

Ingleside Precinct

Bushfire Traffic Analysis

PREPARED FOR:

NSW Department of Planning, Industry and Environment

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ABN: 20 770 707 468

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Executive Summary

This Traffic Analysis uses the AECOM Study as a basis for assessing the ability of existing and proposed new residents of the Ingleside Precinct to evacuate in the event of a bushfire, concluding that those evacuating southwards along Powderworks Road will likely be able to do so satisfactorily under assumed evacuation conditions.

Assessment assumes full, off-site evacuation with no use of Evacuation Centres or Neighbourhood Safer Places. Evacuation is assumed to be triggered by commonly used community evacuation triggers such as emergency radio broadcasts, Fires Near Me application or Emergency Service authorised text messages.

Physical assistance is not provided in the vicinity of the Ingleside Precinct and traffic generated by the proposed development uplift does not evacuate via routes reliant upon any physical, in-person presence of emergency services. To test the efficacy of assistance in catering for the existing wider population catchment, physical assistance is assumed to the east of the study area towards the Mona Vale town centre.

This Traffic Analysis highlights the nuance and definition of the term ‘assistance’ in the context of emergency services intervention in the event of a bushfire. Communication of findings prior to this Traffic Analysis broadly advised ‘assistance’ had been assumed in assessing development uplift of the Ingleside Precinct. Crucially however, physical, in-person emergency services assistance was only assumed at locations to test the efficacy of evacuation of the existing population catchment and not to support that of the Ingleside Precinct.

This nuanced explanation and definition of the term ‘assistance’ is important, and explains potential confusion caused by previous and current, updated reporting of the findings documented in this Traffic Analysis.

The precinct planning process has undertaken regular engagement with key stakeholders to inform the broader precinct planning methodology, including the NSW Department of Planning, Industry and Environment, Northern Beaches Council, NSW Rural Fire Service, NSW Police Force, Local Emergency Management Committee, Transport for NSW, Traffic Management Centre, National Parks and Wildlife Service and Fire & Rescue NSW.

The Traffic Analysis assumes remote assistance, in the form of emergency warning messages via a variety of communication channels, is diligently adhered to by existing and proposed residents of the Ingleside Precinct, with no physical assistance in the form of management of traffic control points provided to assist or ensure evacuation of these residents.

The primary evacuation route for existing and proposed residents of the Ingleside Precinct has been identified through consultation with stakeholders, including emergency services, as southbound along Powderworks Road, given the proximity of large section of the Mona Vale Road state corridor to bushfire prone land.

The AECOM Study therefore tested evacuation via this route and identified the intersection with Kalang Road to be the limiting pinch point at which the progression of traffic travelling southwards along Powderworks Road would be constrained. Conservative analysis of performance at this intersection identified that traffic generated by up to 800 – 1,000 additional dwellings could satisfactorily use this route when assessed against predefined criteria.

The capacity of this pinch point remains the same irrespective of the presence or scale of any development uplift, as capacity is a parameter determined by functions independent to the number of dwellings.

Assessment determines the proposed 980 additional dwellings of the Structure Plan, located south of Mona Vale Road in the vicinity of Powderworks Road, will generate 1,222 vehicle trips in the event of a bushfire evacuation. This determination is based on assumptions informed by demographic and behavioural characteristics of the population catchment, as informed by 2016 census data and behavioural research.

The siting of development around the Powderworks Road corridor, south of Mona Vale Road, is informed by stakeholder consultation and a preference to locate potential uplift suitably close to the primary evacuation route, that being southwards via Powderworks Road. Development north of Mona Vale Road is not considered for several reasons, though primarily given access to the evacuation route would likely require physical, in-person emergency services assistance which cannot be guaranteed.

The Traffic Analysis acknowledges bushfire behaviour is highly variable and dependent upon multiple factors which are difficult to foresee. It uses a wealth of observed input data, research, surveys, and industry expertise 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.

Limitations and exclusions to this Traffic Analysis, and their implications, should be fully understood when considering the findings and next steps.

1. Introduction

1.1. Overview

PDC Consultants has been commissioned by NSW Department of Planning, Industry and Environment (DPIE) to undertake a bushfire traffic analysis (Traffic Analysis) of the revised Ingleside Precinct Structure Plan.

Planning for potential development of the Ingleside Precinct started in 2013, with a draft Land Use and Infrastructure Strategy (Strategy) exhibited for consultation between December 2016 and February 2017. During consultation, submissions were received raising concern over the risk of bushfires in the area.

In response to these submissions and considering the Findings of the NSW Bushfire Inquiry: 1994 Coroner's Report (1994 Bushfire Inquiry), the DPIE further investigated the safety of the Strategy by engaging independent consultants Meridian Urban in 2018 to produce a Bushfire Risk Assessment (Risk Assessment). The conclusion of this Risk Assessment was that the Strategy may expose additional residents to unacceptable bushfire risks. Accordingly, DPIE and Northern Beaches Council (Council) determined that rezoning should not proceed on the exhibited Strategy.

In order to further assess bushfire risks and the potential for existing and potential new residents of the Ingleside Precinct and surrounding area to evacuate in the event of a bushfire, DPIE commissioned AECOM and Meridian Urban to develop a bushfire traffic study of the Ingleside Precinct (AECOM Study).

This study has since been completed and is under internal governmental review. Its findings have led to a redesign of the Ingleside Precinct to provide approximately 800 – 1,000 residential dwellings, located south of the Mona Vale Road state corridor near Powderworks Road.

To support the revised precinct plan, DPIE requested assessment into the ability for new residents of the revised Structure Plan to evacuate in the event of a bushfire. This Traffic Analysis follows on from the AECOM Study by further assessing the methodology and findings in the context of the revised Structure Plan.

1.2. Stakeholder Engagement

The planning process for the Ingleside Precinct has been undertaken with input from key stakeholders throughout, to ensure a robust and coordinated outcome that responds to the requirements of those with vested interest in the development.

The Risk Assessment and AECOM Study were commissioned by DPIE, with feedback and inputs from NSW Rural Fire Service (RFS), NSW Police Force, Council, Local Emergency Management Committee (LEMC), Transport for New South Wales (TfNSW) and Traffic Management Centre (TMC).

This Traffic Analysis continued engagement efforts, with further input, additional to and including the aforementioned, provided by DPIE Planning Delivery Unit (PDU), National Parks and Wildlife Service (NPWS) and Fire & Rescue NSW at meetings held 29/10/20, 05/11/20, 17/11/20 and 19/11/20.

1.3. Structure of this Report

This report documents the findings of our Traffic Analysis and is structured as follows:

- Section 2: Identifies the context in which the Traffic Analysis has been undertaken.
- Section 3: Discusses the AECOM Study methodology and findings.
- Section 4: Describes the proposed development.
- Section 5: Discusses the Traffic Analysis methodology.
- Section 6: Presents the findings of the Traffic Analysis.
- Section 7: Presents the Traffic Analysis limitations and exclusions.
- Section 7: Presents the overall study conclusions.

1.4. References

In preparing this report, reference has been made to the following documents, guidelines, and standards:

- Bushfire Risk Assessment for the Ingleside Planned Precinct, Meridian Urban, 2018 (Risk Assessment).
- Ingleside Bushfire Evacuation Study: Traffic Assessment, AECOM and Meridian Planning 2019 (AECOM Study).
- Preliminary Bushfire Risk & Development Feasibility Review, Eco Logical, 2020 (Eco Logical Review).
- Strategic Bushfire Study, Eco Logical, 2020 (Eco Logical Study).
- Rural Fires Act 1997 No 65, NSW Government.
- Planning for Bushfire Protection, NSW Rural Fire Service (RFS) November 2019 (PBP 2019).
- State Emergency Management Plan, Evacuation Management Guidelines, NSW Government, 2014 (SEMP 2014).
- State Bush Fire Plan, A Sub Plan of the State Emergency Management Plan, NSW Government, 2017 (SBFP 2017).
- Public Information Services Function Area Supporting Plan, NSW Government, 2019 (PISFASC 2019).
- Community Preparedness and Response to the 2017 New South Wales Bushfires, Whittaker and Taylor February 2018 (Whittaker and Taylor).
- Final Report of the NSW Bushfire Inquiry, Owens and O’Kane, 2020 (2020 Bushfire Inquiry).
- Findings of the NSW Bushfire Inquiry: 1994 Coroner’s Report (1994 Bushfire Inquiry).

- Australian Bureau of Statistics Quick Stats 2016 (ABS Quick Stats).
- Austroads Guide to Traffic Management Part 3 Transport Study and Analysis Methods, Austroads April 2020 (Austroads Guide).
- RMS¹ Guide to Traffic Generating Development 2002 (RMS Guide).
- RMS¹ Technical Direction TDT 2013/04a - Guide to Traffic Generating Developments, Updated Traffic Surveys (RMS Guide Update).

¹ Roads and Maritime Services (RMS) has joined with Transport for NSW, with reference to RMS now taken legally to automatically mean TfNSW.

2. Study Context

2.1. Planning for Bushfire Protection 2019

2.1.1. Strategic Planning

A significant revision to PBP 2019 from its 2006 predecessor is the introduction of a new section focussed on strategic planning. Section 4.1 of PBP 2019 notes that land use planning can be an effective tool in minimising or avoiding the impact of natural hazards such as bushfire through directing development away from inappropriate and constrained lands.

PBP 2019 also notes that services and infrastructure that facilitate effective suppression of bushfires need to be provided for during the planning stage. It advocates consideration of firefighting access and evacuation potential of traffic volumes generated in the event of a bushfire and the potential for these evacuation routes to be non-trafficable during a bushfire event.

Strategic planning principles are outlined in PBP 2019 along with identification of areas in which inappropriate development should be avoided through strategic planning.

Section 4.2 of PBP 2019 states that strategic development proposals in bushfire prone areas require the preparation of a Strategic Bushfire Study. This Strategic Bushfire Study has been developed by Eco Logical and should be read in conjunction with this Traffic Analysis. PBP 2019 states that as a minimum, the components outlined in **Table 1** regarding traffic must be included.

Table 1: Bushfire Strategic Study Components

ISSUE	DETAIL	ASSESSMENT CONSIDERATIONS
Access and egress	A study of the existing and proposed road networks both within and external to the masterplan area or site layout.	<ul style="list-style-type: none"> The capacity for the proposed road network to deal with evacuating residents and responding emergency services, based on the existing and proposed community profile; The location of key access routes and direction of travel; and The potential for development to be isolated in the event of a bushfire.

2.1.2. Residential and Rural Residential Subdivisions

As in PBP 2019, for the purposes of this Traffic Analysis, subdivision of land is the creation of lots for residential or rural residential properties.

The subdivision stage of land development provides an opportunity for early siting and access for the incorporation of bushfire protection measures. Section 5 of PBP 2019 reiterates the importance of considering access and egress within the developable land and along the adjoining public road system, as the creation of developments in areas surrounded by bushlands pose significant challenges from a bushfire risk perspective.

Table 5.3b of PBP 2019, repeated below as **Table 2** for reference, identifies several performance criteria and acceptable solutions to provide safe operational access to structures and water supply for emergency services, while residents are seeking to evacuate from an area.

Table 2: Performance Criteria and Acceptable Solutions for Access

PERFORMANCE CRITERIA	ACCEPTABLE SOLUTIONS
Firefighting vehicles are provided with safe, all-weather access to structures. This is achieved where:	<ul style="list-style-type: none"> Property access roads are two-wheel drive, all-weather roads; Perimeter roads are provided for residential subdivisions of three or more allotments; Subdivisions of three or more allotments have more than one access in and out of the development; Traffic management devices are constructed to not prohibit access by emergency services vehicles; Maximum grades for sealed roads do not exceed 15 degrees and an average grade of not more than 10 degrees or other gradient specified by road design standards, whichever is the lesser gradient; All roads are through roads; Dead end roads are not recommended, but if unavoidable, are not more than 200 metres in length, incorporate a minimum 12 metres outer radius turning circle, and are clearly sign posted as a dead end; Where kerb and guttering is provided on perimeter roads, roll top kerbing should be used to the hazard side of the road; Where access/egress can only be achieved through forest, woodland and heath vegetation, secondary access shall be provided to an alternate point on the existing public road system; and One way only public access roads are no less than 3.5 metres wide and have designated parking bays with hydrants located outside of these areas to ensure accessibility to reticulated water for fire suppression.
The capacity of access roads is adequate for firefighting vehicles.	<ul style="list-style-type: none"> The capacity of perimeter and non-perimeter road surfaces and any bridges/causeways is sufficient to carry fully loaded firefighting vehicles (up to 23 tonnes); bridges/ causeways are to clearly indicate load rating.
There is appropriate access to water supply.	<ul style="list-style-type: none"> Hydrants are located outside of parking reserves and road carriageways to ensure accessibility to reticulated water for fire suppression; Hydrants are provided in accordance with the relevant clauses of AS 2419.1:2005 - fire hydrant installations system design, installation, and commissioning; and There is suitable access for a category 1 fire appliance to within 4m of the static water supply where no reticulated supply is available.
For perimeter roads, access roads are designed to allow safe access and egress for firefighting vehicles while residents are evacuating as well as providing a safe operational environment for emergency service personnel during firefighting and emergency management on the interface.	<ul style="list-style-type: none"> Are two-way sealed roads; Minimum 8m carriageway width kerb to kerb; Parking is provided outside of the carriageway width; Hydrants are located clear of parking areas; Are through roads, and these are linked to the internal road system at an interval of no greater than 500m; Curves of roads have a minimum inner radius of 6m; The maximum grade road is 15 degrees and average grade of not more than 10 degrees; The road crossfall does not exceed 3 degrees; and A minimum vertical clearance of 4m to any overhanging obstructions, including tree branches, is provided.

PERFORMANCE CRITERIA	ACCEPTABLE SOLUTIONS
For non-perimeter roads, access roads are designed to allow safe access and egress for firefighting vehicles while residents are evacuating.	<ul style="list-style-type: none"> • Minimum 5.5m carriageway width kerb to kerb; • Parking is provided outside of the carriageway width; • Hydrants are located clear of parking areas; • Roads are through roads, and these are linked to the internal road system at an interval of no greater than 500m; • Curves of roads have a minimum inner radius of 6m; • The road crossfall does not exceed 3 degrees; and • A minimum vertical clearance of 4m to any overhanging obstructions, including tree branches, is provided.
For property access, firefighting vehicles can access the dwelling and exit the property safely.	<ul style="list-style-type: none"> • There are no specific access requirements in an urban area where an unobstructed path (no greater than 70m) is provided between the most distant external part of the proposed dwelling and the nearest part of the public access road (where the road speed limit is not greater than 70kph) that supports the operational use of emergency firefighting vehicles; and • In circumstances where this cannot occur, refer to the rural property access requirement sets out in the 2019 PBP.

Many of the measures identified in **Table 2** relate to civil design of road infrastructure within the developable land, in this case the Ingleside Precinct. Features such as the provision and location of access roads, geometric considerations such as width and curvature and location of road with respect to the water supply are all to be contemplated during strategic and concept design stages.

This Traffic Analysis does not assess whether the components identified in **Table 2** have been adhered to, as the Structure Plan is not yet developed to the detail to which full assessment can be undertaken. This Traffic Analysis does however recognise the importance of these measures and advocates their implementation in development of the Structure Plan for the Ingleside Precinct.

2.2. Emergency Warning and Public Information (Remote Assistance)

2.2.1. Process Overview

During stakeholder engagement discussed in Section 1.2, emergency services and stakeholder representatives made clear that proposed development uplift of the Ingleside Precinct could not be reliant upon physical presence of emergency services personnel to assist traffic departing the area.

It is therefore important to understand the remote assistance the existing and proposed population of the area would receive in the event of a bushfire, in the form of emergency warnings and public information.

Section 8 of the State Emergency Management Plan, Evacuation Management Guidelines 2014 (SEMP 2014) identifies the five-phase evacuation process and is provided as **Figure 1** for reference.

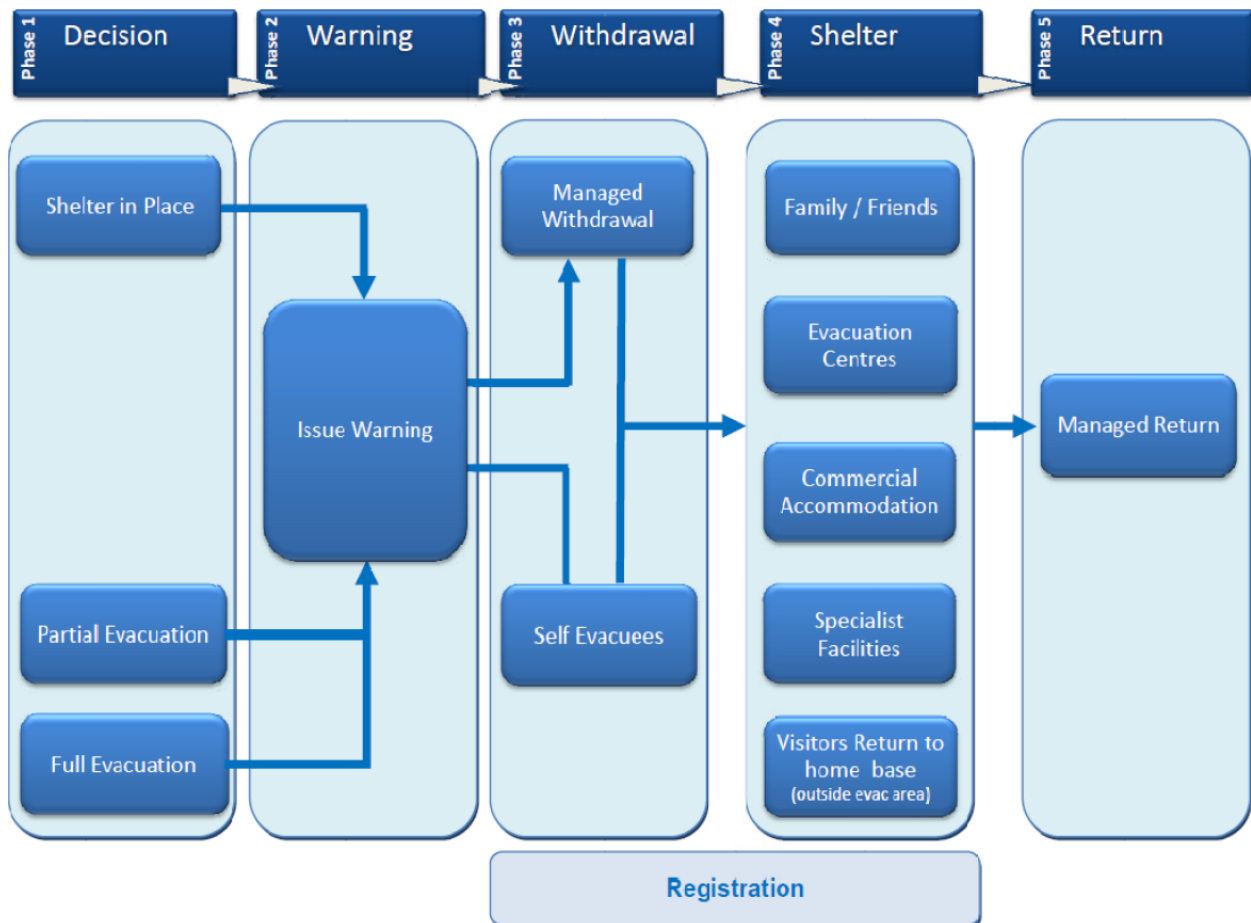


Figure 1: SEMP 2014 Evacuation Process

Phase 2 of the process is dissemination of emergency warnings, which refers to communications from emergency management agencies to the community to inform them of an impending emergency and / or provide them with information or advice regarding the actions they are required to take during an emergency.

Messages will be either a warning to affected people that they prepare to evacuate or a directive that they evacuate immediately or within a given timeframe and may evolve as the emergency or evacuation unfolds.

One important factor to consider is the interface of the evacuation process with human behaviour and decision-making, which become strained in an emergency. Research by Steve Oppen of the NSW State Emergency Service (Oppen 2004 & 2014) identifies that individuals will generally seek to fact-check information or get second opinions to confirm the veracity of the warning messages.

Human processing of important information in an emergency can become illogical or irrational, as people become confused or panicked. Individuals will seek to confirm evacuation warning information with neighbours, consult social media, online news websites, mobile phone apps or other sources. All of this occurs before a decision is made to evacuate.

2.2.2. Warning Message Content and Communication

Warning messaging must follow clear principles, as detailed in Section 10.1 of SEMP 2014, to maximise the responsiveness to an evacuation, as follows:

- Be clear and succinct.
- Be delivered via a number of modes and channels with consideration to the community.

This includes community engagement and liaison prior to an emergency to ensure residents are informed of and aware of such threats, via such means as community meetings, newsletters, information booths, use of social, print, audio and visual media, door to door and telecommunications. The NSW RFS conducts regular community engagement including an annual public information prior to and during the bushfire danger period, providing advice to individuals and businesses on measures to prepare for a bushfire. This engagement is supported by an extensive suite of guidelines and public information to prepare and address the threat of bushfires (State Bush Fire Plan, A Sub Plan of the State Emergency Management Plan, 2017 (SBFP 2017)).

During an emergency event, warnings may be issued to landline or mobile telephones, using a system called Emergency Alert. These messages can be sent to a designated warning area based on landline locations, based on a mobile phone's billing address or based on a mobile phone's last known location². Further communication channels are listed in Section 8.3 of the Public Information Services Functional Area Supporting Plan (PISFASP 2019), with some examples listed below:

- Commercial tv and radio stations and broadcast interruptions
 - Social media platforms
 - Standard Emergency Warning Signal (SEWS)
 - SMS or telephone message systems
 - Websites
 - Phone applications (such as Fires Near Me or Emergency+)
- Use plain and consistent language (e.g., be free of jargon and euphemisms).
 - Translation of key messages.
 - Information for individuals who choose to remain in place.
 - Include explicit information in relation to the evacuation and actions required.

Examples of the information to be included in emergency messaging can be found in Annex C of SEMP 2014 and include the following:

- When to start and / or when to be out by
- How to leave (transport, assistance provided, assembly areas, evacuation routes)
- Where to go (Evacuation Centre location, family / friends etc)

² <https://www.rfs.nsw.gov.au/plan-and-prepare/alert-levels/telephone-warnings>

2.2.3. Supporting Organisations

SBFP 2017 notes Section 9 of the Rural Fires Act 1997 provides that the NSW RFS is responsible for issuing public warnings and alerts about bushfires and bushfire threats in NSW for the purpose of protecting life and property, irrespective of jurisdictional area. Other agencies may assist with response and associated operations, such as evacuation & public information, through the provision of staff and resources.

The NSW RFS may establish a joint media information centre drawing personnel from participating and supporting agencies during periods of significant fire activity. It provides a single source of bush/grass fire information across the State through the NSW RFS public website and social media platforms, regardless of which agency is combating the fire. Incidents entered into the ICON system will be displayed on the NSW RFS website and Fires Near Me app.

The NSW RFS is responsible for issuing advice (including Emergency Alert) for any fire at Emergency Warning level that must be telephoned through to the OpsCen. Facilities for the media are provided within the OpsCen to ensure the timely provision of public information and safety messages to the community during bush/grass fires.

A full list of participating and supporting organisations is provided as Annex 1 of PISFASP 2019.

2.3. Withdrawal and Physical Assistance

2.3.1. Overview

Evacuation is defined in SEMP 2014 as *“a risk management strategy that may be used to mitigate the effects of an emergency on a community. It involves the movement of people to a safer location and their return. For an evacuation to be effective, it must be appropriately planned and implemented.”*

Withdrawal is the orderly removal of people from the defined area of risk, during which the combat agency may liaise with and request assistance to coordinate support and logistics. The combat agencies with legislated authority to order an evacuation include NSW Police Force, Fire & Rescue NSW, NSW RFS or NSW State Emergency Service (SES).

SEMP 2014 notes that despite it being desirable to evacuate people from an impacted area, it may be safer to leave the population in-situ. During evacuation, affected residents are encouraged to use their own methods of transportation where appropriate.

2.3.2. Management of Traffic Control Points (Physical Assistance)

The ‘Standing Operating Procedures – Traffic Control Points During Emergencies’ deals exclusively with the staffing and operation of Traffic Control Points on roads and road related areas during an emergency. This document is administered by the NSW Police Force and recognises two access levels being 'No Entry' and 'Restricted Entry'.

The level of access at a specific point will be determined by the combat agency responsible for the emergency in consultation with the NSW Police Force. Traffic Control Points are to be staffed by NSW Police Force and / or the responsible road owner / authority during an emergency in the first instance. Where appropriate, volunteers from the NSW RFS and NSW SES may assist in this role at the request of the NSW Police Force.

3. AECOM Study

3.1. Methodology

The AECOM Study was commissioned by DPIE to assess the potential impact of bushfire on road network performance during an evacuation and strategy for new and existing residents of the Ingleside Precinct and surrounding population catchment.

The population catchment considered spanned from Duffys Forest in the west, to Newport in the north east inclusive of Church Point and all residential suburbs in between, through to Woorarra and North Narrabeen in the south east, broadly aligning with that of the Risk Assessment.

It was developed using parameters agreed in consultation with several stakeholders and representatives of NSW RFS, NSW Police Force, DPIE, Council, LEMC, TfNSW and TMC.

Representatives of these stakeholders provided inputs, feedback, and concurrence, with findings presented and discussed and inputs on specific assumptions or decisions, such as evacuation routeing for suburbs within the study area, agreed upon.

Within the AECOM Study, full off-site evacuation of the Ingleside Precinct was considered as a worst-case scenario to identify the limit to new development in the precinct. The study adopted a bespoke approach to determining traffic demand in the event of a bushfire, through desktop study of available literature, research, findings, and liaison with the stakeholders. This included consideration of:

- Existing population catchment to consider within the study area.
- The road network upon which traffic will evacuate.
- Demographics of the study area as informed by 2016 census data.
- Existing traffic conditions in the study area.
- The day of the week and time of day which would result in worst-case traffic conditions during an evacuation.
- Seasonal variation of residents and traffic in the study area.
- Likely bushfire ignition locations.
- Worst-case conditions supporting the bushfire spread, such as weather conditions, vegetation, and fuel load.
- The resultant time from bushfire ignition to impact at the study area, referred to as the evacuation window.
- Impact of bushfire and smoke on road closures.
- Vehicle ownership rates of the existing population catchment.

- Dwelling occupancy of the existing population catchment.
- Human behavioural response to bushfires which informs the temporal evacuation profile.
- Proportion of residents likely to stay and defend their property.
- Behavioural response of those currently on the road network and of residents not in the study area at the time a bushfire event occurs.
- Evacuation routeing.
- Resident response to emergency warnings (remote assistance) and community messaging.
- Emergency services response to bushfire evacuation, including road closures and manual override of traffic signals.

Advice and input provided by subject matter experts were used to develop a detailed evacuation strategy. Three scenarios were assessed:

Scenario 1 Unassisted evacuation of the existing population catchment.

Scenario 2 Assisted evacuation of the existing population catchment.

Scenario 3 Assisted evacuation of the existing population catchment plus development uplift.

The conditions and inputs of each scenario were those guided via the engagement and consultation with stakeholders throughout the study. The outcomes of one scenario drove what was assessed in the next, for example there would have been no need to assess assisted evacuation if Scenario 1 confirmed it was not necessary.

3.2. Bushfire Conditions

The AECOM Study considered three forest fire danger index (FFDI) weather scenarios of FFDI 64 (reflective of the 1994 Cottage Point fires), 77 and 116 (being the worst-case FFDI recorded in the area).

Whilst FFDI 116 is a worst-case fire weather scenario, it may not represent a worst-case scenario from a traffic perspective. This is because more people may remain home in advance of an FFDI 77 bushfire than FFDI 116, given significant pre-warning that would occur for higher FFDI conditions, which in turn would lead a proportion of the population to leave the area in advance of the fire arriving, and thus a more temporally spread traffic profile.

This view was endorsed by project stakeholders and emergency services during stakeholder engagement, and thus the AECOM Study considers more people would need to evacuate during a short period of time under FFDI 77 fire weather conditions.

It is noted that under lower FFDI weather conditions it is unlikely such a large population catchment as that assessed by the AECOM Study would be required to evacuate. The assessment is therefore considered very conservative, given it assumes such a significant swath of the existing and proposed population catchment would be required to evacuate with such little pre-warning and emergency messaging.

3.3. Assisted and Unassisted Evacuation

The terms ‘unassisted’ and ‘assisted’ relate to emergency services intervention. Unassisted evacuation assumes residents of the existing and proposed population catchment receive no emergency warning messages and have little knowledge of the location, scale, or impact of the bushfire threat. They are however all routed eastwards to evacuate via Pittwater Road, on the basis bushfire has impacted Mona Vale Road west of McCarrs Creek Road, to ensure a conservative scenario in which evacuation routes are limited.

Assisted evacuation assumes a degree of emergency services intervention and was reflected in the AECOM Study in two key forms:

- Remote assistance via emergency warnings and public information (Section 2.2).
- Physical assistance via in-person management of traffic control points (Section 2.3.2).

3.4. Findings

3.4.1. Scenario 1

In assessing a combination of worst-case assumptions and unassisted off-site evacuation in Scenario 1, the AECOM Study found that evacuation of the existing population catchment in the event of a bushfire would result in significant congestion along Mona Vale Road and local roads in the event no emergency services response or assistance was provided.

The assumptions adopted in Scenario 1 were unrealistically conservative to determine an absolute worst-case against which comparison could be made. These assumptions led to congestion originating at the intersection of Mona Vale Road with Pittwater Road which extended westwards along Mona Vale Road; however, critically, no congestion was observed as originating from the Powderworks Road / Kalang Road intersection, or indeed anywhere along Powderworks Road.

3.4.2. Scenario 2

Scenario 2 therefore tested the efficacy of road network performance under an assisted evacuation of the existing population catchment, that is incorporating remote and physical emergency services assistance to aid evacuation in the area, whilst assuming no residential uplift of the Ingleside Precinct.

This assistance was in the form of remote emergency warnings and public information, as well as physical assistance at certain locations as advised by emergency services. It is crucial to note that physical assistance was largely assumed to assist evacuation of the existing population catchment, which generates congestion towards the east of the study area at the intersection of Mona Vale Road with Pittwater Road. Little to no physical assistance was assumed in the vicinity of the Ingleside Precinct.

Assessment of this scenario confirmed that the broader congestion across the study area, resulting largely from the existing population catchment, is significantly reduced if measures advised by emergency services were enacted to assist evacuation of the existing population catchment.

3.4.3. Scenario 3

As such, Scenario 3 replicated Scenario 2 and assessed an iterative increase in development within the Ingleside Precinct, south of Mona Vale Road in the vicinity of Powderworks Road, until pre-determined criteria were met. These criteria, agreed with DPIE, sought to identify the number of dwellings able to:

- Join the network from a side arm directly onto Powderworks Road.
- Evacuate southbound only.
- Not result in queuing back along Powderworks Road that affected traffic along Mona Vale Road.

The assumption of evacuation routeing southbound only along Powderworks Road was a result of two key earlier findings and inputs to the Scenario. Evacuation westwards along Mona Vale Road was prohibited as bushfire modelling identified bushfire impact of the roadway west of Powderworks Road, thus this section of carriageway would be impassable by vehicles.

Evacuation eastwards along Mona Vale Road beyond Lane Cove Road / Manor Road was advised against by emergency services, who noted the undesirability of vehicles using the section of Mona Vale Road between this intersection and Samuel Street / Ponderosa Parade given the potential bushfire exposure, being bound by bushfire prone bushland on either side. As such, the study assumed emergency warning messages would prohibit and discourage this route, thus directing vehicles southbound along Powderworks Road.

The study assumes that emergency warnings would be effectively disseminated per the protocol established in Section 2.2, such that routeing of vehicles southwards along Powderworks Road is advised by remote assistance from emergency services but is not reliant upon physical emergency services intervention at traffic control points.

Scenario 3 is defined as assisted given the remote emergency warning assistance residents of the new development and existing broader population catchment would receive, in addition to some physical assistance which was assumed towards the eastern end of the study area, at Mona Vale Road intersections with Samuel Street / Ponderosa Parade and Pittwater Road.

It is noted that physical assistance assumed in the model was largely assumed to assist evacuation of the existing population catchment and had little to no impact on the ability for residents of the new Ingleside Precinct development to evacuate.

The AECOM Study identified a dwelling yield of 800 – 1,000 new dwellings for the Ingleside Precinct could satisfactorily meet the above-stated criteria under the assumed conditions.

4. Proposed Development

4.1. Ingleside Precinct

Following investigations undertaken to date and in response to Ingleside Precinct's ability to evacuate in the event of a bushfire, the revised Structure Plan focuses development around the Powderworks Road corridor, as illustrated in **Figure 2**.

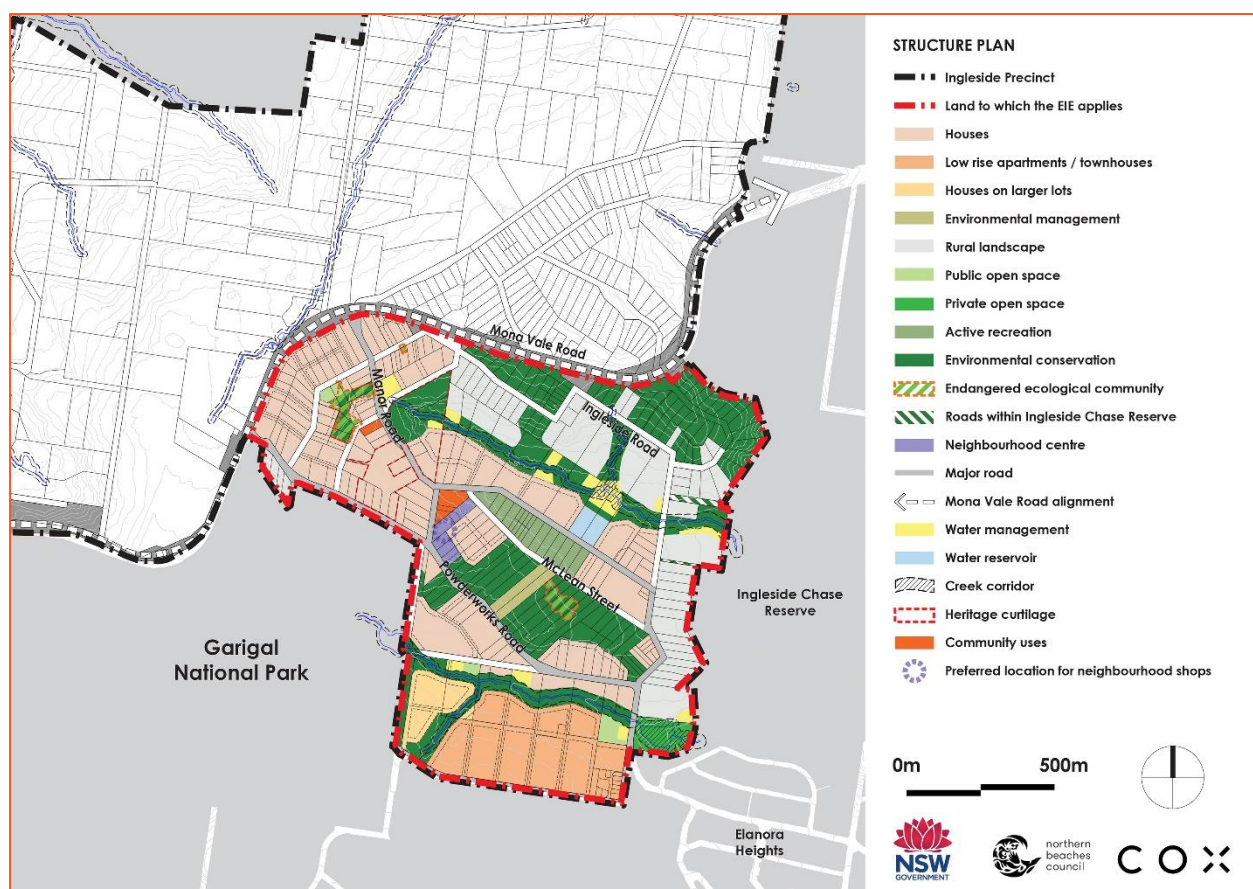


Figure 2: Ingleside Precinct Structure Plan

The AECOM Study discussed in Section 2.2 identified that evacuation along Mona Vale Road of vehicles from any proposed development was undesirable due to it being bordered by bushfire prone land for much of its length, hence development in the revised Structure Plan being situated in close proximity to the key evacuation route of Powderworks Road.

The number of new dwellings proposed within the Structure Plan is 980, supporting an estimated population of approximately 3,200 people. The development covers 153 hectares of land only on the southern side of Mona Vale Road, which contains approximately 130 existing dwellings. No development is proposed north of Mona Vale Road.

4.2. Development North of Mona Vale Road

Throughout the planning process, consideration has been given to development across the broader Ingleside Release Area, illustrated by **Figure 2**, including land north of Mona Vale Road and in the Wirreanda Valley.

Bushfire modelling and assessment undertaken within the AECOM Study identified the likeliest ignition locations as being north west of the Ingleside Precinct in the heavily bushed Ku-ring-gai Chase National Park. This assessment identified the likely fire run under the assessed bushfire conditions as progressing south easterly until it impacted the Ingleside Precinct.

Section 3.4 discusses how liaison with emergency services identified the primary evacuation route for the Ingleside Precinct as being southwards along Powderworks Road, on the basis that travel east and westbound along Mona Vale Road would put residents at risk, given its proximity to bushfire prone land for much of its length.

Evacuation southwards via Powderworks Road is limited by the pinch point priority roundabout with Kalang Road, discussed later in Section 6.2. As such, development to the north of Mona Vale Road was considered as being able to evacuate southwards along Powderworks Road, should residents have the appropriate road connections to access it. Any development north of Mona Vale Road would come at the cost of development south of Mona Vale Road, as the capacity of the limiting pinch point intersection remains the same.

Through discussion with key stakeholders, the AECOM Study adopted an assumption that new development would only occur south of Mona Vale Road for the following reasons:

- The Risk Assessment identifies evacuation of development north of Mona Vale Road would require significant design upgrades to several road corridors including Mona Vale Road, Cabbage Tree Road and Minkara Road for them to function in an emergency.
- It would be situated further away from the impending bushfire threat to the north west.
- It would have easier and faster access to Powderworks Road, the key evacuation route for the area.
- Travel time and distance for evacuation from the south would be lower than that from the north.
- Development north of Mona Vale Road would be required to first cross Mona Vale Road to access Powderworks Road. This inevitably means traversing some distance of Mona Vale Road, which is advised by emergency services as undesirable. It would also increase traffic signal green time required for northern legs of intersections with Mona Vale Road, thus increasing red wait time received by those already evacuating along Mona Vale Road.
- The efficacy of reliance upon warning messages to inform evacuation routeing is reduced for development north of Mona Vale Road, with the project team perceiving an increased risk of residents routeing via means other than Powderworks Road when compared against residents of development south of Powderworks Road.
- No physical assistance at traffic control points is assumed to assist evacuation per emergency services advice.

Following the AECOM Study, development to the north of Mona Vale Road was reconsidered within the revised Structure Plan; however, was ultimately ruled out following feedback obtained from stakeholders, which stated a clear requirement for unassisted evacuation, which could not be guaranteed given the reasons noted above.

4.3. Road Network

The Ingleside Precinct contains a network of several local and collector roads which serve the development and would be used to access the higher order road network in the event of a bushfire. The roads in the vicinity of the Ingleside Precinct considered important in the context of a bushfire are as follows:

- **Mona Vale Road:** A TfNSW Main Road (MR 162), it generally carries one lane of traffic in each direction between intersections with McCarrs Creek Road (west) and Samuel Street / Ponderosa Parade (east) along an undivided carriageway. There are however exceptions, with one-way, two-lane sections provided along with turn bays at certain intersections, including provision of two lanes in each direction between Lane Cove Road / Manor Road and south of Powderworks Road.

Upgrades are currently underway to widen to two lanes in each direction for a 3.2 kilometre stretch between Manor Road and Foley Street (Mona Vale Road East upgrade³), with further upgrades currently in the planning stage for widening of a further 3.4-kilometre section between McCarrs Creek Road and Powderworks Road (Mona Vale Road West upgrade⁴).

It is generally subject to 70 km/h speed zoning restrictions in the vicinity of the site and connects to the broader arterial road network via the Pacific Highway (HW 10) to the south west and Pittwater Road (MR 164) to the east.

- **Powderworks Road:** An unclassified two-way road with one lane in each direction, which runs between a signalised intersection with Mona Vale Road in the north/west and Garden Street to the south/east. It operates speed zoning restrictions of 60 km/h at its northern end, reducing to 50 km/h at the Elanora Heights town centre through to Garden Street. Powderworks Road forms the south/west boundary of the Ingleside Precinct, which terminates at the intersection with Wilga Street at its southern end.
- **Manor Road:** A two-way, two-lane road which runs in a north/west to south/east alignment between its intersection with Mona Vale Road / Lane Cove Road in the north to Wattle Road in the south. Wattle Road in turn provides a connection south/westwards to Powderworks Road whilst also continuing south/eastwards to Ingleside Road. Manor Road, Wattle Road and Ingleside Road are all local roads which operate 50 km/h speed zoning restrictions and ultimately connect to Powderworks Road at their southern ends.

Manor Road runs generally parallel to Powderworks Road and to its north/east, and along with Wattle Road forms an alternative key north/south connection serving the Ingleside Precinct south of Mona Vale Road. It passes centrally through the proposed development south of Mona Vale Road.

³ <https://www.rms.nsw.gov.au/projects/mona-vale-road/mvreast/index.html>

⁴ <https://www.rms.nsw.gov.au/projects/mona-vale-road/mvrwest/index.html>

5. Methodology

5.1. Overview

This Traffic Analysis does not undertake any traffic modelling or replicate the scope of the AECOM Study whatsoever. Rather, it reiterates the key principles adopted by the AECOM Study in the context of the revised Structure Plan.

As such, the methodology set out in this section draws upon and reiterates assumptions and methodology adopted by the AECOM Study, such that findings pertaining to the revised Structure Plan are more succinctly documented in a standalone document.

5.2. Background Traffic

Background traffic in the context of this Traffic Analysis refers to vehicles that would already be on the road at the time a bushfire event occurs. Its consideration is important, as any traffic already on the road network would limit the remaining available capacity for those evacuating from the Ingleside Precinct.

The AECOM Study presents a robust methodology for determining background traffic demand on the road network throughout the development and progression of a bushfire towards the Ingleside Precinct. This assessment begins by acknowledging current, typical traffic demand as informed by traffic surveys and takes several steps to adjust said demand to reflect behavioural responses to an approaching bushfire.

Such steps include:

- Applying a seasonal uplift to account for higher road network demand during summer months.
- Accelerating existing background trips observed as occurring during the fire arrival period to earlier in the peak period, thus reflecting changing travel patterns of those in the area in response to the bushfire.
- Removing trips by residents in the area who would opt to remain away and not travel home if a bushfire were occurring.
- Reroute commuter traffic passing through the study area road network.
- Remove trips from inside the study area destined for outside, on the basis these trips be considered as evacuation trips instead (per the methodology discussed in Section 5.3).

Scenario 3 of the AECOM Study forms the scenario in which development uplift in the Ingleside Precinct is assessed. This scenario reflects full, off-site evacuation of residents in the broader population catchment and the Ingleside Precinct under assisted evacuation conditions, that is having received remote emergency warning messages advising on the direction of travel, with some physical intervention away from the Ingleside Precinct to assist evacuation of the existing population.

The emergency management response assisting the evacuation was informed through engagement of emergency services stakeholders, though was largely assessed to consider how physical assistance would alleviate congestion towards the east of the study area in evacuating the existing population catchment. Assumed physical assistance within the study area has little to no impact on the demand evacuating southbound along Powderworks Road.

Key traffic routeing decisions assumed within the assessment affecting traffic flow near the Ingleside Precinct emergency services advised would be implemented in response to bushfire, remotely via warning messages and physically should resources be available, are listed below:

- Mona Vale Road / Ponderosa Parade / Samuel Street: No access westbound along Mona Vale Road.
- Mona Vale Road / Lane Cove Road / Manor Road: No access northbound to Lane Cove Road. No access eastbound along Mona Vale Road. No access northbound from Manor Road to Mona Vale Road.
- Mona Vale Road / Chiltern Road: No access northbound to Chiltern Road. No access eastbound along Mona Vale Road.
- Mona Vale Road / Powderworks Road: No access northbound from Powderworks Road to Mona Vale Road. No access westbound along Mona Vale Road.
- Mona Vale Road / Tumburra Street and Addison Road: No access westbound along Mona Vale Road.
- Mona Vale Road / Kimbriki Road: No access eastbound along Mona Vale Road.
- Mona Vale Road / McCarrs Creek Road: No access eastbound along Mona Vale Road.

Implementation of these routeing decisions ensures that evacuation southbound along Powderworks Road is undertaken only by those for whom this is the closest and fastest way to depart the vicinity, with no additional superfluous demand using this evacuation route given closures enacted elsewhere.

As discussed in Sections 3.4 and 5.4, these measures were advised via consultation with emergency services and study stakeholders to ensure the most realistic and representative response to bushfire in the area was considered, whilst maintaining conservatism in the traffic demand departing residences to evacuate off-site.

5.3. Evacuation Traffic Demand

Key to determining the ability of residents of the Ingleside Precinct to evacuate in the event of a bushfire is determining the number of vehicles, or traffic demand, that would access the road network in such an event. Conventional means of traffic generation, such as the use of trip rates presented in the RMS Guide and RMS Guide Update, are not valid in the event of a bushfire evacuation, as the number of vehicles accessing the road network is inherently atypical and not reflective of usual peak period traffic demands.

Determining the evacuation traffic demand therefore requires a bespoke approach based on the number of dwellings in the study area and several geographic and behavioural influences. The AECOM Study undertook assessment of a broad population catchment spanning Terrey Hills in the west and Mona Vale in the east, ensuring that existing and proposed new residents of the area were considered when assessing road network performance in the event of a bushfire.

This updated Traffic Analysis assesses work done previously by re-examining the traffic demand generation anticipated from the proposed development and its evacuation routeing in the event of a bushfire. This Traffic Analysis does not re-evaluate or comment on the anticipated traffic generation of existing dwellings within the broader population catchment area, as this was covered by the AECOM Study.

The number of dwellings proposed for the revised Ingleside Precinct Structure Plan is presented in Section 4.1 as 980 new dwellings, increasing the total to 1,100 dwellings given the presence of 130 existing dwellings. Geographic and behavioural influences on traffic generation and routeing of residents of these dwellings are discussed below.

5.3.1. Vehicle Ownership Rate

The vehicle ownership rate is a reference to the average number of vehicles each dwelling in the Ingleside Precinct is expected to own.

2016 census household travel survey data has been used to identify the private motor vehicle ownership rate for the Northern Beaches local government area (LGA) as 0.66 vehicles per person and 1.75 vehicles per dwelling.

5.3.2. Dwelling Occupancy

The dwelling occupancy is a reference to the number of dwellings within the Ingleside Precinct that are expected to be occupied when a bushfire event occurs. ABS Quick Stats confirms that the number of private unoccupied private dwellings in the Northern Beaches LGA during the 2016 census was 9.4%. This compares to a value of 6.9% for the Ingleside State Suburb (SSC).

For a conservative assessment, it has been assumed that 95% of all dwellings are occupied in determining traffic demand expected to use the road network during a bushfire event.

5.3.3. Stay and Defend

This assumption considers the proportion of residents who will stay at home to defend their property in the event of a bushfire, as opposed to using their private vehicles to evacuate.

The policy position attached to the national Fire Danger Rating system advocates for individuals to leave early in Catastrophic conditions and recommends it in Extreme conditions. However, there is strong evidence that suggests that despite messaging, the reality of community action is very different from that which fire agencies would like.

Whittaker and Taylor documents research undertaken into protective responses to a bushfire event, that being the proportion who would attempt to stay and defend their property in the event of a bushfire as opposed to departing.

The study found that of survey respondents who were threatened or impacted by bushfire in 2017, 46.7% stayed or returned to defend their property, although some were not impacted and 6.5% began defending and then left.

A separate survey asked what respondents would do if a Catastrophic Fire Danger warning were issued next summer, with 27% indicating they would get ready to stay and defend.

To ensure conservative assessment of road network conditions, a stay and defend proportion of 25% was adopted for this Traffic Analysis.

5.3.4. Evacuation Time Period

This Traffic Analysis conservatively assumes no pre-warning is given to residents of the Ingleside Precinct and broader population catchment, and thus no early evacuation of residents is possible. This ensures that all traffic demand resulting from the threat of a bushfire is considered as accessing the road network at once, thus generating worst-case road network conditions.

5.3.5. Private Vehicle Usage

The Traffic Analysis assumes all private vehicles owned by residents who would depart in the event of a bushfire would be used. This is a conservative assumption, with no reduction applied to reflect the fact that some residents, such as families, may leave one or more of their cars at their residence in the event of an evacuation.

5.3.6. On-Site Evacuation

To ensure robust assessment of the road network in the event of a bushfire, no on-site evacuation to Evacuation Centres or Neighbourhood Safer Places (NSP) is assumed in determination of trip generation for the southbound evacuation along the Powderworks Road corridor.

5.3.7. Evacuation Traffic Demand Summary

The assumptions presented within this Section are summarised in **Table 3**.

Table 3: Evacuation Traffic Demand Assumptions Summary

ASSUMPTION DESCRIPTION	ASSUMED VALUE
Vehicle ownership rate	1.75 vehicles per dwelling
Dwelling occupancy	95%
Stay and defend	25 % stay and defend 75 % evacuate
Private vehicle usage	100%

The resultant evacuation traffic demand generated by the proposed 980 dwellings, based on the conservative assumptions summarised in **Table 3**, is 1,222 vehicles. Inclusion of the existing 130 dwellings increases this number to 1,372 vehicles.

5.4. Evacuation Routeing

Evacuation in the event of a bushfire involves residents of at-risk properties departing to an area of perceived safety. Such an area is typically urbanised, with a minimum separation of approximately 100 metres to surrounding bushland frontage. Within the Ingleside Precinct, evacuating residents may either travel to an area of low risk within the Precinct that is separated by an asset protection zone (a buffer between a bushfire hazard and buildings), termed herein as ‘on-site evacuation’, or depart the Precinct entirely, termed herein as ‘off-site evacuation’.

This Traffic Analysis is deliberately conservative in assuming all traffic demand generated by the proposed development will evacuate off-site to a place of perceived safety. Further conservatism is incorporated by assuming a single evacuation route is used by all residents of the proposed development, that being southbound along Powderworks Road.

This evacuation routeing is consistent with the Risk Assessment, which identifies Powderworks Road and Manor Road as key evacuation routes, that the intersection of Mona Vale Road with Powderworks Road is exposed to vulnerability given proximity to the Garigal National Park, and marks Powderworks Road in the proximity of Wilga Street as a key ‘egress point’, beyond which access and egress is not discussed.

Evacuation southwards along Powderworks Road is considered suitable and preferable for the proposed development given significant sections of Mona Vale Road pass through bushfire prone land, as illustrated by **Figure 3**. Residents of the proposed development would be advised of evacuation routeing before and during a bushfire event through the measures discussed in Section 2.2.

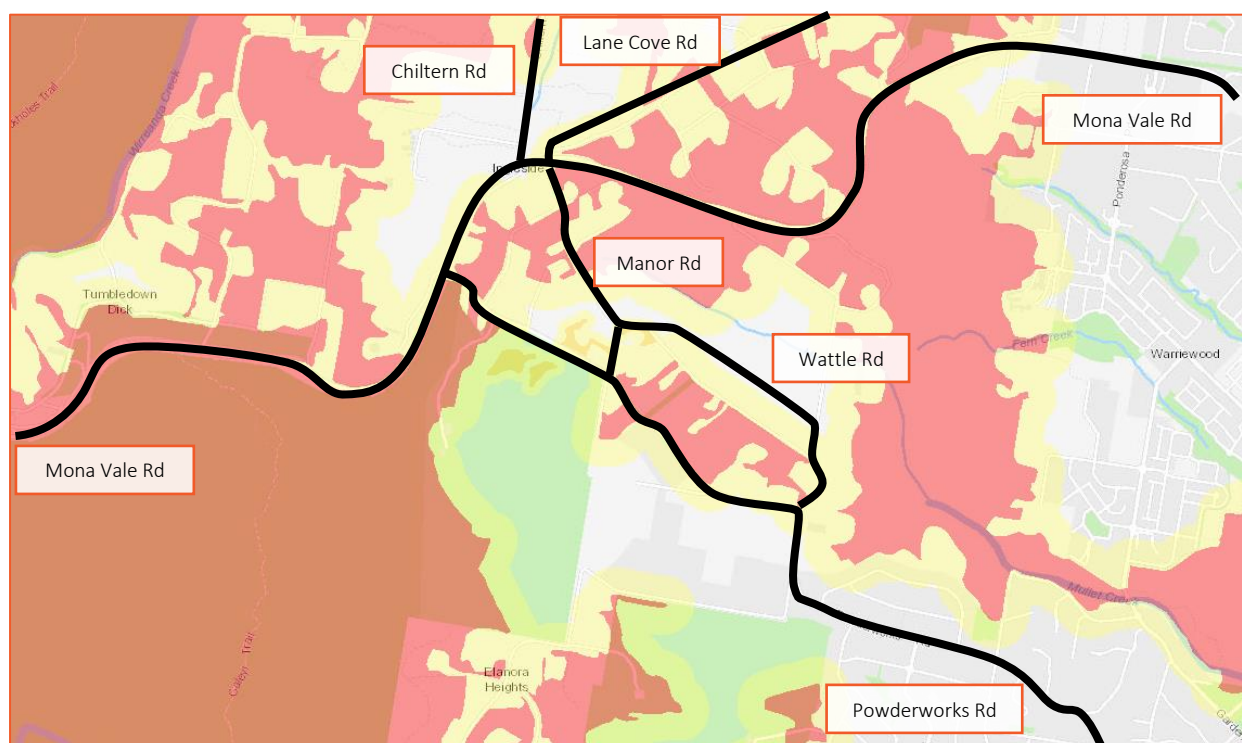


Figure 3: Bushfire Prone Land Mapping

Figure 3 demonstrates long stretches of Mona Vale Road to the west of Powderworks Road and east of Manor Road traverse land considered prone to bushfire⁵, as viewed on the NSW Government ePlanning Spatial Viewer. A significantly shorter section of approximately 500 metres of Powderworks Road also traverses bushfire prone land; however, efforts have been made in the proposed development to lessen the impact of this, further details of which are provided in the associated Eco Logical Study.

Aside from this section of bushfire prone land, **Figure 3** illustrates that Powderworks Road traverses land not as susceptible to impact by bushfire and is considered the most appropriate means of evacuating residents of the proposed development.

This position was shared by emergency services representatives during development of the AECOM Study, as discussed in Section 3.4, and would be communicated by such agencies in practice in the event of a bushfire as discussed in Section 2.2.

It is acknowledged that no guarantee can be made for any physical emergency response, and thus routing of residents southbound along Powderworks Road assumes adherence to the effective dissemination of emergency warning messages discussed in Section 2.2.

5.5. Evacuation Destination

Section 5.4 provides rationale for identifying Powderworks Road southbound as the evacuation route for the Ingleside Precinct. The ultimate destination of those evacuating via Powderworks Road is not critical to this Traffic Analysis, which makes no comment as to the routing of vehicles beyond the southern extremity of the Ingleside Precinct.

This position is informed by emergency services liaison during the AECOM Study, in which emergency services noted a primary objective of relocating at-risk vehicles to areas of low to no risk. Applying that objective to the context of the Ingleside Precinct, bushfire prone land mapping illustrates that dense, urban areas south/east of the Ingleside Precinct, such as Elanora Heights and Narrabeen, are not considered at high risk from bushfire impact. This in turn implies that should vehicles be able to access either of these suburbs, or urban areas beyond such as Dee Why, they would be considered safe regardless of their ultimate journey end.

For this reason, the AECOM Study traffic model study area terminates at the Powderworks Road intersection with Kalang Road, on the basis that beyond this, traffic is considered at lower risk from the threat of bushfire, being in urbanised land which is not considered bushfire prone per NSW RFS mapping. This position is corroborated by the Risk Assessment, which notes the 'egress point' of the study area in this direction as being further north west along Powderworks Road near Wilga Street.

Whilst it is acknowledged that potential congestion arising from intersections outside of the study area has not been assessed, the conservative assumptions taken within the study area and the distance from bushfire prone land supports the position that the Traffic Analysis adequately assesses performance characteristics of the surrounding road network with regards to the proposed development uplift.

⁵ <https://www.rfs.nsw.gov.au/plan-and-prepare/building-in-a-bush-fire-area/planning-for-bush-fire-protection/bush-fire-prone-land>

6. Road Network Performance

6.1. Overview

Section 5 establishes the evacuation traffic vehicle demand and the key route via which said vehicles may evacuate in the event of a bushfire, being southbound along Powderworks Road. This section uses this information to assess the potential traffic demand for the evacuation route and resultant road network performance.

Whilst the scope of this Traffic Analysis is focussed on the Ingleside Precinct and potential implications resulting from it, consideration of the broader population catchment is required to determine how residents of the Ingleside Precinct will be able to evacuate in the event of a bushfire.

6.2. Road Network Pinch Point

To assess whether vehicles departing southwards along Powderworks Road would be able to clear sections of road bordered by bushfire prone land, illustrated by **Figure 3**, the AECOM Study determined a critical downstream pinch point from which potential blocking back would limit southbound traffic's ability to depart the area. This intersection was advised by Council during consultation as being the priority roundabout with Kalang Road in Elanora Heights town centre.

To ensure conservatism, controlling flow at the roundabout, that being the right turn movement from Kalang Road to Powderworks Road (south/east leg), was assumed as 25% of all evacuating traffic from the Woorarra Lookout Reserve census travel zone illustrated by **Figure 4**. This percentage is high considering the likely routing of residents within this area is south/eastwards, away from the approaching bushfire, yet is considered appropriate for ensuring robust assessment of the ability for Powderworks Road to accommodate increased southbound traffic demand.

Adoption of this conservative methodology led to the traffic performance and findings of the AECOM Study, which are summarised in Section 3.4.3 of this report. To reiterate, adoption of these conservative assumptions determined the volume of traffic that was able to evacuate southwards along Powderworks Road, and from that volume the AECOM Study was able to identify the equivalent number of new dwellings the area could support, that being 800 – 1,000 new dwellings.

The traffic model does not continue further along Powderworks Road beyond this intersection given traffic is considered at lower risk from the threat of bushfire, being in urbanised land which is not considered bushfire prone per NSW RFS mapping. The assumptions at Kalang Road have accordingly been coded as deliberately conservative to ensure that blocking back into the study area is sufficiently robust.



Figure 4: Woorarra Lookout Reserve Boundary

6.3. Dwelling Yield

Section 3.4 presents the criteria adopted in the AECOM Study to determine the dwelling yield, which is largely driven by the Powderworks Road southbound movement's ability to clear traffic through the Kalang Road roundabout.

Via traffic assessment of traffic demand through this pinch point, the study concluded a dwelling uplift in the Ingleside Precinct of 800 – 1,000 dwellings. This assessment did not adopt any physical emergency management assistance at the intersection of Powderworks Road and Kalang Road, given the inability to guarantee physical presence of emergency services at the intersection during an evacuation.

This Traffic Analysis adopts this assumption and provides further commentary on the ability of traffic generated by the existing and new Ingleside Precinct dwellings, identified in Section 5.3 as 1,372 vehicles, to evacuate in the event of a bushfire but does not re-examine or reassess the work previously undertaken in identifying this dwelling yield.

6.4. Capacity Analysis

6.4.1. Road Capacity

Road network performance has been assessed using typical mid-block capacities for urban roads with interrupted flows, as set out in Section 6.2.1 of the Austroads Guide to Traffic Management Part 3: Transport Study and Analysis Methods, Austroads 2020 (Austroads Guide).

Despite the potential for development of the Ingleside Precinct to modify the road network to suit traffic requirements, the assumption made in this study is that Powderworks Road remain per its current configuration, that being a two-way road with a single lane in each direction and on-street parking restrictions along its length within the Ingleside Precinct study area.

The southbound single lane carriageway is therefore considered a kerb lane with clearway conditions, which has a theoretical capacity as stated in the Austroads Guide of 900 passenger cars per hour (pc/h).

6.4.2. Vehicle to Capacity Performance

Should only traffic generated by the Ingleside Precinct be required to travel southbound along Powderworks Road in the event of a bushfire, the vehicle to capacity ratio (V/C) for the southbound direction would be per **Table 4**.

Table 4: Vehicle to Capacity Ratio of Powderworks Road Evacuation Route

EVACUATION ROUTE	DEMAND (VEH)	CAPACITY (PC/H)	V/C
Powderworks Road	1,372	900	1.52

Assessment of all traffic using Powderworks Road demonstrates that the number of vehicles evacuating exceeds the hourly capacity. The exceedance is by a factor of 52 %, suggesting that vehicles using one of these roads would require between one and two hours to evacuate.

It is acknowledged that vehicles evacuating via Powderworks Roads are required to first access it via the network of internal local roads, which will operate at capacities as low as 600 pc/h if they are kerb lanes with occasional on-street parking (Austroads Guide). Given the prevalence of local road connections to Powderworks Road throughout

the Ingleside Precinct and the total demand generated, it is evident local roads would have sufficient capacity to accommodate evacuation traffic accessing Powderworks Road.

Mid-block capacity assessment presented in **Table 4** accounts generally for intersections, or interruptions from cross traffic and turning traffic at minor intersections, with uninterrupted flow capacity typically much higher and closer to 2,000 pc/h. Section 6.2 identifies the Powderworks Road priority roundabout with Kalang Road as the first downstream intersection at which traffic evacuating southwards would be required to give way.

The AECOM Study and this Traffic Analysis conservatively assume that no physical emergency services assistance would be enacted here to prevent vehicles turning right from Kalang Road and assist the flow of traffic southwards along Powderworks Road. In contrast, the studies conservatively assume a high proportion of the surrounding residential suburbs make this movement to form robust controlling flow to which southbound traffic must give way.

Given the conservatism built into assessment in many aspects discussed in this Traffic Analysis, and the 1.0-kilometre distance between the roundabout and bushfire prone land upstream along Powderworks Road, queuing from this intersection is not expected to place those evacuating southbound along Mona Vale Road at significant risk.

6.5. Road Network Upgrades

As mentioned previously, this Traffic Analysis conservatively assumes the existing layout of Powderworks Road is retained when assessing road network performance in the event of a bushfire. It is noted however that road network upgrades, particularly in the southbound direction of Powderworks Road south of the Ingleside Precinct, would likely assist evacuation by providing additional capacity.

The AECOM Study did not assess the potential impact of road network upgrades, and thus determination of how any given upgrade may affect the ability of the road network to cater for additional evacuation traffic demand, and thus residential dwelling yield, is not provided or commented upon within this Traffic Analysis.

Given the overarching conservatism the planning process for the Ingleside Precinct has sought to adopt, this Traffic Analysis considers discussion or proposal of any road network upgrades to form a means of further enhancing the resilience of the determined dwelling yield to evacuate in the event of a bushfire, rather than as justification for further intensifying development to achieve a greater yield.

6.6. On-Site Evacuation

This Traffic Analysis and the AECOM Study before it undertook a conservative assessment from a road network performance perspective in assuming traffic demand generated by the Ingleside Precinct and surrounding population catchment would evacuate off-site. This assumption tests worst-case road network performance as the maximum number of vehicles are considered accessing the road network at the same time to evacuate.

Section 5.3.4 notes that this Traffic Analysis assumes a rapid onset bushfire, in which residents have no pre-warning or ability to evacuate early. Full, off-site evacuation is thusly assessed to determine worst-case road network conditions in this event; however, it is likely that a large proportion of residents of the Ingleside Precinct and the broader population catchment would seek shelter on-site, at either an Evacuation Centre or NSP.

The Eco Logical Review outlines a key recommendation as:

“An on-site Evacuation Centre should be provided along with / or the provision of multiple NSPs. Provision of an on-site Evacuation Centre and the reduction in residual risk is a concept not applied for other developments in NSW and approved by the RFS. The development footprint surrounding the Evacuation Centre/NSP will need to eliminate the risk of bushfire penetration beyond the outer-most portion of that nearby development footprint.”

Adoption of one or more suitably designed and situated Evacuation Centres would reduce the traffic demand on the external road network in the event of a bushfire, by providing an alternative to off-site evacuation for residents of the Ingleside Precinct and broader population catchment. On-site evacuation also has the potential to form a safer option and reduce logistical challenges of managing off-site evacuation, including traffic management and congestion.

This view is echoed by NSW RFS, who during stakeholder engagement noted that NSP should be included as an on-site refuge measure to reduce traffic during an emergency. NSW RFS advised their messaging states that a NSP is designed as a place of last resort in bushfire emergencies only, and that travelling to or sheltering at NSP does not guarantee safety. However, they note NSP are designed to be introduced into already established settlement and other, more robust measures should be put forth for new development, hence the conservative approach adopted in assuming no Evacuation Centre or NSP was used by residents.

6.7. Broader Network Impacts

The total potential demand that would depart the Ingleside Precinct in the event of a bushfire is not insignificant and may be departing onto a broader road network on which traffic from other surrounding suburbs is also trying to evacuate, or which have high background traffic volumes.

This Traffic Analysis acknowledges that upon departing the Ingleside Precinct, congestion may be experienced by evacuating vehicles at interfaces with adjacent suburbs, such as in Elanora Heights, Narrabeen or Dee Why. It is noted however that emergency traffic management may be enacted in such an event to assist with traffic evacuation.

The scope of this study has been to assess the ability of the road network to accommodate at-risk residents evacuating from Ingleside Precinct to areas considered safer by emergency services. Broader network implications of a bushfire event were considered in the AECOM Study; however, those further afield may need to be considered in a more regional context to identify whether regional constraints will limit the ability of traffic generated by other areas to evacuate.

7. Limitations and Exclusions

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

- The study assesses the ability of Powderworks Road to accommodate residents evacuating from the Ingleside Precinct and broader population catchment traffic but does not assess broader regional traffic constraints.
- No traffic modelling or intersection analysis has been undertaken to assess detailed, nuanced capacity constraints that may be present within the Ingleside Precinct.
- The study assumes a reasonable degree of emergency management will be enacted in the event of a bushfire, resulting in assisted evacuation conditions. It is acknowledged that no guarantee can be made as to the availability or ability of emergency services to enact any one measure given the high degree of variability under such circumstances.
- It is assumed no visitors or vehicles belonging to non-residents are in the Ingleside Precinct at the time of an evacuation. It is noted that the conservative assumptions informing resident populations offset any potential lack of visitor traffic demand.
- This Traffic Analysis assumes adherence to emergency warning messages discussed in Section 2.2; however, acknowledges research by Oppenheimer that human behaviour and decision-making becomes strained in an emergency, and processing of information may become illogical or irrational.
- No businesses or other traffic generators have been considered within the Central Precinct as generating evacuation traffic above and beyond that generated by residential dwellings.
- This 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.
- No road network upgrades are assessed with respect to their ability to accommodate increased dwelling yield.
- This Traffic Analysis does not comment on the ability of firefighting vehicles to access properties, fire fronts or water supply in the Ingleside Precinct.
- AECOM Study modelling referenced is not sophisticated enough to reflect individual premises' evacuation protocols, with the broader population catchment assumed as using the average household car ownership rates.
- 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.

- This Traffic Analysis bases certain assumptions on research findings of what individuals say they will do in the event of a bushfire; however, their behaviour in reality may be different.
- 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.
- This Traffic Analysis has been driven by a land use planning exercise for the Ingleside Precinct and is not intended to advise on emergency service planning or procedures in the event of a bushfire.
- The AECOM Study traffic model study area terminates south / east of the Powderworks Road intersection with Kalang Road. As such, potential congestion from the Powderworks Road intersection with Garden Street, or Garden Street intersection with Pittwater Road, is not assessed or considered. Assumptions at the Kalang Road roundabout are deliberately conservative as a result.
- Bushfire behaviour is highly variable and dependent upon multiple factors which are difficult to foresee. This assessment uses a wealth of observed input data, research, surveys, and industry expertise 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.
- DPIE, in partnership with NSW RFS, remain ultimately responsible for determining whether the findings of this Traffic Analysis and associated studies satisfy the strategic planning principles and strategic planning assessment considerations of PBP 2019 in the manner intended by PBP 2019.

8. Conclusion

PDC Consultants has been commissioned by The Department of Planning, Industry and Environment to undertake a Traffic Analysis of the Ingleside Precinct. This follows a series of previous studies investigating a state-led rezoning and development uplift in the area.

The report identifies the strategic context within which the Traffic Analysis has been undertaken, that is a requirement of PBP 2019 to consider bushfires during the strategic planning stage of a development or rezoning.

The report identifies how stakeholder engagement, the community profile, proposed development, and behavioural research informs determination of the number of vehicles expected to evacuate the Ingleside Precinct in the event of a bushfire and identifies the key access route and travel direction for those within the Ingleside Precinct wishing to evacuate.

The capacity of the proposed road network is assessed with respect to the number of residents evacuating from the Ingleside Precinct, identifying that those evacuating southwards along Powderworks Road will likely be able to do so satisfactorily under assisted evacuation conditions.

It is noted that this report comprises a desktop study to inform broader strategic planning of the Ingleside 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 and next steps.

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