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Walker Corporation

# Appin and North Appin Precincts

## Bushfire Evacuation Traffic Study

wsp

October 2022

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# Appin and North Appin Precincts
# Bushfire Evacuation Traffic Study

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WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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# 1 Project background

## 1.1 The Appin Project

Greater Sydney's population is projected to grow to approximately 6.1 million by 2041 – over a million more people than currently live in the region.

The NSW Government has identified Growth Areas as major development areas that will assist in accommodating this growth. The Greater Macarthur Growth Area (GMGA) is one such growth area and is a logical extension of the urban form of south-west Sydney. The GMGA is divided into precincts. The Appin Precinct and North Appin Precinct are the southernmost land release precincts of the GMGA. The goal is to deliver 21,000+ dwellings.

The land is to be rezoned and released for development to achieve this goal. A submission has been prepared by Walker Corporation Pty Limited and Walker Group Holdings Pty Limited (the Proponent) to rezone 1,378 hectares of land (the site) within the Appin Precinct from *RU2 Rural Landscape* to the following zones:

**Urban Development Zone**

*Zone 1 Urban Development (UD)*

**Special Purposes Zone**

*Zone SP2 Infrastructure (SP2)*

**Conservation Zone**

*Zone C2 Environmental Conservation (C2)*

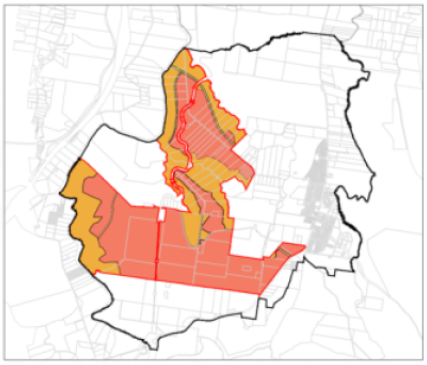
The zonings are shown on the Appin (Part) Precinct Plan (the precinct plan). 'The precinct plan' will be incorporated into the *State Environmental Planning Policy (Precincts – Western Parkland City) 2021* and contain the provisions (clauses and maps) that will apply to 'the site.' 'The precinct plan' envisages the delivery of 12,000+ new homes.

A structure plan has been prepared for the site and is shown on the Appin (Part) Precinct Structure Plan (the structure plan). It identifies staging and the first stage to be developed – Release Area 1. Release Area 1 is anticipated to deliver 3,500+ dwellings.

The submission is aligned with strategic land use planning, State and local government policies and infrastructure delivery. The development potential is tempered by a landscape-based approach that protects the environment and landscape values, shaping the character of new communities. A series of residential neighbourhoods are to be delivered within the landscape corridors of the Nepean and Cataract Rivers, supported by local amenities, transit corridors and community infrastructure.

The submission includes a hierarchy of plans. The plans and their purpose are summarised in Table 1.1.

Table 1.1 Title and Purpose of Plans

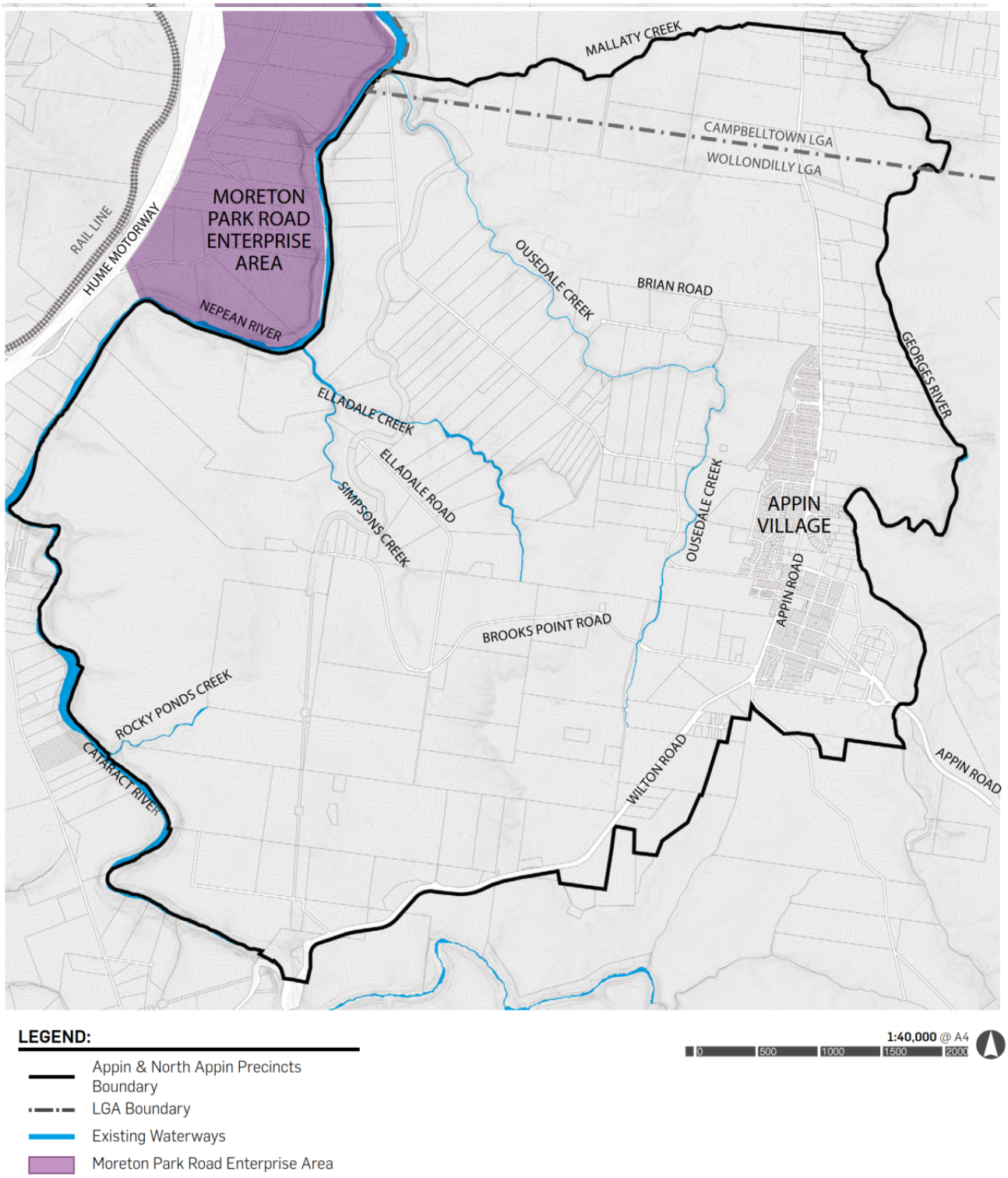
| 1. Appin & North Appin Precincts Indicative Plan | 2. Appin (Part) Precinct Plan (the Precinct Plan) | 3. Appin (Part) Precinct Structure Plan (the Structure Plan) |
|---|---|---|
| Broader context & for information purposes only. It has no statutory weight. It identifies:<br>— Higher-order transport network<br>— Centres hierarchy<br>— School sites<br>— Conservation areas<br>— Residential areas<br>— Cultural sites and connections | It shows the land proposed to be rezoned (the site) and incorporated into a new schedule in the Western Parkland City SEPP 2021.<br>The precinct plan contains the development provisions (clauses and maps) applicable to the site and is used in assessing development applications. | Structure plan for the site, showing staging of release areas.<br>It illustrates land use components including (but not limited to):<br>— Low and medium-density residential<br>— Retail and employment centres<br>— School<br>— Open space<br>— Drainage network/basins<br>— Transport network |
|  <br>**(21,000+ dwellings)** |  <br>**(12,000+ dwellings)** |  <br>**(12,000+ dwellings)**<br>**inc. Release Area 1 - 3,500+ dwellings** |

## 1.2 Introduction

WSP Australia have been engaged by the Proponent to prepare a Strategic Transport Assessment to support the Appin and North Appin Precincts Indicative Plan.

The Appin and North Appin Precincts are the southernmost land release areas of the Greater Macarthur Growth Area (**GMGA**) – refer to Figure 1.1 and Table 2 for key features of the precincts.

The Appin and North Appin Precincts immediately neighbour the suburbs of Gilead to the north, Wilton to the south and Douglas Park to the west. Dharawal National Park, a large protected national park, is located to the east. The precincts are predominately bound by waterways, with Mallaty Creek to the north, George's River to the east, Nepean River to the west and Cataract River to the south.




*Source:* *Walker Corporation, 6 October 2022*

Figure 1.1 Boundary of Appin and North Appin Precincts

Table 1.2 Summary of Appin and North Appin Precincts key attributes

| Location | | Key Attributes | |
|---|---|---|---|
| Appin and North Appin Precincts |  | **Area** | 3,826 ha |
| | | **LGA** | Part Wollondilly<br>Part Campbelltown |
| | | **Proposed Dwellings** | 21,000+ |
| | | **Proposed Population** | 65,000+ |

## 1.3 Strategic Bushfire Assessment

The strategic bushfire planning principles contained in the *Planning for Bush Fire Protection* (NSW Rural Fire Service (NSW RFS), November 2019) indicate that the development will need to provide adequate infrastructure associated with emergency evacuation and firefighting operations. In terms of the road network's ability to accommodate this evacuation:

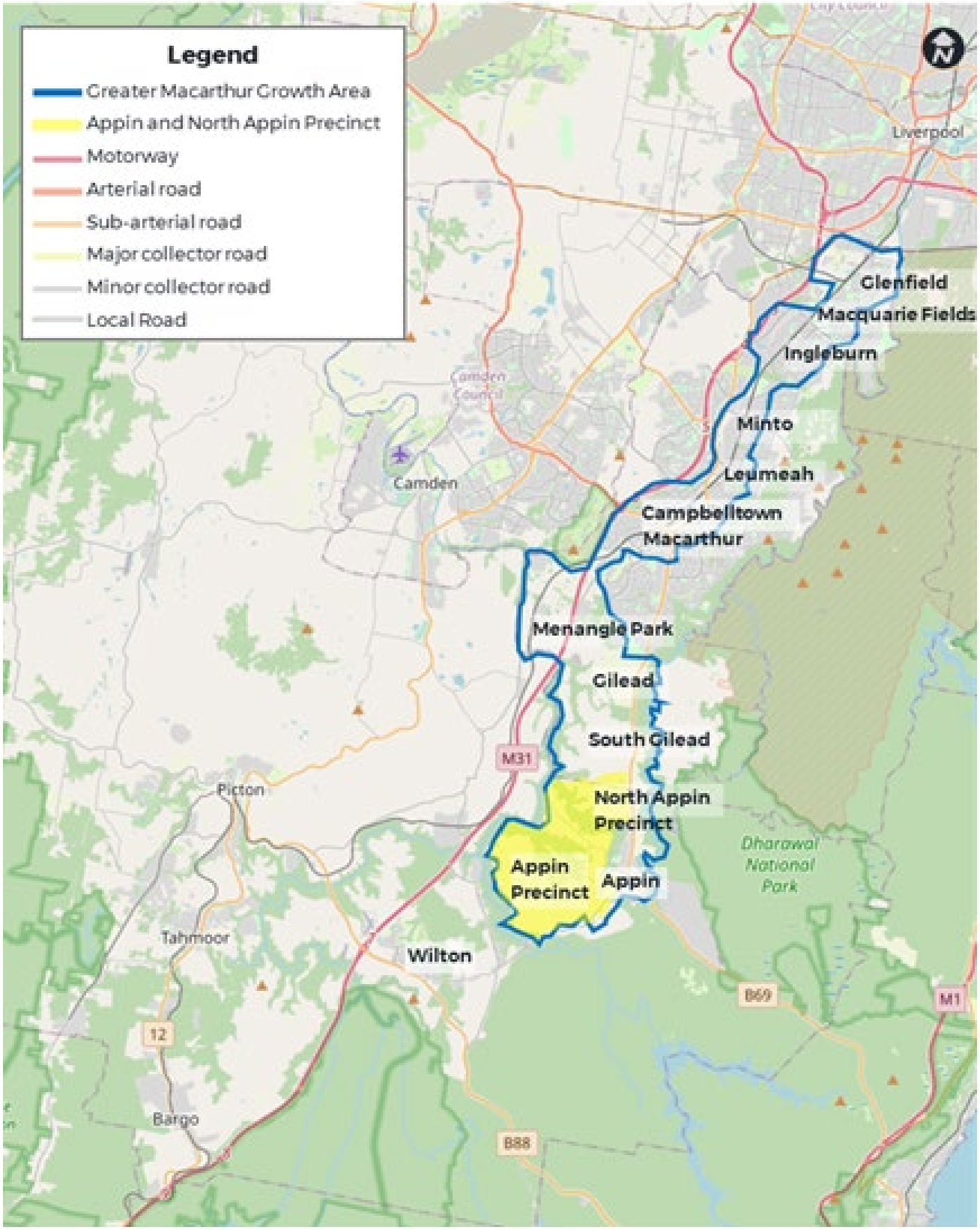
- The development is able to be evacuated during a bush fire considering its siting in the landscape, access limitations, fire history and/or size and scale
- If the development is within an area of high bush fire risk the development does not cause evacuation issues for both existing and new occupants.

The strategic bushfire assessment needs to consider the capacity of the access points to the wider road network and key internal link roads to deal with evacuating residents and responding emergency services. This should include the entire rezoning area plus the existing and future offsite population (if evaluating to outside the development). The assessment should detail the suitability of capacity for each stage of development and road network and project evacuation times.

The identification of appropriate evacuation route options assumes that:

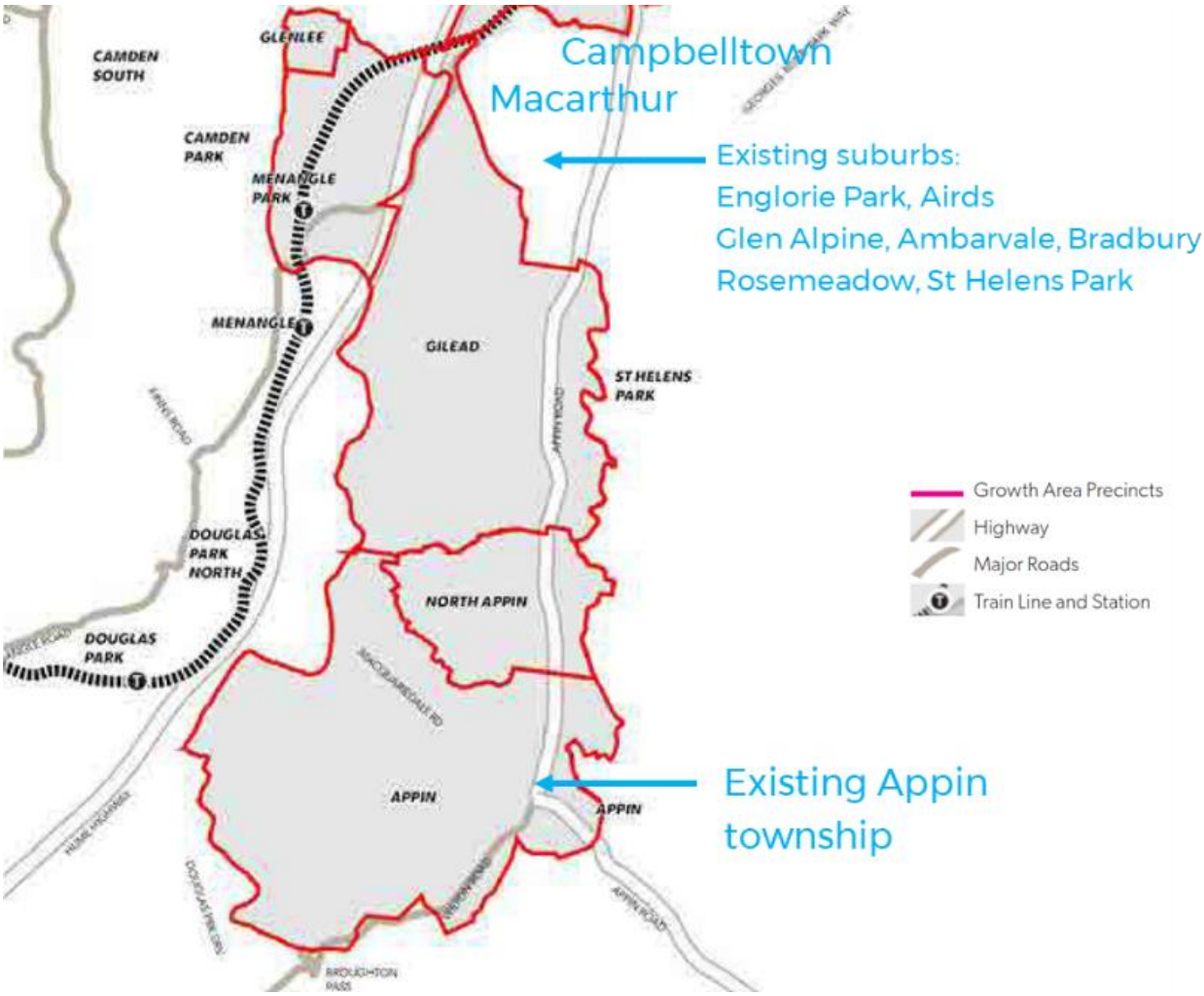
- Evacuation should occur away from (or across) the path of a fire, but not towards it
- Roads that could be cut by fire during the evacuation period are not suitable
- The road must be suitable to use in an emergency situation.

When assessing emergency evacuations, it should be noted that intervention by emergency services may not be available and therefore shouldn't be relied on for road control or other activities. Also, there may be smoke impact on the road impairing visibility and heavy peak demand when emergency warnings are released.



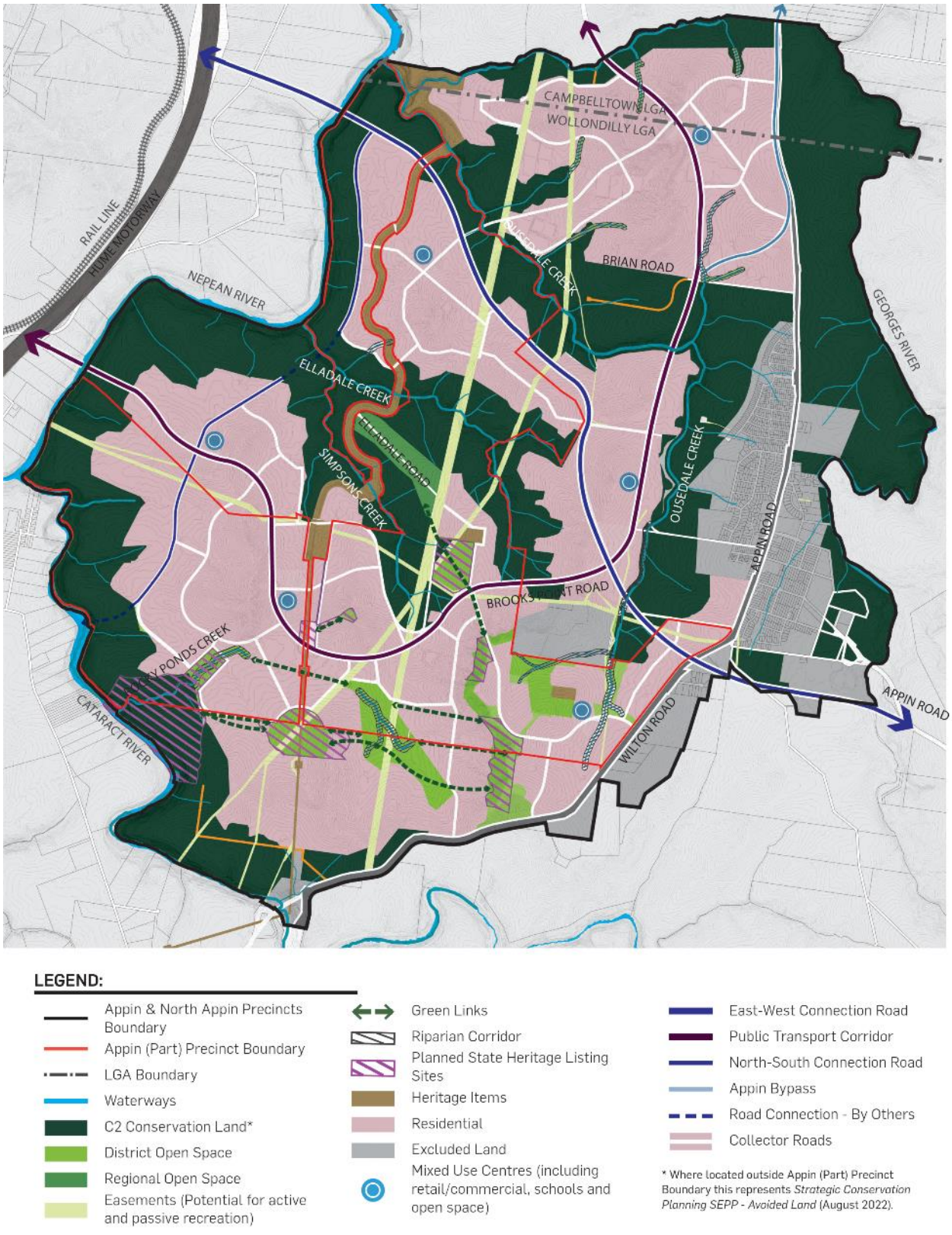

*Base map: Open Maps*

Figure 1.2 Appin and North Appin Precinct position within Greater Macarthur Growth Area




*Source: Greater Macarthur 2040 (Department of Planning and Environment, 2018)*

Figure 1.3 Location of existing suburbs and precincts




*Source:* *Walker Corporation, 06 July 2022*

Figure 1.4 Indicative structure plan

## 1.4 Purpose of this report

This report documents the methodology and assumptions used, and the results of the analysis for the strategic assessment of the Appin and North Appin Precinct. The objectives of the report are:

- Describe the bushfire scenarios that this repot has assessed
- Evaluate the evacuation time of the Appin and North Appin Precincts
- Make conclusions about the suitability of the transport network to facilitate the evacuation of people within the Precinct.

**Conclusions:**

The traffic analysis of the potential evacuation of the Appin and North Appin Precinct in the event of a bushfire has been prepared in consideration of the requirements of *Planning for Bush Fire Protection* (NSW RFS, November 2019). The assessment has included analysis of the mid-block capacity of the roads used to evacuate vehicles, the potential delays at key intersections along the evacuation route and the drive time to evacuate the area, using an estimate of conditions at various stages between 2019 and the completion of the development.

Based on the worst case scenario assessment, it is concluded that, subject to timely decisions to commence the evacuation, the proposed road network has sufficient capacity to facilitate the evacuation of the number of residents planned in the Appin and North Appin Precinct, identifying that the primary evacuation route north to Campbelltown (subject to the prevailing bushfire conditions). The use of multiple evacuation routes for some or all of the evacuation would significantly reduce the evacuation times by up to a half.

It is noted that the following could improve the evacuation times:

- Reduced traffic on the road network, from people avoiding the bushfire zone, would reduce the volume of general traffic on the road network, preserving more space for evacuating vehicles.
- The use of emergency services to manage the evacuation would significantly enhance the chance of an orderly evacuation and avoiding panic from those that are last to leave.
- The provision of appropriate “neighbourhood safe place” areas within the development will reduce the pressure on the road network, reducing evacuation time for those who choose to leave.

The Proposal can be supported in its current form.

## 1.5 Consultation

This strategic assessment is being undertaken in advance of consultation with stakeholders including the NSW RFS and Wollondilly and Campbelltown Councils. It is designed to inform future discussions and be a catalyst for further, more detailed assessment once further details are known.

# 2 Information used in the analysis

## 2.1 Appin and North Appin Precinct

The latest structure plan information for the Appin and North Appin Precinct, contains a total of approximately 21,000+ residential lots with a total employment of approximately 4,130 jobs. The residential lot and employment numbers detailed in Table 2.1 show the distribution across the Appin and North Appin Precinct. The neighbourhoods are shown spatially in the structure plan shown in Figure 2.1. Figure 2.2 shows the stages and the estimated dwelling numbers.

Table 2.1 Lots, Jobs, and Staging for Appin and North Appin Precinct

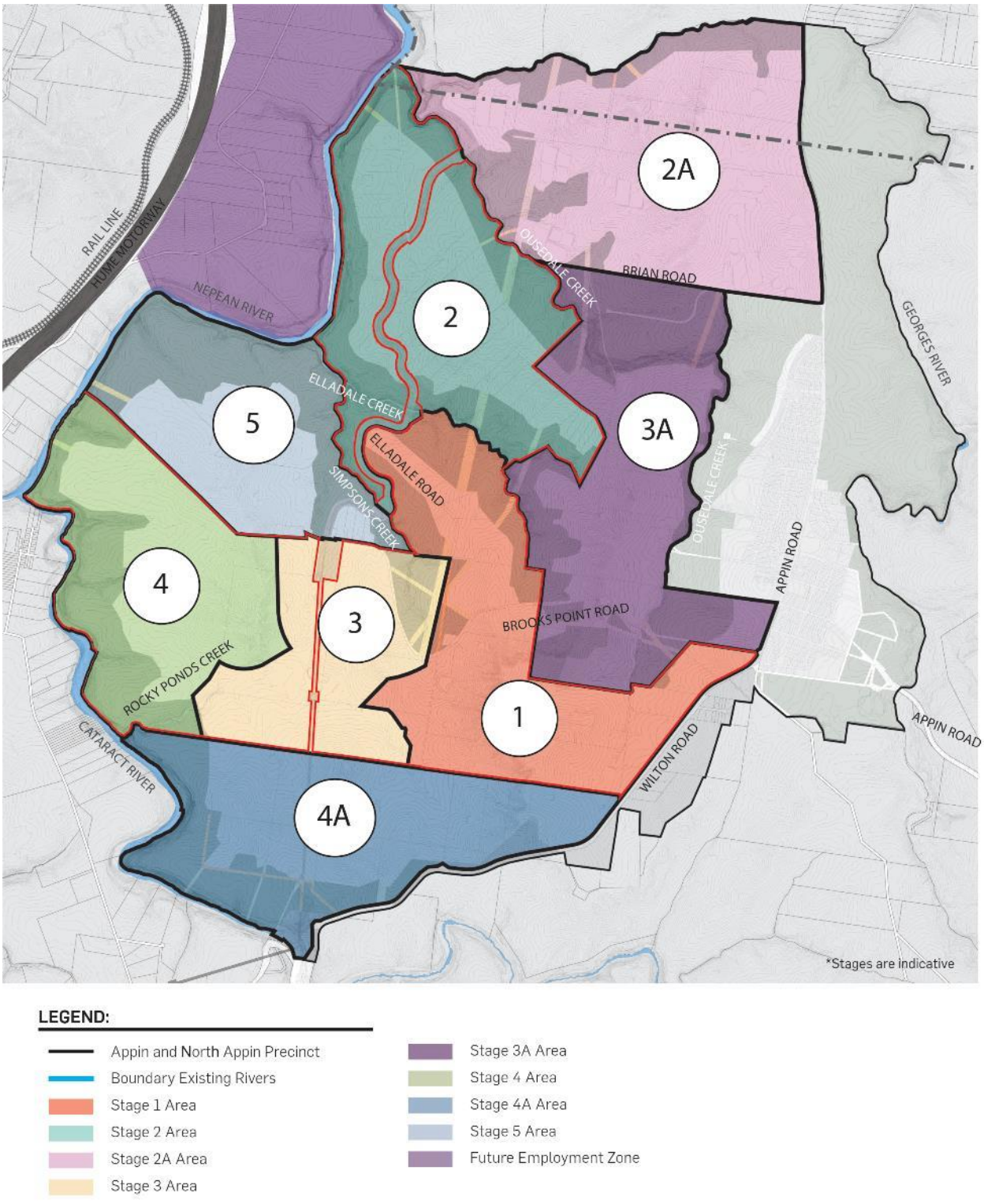
| Neighbourhood | Total lots | % House completions | | | Total jobs | % Job completions | | |
|---|---|---|---|---|---|---|---|---|
| | | 2026 | 2036 | 2056 | | 2026 | 2036 | 2056 |
| 1 | 3,405 | 12% | 100% | 100% | 420 | 0% | 100% | 100% |
| 2 | 3,468 | 0% | 100% | 100% | 400 | 0% | 100% | 100% |
| 2A | 4,354 | 0% | 86% | 100% | 300 | 0% | 0% | 100% |
| 3 | 3,361 | 0% | 0% | 100% | 500 | 0% | 0% | 100% |
| 3A | 2,290 | 0% | 0% | 100% | 2,110 | 0% | 0% | 100% |
| 4 | 2,798 | 0% | 0% | 100% | 0 | 0% | 0% | 100% |
| 4A | 630 | 0% | 0% | 100% | 0 | 0% | 0% | 100% |
| 5 | 1,559 | 0% | 0% | 100% | 400 | 0% | 0% | 100% |
| **Total** | **21,865** | **2%<br>408 lots** | **49%<br>10,633 lots** | **100%<br>21,865 lots** | **4,130** | **0%** | **20%<br>820 jobs** | **100%<br>4,130 jobs** |

*Source: Walker Corporation 24 May 2022*

## 2.2 Appin and North Appin Precinct staging

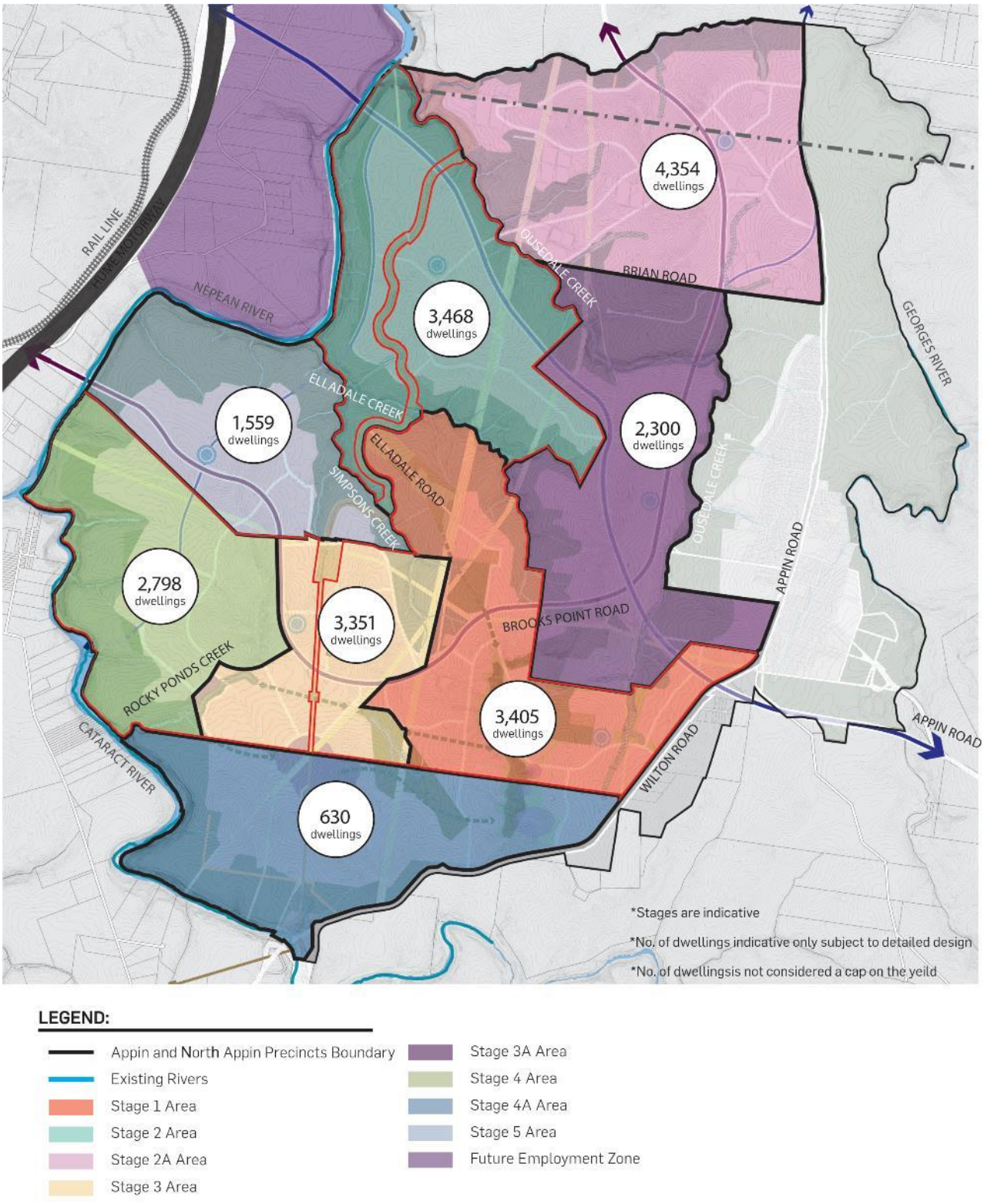
The staging is intended to follow sequentially as indicated by the stage numbering. In terms of road access during the staged development:

- Stage 1, the first stage, will access Wilton Road south of the existing Appin township.
- Stages 2 and 2A will connect to Appin Road north of Appin township. Stage 2 will also have the existing Macquariedale Road for access to Appin, Appin Road and Stage 1 in the interim until the remaining road network is constructed.
- During the release of Stage 2A, a first section of a new East-West Connection Road linking the Hume Motorway to Stage 2 (ultimately connecting to Bulli-Appin Road east of Appin Township will be opened).
- Stages 3 and 3A will consolidate connections between Stages 1 and 2/2A. They will also complete a bypass on the west side of Appin Township. This will also provide part of a new Transit Corridor running parallel to Appin Road.
- Stages 4, 4A and 5 will extend the development to the south-west, ultimately ending with an extension of the Transit Corridor to Douglas Park.




*Source: Walker Corporation, 06 October 2022*

Figure 2.1 Indicative staging plan




*Source: Walker Corporation, 07 October 2022*

Figure 2.2 Appin and North Appin Precinct stages and estimated dwellings

## 2.3 Interim scenarios

A number of interim scenarios are outlined in Table 2.2. In terms of the worst-case scenarios, the ultimate situation (completion of Stage 5 by 2056) is likely to involve the highest competing traffic volumes. All scenarios assume evacuation via Appin Road heading to Campbelltown and excludes access onto the Hume Motorway, Bulli Appin Road and no use of Neighbourhood Safe Places (NSP).

Table 2.2 Outline of interim scenarios

| Interim stage | Access via |
|---|---|
| At Stage 1 | — Use Wilton Road and Appin Road<br>— Brooks Point Road open as alternative in the event that the Stage 1 Appin access road is closed |
| At Stage 2 | — Isolated access, assume one of North Appin access road<br>— Macquariedale Road open as alternative in the event that the North Appin access road is closed |
| At Stage 2A | — As above, assume North Appin access road is open and used by all of Stages 2 and 2A |
| At Stage 3 | — Stages 1 and 3 use Wilton Road and Appin Road<br>— Stages 2 and 2A use North Appin access road and Appin Road |
| At Stage 3A* | — Connection between Stages 1, 2, 2A, 3 and 3A enables bypassing of existing Appin township if congestion occurs<br>— East-West Connection Road constructed but closed<br>— Stages 1 and 3 use Wilton Road and Appin Road<br>— Stages 2, 2A and 3A use North Appin access road and Appin Road |
| At Stage 4* | — Connection between Stages 1, 2, 2A, 3 and 3A enables bypassing of existing Appin township if congestion occurs<br>— East-West Connection Road constructed but closed<br>— Stages 1, 3 and 4 use Wilton Road and Appin Road<br>— Stages 2, 2A and 3A use North Appin access road and Appin Road |
| At Stage 4A* | — Connection between Stages 1, 2, 2A, 3 and 3A enables bypassing of existing Appin township if congestion occurs<br>— East-West Connection Road constructed but closed<br>— Stages 1, 3, 4 and 4A use Wilton Road and Appin Road<br>— Stages 2, 2A and 3A use North Appin access road and Appin Road |
| At Stage 5* | — Connection between Stages 1, 2, 2A, 3 and 3A enables bypassing of existing Appin township if congestion occurs<br>— East-West Connection Road constructed but closed<br>— Stages 1, 3, 4, 4A and 5 use Wilton Road and Appin Road<br>— Stages 2, 2A and 3A use North Appin access road and Appin Road |

Notes * = Assumes worst case scenario with access onto the Hume Motorway constructed but closed due to bushfire incident

## 2.4 Existing population

**Appin township**

The existing Appin township, shown in Figure 1.3, has a population of approximately 2,633 people (based on the 2016 Australian Bureau of Statistics Census). These people are housed in approximately 900 dwellings (2.92 people per dwelling). Appin township includes community facilities, such as Appin Public School, that may be able to be used as a neighbourhood safe place.

**Car ownership**

An analysis of 2016 Census information for the suburbs of Appin, Bradbury, Ambarvale, Rosemeadow, Englorie Park, Glen Alpine and St Helens Park indicated an average car ownership of **1.87 vehicles per dwelling**. This indicates that in the event of an emergency, there may be more than one vehicle per dwelling joining the evacuation.

## 2.5 Future development

Development is planned throughout the Greater Macarthur Growth Area. For this assessment, the future developments at Gilead and South Gilead lie between Appin and the potential evacuation destination of Campbelltown.

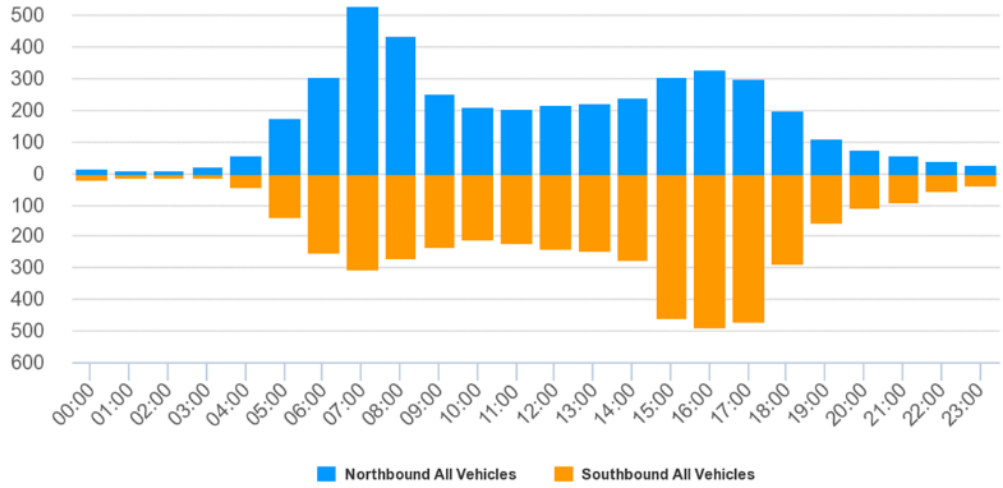
The *Greater Macarthur Priority Growth Area – Draft Growth Centres SEPP Amendment* indicates that Gilead and South Gilead could include 18,100 dwellings (Gilead, Appin Road Planning Proposal, MacroPlanDimasi, June 2018).

In terms of the timing of this development, the *Greater Macarthur Investigation Area, Strategic Transport Infrastructure Study* (Jacobs, 7 December 2017) indicated that Gilead and South Gilead would be 10 per cent complete in 2026, 50 per cent complete in 2036 and 100 per cent complete in 2051.

## 2.6 Road network and traffic volumes

Appin Road provides a connection between south-west Sydney and the Illawarra region, and provides the principal access to Appin township. It is currently a rural road with one lane in each direction. It widens to two lanes in each direction further north near the suburb of Rosemeadow, and there are plans to continue this widening further south as development occurs around Gilead.

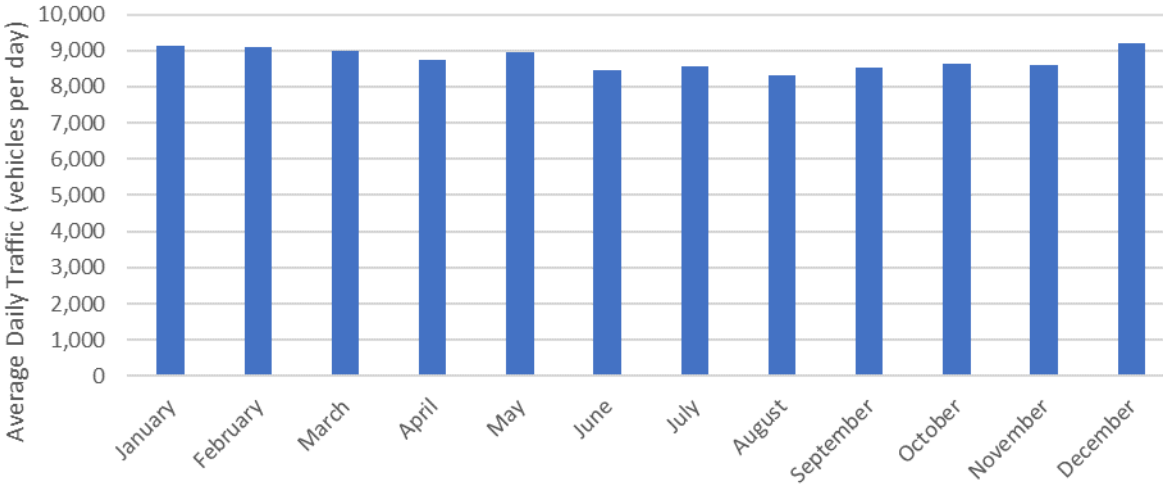
Appin Road currently carries traffic volumes of between 9,000 and 11,000 vehicles per day. With a directional peak of approximately 650 vehicles per hour northbound in the AM peak and southbound in the PM peak on a weekday. The average weekday profile (2007 to 2022) is shown in Figure 2.3.




*Source: Transport for NSW Traffic Volume Viewer, viewed 16 June 2022, 07.750 – Appin Road, 100 m south of King Street*

Figure 2.3 Average daily traffic profile on Appin Road between 2007 and 2022

An analysis of traffic volumes on Appin Road (shown in Figure 2.4) over several years indicated that traffic volumes are slightly higher (by approximately 5 per cent) than the yearly average during the months of December, January and February (also the time of highest bushfire danger).




*Source: Transport for NSW Traffic Volume Viewer, viewed 16 June 2022, 07.750 – Appin Road, 100 m south of King Street*

Figure 2.4 Seasonal variation in traffic volumes on Appin Road

Wilton Road connects the township of Appin and Wilton, which are separated by the Cataract River at Broughton Pass. Wilton Road is a rural road with one lane in each direction. However, Broughton Pass has several hairpin turns with a one lane bridge over the Cataract River (for both directions). It therefore has much lower traffic volumes than Appin Road.

## 2.7 Direction of fire and location of safe evacuation

Based on discussions with Eco Logical Australia, Table 2.3 outlines the risk of bushfire by direction. This is then interpreted to identify safe evacuation locations. Based on this, the most likely external evacuation scenario is all evacuating to the north along Appin Road.

Table 2.3 Bushfire risk and scenario by direction

| Fire direction from | Fire risk | Safe evacuation | Road access | Proposed bushfire evacuation scenario |
|---|---|---|---|---|
| West | Highest based on prevailing conditions | Douglas Park or Menangle | Future East-West Connection Road<br>Hume Motorway interchange<br>Transit Corridor | Closed |
| South | Moderate, road connection has low capacity | Wilton | Wilton Road | Closed |
| East | Lower, but road through bush areas is longer and surrounded by bush, increasing exposure time | Wollongong or Bulli | Bulli-Appin Road | Open, but not preferred due to long travel distance through bush |
| North | Lower, small pockets of bush to the north along Appin Road | Campbelltown | Appin Road<br>Transit Corridor | Open |

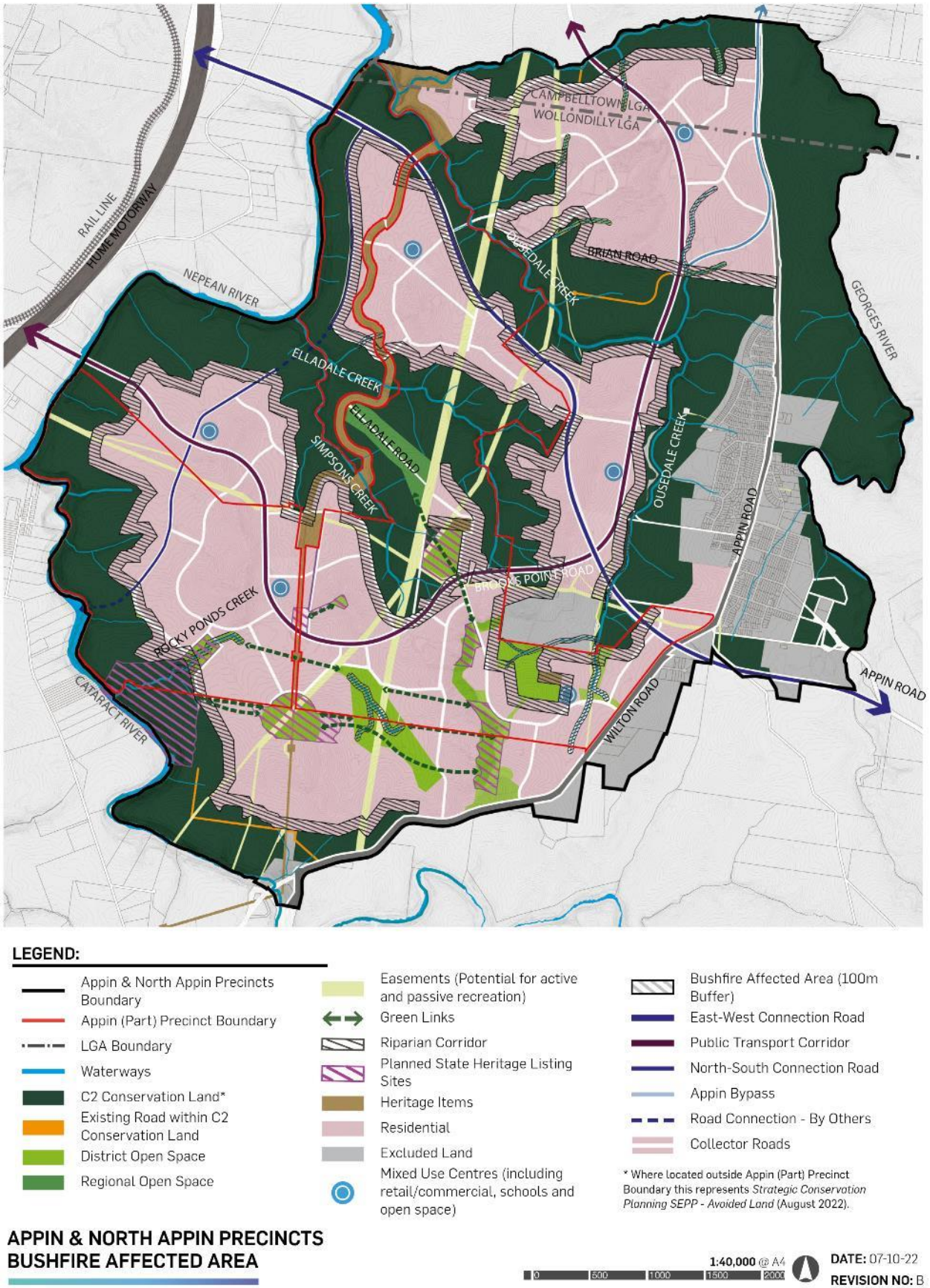
## 2.8 Development near bushland

The development close to bushland (identified as areas within 100 m of an Asset Protection Zone (APZ)) are assumed to be at a greater risk of bushfire attack. Figure 2.5 shows the location of development within 100 m of the APZ.

Table 2.4 shows the number of dwellings within 100 m of an APZ, that could be in a higher risk of bushfire threat. Stages 2 and 2A have the highest number of dwellings affected, while Stages 3A and 5 have the highest percentage of dwellings affected. Of these, Stages 2A and 3A are located close to their evacuation route (Appin Road).

Table 2.4 Number of dwellings within 100 m of an APZ

| Dwelling Category | Stage 1 | Stage 2 | Stage 2A | Stage 3 | Stage 3A | Stage 4 | Stage 4A | Stage 5 | Sub-total within 100 m of APZ |
|---|---|---|---|---|---|---|---|---|---|
| **Lots within 100 m of APZ** | **696** | **823** | **890** | **253** | **786** | **440** | **31** | **460** | **4,380** |
| Total yield | **3,405** | **3,468** | **4,354** | **3,351** | **2,300** | **2,798** | **630** | **1,559** | **21,865** |
| Percentage | 20% | 24% | 20% | 8% | 34% | 16% | 5% | 30% | 20% |




*Source:* *Walker Corporation, 07 October 2022*

Figure 2.5 Development adjacent to bushland (within 100 m of an APZ)

# 3 Bushfire evacuation analysis method

## 3.1 Evacuation scenarios

If a bushfire threatens the future Appin and North Appin Precinct, potential evacuation scenarios include:

- Evacuating at-risk properties to a safe location at nominated neighbourhood safe places (open areas or community facilities) within the development
- Evacuating an entire precinct/stage or the entire area to a suitable location away from the bushfire risk if the severity/risk of the bus fire is higher. For the Appin and North Appin Precinct assessment this is assumed to be Campbelltown in the north.

Based on these broad options, the following bushfire evacuation scenarios have been identified as the critical ones for the assessment of the proposed Appin and North Appin Precinct:

1. Only population within 100 m of APZ boundary
   a. Evacuation to neighbourhood safe places within development (neighbourhood safe places) or suitable open areas
   b. Evacuation north to Campbelltown
2. Whole neighbourhood
   a. Stage 1 before the upgrading of Appin Road (estimated as 2028): Evacuation of Stage 1 north to Campbelltown
   b. Completion of Stages 1, 2 and 2A: Evacuation of Stage 2 north to Campbelltown, normal traffic to Stage 2A
3. All of development
   a. Evacuation of the Appin and North Appin Precinct, Appin township, Gilead and South Gilead north to Campbelltown.

The scenarios testes are designed to be worst-case scenarios to test the boundaries of the potential evacuation times. It is likely that more than one evacuation route will be available, at least for some part or all of the evacuation process, providing extra road capacity and reducing the evacuation times.

It is noted that the following could affect improve the evacuation times:

- Reduced traffic on the road network, from people avoiding the bushfire zone, would reduce the volume of general traffic on the road network, preserving more space for evacuating vehicles.
- The use of emergency services to manage the evacuation would significantly enhance the chance of an orderly evacuation and avoiding panic from those that are last to leave (no emergency services assistance has been assumed).
- The provision of appropriate “neighbourhood safe places” within the development will reduce the pressure on the road network, reducing evacuation time for those who choose to leave.

## 3.2 Assessment method

The method to assess the road network’s ability to accommodate evacuating traffic includes the following steps:

1. Identify the population to be evacuated
2. Estimate the number of vehicles participating in the evacuation
3. Estimate the potential volume of traffic using the road network at the same time, not associated with the evacuation
4. Estimate the spare mid-block capacity on the road network at key locations
5. Check the capacity at critical intersections using traffic modelling
6. Calculate the time required to evacuate the population based on the available capacity
7. Assess the implications for evacuation management decisions.

### 3.2.1 Mid-block capacity assessment

The assessment of mid-block road network capacity assumes the following lane capacities based on the type of road being used for the evacuation:

- Rural road, one lane in each direction: 1,200 vehicles per direction per hour at forced flow based on traffic surveys of other roads in Sydney.
- Multi-lane road, minimum of two lanes in each direction: 1,500 vehicles per lane per hour, assuming limited side access, as is planned for Appin Road in the upgraded locations
- Collector road: 900 vehicles per lane per hour based on urban roads with interrupted flows from the Austroads Guide to Traffic Management Part 3: Transport Study and Analysis Methods, Austroads 2020.

The volume of traffic on the road network is likely to change hour-by-hour. The traffic profile of Appin Road is used to estimate the peak traffic times and the available spare capacity. Based on the traffic data for the traffic counter at 07.750 – Appin Road, 100 m south of King Street, the critical times for bushfire evacuation are:

- 6.00 am to 1.00 pm in the morning peak
- 12.00 pm to 7.00 pm in the afternoon peak.

### 3.2.2 Normal operation trip generation and direction

Trip generation for normal operation is based on the strategic transport assessment undertaken for the Appin and North Appin Precinct, which used the Sydney Traffic Forecasting Model (STFM) using EMME 4.3.7, supplied by Transport for NSW.

The trip generation rates used are summarised in Table 3.1. Trip numbers had the following in/out directional splits of:

- 70 per cent out/30 per cent in during the AM peak hour
- 30 per cent out/70 per cent in during the PM peak hour.

Table 3.1 Peak hour vehicle trip generation rates

| Dwelling type | AM peak hour | PM peak hour |
|---|---|---|
| Traditional, large and rural single dwelling lots – changes over time as the development proceeds[1] | — 2026: 0.84 trips per dwelling<br>— 2036: 0.88 trips per dwelling<br>— 2056: 0.74 trips per dwelling | — 2026: 0.94 trips per dwelling<br>— 2036: 0.99 trips per dwelling<br>— 2056: 0.81 trips per dwelling |
| Medium density[2] | — 0.55 trips per dwelling | — 0.55 trips per dwelling |
| Apartments[2] | — 0.53 trips per dwelling | — 0.32 trips per dwelling |

(1) Calculating trip generation rates based on trip rates per person derived from those in the STFM, that do not typically include local trips to local schools, shops and employment which are typically shorter and often intra-zonal trips

(2) Roads and Maritime Services *Technical Direction TDT13/04a Guide to Traffic Generating Developments* Updated traffic surveys

To maintain consistency with the existing strategic modelling of the Greater Macarthur region, the trip distribution for the Appin and North Appin Precinct was based on nearby areas in the STFM model that contain developments with similar features to those planned for the Appin and North Appin Precinct. Rosemeadow was identified as a mature development with similar land use patterns and the trip distribution was applied from this zone. This was combined with the distribution from Wollondilly Shire to recognise the convenient access to the North-West future employment areas around Western Sydney Airport and the Aerotropolis as well as employment opportunities in Wollongong, a 30-minute drive away.

Table 3.2 Trip direction

| Trip direction | AM peak hour | PM peak hour |
|---|---|---|
| North/Campbelltown | 38% | 40% |
| North/Hume | 16% | 17% |
| North–West | 7% | 9% |
| South | 5% | 5% |
| Internal | 30% | 23% |
| East | 4% | 6% |
| Total | 100% | 100% |

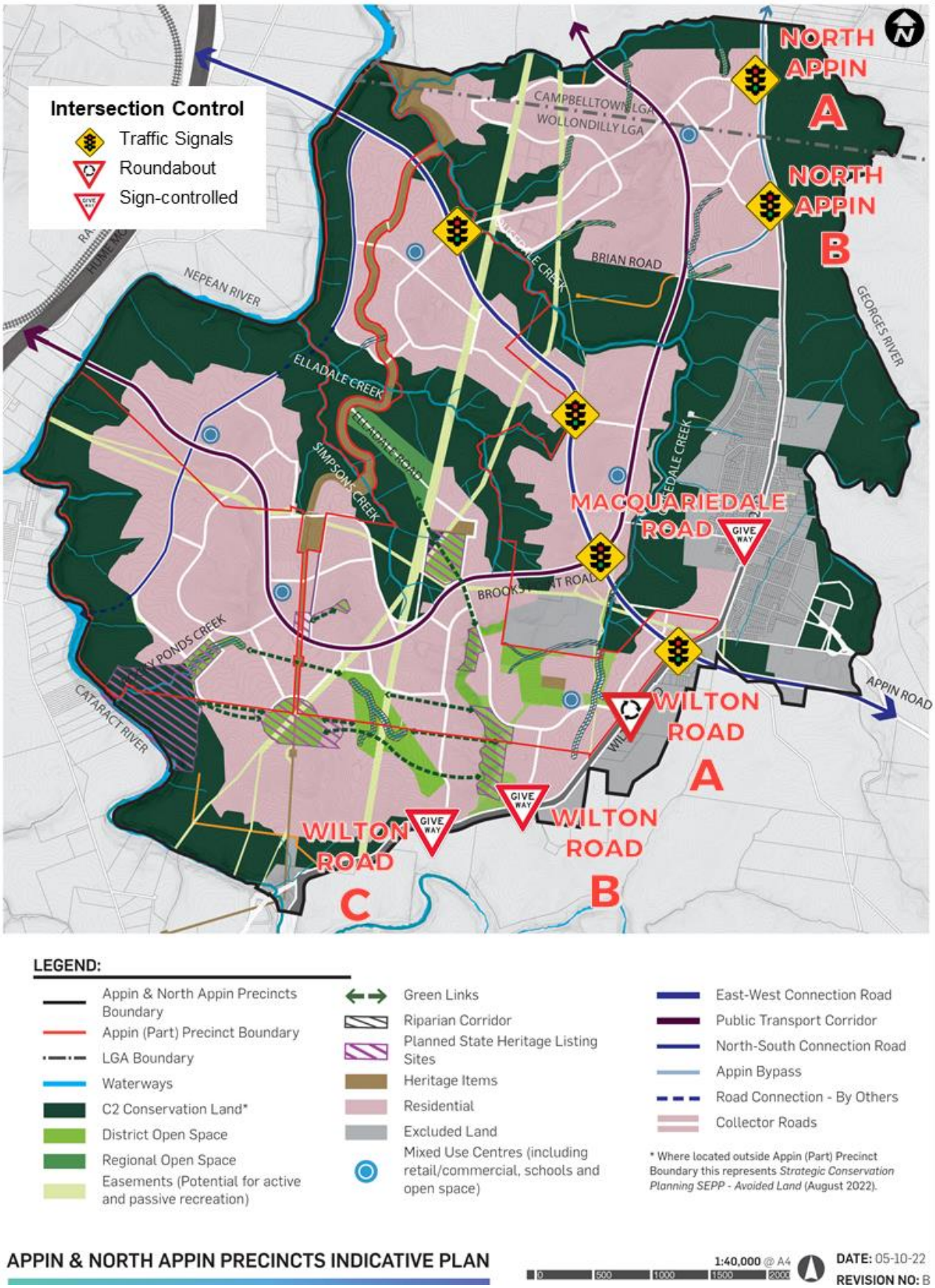
*Source: Analysis of STFM model trip patterns*

### 3.2.3 Bushfire evacuation traffic assumptions

- Appin and North Appin Precinct to include 10,500 dwellings by 2036 and full development of approximately 21,000+ dwellings by 2056.
- Developments north including South Gilead, Gilead, and the existing Appin township may impact Appin Road capacity.
- Stages 1, 4A and 5 use Wilton Road and Appin Road, spread 80 per cent, 10 per cent and 10 per cent between access points.
- Stages 3, 3A, 4 and 5 use the bypass of Appin via the North South transit corridor to join Appin Road.
- Stages 2 and 2A use North Appin access roads and Appin Road.
- Other future roads such as the Transit Corridor and Spring Farm Parkway extension will be available when development as a second evacuation route to Campbelltown.
- Bulli-Appin Road to remain open to traffic in all but Scenario 3a. This is considered a conservatively high assumption as a major incident in the area may close/reduced traffic on Bulli-Appin Road.
- Hume Motorway interchange constructed but not used for evacuation
- If a catastrophic bush fire were to impact the area, Bulli-Appin Road may be closed. However, traffic already on the road network may require evacuation in addition to the local residents.
- 1.87 vehicles per home being evacuated (based on Census information).
- 25% stay and defend out of the total population.
- 95% occupancy at the time of the emergency.
- Minimal/no traffic management by emergency services is preferred.
- From a road network viewpoint, the route to Campbelltown has the highest volume of traffic competing for road space during the AM peak as traffic heads north to Campbelltown and Western Sydney.
- However, the risk of a bushfire is higher in the afternoon following the heat of the day. During the afternoon peak, traffic volumes heading north on Appin Road are lower, meaning that more capacity is available for evacuating traffic.

### 3.2.4 Intersection assessment

For the bushfire evacuation assessment, the intersections that are likely to be critical to the evacuation time will be modelled. These are identified in Figure 3.1 with letters A to E and occur where evacuating traffic may have to give way to regular traffic. Intersections have been assessed using the SIDRA Intersection software.




*Base image source:* *Walker Corporation, 06 October 2022*

Figure 3.1 Assumed intersection control and identified intersections to be modelled

The method included modelling the base traffic volume, including vehicles going about their normal business (not participating in the evacuation, and then increasing the amount of evacuating traffic until the capacity of the intersection is reached.

The intersections and the proposed models to be run are outlined in Table 3.3 below.

Table 3.3 Intersection models for bushfire evacuation scenarios

| Intersection | Scenario 1b | Scenario 2a | Scenario 2b | Scenario 3a |
|---|---|---|---|---|
| North Appin Access A at Appin Road | ✓ | | ✓ | ✓ |
| North Appin Access B at Appin Road | ✓ | | | ✓ |
| Wilton Road and Appin Road | | ✓ | | |
| Wilton Road Access A | ✓ | ✓ | | ✓ |
| Wilton Road Access B | ✓ | | | ✓ |
| Wilton Road Access C | ✓ | | | ✓ |

Notes Scenario 1a = use Neighbourhood Safe Place, no intersection modelling required

### *3.2.5 Travel time assessment*

The travel time assessment includes consideration of three elements

- Internal travel time from each stage to Wilton Road or Appin Road
- Mid-block clearance time based on spare capacity on the road network
- Intersection delays at critical junctions.

# 4 Assessment findings

## 4.1 Mid-block capacity and clearance time

### *4.1.1 Scenario 1b – evacuating dwellings within 100 m of an APZ*

Table 4.1 shows the potential evacuation time of the properties identified at a higher risk of bushfire (within 100 m of an APZ, as identified in Table 2.4. In making this assessment, we have made the following assumptions:

- 1.87 vehicles per dwelling (based on Census information)
- 25% of residents stay and defend
- 95% occupancy of dwellings
- Collector road capacity of 900 vehicles per hour per lane (vphpl) for interrupted flow based on the *Guide to Traffic Generating Developments*
- Average drive speed of 40 km/h.

Stage 2 has the highest evacuation time, assuming all evacuate towards Appin Road through Stage 2A.

Table 4.1 Evacuation of dwellings within 100 m of APZ by single stage

| Stage | Stage 1 | Stage 2 | Stage 2A | Stage 3 | Stage 3A | Stage 4 | Stage 4A | Stage 5 | All Stages |
|---|---|---|---|---|---|---|---|---|---|
| Vehicles evacuating | 929 | 1,099 | 1,188 | 337 | 1,050 | 588 | 41 | 614 | 5,847 |
| Lanes of traffic available | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 4 |
| Minutes to Evacuate Stage including drive time at 40 km/h | **65** | **80** | **41** | **32** | **38** | **51** | **4** | **54** | **116** |

Evacuating combinations of stages in a more extensive bushfire event will place additional strain on the road network.

- Evacuating Stages 2 and 2A simultaneously (approximately 2,300 vehicles) could be achieved in **83 minutes** with two lanes of traffic through Stage 2A.
- Evacuating Stages 3, 4 and 5 (approximately 1,500 vehicles) could be achieved in **116 minutes** (for 1 lane of traffic) or less if vehicles are permitted to use the transit lane in an emergency or use parallel local streets.
- Evacuating Stages 3, 3A, 4 and 5 (approximately 2,600 vehicles) could be achieved in a similar **116 minutes** (assuming two lanes of traffic between Stage 3A and Appin Road).

### *4.1.2 Scenario 2a – evacuating Stage 1 with Appin Road in its current state (with planned upgrade to Gilead)*

The assessment at the completion of Stage 1 has been undertaken to provide information about the suitability of the first release for the Appin and North Appin Precinct, before Appin Road is upgraded, which provides a significant increase in capacity. With approximately 3,000 dwellings being evacuated, the number of vehicles potentially participating in the evacuation is 4,000 and includes the following assumptions:

- A capacity pinch point is likely to occur north of Appin township, with the existing rural road with one lane in each direction.
- Evacuating traffic will need to share the road with regional traffic between the Illawarra and south-west Sydney as well as traffic from Appin itself.

- South Gilead development is not expected to have started.
- Gilead development has commenced. However, it is assumed that the widening of Appin Road to Gilead would be complete, providing additional capacity that accommodates the Gilead traffic.

The results of the analysis are shown in Figure 4.1. They show that available road capacity for evacuating vehicles reduces during the AM and PM peaks. However, the hours either side of the peak hour have more capacity, enabling more vehicles to be evacuated. As stated before, the AM peak is a more critical from a traffic network viewpoint. However, bushfires are more considered to occur in the afternoon. The available capacity during the PM peak is higher.

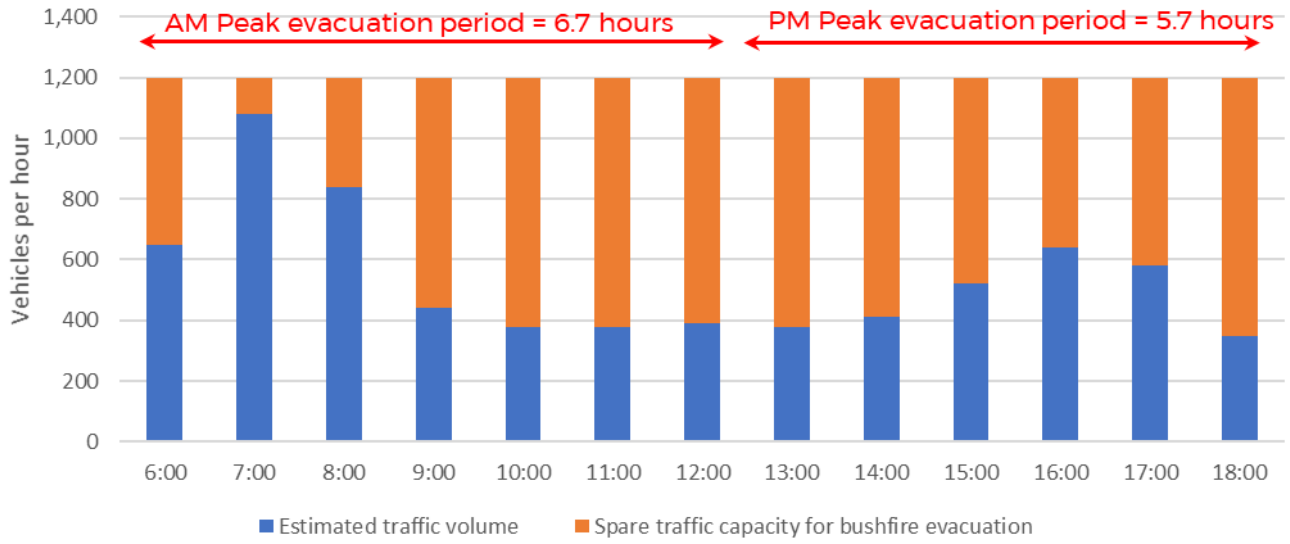



Figure 4.1 Scenario 2a – Estimated traffic volume and spare capacity for bushfire evacuation of Stage 1, Appin Road, north of Appin

*Notes Assumes a capacity of 1,200 vph northbound, north of Appin*

Based on this assessment, the estimated clearance time for 4,000 vehicles is:

- 6.7 hours in the AM peak
- 5.7 hours in the PM peak.

A similar assessment for Appin Road north of Gilead (with a widened Appin Road) indicated clearance times of 2.6 hours in the AM peak and 2.2 hours in the PM peak. This confirms that the section of Appin Road north of Appin township is the critical location for the road network. The opening of the planned Spring Farm Parkway Extension between Appin Road and the Hume Motorway at Gilead, will provide an alternative route for normal traffic and evacuating traffic, reducing the risk of a bottleneck developing further north.

If Bulli-Appin Road is available for evacuation to the east as well as Appin Road to the north, the evacuation times would reduce substantially to:

- **3.2 hours in the AM peak**
- **4.1 hours in the PM peak.**

This assessment is strategic and does not include the impact of queuing on the network. It also assumes reasonable conditions on the road network. If smoke reduces visibility, this could reduce the effective capacity, increasing the clearance time.

These clearance times indicate a need for:

- Early decisions to evacuate large populations of people and/or
- The provision of appropriate “neighbourhood safe place” areas within the development to reduce the pressure on the road network.

### 4.1.3 *Scenario 2b – evacuating Stage 2 with Appin Road widened from North Appin north to Gilead*

The assessment at the completion of Stage 2 has been undertaken as this stage is surrounded by narrow bushland along most of its perimeter. It will rely on access to the neighbouring Stage 2A (North Appin) to get to Appin Road as part of its evacuation route. An alternative access via Macquariedale Road will exist. However, as this is away from the evacuation direction, it has been assumed as a back-up route rather than a primary route.

With approximately 3,450 dwellings being evacuated, the number of vehicles potentially participating in the evacuation is 4,600 dwellings. It is assumed that Appin Road would have already been upgraded to two lanes in each direction from North Appin to Gilead, providing extra capacity and includes the following assumptions:

- Evacuating traffic will need to share the road with regional traffic between the Illawarra and south-west Sydney as well as traffic from Appin itself. However, this is unlikely as a bushfire event is likely to result in lower than usual traffic volumes in the area.
- South Gilead development is not expected to have started.
- Gilead development has commenced. However, it is assumed that the widening of Appin Road to Gilead would be complete, providing additional capacity that accommodates the Gilead traffic.

The results of the analysis are shown in Figure 4.2. They show a similar pattern to that of Scenario 2a. However, the road upgrades of Appin Road means that the spare capacity is higher, translating into lower clearance times.

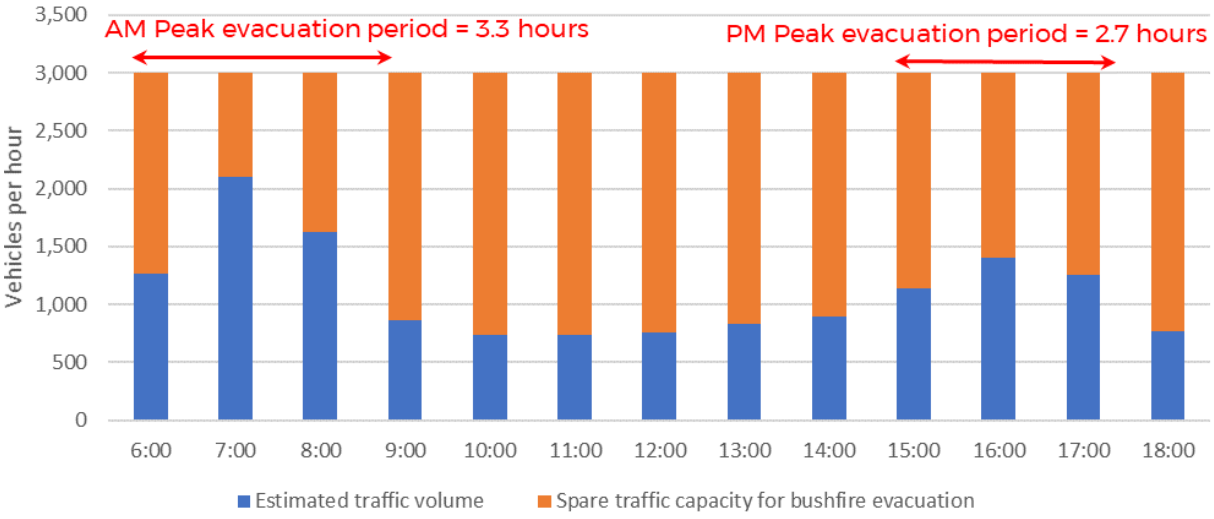



Figure 4.2 Scenario 2b – Estimated traffic volume and spare capacity for bushfire evacuation of Stage 2, Appin Road, north of North Appin

*Notes Assumes a capacity of 3,000 vph northbound, north of North Appin (upgraded to two lanes in each direction)*

Based on this assessment, the estimated clearance time for 4,600 vehicles is:

- 3.3 hours in the AM peak
- 2.7 hours in the PM peak.

While these clearance times are substantially lower than Scenario 2a, they indicate the need for advanced evacuation warning and suitable neighbourhood safe place arrangements to be an important part of the bushfire evacuation response.

If Bulli-Appin Road is available for evacuation to the east as well as Appin Road to the north, the evacuation times would reduce substantially to:

- **2.3 hours in the AM peak**
- **2.4 hours in the PM peak.**

### 4.1.4 Scenario 3a – evacuating entire development, Appin, South Gilead and Gilead

The assessment at the completion of the development in 2056 has been undertaken to understand the implication of a catastrophic bushfire event. The likelihood of an event occurring that requires the evacuation of so many people is low. Its assessment is meant to inform an understanding of the potential decision timeframes.

The proposed road network at completion, shown in Figure 4.3, includes the existing Appin Road sections to the north and east, as well as new connections to the north (Transit Corridor and Spring Farm Parkway Extension) and west (East-West Connection Road that leads to a new interchange with the Hume Motorway and Transit Corridor on its way to Douglas Park).

For this assessment it is assumed:

- The amount of people sheltering-in-place would effectively be zero (complete evacuation)
- Bulli-Appin Road would be closed. However, in the first hour following closure, traffic already on the network would be included in the evacuation.
- Appin Road, the Transit Corridor and the Spring Farm Parkway Extension would all be available to support the evacuation. However, the East-West Connection Road, Bulli-Appin Road, Broughton Pass and the proposed transit corridor connection to Douglas Park would not be open.
- Traffic would be permitted to use the transit lane on the Transit Corridor in the emergency situation.

With a combined number of dwellings to be evacuated of approximately 41,000 dwellings (120,000 people), the number of vehicles potentially participating in the evacuation is 73,000 (including 1,400 vehicles caught on the road network).

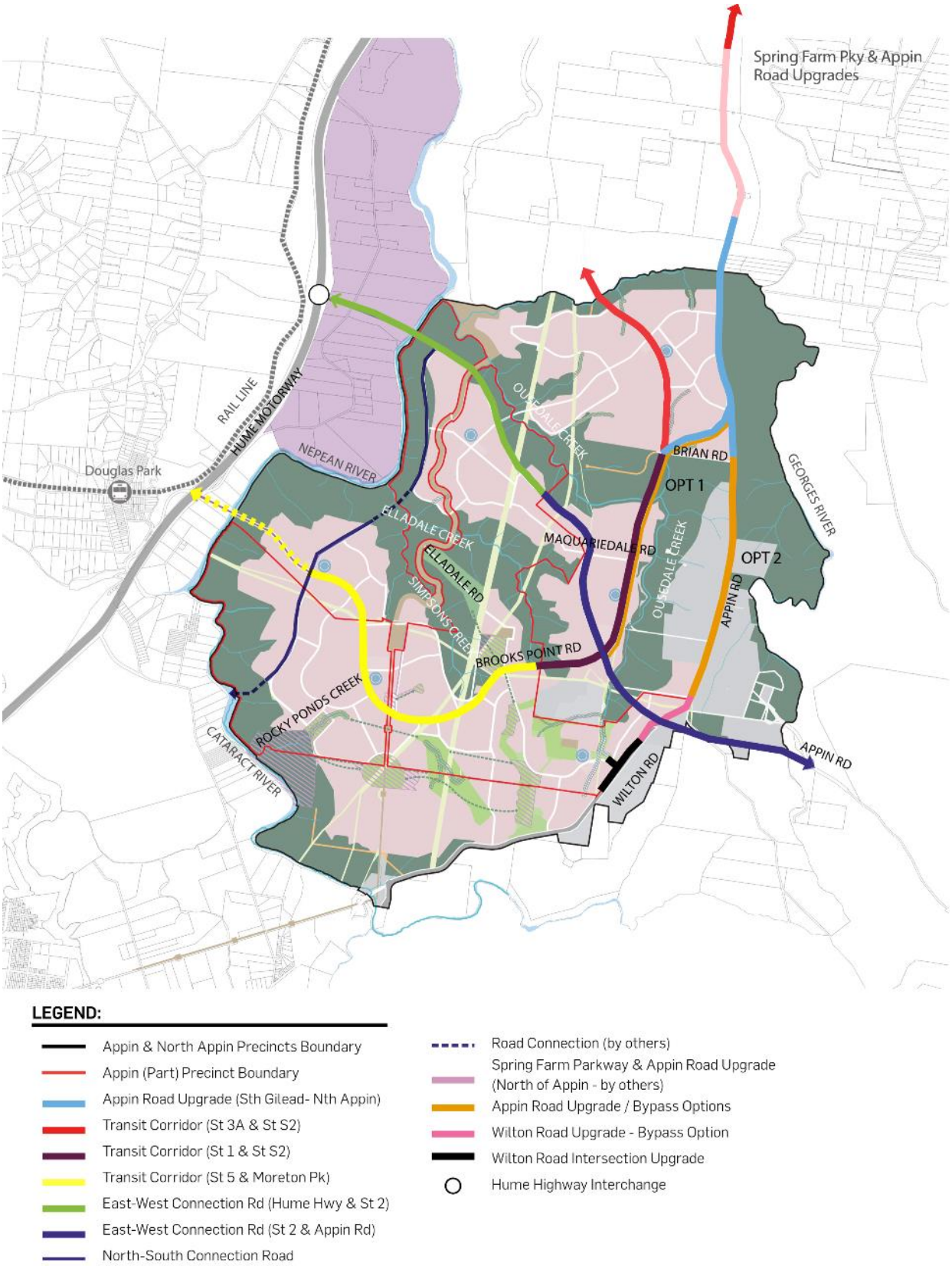
The road network capacity assumed to be available is 9,000 vph (3,000 vph on Appin Road, 3,000 vph on the Transit Corridor and 3,000 on the Spring Farm Parkway Extension).

Based on this assessment, the estimated clearance time is estimated as 8.1 hours. Given the magnitude of the effort an evacuation of this magnitude will significant coordination. The use of emergency services to manage the evacuation would significantly enhance its chance of being orderly and avoiding panic from those that are last to leave.

If Bulli-Appin Road and/or the planned East-West Connection Road are available for evacuation to the east or west as well as Appin Road to the north, the evacuation times would reduce substantially to:

- Appin Road to north and Bulli-Appin Road to the east: **6.2 hours**
- Appin Road to the north and East-West Connection Road to the west: **5.1 hours**
- Appin Road to the north, Bulli-Appin Road to the east and East-West Connection Road to west: **4.3 hours.**

Given the timeframes in volumes to move so many people, it is likely that these additional evacuation routes will be available, at least for part of the evacuation process, providing extra road capacity and reducing the evacuation times.




*Source: Walker Corporation, 07 October 2022*

Figure 4.3 Proposed road network at completion

## 4.2 Intersection assessment

SIDRA Intersection software was used to assess the performance of the key intersections listed in section 3.2.4 with the development during the morning peak hour. The traffic modelling using SIDRA was based on the existing road and intersection geometry or an estimation of what the future intersection geometry could look like. As the weekday morning peak experiences the highest traffic volumes in the evacuation direction, the intersection modelling has concentrated on this peak period. Intersection performance is measured using several criteria including Level of Service and average delay. The definitions of these criteria are outlined in Appendix A. The descriptions shown in Appendix A are for everyday normal operation. They do not apply to an evacuation scenario where traffic conditions will be atypical. They are included for comparison to normal operation only.

### *4.2.1 Scenario 1b – evacuating dwellings within 100 m of an APZ*

In the event of all of the properties within 100 m of the APZ requiring evacuation, a worst case situation would be for all the other properties to continue normal operation. This situation has been modelled in SIDRA. The results are shown in Table 4.2. While the operation is listed as Level of Service F (under normal conditions), in the context of a bushfire emergency where the objective is to get as many vehicles through the road network in the quickest time, the traffic volumes have been increased to the maximum that will fit through the system. This will inevitably push the intersection close to its capacity. A more gradual departure and evacuation would result in lower traffic volumes and intersection delays. Alternative evacuation scenarios, such as having more than one evacuation road open and/or use of neighbourhood safe places, would also reduce the intersection delays.

Table 4.2 SIDRA Intersection modelling results of Scenario 1b

| Intersection | AM peak | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | D/S | Ave. delay (sec/veh) | LoS | 95th %ile Queue length (m) | D/S | Ave. delay (sec/veh) | LoS | 95th %ile Queue length (m) |
| North Appin Access A | 1.98 | 807 | F | 3,464 | 1.89 | 614 | F | 3,147 |
| North Appin Access B | 1.53 | 449 | F | 2,349 | 1.64 | 415 | F | 2,384 |
| Wilton Road Access A | 1.66 | 607 | F | 2,630 | 1.34 | 325 | F | 1,558 |
| Wilton Road Access B | 0.24 | 9 | A | <6 | 0.26 | 10 | A | <6 |
| Wilton Road Access C | 0.27 | 10 | A | 10 | 0.47 | 15 | B | 31 |

Notes D/S – Degree of Saturation. D/S>1.0 over capacity, LoS – Level of Service

The results indicate that in addition to the mid-block evacuation time, the following intersection delays would impact the evacuation times.

- Wilton Road Access A – left turn over-capacity: 10 minutes extra delay to evacuate Stage 1 in the AM peak, 5 minutes in the PM peak
- North Appin Access B – left turn + northbound through movement over-capacity: 9 minutes delay to evacuate stages 1, 3, 3A, 4, 4A and 5 in the AM and PM peaks
- North Appin Access B – left turn + northbound through over capacity: 15 minutes extra delay for all stages in the AM peak, 14 minutes in the PM peak.

These results indicate that there will be additional delays along the corridor north. However, it is noted that people evacuating would be in a low-risk area away from the areas of bushfire risk.

### 4.2.2 Scenario 2a – evacuating Stage 1 with Appin Road in its current state (with planned upgrade to Gilead)

Evacuating Stage 1 could occur with some delay at the access intersection with Wilton Road, with the intersection operating at its capacity. Evacuating traffic would experience delays of around one minute. The additional traffic would also put extra pressure on the intersection of Appin Road and Church Street, as shown in Table 4.3, with an additional three minutes of delay. The total additional intersection delay would be approximately four minutes.

Table 4.3 SIDRA Intersection modelling results of Scenario 2a

| Intersection | AM peak | | | | PM peak | | | |
|---|---|---|---|---|---|---|---|---|
| | D/S | Ave. delay (sec/veh) | LoS | 95th %ile Queue length (m) | D/S | Ave. delay (sec/veh) | LoS | 95th %ile Queue length (m) |
| Appin Road and Church Street, Appin* | 1.26 | 179 | F | 1,064 | 1.11 | 82 | F | 902 |
| Wilton Road Access A | 1.05 | 63 | E | 1,766 | 1.05 | 63 | E | 1,766 |

Notes * Assumes upgrade of intersection of Appin Road and Church Street to traffic signals

### 4.2.3 Scenario 2b – evacuating Stage 2 with Appin Road widened from North Appin north to Gilead

Evacuating Stage 2 could proceed with normal traffic accessing Stage 2A. The intersection of North Appin with Appin Road would operate at capacity, as shown in Table 4.4. The additional delay would be approximately one minute.

Table 4.4 SIDRA Intersection modelling results of Scenario 2b

| Intersection | AM peak | | | | PM peak | | | |
|---|---|---|---|---|---|---|---|---|
| | D/S | Ave. delay (sec/veh) | LoS | 95th %ile Queue length (m) | D/S | Ave. delay (sec/veh) | LoS | 95th %ile Queue length (m) |
| North Appin Access A | 1.04 | 63 | E | 384 | 1.07 | 66 | E | 504 |

### 4.2.4 Scenario 3a – evacuating entire development, Appin, South Gilead and Gilead

Evacuating all of the vehicles from a large area would involve a significant effort, which would only be considered during an extremely serious situation. Given this, we have assumed that background traffic would be stopped. This would prioritise the road network for the evacuating traffic.

Table 4.5 shows that this would mean relatively low delays at intersection south of Appin. However, as each development stage's traffic is added to the evacuating movement, the competition for road space would grow. The intersection of North Appin with Appin Road would experience delays of approximately two minutes.

Table 4.5 SIDRA Intersection modelling results of Scenario 3a

| Intersection | AM Peak | | | | PM Peak | | | |
|---|---|---|---|---|---|---|---|---|
| | D/S | Ave. delay (sec/veh) | LoS | 95th %ile Queue length (m) | D/S | Ave. delay (sec/veh) | LoS | 95th %ile Queue length (m) |
| North Appin Access A | 1.09 | 118 | F | 1,104 | 1.09 | 104 | F | 1,104 |
| North Appin Access B | 0.86 | 28 | B | 238 | 0.86 | 25 | B | 238 |
| Wilton Road Access A | 0.94 | 25 | B | 212 | 0.94 | 25 | B | 212 |
| Wilton Road Access B | 0.16 | 6 | A | 5 | 0.16 | 6 | A | 5 |
| Wilton Road Access C | 0.13 | 6 | A | 4 | 0.13 | 6 | A | 4 |

## 4.3 Drive time assessment

The drive time within the Appin and North Appin Precinct and along Wilton and Appin Roads has been estimated using an assumed average speed of 40 km/h within the development and 50 km/h on Wilton and Appin Road. Figure 4.4 shows the indicative travel distances and drive times for evacuating traffic from each stage to a point on Appin Road at the border of Wollondilly and Campbelltown Council areas. From this point, the drive time to Campbelltown is typically between 10 and 20 minutes.

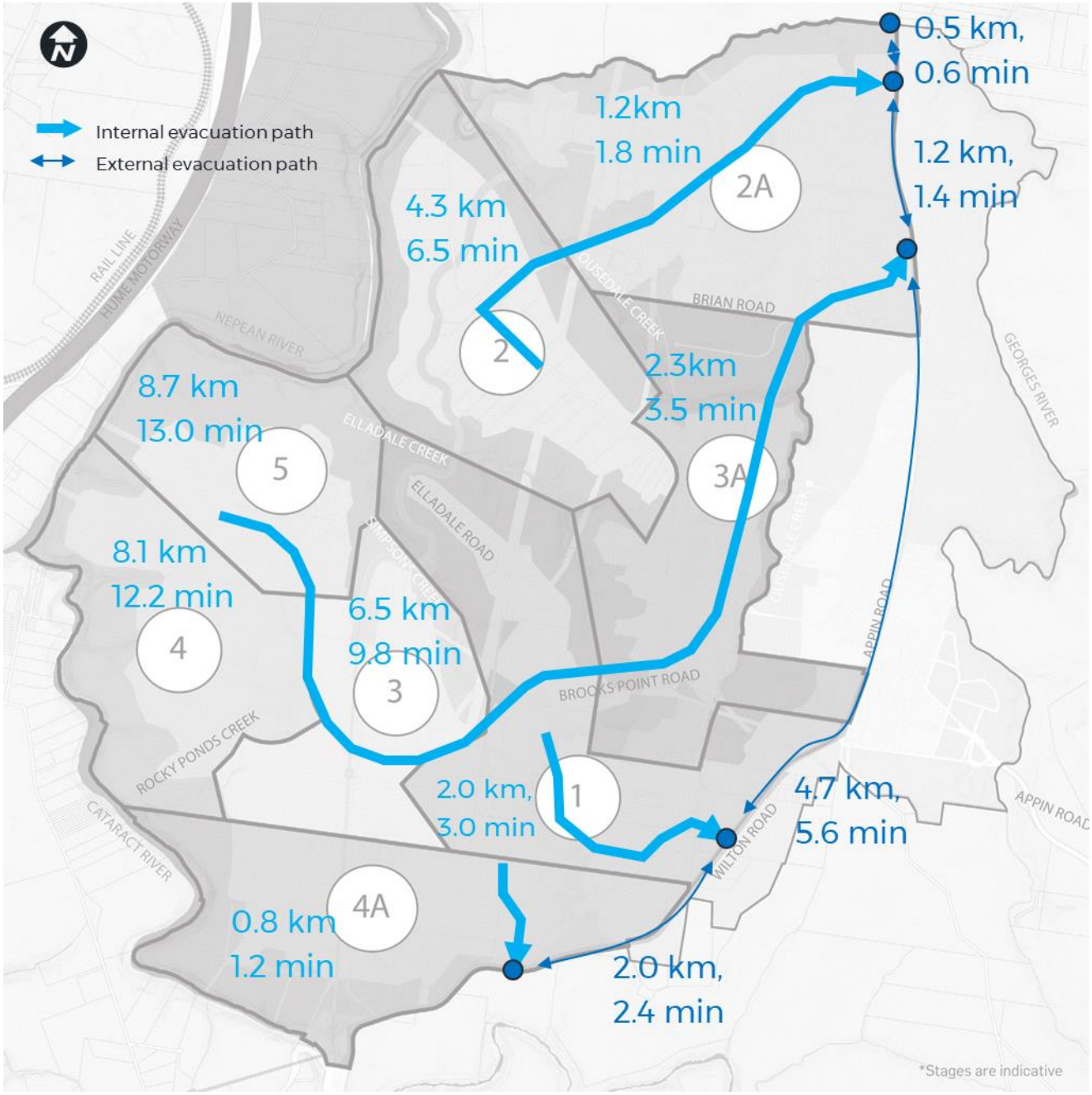



Figure 4.4 Indicative travel distances and travel times for evacuating traffic

## 4.4 Combined evacuation time

The combined evacuation time is the sum of all travel times and includes the mid-block capacity delay, intersection delay and drive times.

### *4.4.1 Scenario 1a – evacuating dwellings within 100 m of an APZ to a neighbourhood safe place location*

Based on the layout of the development, it is understood that each stage would be provided with a suitable neighbourhood safe place location. However, during the construction of Stage 1, a temporary neighbourhood safe place location would be provided in Stage 3.

The drive time within stages is typically around 5 minutes, and the drive time between neighbouring stages is within 10 minutes. The structure plan shown in Figure 2.1 shows a permeable road network with multiple routes within each stage and a minimum of two roads connecting a stage to its adjacent stages or the external road network.

### *4.4.2 Scenario 1b – evacuating dwellings within 100 m of an APZ*

The estimated evacuation time (excluding notification time) combined impact of mid-block road capacity, intersection delays and drive time is shown in Table 4.6. The Stage with the longest evacuation time would be Stage 1 (combined time of 110 minutes), due to the number of people and vehicles being evacuated through it and the intersection delays it would experience as road space is taken up by vehicles from other stages. Other stages with evacuation times of between 1½ and 2 hours are Stages 2, 4 and 5, located at the western boundary of the development.

Table 4.6 Scenario 1b – combined evacuation time of people living within 100 m of an APZ

| Stage | AM peak | | | | PM peak | | | |
|---|---|---|---|---|---|---|---|---|
| | Mid-block capacity | Intersection | Drive time | Total (mins) | Mid-block capacity | Intersection | Drive time | Total (mins) |
| 1 | 65 | 34 | 11 | **110** | 65 | 28 | 11 | **104** |
| 2 | 80 | 15 | 7 | **102** | 80 | 14 | 7 | **101** |
| 2A | 41 | 15 | 2 | **59** | 41 | 14 | 2 | **58** |
| 3 | 32 | 24 | 12 | **68** | 32 | 23 | 12 | **67** |
| 3A | 38 | 24 | 5 | **68** | 38 | 23 | 5 | **67** |
| 4 | 51 | 24 | 14 | **90** | 51 | 23 | 14 | **89** |
| 4A | 4 | 24 | 11 | **39** | 4 | 23 | 11 | **38** |
| 5 | 54 | 24 | 15 | **93** | 54 | 23 | 15 | **92** |

It is noted that the following could affect the evacuation times:

- Reduced traffic on the road network, from people avoiding the bushfire zone, would reduce the volume of general traffic on the road network, preserving more space for evacuating vehicles.
- Including other roads such as the East-West Connection Road or Macquariedale Road could reduce some elements of the evacuation time calculations.

### 4.4.3 Scenario 2a – evacuating Stage 1 with Appin Road in its current state (with planned upgrade to Gilead)

Evacuating all of Stage 1 with Appin Road in its current one lane in each direction state north of Appin would include the following combination of travel time components:

- Mid-block capacity: 6.7 hours in the AM peak and 5.7 hours in the PM peak
- Intersection delay: additional 4 minutes in the AM peak and 2.5 minutes in the PM peak
- Drive time: 11 minutes
- Total evacuation time: 7 hours in the AM peak and 6 hours in the PM peak.

As Appin Road is progressively widened, this travel time will reduce.

If Bulli-Appin Road was open and able to be used for the evacuation, the additional road capacity with two evacuation routes would reduce evacuation times to **3.8 hours in the AM peak** and **4.3 hours in the PM peak**.

### 4.4.4 Scenario 2b – evacuating Stage 2 with Appin Road widened from North Appin north to Gilead

Evacuating all of Stage 2 with regular traffic on Appin Road and travelling to and from Stage 2A (assumed to be unaffected) would include the following combination of travel time components:

- Mid-block capacity: 3.3 hours in the AM peak and 2.7 hours in the PM peak.
- Intersection delay: additional 1 minute
- Drive time: 7 minutes
- Total evacuation time: 3.5 hours in the AM peak and 2.9 hours in the PM peak.

If Bulli-Appin Road was open and able to be used for the evacuation, the additional road capacity with two evacuation routes would reduce evacuation times to **2.5 hours in the AM peak** and **2.6 hours in the PM peak**.

### 4.4.5 Scenario 3a – evacuating entire development, Appin, South Gilead and Gilead

Evacuating the Appin and North Appin Precinct, Appin, South Gilead and Gilead would involve a substantial number of people and vehicles moving, which is likely to take considerable time.

- Section 4.1.4 indicates that the time to evacuate the development based on the mid-block road capacity is 8.1 hours.
- Section 4.2.4 intersection modelling added up to an additional 3 minutes.
- Section 4.3 indicates a maximum drive time of up to 15 minutes.

The combined evacuation time is likely to be around 8.5 hours.

If Bulli-Appin Road and or the East-West Connection Road were open and able to be used for the evacuation, the evacuation times would reduce to as little as **4.5 hours**. Given the timeframes in volumes to move so many people, it is likely that these additional evacuation routes will be available, at lease for part of the evacuation process, providing extra road capacity and reducing the evacuation times.

# 5 Conclusions

WSP Australia has been commissioned by Walker Corporation to undertake a traffic analysis of the potential evacuation of the Appin and North Appin Precinct in the event of a bushfire as a strategic planning stage for the proposed rezoning of the Appin and North Appin Precinct. It is prepared in consideration of the requirements of *Planning for Bush Fire Protection* (NSW RFS, November 2019). The assessment has included analysis of the mid-block capacity of the roads used to evacuate vehicles, the potential delays at key intersections along the evacuation route and the drive time to evacuate the area, using an estimate of conditions at various stages between 2019 and the completion of the development.

The assessment has estimated the following times for evacuation scenarios based on the development stage being evacuated, number of evacuation routes used and the time of the evacuation:

- Option 1a evacuating dwellings within 100 m of an APZ to a neighbourhood safe place location
  - Travel times of between 5 and 10 minutes to a neighbourhood safe place location
- Option 1b evacuating dwellings within 100 m of an APZ to Campbelltown
  - Travel times of between 50 minutes and 2 hours minutes to Campbelltown
- Option 2a evacuating Stage 1:
  - Appin Road north only: 7 hours in the AM peak and 6 hours in the PM peak
  - Appin Road north and east: 3.8 hours in the AM peak and 4.3 hours in the PM peak
- Option 2b evacuating Stage 2:
  - Appin Road north only: 3.3 hours in the AM peak and 2.7 hours in the PM peak
  - Appin Road north and east: 2.5 hours in the AM peak and 2.5 hours in the PM peak
- Option 3a evacuating whole development:
  - Appin Road north only: 8.5 hours
  - Appin Road north and east: 6.2 hours
  - Appin Road north plus East-West Connection Road to west: 5.1 hours
  - Appin Road north and east plus East-West Connection Road to west: 4.3 hours.

Given the timeframes in volumes to move so many people, it is likely that more than one evacuation route will be available, at least for part of the evacuation process, providing extra road capacity and reducing the evacuation times.

It is noted that the following could improve the evacuation times:

- Reduced traffic on the road network, from people avoiding the bushfire zone, would reduce the volume of general traffic on the road network, preserving more space for evacuating vehicles.
- The use of emergency services to manage the evacuation would significantly enhance the chance of an orderly evacuation and avoiding panic from those that are last to leave.
- The provision of appropriate “neighbourhood safe place” areas within the development will reduce the pressure on the road network, reducing evacuation time for those who choose to leave.

Based on the worst case scenario assessment, it is concluded that, subject to timely decisions to commence the evacuation, the proposed road network has sufficient capacity to facilitate the evacuation of the number of residents planned in the Appin and North Appin Precinct, identifying that the primary evacuation route north to Campbelltown (subject to the prevailing bushfire conditions). The use of multiple evacuation routes for some or all of the evacuation would significantly reduce the evacuation times by up to a half.

This report comprises a desktop study to inform broader strategic planning of the Appin and North Appin Precinct and makes no comment or judgement on the risk to or safety of residents evacuating in the event of a bushfire. Limitations and exclusions to this traffic analysis, and their implications, should be fully understood when considering the findings.

# 6 Limitations

This Report is provided by WSP Australia Pty Limited (*WSP*) for Walker Corporation (*Client*) in response to specific instructions from the Client and in accordance with WSP's proposal dated 10 June 2022 and agreement with the Client dated 24 August 2020 (*Agreement*).

## 6.1 Permitted purpose

This report is provided by WSP for the purpose described in the Agreement and no responsibility is accepted by WSP for the use of the Report in whole or in part, for any other purpose (*Permitted Purpose*).

The traffic analysis contained in the report is a land use planning exercise for the Appin and North Appin Precinct as required by *Planning for Bush Fire Protection* (NSW RFS, November 2019) and is not intended to advise on emergency service planning or procedures in the event of a bushfire.

## 6.2 Qualifications and assumptions

The services undertaken by WSP in preparing this Report were limited to those specifically detailed in the Report and are subject to the scope, qualifications, assumptions and limitations set out in the Report or otherwise communicated to the Client.

Except as otherwise stated in the Report and to the extent that statements, opinions, facts, conclusion and/or recommendations in the Report (*Conclusions*) are based in whole or in part on information provided by the Client and other parties identified in the report (*Information)*, those Conclusions are based on assumptions by WSP of the reliability, adequacy, accuracy and completeness of the Information and have not been verified. WSP accepts no responsibility for the Information.

WSP has prepared the Report without regard to any special interest of any person other than the Client when undertaking the services described in the Agreement or in preparing the Report.

Limitations of the traffic analysis are listed below, noting this may not be an exhaustive list.

- The study assesses the ability of Appin Road, Bulli-Appin Road and the potential new East-West Connection Road to accommodate residents evacuating from the Appin and North Appin Precinct and broader population catchment traffic. It does not assess broader regional traffic constraints.
- It is noted that there are no criteria documented by Federal or State agencies with regards to defining a "successful" evacuation, and as such comment on the performance of any such evacuation is subjective, based on input from all available stakeholders and tailored to the subject study area.
- The traffic analysis has been undertaken as a desktop study only and relies upon data from others. No field investigations or verification has been undertaken on this data.
- The traffic analysis makes no comment or judgement on the risk to or safety of residents evacuating in the event of a bushfire.
- While the study does not assume emergency services assistance will be enacted in the event of a bushfire, it is acknowledged that subject to the availability of emergency services, a managed evacuation is more likely to reduce interruptions during the evacuation process, reducing the evacuation time.
- The traffic analysis assumes adherence to emergency warning messages; however, it is acknowledged that people's response to these messages can be varied.

- No consideration is given to unpredictable events which may impact upon the road network's ability to cater for evacuating traffic demand, such as car crashes, broken down vehicles, fallen trees or power lines, utility failures or the like.
- The impact of smoke on driver behaviour is not considered or factored into assessment.
- No businesses, visitors or other traffic generators have been considered as contributing evacuation traffic.
- The analysis does not comment on the ability of firefighting vehicles to access properties, fire fronts or water supply in the Appin and North Appin Precinct.
- Bushfire behaviour is highly variable and dependent upon multiple factors which are difficult to foresee. This assessment uses available information to test a unique set of conditions that are considered representative of how an event may unfold, though does not constitute a prediction, nor claim to be wholly encompassing of the potential outcomes of any bushfire event in the study area.

## 6.3 Use and reliance

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## 6.4 Disclaimer

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# Appendix A

Intersection performance criteria

# A1 Intersection performance criteria

## *Level of Service (LoS)*

Level of Service (LoS) is a basic performance parameter used to describe the operation of an intersection. Levels of service range from A (indicating good intersection operation) to F (indicating over-saturated conditions with long delays and queues). At signalised intersections, the LoS criteria are related to average intersection delay (seconds per vehicle). At priority controlled (give-way and stop controlled) and roundabout intersections, the LoS is based on the modelled delay (seconds per vehicle) for the most delayed movement. The descriptions shown in Table A.1 are for everyday normal operation. They do not apply to an evacuation scenario where traffic conditions will be atypical. They are included for comparison to normal operation only.

Table A.1 Level of Service criteria for intersections for typical everyday operation

| Level of Service | Average Delay (sec/veh) | Traffic Signals, Roundabout | Give Way and Stop Signs |
|---|---|---|---|
| A | Less than 14 | Good operation | Good operation |
| B | 15 to 28 | Good with acceptable delays and spare capacity | Acceptable delays and spare capacity |
| C | 29 to 42 | Satisfactory | Satisfactory, but accident study required |
| D | 43 to 56 | Operating near capacity | Near capacity and accident study required |
| E | 57 to 70 | At capacity. At signals, incidents would cause excessive delays. Roundabouts require other control mode. | At capacity; requires other control mode |
| F | Greater than 71 | Unsatisfactory with excessive queuing | Unsatisfactory with excessive queuing; requires other control mode |

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

## *Degree of saturation (DoS)*

The Degree of Saturation (DoS) is the ratio of demand flow to capacity, and therefore has no unit. As it approaches 1.0, extensive queues and delays could be expected. For a satisfactory situation, DoS should be less than the nominated practical degree of saturation, usually 0.9. The intersection DoS is based on the movement with the highest value.

## *Average vehicle delay*

This is the difference between interrupted and uninterrupted travel times through the intersection and is measured in seconds per vehicle. At signalised intersections and roundabouts, the average intersection delay is usually reported. At priority controlled intersections, the average delay for the most delayed movement is usually reported.

## *Queue length*

Queue length is measured in metres reflecting the number of vehicles waiting at the stop line and is usually quoted as the 95$^{th}$ percentile back of queue, which is the value below which 95 per cent of all observed queue lengths fall. It reflects the number of vehicles per traffic lane at the start of the green period, when traffic starts moving again after a red signal. The intersection queue length is usually taken from the movement with the longest queue length.