities since 2003.

It should be noted that insufficient AADT traffic volume data was available for Chung Wah Terrace (Lambrick Avenue – University Avenue) and along the entire length of University Avenue to produce accident and fatality rates for these midblock lengths.

Midblocks around Berrimah

Wishart Road, Berrimah Road and Tiger Brennan Drive were included in the analysis within the Berrimah region.

Accident rates along all three analysed midblocks for Berrimah Road are relatively low with zero fatalities recorded since 2003 – despite a significant amount of traffic between Stuart Highway and Wishart Road. Berrimah Road, south of Wishart Road, mainly provides access to the East Arm Wharf, however the most common midblock accident type was Overturned.

The AM and PM intervals with the most accidents occurring for both midblocks along Wishart Road were between 6am – 9am and 3pm – 6pm. This is the same result as Stuart Highway and coincides with the peak periods during the morning and afternoon. The most common accident type for the midblocks between Tivendale Road and Berrimah Road was Rear End. This may be reflective of the long queue lengths currently being experienced from the Berrimah Road / Wishart intersection. Current upgrades to this intersection may result in a reduction in the number of Rear End accidents in future years.

Tiger Brennan Drive acts as an alternate route to Stuart Highway for east-west movements and as such carries a significantly larger amount of traffic than most other midblocks within the Palmerston and Berrimah categories. As a result, the AM and PM intervals with accidents most commonly occurring are equivalent to those of Stuart Highway reflecting the peak morning and afternoon traffic movements (6am – 9am, 3pm – 6pm). Accident rates between Berrimah Road and Woolner Road are average when compared to all others analysed, however the section between McMinn Street and Woolner Road has a slightly higher accident rate of 1.02 accidents / million vehicle km per annum as well as the second highest fatality rate analysed – 0.056 fatalities / million vehicle km per annum.

The impact of the INPEX development on road safety is assessed in Section 5.7 of this report.

Traffic Volume   Section 4

This section provides existing traffic volumes and forecasts of future traffic volumes during the construction and operational phases of the proposed development.

4.1 Existing Traffic Volumes and Data

Existing daily and AM and PM peak hour traffic volumes have been determined from a number of sources, from data provided by the Northern Territory DPI and TAMS. An extensive array of vehicle classification and traffic count data (in 15 minute intervals) of the surrounding road network were made available in order to determine general background traffic volumes. Signalised intersection plans, historical road accident data and plans of the Tiger Brennan Drive extension were also forwarded from the Northern Territory Government and were incorporated into the traffic impact assessment.

Surveys were conducted for URS by TAMS from September 23rd to September 25th 2008, to determine turning movement characteristics and vehicle classification. These surveys recorded data between the hours of 7:00am and 9:00am and between 4:00pm and 6:00pm. Weather for both of these days was noted as fine, and the survey was conducted during the normal school term.

Surveys were conducted at the following locations:

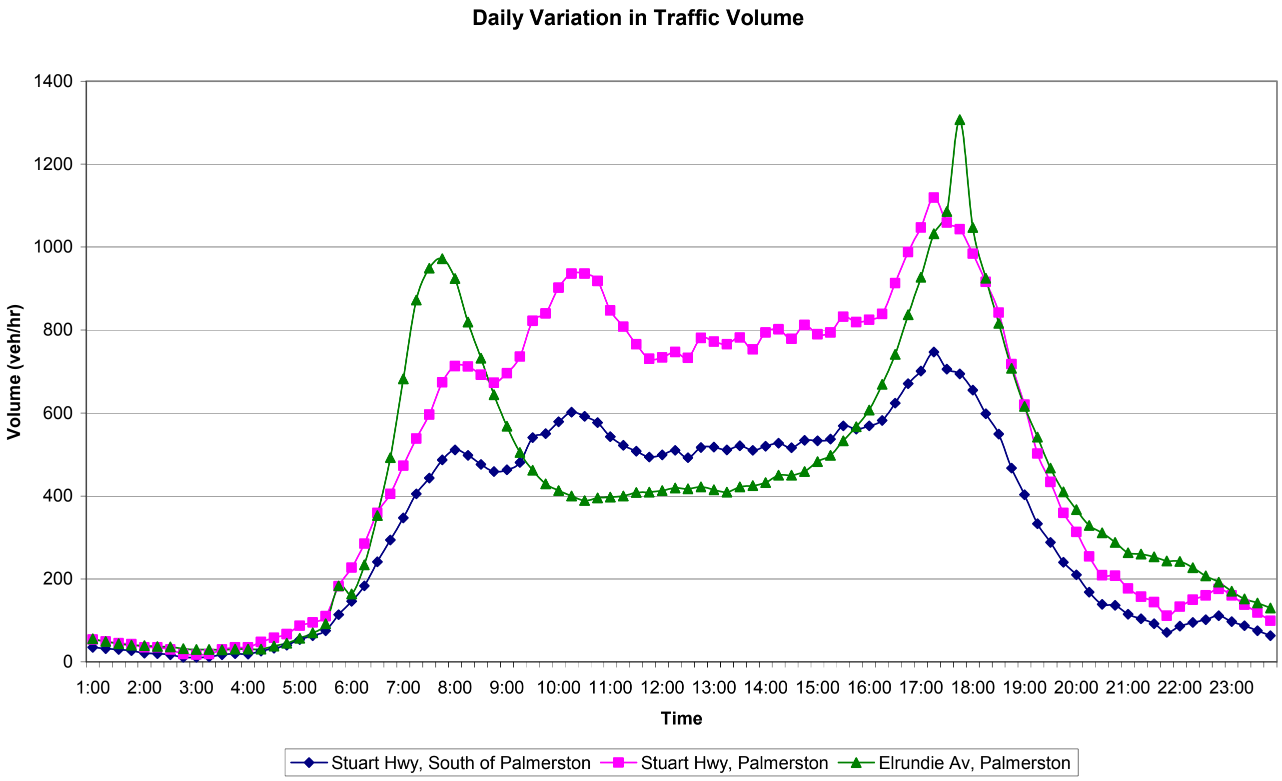
- Stuart Highway / Berrimah Road;
- Stuart Highway / Temple Terrace;
- Stuart Highway / Lambrick Avenue;
- Berrimah Road / Wishart Road;
- Elrundie Avenue / Wishart Road / University Avenue / Hedley Place;
- Elrundie Avenue / Chung Wah Terrace;
- Channel Island Road / Wickham Point Road; and
- Stuart Highway / Jenkins Road.

Data collected during these surveys was combined with traffic count data provided by the Northern Territory DPI to provide turning movement volumes at each intersection.

Table 5.1 shows the AM and PM peak hours for each intersection. From this, it is clear that the morning peak is observed to be between 7.15am and 8.15am for all intersections except one where it is observed as 7.00am – 8.00am. The PM peak was observed to be between the hours of 4.30pm/4.45pm to 5.30pm/5.45pm respectively with a couple of exceptions outside this range (refer table 5.1). In spite of the slight variance in peak times, 7.15am - 8.15am and 4.30pm – 5.30pm were determined to be appropriate for analysis and design purposes. This is because the turning movement survey data was required to be integrated and assessed against the historical traffic data as a consistent data set. These periods were therefore adopted for the traffic engineering analysis of the road network operation and performance.

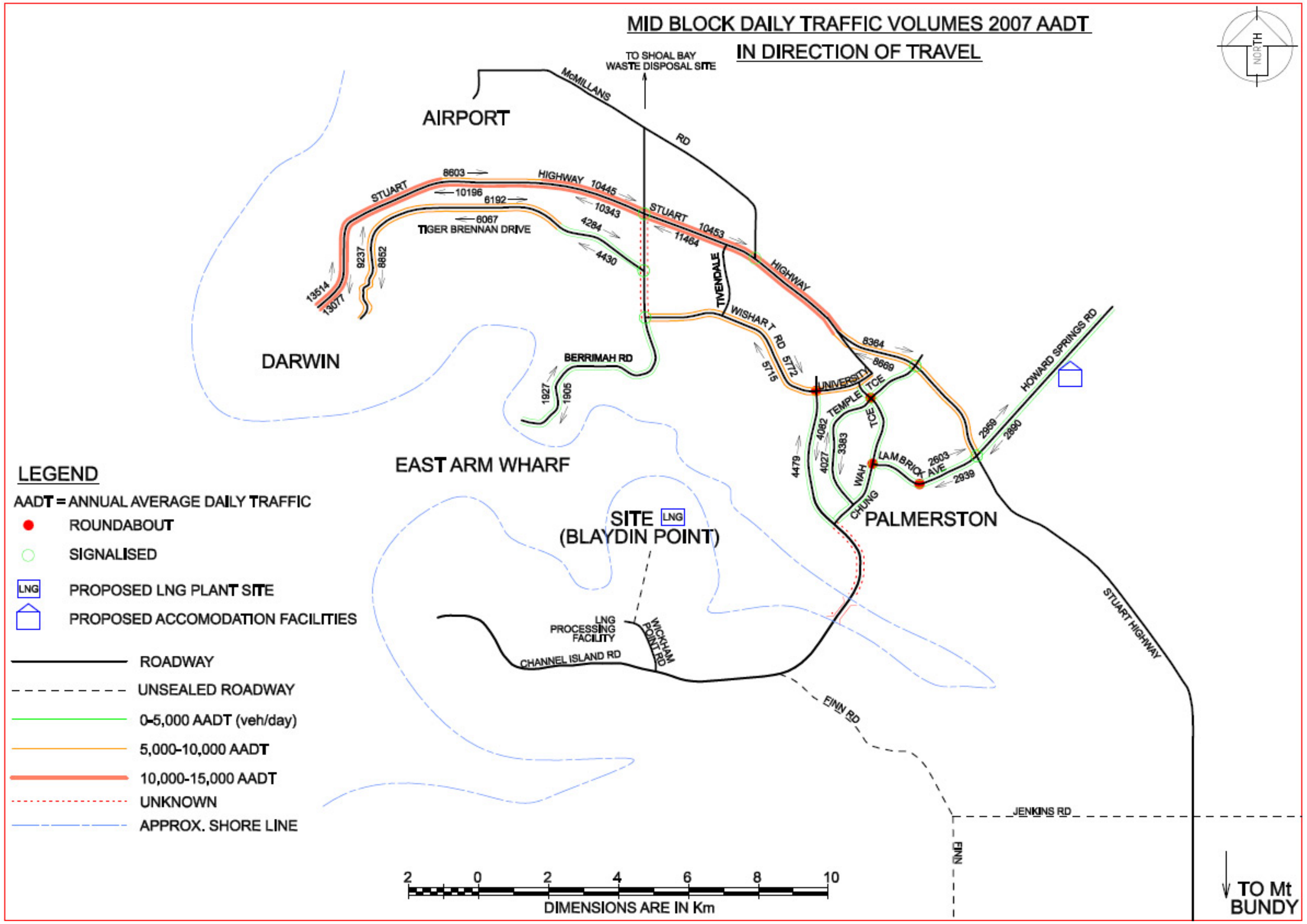
The daily variation in traffic flow varies across the network, but can be illustrated using a sample of locations to show general trends. Figure 4-1 shows the daily traffic flow at three locations, two on Stuart Highway and one on Elrundie Avenue. The figure shows that Elrundie Avenue has two distinct peak periods, in the morning (approximately 7:30am-8:30am) and afternoon (approximately 5:00pm-6:00pm). Stuart Highway also has two peak periods, but shows less variance than Elrundie Avenue. This can be attributed to the different function of the roads, Elrundie primarily servicing commuter traffic, while Stuart Highway is used consistently by a range of different traffic. Other roads in Darwin fall into one of these two categories and exhibit similar traffic variation characteristics to these examples.

Figure 4-1 Daily Variation in Two Way Traffic Volume



Existing midblock daily traffic volumes are shown in Figure 4-2 while Figure 4-3 and Figure 4-4 show the AM (7:15am – 8:15am) and PM peak hour (4:30pm – 5:30pm) turning movement volumes at intersections, including the percentage of commercial vehicles.

Figure 4-2 Midblock Daily Traffic Volumes



Section 4 Traffic Volume

Figure 4-3 AM Peak (7:15am – 8:15am) Turning Movement Volumes 2008

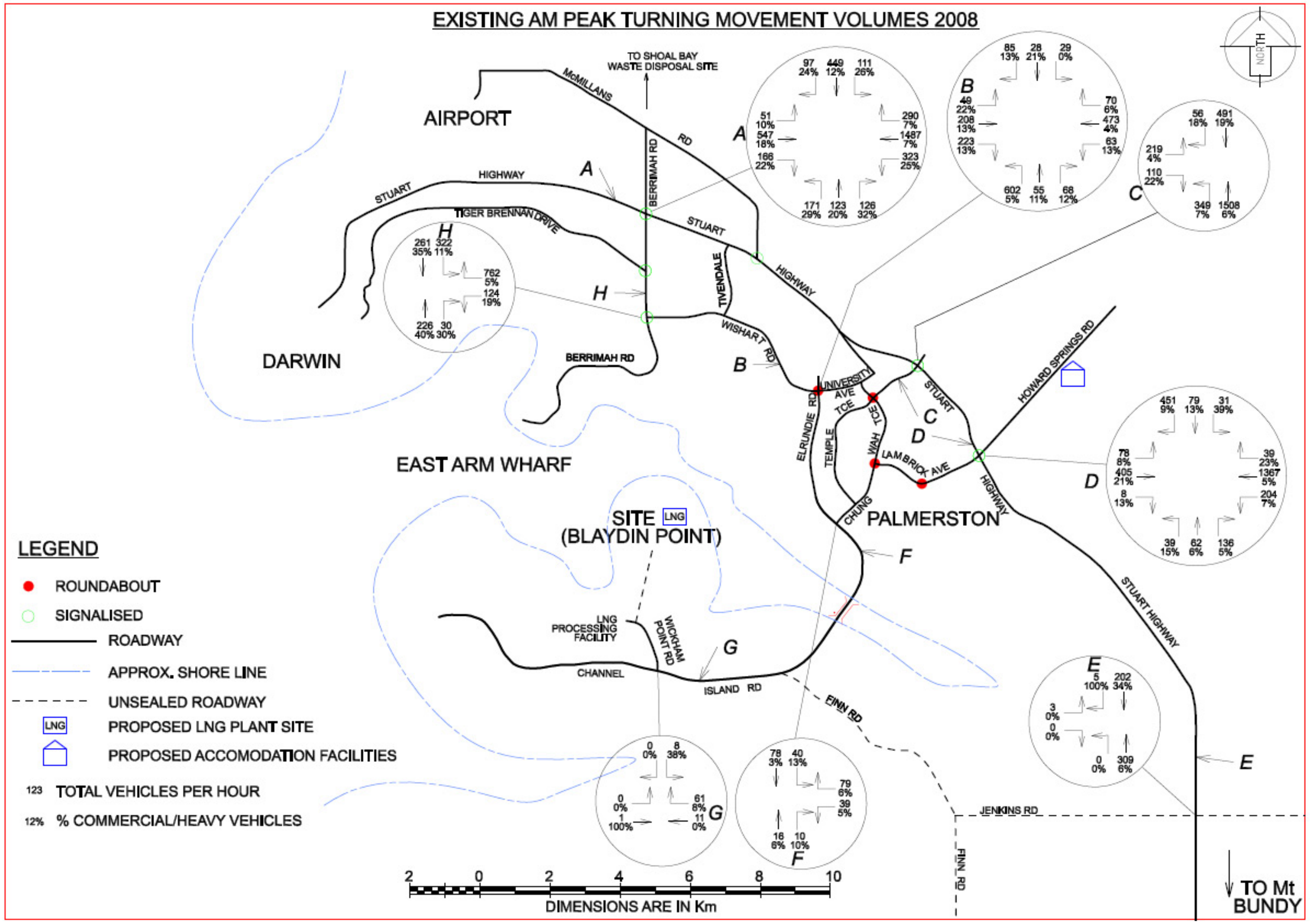
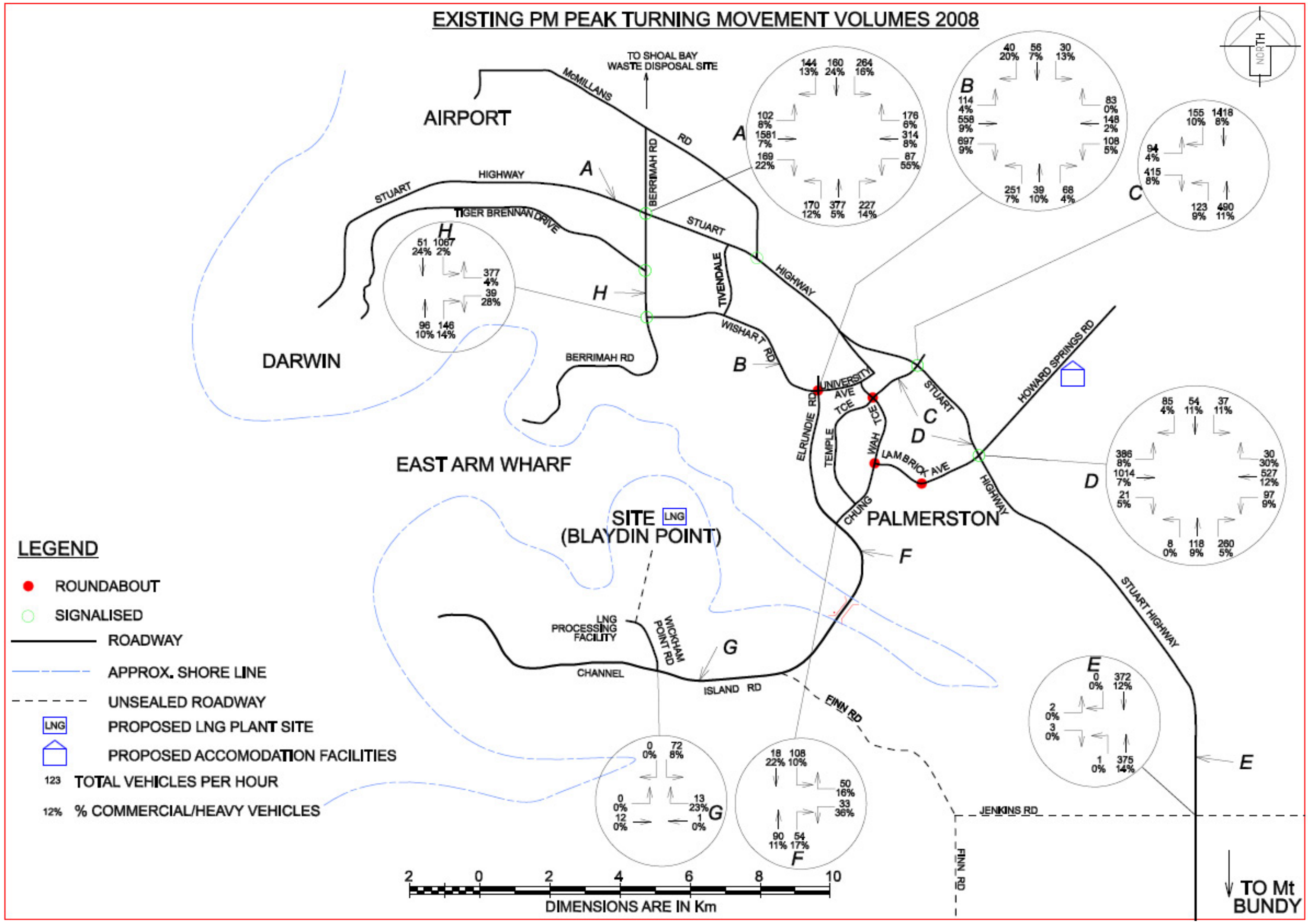


Figure 4-4 PM Peak (4:30pm – 5:30pm) Turning Movement Volumes 2008



4.2 Traffic Generation for Proposed Development

INPEX supplied information to URS regarding the expected road network traffic volumes generated from the construction and operation of the LNG processing plant. Information supplied included an outline of the anticipated traffic volumes associated with employees and construction vehicles. A list of proposed rock quarry sites was also provided as a basis for determining routes for vehicles transporting quarry material.

4.2.1 Construction Traffic

INPEX has provided data showing the predicted traffic generated as a result of the construction of the LNG processing plant. The data is based on the current status of the design using the full module concept where pre-assembled modules are transported by marine vessel to site for erection. It is expected that a small amount of materials and equipment will be transported to site by overland vehicles. Traffic volumes are preliminary estimates due to the lack of detailed data available at this stage in the project.

A summary of the traffic volumes generated by construction activity as provided by INPEX is shown in Table 4-1.

It should be noted that these are average daily volumes that have been calculated using the total estimated number of traffic movements, averaged over 30% of the predicted sixty eight month construction timeline. This method reflects a peak period of construction of approximately twenty months. As previously stated, for the purposes of this analyses, peak is anticipated in 2013.

Impacts of specific scheduling of activities have not been considered and will vary depending on the length of time require to complete each task. For this assessment all activities are assumed to occur concurrently and over the whole construction period, which has been assumed to peak in 2013 for the purposes of the analysis.

Table 4-1 Summary of Traffic Volumes – Construction

Assumed average daily traffic generated at the peak of construction					
Origin	**Destination**	**Activity**	**Mode**	**Vehicle Type**	**No. Round Trips/Day**
Blaydin Point	Shoal Bay Waste Facility	Construction waste, domestic waste and recyclables, green waste and hazardous materials	Road	Commercial Vehicles	30
Blaydin Point	Shoal Bay Waste Facility	Excavation Spoil	Road	Commercial Vehicles	80
Darwin	Blaydin Point	Raw materials, fabricated materials, equipment, consumables, tools, personnel	Road	Commercial Vehicles, Buses, Cars	170
East Arm	Blaydin Point	Fuel, marine materials	Road	Commercial Vehicles	74
East Arm	Darwin	Marine materials	Road	Commercial Vehicles	2
Mt Bundy	Blaydin Point	Rock armour and aggregate	Road	Commercial Vehicles	60
Mt Bundy	East Arm	Rock armour and aggregate	Road	Commercial Vehicles	102
Mt Bundy quarry	Shore Crossing location	Rock armouring for stabilisation of the shore-crossing location	Road	Commercial Vehicles	3
Accommodation Facilities	Blaydin Point	Personnel	Road	Buses Cars	100 125
Accommodation Facilities	Shoal Bay Waste Facility	Waste removal	Road	Commercial Vehicles	2

Note that the volumes shown above are primarily commercial vehicles numbers (buses and B-doubles) with the exception of 100 cars included in the Darwin-Blaydin Point route and 125 cars for the accommodation facilities to site route.

URS understands that these numbers have been generated based on the materials required for construction and the number of personnel working on site.

For the purposes of this study, the data provided has been rounded up to the nearest whole trip and all activities are assumed to be operating concurrently to produce the worst case scenario.

As the specific duration and start/finish times of shifts have not been determined, it has been assumed that all movements of personnel will take place during the AM and PM peak hours. This will produce a worst-case scenario in the event that shifts commence 7:00am – 8:15am and conclude 4:00pm – 5:45pm (these are the peak hours outlined in Section 5.2).

On advice from INPEX, it has been assumed that a bussing program will be in place for employees housed in the accommodation facilities. The majority of employees will travel between the site and accommodation facilities via buses provided by INPEX, with some travelling by car to and from site. During the peak hour periods however it is expected that a number of cars will be generated by the accommodation facilities as a handful of employees will need to access a personal motor vehicle.

The calculation of construction vehicle traffic (excluding personnel transport movements) has been approximated at 7% of the total vehicles per day for each of the peak hour periods. Further explanation of the construction vehicle volume assumptions can be found in Sections 4.4.2 and 5.

4.2.2 Operation

The ongoing operation of the LNG processing plant will generate significantly less traffic than the construction phase of the project. The primary traffic generated by the operational phase will be cars from employee commuting. This traffic is accounted for in future predictions in general traffic growth for the Darwin region, as these predictions include growth in commerce and industry.

For this reason, operational traffic is not analysed in depth and is considered to have a negligible effect when compared to construction traffic. That is, if the road network operates acceptably during construction, it is assumed that it will also operate acceptably after operation commences. It is assumed that operation will commence in 2015.

4.3 Traffic Distribution

For impact assessment, it is assumed that all generated traffic will use the existing road network. Routes have been assigned to each origin-destination trip as described below. Round trips are assumed to use the same route in reverse.

For the worst case scenario, it has been assumed that extension of Tiger Brennan Drive planned for 2010 will not be available. Additionally, it is assumed that no road-trains will be used and the use of unsealed roads is avoided due to maintenance and weather issues.

All routes are assumed to be for B-doubles, with the exception of buses for personnel movements between the site and the accommodation facilities. Over dimension vehicles are not considered here and are detailed in section 7.2.

The traffic routes described below are shown in figures B1 to B10 in Appendix B.

Blaydin Point – Shoal Bay Waste Facility (Figure B1)

Traffic will exit the site via Channel Island Road, continue along the road and turn left at the Elrundie Avenue / Wishart Road / Hedley Place / University Avenue roundabout and continue along Wishart Road. Traffic will follow Wishart Road, turn right at the Berrimah Road / Wishart Road T-intersection and continue along Berrimah Road, crossing Stuart Highway. Berrimah Road turns into Vanderlin Drive on the northern side of Stuart Highway and traffic will continue along this road, crossing McMillans Road where it will turn right into the Shoal Bay Recycling Centre driveway.

This route has been selected as it is the most direct and efficient between origin and destination for commercial vehicles.

Darwin CBD – Blaydin Point (Figure B2)

Traffic will exit Darwin using the Stuart Highway and head east to the intersection with Berrimah Road. The route then turns right onto Berrimah Road, then left onto Wishart Road. At the roundabout intersection with Elrundie Avenue the route turns right. Continue along Elrundie Avenue, which will change into Channel Island Road, continue along Channel Island Road, the route takes a right turn at Wickham Point Road to the site on Blaydin Point.

Although Tiger Brennan Drive provides an alternate, more direct route to Berrimah Road from Darwin CBD, the Stuart Highway has be assigned to this route as it is a major arterial road and is more suitable for commercial vehicles. The Highway has greater capacity than Tiger Brennan Drive.

East Arm Wharf – Blaydin Point (Figure B3)

Traffic will exit East Arm Wharf and head north on Berrimah Road, the route takes a right turn at Wishart Road and then right again at the roundabout intersection with Elrundie Avenue, which will change into Channel Island Road, the route takes a turn right at Wickham Point Road to the site on Blaydin Point.

East Arm Wharf – Darwin CBD (Figure B4)

Traffic will exit the East Arm Wharf and head north on Berrimah Road, the route takes a left turn onto the Stuart Highway which leads directly to Darwin CBD. Although Tiger Brennan Drive provides an alternate, route to Darwin from Berrimah Road, the Stuart Highway has be assigned to this route as it is a major arterial road and is more suitable for commercial vehicles.

Mt Bundy – Blaydin Point (Figure B5)

Mt Bundy lies to the south of the Darwin Region along the Arnhem Highway. The most efficient route (using sealed roads) between the sites is to head north from Mt Bundy, turning right at Stuart Highway, and then turn left off the Stuart Highway at Lambrick Avenue. At the end of Lambrick Avenue the route takes a left onto Chung Wah Terrace followed by another left onto Channel Island Road which will take traffic directly to the site.

Mt Bundy – East Arm Wharf (Figure B6)

The Stuart and Arnhem Highways connect Mt Bundy to the Darwin Region and a left turn at the Stuart Highway / Berrimah Road provides direct access to the East Arm Point.

Blaydin Point to Accommodation Facilities (Figure B7)

Exit Blaydin Point site travelling south and turn left onto Channel Island Road. Follow Channel Island Road until it intersects with Chung Wah Terrace and turn right. Continue along Chung Wah Terrace and turn right at the roundabout where it intersects Lambrick Avenue. Follow Lambrick Avenue over Stuart Highway where it continues as Howard Springs Road. Access to the accommodation facilities will be via a new intersection with Howard Springs Road.

Palmerston – Darwin CBD (Figure B8)

A number of routes exist for travel between Palmerston and Darwin. However, in order to determine the worst case scenario for traffic impact, the route assigned also carries the majority of other generated traffic. From Palmerston, the route heads west along Wishart Road, then right on to Berrimah Road, then left onto Stuart Highway.

4.4 Future Traffic Volumes

4.4.1 Background Volume

Increases in traffic volumes until both 2013 and 2015 have been estimated based on historical traffic data between 1998 and 2007 to produce a three, five and nine year average in vehicle volume growth. These two future years were analysed since 2013 is the assumed peak of construction (refer section 4.2.1 Construction Traffic) and 2015 is the estimated date of completion for the construction period, and the commencement of the operation period (refer section 4.2.2 Operation). These figures were analysed for the areas of Darwin, Berrimah and Palmerston as each region is anticipated to have different population growths until 2015.

Section 4 Traffic Volume

Population growth is expected to generate additional traffic in Darwin and its surrounding areas. Historical traffic data between 1998 and 2007 was analysed to determine the recent increase in traffic for the Darwin, Berrimah and Palmerston regions. The calculated average over the nine year period was found to be conservative, so a three and five year average was calculated to reflect more accurately the recent development occurring – particularly in the Berrimah and Palmerston regions. The two growth rates were found to be nearly equivalent at each of the sites, with the three year growth rate producing a slightly higher value. As such, the three year growth rates for Darwin (2.20%pa), Berrimah (2.99%pa) and Palmerston (4.39%pa) were used to approximate the anticipated traffic volumes for 2015. The higher growth rates were used as it is anticipated that industry, investment and population growth in Palmerston and the Darwin region will rise in the future.

These growth rates are summarised in Table 4-2 below.

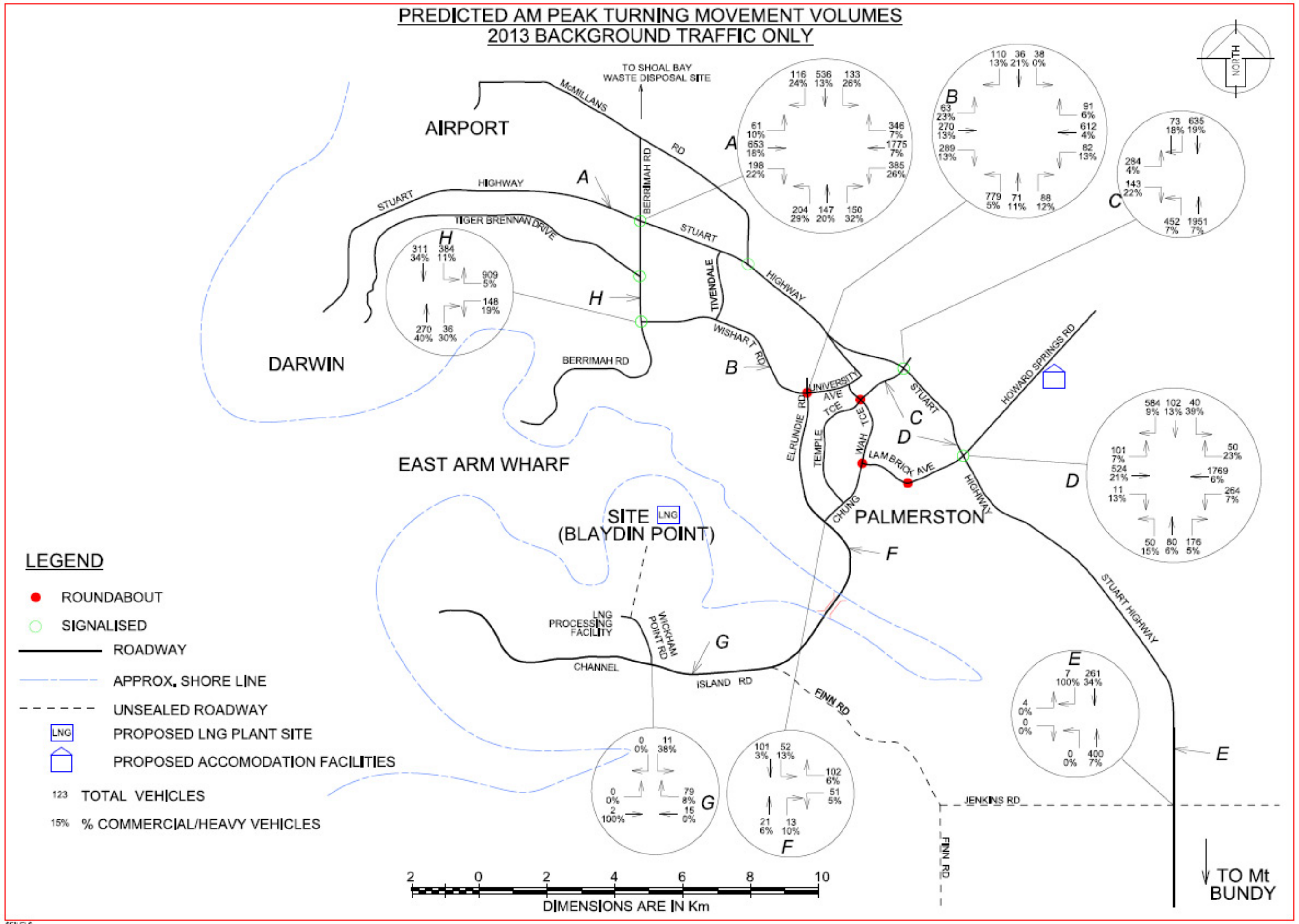
Table 4-2 Traffic Growth Rates

Area	Darwin	Berrimah	Palmerston
Nine Year Historical Average (%pa)	0.75%	1.01%	2.20%
Five Year Historical Average (%pa)	2.24%	2.91%	3.73%
Three Year Historical Average (%pa)	2.20%	2.99%	4.39%
2008 to 2015 Adopted Growth Rate (%pa)	**2.20%**	**2.99%**	**4.39%**

Using each area's respective growth rates will illustrate more accurately the demand on each individual intersection as growth in the satellite regions of Darwin (i.e. Berrimah and Palmerston) are significantly higher than Darwin.

Figures 4-5 and 4-6 outline the 2013 and 2015 forecast future background traffic volumes during the AM (7:15am to 8:15am) and PM (4:30pm to 5:30pm) peak hours respectively. It is estimated that 2015 is the date of completion for the construction period, and the commencement of the operation period and as such, background traffic has been analysed for that year.

Figure 4-5 AM Peak Traffic Volume – Background Traffic



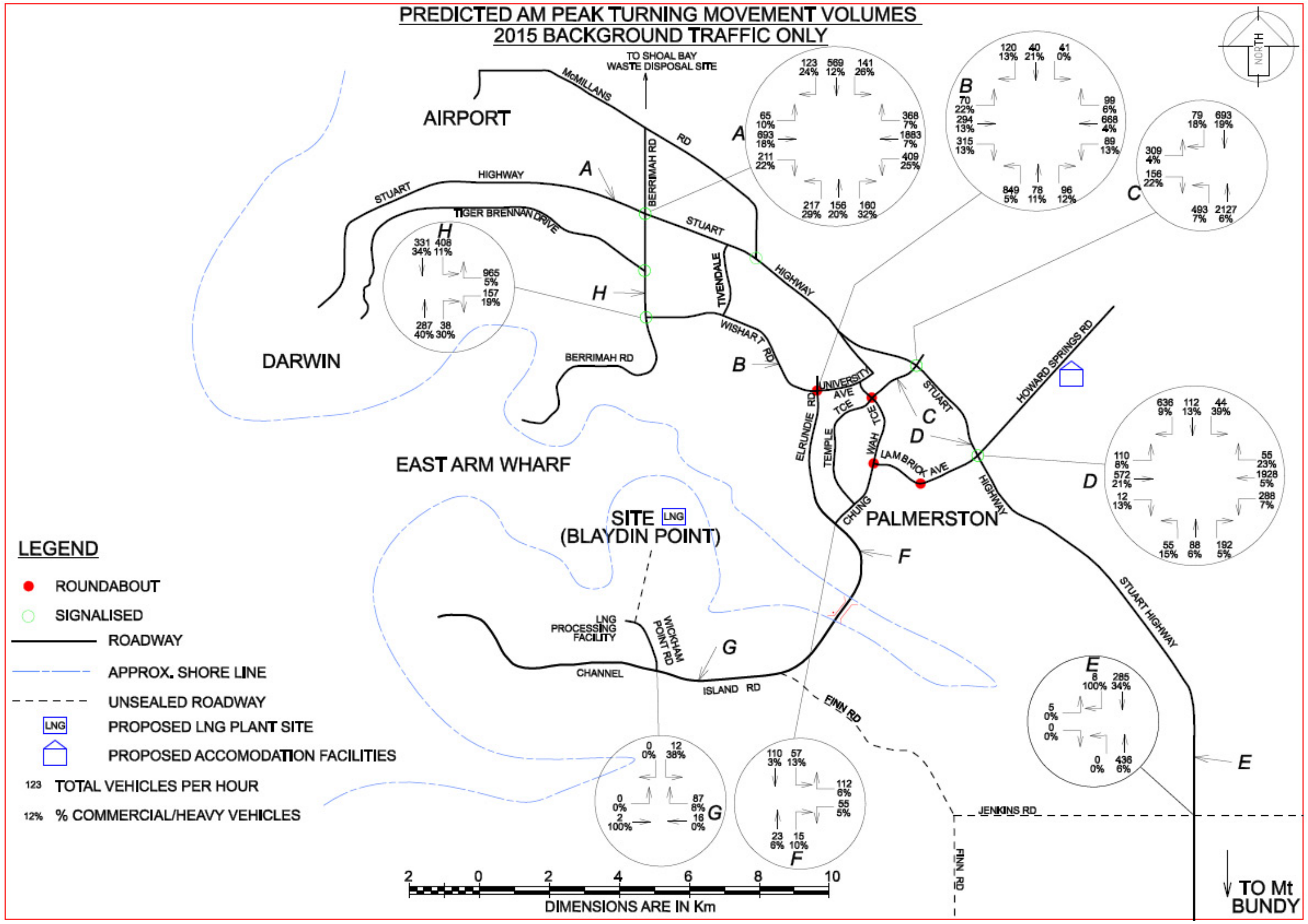
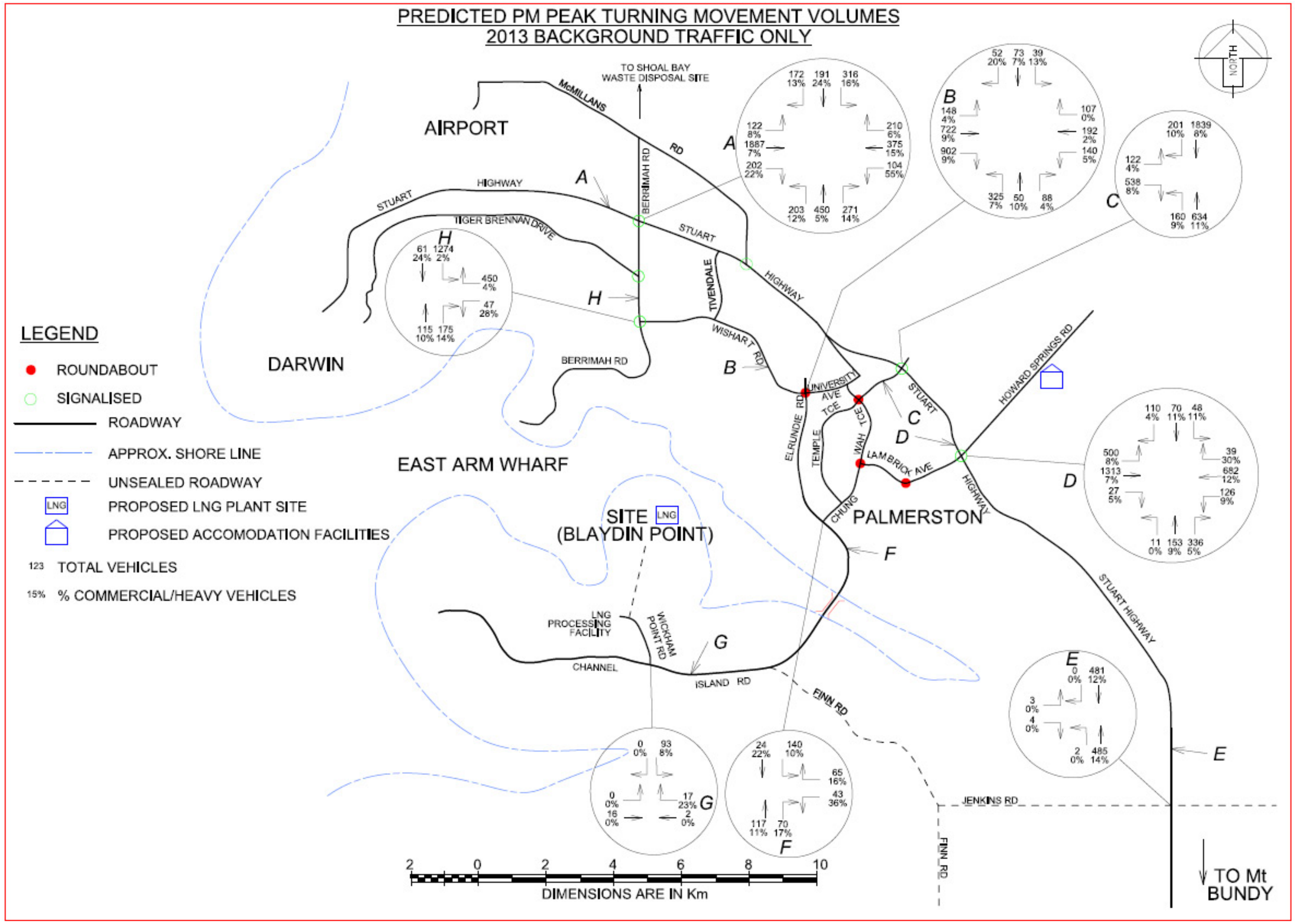
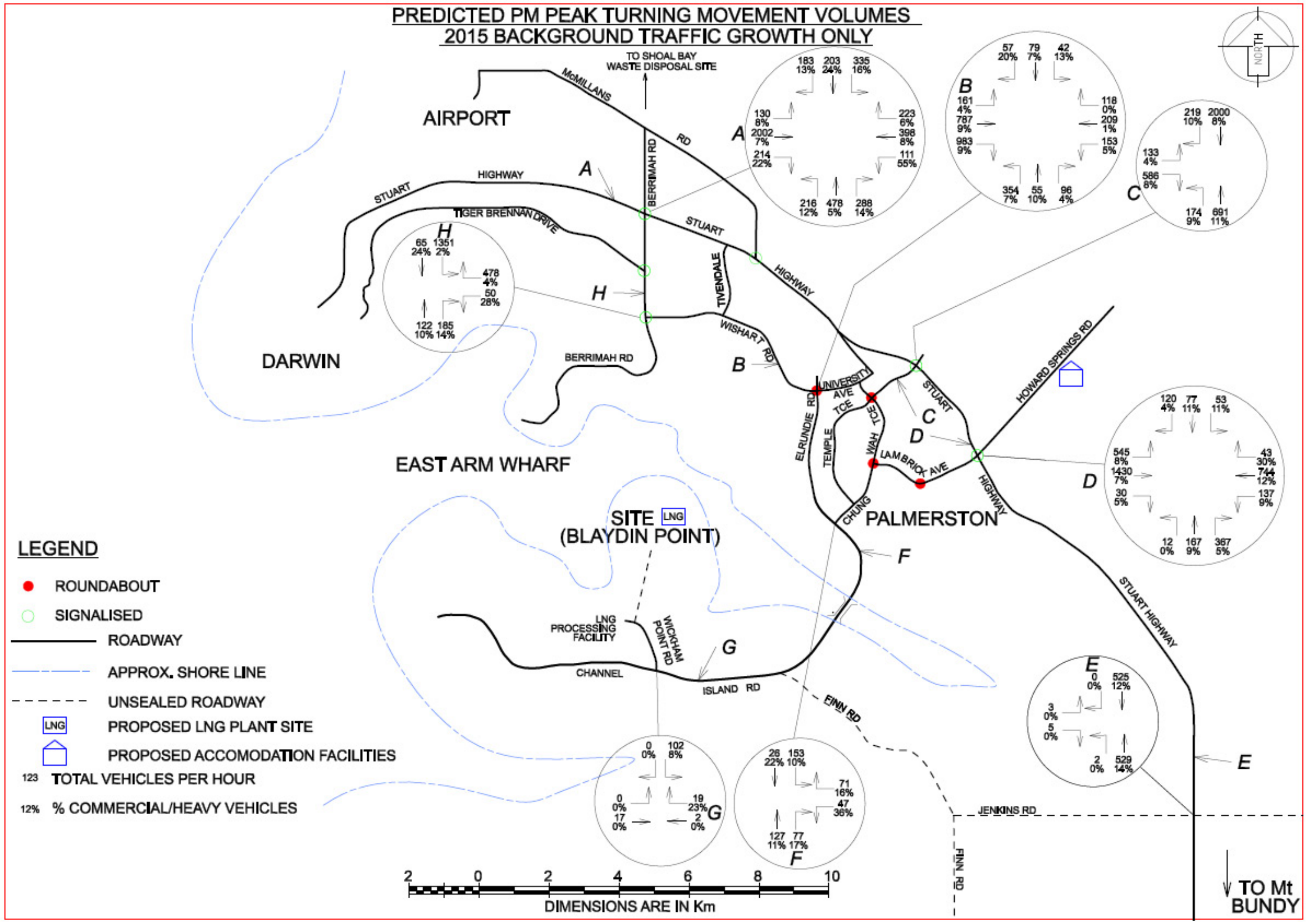

PREDICTED AM PEAK TURNING MOVEMENT VOLUMES
2015 BACKGROUND TRAFFIC ONLY
NORTH
TO SHOAL BAY WASTE DISPOSAL SITE
AIRPORT
DARWIN
EAST ARM WHARF
PALMERSTON
SITE (BLAYDIN POINT)
LNG PROCESSING FACILITY
McMILLANS RD
BERRIMAH RD
STUART HIGHWAY
TIGER BRENNAN DRIVE
TIVENDALE
WISHART RD
UNIVERSITY AVE
TEMPLE TCE
WAH TCE
ELRUNDIE RD
LAMBRICK AVE
CHUNG
HOWARD SPRINGS RD
WICKHAM POINT RD
CHANNEL ISLAND RD
FINN RD
JENKINS RD
TO Mt BUNDY
LEGEND
ROUNDABOUT
SIGNALISED
ROADWAY
APPROX. SHORE LINE
UNSEALED ROADWAY
PROPOSED LNG PLANT SITE
PROPOSED ACCOMODATION FACILITIES
123 TOTAL VEHICLES PER HOUR
12% % COMMERCIAL/HEAVY VEHICLES
DIMENSIONS ARE IN Km

Figure 4-6 PM Peak Traffic Volume – Background Traffic



Section 4 Traffic Volume



4.4.2 Generated Traffic

From the routes described in section 4.3, and the peak hour trips generated by the development described in 4.2.1, the peak hour turning movement volumes at the key intersections on the road network can be determined, showing traffic generated by the construction of the development.

For the purposes of this analysis, the generated vehicle movements include all construction related traffic including cars, commercial vehicles (trucks) and personnel transportation movements (buses and cars). Personnel transportation movements indicate the 50 bus round trips and 125 single car trips (based on table 4.1) anticipated for each peak hour period in order to transport personnel from the accommodation facilities to Blaydin Point.

The data supplied for the generated construction vehicles was provided in 'vehicles per day' format. In order to be input into peak AM and PM periods, the data had to be reduced into 'vehicles per peak hour'. This was deduced by the following criteria:

- Night curfew between 8pm and 6am – leaving 14 hours for deliveries per day;
- Assume a factor of 7% (1 in 14 hours) to be equal to the peak hour. This is due to vehicle movements being performed throughout the entire day – not just during the peak period itself;
- The term 'roundtrip' being equivalent to one movement away from the origin towards the destination (full truck), and another movement away from the destination towards the origin (empty truck). The route chosen for each pair of movements was assumed to be identical; and
- The number of total bus and car roundtrips required to transport employees between the accommodation facilities and the development will be conducted during the AM and PM peaks. This will provide a worst case scenario for the intersections involved if shift working hours align with the morning or afternoon peak periods. It is assumed buses will return to the accommodation facilities during the day and hence will enter and exit the site and accommodation facilities in both the AM and PM peaks. This has been represented as a round trip, rather than a single trip. Car trips for employee transportation are assumed to be single trips in each peak, with cars parked on site for the duration of the shift.

Figures 4-7 and 4-8 outline generated construction traffic volume during the AM and PM peak periods respectively.

Traffic Volume

Figure 4-7 AM Peak Traffic Volume – Generated Construction Traffic

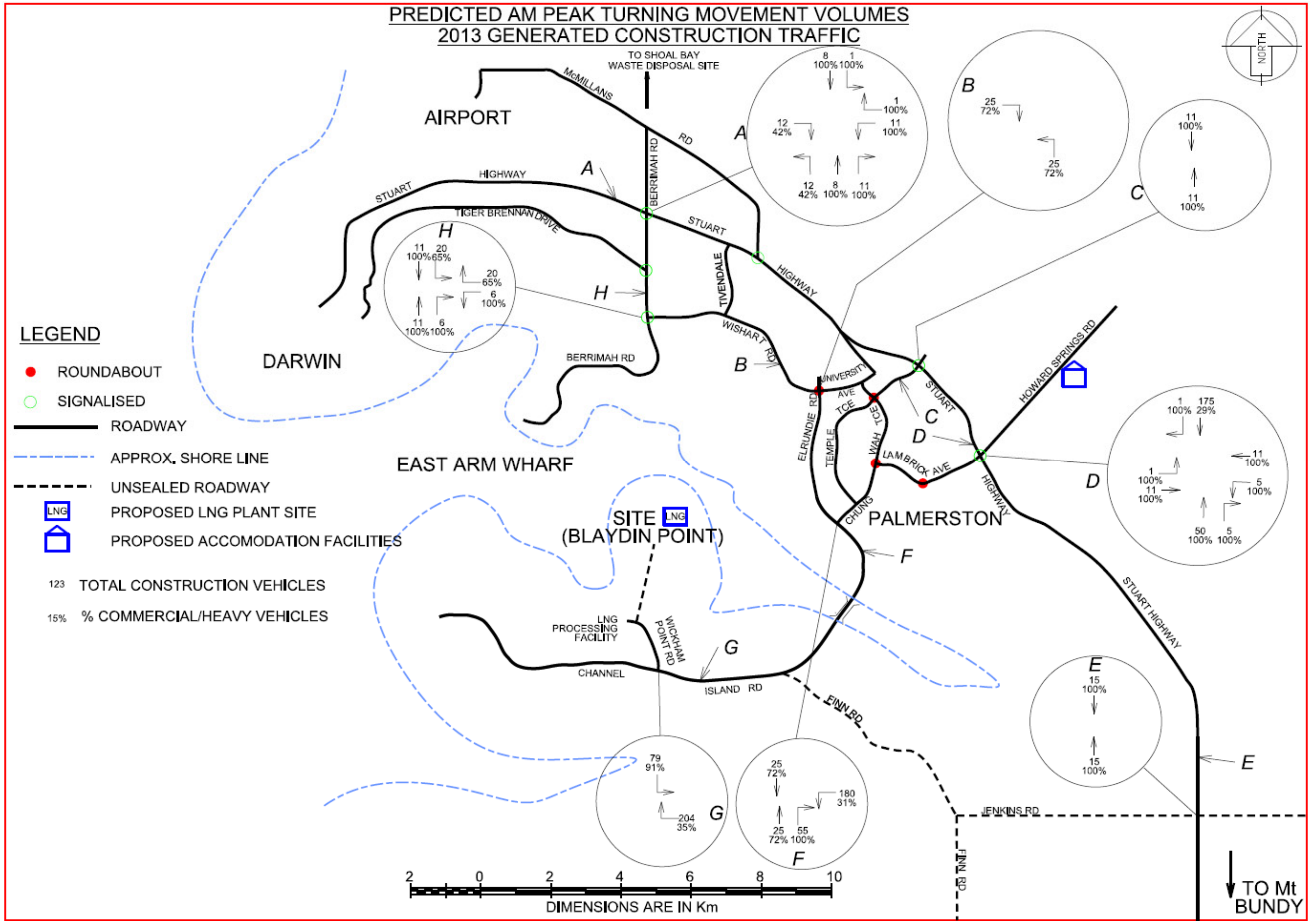
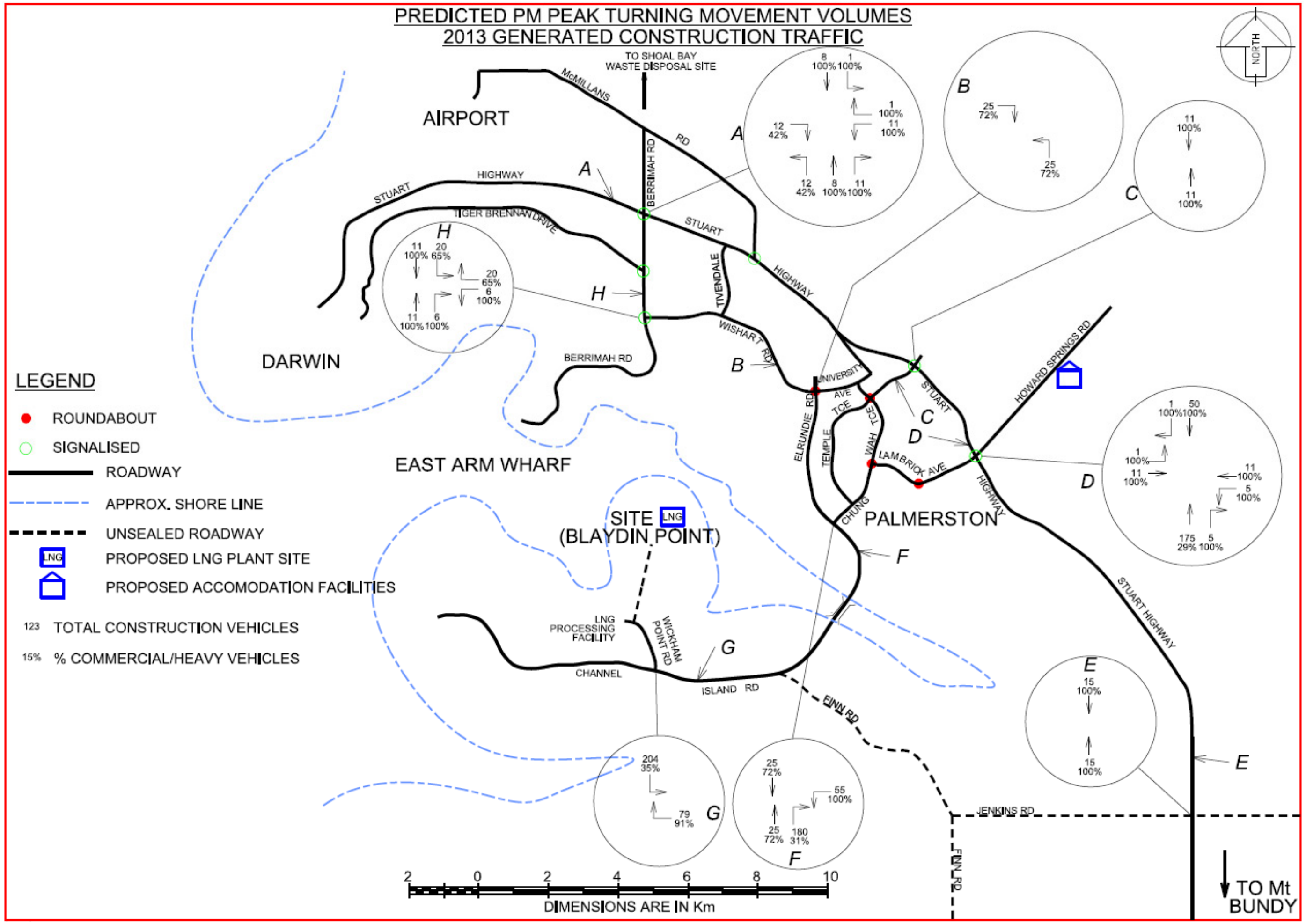


Figure 4-8 PM Peak Traffic Volume – Generated Construction Traffic



4.4.3 Total Volume

The total volume of traffic on the road network at the time of construction is determined by adding the forecast background traffic volume (existing volumes extrapolated using historical traffic growth) and the generated volume from the construction of the development.

As described in Section 2.1, the adopted design year is 2013, representing the peak of construction activity.

The total increase in daily traffic volumes due to increased background traffic and the impact of the construction traffic can be seen in Figure 4-9, which shows traffic volumes for Elrundie Avenue, a representative road in the network. The additional 2013 traffic due to the construction can be seen to be very small – about 3.2% of the total traffic and 3.3% of the background growth in the AM peak hour.

Figures 4-10 and 4-11 outline the total traffic volumes (background and construction) during the AM and PM peak periods respectively. Some notes regarding the figures:

- An allowance has been made for some buses turning right out of Temple Terrace and this is to cater for the generation of ancillary traffic (for example, service vehicles).

Figure 4-9 Daily Variation in Traffic Volume at Elrundie Avenue for 2013

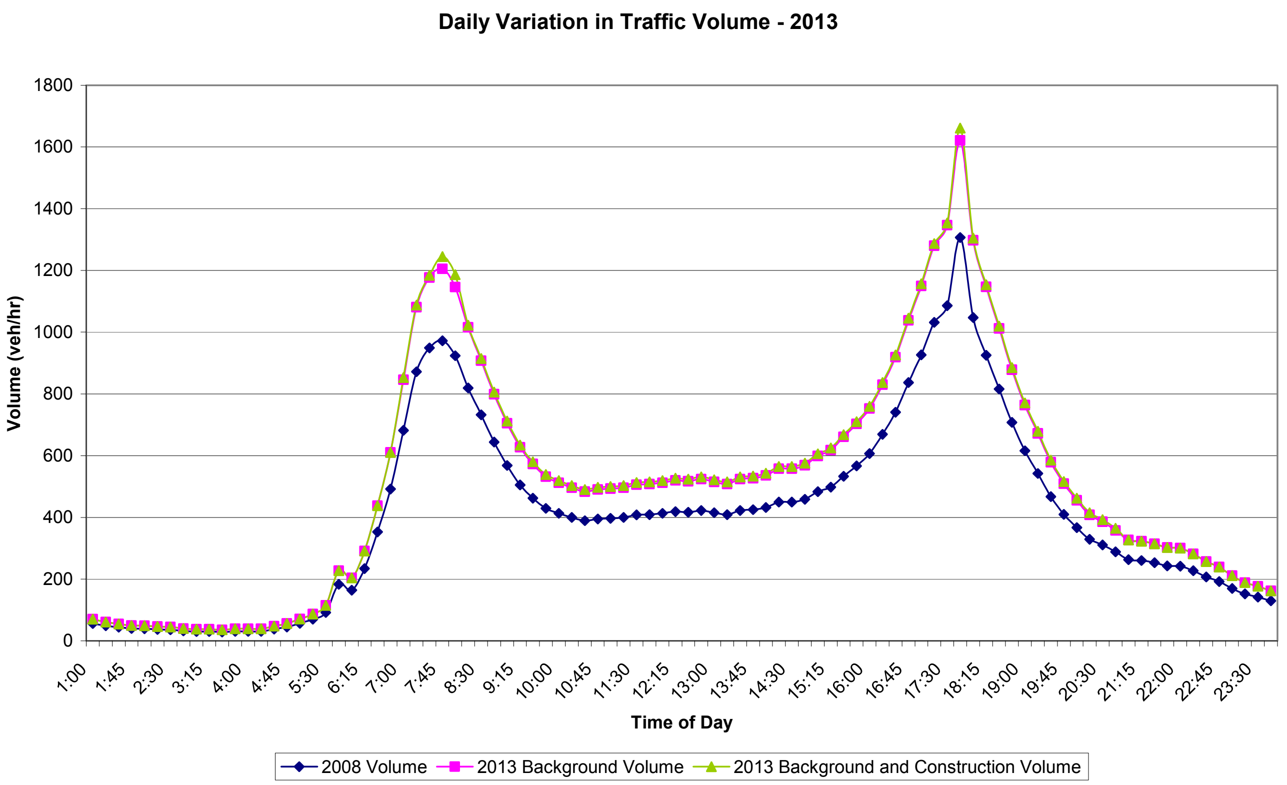


Figure 4-10 AM Peak Total Traffic Volume

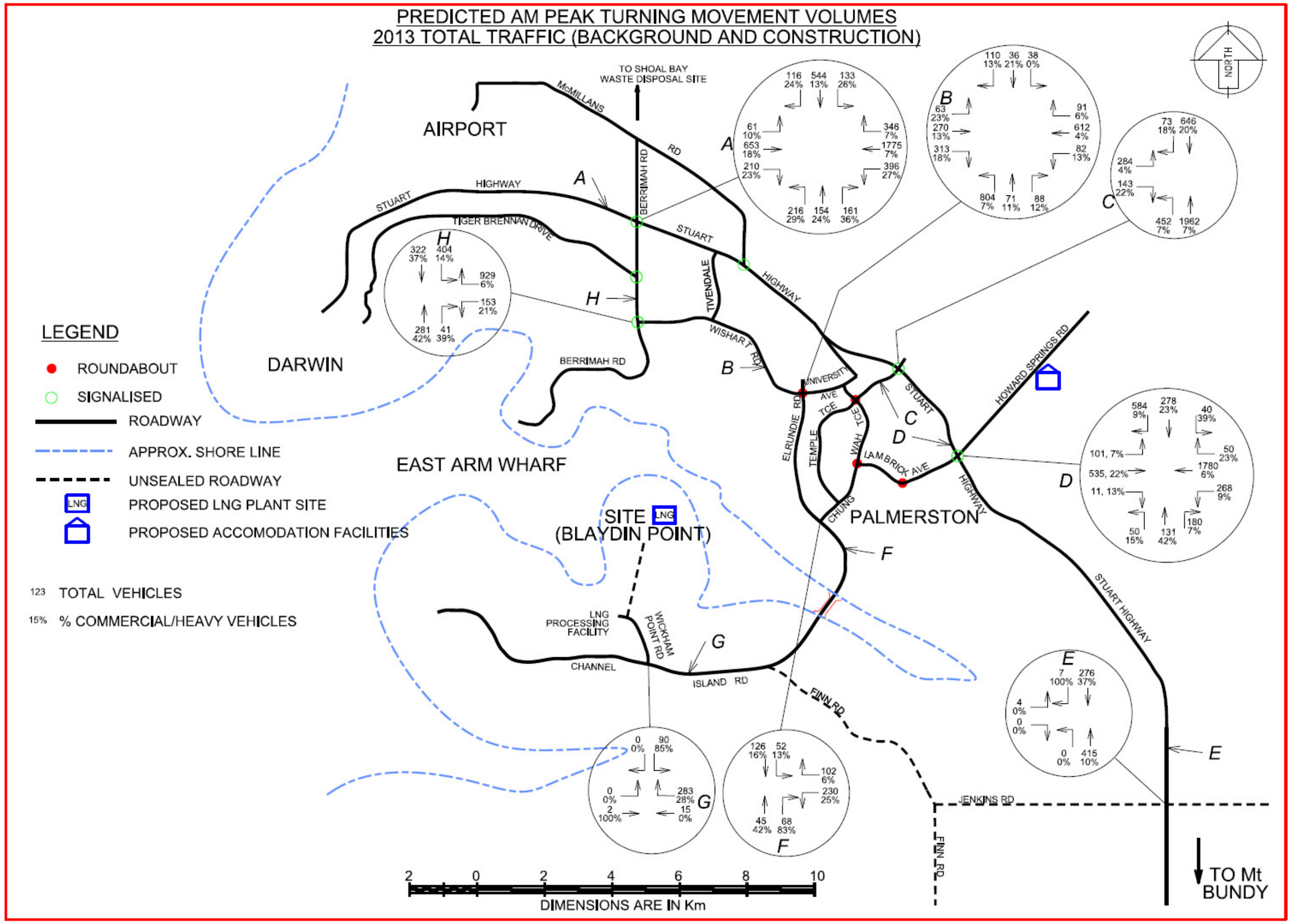
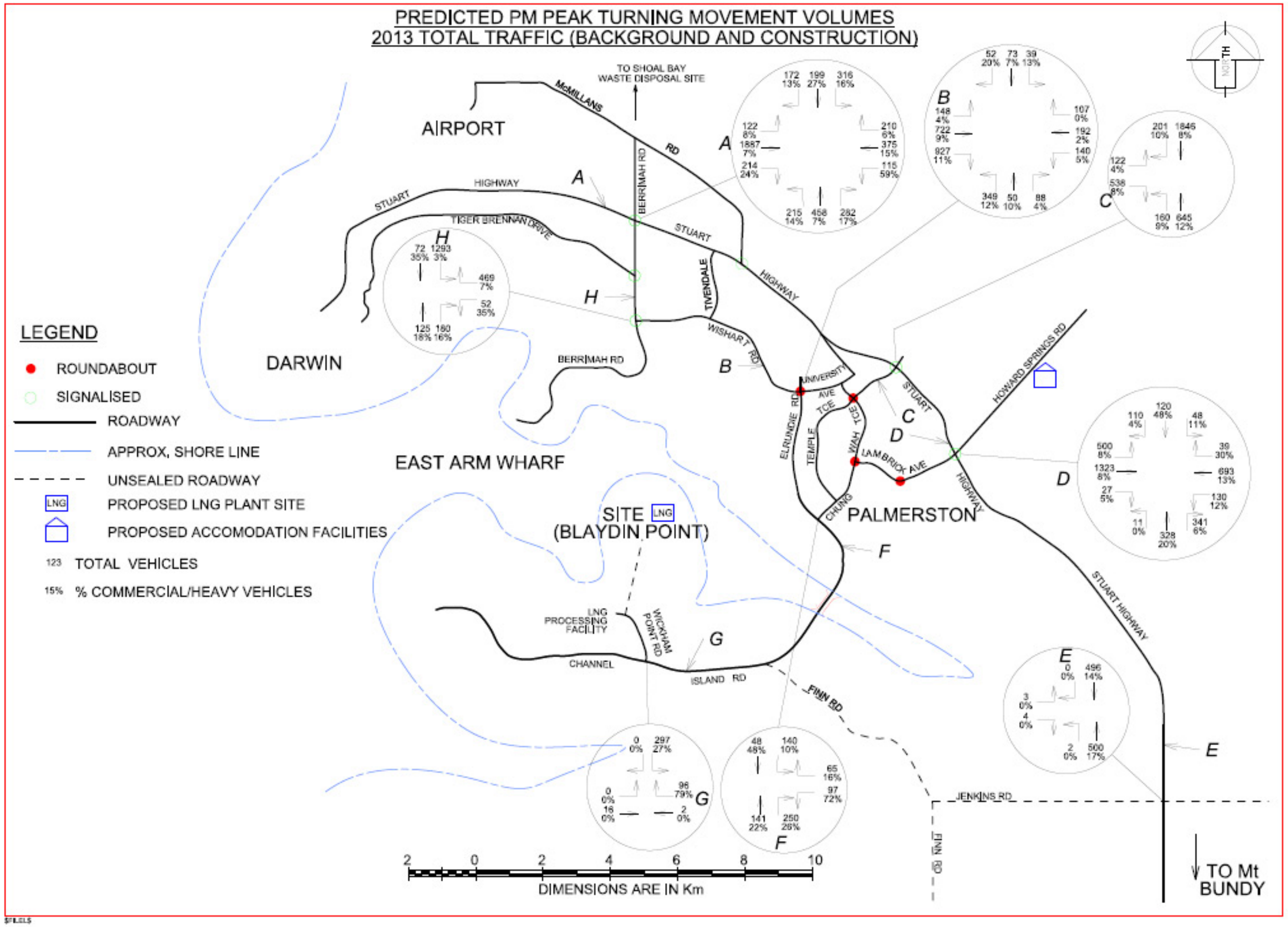


Figure 4-11 PM Peak Total Traffic Volume



5.1 Analysis Method

The SIDRA modelling package was used to analyse both the existing and future performance of the road network incorporating the proposed development construction. Intersections have the greatest impact on the flow of traffic through an urban network and hence the performance of a network is largely determined by the performance of its intersections. While not all intersections in the relevant network for this study were analysed, by studying the major intersections, the general performance of the entire network can be understood.

The eight major intersections modelled and analysed for the network affected by the INPEX development were:

- Elrundie Avenue / Wishart Road / Hedley Place / University Avenue – roundabout;
- Berrimah Road / Wishart Road – signalised T-intersection;
- Elrundie Avenue / Chung Wah Terrace – unsignalised T-intersection;
- Stuart Highway / Berrimah Road – signalised intersection;
- Stuart Highway / Lambrick Avenue – signalised intersection;
- Stuart Highway / Temple Terrace – signalised T-intersection;
- Channel Island Road / Wickham Point Road – unsignalised T-intersection; and
- Stuart Highway / Jenkins Road – unsignalised intersection.

SIDRA is a commonly used intersection analysis software package, which uses traffic volumes, intersection geometry and intersection control (eg signals, roundabouts etc) to determine intersection operational performance.

The Degree of Saturation (DoS) and 95% Queue Length for each approach of the intersections has been used as a guide to determine the baseline characteristics of the existing performance of the road network at the key intersections. This information can then be used as a comparison with the anticipated construction vehicle movements to determine the traffic impact of the development.

In this analysis, DoS is used as a primary measure of an intersection or movements operating performance level and can be related to congestion levels experienced by road users. For example, a DoS of 1.0 represents a fully saturated intersection or movement, in which congestion levels are high resulting in queuing and delays, while a DoS of 0.80 represents an acceptable level of stable traffic flow, but with restrictions on desired speed and manoeuvrability. Generally a DoS of 0.95 or below is considered acceptable in traffic engineering in an urban road network, although often intersections will be shown to be operating at capacity in existing conditions. The lower DoS threshold is used in design to provide some spare capacity as a “factor of safety”.

Queue lengths have also been analysed as they are generally used in traffic engineering practice to determine lengths of dedicated turn lanes when preparing functional designs. They can also be used to determine if queue lengths will impact on upstream intersections on a given road. These measurements are also used as a secondary performance indicator in conjunction with DoS as a ‘reality check’ to understand if changes in traffic volumes produce unrealistic queue lengths. Such an increase would suggest an issue in operating performance levels.

It should be noted that the worst case results for DoS and 95% Queue Length may come from different movements within an intersection in the same model. This is due to the interaction between traffic volumes, signal timing and geometric layouts of each intersection. For example, a through movement in a single exclusive lane may exhibit a very long queue length, but have a lower DoS as traffic can flow through the intersection unimpeded, whereas a shared through and right lane turning lane may have a shorter queue length, but higher DoS as the right turns block through traffic movement.

It should also be noted that the SIDRA modelling analyses each intersection to produce the most efficient outcome for the intersection overall. This may include altering traffic signal timing from existing configurations to produce an acceptable level of performance across the entire intersection. For example, if traffic volumes are added to secondary roads, green time may be reduced on the main road to accommodation the additional volume on the secondary road. This may then result in the main road movement becoming the critical movement, even though no additional volume has been added to that movement.

Additional information such as Level of Service, Control Delay and Effective Intersection Capacity has also been reviewed for each intersection during AM and PM peak periods. This information can be provided by URS on request.

5.2 Assumptions for SIDRA Modelling

Intersection Geometry and Control

For the four signalised intersections modelled, Northern Territory DPI provided signal plans, which show the geometric layout and phasing arrangements. However, the time allocation for each movement was unavailable. Instead, the default time calculated by SIDRA for each signalling phase was adopted. Geometry for unsignalised intersections was sourced from publicly availably aerial photographs.

The intersection geometry and layout for the Berrimah Road/Wishart Road intersection has been modelled as the upgraded layout, due for completion in 2009, in all cases as the existing layout.

Traffic Volumes

The through movements for Stuart Highway (inbound and outbound) at the following intersections were not surveyed during the turning movement surveys:

- Stuart Highway / Berrimah Road;
- Stuart Highway / Lambrick Avenue; and
- Stuart Highway / Temple Terrace.

Traffic count data provided by the Northern Territory DPI was used to provide through movement volumes at the above intersections.

The modelling for each intersection was based on the AM and PM peak hourly volumes and it should be noted that the peak hours observed at each intersection vary between sites.

Table 5-1 summarises the peak AM and PM hour period, in the SIDRA modelling for each intersection.

Table 5-1 AM and PM peak hours for each intersection

Intersection	AM Peak Hour	PM Peak Hour
Elrundie Avenue / Wishart Road / Hedley Place / University Avenue	7:15am – 8:15am	4:45pm – 5:45pm
Berrimah Road / Wishart Road	7:15am – 8:15am	4:30pm – 5:30pm
Elrundie Avenue / Chung Wah Terrace	7:00am – 8:00am	4:45pm – 5:45pm
Stuart Highway / Berrimah Road	7:15am – 8:15am	4:00pm – 5:00pm
Stuart Highway / Lambrick Avenue	7:15am – 8:15am	4:45pm – 5:45pm
Stuart Highway / Temple Terrace	7:15am – 8:15am	4:30pm – 5:30pm
Channel Island Road / Wickham Point Road	7:15am – 8:15am	4:15pm – 5:15pm
Stuart Highway / Jenkins Road	7:15am – 8:15am	4:30pm – 5:30pm

It has been assumed for modelling purposes that the estimated midpoint of the project (during the year 2013) will coincide with the peak of construction and hence will produce the highest volume of construction traffic.

Other assumptions are as follows;

- A new intersection will need to be constructed to access the accommodation facilities from Howard Springs Road. This new intersection has not been modelled as it is highly likely that it can be designed to minimise any impact on the existing road network.

5.3 Existing Performance

The SIDRA modelling package was used to analyse the performance of the existing road network to identify the current traffic characteristics (2008) of the eight key intersections identified on the nominated routes for commercial vehicle, bus and car movements during the construction of the project.

5.3.1 Existing AM Peak Performance

Tables 5-2a and 5-2b summarise the degree of saturation and queue length for each intersection. The movement at each intersection with the highest degree of saturation or 95% queue length for the analysed AM peak hour. A movement is a single through, or left, or right turn on one approach to the intersection. The worst case across all the movements is quoted as the overall value for the intersection, which is common practice. The highest value for each measure is used as the overall result for the entire intersection.

Table 5-2a 2008 Degree of Saturation during AM Peak

Intersection	Degree of Saturation	
	Max Degree of Saturation	Turning Movement
Elrundie Avenue / Wishart Road / Hedley Place / University Avenue	0.48	Northbound Elrundie Ave: left turn into Wishart Road (inbound)
Berrimah Road / Wishart Road	0.88	Westbound Wishart Rd: left (outbound) and right (inbound) turns into Berrimah Rd
Elrundie Avenue / Chung Wah Terrace	0.05	Westbound Chung Wah Tce: right turn into Elrundie Ave (inbound)
Stuart Highway / Berrimah Road	0.87	Southbound Vanderlin Dve: through movement into Berrimah Rd
Stuart Highway / Lambrick Avenue	0.82	Southwest-bound Howard Springs Rd: right turn into Stuart Highway (inbound) and through movement into Lambrick Ave
Stuart Highway / Temple Terrace	0.83	Northwest-bound Stuart Highway: through movement (inbound)
Channel Island Road / Wickham Point Road	0.04	Northwest-bound Channel Island Rd: right turn into Wickham Point Rd (outbound)
Stuart Highway / Jenkins Road	0.09	Northbound Stuart Highway: through movement (inbound)

As can be seen from Table 5-2a, all intersections are currently operating below the 0.95 Degree of Saturation threshold during the AM peak. This shows that the road network currently has spare capacity.

Table 5-2b 2008 Queue Lengths during AM Peak

Intersection	95% Queue Length	
	Max 95% Queue Length (metres)	Turning Movement
Elrundie Avenue / Wishart Road / Hedley Place / University Avenue	38	Northbound Elrundie Ave: left turn into Wishart Road (inbound)
Berrimah Road / Wishart Road	331	Westbound Wishart Rd: left (outbound) and right (inbound) turns into Berrimah Rd
Elrundie Avenue / Chung Wah Terrace	No more than 1 car	Southbound Elrundie Ave: through movement (outbound)
Stuart Highway / Berrimah Road	223	Westbound Stuart Highway: through movement (inbound)
Stuart Highway / Lambrick Avenue	195	Northwest-bound Stuart Highway: through movement (inbound)
Stuart Highway / Temple Terrace	178	Northwest-bound Stuart Highway: through movement (inbound)
Channel Island Road / Wickham Point Road	0	-
Stuart Highway / Jenkins Road	0	-

The intersection of Berrimah Road and Wishart Road has the longest queue length, which is consistent with on site observations. However, this intersection is currently in the process of being upgraded.

5.3.2 Existing PM Peak Performance

Table 5-3a and 5-3b summarise which turning movement at each intersection created the highest degree of saturation or 95% queue length, for the analysed PM peak hour.

Table 5-3a 2008 Degree of Saturation during PM Peak

Intersection	Degree of Saturation	
	Max Degree of Saturation	Turning Movement
Elrundie Avenue / Wishart Road / Hedley Place / University Avenue	0.59	Westbound Wishart Rd: through movement into University Ave (outbound) and right turn into Elrundie Ave (outbound)
Berrimah Road / Wishart Road	0.86	Southbound Berrimah Rd: left turn into Wishart Rd (outbound)
Elrundie Avenue / Chung Wah Terrace	0.07	Eastbound Elrundie Ave: left turn into Chung Wah Tce (outbound)
Stuart Highway / Berrimah Road	0.89	Southbound Vanderlin Dve: right turn into Stuart Highway (inbound)
Stuart Highway / Lambrick Avenue	0.70	Southeast-bound Stuart Highway: through movement (outbound)
Stuart Highway / Temple Terrace	0.76	Southeast-bound Stuart Highway: through movement (outbound)
Channel Island Road / Wickham Point Road	0.04	Southwest-bound Wickham Point Rd: left turn into Channel Island Rd (inbound)
Stuart Highway / Jenkins Road	0.11	Northbound Stuart Highway through movement (inbound)

As can be seen from Table 5-3a, all intersections are currently operating below the 0.95 Degree of Saturation threshold during the PM peak. This shows that the road network currently has spare capacity.

Table 5-3b 2008 Queue Lengths during PM Peak

Intersection	95% Queue Length	
	Max 95% Queue Length (metres)	Turning Movement
Elrundie Avenue / Wishart Road / Hedley Place / University Avenue	44	Westbound Wishart Rd: through movement into University Ave (outbound)
Berrimah Road / Wishart Road	228	Southbound Berrimah Rd: left turn into Wishart Rd (outbound)
Elrundie Avenue / Chung Wah Terrace	No more than 1 car	Northbound Elrundie Ave: through movement (inbound)
Stuart Highway / Berrimah Road	284	Eastbound Stuart Highway: through movement (outbound)
Stuart Highway / Lambrick Avenue	124	Southeast-bound Stuart Highway: through movement (outbound)
Stuart Highway / Temple Terrace	109	Southeast-bound Stuart Highway: through movement (outbound)
Channel Island Road / Wickham Point Road	0	-
Stuart Highway / Jenkins Road	0	-

The intersection of Berrimah Road and Stuart Highway has the longest queue length, which is consistent with on site observations.

5.4 Analysis with Construction Traffic Included

The construction traffic generation is discussed in Section 4.4.2. This section discusses the impact of this traffic on the 2013 road network.

5.4.1 Comparison of Background Traffic Growth with Generated Construction Phase Related Vehicles

Table 5-4 compares the 2013 analysis of the performance of the road network in 2013 with the background traffic growth to the case in which all traffic related generated by the construction phase of the development is added on top of the background traffic.

Table 5-4a 2013 Traffic – Background Traffic Growth & Generated Construction Traffic: Degree of Saturation

		2013 Background traffic growth only	2013 Total including Generated Construction Traffic	Intersection Movement Causing DoS	Comment
Elrundie Avenue / Wishart Road / Hedley Place / University Avenue	AM	0.77	0.82	Northbound Elrundie Ave: left turn into Wishart Road (inbound)	Below acceptable threshold of 0.95
	PM	0.79	0.81	Eastbound Wishart Rd: right turn into Elrundie Ave (outbound)	Below acceptable threshold of 0.95
Berrimah Road / Wishart Road	AM	0.73	0.76	Westbound Wishart Rd right (inbound) turn into Berrimah Rd	Below acceptable threshold of 0.95
	PM	0.90	0.91	Southbound Berrimah Rd: left (outbound) turn into Wishart Rd	Below acceptable threshold of 0.95
Stuart Highway / Berrimah Road	AM	0.90	0.90	Southbound Vanderlin Dve: through movement into Berrimah Rd	Below acceptable threshold of 0.95
	PM	1.00	1.00	Eastbound Stuart Highway: through movement (outbound)	No incremental impact
Stuart Highway / Lambrick Avenue	AM	0.96	1.06	Southwest bound Howard Springs Rd through movement (inbound)	Incremental impact noted
	PM	0.84	0.90	Southeast-bound Stuart Highway: through movement (outbound)	Below acceptable threshold of 0.95
Elrundie Avenue / Chung Wah Terrace	AM	0.07	0.15	Westbound Chung Wah Tce left (outbound) turn into Elrundie Ave	Below acceptable threshold of 0.95
	PM	0.09	0.17	Northbound Elrundie Avenue right (outbound) turn into Chung Wah Tce	No incremental impact
Channel Island Road / Wickham Point Road	AM	0.10	0.19	Northwest-bound Channel Island Road right turn into Wickham Point Road (outbound)	No incremental impact
	PM	0.11	0.11	Southeast-bound Wickham Point Road left (iinbound) turn into Channel Island Road	No incremental impact
Stuart Highway / Temple Terrace	AM	0.86	0.87	Northwest-bound Stuart Highway: through movement (inbound)	No incremental impact
	PM	0.90	0.90	Northeast-bound Temple Tce right (outbound) turn into Stuart Highway	No incremental impact

It should be noted that the Stuart Highway/Berrimah Road intersection is likely to operate at capacity in 2013 (indicated by a Degree of Saturation of 1.00) without the inclusion of any traffic generated by the INPEX development and the impact of generated traffic does not cause any incremental impact.

The intersection of Stuart Highway/Lambrick Avenue is also shown to be operating above the 0.95 Degree of Saturation threshold for both the background traffic growth and construction traffic analysis.

Table 5-4b 2013 Traffic – Background Traffic Growth & Generated Construction Traffic: 95% Queue Length (meters)

		2013 Background traffic growth only	2013 Total including Generated Construction Traffic	Intersection Movement Causing 95% Queue Length	Comment
Elrundie Avenue / Wishart Road / Hedley Place / University Avenue	AM	114	114	Northbound Elrundie Ave: left turn into Wishart Road (inbound)	No incremental impact
	PM	93	103	Westbound Wishart Rd: through movement into University Ave (outbound) and right turn into Elrundie Ave (outbound)	Acceptable incremental impact
Berrimah Road / Wishart Road	AM	89	98	Westbound Wishart Rd: right (inbound) turn into Berrimah Rd	Acceptable incremental impact
	PM	324	378	Southbound Berrimah Rd: left (outbound) turn into Wishart Rd	Acceptable incremental impact
Stuart Highway / Berrimah Road	AM	341	356	Westbound Stuart Highway: through movement (inbound)	Acceptable incremental impact
	PM	469	495	Eastbound Stuart Highway: through movement (outbound)	No incremental impact
Stuart Highway / Lambrick Avenue	AM	556	791	Northwest-bound Stuart Highway: through movement (inbound)	Incremental impact noted
	PM	224	308	Southeast-bound Stuart Highway: through movement (outbound)	Incremental impact noted
Stuart Highway / Temple Terrace	AM	279	294	Northwest-bound Stuart Highway: through movement (inbound)	No incremental impact
	PM	214	219	Southeast-bound Stuart Highway: through movement (outbound)	No incremental impact

Most queue length increases are acceptable as the overall intersection performances do not suggest operational issues. The exception to this is the Stuart Highway / Lambrick Avenue intersection during both the

AM and PM peak hours. The AM peak period indicates the most significant traffic impact resulting in an increase in traffic queue for inbound Stuart Highway traffic of approximately 235 metres. However this is a reflection of the Degree of Saturation being above the 0.95 threshold during both the background traffic growth and construction phase scenarios. As such, the increase in queue length is directly associated with the poor performance of the intersection with or without construction activity occurring.

5.4.2 Accommodation Facilities Location

An analysis year of 2013 has been selected as this aligns with the estimated peak construction period of the project – hence the largest amount of vehicle traffic. Summaries of the SIDRA models for the 2013 construction traffic can be provided by URS on request.

For the purposes of the personnel movement impact analysis the Whitewood Road / Howard Springs Road intersection has also been analysed. A 20/80 directional split has been assumed for vehicle movements at this intersection whereby 20% of vehicle movements along Howard Springs Road will continue through the intersection. The remaining 80% will turn into or out from Whitewood Road and utilise the southern leg of the Howard Springs Road approach.

AM Peak Hour

Tables 5-5a and 5-5b below outline the performance of each intersection in its expected 2013 form, during the AM peak hour. The first column provides the 2013 AM peak hour characteristics where the construction traffic has been included, without the buses to transport personnel. The column to the right of this highlights how the personnel transportation affects the performance of the intersection (i.e. accommodation facilities to Blaydin Point) once they are included. The difference is the 50 buses travelling between the Accommodation Facility and Blaydin Point in the peak hour (round trips), and the 125 car single trips for personnel going between the Accommodation Facility and Blaydin Point (inbound to Blaydin Point during AM peak and outbound to Accommodation Facilities during PM peak).

It should be noted that degree of saturation, queue length and other performance indicators (e.g. delay) are all related and therefore it is common practice in traffic engineering to refer to degree of saturation only. Queue lengths are also quoted as they are important in reviewing or designing intersection geometry to ensure short lanes are of sufficient length to accommodate queues. Generally, queue lengths are not an issue at the analysed intersections unless specifically discussed.

Table 5-5a AM Peak Hour – Generated Construction and Personnel Traffic: Degree of Saturation

	2013 AM Peak (Construction, without personnel)	2013 AM Peak including Construction and Personnel Traffic	Intersection Movement Causing DoS	Comment
Elrundie Avenue / Chung Wah Terrace	**0.07**	0.15	Westbound Chung Wah Tce turning left (outbound) into Elrundie Ave	DoS <0.95
Stuart Highway / Lambrick Avenue	**0.96**	1.06	Southwest-bound Howard Springs through movement (inbound) and right (inbound) turn into Stewart Highway	Incremental impact noted
Channel Island Road / Wickham Point Road	**0.10**	0.19	Northwest-bound Channel Island Rd: right turn into Wickham Point Rd (outbound)	DoS <0.95
Whitewood Road / Howard Springs Road	**0.55**	0.79	Westbound Whitewood Rd left (inbound) turn into Howard Springs Rd	DoS <0.95

Table 5-5b AM Peak Hour – Generated Construction and Personnel Traffic: 95% Queue Length (meters)

	2013 AM Peak (Construction without personnel)	2013 AM Peak including Construction and Personnel Traffic	Intersection Movement Causing 95% Queue Length	Comment
Elrundie Avenue / Chung Wah Terrace	**No more than 1 car**	No more than 1 car	Southbound Elrundie Ave: through movement (outbound)	No incremental impact
Stuart Highway / Lambrick Avenue	**579**	791	Northwest-bound Stuart Highway: through movement (inbound)	Incremental impact noted
Channel Island Road / Wickham Point Road	**0**	0	-	No incremental impact
Whitewood Road / Howard Springs Road	**45**	84	Westbound Whitewood Rd left (inbound) and right (outbound) turns into Howard Springs Rd	No incremental impact

PM Peak Hour

Tables 5-6a and 5-6b summarise the same information as Tables 5-5a and 5-5b above but for the PM Peak Hour.

Table 5-6a PM Peak Hour – Generated Construction and Personnel Traffic: Degree of Saturation

	2013 PM Peak (Construction without personnel)	2013 PM Peak including Construction and Personnel Traffic	Intersection Movement Causing DoS	Comment
Elrundie Avenue / Chung Wah Terrace	**0.09**	0.17	Northbound Elrundie Ave: turning right (outbound) into Chung Wah Tce	DoS <0.95
Stuart Highway / Lambrick Avenue	**0.85**	0.90	Southeast-bound Stuart Highway: through movement (outbound)	DoS <0.95
Channel Island Road / Wickham Point Road	**0.11**	0.11	Southwest-bound Wickham Point Rd: left turn into Channel Island Rd (inbound)	DoS <0.95
Whitewood Road / Howard Springs Road	**0.70**	0.83	Northeast-bound Howard Springs Road right (outbound) turn into Whitewood Rd	DoS <0.95

Table 5-6b PM Peak Hour – Generated Construction and Personnel Traffic: 95% Queue Length (meters)

	2013 PM Peak (Construction without personnel)	2013 PM Peak including Construction and Personnel Traffic	Intersection Movement Causing 95% Queue Length	Comment
Elrundie Avenue / Chung Wah Terrace	**No more than 1 car**	No more than 1 car	Northbound Elrundie Ave: through movement (inbound)	No incremental impact
Stuart Highway / Lambrick Avenue	**230**	308	Southeast-bound Stuart Highway: through movement (outbound)	Acceptable incremental impact
Channel Island Road / Wickham Point Road	**0**	0	-	No incremental impact
Whitewood Road / Howard Springs Road	**87**	125	Northeast-bound Howard Springs Road right (outbound) turn into Whitewood Rd	No incremental impact

Impact of Population Growth versus Construction Traffic Movements

The previous analysis shows the impact that the route for the personnel transportation movements has on the modelled intersections. The analysis shows that most intersections can operate below the 0.95 degree of saturation threshold when considering non-personnel traffic movements. The exception to this is the Stuart Highway/Lambrick Avenue intersection in the AM and PM peak hours. However, it should be noted that this intersection was also shown to be above the threshold when considering the background traffic growth only for 2015. Hence it is anticipated that this intersection is likely to reach its capacity in the future year period considered in this report, regardless of the construction traffic (both personnel and non-personnel) impact.

Personnel Movement Impact

The personnel movements utilise the intersections of Elrundie Avenue / Chung Wah Terrace, Stuart Highway / Lambrick Avenue, Howard Springs Road / Whitewood Road and Channel Island Road / Wickham Point Road. The degree of saturation and queue lengths for Elrundie Avenue / Chung Wah Terrace and Channel Island Road / Wickham Point Road during the AM and PM peak periods have insignificant increases when they are incorporated with the generated construction movements.

Performance of the Stuart Highway / Lambrick Avenue intersection is adversely impacted by the construction activity for the development. During the AM peak period, the Degree of Saturation for the intersection rises from 0.96 to 1.06. The queue length also increases, by 235 metres, or the equivalent of 40 cars. Considering this intersection is anticipated to operate above acceptable operating conditions by 2013 without the proposed development and congestion is expected to only occur over the peak construction period, and is limited to the AM peak hour, this temporary increase in congestion may be acceptable, as it is akin to reduced operating performance during roadworks. In addition, the congestion over the construction period is less than that expected in general background traffic growth by the year 2015. The impact of this scenario during the PM peak hour is far less than that experienced in the AM peak. During the PM peak, the degree of saturation remains below the 0.95 threshold.

Sensitivity testing using SIDRA indicates that this intersection may benefit from reconfiguration of the lane layouts and revised phasing on the Lambrick Avenue and Howard Springs Road approaches, leading to a slightly lower Degree of Saturation in both the construction period and for general background traffic growth. However the Degree of Saturation is realistically only substantially reduced by adding one through lane in each direction on Stuart Highway on the approach and departure of this intersection. As noted above, this would only be required during the construction period.

It should also be noted that this analysis does not take into account the future upgrade of Tiger Brennan Drive, which may change traffic distribution patterns in this area significantly.

The increased traffic associated with the accommodation facilities is expected to have a minimal impact on the operation of the Howard Springs Road / Whitewood Road intersection, which will remain well below acceptable operating performance thresholds. The existing northbound passing lane on Howard Springs Road provides sufficient capacity to cater for the proposed increases in traffic due to personnel movements.

The impact of the Tiger Brennan Drive extension project may change traffic distribution around the Stuart Highway / Lambrick Avenue intersection as it will provide motorists with a direct east-west route alternative to Stuart Highway. This is expected to reduce demand along Stuart Highway, and therefore reduce the demand at the Stuart Highway / Lambrick Avenue intersection. If it is anticipated that the Tiger Brennan Drive extension will be completed prior to the INPEX construction period, a review of this intersection may be warranted.

In summary, the location of the accommodation facilities has little overall impact on the 2013 road network, with the exception of the Stuart Highway/Lambrick Avenue intersection during the AM peak period.

5.5 Future Performance (Without Operations Traffic)

The traffic growth rates for the surrounding regions are discussed in Section 4.4.1. This section discusses the road network performance in 2015 (estimated year of construction completion) for the ‘no development’ traffic, on the network that is expected to exist in 2015 (ie. including all relevant upgrades identified in Section 3.3). The purpose of this analysis is to determine baseline conditions and therefore the incremental impact of the additional traffic generated by the development.

Tables 5-7a and 5-7b provide a summary for each intersection during its AM and PM Peak Hour to show its future Degree of Saturation and 95% Queue length with regards to the specified growth scenarios. Please note that the critical movements at each intersection producing the overall values in this table for the 2008 base scenario (as detailed in Tables 5-2 and 5-3) remain the same critical movement in 2015 (Sections 5.3.1 and 5.3.2).

Values for the Berrimah Road / Wishart Road intersection for 2015 have been based on the improved intersection geometry design currently being constructed as indicated in Figure 3-1. As additional turning lanes are amongst the intersection improvements, most values for the 2015 are lower than the 2008 analysis.

Summaries of the SIDRA models for the 2015 background traffic growth can be provided by URS on request.

Table 5-7a 2015 Estimated Traffic Growth Impact (no operations traffic included): Degree of Saturation

	2008 AM Peak	2015 AM Peak	2008 PM Peak	2015 PM Peak
Elrundie Avenue / Wishart Road / Hedley Place / University Avenue	**0.48**	0.93	**0.59**	0.87
Berrimah Road / Wishart Road	**0.88**	0.77	**0.86**	0.93
Elrundie Avenue / Chung Wah Terrace	**0.05**	0.07	**0.07**	0.09
Stuart Highway / Berrimah Road	**0.87**	0.94	**0.89**	1.03
Stuart Highway / Lambrick Avenue	**0.82**	1.05	**0.70**	0.86
Stuart Highway / Temple Terrace	**0.83**	0.88	**0.76**	0.89
Channel Island Road / Wickham Point Road	**0.04**	0.05	**0.04**	0.06
Stuart Highway / Jenkins Road	**0.09**	0.12	**0.11**	0.16

Table 5-7a 2015 Estimated Traffic Growth Impact (no operations traffic included): 95% Queue Length (meters)

	2008 AM Peak	2015 AM Peak	2008 PM Peak	2015 PM Peak
Elrundie Avenue / Wishart Road / Hedley Place / University Avenue	**38**	114	**44**	137
Berrimah Road / Wishart Road	**331**	97	**228**	364
Elrundie Avenue / Chung Wah Terrace	**No more than 1 car**	No more than 1 car	**No more than 1 car**	No more than 1 car
Stuart Highway / Berrimah Road	**223**	412	**284**	557
Stuart Highway / Lambrick Avenue	**195**	802	**124**	272
Stuart Highway / Temple Terrace	**178**	340	**109**	292
Channel Island Road / Wickham Point Road	**0**	0	**0**	0
Stuart Highway / Jenkins Road	**0**	0	**0**	0

As can be seen from Table 5-7a, all intersections are able to operate at or below the 0.95 degree of saturation threshold for both peak hours in 2015, with the exception of Stuart Highway/Lambrick Avenue in the AM peak and Stuart Highway/Berrimah Road intersection in the PM peak.

These two intersections have the most significant increase in queue lengths and Degrees of Saturation and are operating above desired thresholds in 2015. These intersections may require potential upgrades regardless of the impact of construction related traffic. Queue lengths can be used in this instance to assist in determining potential upgrade options.

5.6 Operation Phase

Vehicle movements generated from this development during on-going operation will be significantly less than those forecast for the peak construction phase (as modelled in Section 5.5). The analysis during the construction phase has shown that general background vehicle growth in the surrounding areas is the influencing factor to capacity and queue issues for the intersections modelled – and not the inclusion of construction vehicles themselves.

Therefore, the traffic generation of the site once it becomes operational is less than the construction outcomes. As a result, no roadworks are identified for the operational phase of the development.

5.7 Road Safety

The accident analysis identified a number of specific locations on the road network with relatively higher accident rates, and also a number of specific types of accident that are more prevalent at particular locations.

Stuart Highway has the highest total number of accidents of all roads to be used by the traffic generated by the development. Channel Island Road has the highest fatality rate and all traffic accessing the Blaydin Point site will utilise this road.

However, it is not anticipated based on this analysis that traffic generated by the development will compromise road safety.

5.8 Findings from Analysis

The proposed development is not expected to create an overall significant incremental adverse impact on the operation of the road network when compared to background traffic growth. However, it should be recognised that there are a number of key intersections that will be congested by the time construction reaches its peak, due to background traffic growth in Darwin, driven by the on-going increase in population (and the distribution of this population in the satellite suburbs). The roadworks required to mitigate the traffic impact of the development are localised.

Table 5-8 summarises the SIDRA outcomes for all cases analysed. The peak hour with the highest Degree of Saturation has been reproduced in this table.

The following outcomes warrant consideration;

- The Stuart Highway/Berrimah Road intersection is shown to operate above the acceptable Degree of Saturation threshold during construction in the PM peak hour. However, there is no incremental impact from the generated construction traffic when compared to general traffic growth in the same year. Therefore upgrading this intersection should not be required.

- The Stuart Highway/Lambrick Avenue intersection shows an incremental impact in Degree of Saturation from the generated construction traffic when compared to general traffic growth in the same year. There are three possible approaches that can be taken;

  1) As the impact is related only to the highest period of construction activity, the temporary congestion at this one intersection over one hour of the day can be accepted as a consequence of the development.

  2) Stuart Highway can be widened locally on each side of this intersection (noting that this is only necessary to accommodate a short period of construction activity through the intersection). The approach sides on Stuart Highway are widened to allow for vehicles to queue in the new lane created at the stop line of the Lambrick Avenue intersection. The departure side of Stuart Highway is also widened to provide a sufficient distance to allow vehicles to merge from the new lane into the existing lanes after passing through the intersection. Howard Springs Road and Lambrick Avenue already have two right turning lanes. It is uncommon to provide more than this as it compromises safety due to three vehicles abreast turning right in each direction. Therefore the only safe option for increasing capacity is widening on Stuart Highway. SIDRA analysis shows that adding through or left turn lanes on either or both side roads does not sufficiently reduce the degree of saturation.

  3) The impact of the Tiger Brennan Drive extension project may change traffic distribution around the Stuart Highway / Lambrick Avenue intersection as it will provide motorists with a direct east-west route alternative to Stuart Highway. If it is anticipated that the Tiger Brennan Drive extension will be completed prior to the INPEX construction period, it is likely this intersection will accommodate construction traffic and operate at an acceptable level of performance.

These are the only traffic issues arising from the INPEX development.

A connection from the accommodation facility to the existing road network will need to be constructed, to normal design standards (ie not over dimensional vehicles including road trains).

It should be noted that the model does not take into account the influence of the new Tiger Brennan Drive extension project which is anticipated to be completed in 2010. If this project is completed prior to the development of the LNG facility, the results of the modelling will change due to a shift in the usage of roads affected by the TBD extension. Overall, the network should operate more efficiently if this occurs, increasing overall capacity. This may result in reduced queue lengths and lower Degrees of Saturation from the modelled results. Intersections which may be directly affected by this proposal include;

- Elrundie Avenue / Wishart Road / University Avenue / Hedley Place;
- Berrimah Road / Wishart Road;
- Tiger Brennan Drive / Berrimah Road;
- Stuart Highway / Berrimah Road;
- Stuart Highway / Lambrick Avenue; and
- Stuart Highway / Temple Terrace.

Table 5-8a Summary of SIDRA Analysis: Degree of Saturation

	2008 Conditions	2013 Background Traffic Growth	2013 including Generated Construction Traffic	2015 Background Traffic Growth	Intersection Movement Causing DoS	Comment
Elrundie Avenue/Wishart Road/Hedley Place/University Avenue (AM peak)	0.48	0.77	0.82	0.93	Northbound Elrundie Ave: left turn into Wishart Road (inbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Berrimah Road/Wishart Road (PM peak)	0.86	0.90	0.91	0.93	More than one intersection movement Southbound Berrimah Rd: left turn into Wishart Rd (outbound); and Northbound Berrimah Rd: right turn into Wishart Rd (outbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Elrundie Avenue/Chung Wah Terrace (PM peak)	0.07	0.09	0.17	0.09	Northbound Elrundie Ave: right (outbound) turn into Chiung Wah Tce	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Stuart Highway/Berrimah Road (PM peak)	0.89	1.00	1.00	1.03	More than one intersection movement Southbound Vanderlin Dve: right turn into Stuart Highway (inbound); Eastbound Stuart Highway: through movement (outbound); and Northbound Berrimah Rd: right turn into Stuart Highway (outbound)	Generated traffic creates incremental impact. Intersection operating above capacity without impact of generated traffic by 2015.

	2008 Conditions	2013 Background Traffic Growth	2013 including Generated Construction Traffic	2015 Background Traffic Growth	Intersection Movement Causing DoS	Comment
Stuart Highway/Lambrick Avenue (AM peak)	0.82	0.96	1.06	1.05	More than one intersection movement Southwest-bound Howard Springs Rd: right turn into Stuart Highway (inbound); Southwest-bound Howard Springs Rd: through movement; and Northwest-bound Stuart Highway: through movement (inbound)	Generated traffic increases degree of saturation. Intersection operating above capacity without impact of generated traffic by 2015.
Stuart Highway/Temple Terrace (PM peak)	0.76	0.90	0.90	0.89	Southeast-bound Stuart Highway: through movement (outbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Channel Island Road/Wickham Point Road (AM peak)	0.04	0.11	0.19	0.06	Northwest-bound Channel Island Road turning right into Wickham Point Road (outbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Stuart Highway/Jenkins Road (PM peak)	0.11	0.11	0.15	0.16	Northbound Stuart Highway: through movement (inbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.

Table 5-8b Summary of SIDRA Analysis: 95% Queue Length (meters)

	2008 Conditions	2013 Background Traffic Growth	2013 including Generated Construction Traffic	2015 Background Traffic Growth	Intersection Movement Causing 95% Queue Length	Comment
Elrundie Avenue/Wishart Road/Hedley Place/University Avenue (AM peak)	38	114	114	114	Northbound Elrundie Ave: left turn into Wishart Road (inbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Berrimah Road/Wishart Road (PM peak)	228	324	378	364	Southbound Berrimah Rd: left turn into Wishart Rd (outbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Elrundie Avenue/Chung Wah Terrace (PM peak)	No more than 1 car	No more than 1 car	No more than 1 car	No more than 1 car	Northbound Elrundie Ave: through movement (inbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Stuart Highway/Berrimah Road (PM peak)	284	469	495	557	Eastbound Stuart Highway: through movement (outbound)	Generated traffic creates incremental impact. Intersection operating above capacity without impact of generated traffic by 2015.
Stuart Highway/Lambrick Avenue (AM peak)	195	556	791	802	Northwest-bound Stuart Highway: through movement (inbound)	Generated traffic increases queue length. Intersection operating above capacity without impact of generated traffic by 2015.
Stuart Highway/Temple Terrace (AM peak)	109	214	294	292	Northwest-bound Stuart Highway: through movement (inbound)	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.

	2008 Conditions	2013 Background Traffic Growth	2013 including Generated Construction Traffic	2015 Background Traffic Growth	Intersection Movement Causing 95% Queue Length	Comment
Channel Island Road/Wickham Point Road (PM peak)	0	0	0	0	-	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.
Stuart Highway/Jenkins Road (PM peak)	0	0	0	0	-	Generated traffic creates negligible incremental impact compared to background traffic growth. Intersection can operate below required threshold.

Section 6 Site Requirements

6.1 Site Access

The only access from existing road infrastructure is via Channel Island Road that runs east-west to the south of the development and then via Wickham Point Road. It is assumed that some form of control / security gating will be installed at the entrance to the site and the existing unsealed access track upgraded. The configuration of this entrance must take into account the amount of vehicles that access and egress the site – particularly with regards to the large proportion of commercial vehicles during peak construction periods.

During the construction period, consideration needs to be given to the priority for traffic at this intersection. Whilst Wickham Point Road is currently the priority route, during construction it is likely that there will be more traffic using the access road to the Blaydin Point site and hence priority for this road should be considered.

The intersection of Wickham Point Road and Channel Island Road provides sufficient area for road train turning movement and is likely to be able to accommodate oversized vehicles. There is significant evidence of “hoon” activity in the area, with tyre marks on the road and large amounts of rubbish in the surrounding area.

6.2 Internal Circulation

The internal road layout should take into consideration that a large number of commercial vehicle and bus movements will occur within the site. A continuous circulating internal road layout should be employed in order to reduce the likelihood of commercial vehicles being required to perform hazardous reversing or turning movements. Examples of continuous circulation may be by providing a one-way direction at all times or in allowing ample space for large vehicles to safely perform a u-turn movement (without the need to do three-point turns).

Commercial vehicles will generally be performing through movements within the site whereby they will be delivering or picking up certain materials and continuing on to their destination. Cars, on the other hand, will mainly be used for personal travel and will be situated at the site for extended durations. In addition, it is anticipated that buses will be utilised to transport employees to and from the site and their movements within the facility must also be considered. Such a mix of vehicles increases the safety risk of circulating traffic within the site. It is therefore suggested that commercial vehicle through movements be separated from bus and car movements to reduce the possibility for conflict occurring. Once buses and cars have parked within the site, they will generate pedestrians. The safety and circulation of pedestrians within the development must also be taken into consideration and, where possible, conflict points should be avoided or appropriately managed (i.e. adequate visibility at pedestrian crossing locations).

6.3 On-Site Parking

Carparking within the site should be designed to provide adequate parking for cars and (if required) buses and commercial vehicles. It has been calculated that approximately 15 commercial vehicles and 50 buses will be generated at the site per day during peak periods and it is anticipated that there will be approximately 125 cars parked at this site during the day for employees.

Articulated trucks and buses (not including road trains) have a swept path with a 26 m radius and this should be considered when designing 90 degree parking bays. This need for safe turning areas can be minimised by using 45 degree angle parking bays for large vehicles.

It is assumed that parking provision will be required for only a small proportion of commercial vehicles, as the majority will be completing round trips, with loading and unloading occurring on site before moving to their next location. Commercial vehicles should be accommodated within an off site depot outside working hours and for maintenance purposes. This will ensure space on site is used efficiently.

Similarly, bus parking needs can be minimised by providing a circulation route around specific sites within the LNG facility to drop off and pick up employees. Buses can then be stored at an off site facility until further required. These needs may be filled through the use of a subcontract whereby buses can be provided as needed and then used for other purposes when not required. The provision of a number of bus stops within the LNG facility will also minimise pedestrian movements required to increase safety.

Provision will also be needed for some visitor car parking near the main site office.

A general guide for car parking space is 25m^2 per car which allows safe circulation space. Commercial vehicle and bus parking area can vary according to configurations, but is in the order of 170-250m^2 per vehicle.

During the operation phase, it is assumed that the parking provided during construction can be transformed into car parking to accommodate employee commuters.

The design of car parking facilities should consider the Australian Standards for Parking Facilities;

- AS 2890.1:2004 Parking facilities Part 1: Off-street car parking
- AS 2890.2:2002 Parking facilities Part 2: Off-street commercial vehicle facilities

Section 7 Other Items

7.1 Stakeholder Consultation

The Socio-Economic Impact Assessment Consultations undertaken by URS for INPEX was based on one-on-one meetings with key stakeholders to assist in identifying and assessing the impacts associated with the gas plant development. The consultation addressed a wide range of positive and negative impacts across a broad range of categories associated with the construction and operation of the gas plant (e.g. living standards, accommodation difficulties, skill shortages, sediment control, and impact to fisheries). A handful of stakeholders identified issues with regards to traffic and increased road use derived directly from the development, which are summarised as follows:

- The influx of personnel to the area may increase the likelihood of drink driving or other driver safety concerns, especially if the accommodation facilities are located away from service amenities,
- There may be an increase of vehicles on the traffic network during peak periods,
- Roads that are unsuitable for large traffic volumes or large trucks (i.e. unsealed) may be utilised for the project, and;
- The potential for congestion in the local streets increasing significantly as a result of the construction traffic.

Litchfield Council expressed particular concerns about increased traffic and road safety risks resulting from the construction project. There had been some resentment amongst some local people of the traffic congestion caused during the construction of the ConocoPhillips LNG processing facility. If the traffic volumes increased substantially (as they expected they would during construction) then access via Jenkins Road and Finn Road would be an issue: there would most likely be traffic build up and potentially safety issues. INPEX would need to consider the Litchfield Shire Council's concerns when determining the traffic routes and times of travel of personnel to reduce impacts on the current traffic patterns to a minimum where possible.

It should be noted that the analysis presented in Section 5 shows that the proposed development of itself will not have a significant impact on traffic congestion in the Darwin region, which may be useful to allay stakeholder and community concerns.

7.2 Over-Dimension Vehicles

The Northern Territory DPI has advised URS that permits will be required for all over-dimension vehicles (geometric and mass). In order to approve the permits, a detailed logistics plan will need to be developed. Logistics plans will need to be submitted for individual components (i.e. each separate vehicle) as well as the entire program of planned movements.

Permit applications must include, but are not limited to individual axle loads, gross mass and vehicle configuration. For over dimension loads, route selection, potential traffic conflicts and proposed traffic management must also be provided in order to be assessed.

DPI also recognised several issues in the surrounding areas that may need to be addressed when planning the routes for over-dimension vehicles:

- Some overhead transmission lines may require lifting. A site investigation should be conducted along the proposed over-dimension route to determine whether low lying transmission lines pose a hazard;
- Some traffic signals may need to be laid down in order to allow for adequate movement of over-dimension vehicles;

- Rail crossings have width issues for over-dimension vehicles as these roads are generally a single carriageway with one lane in each direction. Noted rail crossings exist on Berrimah Road, Wishart Road (two) and Channel Island Road;
- Elizabeth River Bridge is a single carriageway bridge with one lane in each direction and has permanent railings with no shoulders. A previous project utilised hydraulic jacks in order to lift their loads above the height of the bridge barriers;
- Channel Island Road may cause an issue for over-dimension vehicles accessing the site. A previous project used drop kerbing as well as other measures to provide adequate access for over-dimension vehicles – however additional works may be required for this project; and
- Stuart Highway would be a preferred route over Tiger Brennan Drive for over-dimension vehicles as it is dual carriageway with two lanes in each direction. This will minimise the impact these larger vehicles will have on vehicles travelling in the opposing direction.

The Department, requested that templates for loads and the log for roads be submitted along with the proposed schedule of operation where over-dimension vehicles may be required. They have stipulated that it is unacceptable to close a length of road for an extended period of time and the over-dimension vehicle will need pull-off locations to allow banked up traffic to overtake. It has been identified that the planning for over-dimension vehicles will require a number of parties to be involved and therefore careful planning is needed. The submitted plans and documents for over-dimension vehicle movements will need to be submitted to DPI several months prior to allow for advanced warning and adequate time for planning.

In addition, Litchfield Council has shown reservations for over-dimension vehicles to utilise the unsealed Jenkins Road. Upgrades may be required to provide suitable access to larger vehicles. Furthermore, there arise additional maintenance issues as well as the affects of the wet season if the road remains unsealed.

It should be further noted that road trains are not permitted within Palmerston and must instead use Tivendale Road to access Stuart Highway. The access route to Stuart Highway may be altered upon the completion of the Tiger Brennan Drive upgrade and extension.

Local roads within Palmerston are designed for 19 metre articulated vehicles which includes B-double vehicles and standard buses. Road geometry limits manoeuvring ability for long articulated buses within Palmerston, especially at roundabouts and therefore it is suggested to use standard buses in this area.

7.3 Public Transport

The current public transport network provides access between all three proposed accommodation facilities sites and Palmerston (and then onto Darwin CBD). It is anticipated that employees residing in the accommodation facilities will require public transport services to access shopping, social and other amenities in Palmerston and Darwin CBD. Timetables of these services should be reviewed once the final location of the facilities is determined to ensure adequate capacity is available for the employees.

A suggested alternative to public transport is for INPEX to provide a private bus service to amenities for their employees.

The proposed LNG processing plant at Blaydin Point currently has no public transport accessing Wickham Point Road.

Section 8 Conclusion

The greatest traffic impact of the LNG plant development at Blaydin Point will occur during the construction period of the development. Traffic generated during this phase will consist of construction related commercial vehicle movements and employee transport between the site and the accommodation facilities.

The proposed development is not expected to create an overall significant incremental adverse impact on the operation of the road network when compared to background traffic growth. However, it should be recognised that there are a number of key intersections that will be congested by the time construction reaches its peak, due to background traffic growth in Darwin, driven by the on-going increase in population (and the distribution of this population in the satellite suburbs). The roadworks required to mitigate the traffic impact of the development are localised and possibly consistent with the larger long term requirements associated with the growth of Darwin and surrounds.

It should be noted that the analysis does not take into account the influence of the new Tiger Brennan Drive extension project which is anticipated to be completed in 2010. If this project is completed prior to the development of the LNG facilities, the results of the modelling will change due to a shift in the usage of roads affected by the new Tiger Brennan Drive. Overall, the network should operate more efficiently if this occurs.

The following outcomes warrant consideration;

- The Stuart Highway/Berrimah Road intersection is shown to operate above the acceptable Degree of Saturation threshold during the period of maximum construction activity in the AM peak hour. However, there is no incremental impact from the generated construction traffic when compared to general traffic growth in the same year. Therefore upgrading this intersection should not be required.
- The Stuart Highway/Lambrick Avenue intersection shows an incremental impact in Degree of Saturation from the generated construction traffic when compared to general traffic growth in the same year due to the location of the accommodation facilities. There are three possible approaches that can be taken;

  1) As the impact is related only to the highest period of construction activity, the temporary congestion at this one intersection over one hour of the day can be accepted as a consequence of the development.
  2) Stuart Highway can be widened locally on each side of this intersection (noting that this is only necessary to accommodate a short period of construction activity through the intersection). The approach sides on Stuart Highway are widened to allow for vehicles to queue in the new lane created at the stop line of the Lambrick Avenue intersection. The departure side of Stuart Highway is also widened to provide a sufficient distance to allow vehicles to merge from the new lane into the existing lanes after passing through the intersection. Howard Springs Road and Lambrick Avenue already have two right turning lanes. It is uncommon to provide more than this as it compromises safety due to three vehicles abreast turning right in each direction. Therefore the only safe option for increasing capacity is widening on Stuart Highway. SIDRA analysis shows that adding through or left turn lanes on either or both side roads does not sufficiently reduce the degree of saturation.
  3) The impact of the Tiger Brennan Drive extension project may change traffic distribution around the Stuart Highway / Lambrick Avenue intersection as it will provide motorists with a direct east-west route alternative to Stuart Highway. This is expected to reduce demand along Stuart Highway, and therefore reduce the demand at the Stuart Highway / Lambrick Avenue intersection. If it is anticipated that the Tiger Brennan Drive extension will be completed prior to the INPEX construction period, it is likely this intersection will accommodate construction traffic and operate at an acceptable level of performance.

Conclusion Section 8

The location of the employee housing accommodation facilities is to be Howard Springs Sections 2819 and 2818. The major implications presented by the proposed site are that the accommodation facilities location would have an impact on the capacity of the Stuart Highway/Lambrick Avenue intersection during the AM peak period (as described above). In addition, the construction of a new intersection would be required on Howard Springs Road for access to the sites.

These are the only roadworks that may be required in addition to the connection from the accommodation facility to the existing road network, to normal design standards (ie not over dimensional vehicles including road trains).

The use of over dimension vehicles may also require that some localised road upgrades are required such as shoulder strengthening or drop kerbing along the selected route.

It is recommended that the following issues be considered in the planning of the INPEX LNG development;

- Oversize vehicles will require plans and permits, which may include some road improvements
- Investigate minimising personnel and construction movements during peak hours, where possible
- Bus transport from the accommodation facilities to the site will minimise car impact
- The use of unsealed roads should be avoided
- Appropriate on site provision for parking and manoeuvring of vehicles both at the LNG plant site and employee accommodation facilities should be incorporated into their design
- Consideration of offsite maintenance and parking for commercial vehicles and buses will minimise parking requirements
- Circulation routes with designated bus stops within the LNG plant site for employee buses will enable efficient traffic flow through the site
- The intersection at which the accommodation facilities join the road network will require detailed design and traffic management plans for construction to minimise impact on the existing road network
- The possible upgrade of the Stuart Highway/Lambrick Avenue intersection.

Section 9 Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of INPEX, Browse Ltd. and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated August 2008.

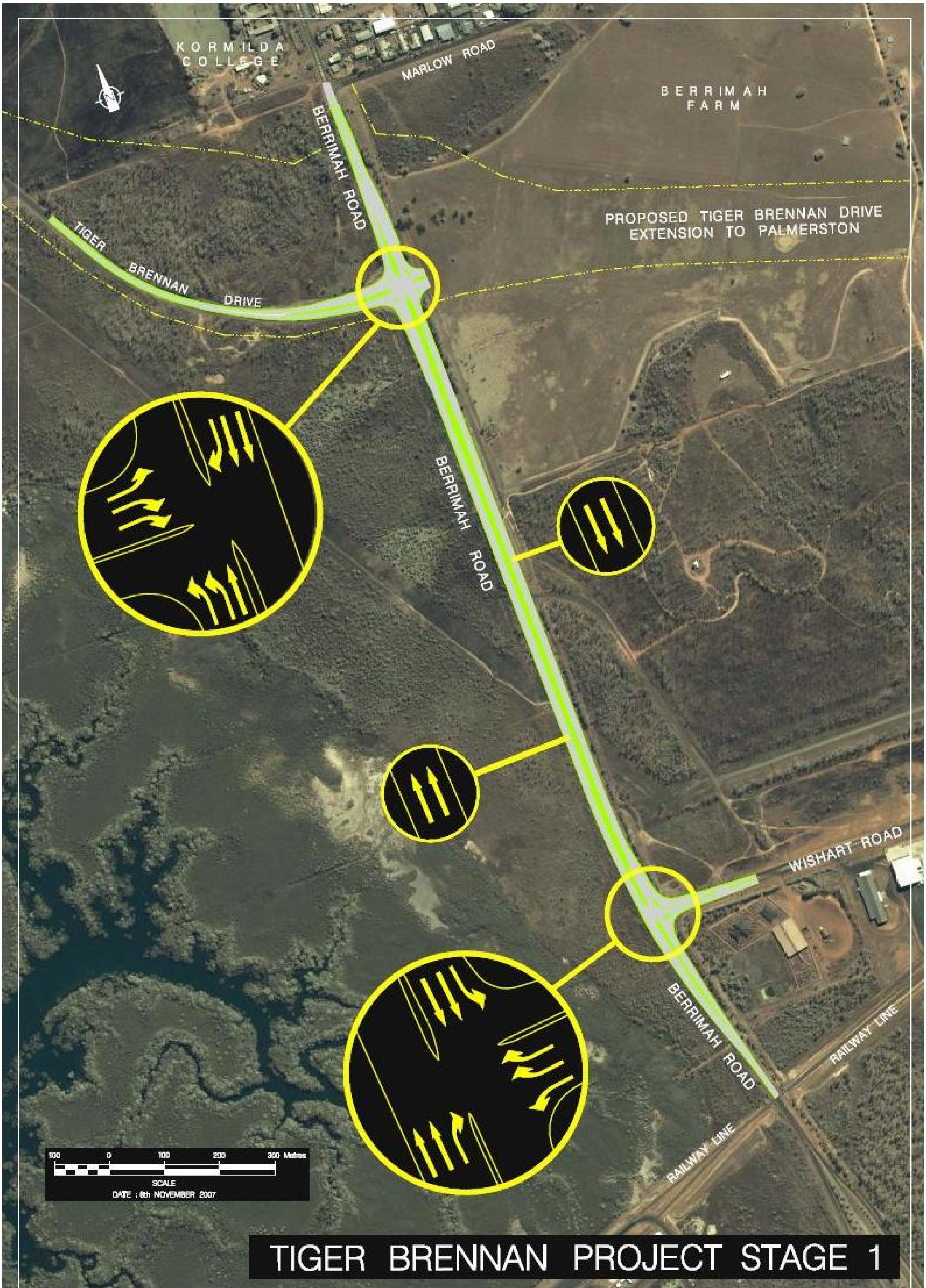
The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared in October 2009 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Road Upgrade Works (photos only)

Appendix A



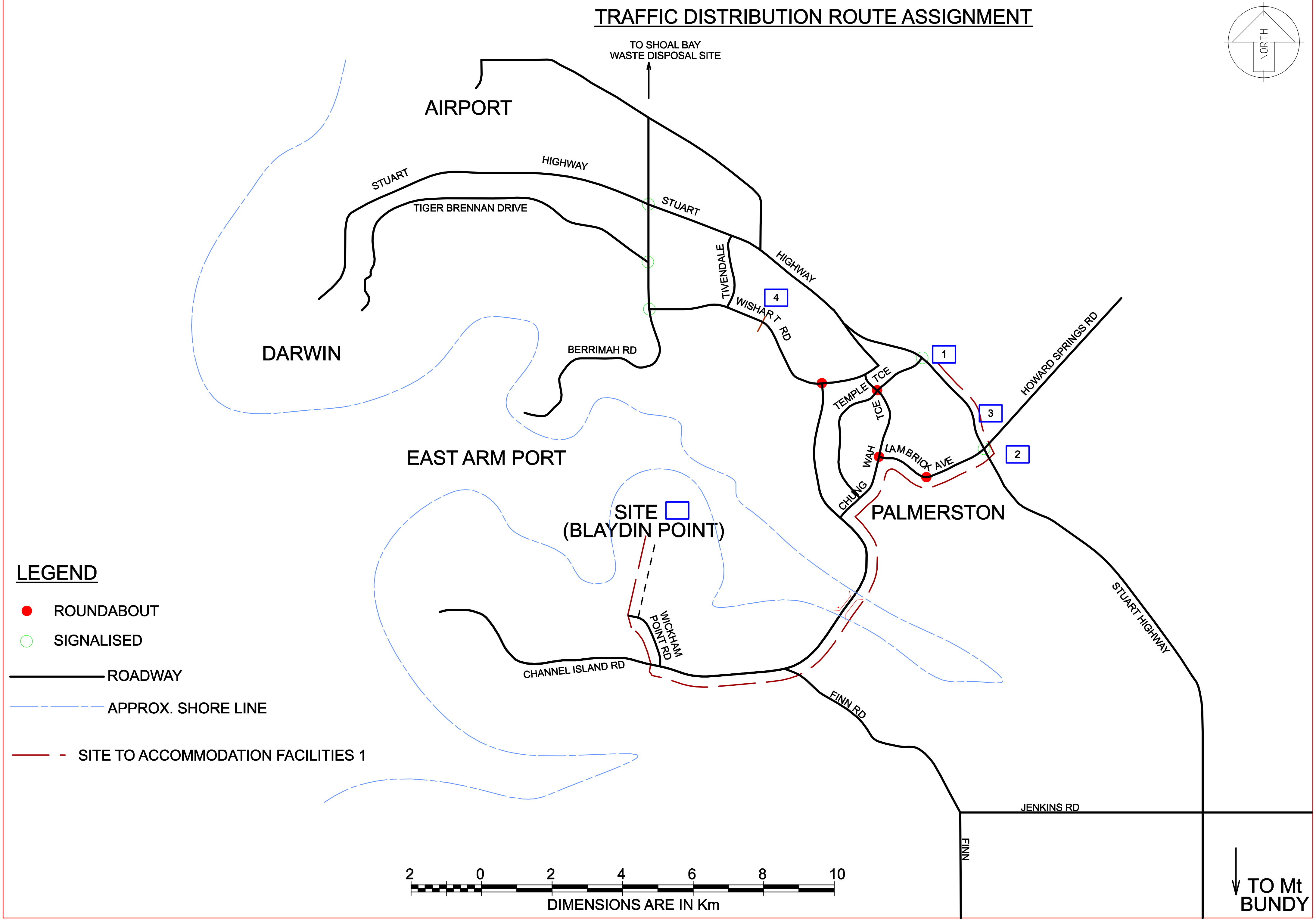
TIGER BRENNAN PROJECT STAGE 1

BERRIMAH
BERRIMAH ROAD
KORMILDA COLLEGE
BERRIMAH FARM
PRISON
TIVENDALE ROAD
STUART HIGHWAY
CARAVAN PARK
PINELANDS ESTATE
TIGER BRENNAN DRIVE
ROYSTONEA AVENUE
WISHART ROAD
STAGE 1
STAGE 2
STAGE 3
RAILWAY LINE
TIVENDALE RD
RAIL CORRIDOR
HUDSON CREEK
RAILWAY YARDS
CHARLES DARWIN UNIVERSITY PALMERSTON CAMPUS
UNIVERSITY AVENUE
PALMERSTON CITY CENTRE
FAIRWAY WATERS
PALMERSTON
100 0 100 200 300 Metres
SCALE
PLOT DATE : 11th APRIL 2008
© NORTHERN TERRITORY OF AUSTRALIA
(3 STAGES OF PROPOSED EAST ARM PORT ACCESS ROUTE – TIGER BRENNAN DRIVE WITH DUPLICATED SECTION BETWEEN TIVENDALE ROAD, AND STUART HIGHWAY OVERPASS AND INCLUDES BERRIMAH ROAD RAILWAY OVERPASS)
AERIAL PHOTOGRAPHY DETAILS:
DARWIN AUSIMAGE
DARWIN COVERAGE 2006
© DEPARTMENT OF PLANNING & INFRASTRUCTURE – 2006
Australian Government
Northern Territory Government
TIGER BRENNAN DRIVE EXTENSION
(DEVELOPMENT STAGES)

Traffic Distribution Route Assignment

Appendix B

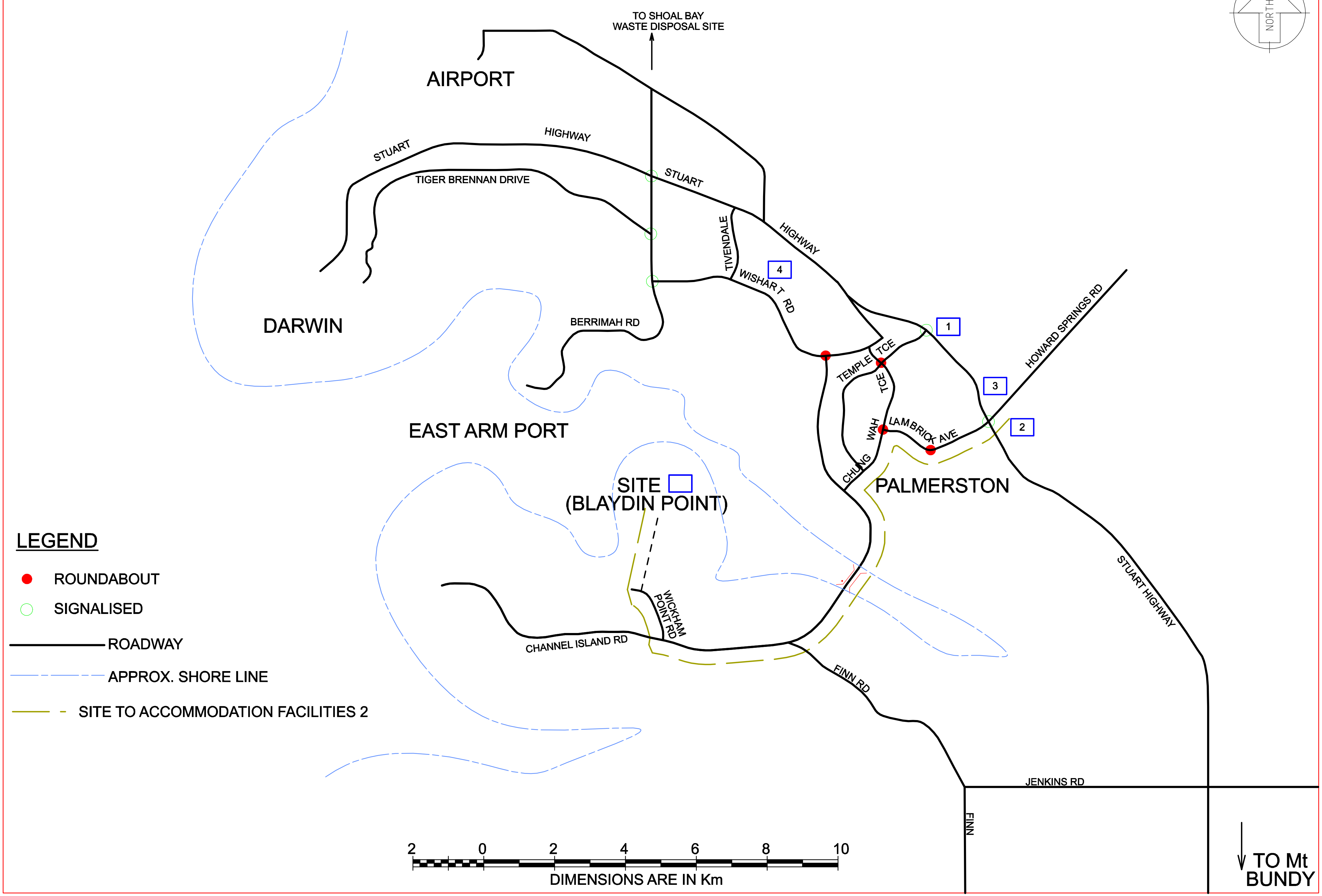
TRAFFIC DISTRIBUTION ROUTE ASSIGNMENT



LEGEND

- ROUNDABOUT
- SIGNALISED
- ROADWAY
- APPROX. SHORE LINE
- SITE TO ACCOMMODATION FACILITIES 1

TRAFFIC DISTRIBUTION ROUTE ASSIGNMENT



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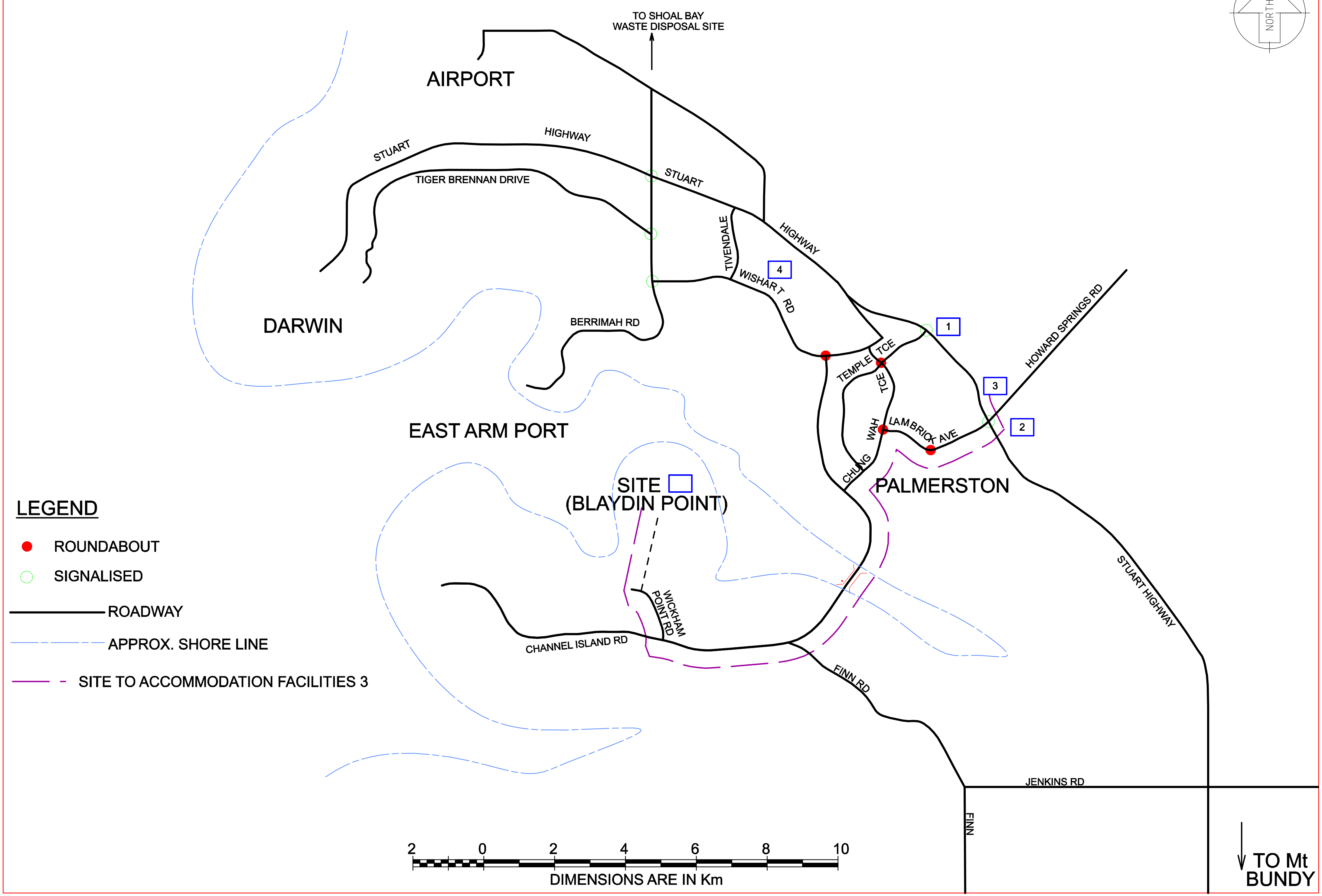

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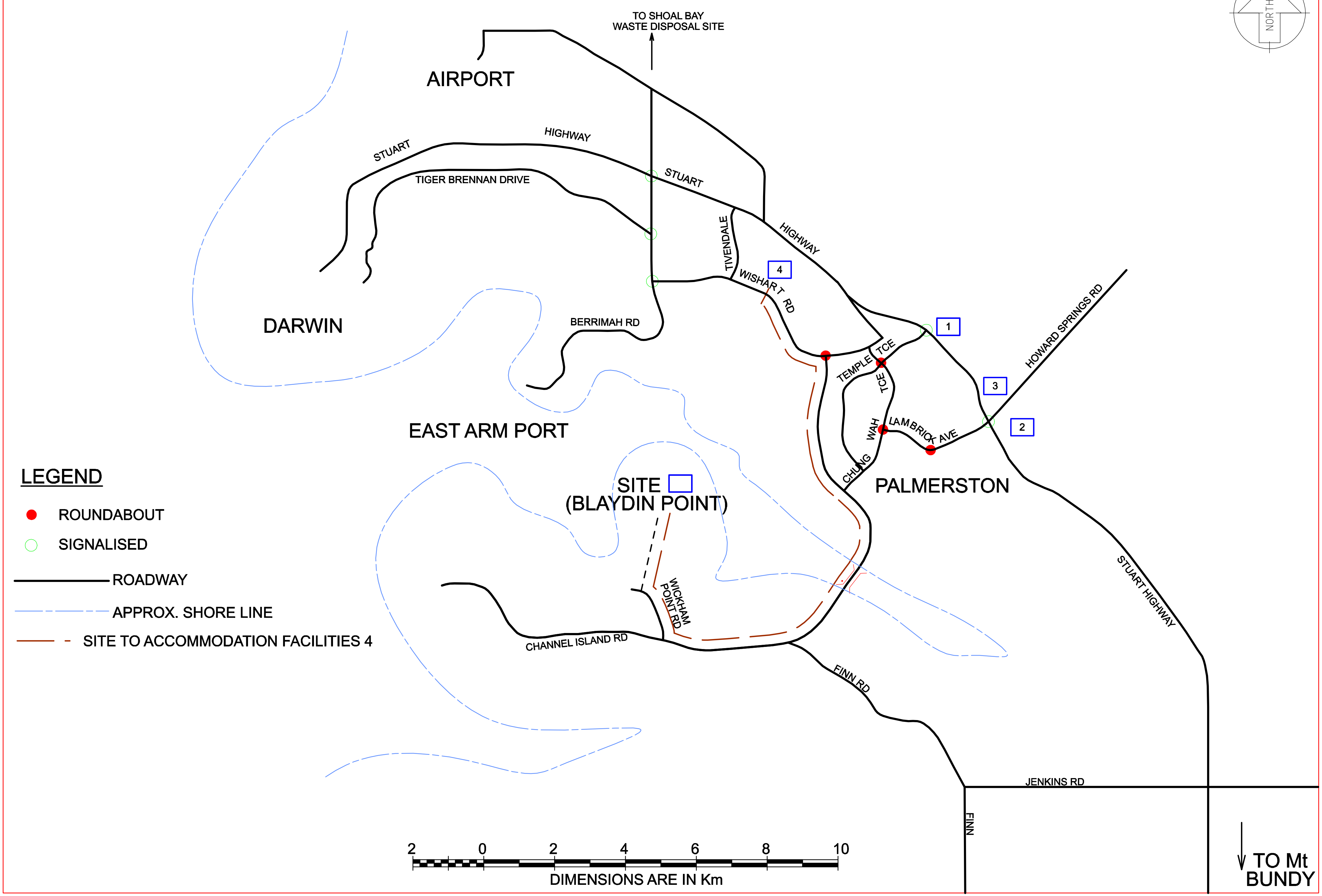

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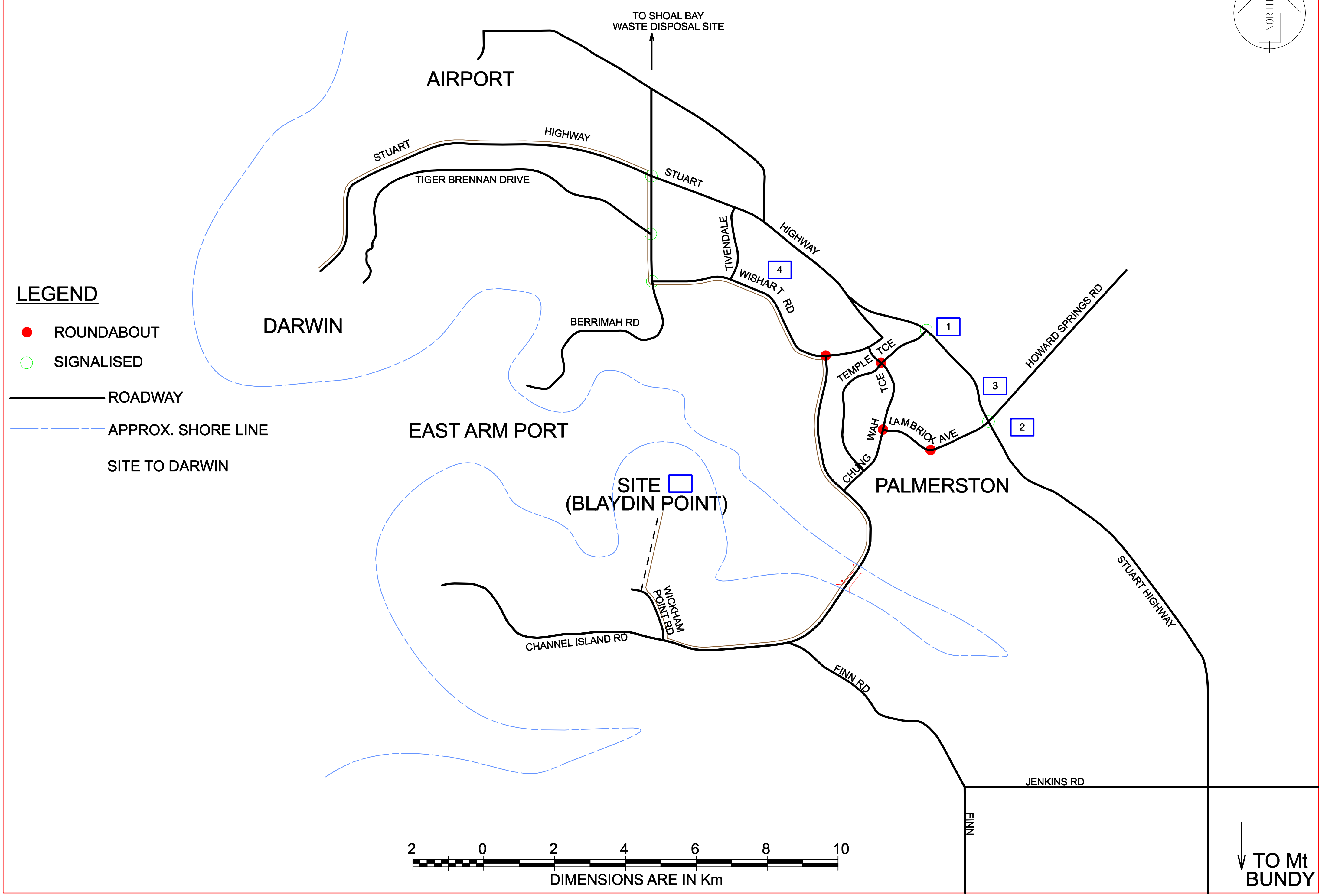

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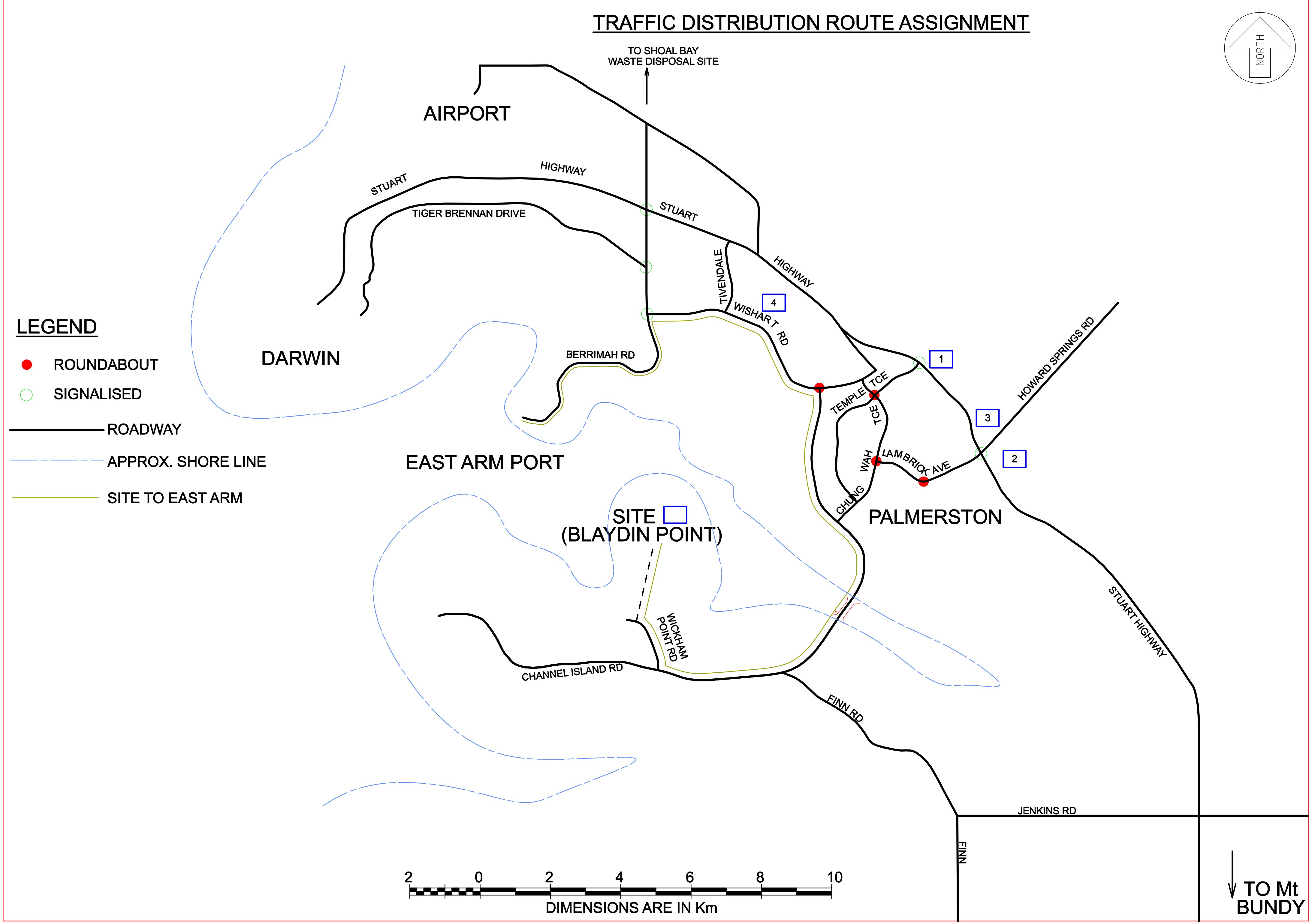

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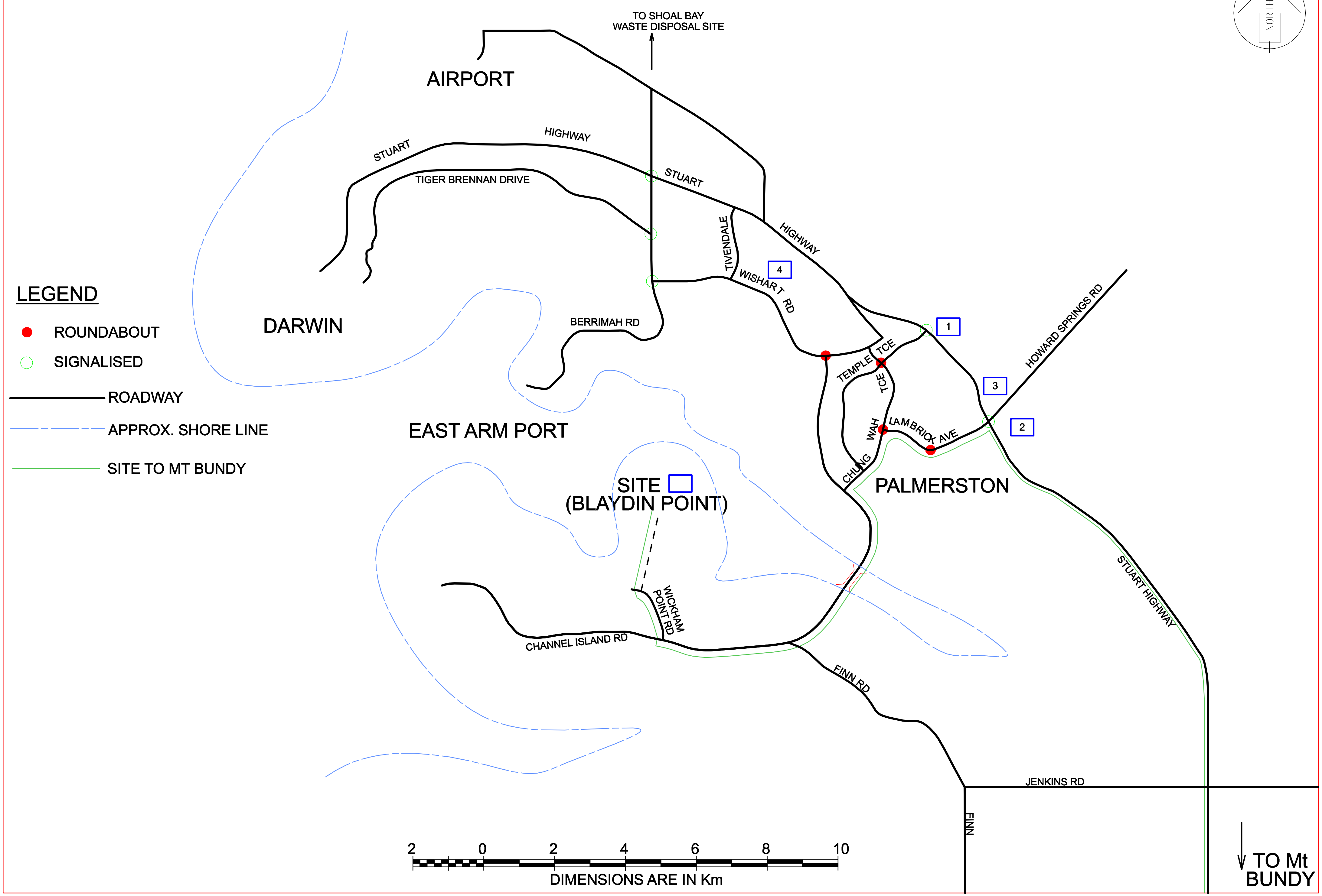

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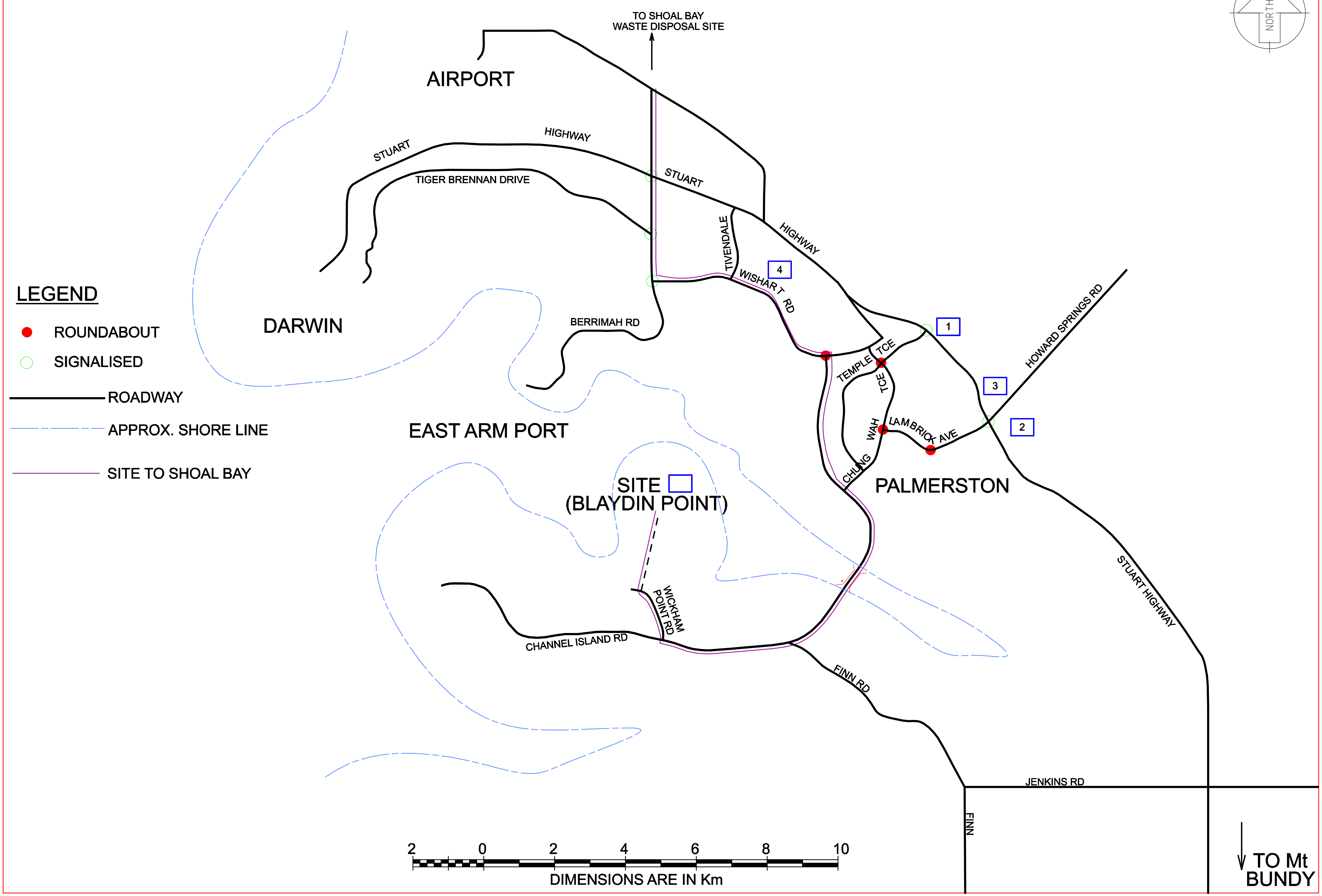

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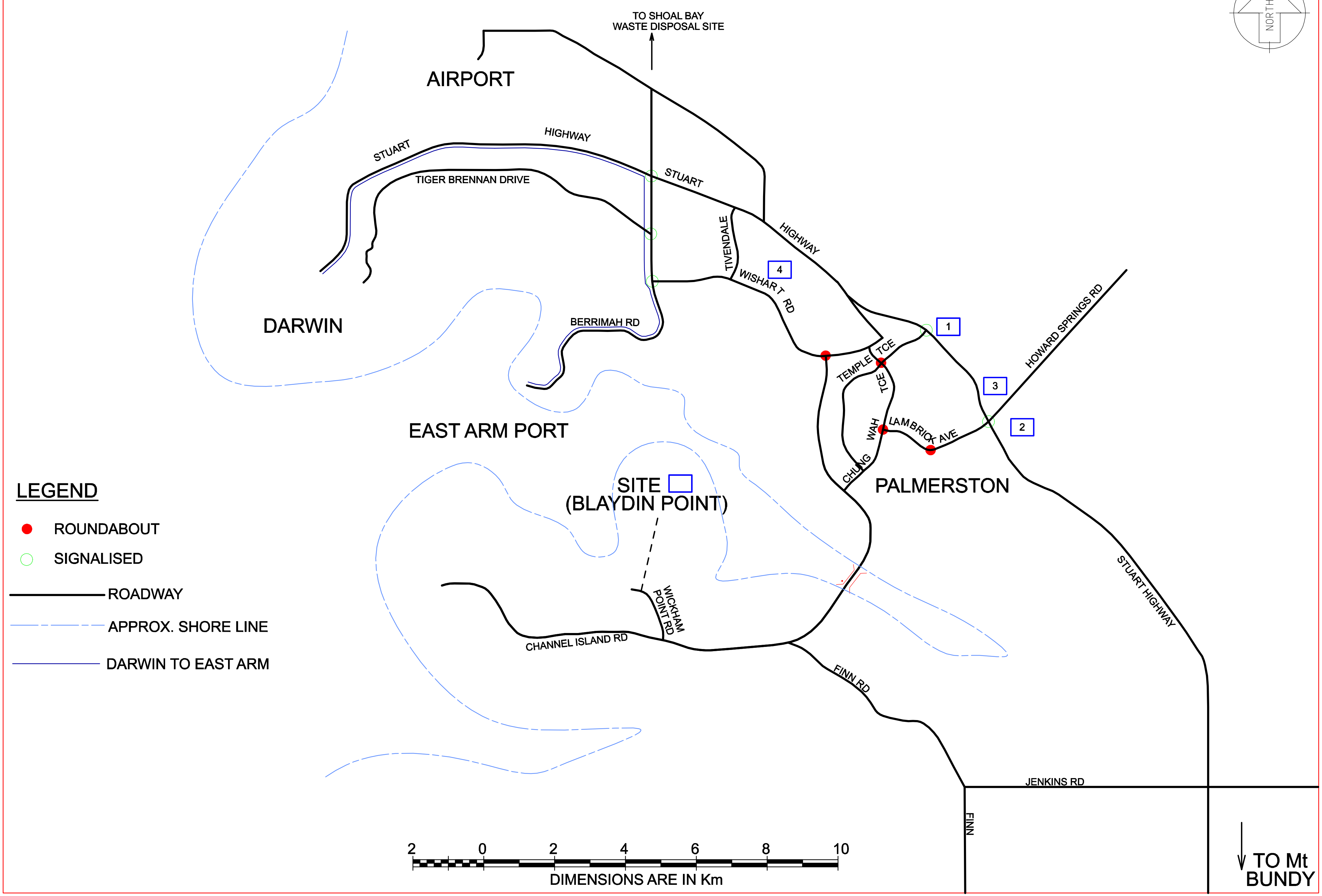

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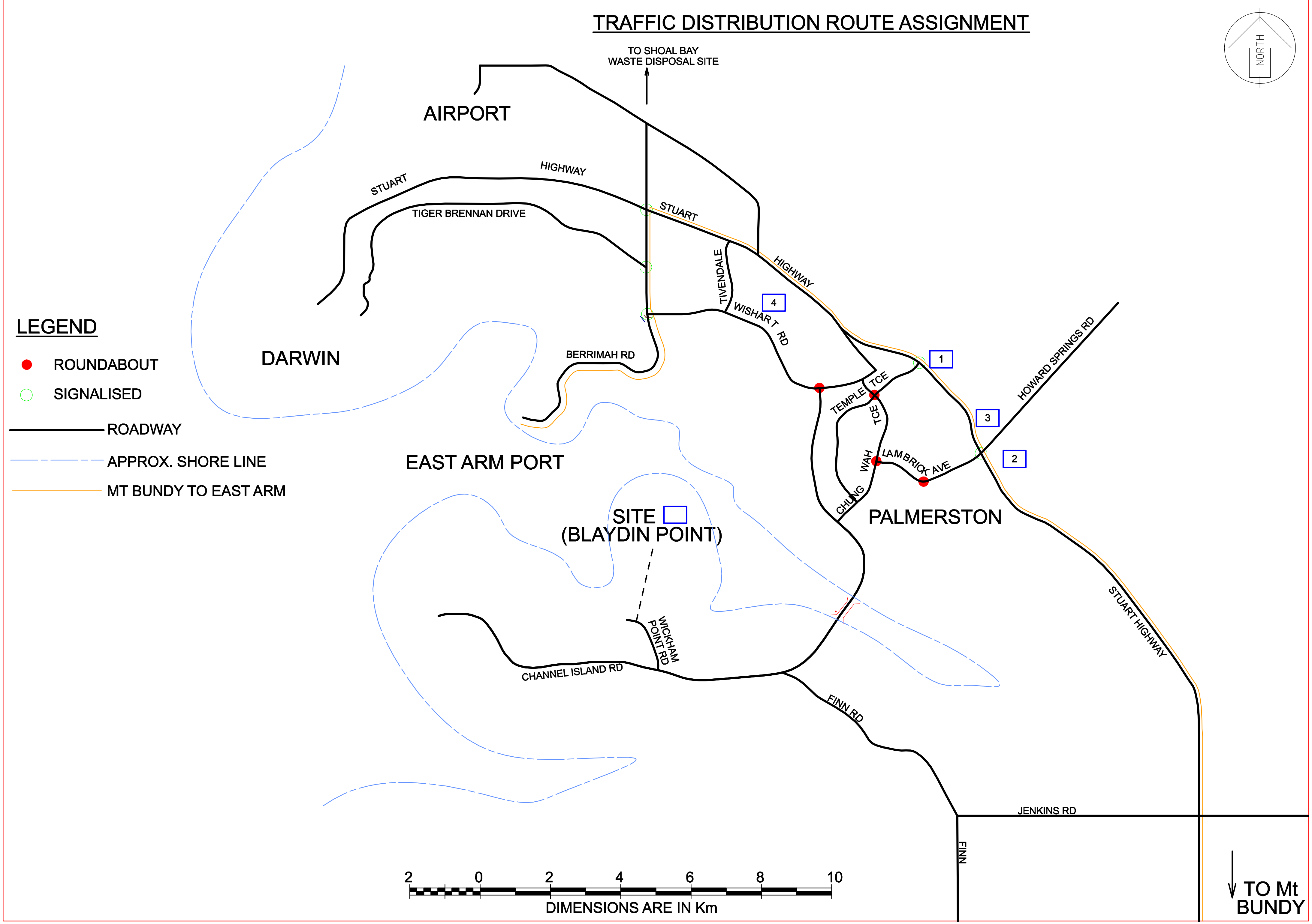

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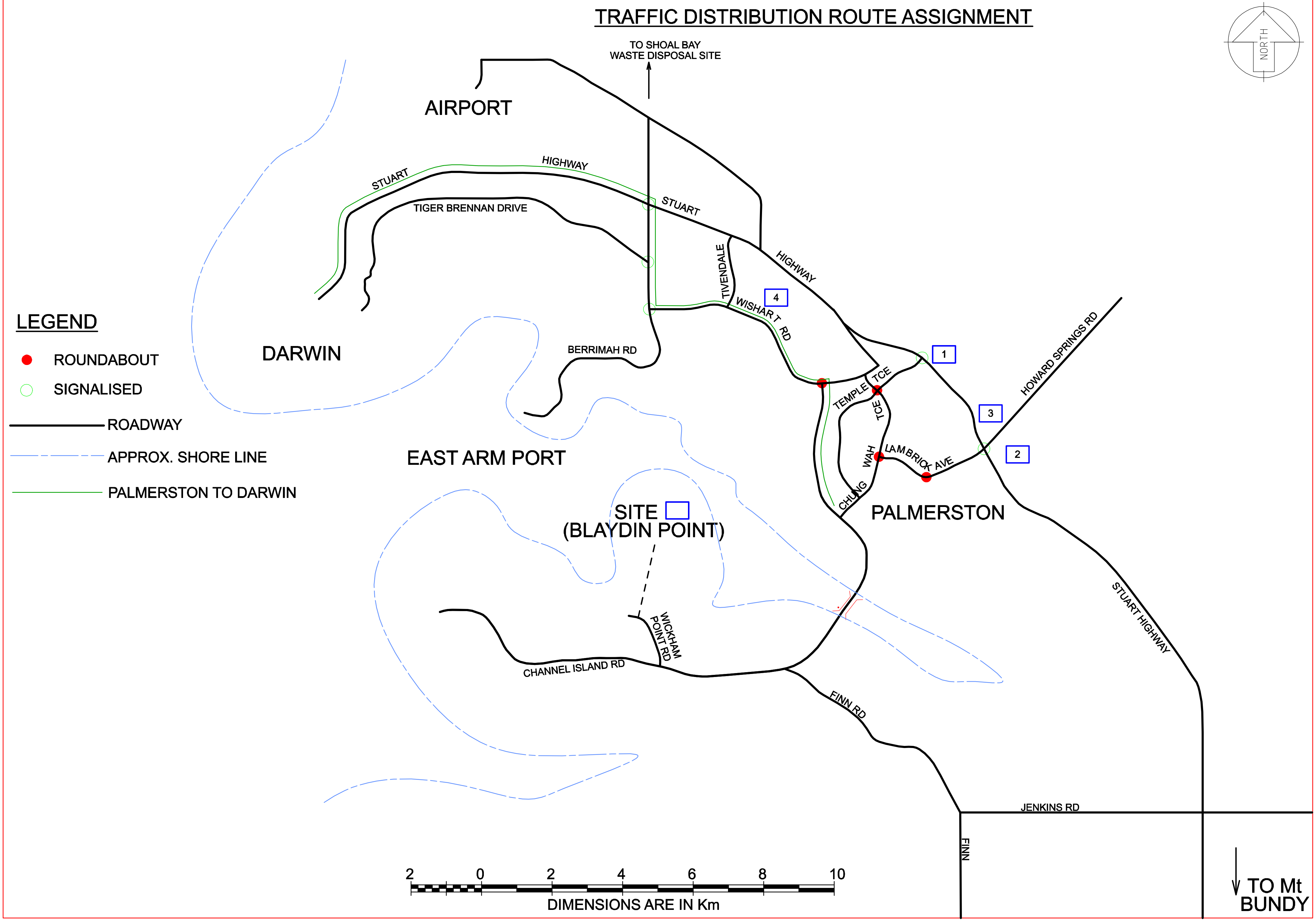

LEGEND

- ROUNDABOUT
- SIGNALISED
- ROADWAY
- APPROX. SHORE LINE
- PALMERSTON TO DARWIN