



**Gardens Hill
Development Lots 6907
+ 6908 (SN 25+16)
Blake St, The Gardens**

Final 1.2

Prepared by i3 consultants WA for
Irwinconsult & Makrylos Group

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Project details

Project	Gardens Hill Development Lots 6907 + 6908 (SN 25+16) Blake St, The Gardens
Project ID	00301
Client	Irwinconsult & Makrylos Group
Description	A Preliminary Traffic Assessment report to assess the feasibility and likely traffic impacts of a mixed use development on Lots 6907 & 6908 The Gardens comprising of 1,000 dwellings, Café's, Restaurants, Deli's, Retail, Green Open Spaces, Botanic Gardens Links and Viewing Platforms with a single access off Gardens Road.

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Revision Record: Version F1.1 corrects Table 5 with PM split now 65%/35% (previously 65%/55%). Table 7 and Figures 14 & 29 updated to reflect effect of correction. Overall impacts for PM generated OUT traffic are less than reported as a result of this correction. F1.2 reflects access relocated from 80 m south of Chin Quan Rd to 215 south (i.e. 140 m north of Melville St) to take advantage of clear area of vegetation. No assessed impact on findings or recommendations.

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A combination of Road Safety Auditing, Crash Investigation and Traffic Impact Assessment skills allows for the impact of traffic generating developments on the likely safety performance of the road network to be fully assessed within an appropriate risk management process.

ABOUT THE GARDENS & DARWIN'S INNER SUBURBS

The proposed *Development Site* is located in the City of Darwin suburb of The Gardens which forms part of the Northern Territory Planning Commission's *Inner Suburbs Area Plans* and *Compact Urban Growth* initiatives.

The Northern Territory Planning Commission is using the recently adopted Compact Urban Growth Policy to guide the preparation of *Area Plans* for Darwin's Inner Suburbs. The *Area Plans* aim to:

- identify activity centres and public transport nodes, where higher dwelling and commercial density may be encouraged;
- identify transition areas around these centres and nodes, where dwelling density will become less intense, and will transition to lower densities generally matching the surrounding locality (generally around 400 metres away from the activity centre and public transport node);
- encourage development that is consistent with the predominate housing and building types in the area.

These guiding principles will assist with balancing the demands of a growing population with the lifestyle aspirations of the community.

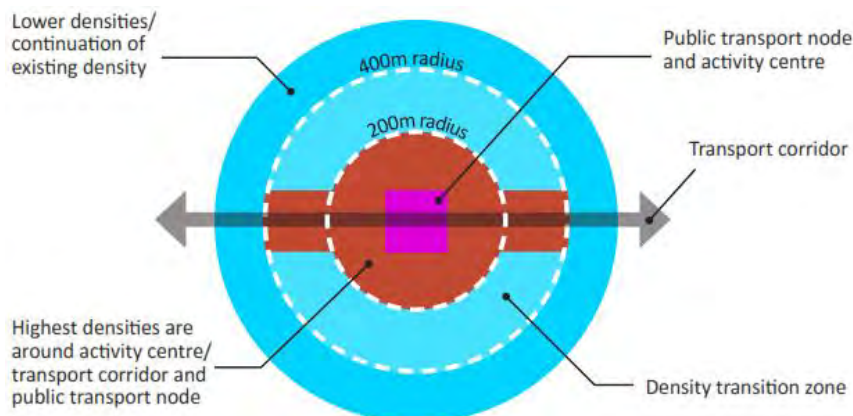


Figure 1 – The Compact Urban Growth Model

Higher densities are encouraged within 400 metres of activity centres and high frequency public transport corridors.

The following flow chart represents the three stages of preparation for the inner suburbs *Area Plans*.



I INTRODUCTION AND SUMMARY

This Preliminary Traffic Assessment (PTA) report has been prepared to assess the feasibility and likely traffic impacts of a mixed use development on Lots 6907 & 6908 The Gardens comprising of 1,000 dwellings, Café's, Restaurants, Deli's, Retail, Green Open Spaces, Botanic Gardens Links and Viewing Platforms with a single vehicular access off Gardens Road.

The assessment has been carried out in the context of the Northern Territory Planning Commission's Inner Suburbs *Area Plans* and *Compact Urban Growth Policy* initiatives and as such has been prepared in accordance with the principles outlined in the following documents:

- *Darwin Regional Land Use Plan 2015* ⁽³⁾;
- *Darwin Inner Suburbs Area Plans* ⁽⁴⁾;
- *Northern Territory Compact Urban Growth Policy* ⁽⁵⁾;
- *Northern Territory Planning Scheme* ⁽⁶⁾;
- *Darwin City Centre Master Plan* ⁽⁷⁾; and
- *Research Report AP-R488-15 "Safe System in the Planning Process"* ⁽⁸⁾

I.1 PURPOSE OF REPORT AND STUDY OBJECTIVES

The purpose of this report is to assess the feasibility of a 1,000 dwelling Mixed Use Development on Lots 6907 & 6908 The Gardens with sole vehicular access off Gardens Road in the context of Section 4.3 (Traffic Management) of the *Northern Territory Compact Urban Growth Policy*, i.e.:

Objective:

To ensure that higher density residential proposals do not cause a detrimental impact on vehicle movement.

Key Performance Indicators:

1. *Can the existing road network support the proposed density increase (i.e. Is it likely that the development will result in intersection failure)?*
2. *Is the road reservation adjoining the proposal wide enough to cater for on-street car parking and vehicle movement? Higher density residential development is not encouraged:*
 - a) *In cul-de-sacs: and*
 - b) *On road reserves less than 17 metres in width for lower and medium density developments; or*
 - c) *On road reserves less than 20 metres in width for high densities.*

1.2 EXECUTIVE SUMMARY

1.2.1 SITE LOCATION AND STUDY AREA

The *Development Site* is on Lots 6907 and 6908 on the western end of Blake Street and northeast of Gardens Road.

The *Study Area* includes Gardens Rd, Stuart Hwy (McMinn-Geranium), Daly St (north of Mitchell), Mitchell St (west of Daly), Lambell Tce (north of Mitchell) and Gilruth Avenue (south of Gardens) and all roads within these.

1.2.2 DEVELOPMENT DESCRIPTION

Due to the conceptual nature of the proposal there are no development plans at this stage. The concept is to provide a mixed use development of around 1,000 dwellings with vehicular access off Gardens Rd. Following issue of the previous Preliminary Traffic Assessment reports, a 'Parklands' Access Option Plan has been prepared and is included in **Appendix D** of this report.

1.2.3 TYPES OF STUDIES UNDERTAKEN

- Review of background data and the *Darwin Inner Suburbs Area Plan* project, policies and guidelines including those for *Compact Urban Growth*, i.e. High Density Residential Development;
- Review and consolidation of peak hour traffic survey data at 7 key intersections within the *Study Area*;
- Spreadsheet traffic volume models based on survey data; and
- *SIDRA Intersection 6.1* computer modelling of intersection performance and capacity criteria including network modelling.

1.2.4 PRINCIPAL FINDINGS

The *Development Site* can be accessed by from Gardens Rd with little impact on the road network. Removing vehicular access from Blake St will reduce the impact of traffic on Melville St, Gardens Hill Cr and Geranium St which are all Local Roads. Pedestrian and cycle access should be provided off Gardens Rd and Blake St.

This *PTA* has determined that four intersections in the vicinity of the *Development Site* are likely to experience impacts greater than 5% of their forecast 2025 volumes. A detailed assessment of forecast *Average Delay* and *Degree of Saturation* for all of these intersections for the *Horizon Years* of 2025 and 2035 has indicated that these intersections are expected to perform within capacity with the majority performing with spare capacity.

1.2.5 CONCLUSION

The concept development has been assessed as complying with the Objective and Key Performance indicators of Section 4.3 (Traffic Management) of the Northern Territory's *Compact Urban Growth Policy*.

1.2.6 RECOMMENDATIONS



It is recommended that this *Preliminary Traffic Assessment* report is accepted as an indicative representation of the traffic and transport impacts associated with the proposed development as described in this report and hence compliant with the Objective and Key Performance indicators of Section 4.3 (Traffic Management) of the Northern Territory's *Compact Urban Growth Policy*.

The following issues have been identified as existing concerns with the transportation network in the vicinity of the *Development Site*. They should **not** be considered as warranting action purely as a result of the proposed development. They should be considered by the relevant road authority regardless of whether the proposed development is approved or not.

- That consideration is given to extending the right turn lane on the north-western approach of McMinn St to its intersection with Daly Street as this intersection is forecast to approach capacity with the City Gate and other developments in the area; and
- That the *Area Plans* take into consideration concerns regarding additional through traffic on Melville St, Gardens Hill Cr and Geranium St through a combination of measures that discourage through traffic on local roads and encourage traffic onto Collector and Arterial Road routes to access high traffic generating developments in the area. It is also recommended that each *Area Plan* is supported by a *Traffic Impact Assessment* report as per the guidance provided in AGTM12 (2).

2 PROPOSED DEVELOPMENT

2.1 OFF-SITE (OR BACKGROUND) DEVELOPMENT

The *Development Site* contains a transmission tower that is now redundant due to the switchover from analogue to digital TV and radio transmissions in Darwin in late 2013.

The *Development Site* was originally a single lot (Lot 5523) that was later subdivided to create Lots 6907 and 6908. Lot 6908 does not contain any analogue television transmission infrastructure, but it does completely surround Lot 6907 which contains infrastructure for the transmission of a nominated service (analogue television). Lot 6908 provides access to Lot 6907, via an easement. On 1 January 2014 all transmission equipment ceased to be 'regulated assets' under the National Transmission Network Sale Act 1998.



Photograph 1 – *Development Site* – Existing Environment

Lot 6907 is wholly contained within Lot 6908 but has an Access Easement so that both Lots are accessible off Blake Street, hence the Blake St address. The combined area of the 2 lots is 52,340 m² (5.234 ha).

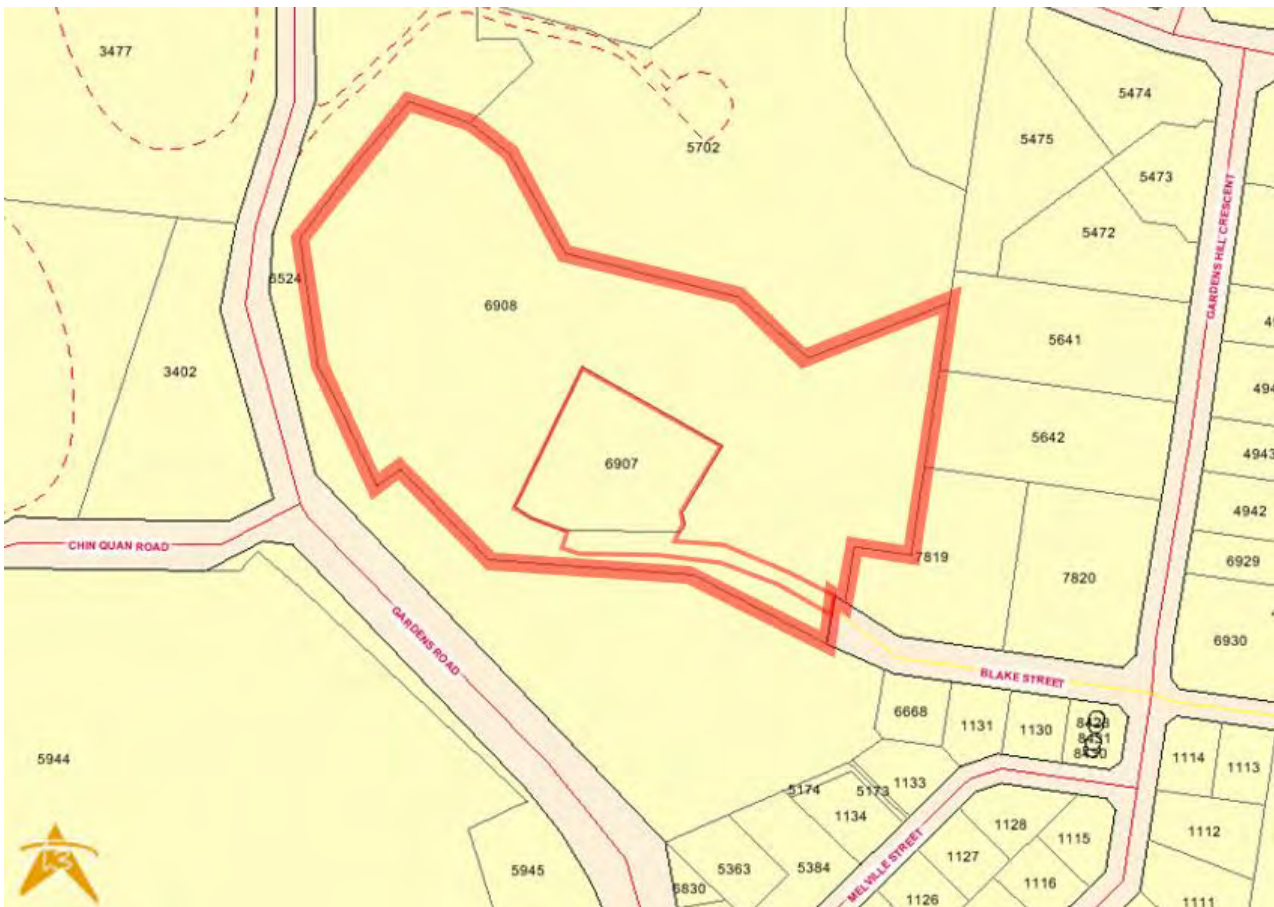


Figure 2 – Lots 6907 and 6908 showing access easement for Lot 6907 to Blake St

Existing Infrastructure on-site includes road, drainage, transmission facilities and buildings as shown in Figure 3.

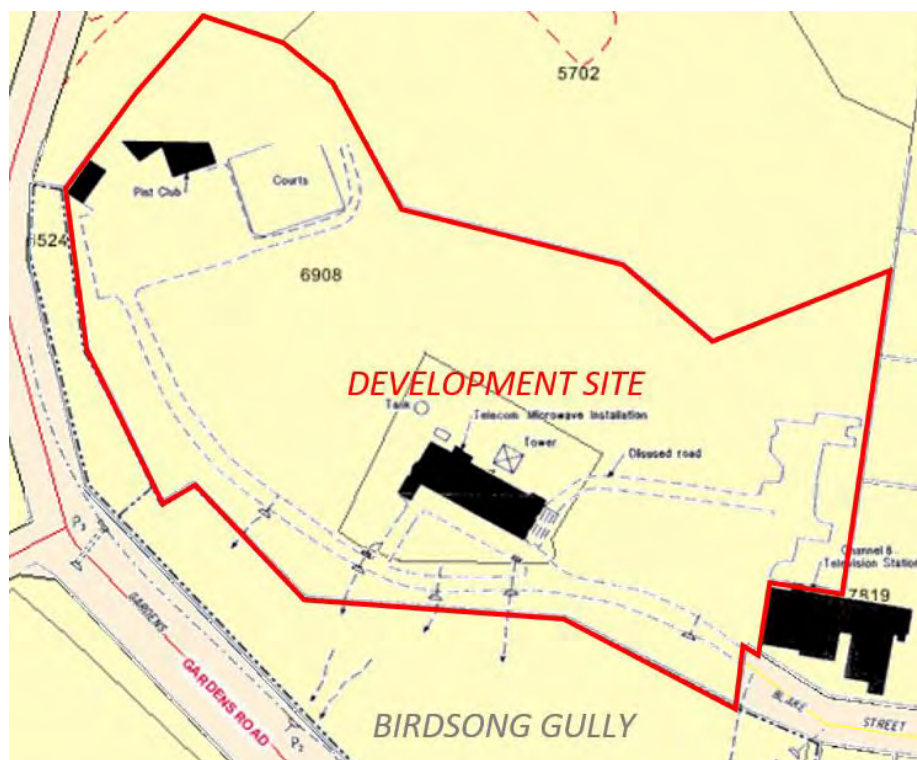


Figure 3 – Existing Development on site

2.2 DESCRIPTION OF ON-SITE DEVELOPMENT

2.2.1 LAND USE AND INTENSITY

Due to the conceptual nature of the proposal there are no development plans at this stage. The concept is to provide a mixed use development of around 1,000 dwellings within the area indicated in Figure 3 on the previous page based on the following concepts provided by the proponent:

- Include public artwork designed to represent different flora and fauna and animals found within the Botanical Gardens;
- Incorporate cafes, a deli, restaurants, with outdoor dining areas overlooking green open spaces, BBQ areas, shaded children's playground equipment, overlooking green open spaces, retail space and an elevated viewing deck which will enable residents and visiting members of the public to view the impressive vista over the Botanical Gardens, Mindil Beach and East Point Reserve.
- The development masterplan should include extensive landscaped areas;
- There is currently one roadway accessing the site, and this is through Blake Street. The access road into the site should be through the contaminated Birdsong Gully, as this will provide minimum disruption to the residents of the Gardens. The Bird Gully area to date, has not been developed to provide a level of service or amenity that would be attractive to visitors and residents. Current facilities remain non-existent and usage is minimal. The area was used as a landfill site after Cyclone Tracey and recent investigations have indicated this landfill is asbestos contaminated. The gully should be rehabilitated, to include the removal of the asbestos, extensive planting, seating and artwork, which will provide a level of amenity that is attractive to residents and visitors, making it a valuable and valued asset within the Gardens;
- The end of Blake Street should become a cul-de-sac to eliminate traffic through Gardens Hill Crescent. The road access into the site should be through the gully, which should also include a pedestrian walkway/cyclepath, to allow existing Gardens residents to access the development, as well as the surrounding recreational facilities.
- The proposed development will activate the existing amenity and add vibrancy and vitality to an area that is currently neglected and sitting redundant. This site should be designed to include mixed use development that will capture the amazing views, provide connectivity with the neighbourhood and surrounding green open spaces, and bring people together and enhance the sense of community and social interaction in this beautiful area.

2.2.3 SITE PLANS

As this is an assessment of a development concept there are no site plans at this stage. The Survey Plan (L.T.O. 98/127) for the *Development Site* is included in **Appendix A**. Following issue of the previous Preliminary Traffic Assessment reports, a 'Parklands' Access Option Plan has been prepared and is included in **Appendix D** of this report.

2.2.4 ZONING

The two lots are currently zoned CP (Community Purposes). Clause 5.1 of the *Northern Territory Planning Scheme (NTPS)* ⁽⁶⁾ indicates that this zoning does not allow for residential dwellings unless they are associated and ancillary to the primary use of the land – refer Figure 4. On this basis, the two lots will require rezoning to Zone HR (High Density Residential) if the proposed development is to proceed.

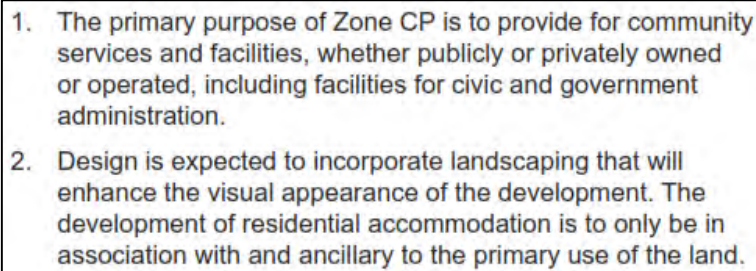
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1. The primary purpose of Zone CP is to provide for community services and facilities, whether publicly or privately owned or operated, including facilities for civic and government administration.
 2. Design is expected to incorporate landscaping that will enhance the visual appearance of the development. The development of residential accommodation is to only be in association with and ancillary to the primary use of the land.

Figure 4 – Clause 5.21 of NTPS: Zone CP – Community Purposes

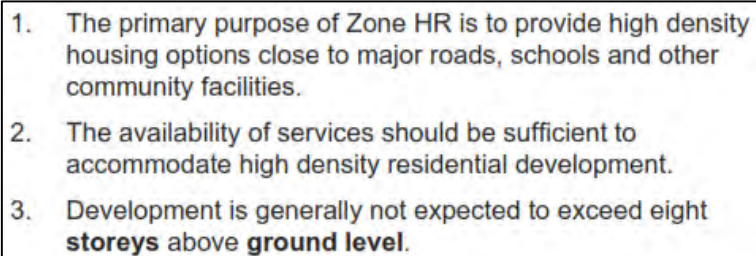
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1. The primary purpose of Zone HR is to provide high density housing options close to major roads, schools and other community facilities.
 2. The availability of services should be sufficient to accommodate high density residential development.
 3. Development is generally not expected to exceed eight **storeys above ground level**.

Figure 5 – Clause 5.4 of NTPS: Zone HR – High Density Residential

2.2.5 PHASING, TIMING & HORIZON YEAR

The proposal is a long term concept unlikely to be commenced or completed within the next 15-20 years.

3 EXISTING AREA CONDITIONS

3.1 STUDY AREA

The *Study Area* is shown in Figure 6. A single vehicular access of Gardens Rd has been selected at a location approximately 140 m north of Melville St and 215 m south of Chin Quan Rd as this avoids the influence of other intersections on its performance and takes advantage of a relatively clear area of vegetation through the Birdsong Gully contaminated area.



Figure 6 – Study Area

3.1.1 AREA OF INFLUENCE

The *Area of Influence* of development generated traffic is expected to be within the *Study Area* indicated in Figure 6 on the previous page. This *Study Area* includes the nearest intersection connections with the arterial road network to the *Development Site*, i.e. Stuart Hwy via Gardens Rd/ McMinn St and Gilruth Rd via Gardens Rd/ Chin Quam Rd.

A check of the impact on the following Key intersections (*Ki*'s) has been undertaken and is discussed in **Section 4** (Projected Traffic).

- *Ki1* Development Access/ Gardens Rd;
- *Ki2* Gardens Rd/ Gardens Hill Cr;
- *Ki3* Chin Quan Rd/ Gardens Rd;
- *Ki4* Gardens Rd/ Gilruth Ave
- *Ki5* Daly St/ McMinn St/ Stuart Hwy;
- *Ki6* Daly St/ Gardens Rd; and
- *Ki7* Geranium St/ Stuart Hwy

3.1.2 AREA OF SIGNIFICANT TRANSPORTATION IMPACT

The City of Darwin (*CoD*) and the Northern Territory Government (*NTG*)'s Department of Transport (*DoT*) generally require that a detailed assessment of intersections is undertaken when the forecast impact of a proposed development generates more than 5% of the volume of any intersection within *the Area of Influence* of the proposed development. Accordingly, the identification of intersections requiring detailed assessment is included in **Section 4** (Projected Traffic).

3.2 STUDY AREA LAND USE

3.2.1 EXISTING LAND USES

As indicated in **Section 2.1**, the existing site is a redundant television and radio transmitter facility and hence has no existing traffic generation.

Existing land use within the *Study Area* includes High Density Residential, Medium Density Residential, Organised Recreation, Public Open Space, Service Commercial and Community Purpose, as shown in Figure 7.

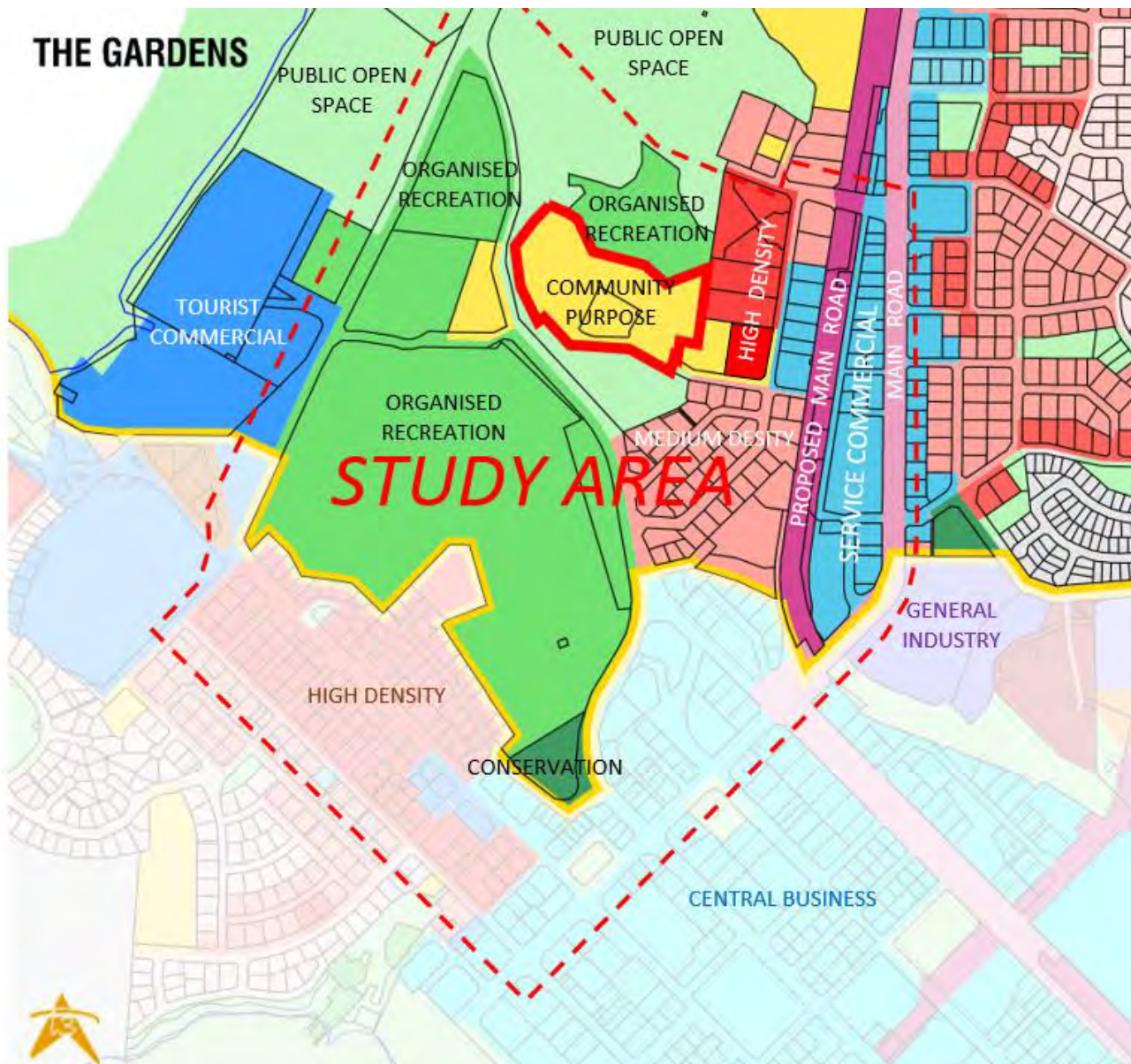


Figure 7 – Existing Land Use within Study Area (Darwin Inner Suburbs Area Plans: Town Planning Zones)

Figure 7 shows the *Development Site* is currently zoned Community Purpose. It also shows the lot on the east side of the *Development Site* (Lot 7820) on the NW corner of Gardens Hill Cr/ Blake St as High Density instead of Community Purpose to reflect the recent Ministerial Approval to rezone this.



The land between the *Development Site* and Gardens Rd is known as Birdsong Gully, as shown in Figure 3 on page 11. This links to the Public Open Space to the north of the site which comprises of the Darwin Botanic Gardens.

With the increased awareness for a rational approach to the development of Australian Botanic Gardens; a Master Plan has been developed to upgrade the Darwin Botanic Garden. Birdsong Gully which is part of the proposal to upgrade the Gardens is surrounded by Blake Street, Melville Street and Gardens Road. It is a rainforest area with two distinct zones. One area along the steep cliff slope has sparse native vegetation with coffee bush at the top of the escarpment. The second area is of moderate slope and includes the low-lying wetlands. This area has dense native vegetation mainly along the drains, scrub areas and fig trees near Gardens Road.

The gully has been neglected for a long time and now provides an environment for mosquito breeding. The Botanic Gardens Master Plan proposes to develop Birdsong Gully as a feature of local native plants with a central water body. There is currently only one walkway track, which is not maintained to a high standard. The Botanic Gardens Master Plan envisages a network of tracks to attract residents and tourists.

As indicated in **Section 2.2.1**, the proposed Mixed Use development provides an opportunity for improvements to Birdsong Gully that could be consistent with the objectives of the Botanic Gardens Master Plan, i.e. increasing and improving access and viewing opportunities to areas within and over the Botanic Gardens. It is understood that discussions are being held in this regard and that this *Preliminary Traffic Assessment* will assist in providing stakeholders with information regarding likely traffic impacts, access and road network performance in the vicinity of the Darwin Botanic Garden.

3.2.2 EXISTING ZONING

All lots within the *Study Area* are zoned as either Zone MD (Medium Density Residential), Zone HR (High Density Residential), Zone CB (Central Business), Zone SC (Service Commercial), Zone PS (Public Open Space), Zone OR (Organised Recreation), Zone (CP) Community Purpose or Zone CN (Conservations) as shown in Figure 7 on the previous page.

The purpose of the relevant zones and the specific conditions relating to same are set out in Table 1 on the following page.

NTPS Clause & Zone			Condition 1	Condition 2	Condition 3
5.2	MD	Multiple Dwelling Residential	The primary purpose of Zone MD is to provide for a range of housing options to a maximum height of two storeys above ground level.	The scale, character and architectural style of infill development should be compatible with the streetscape and surrounding development.	A single dwelling on a lot less than 600 m ² should be integrated in terms of design and site layout with adjacent development and infrastructure.
5.4	HR	High Density Residential	The primary purpose of Zone HR is to provide high density housing options close to major roads, schools and other community facilities.	The availability of services should be sufficient to accommodate high density residential development.	Development is generally not expected to exceed eight storeys above ground level.
5.7	CB	Central Business	The primary purpose of Zone CB is to provide for a diversity of activities including administrative, judicial, professional, office, entertainment, cultural, residential and retail and other business activities with a commitment to the separation of incompatible activities.	Building form and design is expected to be sensitive to the needs of pedestrian movement and facilitate the creation of safe and active street frontages and public places and a vibrant commercial precinct.	
5.9	SC	Service Commercial	The primary purpose of Zone SC is to provide for commercial activities which, because of the nature of their business or size of the population catchment, require large sites.		
5.14	PS	Public Open Space	The primary purpose of Zone PS is to provide public areas for recreational activity.	Development should be limited to that which is for public use and enjoyment consistent with the recreational opportunities of the land and which has minimal adverse impact (if any) on adjoining or nearby property.	
5.15	OR	Organised Recreation	The primary purpose of Zone OR is to provide areas for organised recreational activities.	Development is to be limited to that which is consistent with the recreational opportunities of the land.	
5.21	CP	Community Purposes	The primary purpose of Zone CP is to provide for community services and facilities, whether publicly or privately owned or operated, including facilities for civic and government administration.	Design is expected to incorporate landscaping that will enhance the visual appearance of the development. The development of residential accommodation is to only be in association with and ancillary to the primary use of the land.	
5.22	CN	Conservation	The primary purpose of Zone CN is to conserve and protect the flora, fauna and character of natural areas.	Development is to be sensitive to the natural features and habitats of the zone and be so sited and operated as to have minimal impact on the environment.	

Table 1 – Zones MD, HR, CB, SC, PS, OR, CP and CN Criteria

3.2.3 ANTICIPATED FUTURE DEVELOPMENT

The Northern Territory Planning Commission is using the recently adopted Northern Territory *Compact Urban Growth Policy (CUGP)* to guide the preparation of *Area Plans* within the context of the Compact Urban Growth Model shown in Figure 1 on page 6. The stated guiding principles of this model are to:

- Identify activity centres and public transport nodes, where higher dwelling and commercial density may be encouraged;
- Identify transition areas around these centres and nodes, where dwelling density will become less intense, and will transition to lower densities generally matching the surrounding locality (generally around 400 metres away from the activity centre and public transport node); and
- Encourage development that is consistent with the predominate housing and building types in the area.

These guiding principles will assist with balancing the demands of a growing population with the lifestyle aspirations of the community. ⁽⁵⁾

As indicated in **Section 1**, The Gardens has been identified for development in the context of the *CUGP* and has been identified for higher density development as part of the *Darwin Inner Suburbs Area Plans* that are currently under preparation. As such the *Study Area* is expected to experience changes in residential density and zoning in areas within 400 m of the nearest *Activity Centres* (i.e. the Westralia St Activity Centre and Darwin CBD), *Service Commercial Corridor* (i.e. Stuart Hwy) and *Transport Corridors* (i.e. Stuart Hwy, Gilruth Ave and Westralia St), as shown in Figure 8.

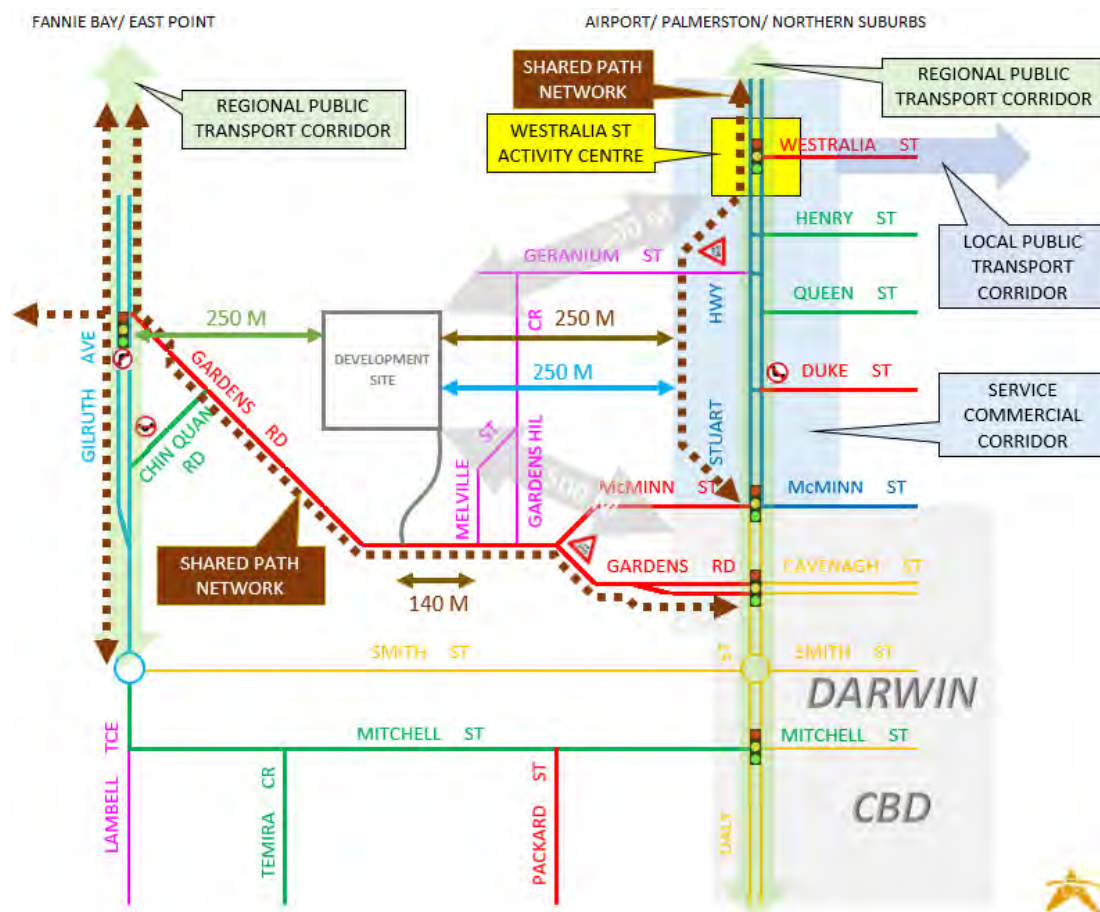


Figure 8 – Development Site in context of Darwin Inner Suburbs Area Plan principles

3.3 SITE ACCESSIBILITY

3.3.1 AREA ROADWAY SYSTEM

3.3.1.1 Existing

The *Development Site* currently has vehicular access provided off the Blake Street cul-de-sac west of Gardens Hill Cr. As indicated in Section 4.3 (Traffic Management) of the NTG's CUGP, "higher density residential is not encouraged in cul-de-sacs" hence the proposal is to provide access to the *Development Site* off Gardens Road through Birdsong Gully.

The existing cul-de-sac end of Blake Street is shown in Photograph 2.



Photograph 2 – Blake St cul-de-sac (existing access to Lots 6907 & 6908 through gates)

The existing road hierarchy ⁽⁹⁾ within the *Study Area* is shown in Figure 9.

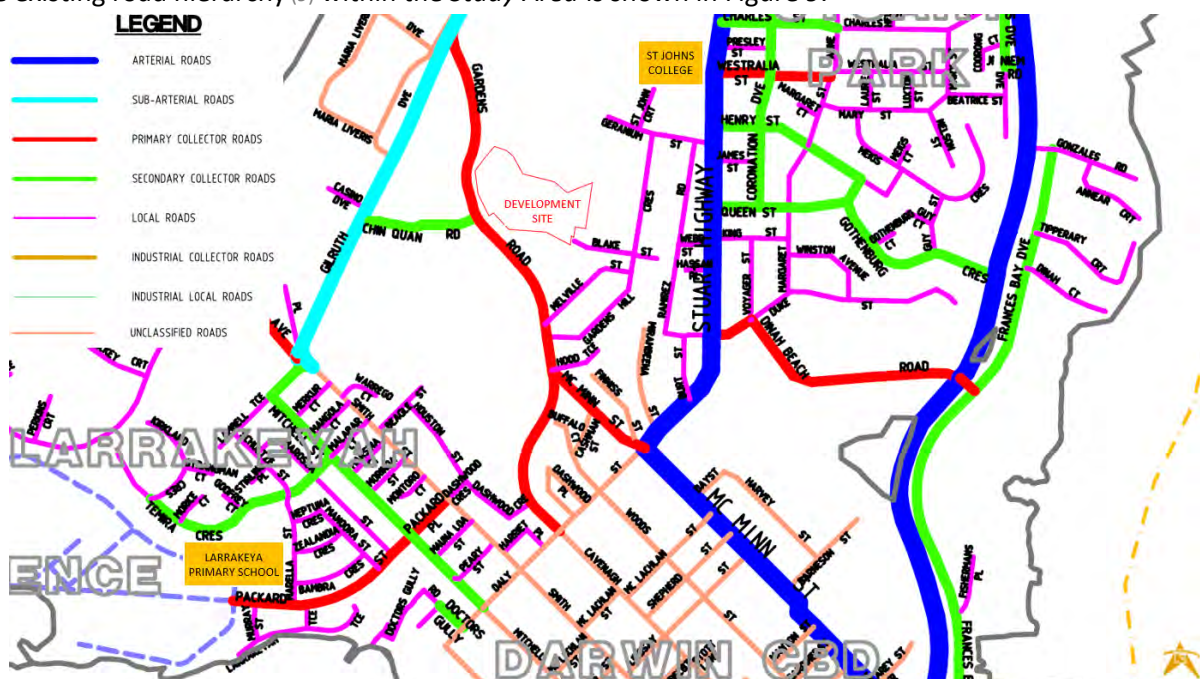


Figure 9 – Existing Road Hierarchy in vicinity of the *Study Area*



Figure 9 on the previous page shows that existing vehicular access to the *Development Site* is off Blake St, a Local Road. Should this access arrangement be retained all vehicular traffic to and from the site would travel to and from the nearest Arterial Roads (i.e. Stuart Highway and Gilruth Avenue) via Blake St, Gardens Hill Cr and Geranium St, all of which are Local Roads. By relocating the vehicular access off Gardens Road to approximately 140 m north of the Melville St intersection, the majority of traffic to and from the *Development Site* would travel to and from the Arterial Road network via Gardens Rd (Primary Collector), McMinn St (Primary Collector) and Chin Quan Rd (Secondary Collector). On this basis, the proposed vehicular access off Gardens Rd is considered to be consistent and complimentary to the intended function of the adjacent road network and hence reduces the impact of a high density residential development on the Local Road network which in turn is consistent with the Key Performance Indicator of Section 4.3 (Traffic Management) of the *CUGP*.

3.3.1.2 Future

As indicated in **Section 3.2.3**, The Gardens is subject to the development of an *Area Plan* within the guiding principles of the *CUGP*. An overlay of the *Development Site* with the *Transport Plan* from the *Darwin Inner Suburbs Area Plans* is shown in Figure 10 and includes annotation indicating the existing road hierarchy and traffic control at *Key intersections*, 200 m and 400 m radius from the *Development Site* and vehicular access routes to and from the *Development Site* based on access off Gardens Rd.

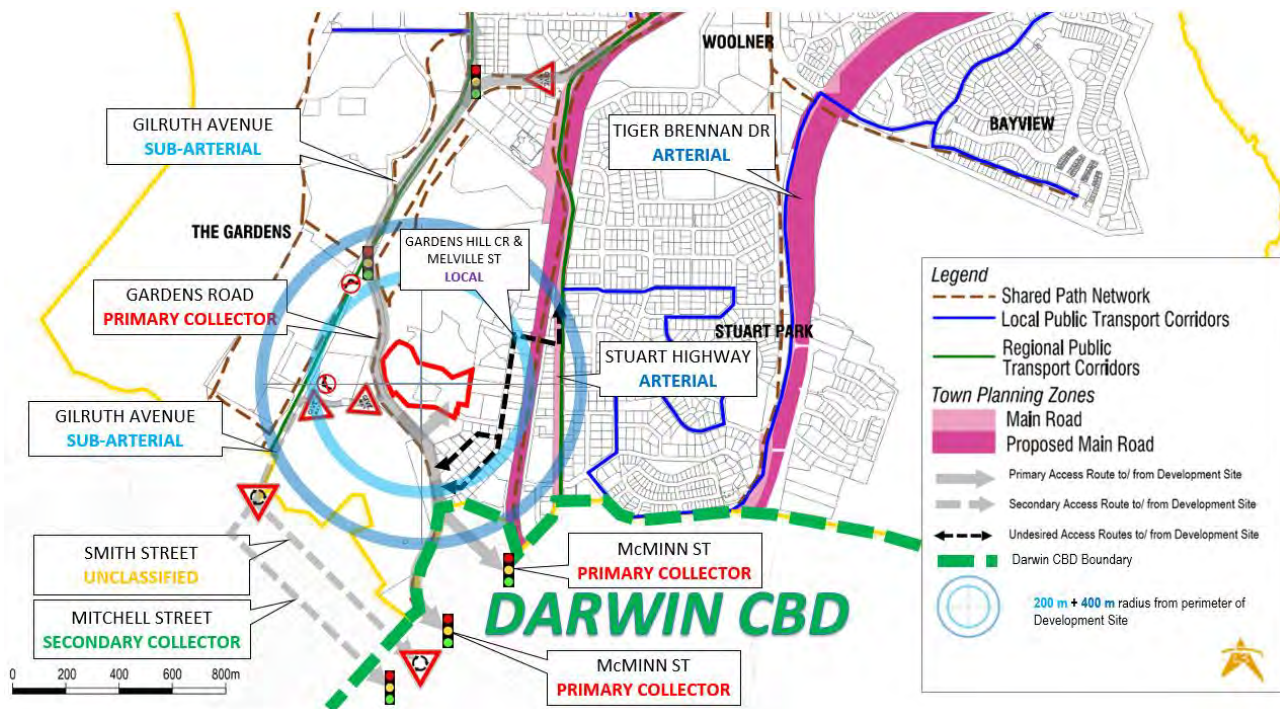


Figure 10 – Assessed future road network based on the *Darwin Inner Suburbs Area Plans Transport Plan*

Figure 10 indicates that the *Development Site* is located within 200 metres of the Proposed Main Rd (Stuart Hwy) and Regional Public Transport Corridors (Stuart Hwy and Gilruth Ave) and within 400 metres of the Darwin CBD boundary. It is also within 200 m of the proposed Stuart Hwy Service Commercial Corridor and within 400 m of the Westralia St Activity Centre, as shown in Figure 8 on page 19.

All of the above indicates that the proposal is consistent with the guiding principles of the *CUGP* **provided that** it can be demonstrated that the existing and proposed road network can support the proposed density increases. This is assessed in **Section 5** (Transport analysis).

3.3.2 TRAFFIC VOLUMES AND CONDITIONS

i3 has undertaken a large number of projects in and around the *Study Area* over the last six years and hence has been able to prepare a forecast 2025 weekday AM and PM Peak Hour traffic volume spreadsheet based on the survey data for these projects and applying 2% per annum growth where the forecast volumes were for *Horizon Years* less than this. This data is shown in **Appendix B**. In general all assessed intersections and roads have spare capacity although the Daly St/ McMin St/ Stuart Hwy intersection is forecast to approach, but not reach, capacity as a result of the City Gate Development and it has been recommended that an extension of the right turn lane on the north-western approach of McMin St to its intersection with Daly Street should be considered to improve conditions at this intersection. (10)

3.3.3 PUBLIC TRANSPORT

As indicated in Figure 8 on page 19 and Figure 10 on page 22, the *Development Site* is within 200 m of Regional Public Transport Corridors and hence meets the criteria for high density residential development within the *CUGP* in this regard. Existing Bus Routes and stops within 400 m of the *Development Site* are shown in Figure 11.



Figure 11 – Existing Bus Routes and Stops within 400 m of the *Development Site*

3.3.4 PEDESTRIANS AND CYCLISTS

There are shared paths along the south side of Gardens Rd, east side of Gilruth Ave and west side of Stuart Hwy that are part of the Regional Network as shown in Figure 11 and Figure 12.

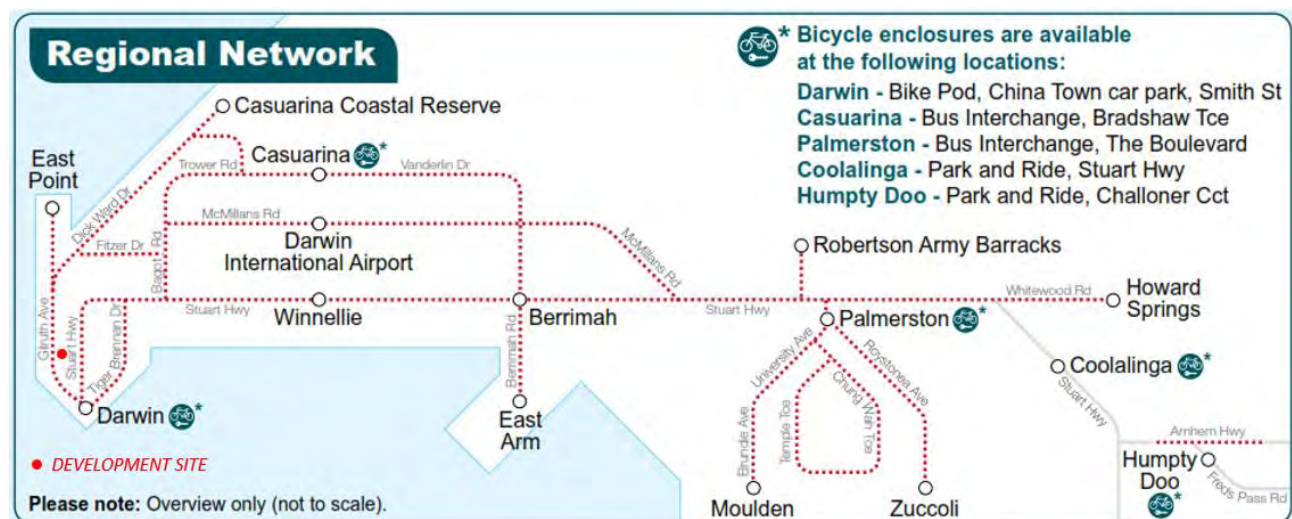


Figure 12 – Regional Cycle Network Plan

4 PROJECTED TRAFFIC

4.1 SITE TRAFFIC (EACH HORIZON YEAR)

As indicated in **Section 2.2.5** the proposal is a long term concept unlikely to commence within the next 15-20 years.

Section 3.3.2 and **Appendix B** has identified forecast base 2025 traffic volumes which in turn are based on forecast volumes within *Traffic Impact Assessment* reports for a variety of developments within and around the *Study Area*.

In order to provide an indication of the likely traffic impact of the proposed Mixed Use Development with 1,000 dwellings on Lots 6907 and 6908, *Horizon Years* of 2025 and 2035 have been adopted. The forecast 2025 base volume data has been used within a *SIDRA Intersection* model to assess impacts at each of the identified *Key intersections* where the forecast volume of traffic generated by the Mixed Use Development exceeds 5% of the forecast 2025 base volumes and these models have then been assessed for sensitivity with 2% per annum growth over a further 10-year period to 2035.

4.1.1 TRIP GENERATION

Section 4.5.5 (Traffic generation) of *AGTM12* ⁽²⁾ indicates that “Traffic generation can be estimated using trip generation rates established in previous surveys. Locally derived rates are preferred to those applying elsewhere.”

Section 3.1 (Land Use Traffic Generation) of the *RTA (NSW) Guide to Traffic Generating Developments* ⁽¹¹⁾ indicates that “The traffic generation potential of developments can be assessed in many situations by referring to the (RTA) Authority’s Land Use Traffic Generation – Data and Analysis reports” and that “Surveys of existing developments similar to the proposal can also be undertaken and comparisons drawn.”

Trip generation is often determined from publications such as the *RTA NSW* publication *Guide to Traffic Generating Developments* and the *ITE USA* publication *Trip Generation Manual* ⁽¹²⁾. Some of the 2002 *RTA NSW* rates have recently been revised via the issue of an update based on 2013 surveys ⁽¹³⁾. The rates for 2 Bedroom Apartments based on the *RMS* Updated rates are shown in Table 2.

2 Bed Apt	Rate	Unit
AM Peak	0.53	Trips per apartment
	0.35	Trips per car space
	0.21	Trips per bedroom
PM Peak	0.32	Trips per apartment
	0.26	Trips per car space
	0.15	Trips per bedroom

Table 2 – Trip Generation Rates from *RMS Update to RTA Guide to Traffic Generating Developments*

In accordance with *AGTM12* statement that “Locally derived rates are preferred to those applying elsewhere”, traffic generation for the residential component has been estimated using trip generation rates established from previous surveys undertaken by *i3* at two multiple residential developments within 1,200 m of the *Development Site* as described on the following pages. These locally derived rates are preferable to those applying elsewhere as they take into account observed and actual practices at similar developments with similar attractors and generators.

‘THE IMPERIAL APARTMENTS’ (40 UNITS) 144 SMITH STREET (CNR DASHWOOD CRESCENT)



Photograph 3 – looking south at ‘The Imperial Apartments’, cnr Smith St/ Packard Pl/ Dashwood Cr

Dwellings	AM Peak Hour		AM Rate		PM Peak Hour		PM Rate	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
40	1	10	0.03	0.25	12	5	0.30	0.13
	9%	91%	9%	91%	71%	29%	71%	29%
	11		0.275		17		0.425	

Table 3 – ‘The Imperial Apartments’ surveyed peak hour trips

‘THE SENTINEL’ (43 UNITS) 1 DALY STREET (CNR DOCTOR’S GULLY ROAD)



Photograph 4 – looking north at ‘The Sentinel’, cnr Daly St/ Doctor’s Gully Rd

Dwellings	AM Peak Hour		AM Rate		PM Peak Hour		PM Rate	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
43	1	11	0.02	0.26	7	5	0.16	0.12
	8%	92%	8%	92%	58%	42%	58%	42%
	12		0.279		12		0.279	

Table 4 – ‘The Sentinel’ surveyed peak hour trips

Based on the survey data shown on the previous page, it has been determined that the rates in Table 5 (representing the highest rates and the average IN/ OUT split of those surveyed) are the appropriate rates to use for the proposed development.

AM Peak Hour		PM Peak Hour	
IN	OUT	IN	OUT
0.280		0.425	
9%	91%	65%	35%

Table 5 – Adopted Trip Generation Rates and Split

The rates in Table 5 are comparable to those in the *RMS Update*, as shown in Table 6.

Data Source	AM Peak Hour		PM Peak Hour	
i3 Darwin Surveys	0.280		0.425	
RMS Update range	0.07	0.32	0.06	0.41

Table 6 – Adopted Rates v *RMS Update* Rate Range

The rates above are for the residential component of the proposed Mixed Use Development. It is anticipated that the development will also include Café's, Restaurants, Deli's, Retail, Green Open Spaces, and Viewing Platforms. Rather than attempt to predict road network peak hour trip generation based on these uses it is considered more prudent to ignore these trips as there will be an element of internal trips to and from these land uses (i.e. between these land uses and the residential dwellings) that will most likely balance out the external trips to and from these land uses.

4.1.2 TRIP DISTRIBUTION (IN/ OUT SPLIT)

Trip Distribution is based on the proportions of traffic observed to turn into and out of the surveyed residential developments in **Section 4.1.1**.

4.1.3 MODAL SPLIT

Modal split has not been undertaken as all trips are based on surveyed vehicular trips. Refer **Sections 3.3.3** and **3.3.4** for details of public transport, walking and cycling facilities. These, along with the proximity of the *Development Site* to the *CBD* are considered attractive enough to encourage use of these alternative forms of transport.

4.1.4 TRIP ASSIGNMENT

Trip assignment is based on the proportion of turning traffic derived from previous traffic surveys at intersections and developments in and around the *Study Area*. The resultant Trip Origin/ Destination percentages are shown in Figure 13 on the following page.

Preliminary Traffic Assessment

Gardens Hill Development Lots 6907 + 6908 (SN 25+16) Blake St, The Gardens

Prepared for Irwinconsult & Makrylos Group

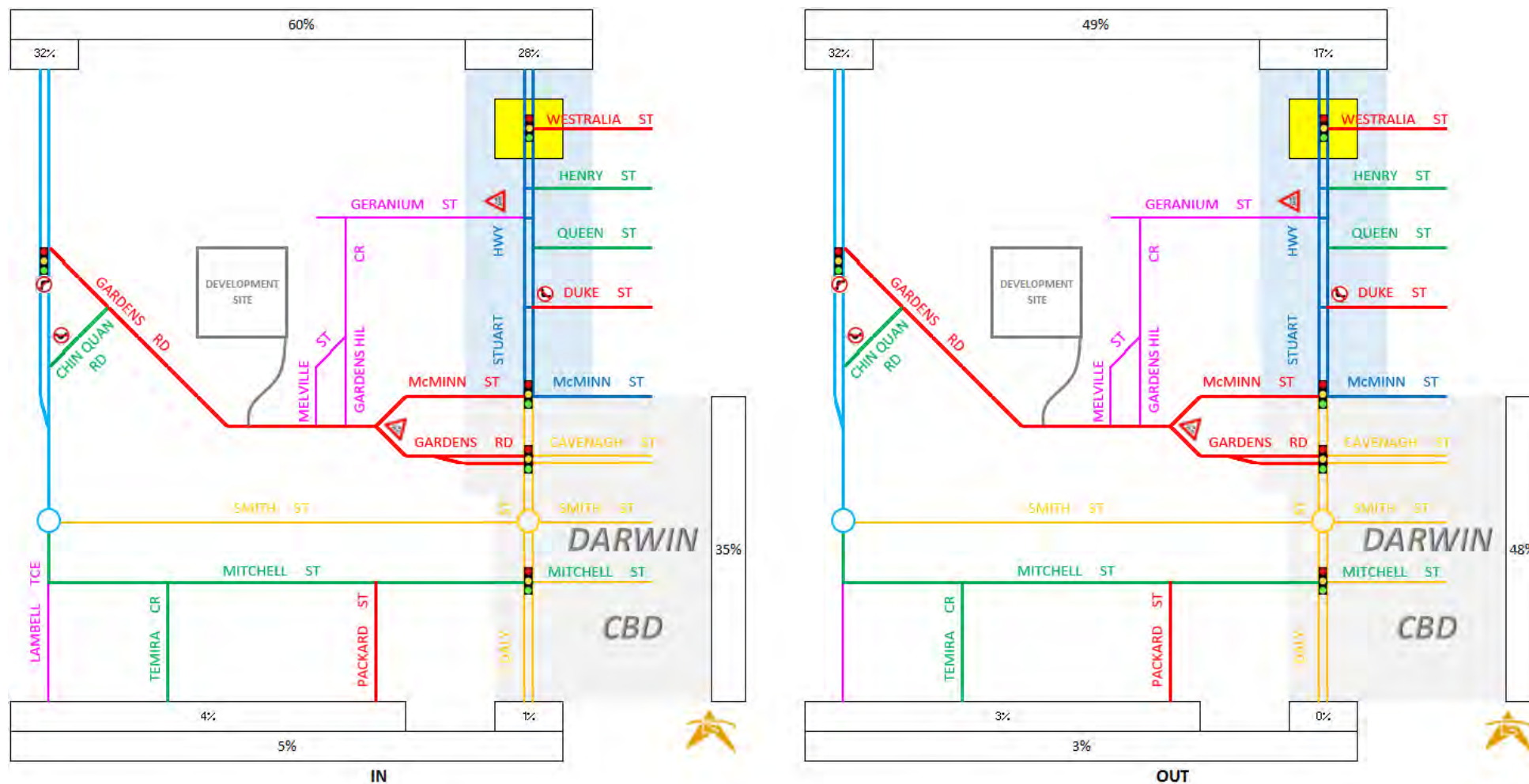


Figure 13 – AM/ PM Peak Hour Trip Origin/ Destination percentages

4.2 TOTAL TRAFFIC (2025 HORIZON YEAR)

An assessment of the forecast 2025 base volumes (**Appendix B**) and Development Generated traffic volumes (**Appendix C**) through each of the identified *Key intersections* has been carried out and is shown in Table 7.

Intersection	AM Peak Hour			PM Peak Hour		
	2025 Volume	Dev Volume	Vol Impact	2025 Volume	Dev Volume	Vol Impact
Ki1 Development Access/ Gardens Rd	844	281	33.3%	718	426	59.3%
Ki2 Gardens Rd/ Gardens Hill Cr	908	169	18.6%	802	256	31.9%
Ki3 Chin Quan Rd/ Gardens Rd	859	112	13.1%	738	170	23.1%
Ki4 Gardens Rd/ Gilruth Ave	1,814	90	5.0%	1,706	136	8.0%
Ki5 Daly St/ McMinn St/ Stuart Hwy	3,785	79	2.1%	3,469	145	4.2%
Ki6 Daly St/ Gardens Rd	3,284	73	2.2%	2,545	85	3.3%
Ki7 Geranium St/ Stuart Hwy	3,914	50	1.3%	3,225	101	3.1%

Table 7 – Assessed forecast 2025 base and development generated traffic volumes through each Ki

Table 7 indicates that four of the *Key intersections* are forecast to experience additional traffic volumes in excess of 5% of the 2025 base volumes and hence warrant detailed assessment. It is noted that all four of these intersections are along Gardens Road. The forecast total traffic in 2025 with full development of Lots 6907 and 6908 for each peak hour are shown in Figure 14 on the following page.

Preliminary Traffic Assessment

Gardens Hill Development Lots 6907 + 6908 (SN 25+16) Blake St, The Gardens

Prepared for Irwinconsult & Makrylos Group

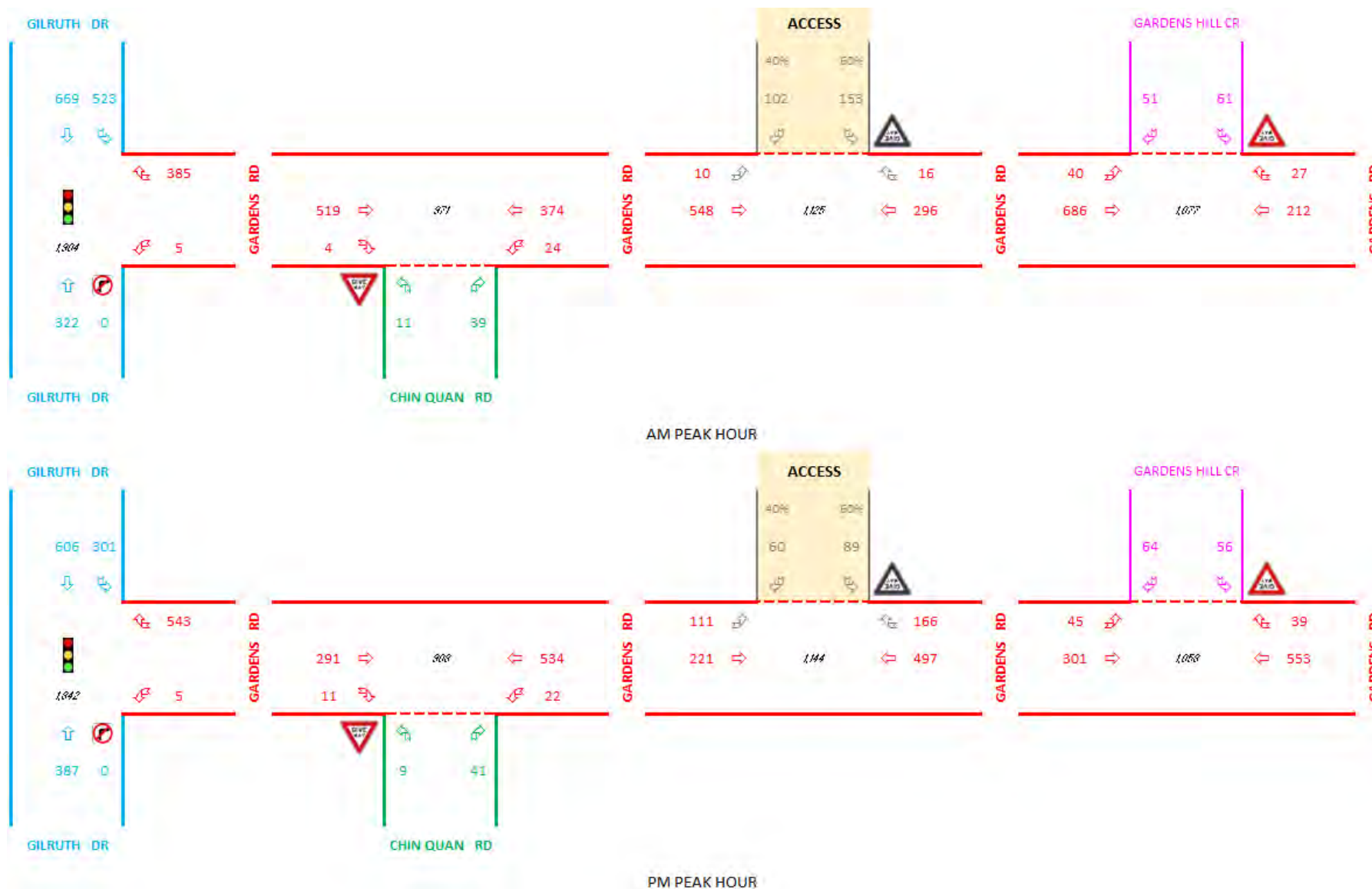


Figure 14 – Forecast total 2025 Peak Hour traffic volumes with development on Lots 6907 and 6908

5 TRANSPORTATION ANALYSIS

5.1 SITE ACCESS

As indicated in **Section 2.2.1** and assessed in **Section 3.3.1**, it is proposed to provide vehicle access off Gardens Road instead of Blake St. This is consistent with the requirements of Section 4.3 (Traffic Management) of *CUGP* as well as good transportation practice as it provides access to and from the Arterial Road network via Connector Roads instead of Local Roads.

Section 4.3 of *CUGP* also requires that the road reservation adjoining a high density residential *Development Site* is wide enough to cater for on-street car parking and vehicle movement and is 20 metres or more in width. Based on an assumed access location approximately 215 m southwest of the Chin Quan Rd intersection, the road reserve width of Gardens Rd at the access location is approximately 36 m (refer Figure 15), well in excess of the required minimum of 20 m. In addition to this there would not be any demand for on-street parking as the *Development Site* is separated from Gardens Road by Lot 6524 which comprises of Birdsong Gully and the Darwin Botanical Garden. It is also proposed to provide for all parking demand on-site.

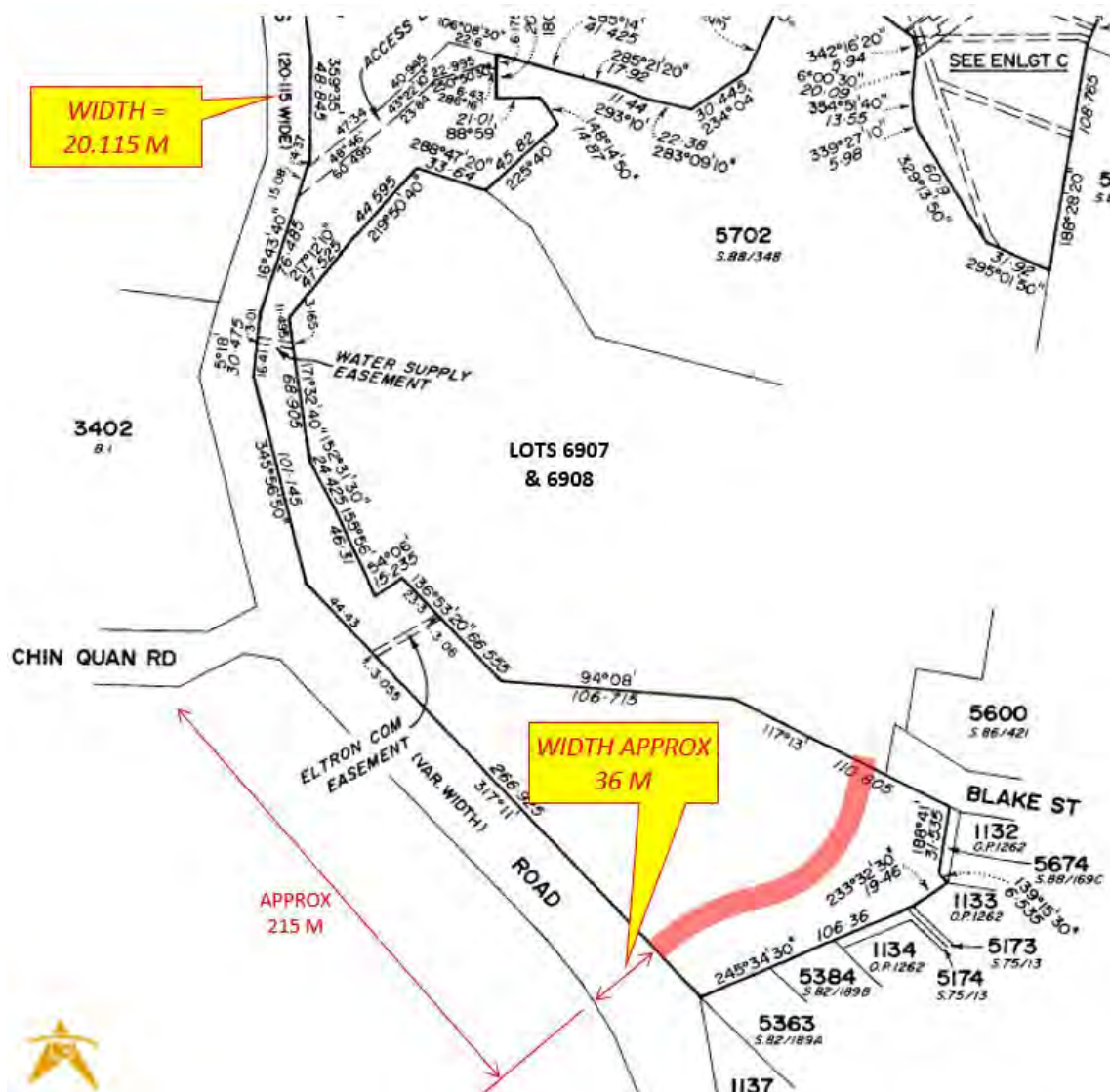


Figure 15 – Assessed Road Reserve width on Gardens Rd at proposed access location

5.2 CAPACITY AND LEVEL OF SERVICE

The capacity and level of service of each *Key intersection* with forecast development generated volumes greater than 5% of the base intersection volumes in 2025 has been assessed using *SIDRA Intersection 6.1* computer modelling software.

SIDRA Intersection assesses a number of different intersection performance criteria including *Level of Service* and *Average Delay*. A summary of these is provided in Table 8.

SIDRA v/c & colour code	LoS	Average Delay per vehicle (d) in seconds				v/c Range	Performance Comments
		Unsignalised intersections	Roundabouts	Signalised intersections	All (RTA)		
< 0.6	A	$d \leq 10$	$d \leq 10$	$d \leq 10$	$d \leq 14.5$	≤ 0.44	Good operation and plenty of spare capacity <i>Stable free flow conditions where drivers are able to select desired speeds and to easily manoeuvre within the traffic stream.</i>
	B	$10 < d \leq 15$	$10 < d \leq 20$	$10 < d \leq 20$	$14.5 < d \leq 28.5$		
	C	$15 < d \leq 25$	$20 < d \leq 35$	$20 < d \leq 35$	$28.5 < d \leq 42.5$	0.45 - 0.64	Acceptable delays and spare capacity <i>Stable flow but most drivers are restricted to some extent in their ability to select their desired speed and to manoeuvre within the traffic stream.</i>
0.6 - 0.7							
0.7 - 0.8	D	$25 < d \leq 35$	$35 < d \leq 50$	$35 < d \leq 55$	$42.5 < d \leq 56.5$	0.65 - 0.84	Acceptable delays (Expected typical peak hour conditions) <i>Close to the limit of stable flow. All drivers are restricted in their ability to select their desired speed and to manoeuvre within the traffic stream. Small increases in traffic flow may cause operational problems.</i>
0.8 - 0.9							
0.9 - 1.0	E	$35 < d \leq 50$	$50 < d \leq 70$	$55 < d \leq 80$	$56.5 < d \leq 70.5$	0.85 - 1.04	Near capacity and sensitive to disturbances in flows <i>Traffic volumes are close to capacity and there is virtually no freedom to select desired speeds. Flow is unstable and minor disturbances within the traffic stream will cause breakdown leading to long queues and delays.</i>
> 1.0	F	$50 < d$	$70 < d$	$80 < d$	$70.5 < d$	> 1.25	At Capacity - Requires other control mode and/or additional lanes <i>In the zone of forced flow where the amount of traffic approaching the point under consideration exceeds that which can pass. Flow breakdown occurs and extensive queues and delays result.</i>

Table 8 – Summary of Intersection Performance Criteria (AGTM03 ⁽¹⁴⁾)

5.2.1 EXISTING CONDITIONS

As indicated in **Section 3.3.2**, all assessed intersections and roads have spare capacity although the Daly St/ McMinn St/ Stuart Hwy intersection is forecast to approach but not reach capacity as a result of the City Gate Development. It has been recommended that an extension of the right turn lane on the north-western approach of McMinn St to its intersection with Daly Street is considered to improve conditions at this intersection. ⁽¹⁰⁾

5.2.2 TOTAL 2025 TRAFFIC (EXISTING + GROWTH + DEVELOPMENT SITE)

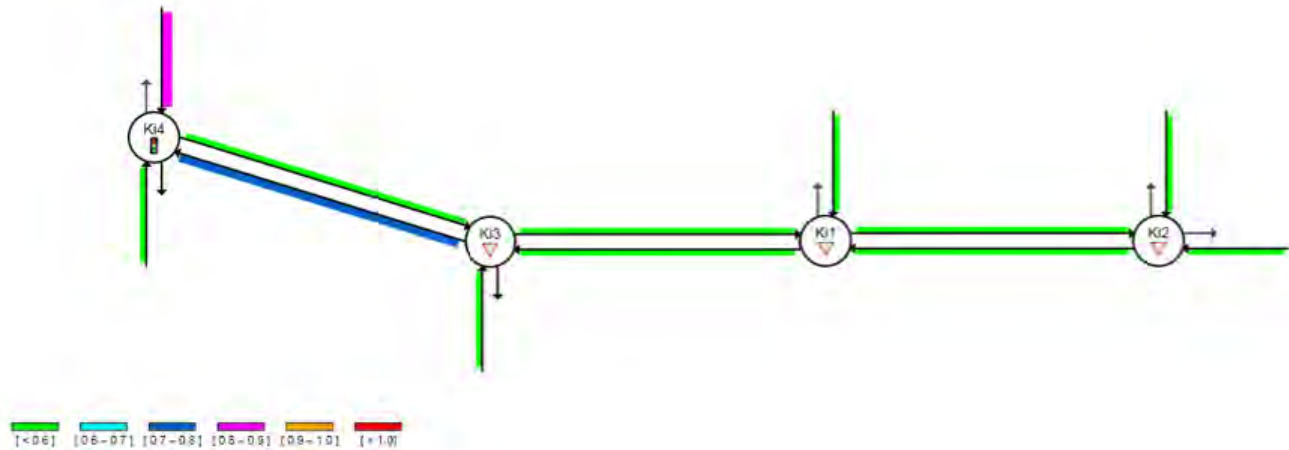
The forecast *Degree of Saturation* and *Level of Service* for each assessed *Key intersection* is shown in Figure 16 and Figure 17 respectively in on the following pages. These show that all assessed intersections and sections of roads are forecast to continue to operate with acceptable delays and spare capacity.



DEGREE OF SATURATION

Ratio of Demand Volume to Capacity (v/c ratio)

Network: Gllruth - Gardens Hill AM



DEGREE OF SATURATION

Ratio of Demand Volume to Capacity (v/c ratio)

Network: Gllruth- Gardens Hill PM

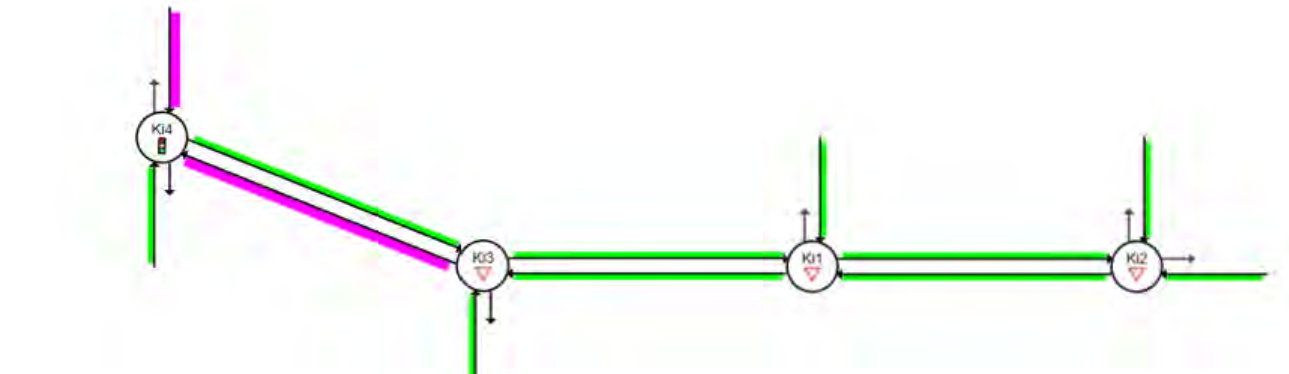


Figure 16 – Forecast *Degree of Saturation*: 2025 (with proposed development)

SITE LEVEL OF SERVICE
 Approach Level of Service for Network Sites
 ◇◇ Network: Gilruth-Gardens Hill AM



SITE LEVEL OF SERVICE
 Approach Level of Service for Network Sites
 ◇◇ Network: Gilruth-Gardens Hill PM

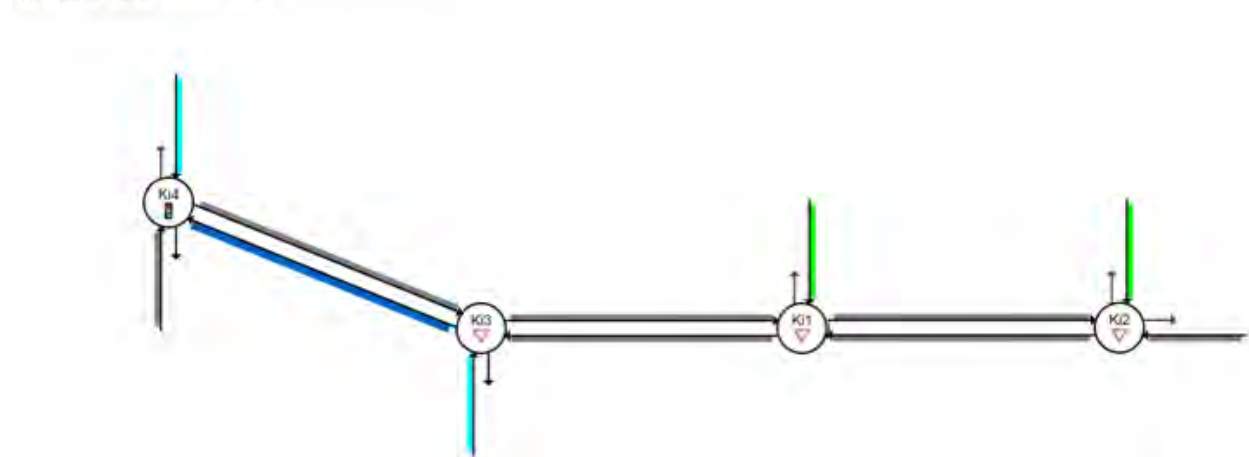


Figure 17 – Forecast *Level of Service*: 2025 (with proposed development)

As indicated in **Section 2.2.5**, the proposal is a long term concept unlikely to be commenced or completed within the next 15-20 years. On this basis, the 2025 assessment shown in Figure 16 and Figure 17 on the previous page may not be representative of the situation in 2035. Accordingly, sensitivity analysis of each intersection has been undertaken within *SIDRA Intersection* using 2% per annum growth from 2025 to 2035. 2% was applied to all data (i.e. applied to the development generated traffic even through this cannot grow) to ensure that other high density residential development as well as *Service Commercial Corridor* and *Activity Centre* generated traffic is taken into account.

The assessed *Average Delay* per vehicle for the worst vehicle movement (seconds) and highest Degree of Saturation in any lane for each intersection and peak hour for the 10 year period from 2025 to 2035 is shown in Figure 18 to Figure 25 on the following pages.

These figures show that none of the intersections is expected to reach a *Degree of Saturation* greater than 0.91 or *Average Delays* greater than 41 seconds and hence will generally operate at levels below or at those expected during peak hour periods. A summary of the assessed 2035 intersection performance criteria is provided as Table 9.

Intersection	AM Peak Hour		PM Peak Hour	
	<i>Average Delay</i>	<i>Degree of Saturation</i>	<i>Average Delay</i>	<i>Degree of Saturation</i>
Ki1 Development Access/ Gardens Rd	35.0	0.87	41.0	0.91
Ki2 Gardens Rd/ Gardens Hill Cr	14.2	0.32	13.9	0.36
Ki3 Chin Quan Rd/ Gardens Rd	16.2	0.62	18.2	0.55
Ki4 Gardens Rd/ Gilruth Ave	16.0	0.44	15.2	0.38

Good operation and plenty of spare capacity
Acceptable Delays (Typical Peak Hour Conditions)
Sensitive to disturbances in flows
Near, but not at, capacity

Table 9 – Assessed 2035 Intersection Performance Criteria

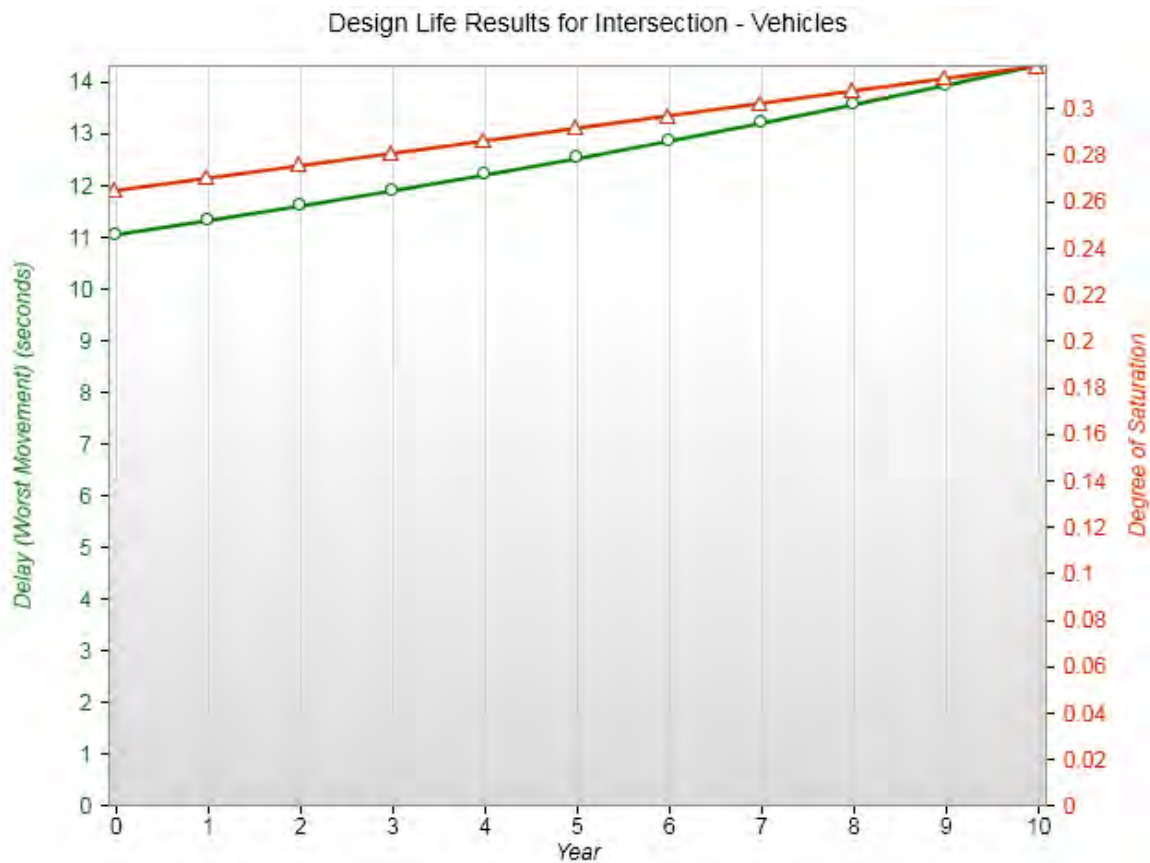


Figure 20 – Chin Quam/ Gardens Average Delay + Degree of Saturation 2025 - 2035 (Year 0-10) AM

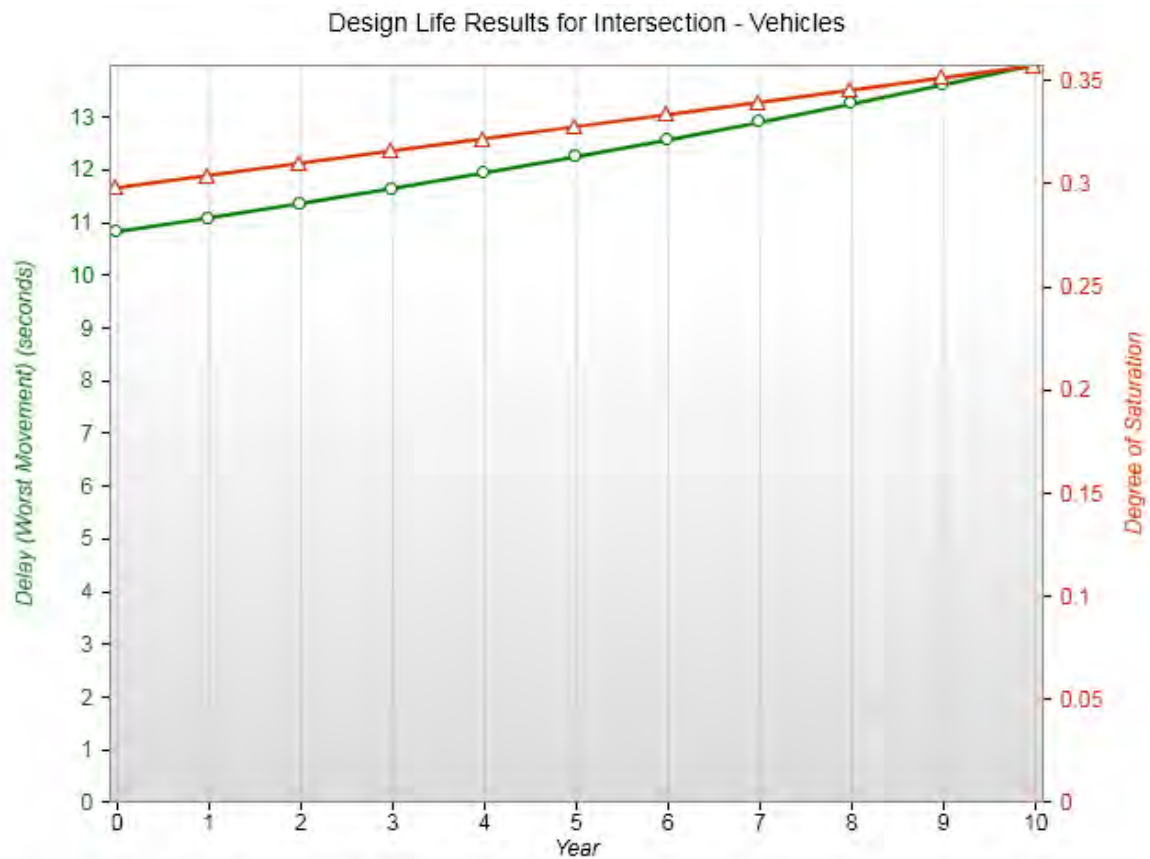


Figure 21 – Chin Quam/ Gardens Average Delay + Degree of Saturation 2025 - 2035 (Year 0-10) PM

5.3 TRANSPORTATION SAFETY

This *PTA* has assumed that the access point off Gardens Road will be located approximately 215 m southwest of the Chin Quan Rd intersection and 140 m northwest of the Melville St intersection. This distance is sufficient to avoid influences of one intersection over the other. It also results in a right-left staggered T intersection arrangement for development generated traffic travelling between the *Development Site* and Gilruth Avenue via Chin Quan Rd. A right-left stagger avoids the probability of a vehicle entering the through road and then suddenly stopping when it cannot complete the next right turn which results in a rear-end crash hazard. A four-way intersection with Chin Quan Rd is also avoided. Four-way intersections have a higher crash potential than T intersections.

It will be necessary to ensure that the proposed access meets all of the sight line requirements in order for it to operate in a safe manner. It is expected that this will be assessed at the preliminary and detailed design stages.

5.4 TRAFFIC CONTROL

This *PTA* is based on the indicative traffic controls remaining as is. Whilst direct vehicular access to Blake St reduces the potential for Melville St, Gardens Hill Cr and Geranium St to be used by traffic travelling to and from the *Development Site* there is likely to be a proportion that uses this route to 'short cut' the traffic lights at the Daly St/ McMinn St/ Stuart Hwy intersection. The Trip Assignment in this *PTA* report assumes that 10% of traffic will use these local streets unless additional measures are put in place to discourage the use of these streets by through traffic, as currently occurs. It is anticipated that the *Area Plan* will consider this in more detail.

As indicated in previous traffic studies, the Daly St/ McMinn St/ Stuart Hwy intersection is forecast to approach, but not reach, capacity as a result of the City Gate Development and it has been recommended that an extension of the right turn lane on the north-western approach of McMinn St to its intersection with Daly Street is considered to address this. ⁽¹⁰⁾

5.5 PARKING

5.5.1 ON-STREET PARKING

There is not expected to be any demand for on-street parking on Gardens Rd as the *Development Site* is separated from Gardens Road by Lot 6524 which comprises of Birdsong Gully and the Darwin Botanical Garden. It is also proposed to provide for all parking demands on-site.

5.5.2 OFF-STREET PARKING LAYOUT

It is anticipated that all parking demands will be met on-site.

6 IMPROVEMENT ANALYSIS

6.1 IMPROVEMENTS TO ACCCOMODATE EXISTING TRAFFIC

All assessed roads and intersections currently operate within capacity although a previous traffic study for the City Gate development has recommended that an extension of the right turn lane on the north-western approach of McMin St to its intersection with Daly Street is considered as this intersection is forecast to approach capacity with this and other developments in the area ⁽¹⁰⁾.

There are concerns that through traffic volumes on Melville St, Gardens Hill Cr and Geranium Cr will increase as a result of the higher density development proposed as part of the *Darwin Inner Suburbs Area Plans* and associated *Compact Urban Growth Policy*. This development proposal attempts to address this by relocating the access from Blake St to Gardens Rd. It is recommended that the *Area Plans* also take this concern into consideration, preferably through a combination of measures that discourage through traffic on local roads and encourage traffic onto Collector and Arterial Road routes to access high traffic generating developments in the area.

6.2 ADDITIONAL IMPROVEMENTS TO ACCOMMODATE SITE TRAFFIC

No specific improvements identified to accommodate the proposed development generated traffic as existing intersections and roads have spare capacity to accommodate this with little impact on performance.

6.3 ALTERNATIVE IMPROVEMENTS

None identified or warranted.

6.4 STATUS OF IMPROVEMENTS ALREAY FUNDED, PROGRAMMED OR PLANNED

None identified other than the development of *Area Plans* in accordance with *the Darwin Inner Suburbs Area Plans* project and associated *Compact Urban Growth Policy*.

6.5 EVALUATION

Not applicable (i.e. no amendments or remedial measures to evaluate).

7 FINDINGS

7.1 SITE ACCESSIBILITY

The *Development Site* can be accessed by from Gardens Rd with little impact on the road network. Removing vehicular access from Blake St will reduce the impact of traffic on Melville St, Gardens Hill Cr and Geranium St which are all Local Roads. Pedestrian and cycle access should be provided off Gardens Rd and Blake St.

7.2 TRANSPORTATION IMPACTS

This *PTA* has determined that four intersections in the vicinity of the *Development Site* are likely to experience impacts greater than 5% of their 2025 volumes. A detailed assessment of forecast *Average Delay* and *Degree of Saturation* for all of the intersection for the *Horizon Years* of 2025 and 2035 has indicated that all of these intersections are expected to perform within capacity with the majority performing with spare capacity.

7.3 NEED FOR ANY IMPROVEMENTS

None identified that are relative to the proposed development.

7.4 COMPLIANCE WITH APPLICABLE LOCAL CODES

The concept development has been assessed as complying with the Objective and Key Performance indicators of Section 4.3 (Traffic Management) of the Northern Territory's *Compact Urban Growth Policy*.



8 RECOMMENDATIONS

It is recommended that this *Preliminary Traffic Assessment* report is accepted as an indicative representation of the traffic and transport impacts associated with the proposed development as described in this report and hence complies with the Objective and Key Performance indicators of Section 4.3 (Traffic Management) of the Northern Territory's *Compact Urban Growth Policy*.

The following issues have been identified as existing concerns with the transportation network in the vicinity of the *Development Site* but should **not** be considered as warranting action purely as a result of the proposed development. They should be considered by the relevant road authority regardless of whether the proposed development is approved or not.

- That consideration is given to extending the right turn lane on the north-western approach of McMinn St to its intersection with Daly Street as this intersection is forecast to approach capacity with the City Gate and other developments in the area; and
- That the *Area Plans* take into consideration concerns regarding additional through traffic on Melville St, Gardens Hill Cr and Geranium St through a combination of measures that discourage through traffic on local roads and encourage traffic onto Collector and Arterial Road routes to access high traffic generating developments in the area. It is also recommended that each *Area Plan* is supported by a *Traffic Impact Assessment* report as per the guidance provided in AGTM12 (2).

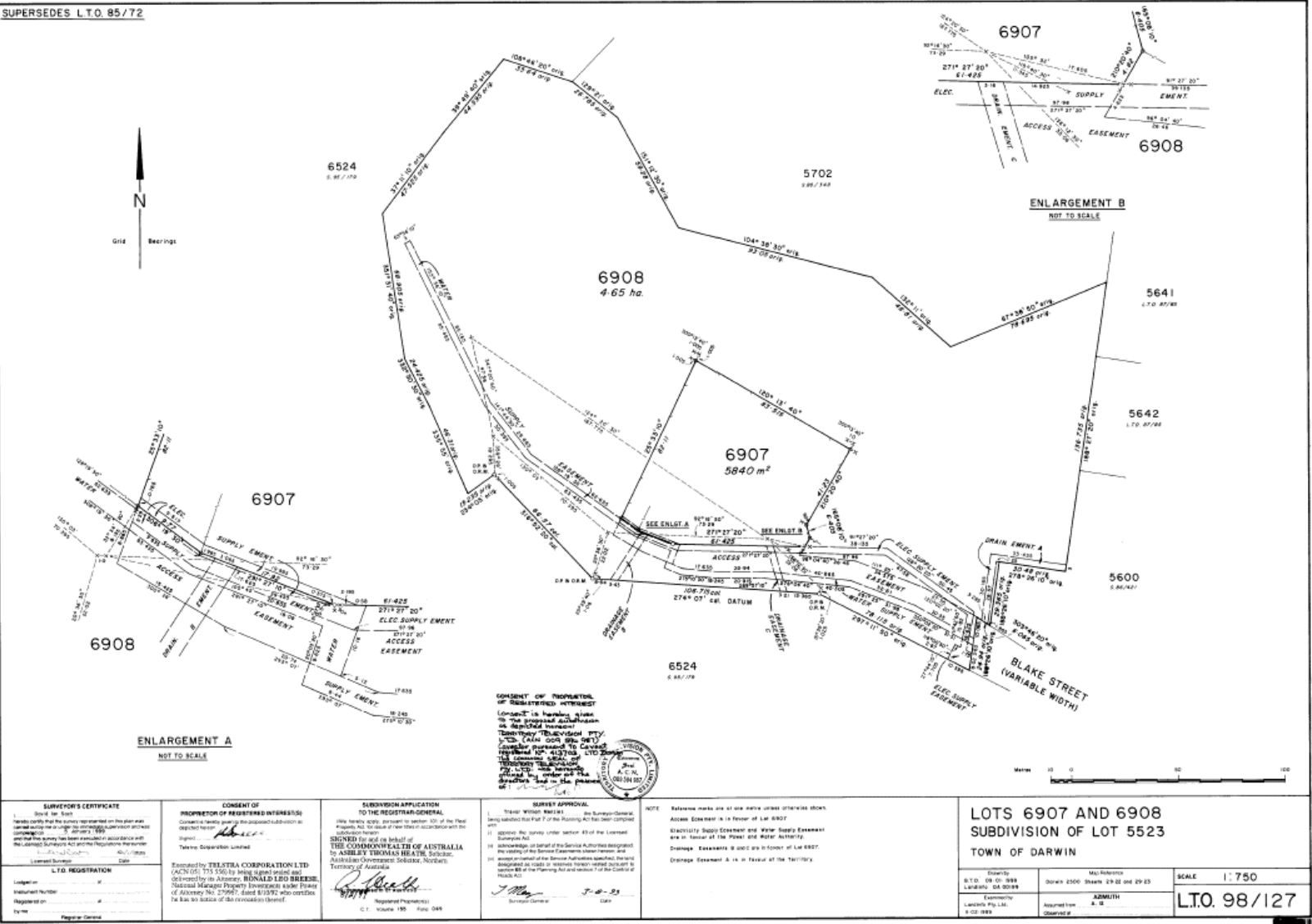


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13. **NSW Government.** *Guide to Traffic Generating Developments Updated traffic surveys*. Transport, Roads & Maritime Services. Sydney : NSW Government, August 2013. p. 22, Technical Direction. RMS.13.298.
14. **Austrroads.** *Guide to Traffic Management Part 3: Traffic Studies and Analysis*. Sydney : Austrroads Incorporated, 2009. p. 196. Vol. 3. ISBN 978-1-921551-77-2.



APPENDIX A SITE SURVEY PLAN



(Without Development on Lots 6907 and 6908)

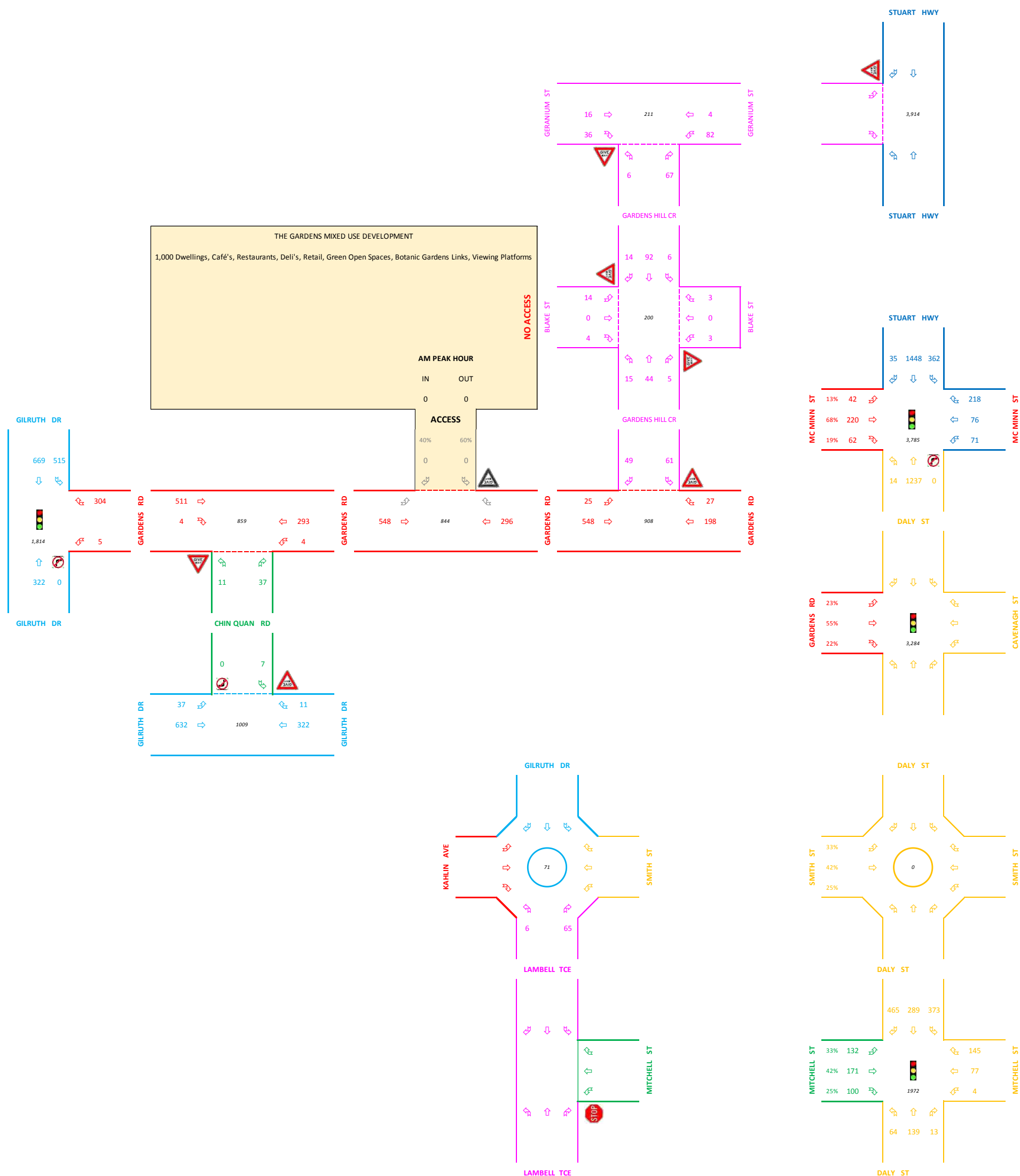


Figure 26 – Forecast 2025 AM Peak Hour Traffic Volumes without development on Lots 6907 & 6908)

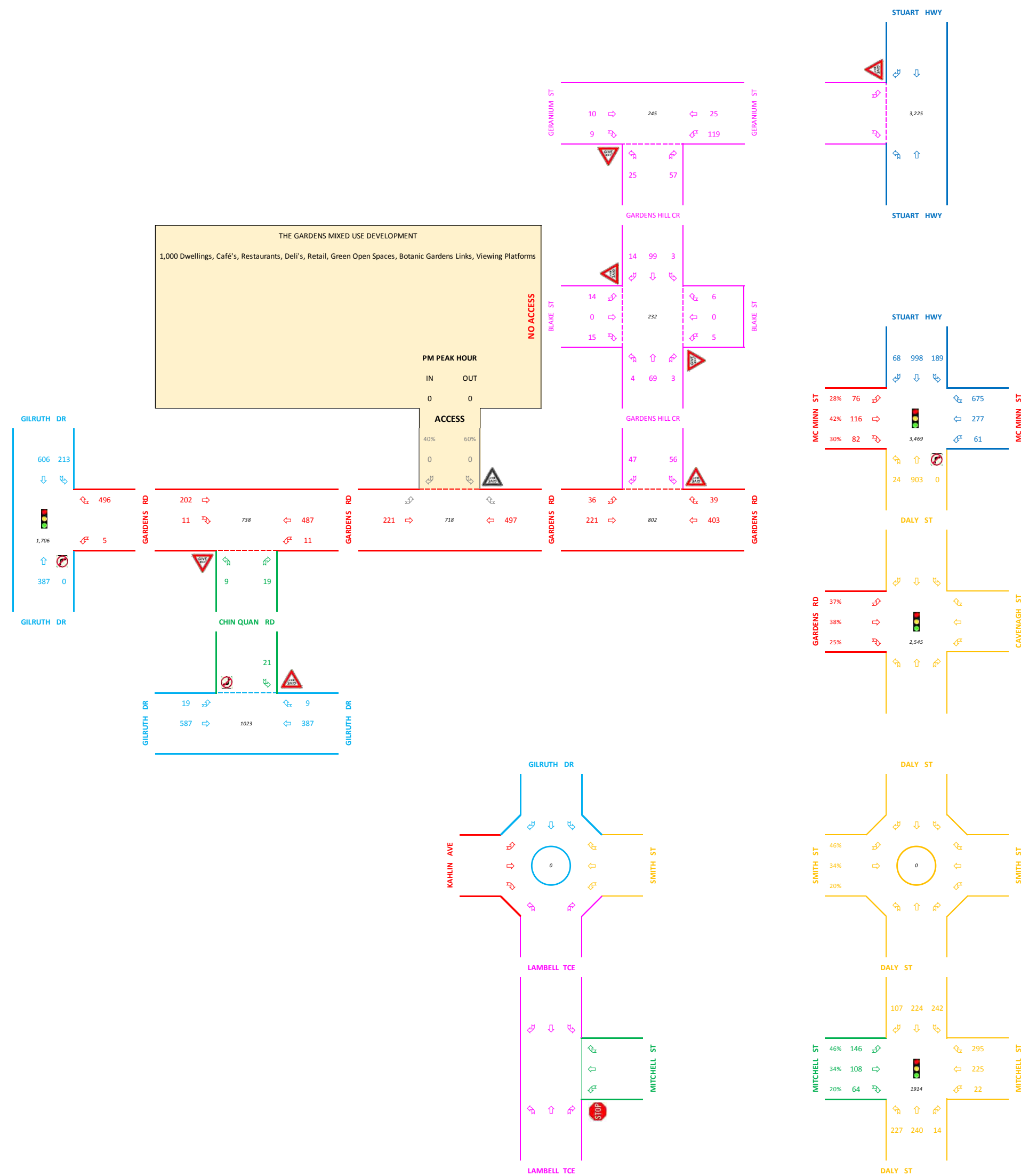


Figure 27 – Forecast 2025 PM Peak Hour Traffic Volumes without development on Lots 6907 & 6908)

APPENDIX C FORECAST DEVELOPMENT GENERATED TRAFFIC VOLUMES

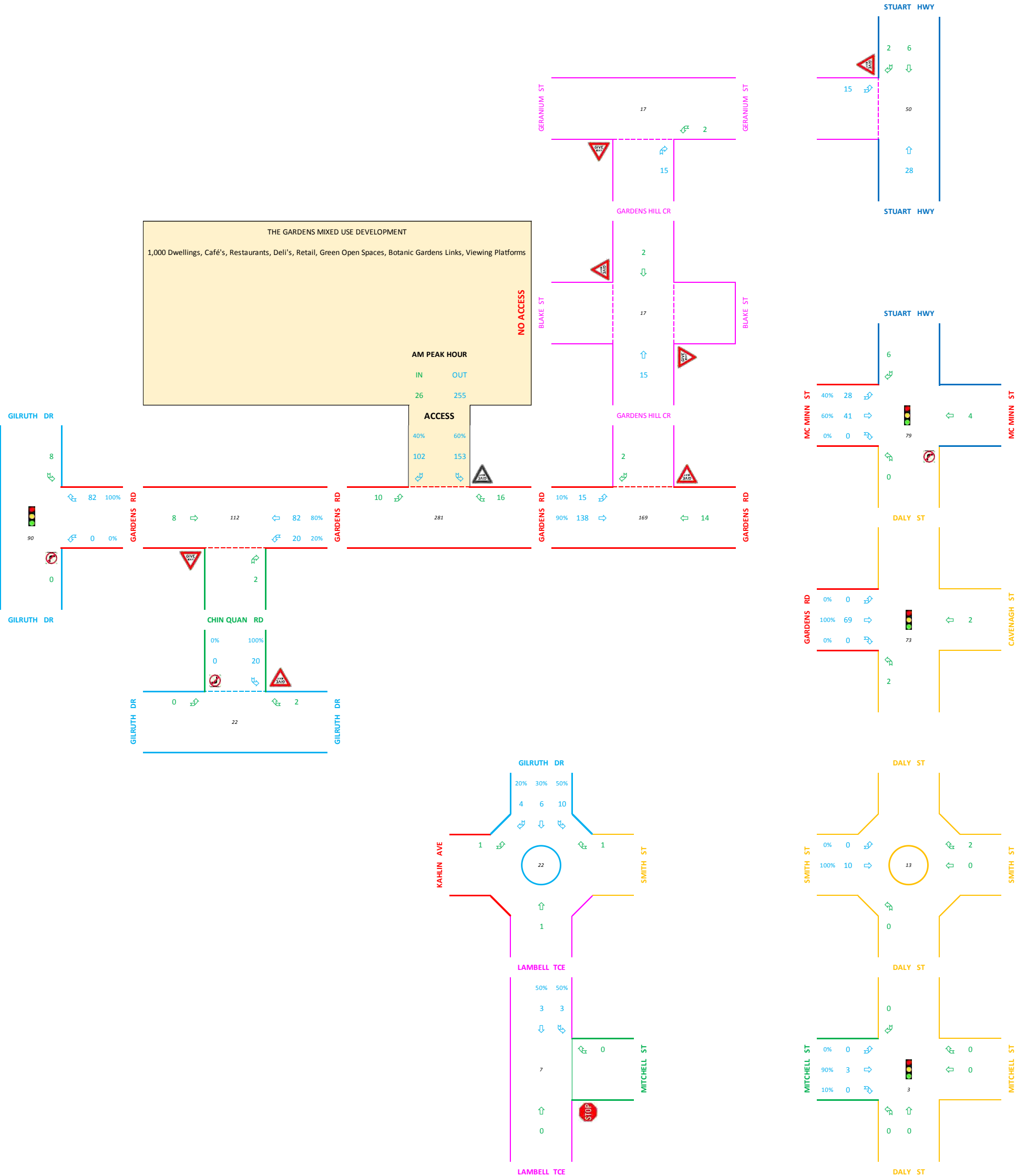


Figure 28 – Forecast AM Peak Hour Development Generated Traffic Volumes

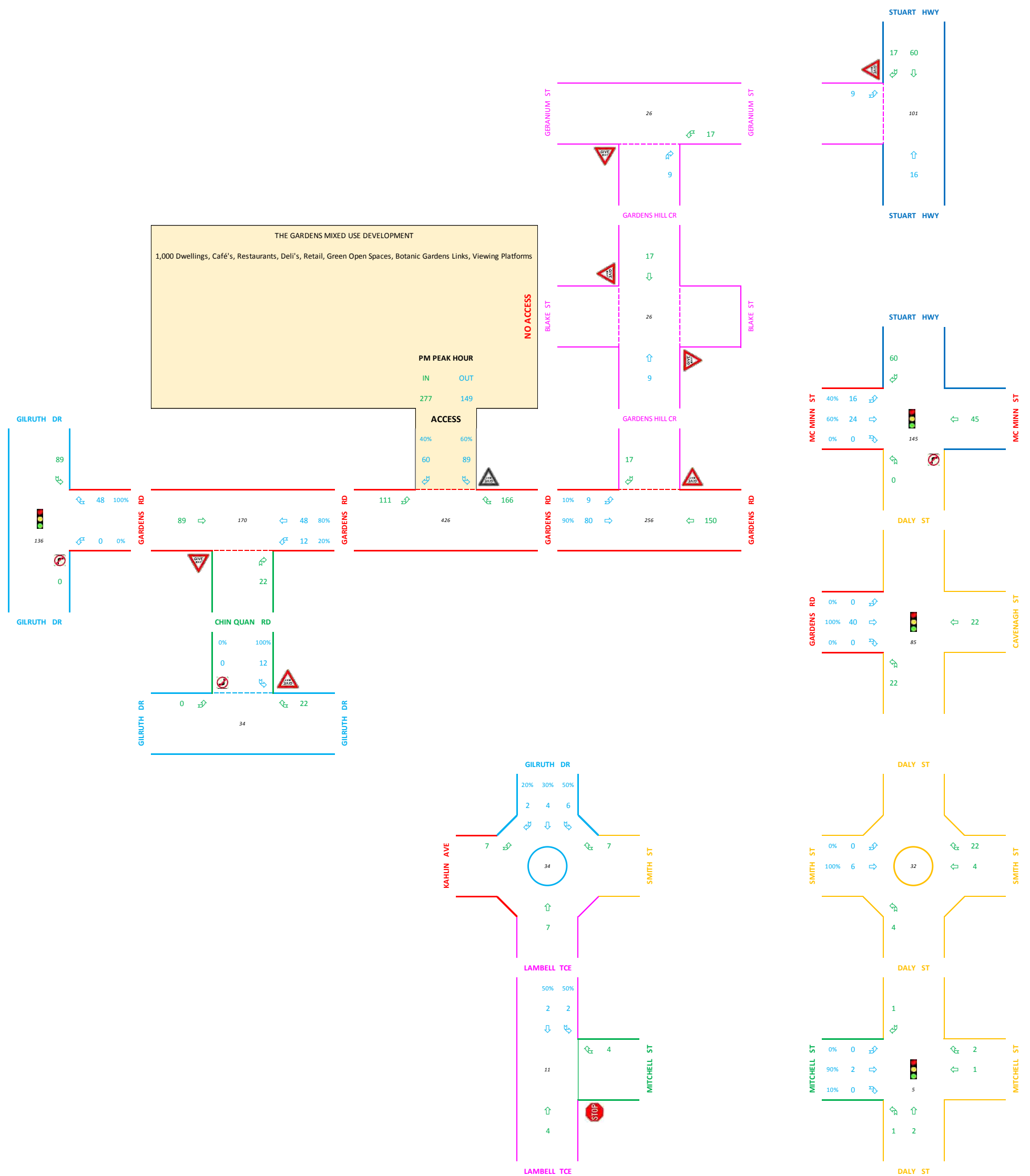


Figure 29 – Forecast PM Peak Hour Development Generated Traffic Volumes

APPENDIX D ‘PARKLANDS’ ACCESS OPTION PLAN



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Your Ref:
Our Ref: 16702

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4/02/2019

LOTS 6907+6908 GARDENS HILL, THE GARDENS TECHNICAL NOTE

1 INTRODUCTION

This Technical Note has been prepared by myself (David Wilkins, Principal and Senior Traffic Engineer - i3 consultants WA) in response to a request to undertake modelling and assessment of an option to progressively develop Lots 6907+6908 Gardens Hill with sole access off Blake Street instead of Gardens Road, as shown in Figure 1 below. This Technical Note represents an update of key criteria within the November 2015 Preliminary Traffic Assessment report for 'Gardens Hill Development Lots 6907 + 6908 (SN 25+16) Blake St, The Gardens' (Final 1.2), hereinafter referred to as the previous assessment report.

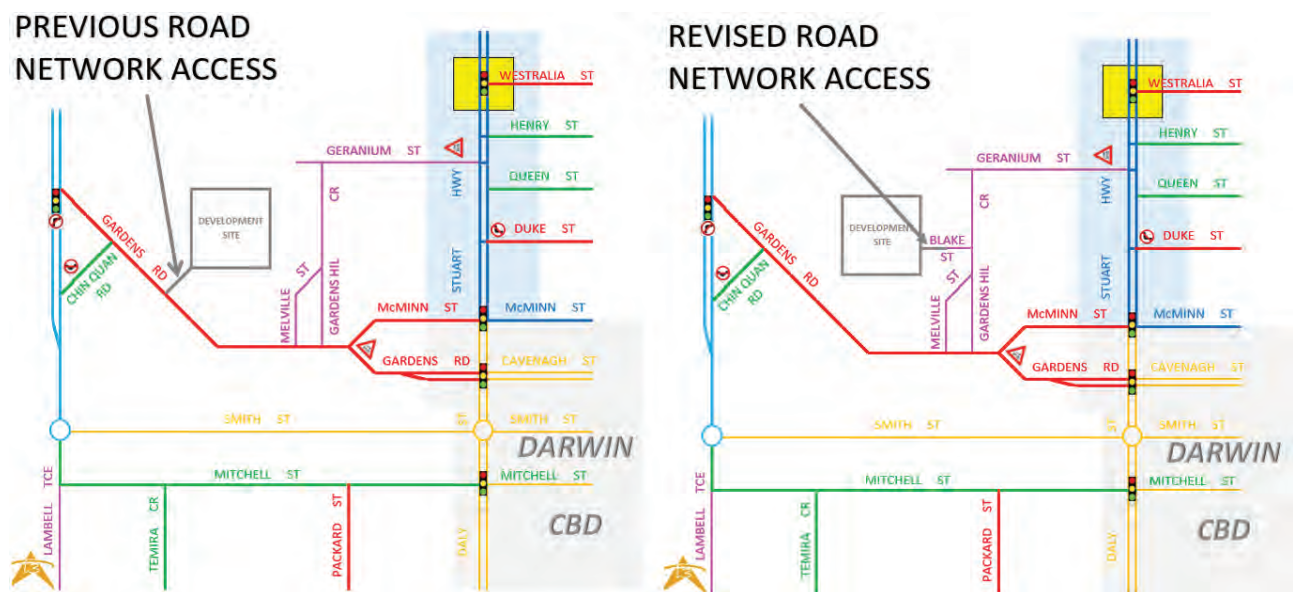


Figure 1 – Previously assessed road network access and revised road network access

2 INTENT AND LEVELS OF DEVELOPMENT

The intent of this Technical Note is to determine and document the level of development that could be undertaken on Lots 6907 + 6908 before the road network experiences unacceptable delays and levels of performance. The previous assessment report identified three Key Intersections that are most susceptible to increased traffic volumes with the revised access. These three Key intersections are shown in Figure 2 below, along with the City of Darwin's road classifications. This figure also shows Secondary intersection 1 (Si1) which was previously assessed due to the expected high proportion of right turning traffic compared to through traffic.

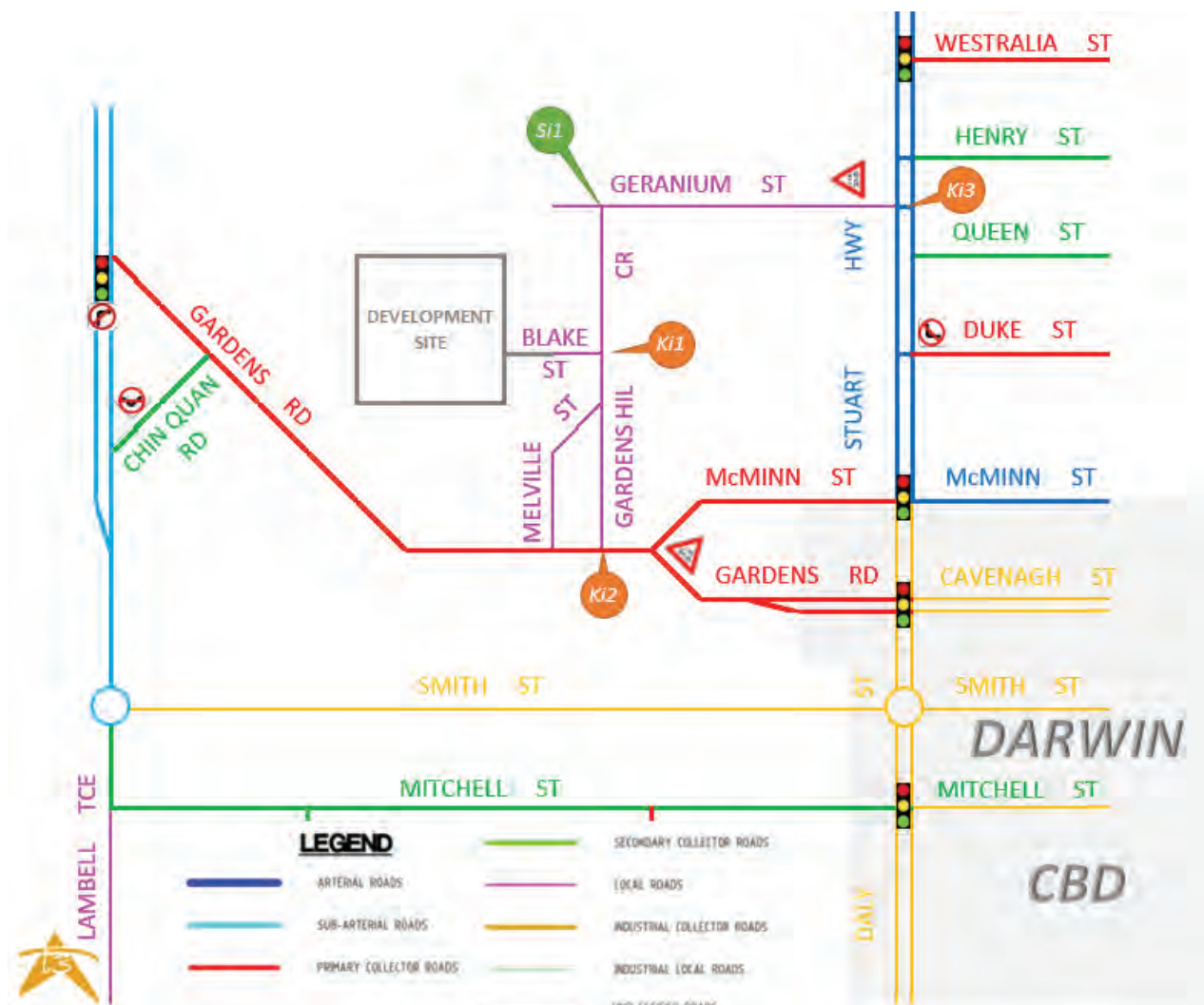


Figure 2 - Key intersections and City of Darwin road classifications

The previous assessment indicated that all of the intersections, with the exception of Ki3 (Germanium St/ Stuart Hwy), would operate within acceptable performance criteria with full development on Lots 6907/ 6908 as described previously. On the basis of the above, this Technical Note is limited to assessment of the forecast performance of Ki3 (Geranium St/ Stuart Hwy) with different levels of development over different time periods as shown in Figure 3 and Table 1 on the following page.

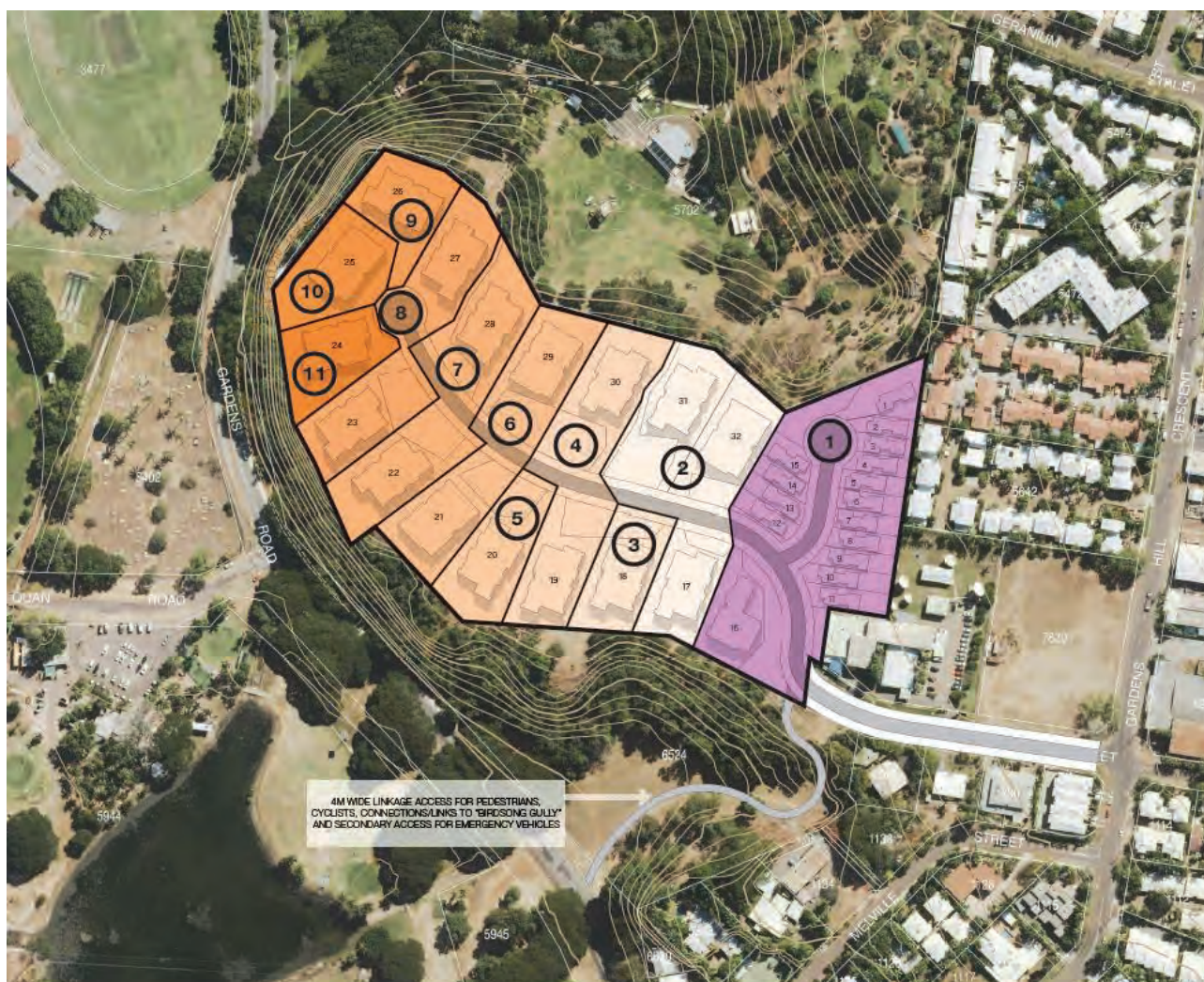


Figure 3 – Development Stages by Area

Stage	m ²	ha	Lots	Residential (Units)		Commercial (m2)		Program	
				Dwellings	Retirement	Health	Café/ Restaurant	Year	Years
1	11,841	1.184	16	15	35	100	100	2027	9
2	7,619	0.762	3	85				2033	15
3	2,170	0.217	1	25				2035	17
4	5,705	0.571	2	62				2039	21
5	2,441	0.244	1	25			100	2041	23
6	5,372	0.537	2	60			200	2045	27
7	5,199	0.520	2	58			200	2049	31
8	4,896	0.490	2	54				2053	35
9	2,102	0.210	1	23				2059	41
10	2,657	0.266	1	30				2059	41
11	2,337	0.234	1	0	35	100	100	2059	41
TOTAL	52,340	5.234	32	437	70	200	700		

Table 1 – Development Stages Yield Data

3 EXISTING ROAD NETWORK PERFORMANCE

A SIDRA Intersection performance model has been prepared for the Geranium St/ Stuart Hwy intersection based on extensive traffic surveys undertaken by Matrix Traffic & Transport Data who were commissioned to undertake 12-hour counts (6 AM to 6 PM) at the intersection on Tuesday 8th November 2016. The count included heavy and light vehicles as well as pedestrian and cyclist's volumes broken down into 15-minute intervals.

SIDRA Intersection (**S**ignalised and unsignalised **I**ntersection **D**esign and **R**esearch **A**id) is an advanced lane-based micro-analytical tool for the design and evaluation of individual intersections and networks of intersections including modelling of separate Movement Classes (Light Vehicles, Heavy Vehicles, Buses, Bicycles, Large Trucks, Light Rail / Trams etc...). It provides estimates of capacity, level of service and a wide range of performance measures including delay, queue length and stops for vehicles and pedestrians, as well as fuel consumption, pollutant emissions and operating cost. An explanation of key performance criteria used in SIDRA Intersection and in this Technical Note is provided as Table 2 below.

SIDRA v/c & colour code	LoS	Average Delay per vehicle (d) in seconds				v/c Range	Performance Comments
		Unsignalised intersections	Roundabouts	Signalised intersections	All (RTA)		
< 0.6	A	$d \leq 10$	$d \leq 10$	$d \leq 10$	$d \leq 14.5$	≤ 0.44	Good operation and plenty of spare capacity <i>Stable free flow conditions where drivers are able to select desired speeds and to easily manoeuvre within the traffic stream.</i>
	B	$10 < d \leq 15$	$10 < d \leq 20$	$10 < d \leq 20$	$14.5 < d \leq 28.5$		
	C	$15 < d \leq 25$	$20 < d \leq 35$	$20 < d \leq 35$	$28.5 < d \leq 42.5$	0.45 - 0.64	Acceptable delays and spare capacity <i>Stable flow but most drivers are restricted to some extent in their ability to select their desired speed and to manoeuvre within the traffic stream.</i>
0.6 - 0.7	D	$25 < d \leq 35$	$35 < d \leq 50$	$35 < d \leq 55$	$42.5 < d \leq 56.5$	0.65 - 0.84	Acceptable delays (Expected typical peak hour conditions) <i>Close to the limit of stable flow. All drivers are restricted in their ability to select their desired speed and to manoeuvre within the traffic stream. Small increases in traffic flow may cause operational problems.</i>
0.7 - 0.8							
0.8 - 0.9							
0.9 - 1.0	E	$35 < d \leq 50$	$50 < d \leq 70$	$55 < d \leq 80$	$56.5 < d \leq 70.5$	0.85 - 1.04	Near capacity and sensitive to disturbances in flows <i>Traffic volumes are close to capacity and there is virtually no freedom to select desired speeds. Flow is unstable and minor disturbances within the traffic stream will cause breakdown leading to long queues and delays.</i>
> 1.0	F	$50 < d$	$70 < d$	$80 < d$	$70.5 < d$	> 1.25	

Table 2 – Key intersection performance criteria and descriptions

The 12-hour survey data indicates peak hours for the Geranium St/ Stuart Hwy intersection are between 7.30-8.30 AM and 4.45-5.45 PM.

Hour Starting
12hr Totals

Vehicle Type
All Vehicles

Geranium St

Total Eastbd

Peds G	43
AM Peak	3
PM Peak	7

Total Westbd

Peds H	27
AM Peak	0
PM Peak	5

Stuart Hwy

Total Northbd

Peds F	AM Peak	0	0
	PM Peak	0	0

Total Southbd

Peds E	AM Peak	0	0
	PM Peak	0	0

Selected Hour & Vehicle Type

11,683	237	710	11,002	11,949
100%	2%	6%	92%	100%

AM Peak (Vol) (%)

965	13	109	1,739	1,861
19%	1%	6%	93%	31%

PM Peak (Vol) (%)

1,644	13	86	1,105	1,204
25%	1%	7%	92%	20%

Geranium St

Total Eastbd

916	100	100
100%	25%	20%

Total Westbd

960	128	107
100%	29%	21%

Stuart Hwy

Total Northbd

Peds A	AM Peak	0	6
	PM Peak	2	6

Total Southbd

Peds B	AM Peak	2	14
	PM Peak	2	14

Selected Hour & Vehicle Type

11,209	250	10,622	337	11,431
100%	2%	95%	3%	100%

AM Peak (Vol) (%)

901	19	854	28	1,769
19%	2%	95%	3%	30%

PM Peak (Vol) (%)

1,578	21	1,536	21	1,131
24%	1%	97%	1%	20%

AM Peak 07:30 to 08:30
PM Peak 16:30 to 17:30

i 3 c 1 6 7 0 2

Two of the best indicators of intersection performance for unsignalised intersections is the Degree of Saturation (also referred to as the volume/ capacity ratio or v/c) and Level of Service (LoS). The Austroads document *Guide to Traffic Management Part 3: Traffic Studies and Analysis* (AGTM03) provides guidance with respect to intersection performance criteria. A summary of these is provided as Table 2 on page 4.

The survey data has been used to create a SIDRA model for the Geranium St/ Stuart Hwy intersection for each peak hour. This intersection has a wide median island and break in Stuart Hwy at Geranium St that allows for what is termed a ‘two-stage crossing’ for driver’s turning right out of Geranium St. To model this, SIDRA requires that a model is prepared for each stage and that the two models are then linked in a network.

A diagrammatic representation of the 2-stage model is shown in Figure 5 below, along with an aerial photograph of the actual layout of the intersection. The right turn into Geranium St is modelled on the left side of the median as these drivers are only required to give way to northbound Stuart Hwy traffic. If it was modelled on the right side the model would assume that these drivers would give-way to right turning traffic out of Geranium St and provide incorrect intersection performance results. The model also shows two lanes in the median break for right turning traffic out of Geranium St. This reflects the practice of up to two right turning vehicles waiting in this break.

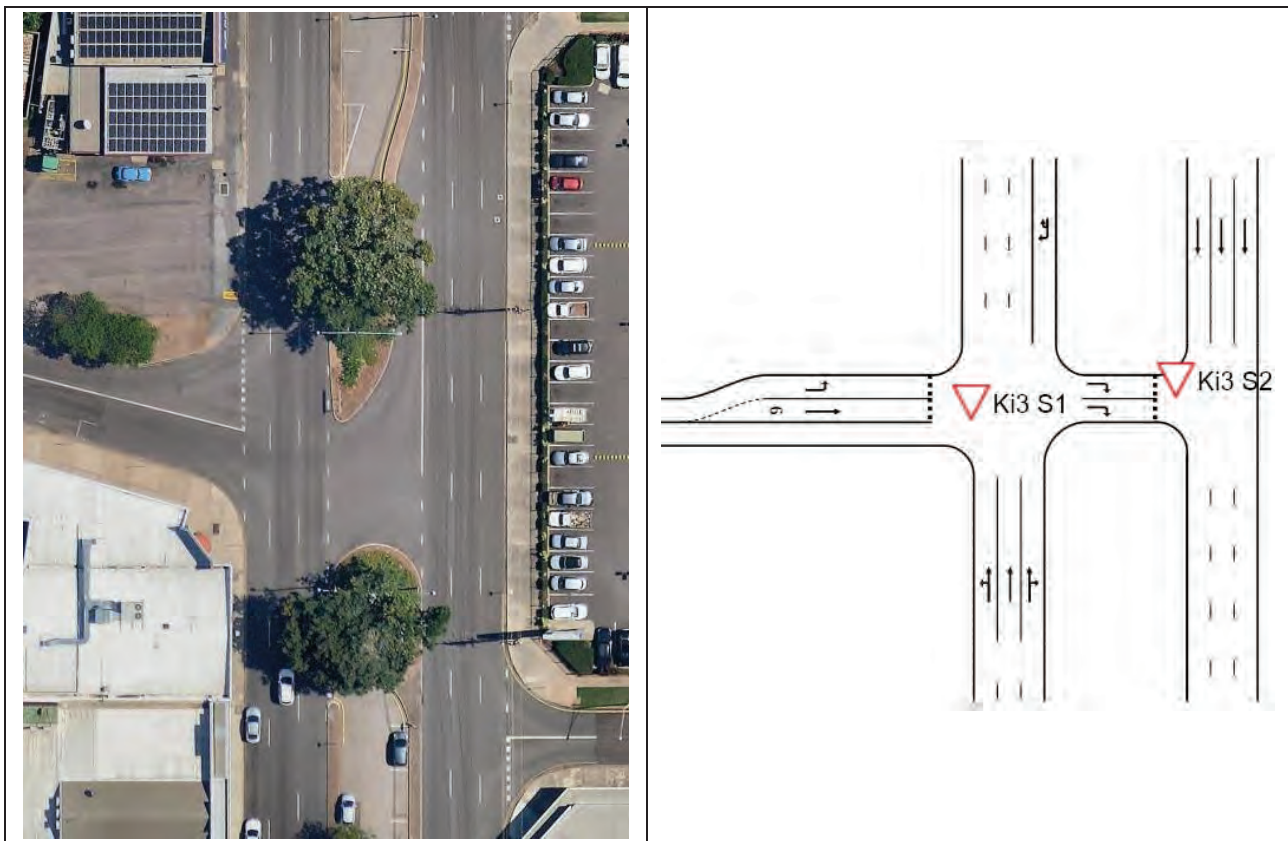


Figure 5 – Existing intersection layout and diagrammatic representation of the SIDRA model

The assessed Degree of Saturation for each movement and peak hour based on the 2016 survey data is shown graphically in Figure 6 and Figure 7 below.

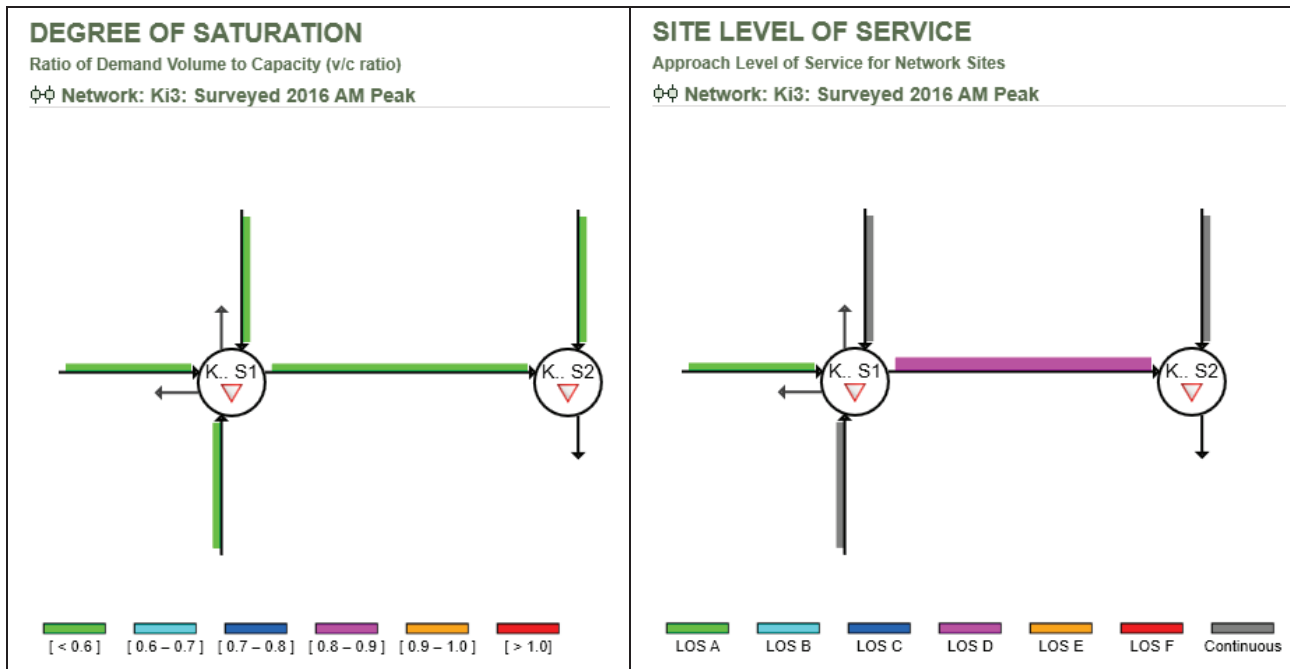


Figure 6 – Assessed 2016 intersection performance during the AM Peak Hour

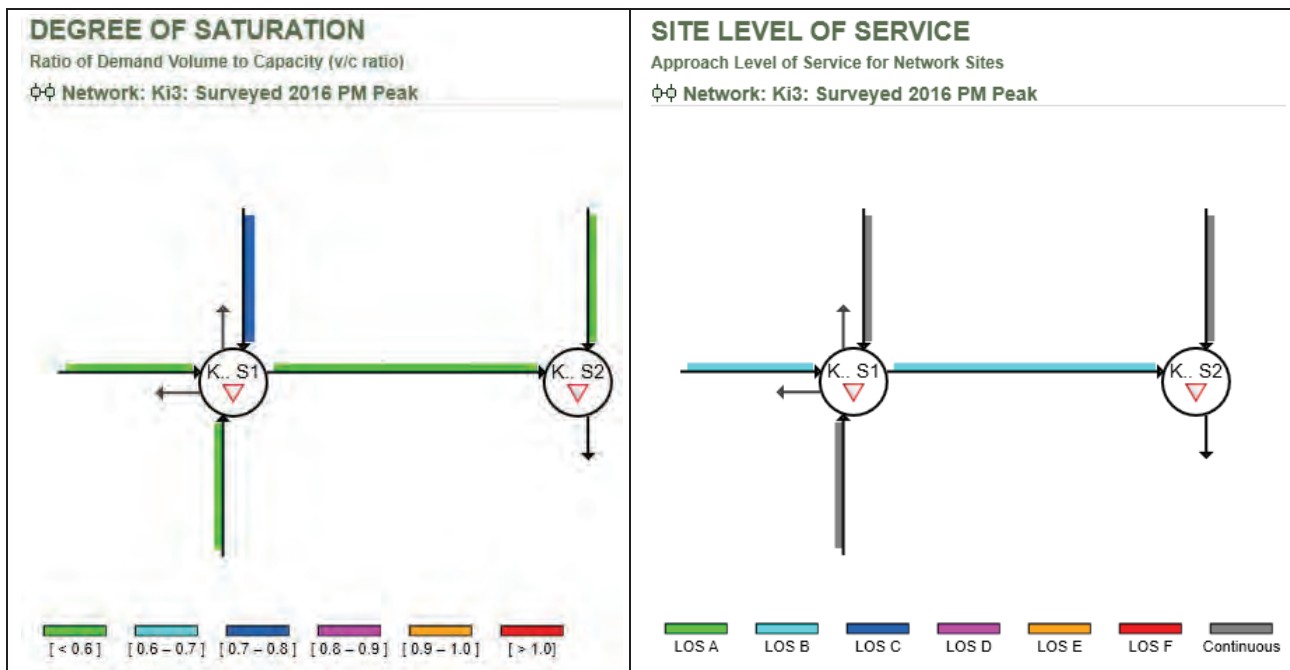


Figure 7 – Assessed 2016 intersection performance during the PM Peak Hour

The SIDRA models with the 2016 survey data indicate that the Geranium St/ Stuart Hwy intersection currently performs within acceptable intersection performance criteria although it is noted that there are legs within the intersection that have movements with a degree of saturation between 0.7 and 0.8 and a Level of Service D during each peak hour. A more detailed assessment of individual movements during the peak hours is provided as Figure 8 and Figure 9 below. This indicates that the key movement impacting on intersection performance is the right/ U turn movement for southbound Stuart Hwy traffic during the PM peak hour.

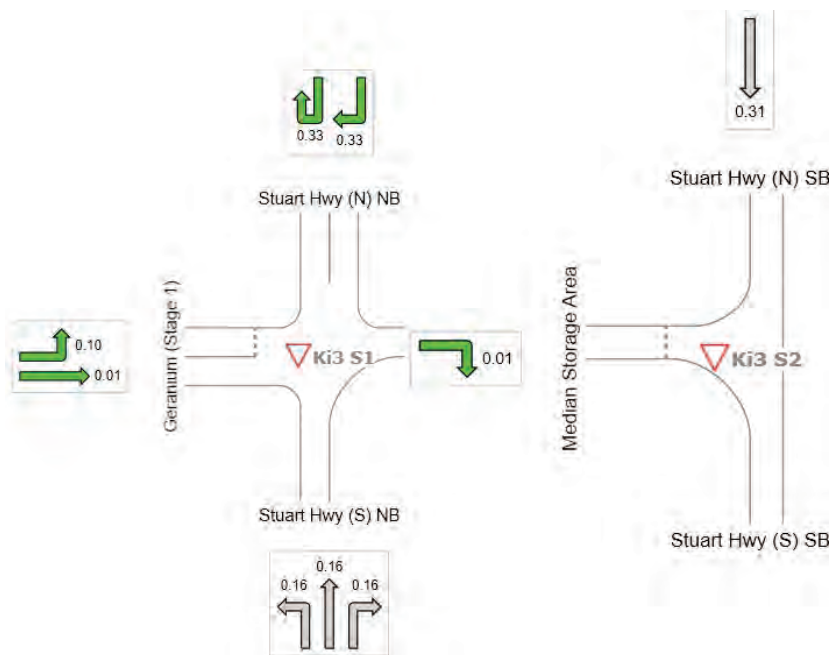


Figure 8 – Assessed turning movement Degree of Saturation during the AM peak hour with 2016 volumes

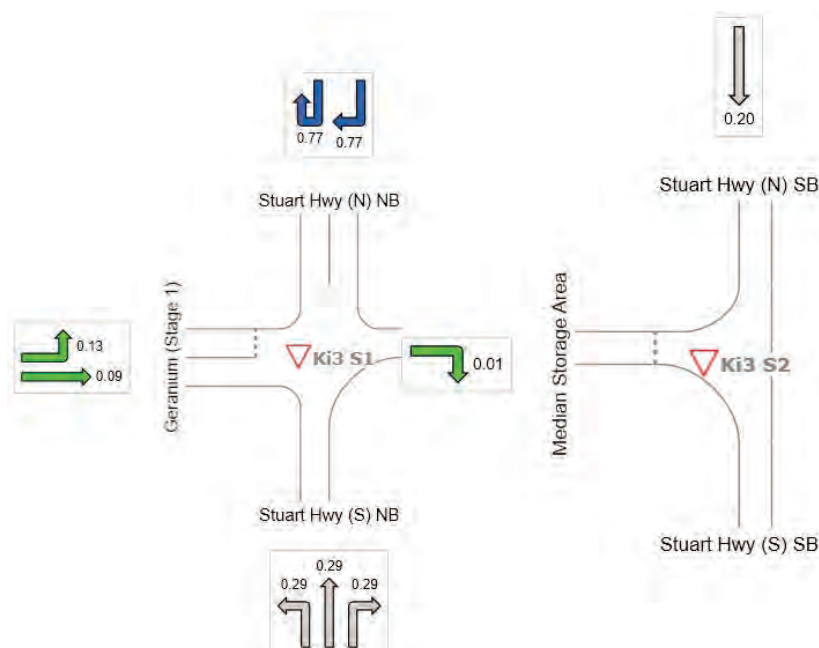


Figure 9 – Assessed turning movement Degree of Saturation during the PM peak hour with 2016 volumes

4 PROPOSED ROAD NETWORK PERFORMANCE

Construction of a new arterial entry road into the CBD from the north, known as the Garramilla Boulevard project, commenced in June 2018. It was previously referred to as the Barneson Boulevard Project. This project is programmed for completion by the end of 2020. The alignment is shown in Figure 10 below.

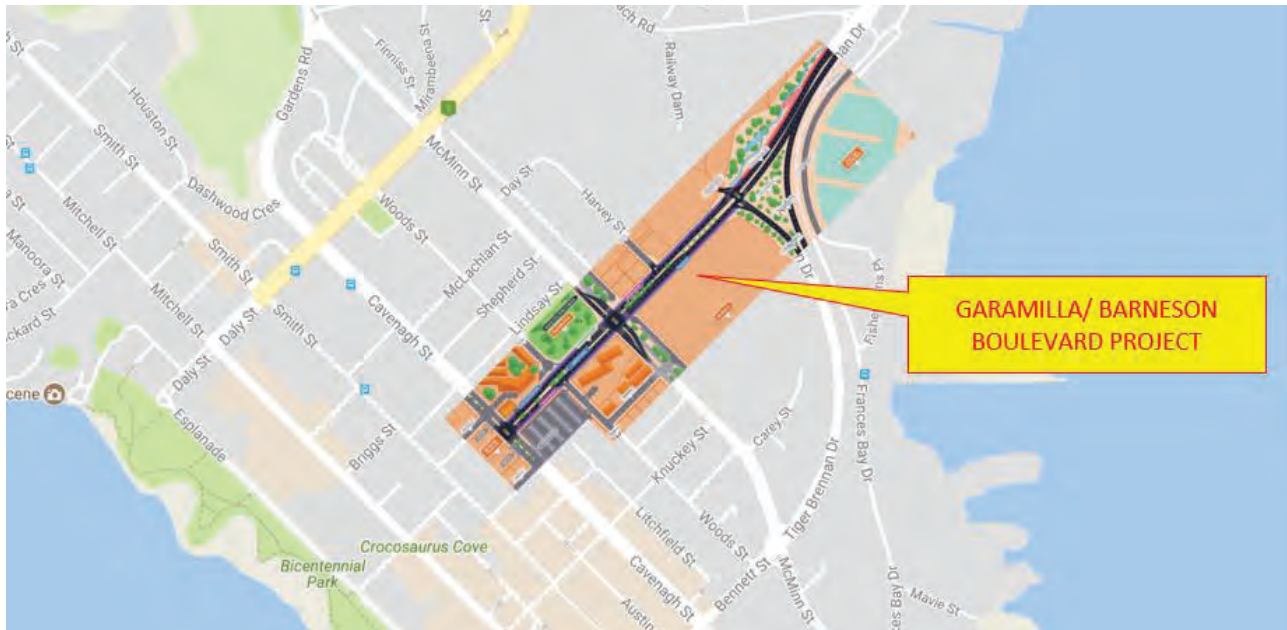


Figure 10 – Garramilla Boulevard alignment (Tiger Brennan Dr to Cavenagh St)

Modelling associated with this proposal has indicated that traffic volumes on Stuart Hwy are likely to decrease compared to current 2016 volumes.

The previous assessment report retained the 2016 base volumes, along with additional traffic forecast to be generated by development on Lot 7820 (Elysium) and then assessed the worst performing intersection, i.e. Ki3: Geranium St/ Stuart Hwy with the forecast retained volumes on Stuart Hwy in the *Barneson Boulevard Model*.

Subsequent analysis of the Barneson Boulevard Model by myself in November 2017 as part of the public comment process revealed concerns with this model. The response from the Department of Infrastructure, Planning and Logistics, via the Deputy Chief Minister, Minister for Infrastructure, Planning and Logistics (8 March 2018) was that the *Barneson Boulevard Model* was considered appropriate.

Following a request from the proponent in July 2018 to update the previous assessment report to reflect a revised staged development, I undertook an assessment of historical traffic volumes on Stuart Hwy in the vicinity of Geranium St since 1994 and plotted 'forecast' traffic volume data from the *Barneson Boulevard Model* and the Department of Infrastructure, Planning and Logistics' *Land Use Scenario Demand Driven Model*. This assessment is provided graphically as Figure 11 on the following page.

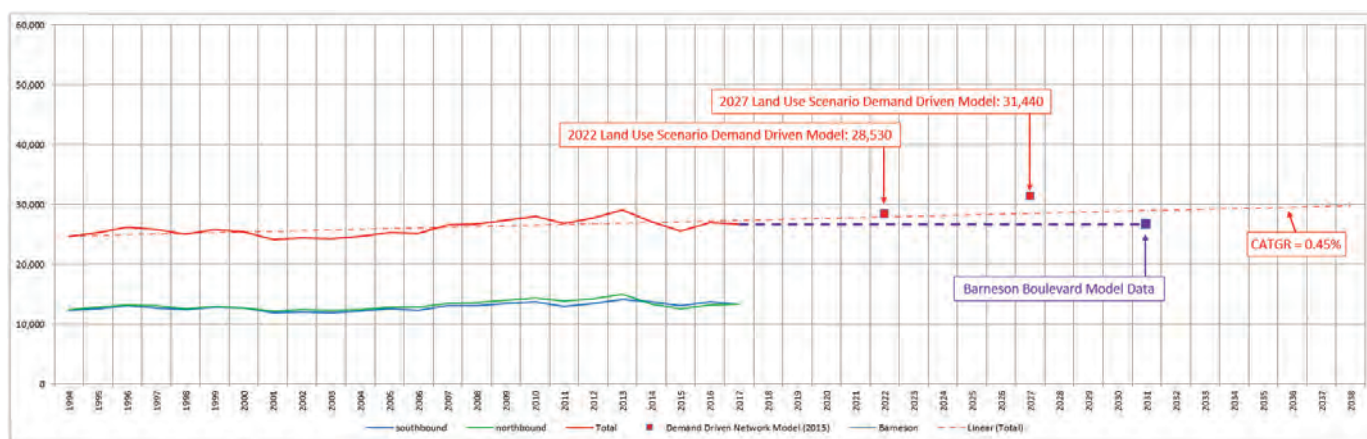


Figure 11 – Plot of historical traffic volumes on Stuart Hwy between 1994 and 2017 and various traffic model forecast volumes

Figure 11 indicates that the existing Compound Annual Traffic Growth Rate (CATGR) on Stuart Hwy is 0.45% and that adopting the Barneson Boulevard Model would result in zero background traffic volume growth on Stuart Hwy between 2016 and 2031. This is due to an initial reduction in volumes when the Garramilla/ Barneson Boulevard is opened in 2020 and subsequent Compound Annual Traffic Growth of around 0.45% resulting in a return to 2016 volumes in 2031.

Figure 11 was forwarded to the Department of Infrastructure, Planning and Logistics for comment on 26th November 2018. The response received on 17th December 2018 was “the Department does not support the use of the (Barneson Boulevard Model) data as the only source for your development TIA. However, the 0.45% CATGR is more appropriate for Stuart Highway as the through traffic volume data between 2018 and 2031.”

Adopting the indicated CATGR of 0.45% for Stuart Hwy for the indicated 13 years between 2018 and 2031 without any additional traffic from either the Elysium Development or development on Lots 6907 and 6908 would result in a forecast Degree of Saturation (or v/c) of 0.91 in 2031, indicating that it is near capacity and sensitive to disturbances in flow. It would reach capacity 6 years later (in 2038 without development) and require alternative control such as traffic signals or the prohibition of right turns. The Department of Infrastructure, Planning and Logistics has indicated that the 'Stuart Park Bypass' is likely to be constructed by 2035 to address this. This bypass project is shown in Figure 13 on the following page and includes traffic signal control at Geranium St intersection.

GRAPHS - Design Life Analysis

Average control delay per vehicle for the worst vehicle movement (seconds) and Highest degree of saturation in any lane

▽ Site: Ki3 S1: Surveyed 2016-2031 PM Peak

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 Giveaway / Yield (Two-Way)
 Design Life Analysis (Capacity): Results for 19 years

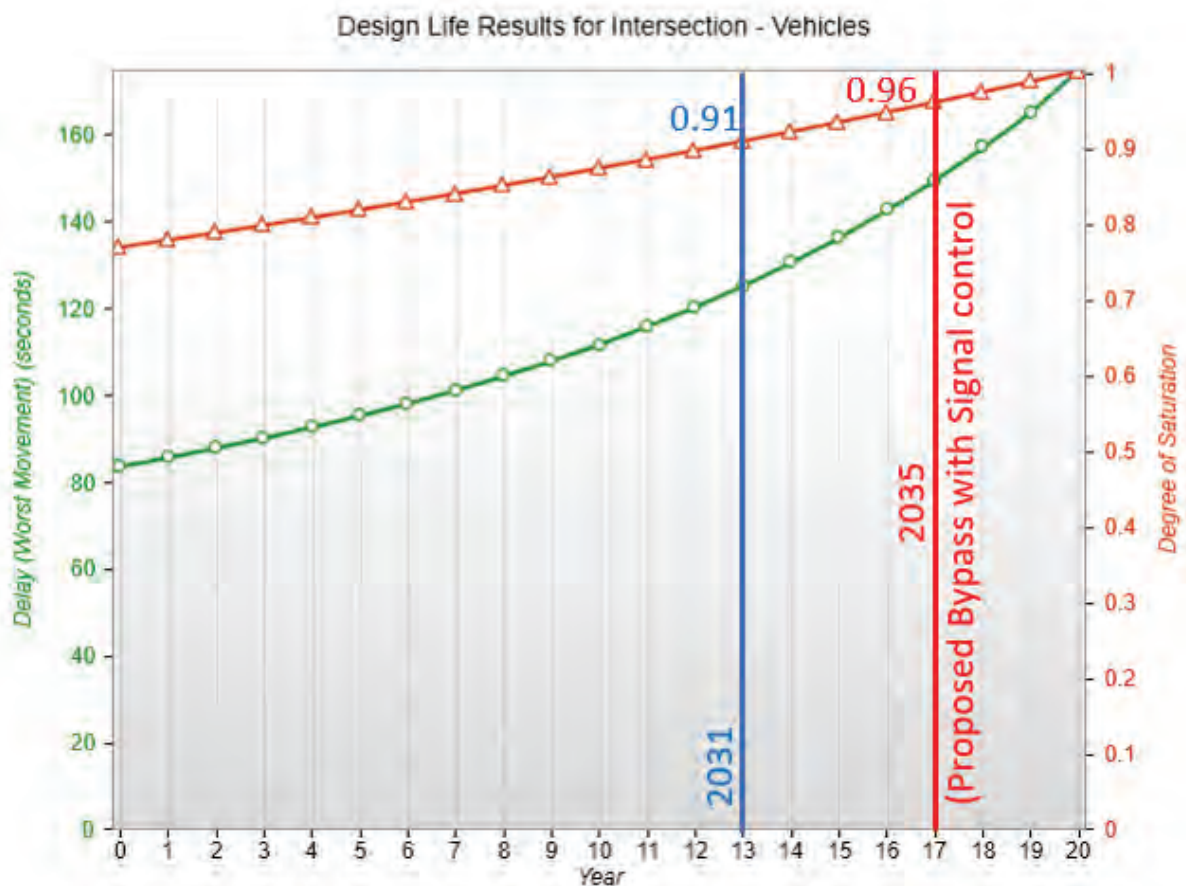


Figure 12 – Assessed design life of the Geranium St/ Stuart Hwy intersection with 0.45% compound annual traffic growth rate on Stuart Hwy

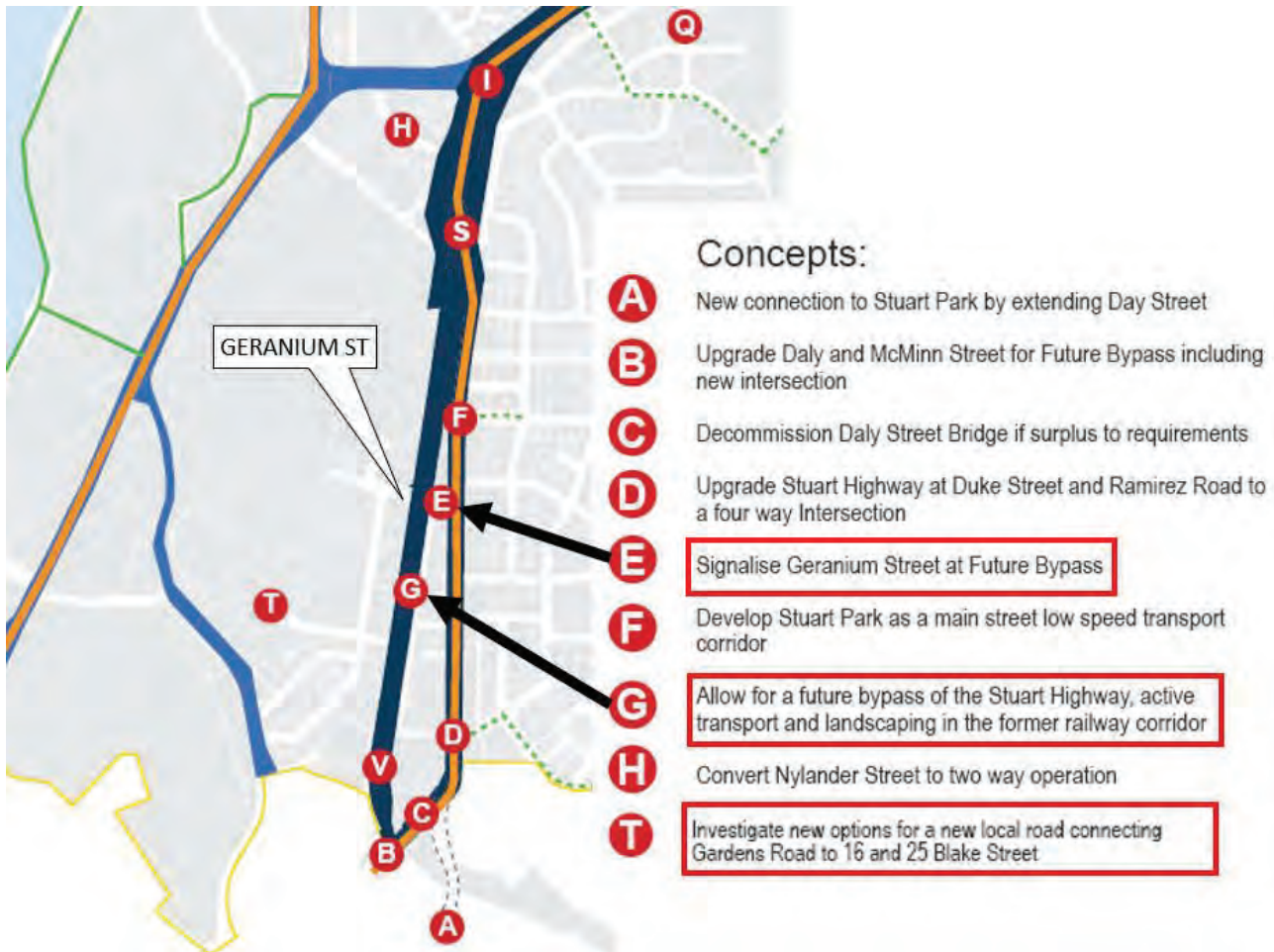


Figure 13 – Annotated extract from *Darwin Inner Suburbs Area Plan: Movement and Transport Diagram*

Based on the assessment of the existing road network and request from the Department of Infrastructure, Planning and Logistics to use CATGR of 0.45% for Stuart Hwy background traffic, it has been determined that the best method to achieve the stated objective is to:

1. Prepare a revised trip assignment based on staged development and forecast volumes through the Geranium St/ Stuart Hwy intersection;
2. Add the revised trip generation volumes to the 2016 volumes and Elysium Volumes;
3. Assess the Geranium St/ Stuart Hwy with these additional volumes in SIDRA Intersection with the existing Give-Way controlled 'T' intersection layout up to 2035 and Traffic Signal controlled 'T' intersection with the proposed Stuart Park Bypass Road after 2035 and up to 2041(i.e. Stage 5 completion) with the following two background traffic growth scenarios:
 - o CATGR of 0.45% on Stuart Hwy for through movements; and
 - o Barneson Boulevard Model data for Stuart Hwy through movements.

5 ASSESSMENT

5.1 TRIP GENERATION

Section 4.5.5 (Traffic generation) of the Austroads publication *Guide to Traffic Management Part 12: Traffic Impacts of Developments (AGTM12 - 2016)* indicates that “Traffic generation can be estimated using trip generation rates established in previous surveys. Locally derived rates are preferred to those applying elsewhere.”

Section 3.1 (Land Use Traffic Generation) of the RTA (NSW) publication *Guide to Traffic Generating Developments* indicates that “The traffic generation potential of developments can be assessed in many situations by referring to the (RTA) Authority’s Land Use Traffic Generation – Data and Analysis reports” and that “Surveys of existing developments similar to the proposal can also be undertaken and comparisons drawn.”

Trip generation is often determined from publications such as the RTA NSW publication *Guide to Traffic Generating Developments (2002)* and the ITE USA publication *Trip Generation Manual (v9 - 2012)*. Some of the 2002 RTA NSW rates were revised via the issue of an update based on 2013 surveys.

In accordance with the *AGTM12* statement that “Locally derived rates are preferred to those applying elsewhere”, traffic generation for the residential component has been estimated using trip generation rates established from surveys undertaken by i3 at three multiple residential developments within 1,200 m of the Development Site as described on the following pages. These locally derived rates are preferable to those applying elsewhere as they consider observed and actual practices at similar developments with similar attractors and generators. They also effect the growing trend towards the selection of alternatives to single occupancy car trips to and from places of employment such as greater use of public transport (buses) walking, cycling and ‘on-demand’ ride sharing.

‘The Imperial Apartments’ (40 Units) 144 Smith Street (Cnr Dashwood Crescent)



Photograph 1 – looking south at ‘The Imperial Apartments’, cnr Smith St/ Packard Pl/ Dashwood Cr

Dwellings	AM Peak Hour		AM Rate		PM Peak Hour		PM Rate	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
40	1	10	0.03	0.25	12	5	0.30	0.13
	9%	91%	9%	91%	71%	29%	71%	29%
	11		0.275		17		0.425	

Table 3 – ‘The Imperial Apartments’ surveyed peak hour trips

‘The Sentinel’ (43 Units) 1 Daly Street (Cnr Doctor’s Gully Road)



Photograph 2 – looking north at ‘The Sentinel’, cnr Daly St/ Doctor’s Gully Rd

Dwellings	AM Peak Hour		AM Rate		PM Peak Hour		PM Rate	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
43	1	11	0.02	0.26	7	5	0.16	0.12
	8%	92%	8%	92%	58%	42%	58%	42%
	12		0.279		12		0.279	

Table 4 – ‘The Sentinel’ surveyed peak hour trips

Mangola Court (28 Dwellings) Larrakeyah

There are a number of existing residential developments in Mangola Ct in Larrakeyah of a similar size to those in the proposed development that can be easily and accurately surveyed due to limited access points and the ability to observe and record all movements in and out, including vehicular, pedestrian and cyclists. Some pedestrian trips are associated with public transport trips; i.e. walking to and from nearby bus stops. Existing developments are shown in Photograph 3 to Photograph 8 on pages 16 to 18. A summary of these is provided as Figure 14 below. Survey data is shown in Table 5 below.



Figure 14 – Existing Dwelling Numbers on Mangola Ct

Existing Dwellings 28	Existing Trip Generation				Modal Share
	AM Peak Hour		PM Peak Hour		
	IN	OUT	IN	OUT	
Vehicles	2	7	5	2	76%
Pedestrians	2	2	0	0	19%
Cyclists	0	1	0	0	5%

Table 5 – Surveyed Trip Generation from existing residential developments on Mangola Ct



Photograph 3 – Existing 8 Unit Apartment Development at 3 Mangola Ct



Photograph 4 – Existing 6 Unit Apartment Development at 5 Mangola Ct



Photograph 5 – Existing 16 Unit Apartment at 139 Smith St viewed from Mangola Ct cul-de-sac



Photograph 6 – Existing 8 Unit Apartment at 6 Mangola Ct



Photograph 7 – Existing Single Residential Dwelling at 4 Mangola Ct



Photograph 8 – Existing 4 Unit Residential Development at 2 Mangola Ct

A summary of the assessed residential trip generation rates based on survey data at three similar residential development sites in Larrakeyah within 1,200 m of the proposed development site, is shown in Table 6 below.

Land Use	Surveyed Trip Generation Rate			
28 dwellings in Mangola Court Larrakeyah June 2015	0.32	cars	per	dwelling AM Peak
	0.14	peds	per	dwelling AM Peak
	0.04	cycle	per	dwelling AM Peak
	0.25	cars	per	dwelling PM Peak
	0.04	peds	per	dwelling PM Peak
	0.04	cycle	per	dwelling PM Peak
40 dwelling 'Imperial Apartments' Larrakeyah	0.28	cars	per	dwelling AM Peak
	0.43	cars	per	dwelling PM Peak
43 dwelling 'The Sentinel Apartments' Larrakeyah	0.28	cars	per	dwelling AM Peak
	0.28	cars	per	dwelling PM Peak

Table 6 – Summary of surveyed AM and PM Peak Hour Residential Trip Generation Rates in Larrakeyah

Based on the above, it has been deemed appropriate to adopt the residential trip generation rates based on the 95%ile of the surveyed rates, as shown in Table 7 below.

Average AM Rates	0.29
95%ile AM Rates	0.32
Average PM Rates	0.32
95%ile PM Rates	0.41

Table 7 – Adopted Regular Residential Trip Generation Rates (i.e. excludes Retirement Dwellings)

The adopted trip generation for the remaining land uses has been undertaken based on the weekday AM and PM peak hour trip generation data shown in Table 8 and Table 9 below sourced from the NSW Transport RMS Technical Direction TDT 2013/04A and previous versions for land uses not included in this:

Land Use	Trip Generation Rate	Trip Distribution	
		IN	OUT
Retirement	0.2 trips/ dwelling	50%	50%
Health	2.67 trips/ consulting room (1 room/ 50m ²)	59%	41%
Café/ Restaurant	5 trips per 100 m ²	67%	33%

Table 8 – Adopted Weekday AM Peak Hour trip generation data

Land Use	Trip Generation Rate	Trip Distribution	
		IN	OUT
Retirement	0.2 trips/ dwelling	50%	50%
Health	2.67 trips/ consulting room (1 room/ 50m ²)	41%	59%
Café/ Restaurant	5 trips per 100 m ²	67%	33%

Table 9 – Adopted Weekday PM Peak Hour trip generation data

Based on the Yield Data in Table 1 on page 3, the assessed peak hour trip generation for Stages 1 to 5 between 2027 and 2041 is provided as Figure 15 below.

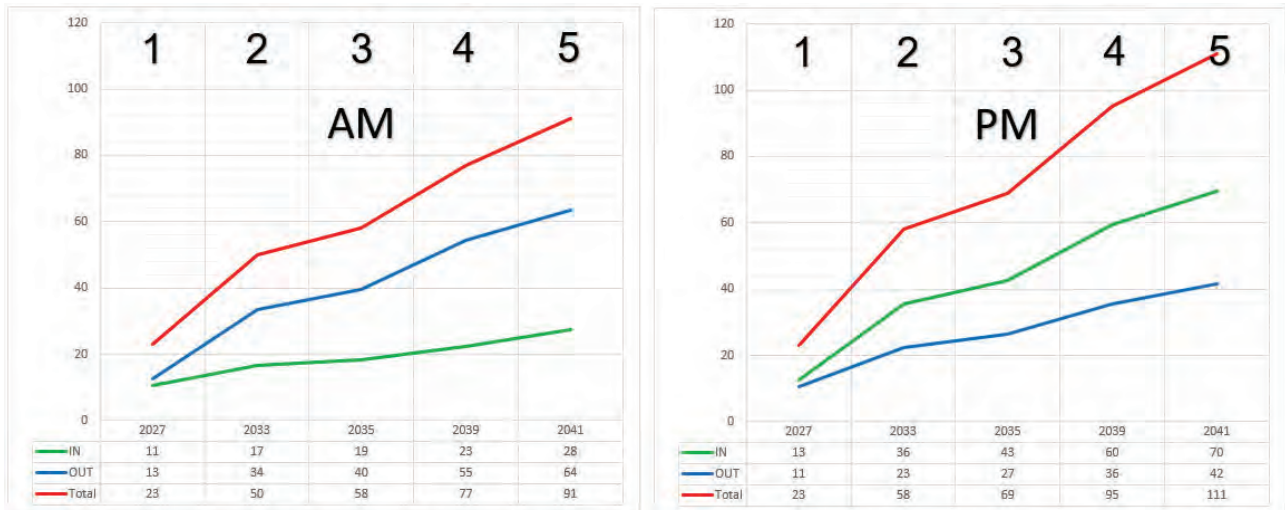


Figure 15 – Forecast trip development trips for each development stage: weekday AM and PM peak hours

Figure 15 indicates that Stages 1 to 4 of the proposed development is a moderate impact (i.e. generating less than a total of 100 trips during the peak hour) that would not normally warrant a detailed assessment provided that there is spare capacity on the external road network.

Unfortunately, adopting a CATGR of 0.45% for Stuart Hwy indicates that the Geranium St/ Stuart Hwy intersection would reach capacity by 2038 without the Elysium development and proposed development of Lots 6907 and 6908. It is therefore futile to model development stages after Stage 3 (2035) with 0.45% CATGR unless it is on the basis of a change of control at the intersection.

Based on the above assessment and preceding information in this Technical Note, it is considered appropriate to model and assess the Geranium St/ Stuart Hwy intersection with the forecast volumes for each stage between and including 1 and 5 in SIDRA Intersection with the existing Give-Way controlled 'T' intersection layout up to 2035 (i.e. Stages 1 – 3) and Traffic Signal controlled 'T' intersection with the proposed Stuart Park Bypass after 2035 for stages 4 and 5 (up to 2041) with the following two background traffic growth scenarios:

- CATGR of 0.45% on Stuart Hwy for through movements; and
- Barneson Boulevard Model data for Stuart Hwy through movements.

5.2 TRIP ASSIGNMENT

The trip assignment of generated traffic on the road network and through the Geranium St/ Stuart Hwy intersection is based on 75% of traffic travelling to and from the CBD and south, and 25% of traffic travelling to and from the north, as shown in Figure 16 below. This results in 20% of trips to and from Stuart Hwy north of Geranium St and reflects the expectation that the majority of peak hour trips, i.e. journey to work trips, would be between the development site and the Darwin CBD.

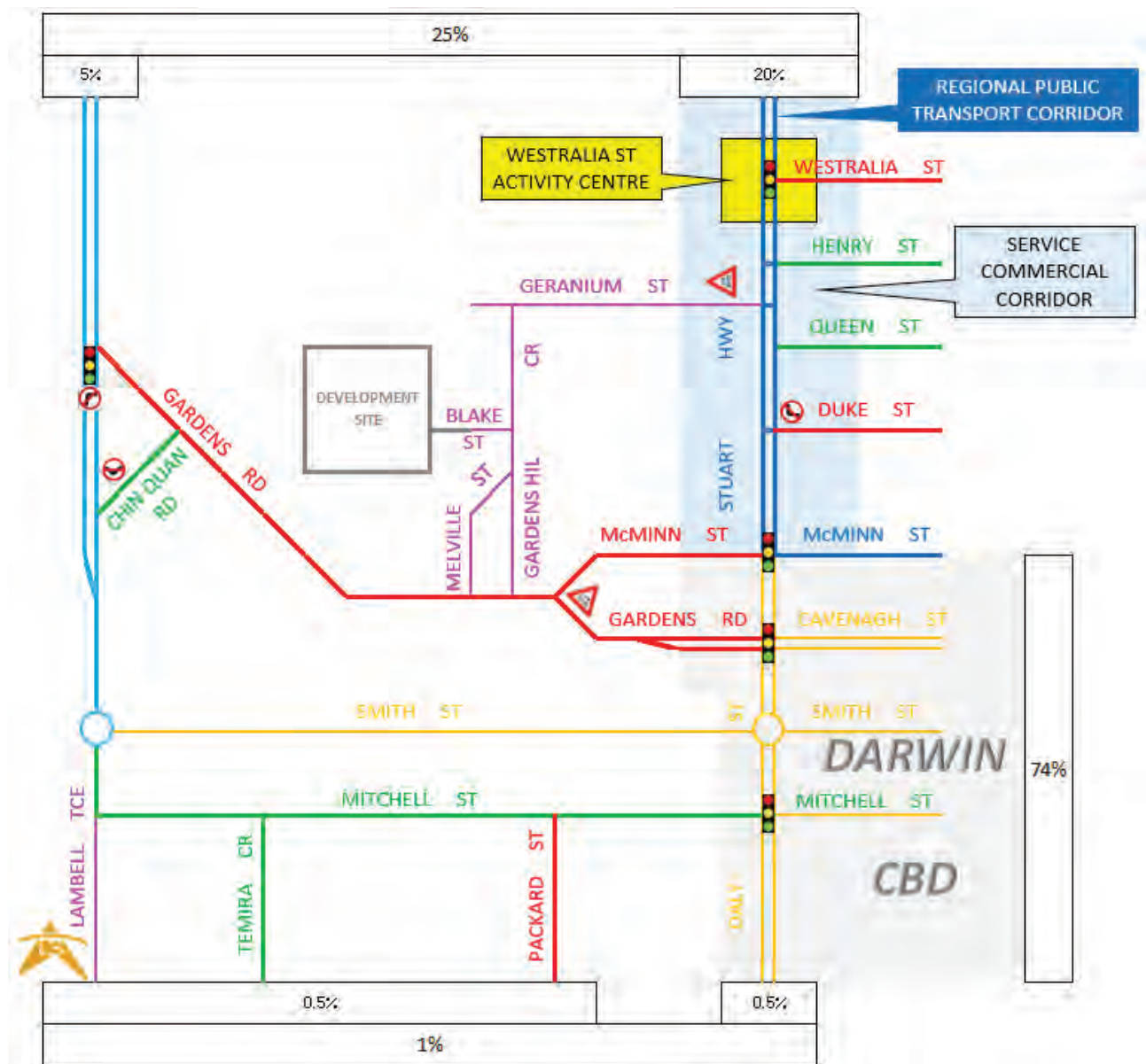


Figure 16 – Adopted Trip Origin and Destination Percentages

5.3 STAGE 1 (2027) DEVELOPMENT WITH 0.45% CATGR ON STUART HWY

The forecast total road network traffic volumes with Stage 1 development on Lots 6907 + 6908, including those forecast to be generated by Elysium Mixed Use Development and 0.45% CATGR on Stuart Hwy to 2027 is shown in Figure 17 below for the AM Peak Hour and Figure 18 for the PM Peak Hour on the following page.

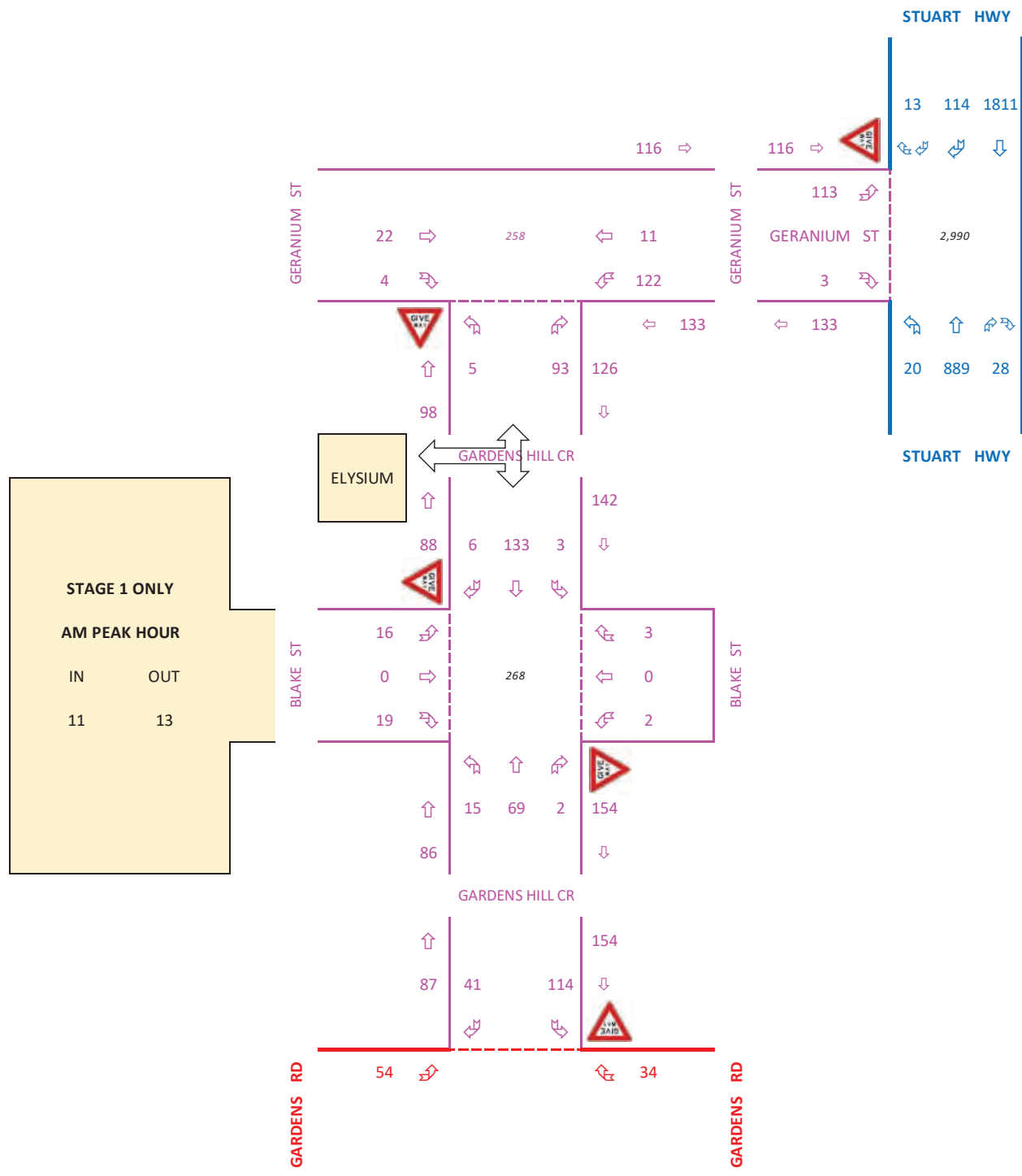


Figure 17 – Forecast Stage 1 Total AM Peak Hour Volumes

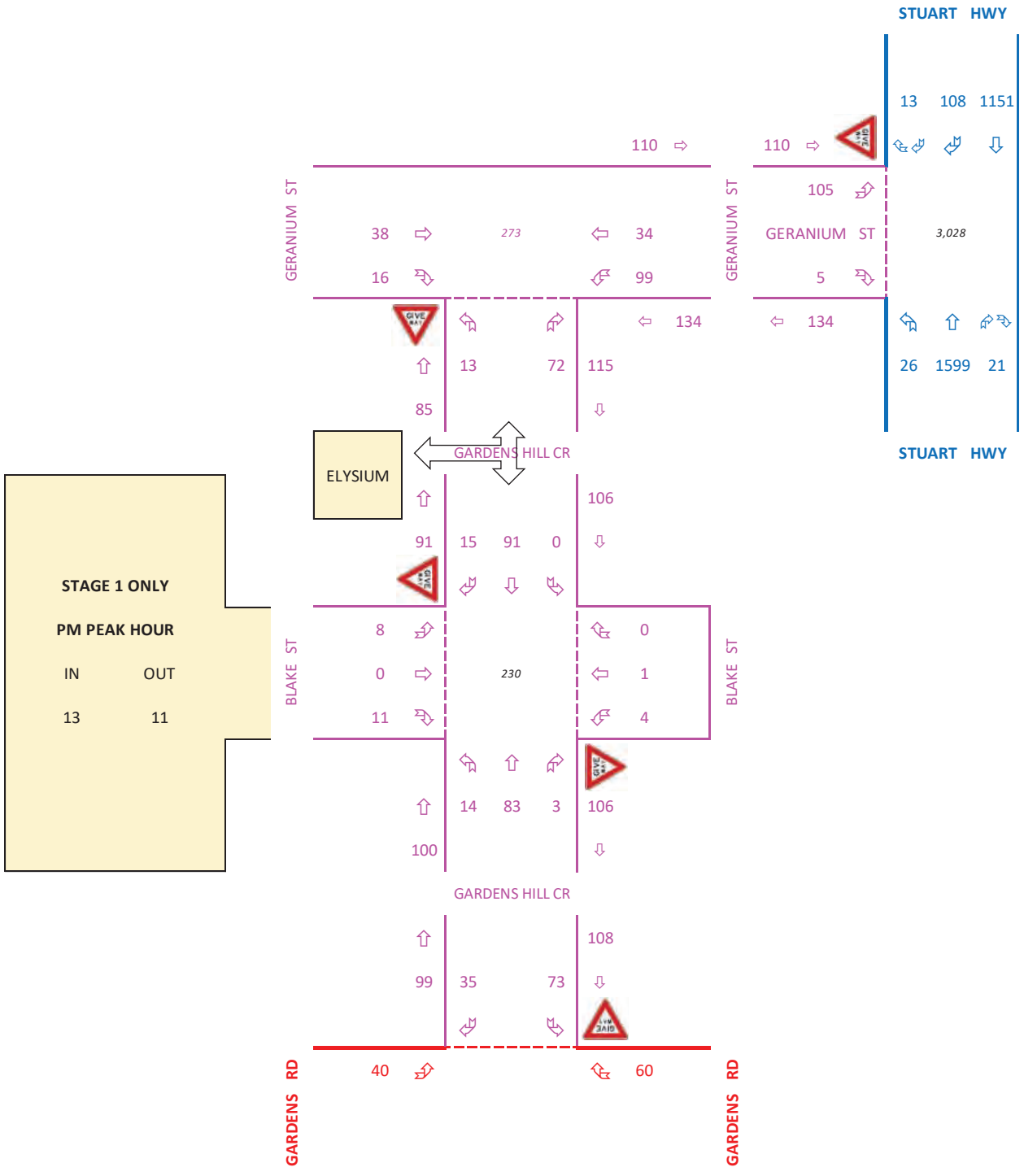


Figure 18 – Forecast Stage 1 Total PM Peak Hour Volumes

The assessment of the forecast Stage 1 2027 peak hour volumes is shown in Figure 19 and Figure 20 below.

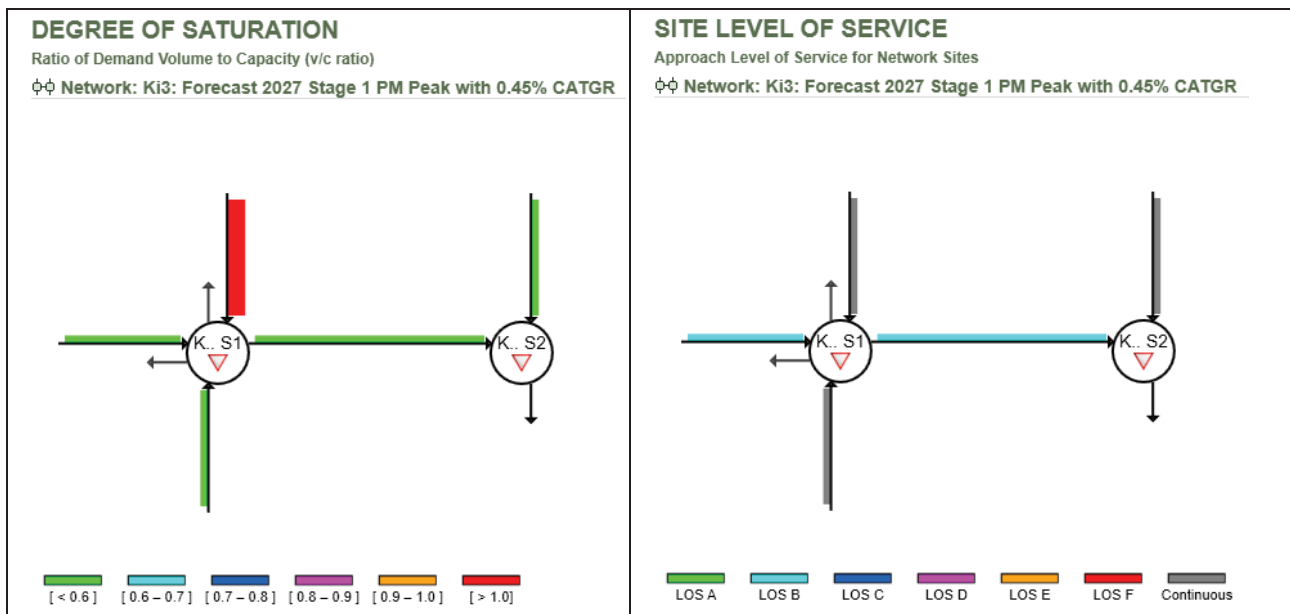
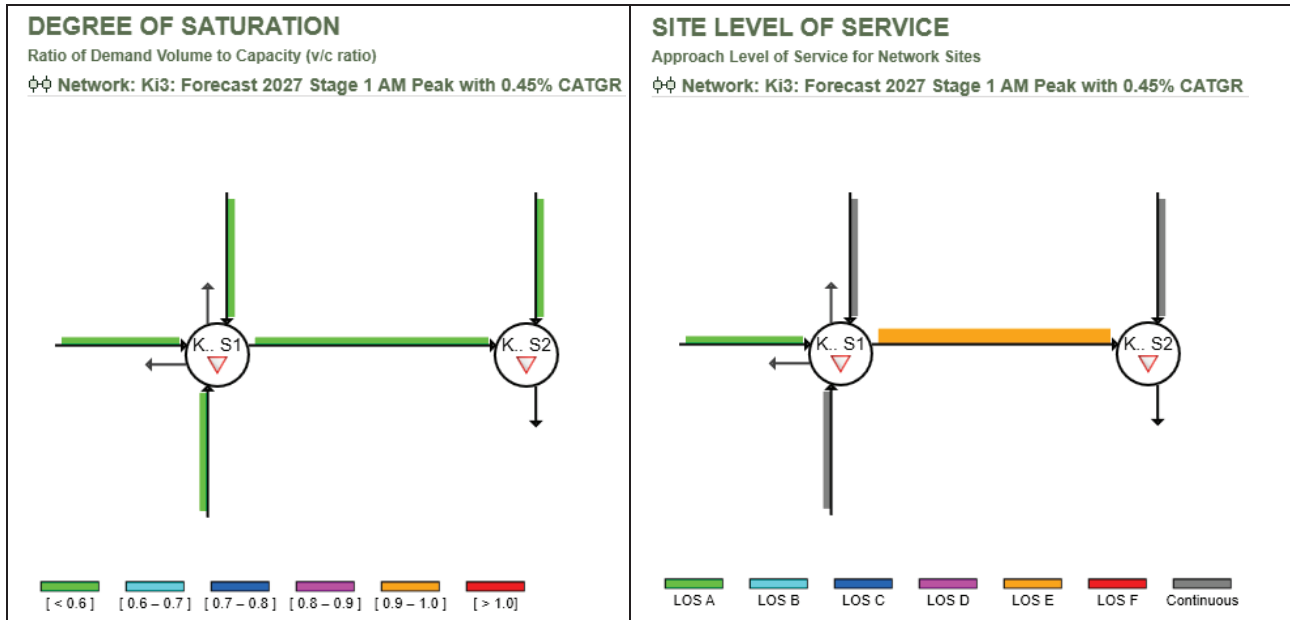


Figure 19 and Figure 20 show that the Geranium St/ Stuart Hwy intersection is expected to continue to perform within accepted intersection performance criteria with Stage 1 development of Lots 6907 + 6908, including the Elysium development, with the exception of the right turn and U turn for Stuart Hwy southbound traffic during the afternoon peak hour.

A more detailed assessment of individual movements during the PM peak hour is provided as Figure 21 below. This indicates that the key movement impacting on intersection performance is the right/ U turn movement for southbound Stuart Hwy traffic during the PM peak hour.

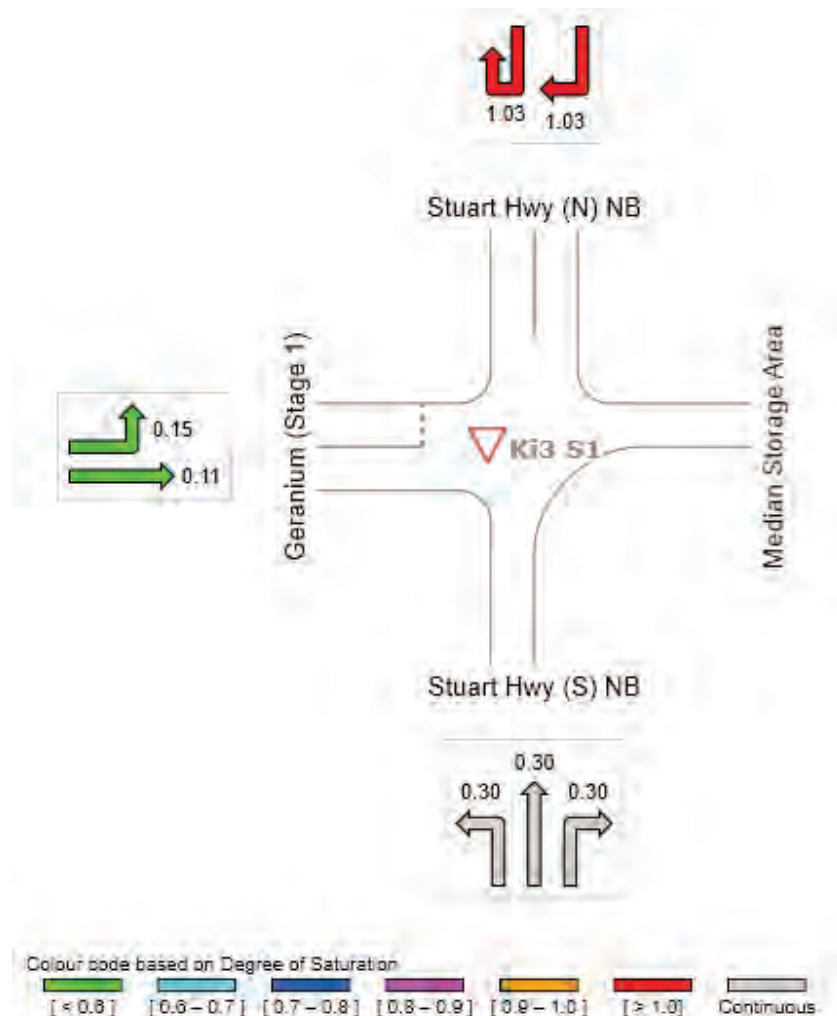


Figure 21 – Assessed turning movement Degree of Saturation during the PM peak hour with 2035 volumes

The assessed degree of saturation is only just above the desired threshold of 1.0, i.e. 1.03. Bearing in mind that this assessment is for the busiest peak hour and that there are many intersections in Darwin that experience degrees of saturation higher than this during the busiest peak hour, it is considered that the forecast performance is acceptable in this instance, particularly in the case that the approving authorities insist on the adoption of 0.45% CATGR for background traffic and taking into account that the intersection will ultimately be controlled by traffic signals in the future.

On the basis of the assessment that Stage 1 development with 0.45% CATGR for background traffic will result in a degree of saturation of 1.03 for right turns into Geranium St from Stuart Hwy, there is no need to undertake assessment of Stages 2 to 5 with 0.45% CATGR for background traffic as this will result in higher right turning volumes and therefore unacceptable degrees of saturation for this movement.

6 STUART HWY BASE VOLUMES

The assessment in **Section 5** has confirmed that the Geranium St/ Stuart Hwy intersection is very sensitive to increased volumes and is therefore unable to accommodate the forecast increased traffic into or out of Geranium St other than those generated by Stage 1 of the development to 2027 based on 0.45% CATGR for Stuart Hwy through movements to 2027. The key movement is the right turn into Geranium St from Stuart Hwy. This turning movement gives priority to northbound Stuart Hwy traffic and it is therefore likely that a reduction in the northbound Stuart Hwy through traffic may allow for an increase in right turning traffic from Stuart Hwy into Geranium St without the need for a change in control, such as traffic signals.

The advice from the Department of Infrastructure, Planning and Logistics (DIPL) on 17th December 2018 that “the Department does not support the use of the (Barneson Boulevard Model) data as the only source for your development TIA” and that “the 0.45% CATGR is more appropriate for Stuart Highway as the through traffic volume data between 2018 and 2031” is not consistent with previous comments.

DIPL prepared a report to the City of Darwin in October 2017 titled *Barneson Boulevard and Tiger Brennan Drive Stage 3*. The stated purpose of this report is “to provide City of Darwin clarity and sufficient information to be able to confidently support the Barneson Boulevard project as an iconic, green infrastructure project that will breathe life into this part of the CBD. A significant body of work has been undertaken and is summarised in this report.” The report also clearly indicates that **“This report should not be used for anything other than the intended purpose.”**

The DIPL report to the City of Darwin states that Barneson Boulevard “provides a much higher level of service across a number of roads until 2027.” This statement is supported by Table 1 and Table 2 in the report that shows the Level of Service on Stuart Hwy between McMinn St and Duke St for Outbound (i.e. northbound) traffic during the PM peak hour reduces from ‘C’ in 2017 without Barneson Boulevard to ‘A’ in 2027 with Barneson Boulevard. The page of the report including these tables and the quoted comments is reproduced as Figure 22 on the following page.

Whilst I have concerns with the Barneson Boulevard Model, I also have concerns with adopting a base model that assumes that the Barneson Boulevard project will have no impact on the historical growth rate on Stuart Hwy in the vicinity of the CBD, which has been 0.45% (compound) for the last 23 years. The stated objective of providing an additional arterial road into and out of the Darwin CBD is to reduce the pressure on other arterial roads into and out of the Darwin CBD, as indicated in the report to the City of Darwin. On this basis, I believe that it is more prudent to adopt 2031 volumes on Stuart Hwy that are the same as the surveyed 2016 volumes and to then increase these at a CATGR of 0.45% for the following years. For ease of reference, I have refereed to this scenario as the *Barneson Model*. This scenario is consistent with the graph shown in Figure 11 on page 10. An assessment using this model has been undertaken and is included in the following sections. It is limited to the PM peak hour as it has already been determined that this is the critical assessment period.

Barneson Boulevard and Tiger Brennan Drive Stage 3 – Report to City of Darwin

Table 1 – Level of Service - Traffic Scenario – 2017 Base Case (Without Barneson Boulevard)

	Tiger Brennan Drive – McMinn Street to Dinah Beach	Stuart Highway – McMinn Street to Duke Street	Bennett Street – McMinn Street to Cavenagh Street	Daly Street – McMinn Street to Cavenagh Street	McMinn Street – Stuart Highway to Tiger Brennan Drive	Knuckey Street – McMinn Street to Cavenagh Street
	AM Peak					
Inbound	A	C	D	D	D	C
Outbound	A	A	A	A	A	C
	PM Peak					
Inbound	A	A	C	C	C	A
Outbound	A	C	D	D	D	A

Table 2 – Level of Service - Traffic Scenario – 2027 with Barneson Boulevard

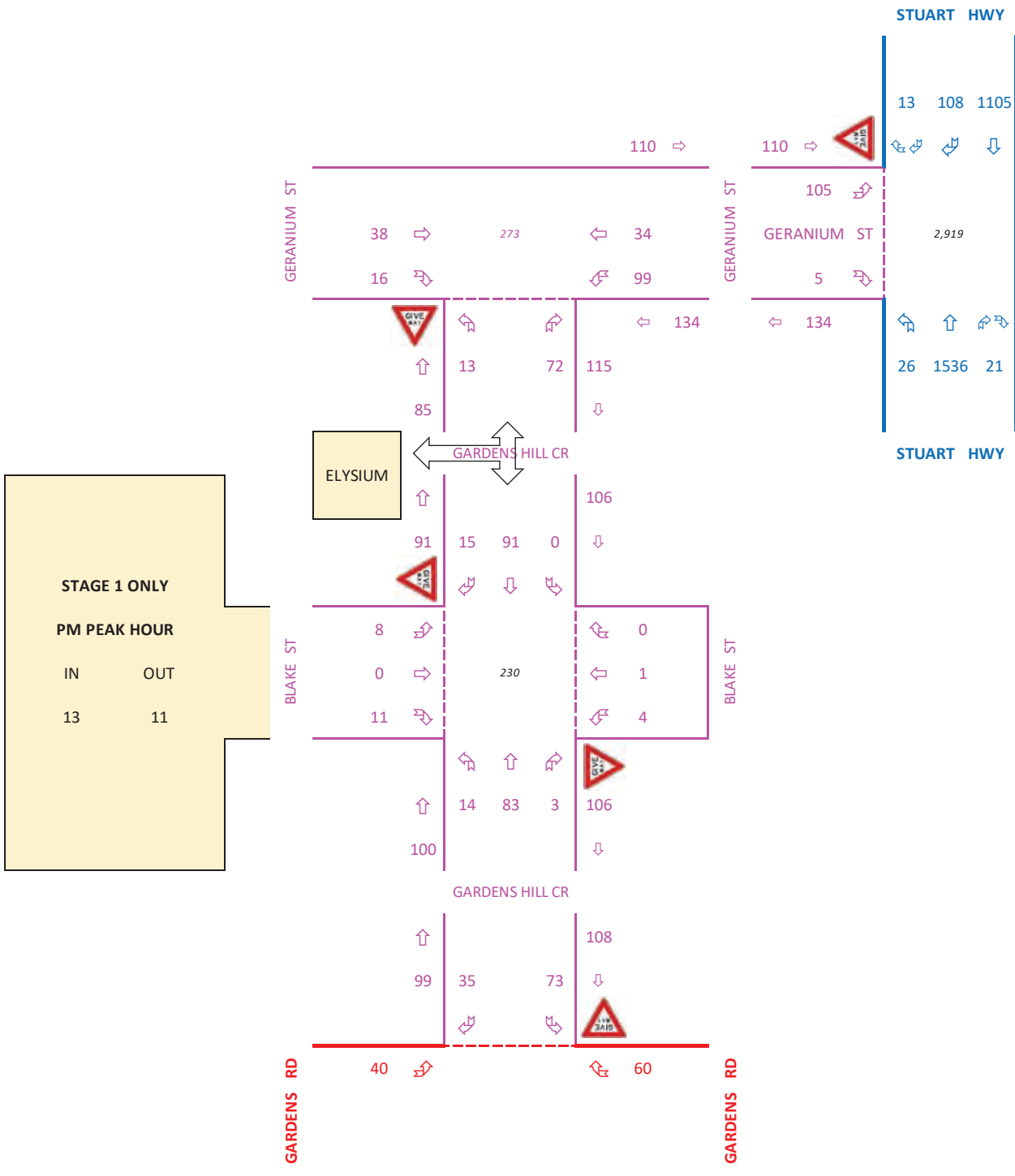
	Tiger Brennan Drive – McMinn Street to Dinah Beach	Stuart Highway – McMinn Street to Duke Street	Bennett Street – McMinn Street to Cavenagh Street	Daly Street – McMinn Street to Cavenagh Street	McMinn Street – Stuart Highway to Tiger Brennan Drive	Knuckey Street – McMinn Street to Cavenagh Street
	AM Peak					
Inbound	A	A	C	D	C	A
Outbound	A	A	A	A	A	A
	PM Peak					
Inbound	A	A	A	C	A	A
Outbound	A	A	A	D	C	A

The model shows that Bennett, Daly and McMinn Street are currently at level of service D. What this means is that if an incident occurs on the network, the CBD becomes gridlocked. This is also an issue for emergency management.

Barneson Boulevard relieves this and provides a much higher level of service across a number of roads until 2027. In 2027, Barneson Boulevard level of service is predicted to reduce to level of service D. However, due to the high level of service on a number of other roads, traffic will redistribute and service the CBD beyond the predicted 10 years.

6.1 STAGE 1 (2027) DEVELOPMENT WITH *BARNESON MODEL* DATA

The forecast total road network traffic volumes with Stage 1 development only on Lots 6907 + 6908, including those forecast to be generated by Elysium Mixed Use Development and *Barneson Model* data is shown in Figure 23 below.



The assessment of the forecast 2027 (Stage 1) PM peak hour volumes is shown in Figure 24 below.

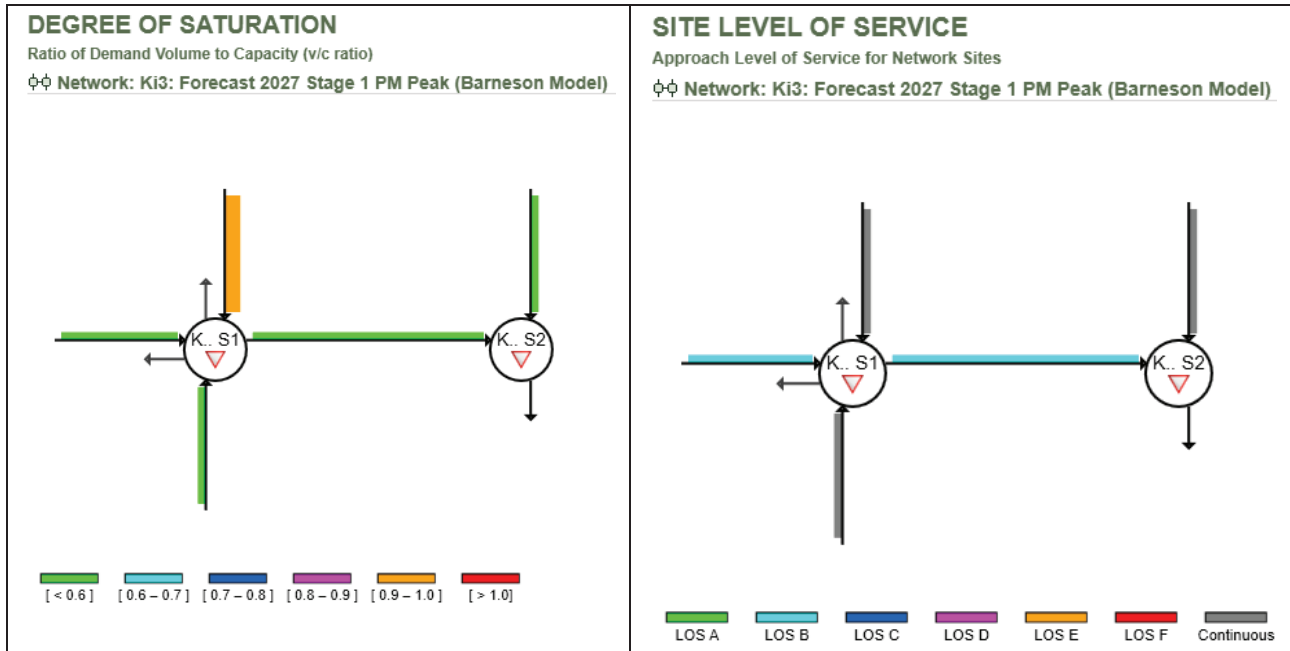


Figure 24 – Assessed 2027 Stage 1 intersection performance during the PM Peak Hour with *Barneson Model*

Figure 24 shows that based on the *Barneson Model*, the Geranium St/ Stuart Hwy intersection is expected to continue to perform within accepted intersection performance criteria with Stage 1 development of Lots 6907 + 6908, including the Elysium development.

A more detailed assessment of individual movements during the PM peak hour is provided as Figure 25 on the following page. This indicates that the key movement impacting on intersection performance is the right/ U turn movement for southbound Stuart Hwy traffic during the PM peak hour.

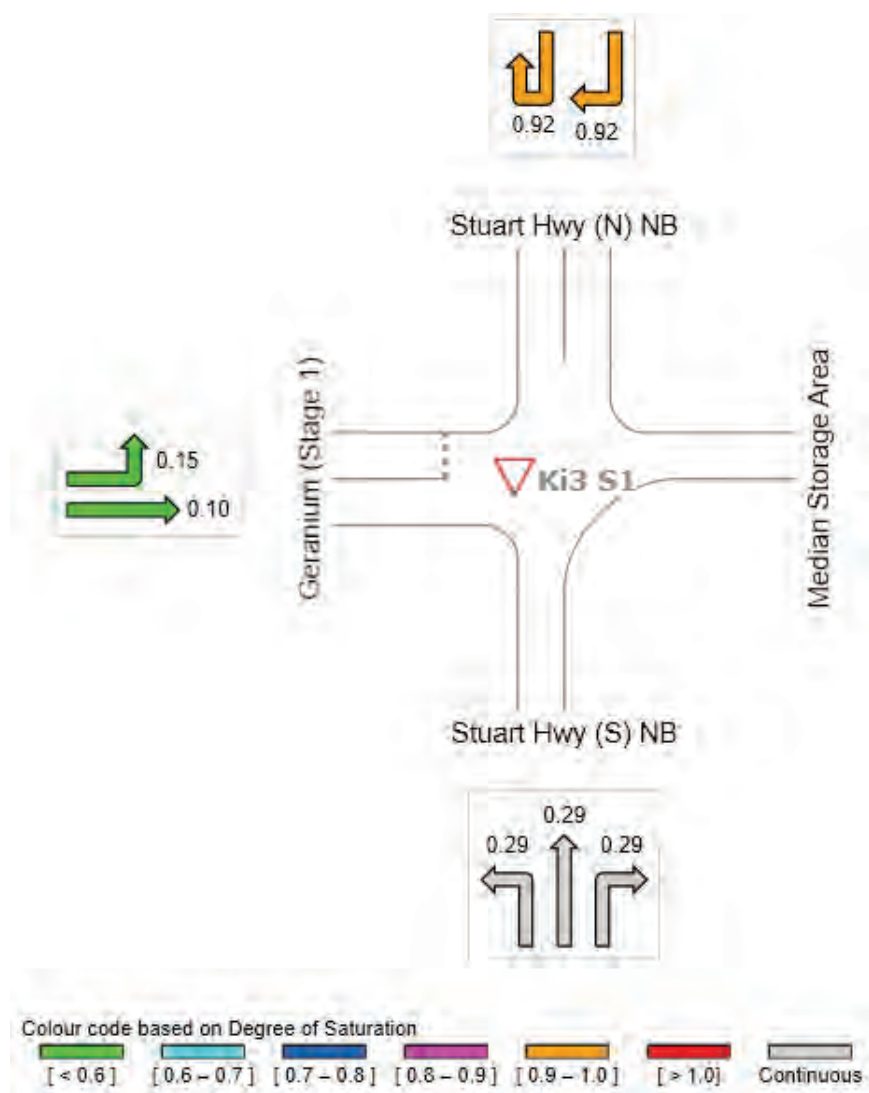
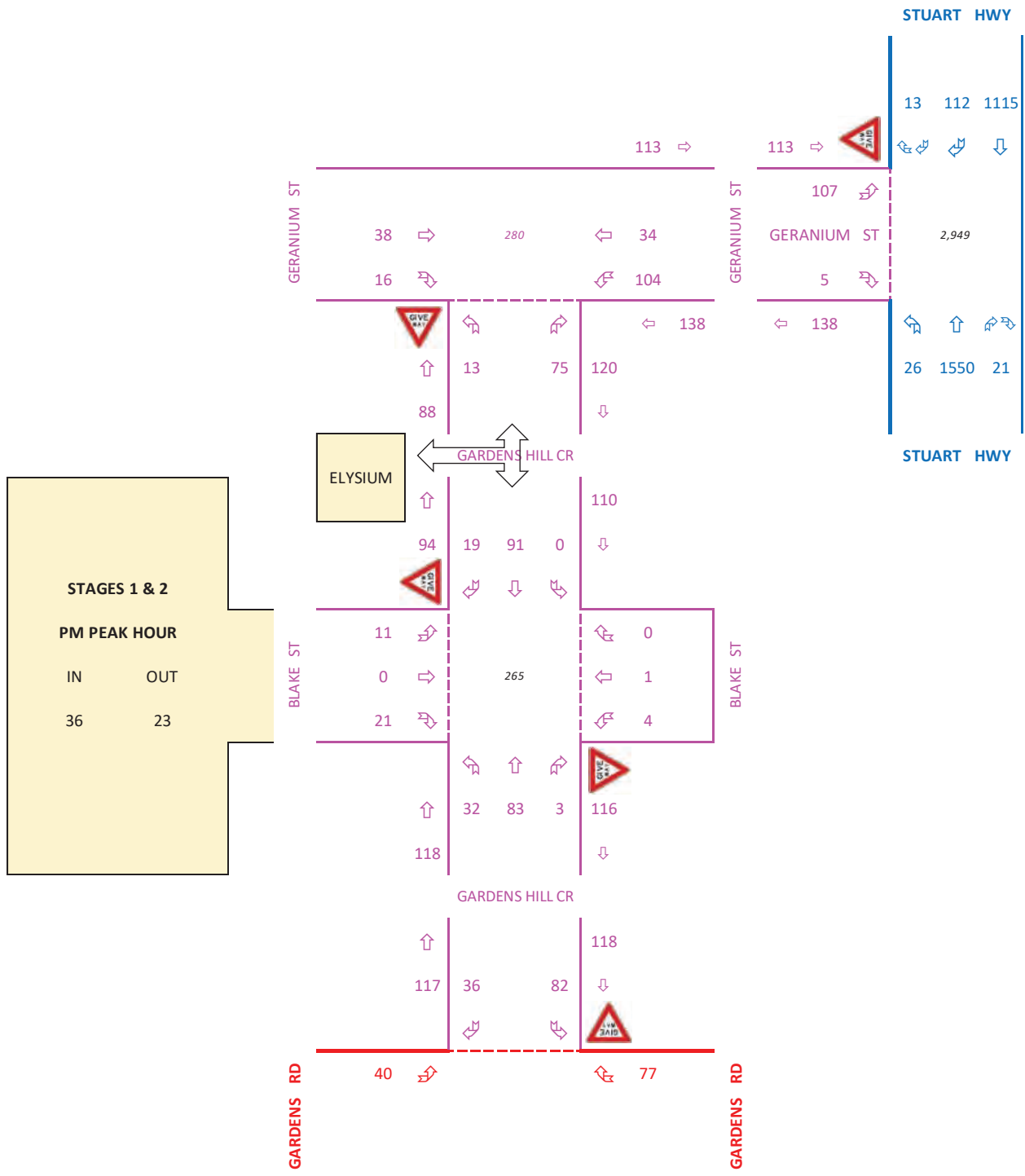


Figure 25 – Assessed turning movement Degree of Saturation during the PM peak hour with 2027 Barneson Model volumes

6.2 STAGES 1-2 (2033) DEVELOPMENT WITH *BARNESON MODEL* DATA

The forecast total road network traffic volumes with Stage 1 and 2 development on Lots 6907 + 6908, including those forecast to be generated by Elysium Mixed Use Development and *Barneson Model* data is shown in Figure 26 below.



The assessment of the forecast 2033 (Stage 1 & 2) PM peak hour volumes is shown in Figure 27 below.

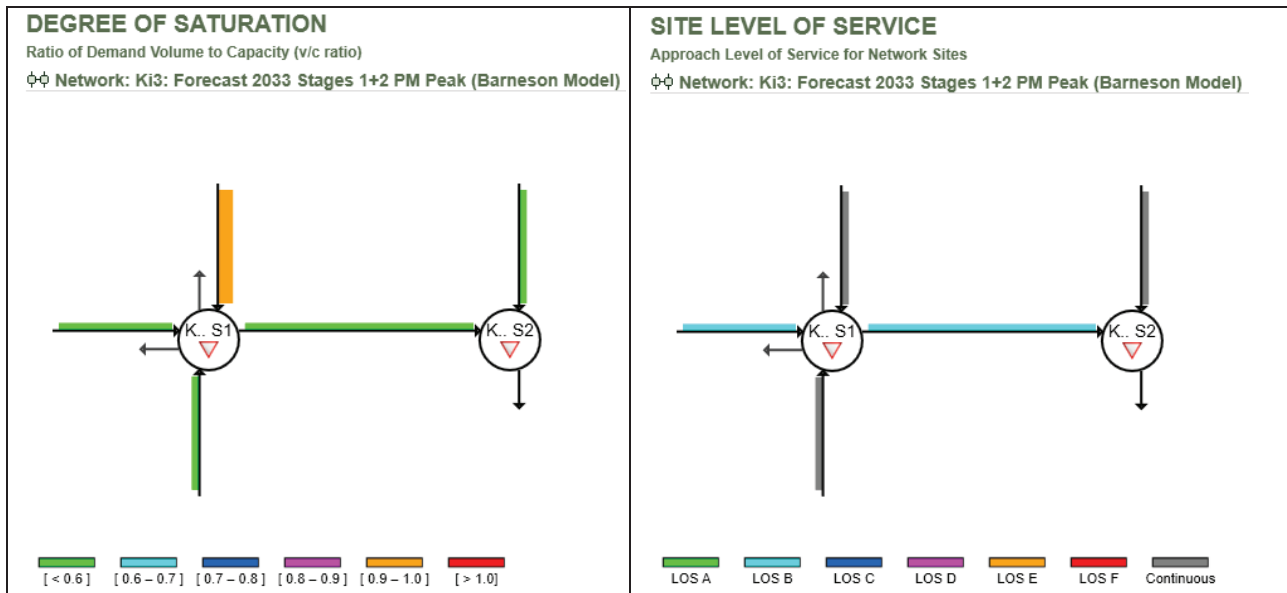


Figure 27 – Assessed 2033 Stage 1-2 intersection performance during the PM Peak Hour with *Barneson Model*

Figure 27 shows that based on the *Barneson Model*, the Geranium St/ Stuart Hwy intersection is expected to continue to perform within accepted intersection performance criteria with Stage 1 and 2 development of Lots 6907 + 6908, including the Elysium development.

A more detailed assessment of individual movements during the PM peak hour is provided as Figure 28 on the following page. This indicates that the key movement impacting on intersection performance is the right/ U turn movement for southbound Stuart Hwy traffic during the PM peak hour. The assessment indicates that the forecast degree of saturation of 0.97 indicates that any further increases in right turning or northbound Stuart Hwy traffic volumes is likely to result in this movement experiencing delays above that considered acceptable. As indicated in **Section 4**, the Department of Infrastructure, Planning and Logistics has indicated that the 'Stuart Park Bypass' is likely to be constructed by **2035** and that this will include traffic signal control at the Geranium St intersection.

On the basis of the above, the remaining stages are assessed with the existing layout and the proposed traffic signals.

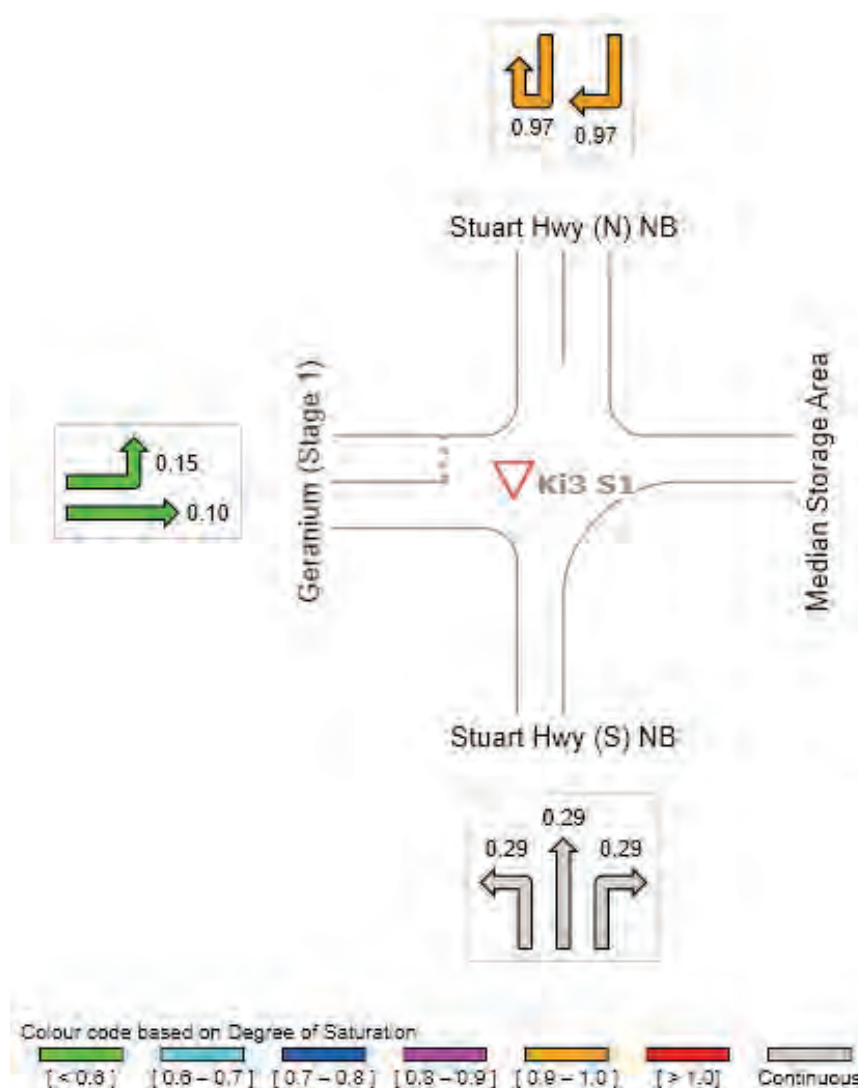


Figure 28 – Assessed turning movement Degree of Saturation during the PM peak hour with 2033 volumes

6.3 STAGES 1-3 (2035) DEVELOPMENT WITH *BARNESON MODEL* DATA AND TRAFFIC SIGNAL CONTROL

The forecast total road network traffic volumes with Stages 1 to 3 development on Lots 6907 + 6908, including those forecast to be generated by Elysium Mixed Use Development and *Barneson Model* data is shown in Figure 29 below.

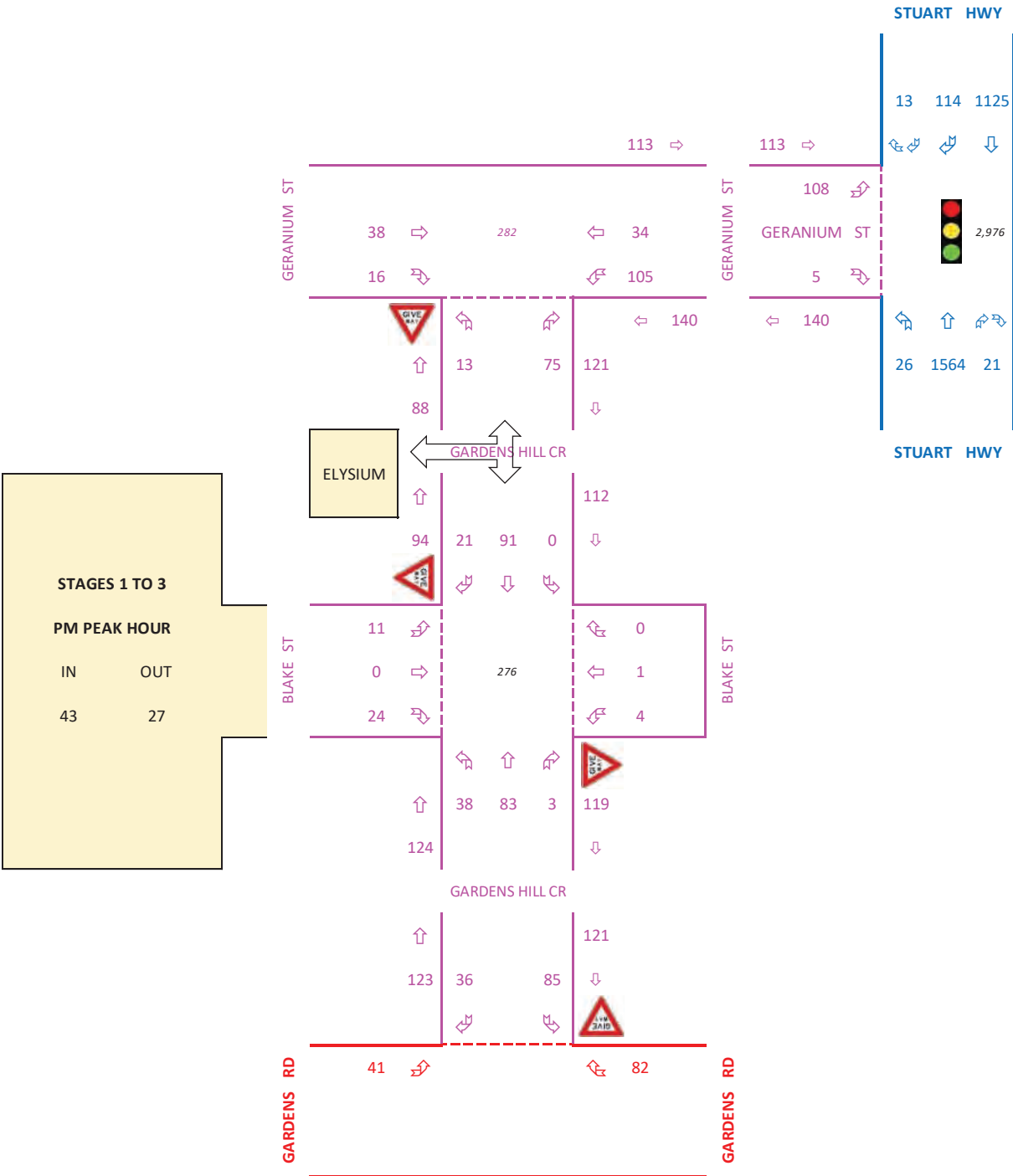


Figure 29 – Forecast Total 2035 PM Peak Hour Volumes with Stages 1-3 Development (*Barneson Model*)

The assessment of the forecast 2035 (Stages 1-3) PM peak hour volumes is shown in Figure 30 below for the existing Give Way T intersection layout and in Figure 31 on the following page with the Stuart Park Bypass with Traffic Signal Control (Programmed for 2035).

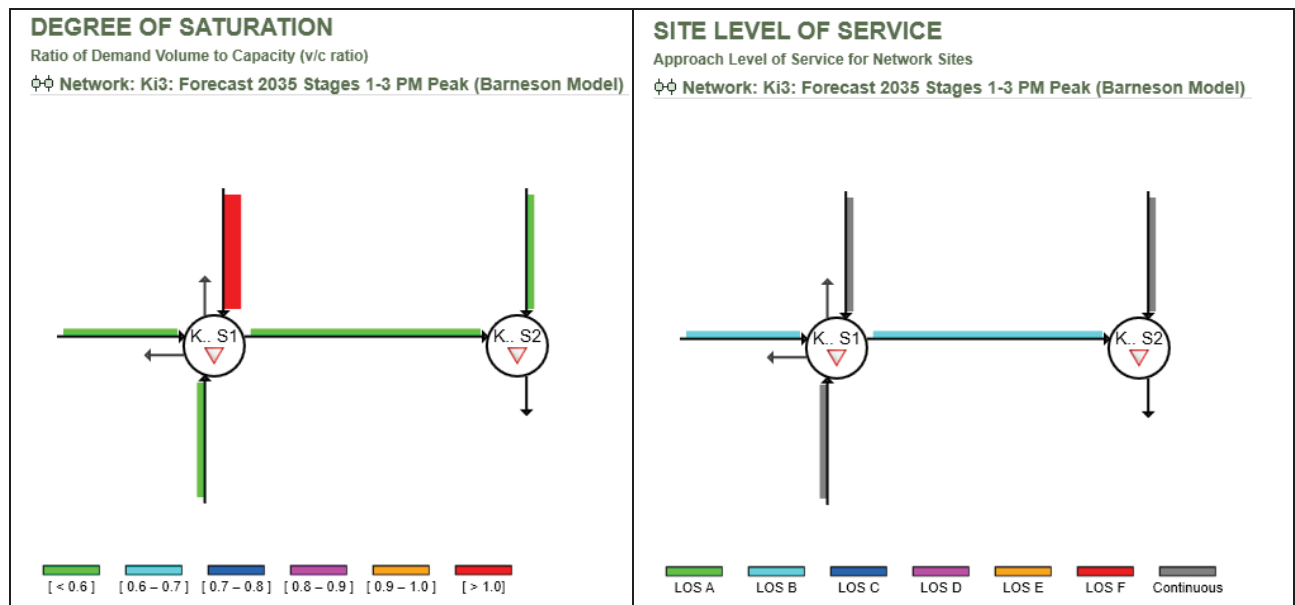


Figure 30 – Assessed 2035 Stage 1-3 intersection performance during the PM Peak Hour with *Barneson Model* and existing layout (i.e. Give-Way 'T')

The forecast degree of saturation for the Stuart Hwy southbound right/ U turn is 1.01 and can be deemed to be acceptable, as per comment provided under Figure 21 on page 25.

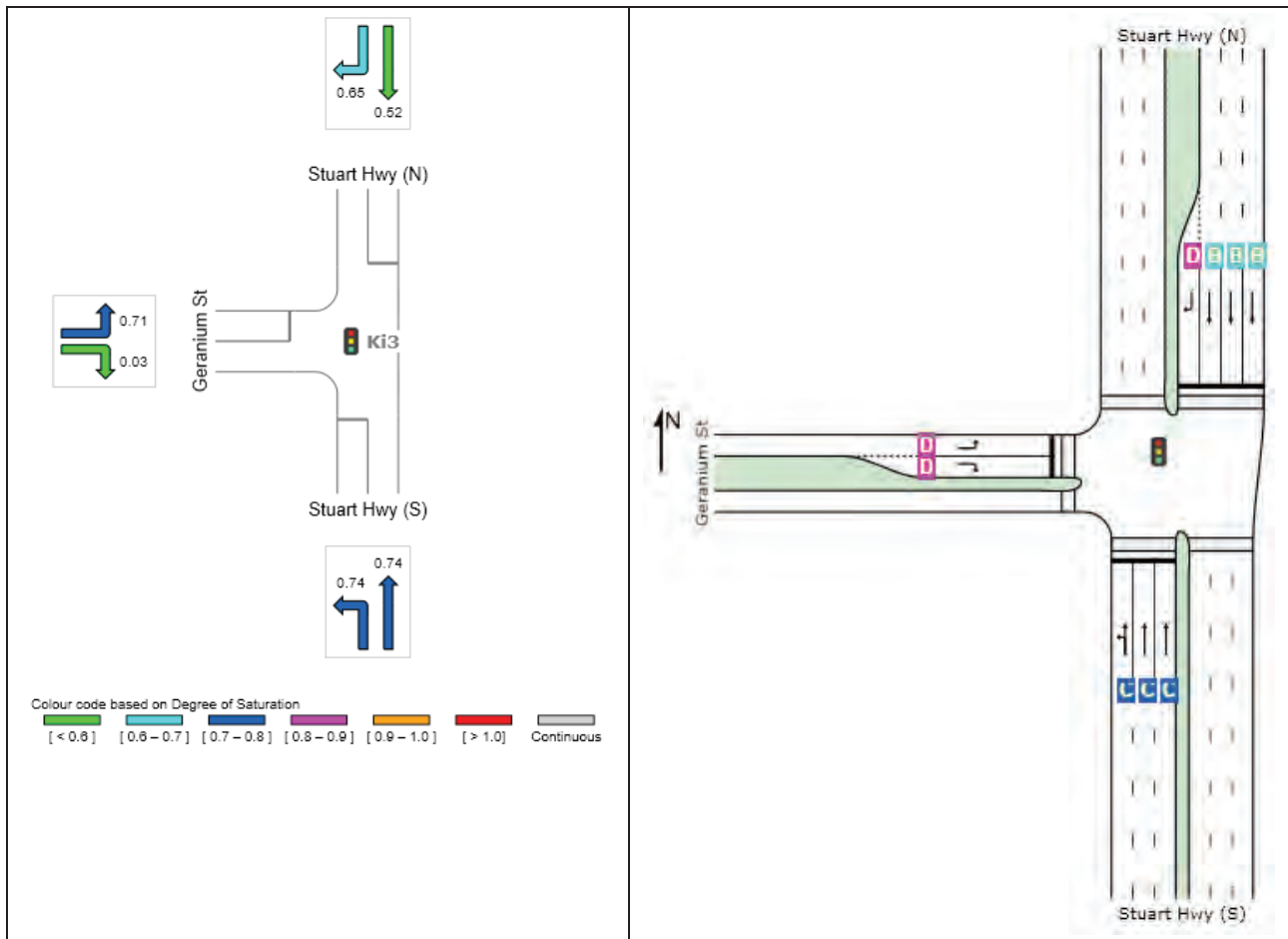
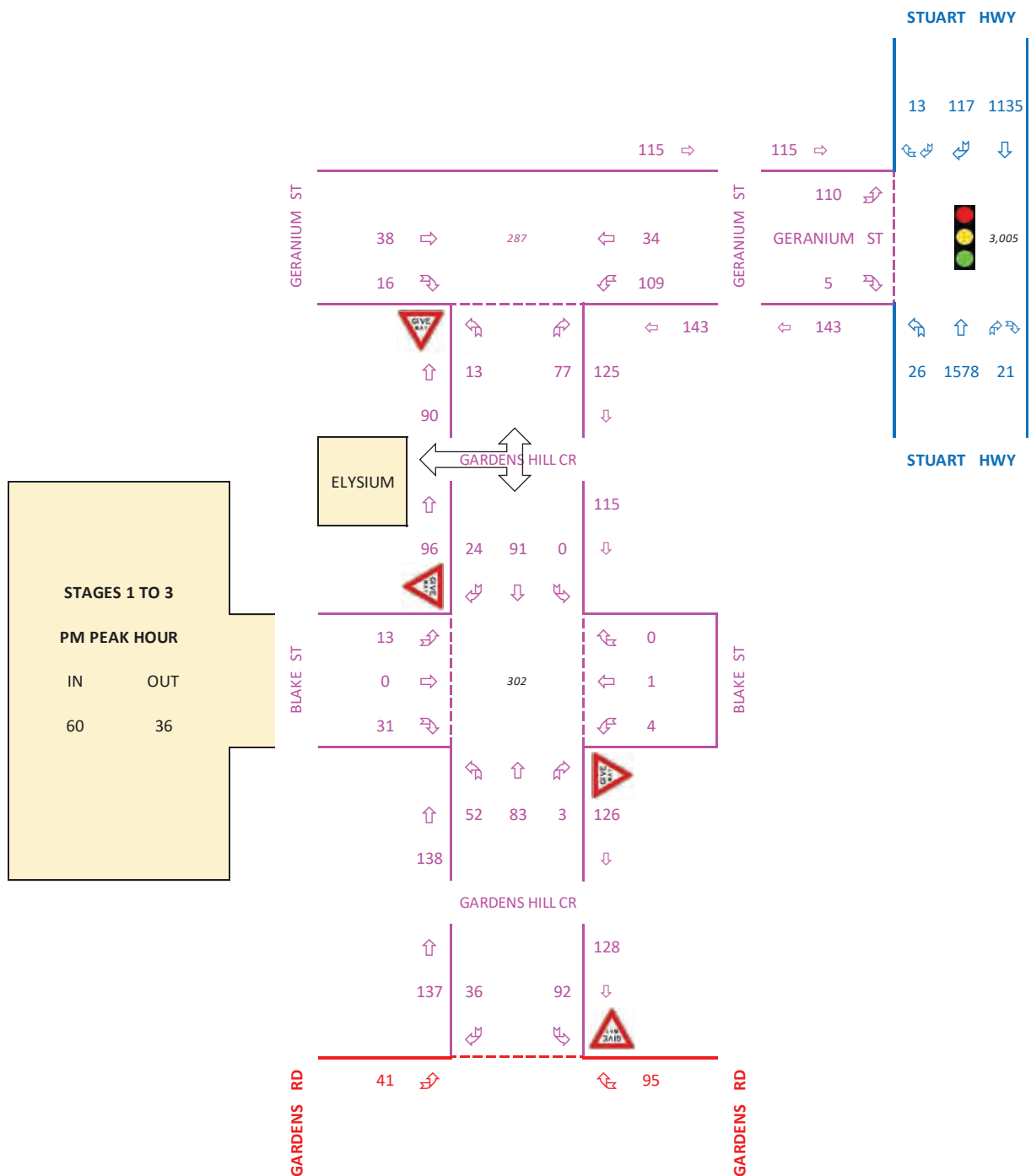


Figure 31 – Assessed 2035 Stage 1-3 intersection performance during the PM Peak Hour with *Barneson Model* and Stuart Park Bypass with Traffic Signal Control

Figure 31 above shows that based on the *Barneson Model*, the Geranium St/ Stuart Hwy intersection is expected to perform within accepted intersection performance criteria with Stages 1 to 3 development of Lots 6907 + 6908, including the Elysium development and the proposed traffic signals at the new Stuart Park Bypass/ Geranium St intersection programmed for 2035.

6.4 STAGES 1-4 (2039) DEVELOPMENT WITH *BARNESON MODEL* DATA AND TRAFFIC SIGNAL CONTROL

The forecast total road network traffic volumes with Stages 1 to 4 of development on Lots 6907 + 6908, including those forecast to be generated by Elysium Mixed Use Development and *Barneson Model* data is shown in Figure 32 below.



The assessment of the forecast 2039 (Stages 1-4) PM peak hour volumes is shown in Figure 33 below for the existing Give Way T intersection layout and in Figure 34 on the following page with the Stuart Park Bypass with Traffic Signal Control (Programmed for 2035).

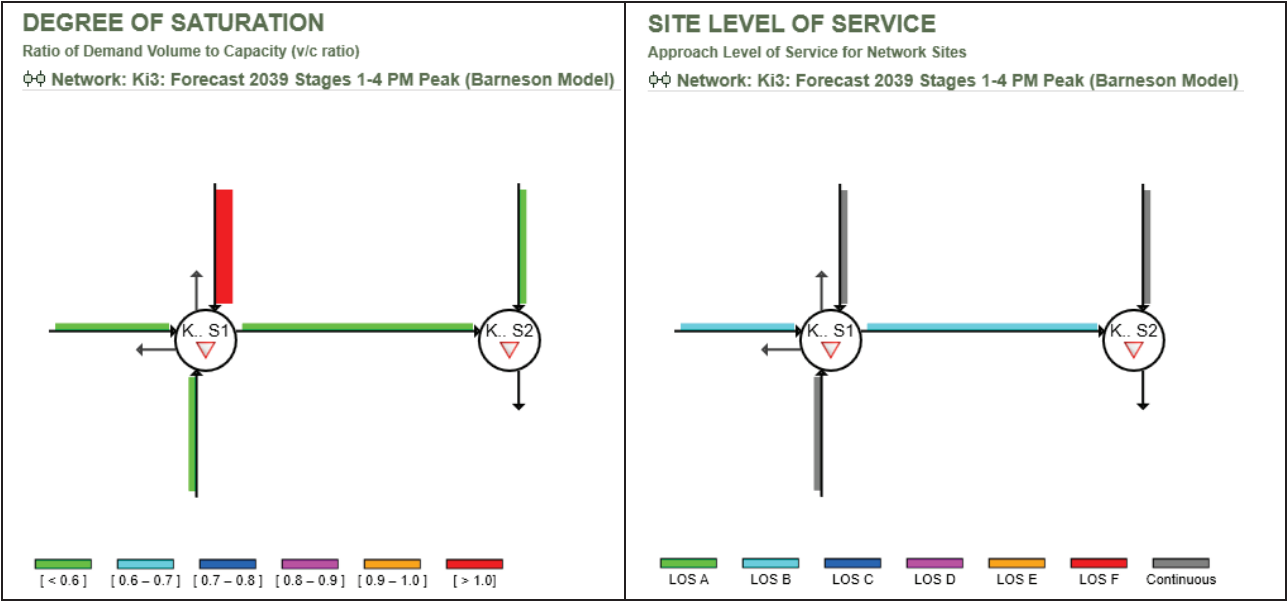


Figure 33 – Assessed 2039 Stage 1-4 intersection performance during the PM Peak Hour with *Barneson Model* and existing layout (i.e. Give-Way ‘T’)

The forecast degree of saturation for the Stuart Hwy southbound right/ U turn is 1.05 and could be deemed to be acceptable, as per comment provided under Figure 21 on page 25.

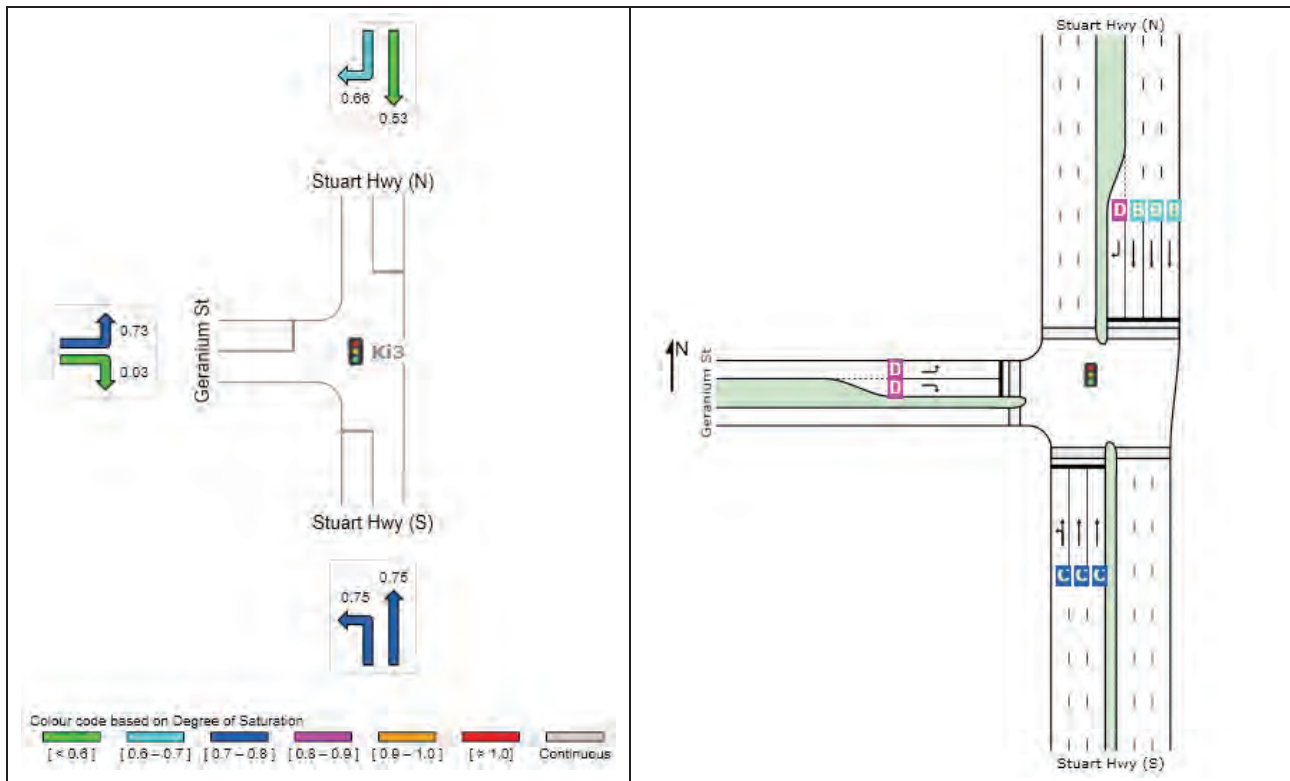


Figure 34 – Assessed 2039 Stage 1-4 intersection performance during the PM Peak Hour with *Barneson Model* and Stuart Park Bypass with Traffic Signal Control

Figure 34 above shows that based on the Barneson Model, the Geranium St/ Stuart Hwy intersection is expected to perform within accepted intersection performance criteria with Stages 1 to 4 development of Lots 6907 + 6908, including the Elysium development and the proposed traffic signals at the new Stuart Park Bypass/ Geranium St intersection programmed for 2035.

6.5 STAGES 1-5 (2041) DEVELOPMENT WITH *BARNESON MODEL* DATA AND TRAFFIC SIGNAL CONTROL

The forecast total road network traffic volumes with Stages 1 to 5 of development on Lots 6907 + 6908, including those forecast to be generated by Elysium Mixed Use Development and *Barneson Model* data is shown in Figure 35 below.

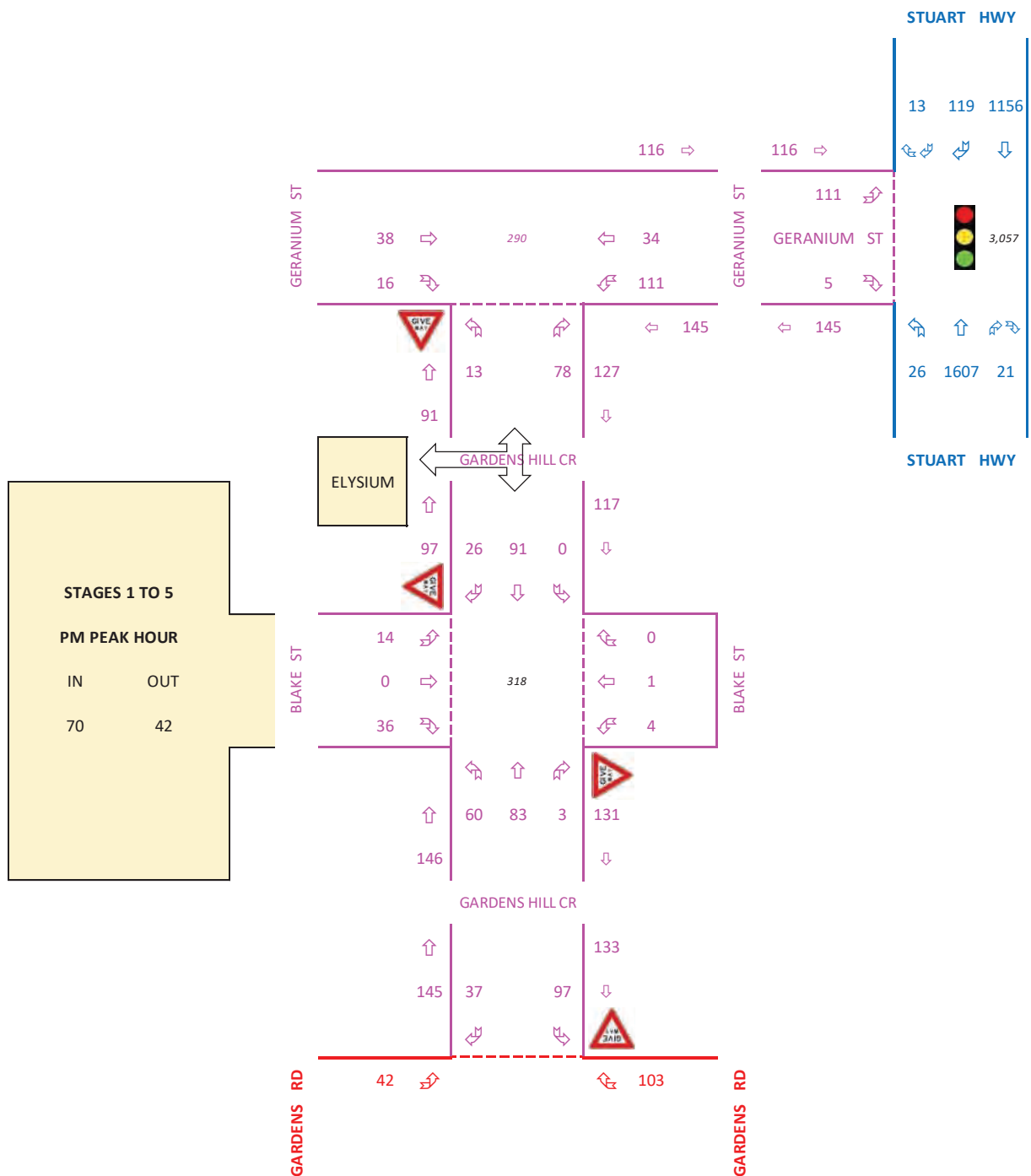


Figure 35 – Forecast Total 2041 PM Peak Hour Volumes with Stages 1-5 Development (*Barneson Model*)

The assessment of the forecast 2039 (Stages 1-5) PM peak hour volumes is shown in Figure 36 below for the existing Give Way T intersection layout and in Figure 37 on the following page with the Stuart Park Bypass with Traffic Signal Control (Programmed for 2035).

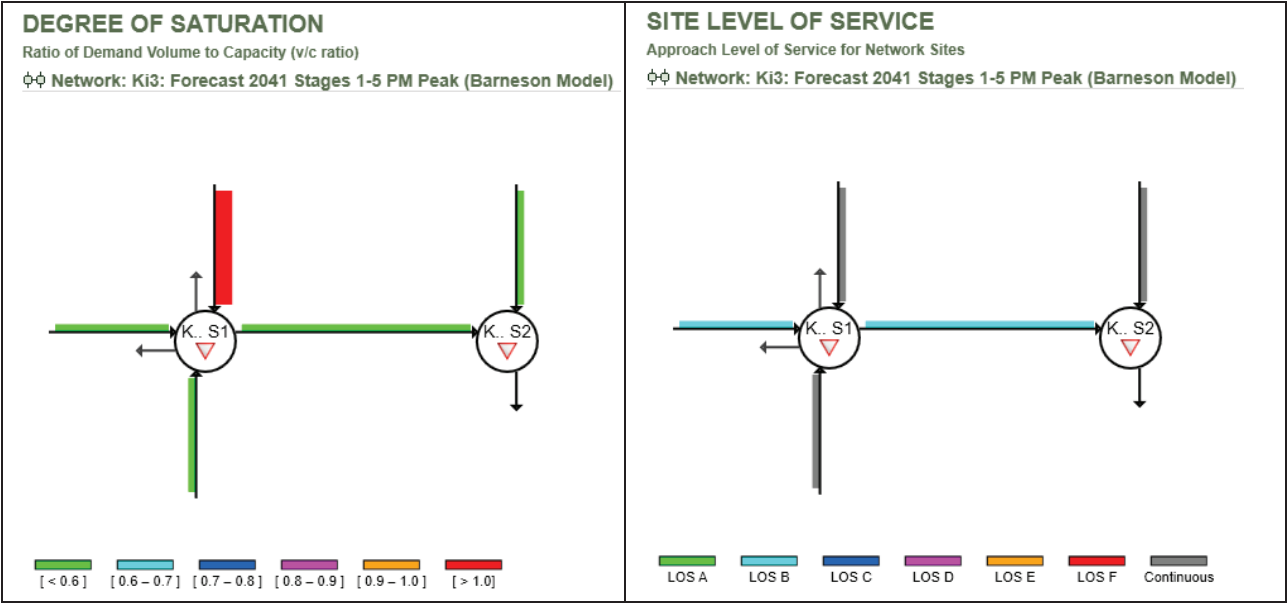


Figure 36 – Assessed 2041 Stage 1-5 intersection performance during the PM Peak Hour with *Barneson Model* and existing layout (i.e. Give-Way ‘T’)

The forecast degree of saturation for the Stuart Hwy southbound right/ U turn is 1.12 and deemed to be unacceptable.

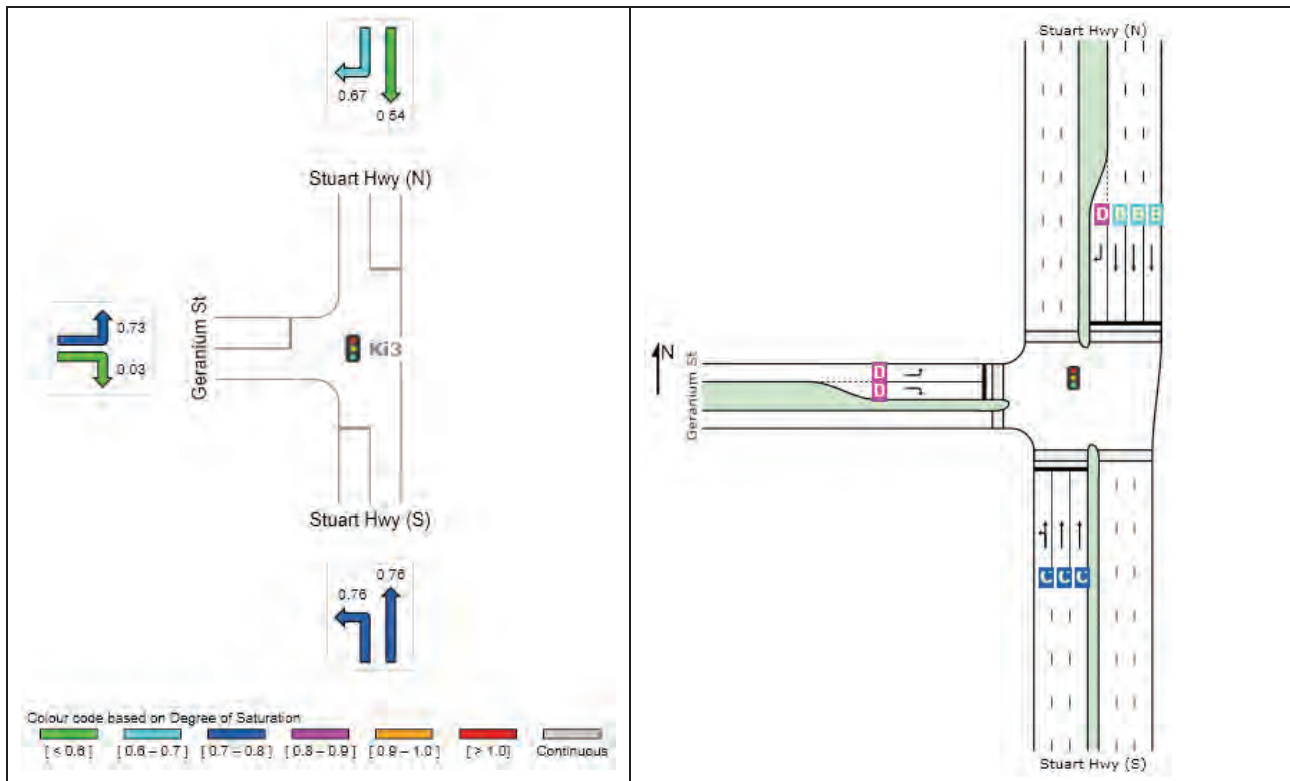


Figure 37 – Assessed 2041 Stage 1-5 intersection performance during the PM Peak Hour with *Barneson Model* and Stuart Park Bypass with Traffic Signal Control

Figure 37 above shows that based on the *Barneson Model*, the Geranium St/ Stuart Hwy intersection is expected to perform within accepted intersection performance criteria with Stages 1 to 5 development of Lots 6907 + 6908, including the Elysium development and the proposed traffic signals at the new Stuart Park Bypass/ Geranium St intersection programmed for 2035.

6.6 FULL DEVELOPMENT (2059) WITH *BARNESON MODEL* DATA AND TRAFFIC SIGNAL CONTROL

The preceding assessment has indicated traffic generation associated with all of the assessed development stages, i.e. stages 1 to 5, can be accommodated within the proposed traffic signal-controlled Stuart Park Bypass/ Geranium St intersection.

Based on this, the proponent has requested an assessment based on full development with the proposed traffic signal-controlled Stuart Park Bypass/ Geranium St intersection.

Full development is not expected until 2059. Determining background traffic volumes on Stuart Bypass in 2059, i.e. 43 years since detailed surveys in 2016 is difficult to undertake with a high level of confidence due to the many variables, e.g. population growth or decline, changes in journey to work modes, changes in work hours and locations, changes in peak hour traffic distribution, changes associated with autonomous and connected vehicles and introduction of 'smart' roads and freeways.

In the interest of maintaining consistency with the preceding assessments, this Technical Note can assess likely performance based on the same *Barneson Model*, i.e. adopting 2031 volumes on Stuart Hwy that are the same as the surveyed 2016 volumes and increasing these at a CATGR of 0.45% for the following years.

The forecast total road network traffic volumes with full development on Lots 6907 + 6908, including those forecast to be generated by Elysium Mixed Use Development based on the *Barneson Model* data is shown in Figure 38 on the following page.

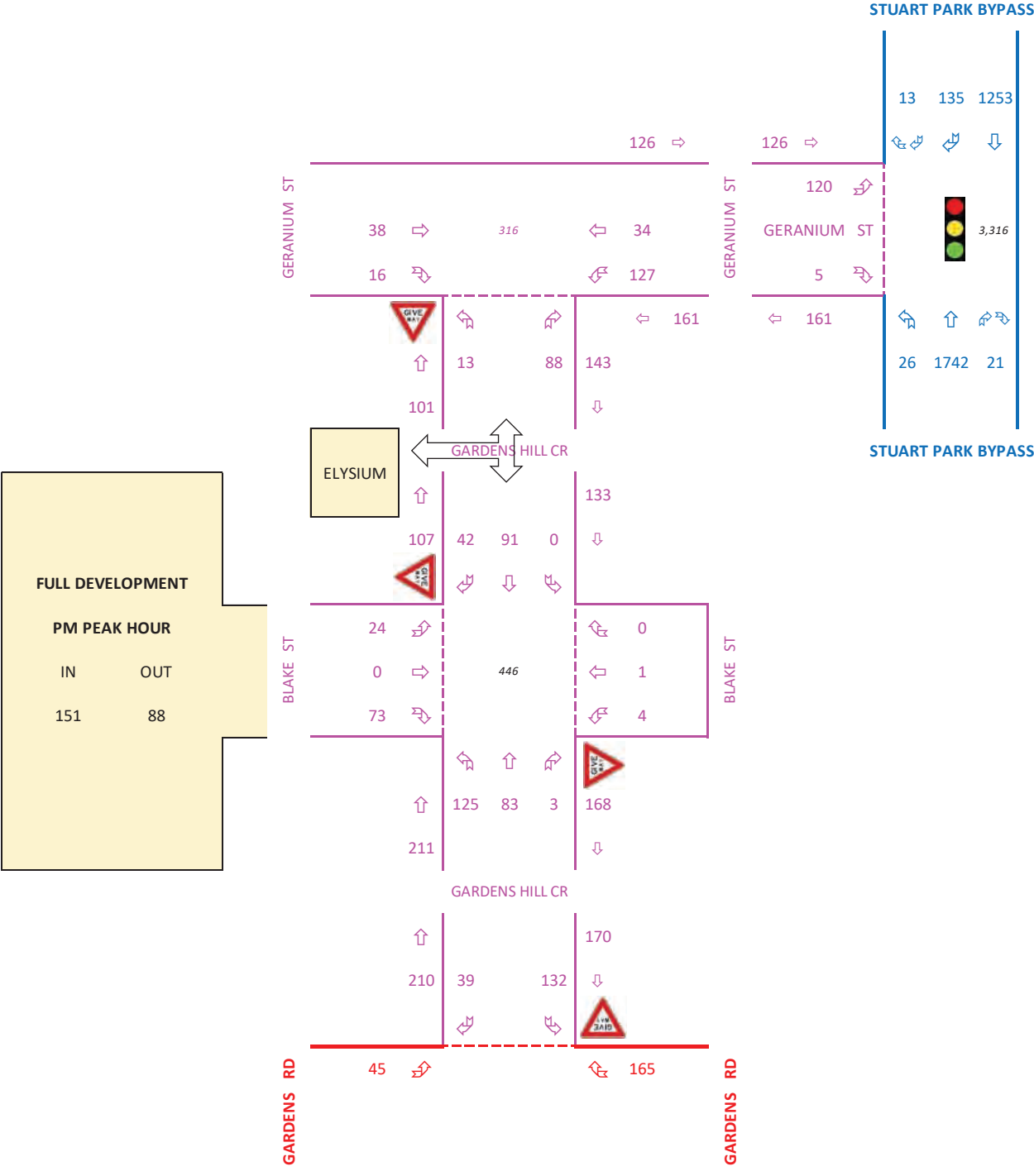


Figure 38 – Forecast Total 2059 PM Peak Hour Volumes with Full Development (Barneson Model)

The assessment of the forecast 2059 (Full Development) PM peak hour volumes is shown in Figure 39 below.

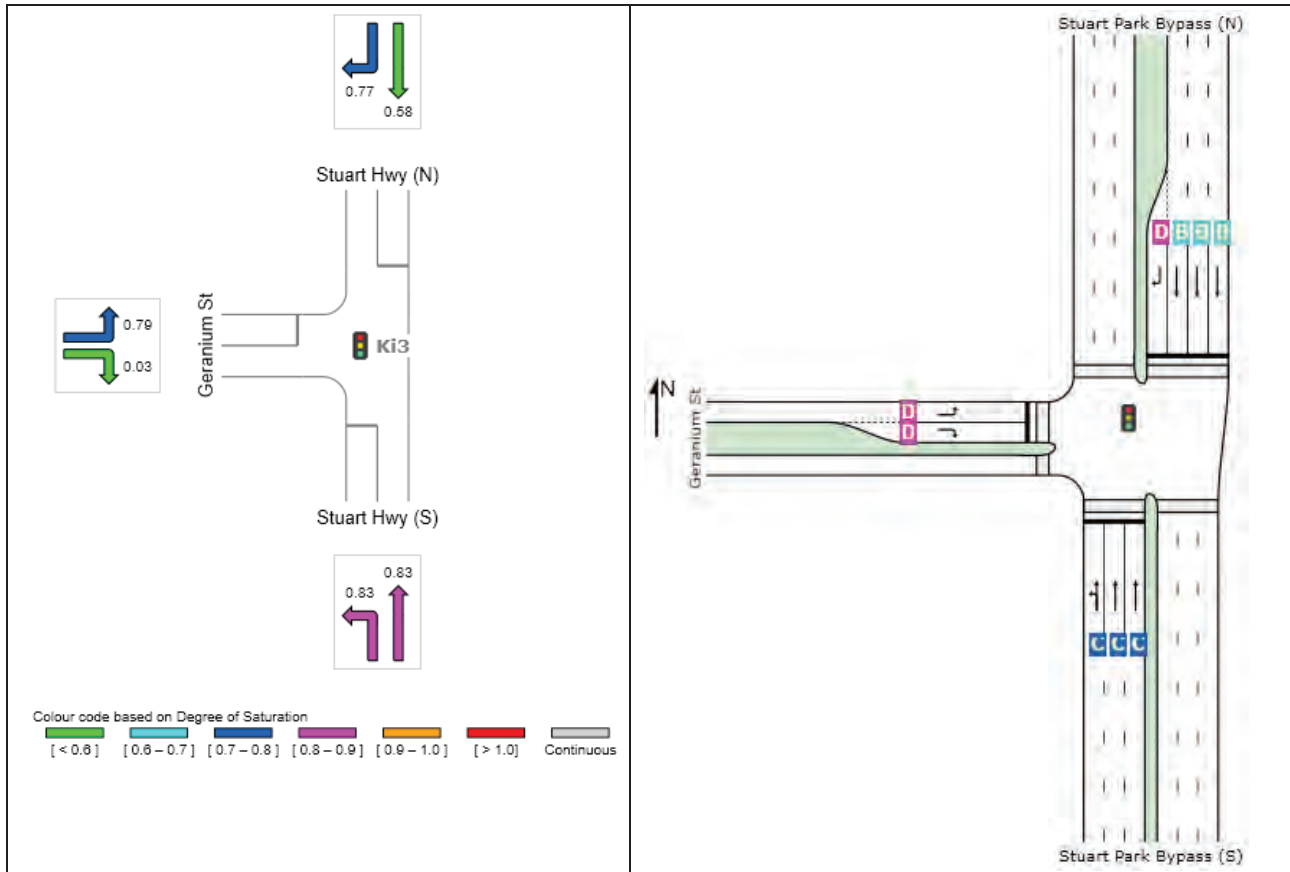


Figure 39 – Assessed 2059 Full Development intersection performance during the PM Peak Hour with *Barneson Model* and Stuart Park Bypass with Traffic Signal Control

Figure 39 above shows that based on the *Barneson Model*, the Geranium St/ Stuart Hwy intersection is expected to perform within accepted intersection performance criteria with full development on Lots 6907 + 6908, including the Elysium development and the proposed traffic signals at the new Stuart Park Bypass/ Geranium St intersection (programmed for 2035).

7 FINDINGS

This Technical Note has determined that based on the *Barneson Model* that returns Stuart Hwy traffic volumes to 2016 levels in 2031 and then increases these at a rate of 0.45% CATGR, that Stage 1 and 2 development of Lots 6907/ 6908 can be undertaken without any modifications required to the road network.

It is possible that Stage 3 and 4 development could also be undertaken up to 2039 without any modifications to the road network if base volumes on Stuart Hwy do not return to higher levels following the completion of the Garramilla/ Barneson Boulevard project and the impacts of reduced population growth and increased public transport, walking, cycling facilities and options.

Development of Stages 5 to 11, i.e. full development of Lots 6907/ 6908, can be undertaken provided that traffic signal control is provided at the Geranium St intersection as per the proposed Stuart Park Bypass project programmed for 2035. Assessment of the signals with the increased volumes has indicated that this will perform within acceptable criteria.

A summary of the assessment and stages 1 to 3 is provided as Figure 40 below.

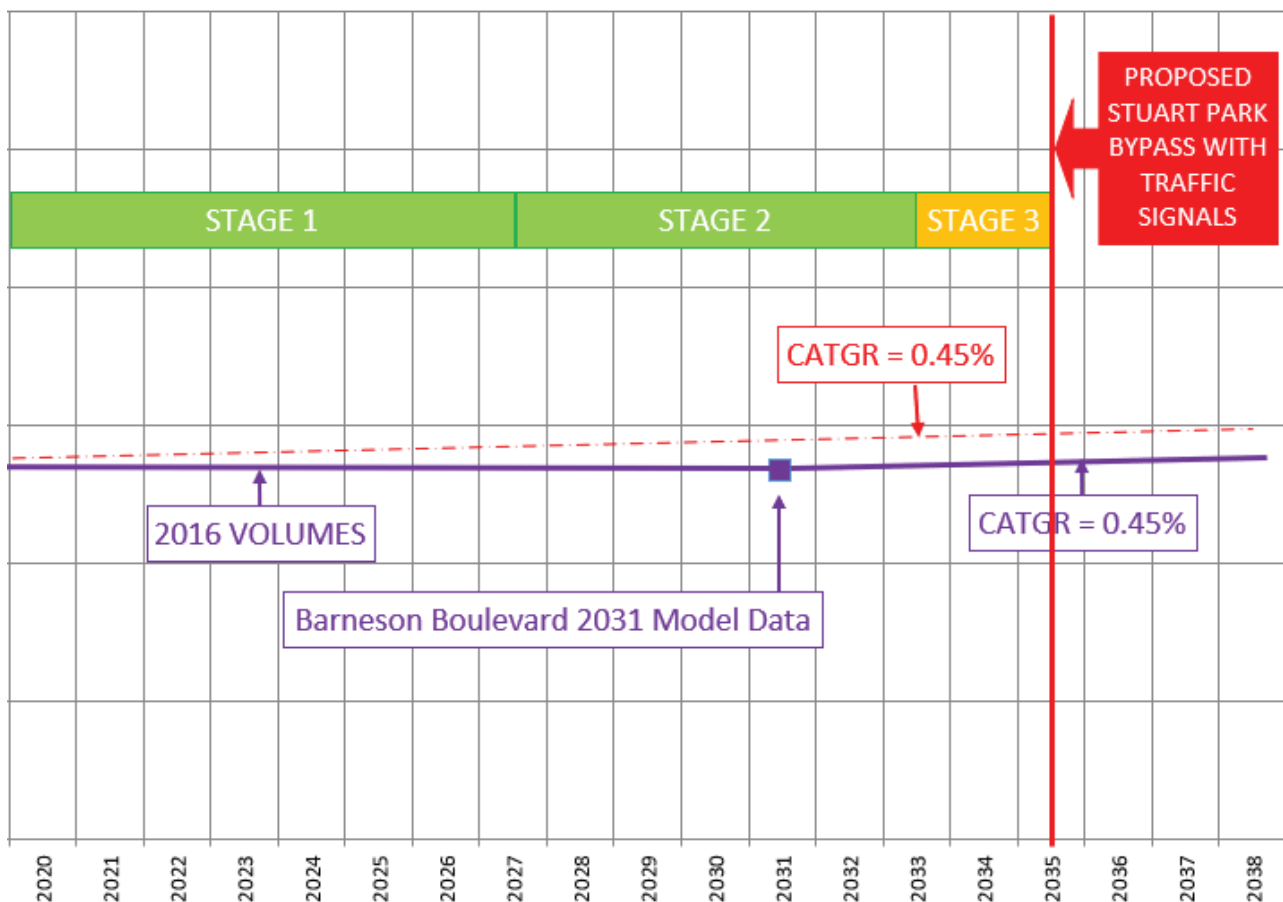


Figure 40 – Summary of assessed time frame for development of stages 1 to 3 and associated base data

A fully revised TIA assessing all intersections with the *Barneson Model* base data and the stages 1 to 11 of development is recommended to confirm that all other intersections will operate within acceptable criteria.

It is recommended that a revised TIA does not proceed until such time as the approving authorities have indicated acceptance of the *Barneson Model* assessment methodology.

A handwritten signature in black ink, appearing to read 'David Wilkins'.

Digitally signed by David
Wilkins
Date: 2019.02.04 16:59:56
+08'00'

David Wilkins

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ABOUT THE AUTHOR

David Wilkins has over 35 years of practical experience in traffic engineering, road safety and transport planning in both the UK and Australia and is an RTA NSW Certified Level 3 Lead Auditor (RSA-08-0178) and Main Roads Western Australia (MRWA) accredited Senior Road Safety Auditor (SRSA 0101). In addition to this, David is an MRWA accredited Crash Investigation Team Leader and Roadworks Traffic Manager (MRWA-RTM-10-RTM20). David has undertaken 100 road safety audits in the last five years and 242 road safety audits since 2001 across the full range of stages from feasibility through to pre-opening, including roadworks, existing roads, schools and mine sites.

David's specialist skills are in the management and development of transport infrastructure and planning, particularly with respect to road safety engineering, roadworks traffic management, traffic engineering, crash investigation, road safety audits, alternative transport systems (TravelSmart, shared paths, cycle facilities), transport statements, transport assessments, parking demand management, local area traffic management, speed management, accessible environments and innovation.

David specialises in undertaking and preparing traffic impact assessments in accordance with either the WAPC document 'Transport Impact Assessment Guidelines' or Austroads 'Guide to Traffic Management Part 12: Traffic Impacts of Developments'. In the last 7 years, David has personally prepared over 170 traffic and transport impact reports in accordance with these guidelines.