Newcastle Inner City Bypass – Rankin Park to Jesmond

Refined Strategic Design Report

April 2016

THIS PAGE LEFT INTENTIONALLY BLANK

Executive summary

Introduction

Roads and Maritime Services is planning to construct the fifth section of the Newcastle Inner City Bypass between Rankin Park and Jesmond (the project).

The Newcastle Inner City Bypass provides improved traffic flows across the western suburbs of Newcastle and connects key regional destinations such as Bennetts Green, Charlestown and Jesmond shopping centres, John Hunter Hospital, Newcastle University and the Pacific Highway.

A strategic design for the Rankin Park to Jesmond project was displayed for community comment in 2007. Feedback was considered to finalise the preferred route corridor, which was subsequently reserved in Newcastle City Council's Local Environmental Plan.

In June 2014, the NSW Government announced funding for Roads and Maritime to continue development and planning for the project.

Roads and Maritime has since carried out a comprehensive review of the 2007 strategic design to ensure the bypass best meets the project objectives. The refined strategic design is being displayed for community comment for four weeks during May and June 2016. This provides an opportunity for the community to review the refined strategic design and provide feedback.

Design development process

The process for developing the refined strategic design has broadly involved the following steps:

- Review of previous work and investigations
- Establishment of design criteria for the development of the refined strategic design and subsequent concept design
- Review of the 2007 strategic design
- Identify constraints and opportunities in the study area
- Traffic data collection, assessment and modelling
- Field investigations including environmental and geotechnical surveys
- Community and stakeholder consultation
- Develop potential refinements to the alignment and interchange options
- Cost estimation, economic analysis and evaluation of options
- Value management workshops to assist with selection of a preferred option
- Further design and assessment to allow the recommendation of a refined strategic design for public display.

This refined strategic design report aims to summarise the investigations which have been carried out to review the 2007 strategic design and develop the refined strategic design for the Rankin Park to Jesmond project.

The report is intended to provide a basis for further refinement and development of the concept design during the environmental assessment through to project approval.

Options assessment

The development of the refined strategic design was broadly carried out in two parts:

- Alignment options – includes investigating the need, form and function of a hospital access
- Interchange options – connections at the northern and southern ends of the project.

Short-listed options were developed with consideration of issues raised by the community when feedback on the project was sought in early 2015. The short-listed options were then compared and assessed based on a combination of engineering, environmental, geotechnical, social, economic, constructability and functional considerations.

Recommended refined strategic design

The proposed bypass would be about 3.4 kilometres of four-lane divided road and would include:

- Northern interchange with a bridge over Newcastle Road to join the existing Jesmond to Sandgate section of the bypass. The intersection below the bridge would be controlled by traffic lights
- Hospital interchange providing access between the John Hunter Hospital and the bypass. The interchange includes a bridge over the bypass to separate traffic
- Southern interchange at Lookout Road with the bypass travelling under McCaffrey Drive
- Structures along the route to allow fauna movements, bushwalker access and drainage
- Off-road provisions for pedestrians and cyclists.

A half-interchange to provide access to the hospital to and from the north was assessed as having strong economic benefits, with improved traffic flow on the surrounding road network. As a result the half-interchange is shown in the refined strategic design. Further consultation with NSW Health Infrastructure is being carried out to finalise the configuration of the interchange near the hospital.

In assessing options for the southern interchange, a detailed review was carried out to investigate the need to provide a northbound on-ramp from McCaffrey Drive and/or southbound off-ramp to McCaffrey Drive. The investigations found that while design and construction of the ramps is technically possible, the low forecast usage of the ramps and the high cost to build makes the ramps not economically viable. As a result, the addition of McCaffrey Drive ramps have not been included in the refined strategic design.

Key benefits of the refined strategic design

The key benefits of the refined strategic design include:

- Improved traffic performance of the northern and southern interchanges
- Improved traffic flow for motorists using the Newcastle Inner City Bypass
- Improved traffic flow on key parts of the surrounding road network, in particular the existing route of Lookout Road, Croudace Street and Newcastle Road
- Improved connectivity for John Hunter Hospital with provision of a half-interchange providing access to and from the north
- Minimises environmental impacts including impacts on threatened species
- Reduction in potential noise and visual impacts on nearby residential areas
- Provides an overall design that better meets the project objectives.

Next steps

Feedback received on the refined strategic design will be considered to further refine and prepare the concept design and environmental assessment in the form of an Environmental Impact Statement (EIS).

The EIS will be displayed for comment by the NSW Department of Planning and Environment. This is expected to occur in late 2016 at which point further community feedback will be sought.

The objective is to develop and ultimately obtain project approval from the Minister for Planning, which would allow the project to progress into the detailed design and construction phase.

Contents

Figures and tables

1. Introduction

This section introduces the project, outlines the purpose of this report, provides an overview of the study area, strategic context, project objectives and describes the structure of the report.

1.1. Project overview

Roads and Maritime Services is seeking approval to construct the fifth section of the Newcastle Inner City Bypass between Rankin Park and Jesmond (the project).

The Newcastle Inner City Bypass is part of the Roads and Maritime long-term strategy to provide an orbital road within the Newcastle road network to connect the Pacific Highway at Bennetts Green and the Pacific Highway at Sandgate.

The Newcastle Inner City Bypass provides improved traffic flows across the western suburbs of Newcastle and connects key regional destinations such as Bennetts Green, Charlestown and Jesmond shopping centres, John Hunter Hospital, Newcastle University and the Pacific Highway.

The Rankin Park to Jesmond project would involve the construction of a new 3.4 kilometre four-lane dual carriageway highway between the intersection of Lookout Road, New Lambton Heights and the intersection of Newcastle Road and the existing Jesmond to Shortland section of the Newcastle Inner City Bypass.

Key features of the project would include:

- Roadway – the new roadway would consist of two lanes in each direction, separated by a median along the length of the project. The roadway would be constructed on large cut and fill embankments, which would be required due to the steeply undulating terrain
- Interchanges – a northern and a southern interchange would be constructed at either end of the project, to enable connections with the existing sections of the Newcastle Inner City Bypass and key arterial roads such as Newcastle Road and Lookout Road
- Construction of the interchanges would involve modification of the intersection of Lookout Road and McCaffrey Drive, and the intersection of Newcastle Road and the existing Jesmond to Shortland section of the Newcastle Inner City Bypass
- A western connection to John Hunter Hospital has also been investigated, in consultation with New South Wales Health Infrastructure and Hunter New England Local Health District (refer to **Section 4.2.10)**
- Structures – bridges and/or culverts would be constructed to provide access for people and/or animals across the bypass. The size and design of these structures would be confirmed during the concept design and environmental assessment phase.

1.2. Purpose and scope of this report

A strategic design for the Rankin Park to Jesmond project was displayed for community comment in 2007. Feedback was considered to finalise the preferred route corridor, which was subsequently reserved in the Newcastle Local Environmental Plan. In 2008 Roads and Maritime released a Submissions Report to provide responses to submissions received during the 2007 public display.

In June 2014, the NSW Government announced funding for Roads and Maritime to continue development and planning for the project. Roads and Maritime engaged Aurecon Australasia Pty Ltd (Aurecon) in November 2014 to prepare the concept design and environmental assessment for the project.

As part of this process, Roads and Maritime and Aurecon (the project team) have undertaken a comprehensive review of the 2007 strategic design to ensure the project provides the best outcome for meeting the project objectives. This has included developing and assessing alignment and interchange options.

The review considered issues raised by the community when feedback on the project was sought in early 2015 and has also considered a range of environmental, engineering and traffic issues.

This refined strategic design report is intended to provide a basis for further refinement and assessment of the concept design during the environmental assessment through to project approval. The objective is to develop and ultimately obtain project approval from the Minister for Planning, to allow the project to progress into the detailed design and construction phase.

The process for developing the refined strategic design has broadly involved the following steps:

- Review of previous work and investigations
- Establishment of design criteria for the development of the refined strategic design and subsequent concept design
- Review of the 2007 strategic design
- Identify constraints and opportunities in the study area
- Traffic data collection, assessment and modelling
- Field investigations including environmental and geotechnical surveys
- Community and stakeholder consultation
- Develop potential refinements to the alignment and interchange options
- Cost estimation, economic analysis and evaluation of options
- Value management workshops to assist with selection of a preferred option
- Further design and assessment to allow the recommendation of a refined strategic design for public display.

Details of these elements of the process are discussed in the following sections of this report.

The purpose of the report is to describe the process of developing the refined strategic design and outline the changes that have been made to the design since it was displayed in 2007.

The report aims to provide further information to the community as part of the display of the refined strategic design for the Rankin Park to Jesmond project.

1.3. Study area for the proposal

The project is located in the Newcastle local government area, about 11 kilometres west of the Newcastle central business district and about 160 kilometres north of Sydney, NSW (refer to **Figure 1.1**).

The study area includes the existing bushland corridor and surrounding areas that may be disturbed during construction or indirectly impacted as a result of the proposal.

The study area includes part of the suburbs of Rankin Park, New Lambton Heights, Lambton, Wallsend, Jesmond and Elermore Vale. The study area also contains part of the Sygna Close Reserve, George McGregor Park, Invermore Close Reserve and Dangerfield Drive Reserve, Jesmond Park and land zoned as bushland reserve, which are used by recreational bushwalkers and off-road cyclists.

The study area is surrounded by residential suburbs to the west and includes John Hunter Hospital to the east. The study area is bounded to the north by Newcastle Road and to the east by Croudace Street/Lookout Road.

1.4. Strategic context and need

The Newcastle Inner City Bypass is part of Roads and Maritime's long-term strategy to provide an orbital road within Newcastle's road network.

In the 1950s a north-south road corridor within the Newcastle urban area was identified in the Northumberland County Planning Scheme. The corridor extended from the Bennetts Green area to the Pacific Highway at Sandgate. It was intended to accommodate the then proposed Sydney to Newcastle Freeway. However in the 1970s the decision was made to route the Freeway to the west of Lake Macquarie (F3 Freeway, now M1 Pacific Motorway). Most of the eastern corridor remained within planning schemes and has been used instead to accommodate completed sections of the Newcastle Inner City Bypass.

Sections of the Newcastle Inner City Bypass have opened progressively since the early 1980s as shown in **Figure 1.2.**

Figure 1.2 Newcastle Inner City Bypass

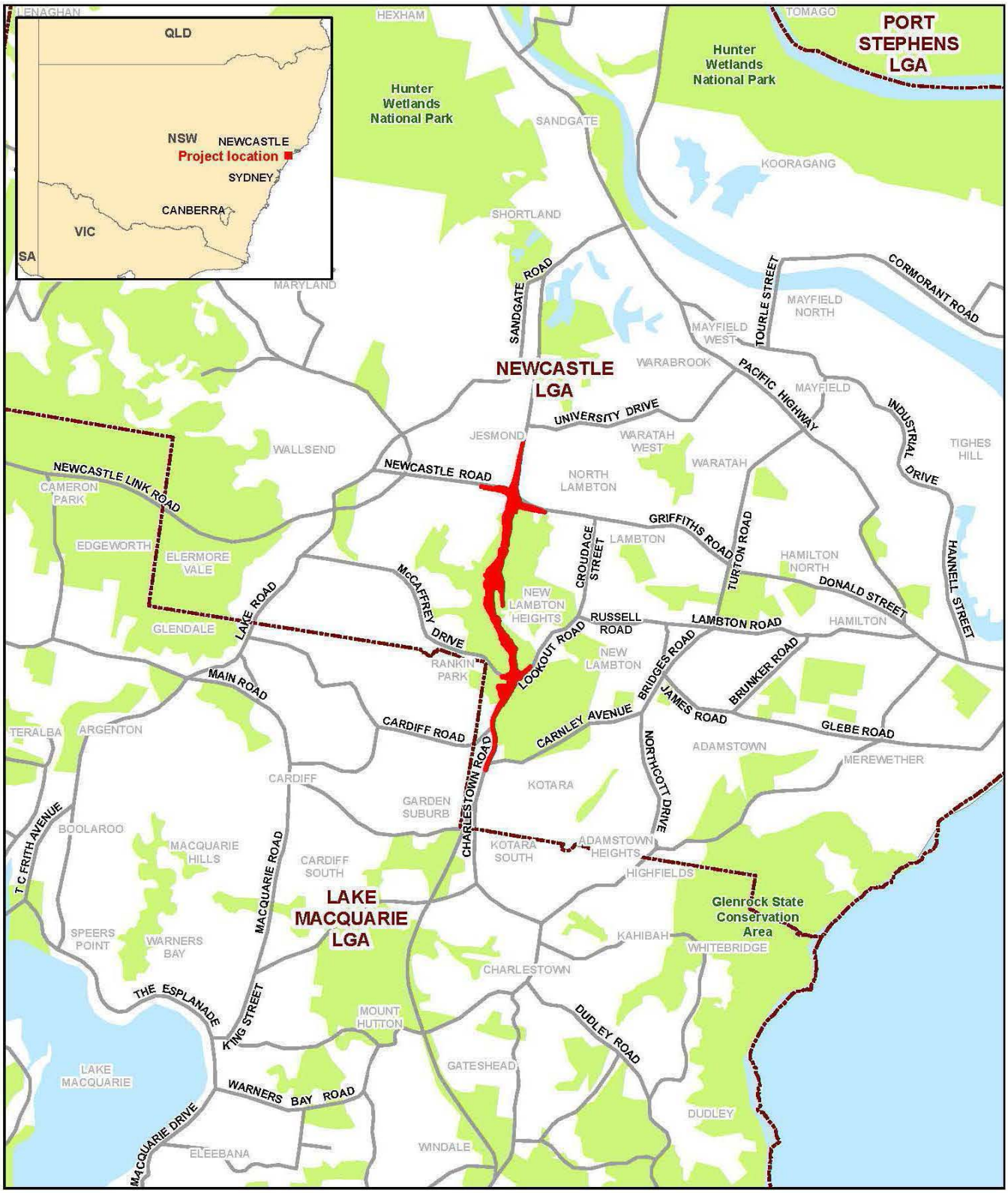


Figure 1.1 Locality Map

In 1985, an EIS was completed for the Rankin Park to Jesmond section. The assessment investigated various route options to integrate with the proposed John Hunter Hospital, with a preferred route selected on the western side of the hospital campus.

In 2006 Roads and Maritime completed a route options study for the project, which included the investigation of the feasibility of a western access to John Hunter Hospital. A preferred option and strategic design was displayed for community comment in 2007 (refer to **Section 2.1**).

Following consideration of community feedback, a submissions report was issued in March 2008. The preferred option was subsequently finalised and the preferred route corridor updated in the Newcastle Local Environmental Plan 2012 (Newcastle LEP 2012).

The road network surrounding the project currently suffers from traffic congestion and delays at key intersections. These issues are likely to worsen in the future as traffic volumes increase, with existing traffic volumes along this route currently in the order of 40,000 to 60,000 vehicles per day. Significant road user delays are experienced within the network, particularly during peak periods. At-grade intersections currently produce conflict points, resulting in congestion and traffic delays. The risk of maintaining the current configuration of the network is increased congestion and the costs to the community of that congestion.

There are a number of constraints along the existing route which include:

- Eleven sets of existing traffic lights on Lookout Road/Croudace Street/Newcastle Road from the McCaffrey Drive intersection to the Newcastle Road intersection
- Sixteen uncontrolled intersections with local and regional roads
- A large number of driveways to private properties, which reduce traffic speed below the 60 km/h speed limit and contribute to traffic congestion.
- A public school located on Croudace Street with 40 km/h school zones in place during peak hours.
- Existing speed limits on the surrounding road network are detailed below:
- Lookout Road – 60 km/h, 70 km/h
- Croudace Street – 60 km/h
- Newcastle Road – 70 km/h
- McCaffrey Drive – 60 km/h
- Russell Road – 60 km/h.

Local residential streets are generally 50 km/h.

The project would provide free flowing north-south travel conditions and bypass 11 sets of traffic lights along the existing route. Interchanges would reduce the number of conflict points currently at intersections, providing a safer route. The project would reduce travel times along the route for all road users including heavy vehicles.

Construction of the Rankin Park to Jesmond project would form part the Newcastle Inner City Bypass and provide traffic relief to key parts of the surrounding road network, in particular the existing route of Lookout Road, Croudace Street and Newcastle Road.

The project is consistent with the following relevant NSW strategic plans:

- *NSW State Infrastructure Strategy 2012* – The project would support the strategy's transport goals by the construction of the fifth stage of a regional highway and improving efficiency of traffic movements within Newcastle
- *NSW State Plan 2021* – The project would support the plan's transport and safety goals by relieving traffic congestion on the existing Lookout Road, Croudace Street and Newcastle Road route. The project would also create a new travel route with fewer intersections and more consistent speed zones than current transport routes through the area
- *NSW Long Term Transport Master Plan 2012* – The project would meet the objectives of the Long Term Transport Master Plan by creating a safer travel environment for users of the road network.

1.5. Project objectives

The primary objectives for the project are to:

- Provide continuity of the Newcastle Inner City Bypass between Bennetts Green and Sandgate
- Reduce travel times and improve traffic flow on the Newcastle Inner City Bypass
- Provide traffic relief on key parts of the surrounding road network.

In so doing, it is intended to:

- Improve road safety
- Minimise impacts on the natural and built environment
- Provide value for money.

The refined strategic design will be further developed into a concept design and associated environmental assessment, which will support the project objectives listed above by:

- Designing the project works to consider the environmental constraints and avoid or minimise impacts to the environment
- Satisfying the technical requirements with respect to the design of the project works
- Optimising the concept design to ensure that the project can be practically and efficiently constructed and maintained while meeting all other project objectives
- Applying appropriate urban design, landscape and visual principles in the concept design of the project elements
- Undertaking appropriate community and stakeholder consultation
- Designing all connections, modifications and improvements necessary to link the project works to the existing road network
- Planning temporary arrangements that minimise disruption to local and through traffic and that maintain access to adjacent properties during construction
- The overall project goal is to achieve the best possible result for each of the above objectives, both in isolation and when considered together.

1.6. Benefits

Key benefits of the proposal include:

- Improved traffic flow for motorists using the Newcastle Inner City Bypass by bypassing 11 sets of traffic lights along the existing route
- Reduced congestion on key parts of the surrounding road network, in particular the existing route of Lookout Road, Croudace Street and Newcastle Road
- Improved connectivity to John Hunter Hospital with provision of a western access.

1.7. Structure of this report

This report outlines the process used to identify and develop a refined strategic design for the project. Specifically, this report:

- Summarises community and stakeholder involvement to date, and the ongoing consultation proposed by Roads and Maritime (refer to **Section** 2)
- Describes the review of the existing strategic design within the context of the features within the study area (refer to **Section** 3)
- Summarises the constraints and opportunities, provides an overview of each of the options and describes the assessment and selection of the preferred option for the alignment and interchanges (refer to **Section** 4)
- Summarises the traffic assessment, cost estimating and economic analysis undertaken to inform the development of the refined strategic design (refer to **Section** 5)
- Provides a detailed description of the recommended preferred option adopted as the refined strategic design (refer to **Section 6**)
- Outlines the next steps to be taken for the project (refer to **Section** 7).

2. Community and stakeholder consultation

This section provides an overview of community and stakeholder consultation that has occurred to date and proposed in the future.

2.1. Community and stakeholder consultation to date

A preferred route and strategic design was last displayed for comment in 2007. A Submissions Report was prepared by Roads and Maritime in 2008 to document submissions from the public display (RTA 2008). A total of 38 submissions were received from the community and stakeholders.

The project received a number of submissions of support, while other submissions raised concerns, including:

- Private property acquisition and compensation
- Impacts to biodiversity
- Assessment of environmental impacts
- Removal of bushwalking and mountain biking tracks within the study area
- Proposed interchange design of the project with McCaffrey Drive/Lookout Road
- Proposed intersection design of the project with John Hunter Hospital.

These submissions were considered in order to finalise the preferred route corridor, which was subsequently reserved in the Newcastle Local Environmental Plan 2012.

Since project planning recommenced in June 2014 Roads and Maritime has undertaken ongoing community consultation. Key community consultation and communication activities undertaken for the project to date (refer to **Appendix A** – Community consultation material) include:

- Display of the preferred route corridor and strategic design for comment (February 2007)
- Release of Newcastle Inner City Bypass Rankin Park to Jesmond Submissions Report (March 2008)
- Community update (June 2014)
- Project update (February 2015)
- Community information drop-in sessions at Jesmond (March 2015)
- Project update (May 2015) including Frequently Asked Questions (FAQ's).

The project team is consulting with key local stakeholders including Newcastle City Council, Lake Macquarie City Council, John Hunter Hospital (NSW Health Infrastructure and Hunter New England Local Health District), Fire and Rescue NSW (bushfire management) and utility authorities.

A range of relevant state and commonwealth government agencies and external stakeholders have also been consulted as part of the review and refinement of the strategic design and development of the environmental assessment.

These include:

- Transport for NSW
- Department of Planning and Environment
- NSW Office of Environment and Heritage
- Department of Primary Industries
- Department of the Environment
- National Parks and Wildlife Service
- NSW Office of Water
- Newcastle City Council
- Lake Macquarie City Council
- NSW Health Infrastructure
- Hunter New England Local Health District
- Fire and Rescue NSW
- NSW Rural Fire Services
- Mine Subsidence Board
- Emergency services.

2.2. Key issues raised

Key issues raised by stakeholders and the community include:

- The impacts on local residents, including potential noise, traffic and visual impacts
- The impact on the bushland corridor and flora and fauna species
- The impacts of not providing a northbound on-ramp and/or southbound off-ramp at the Southern Interchange
- The need for a full access connection to John Hunter Hospital with the bypass
- Potential impacts for pedestrian access to and across the bushland corridor
- The need for off-road cyclist provisions as part of the project.

All of these issues have been investigated and considered as part of the development of the refined strategic design.

2.3. Ongoing consultation

Consultation for this stage of the project is ongoing. The refined strategic design will be on display for comment in May and June 2016. Comments are welcome from members of the public, government agencies and stakeholders, with written submissions via email, the project website or by post.

Community information sessions will be held during the display period to provide the community and stakeholders with an opportunity to learn more about the project and give feedback to the project team in person. Roads and Maritime will review and consider all comments and incorporate them in the decision-making stages of the project as appropriate.

Consultation and community involvement will continue through the concept design and environmental assessment phase of the project.

Future consultation for the project will include:

- Public display of the concept design and environmental assessment which will be in the form of an environmental impact statement (EIS). This will be for a minimum of 30 days. Advertisements will be placed in newspapers advising of the public exhibition and where the EIS can be viewed. These will also provide advice about making a submission on the project and will outline how these submissions will be considered and responded to during the planning process. This display will be managed by the NSW Department of Planning and Environment
- Written communication to all property owners within the vicinity of the proposed alignment which will advise of the environmental assessment process and the public display phase of the EIS
- Community information sessions will be held during the EIS public display period.

The Roads and Maritime project website will be updated with new information throughout the planning process and will highlight the status of the community comment periods.

3. Review of the 2007 strategic design

This section provides a description of the existing strategic design that was displayed in 2007 and summarises the outcomes of the strategic design review.

3.1. 2007 strategic design

3.1.1. Description

The 2007 strategic design consists of a four-lane dual carriageway (two lanes in each direction) between Lookout Road, near its intersection with McCaffrey Drive and the existing section of Newcastle Inner City Bypass at Jesmond, immediately north of the existing roundabout on Newcastle Road (refer to **Figure 3.1**).

Heading north to south, the alignment starts at the southern end of the existing Jesmond to Shortland section of the Newcastle Inner City Bypass. The alignment bridges over Newcastle Road and continues south about 20 to 100 metres to the east of residential properties. The alignment is on a vertical grade from Newcastle Road climbing to the south where it crosses and cuts into an east-west ridgeline. A potential left-in and left-out western connection to the John Hunter Hospital is provided at this location.

A 100 metre long bridge is provided over a gully and associated creek line around 150 metres south of the potential connection to the hospital. The bridge would reduce vegetation clearing and allow for access under the bypass for both fauna and recreational users of the bushland corridor.

South of the ridgeline the alignment curves to the left in a south easterly direction before running parallel to the hospital's southern car park with the alignment being relatively flat in grading through this section. The alignment then curves to the right traversing a series of steep gullies and creek lines. A short 30 metre bridge is provided about 350 metres north of McCaffrey Drive over a large gully and associated creek line. The bridge would allow for access under the bypass for fauna in the bushland corridor. The alignment is on a steep vertical grade in this section passing under McCaffrey Drive at about 10 per cent grade before connecting onto Lookout Road south of McCaffrey Drive.

At the northern end it was proposed to modify the existing Jesmond roundabout to provide an interchange including a bridge over Newcastle Road to eliminate conflicts between north-south and east-west traffic on Newcastle Road. There would be new connections to the roundabout on the southern side of Newcastle Road for the northbound off-ramp and southbound on-ramp.

At the southern end it was proposed to incorporate a half-interchange with Lookout Road with south-facing ramps and the bypass travelling under McCaffrey Drive. South-facing ramps include:

- Northbound off-ramp to McCaffrey Drive and Lookout Road
- Southbound on-ramp from Lookout Road to the bypass.

The strategic design did not provide a northbound on-ramp from McCaffrey Drive to the bypass nor a southbound off-ramp from the bypass to McCaffrey Drive.

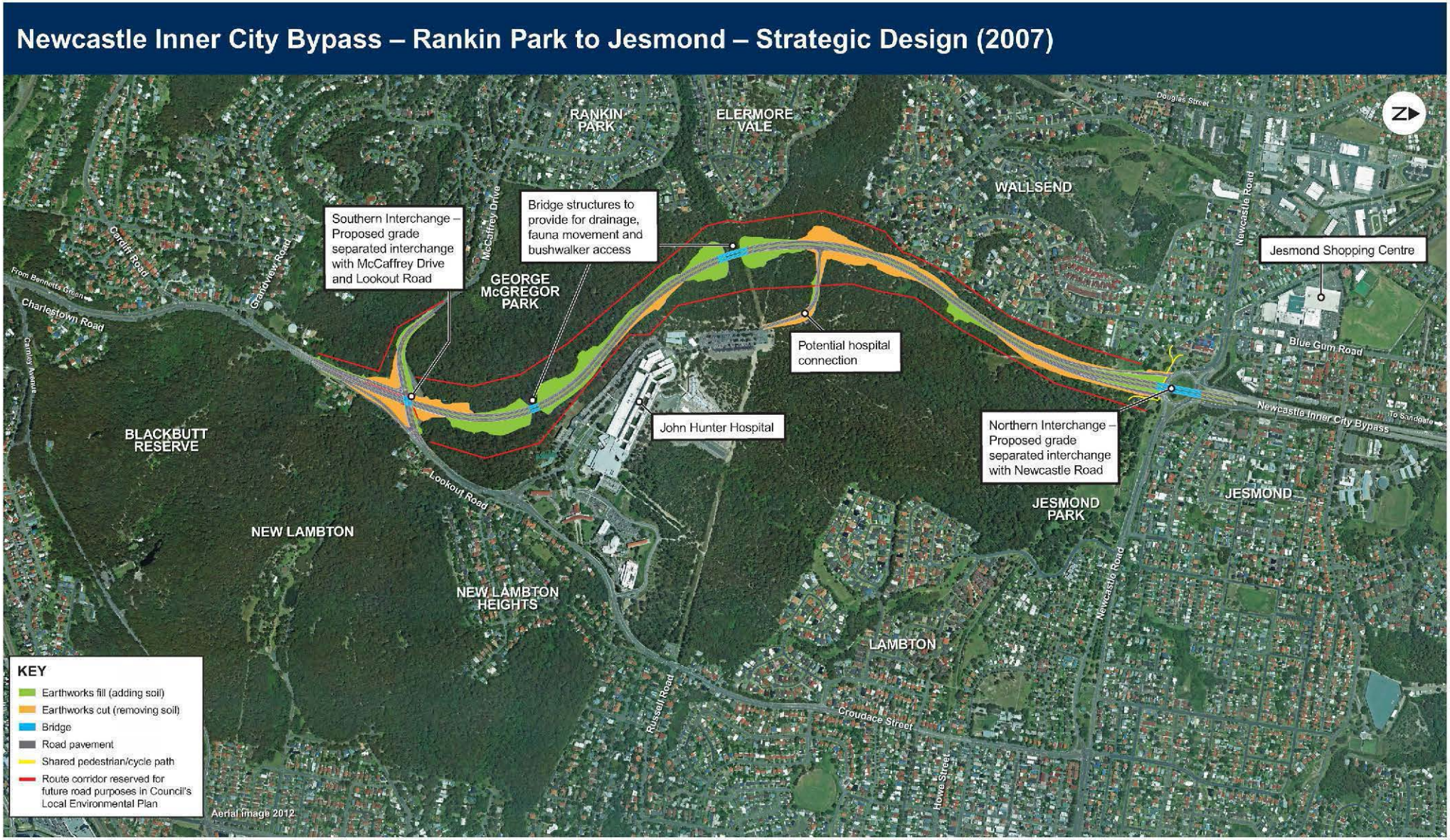


Figure 3.1 2007 strategic design

3.2. Review of the 2007 strategic design

Roads and Maritime and Aurecon (the project team) have undertaken a comprehensive review of the 2007 strategic design.

The review identified a number of potential issues with the 2007 strategic design, which would need further investigation and assessment, which are detailed below.

3.2.1. Functionality and traffic performance

Northern Interchange

Traffic modelling identified traffic performance issues with the interchange design.

Key issues identified include:

- Insufficient traffic carrying capacity on Newcastle Road associated with the use of the existing two lane roundabout as part of the interchange configuration
- Traffic congestion as a result of additional conflict points associated with the new connections to the roundabout on the southern side of Newcastle Road for the northbound off-ramp and southbound on-ramp.

Hospital Interchange

The strategic design showed a potential western connection to the hospital. The connection is for southbound left-in and left-out movements only.

Key issues identified for further consideration include no access provided for northbound vehicles to enter or exit the hospital.

Southern Interchange

Traffic modelling identified traffic performance issues with the interchange design.

Key issues identified include:

- Traffic capacity issues with the strong northbound movement that continues on Lookout Road north of the interchange. This movement is required to take a single lane off-ramp to turn right at a new intersection with McCaffrey Drive controlled by traffic lights
- Traffic capacity issues with the strong right turn out of McCaffrey Drive which passes through two sets of traffic lights
- The left turn out of McCaffrey Drive is controlled by traffic lights removing the more efficient existing left slip lane movement.

3.2.2. Design criteria

The design criteria that were adopted for the 2007 strategic design are summarised in **Table 1**.

Table 1 Design criteria – 2007 strategic design

Design element	Design criteria
Design speed	90 km/h horizontal 90 km/h vertical
Posted speed limit	90 km/h
Number of lanes	Two lanes in each direction
Traffic lane width	3.5 m
Outside shoulder widths	2.5 m (including adjacent to safety barrier)
Inside shoulder widths	1.0 m
Median width	6 m with safety barrier
Minimum horizontal radius	460 m minimum
Maximum vertical grade	10 % maximum
Vertical clearance bridges to overhead	5.3 m minimum
Design vehicle	19.5 m semi-trailer 26 m B-double

Key issues identified with the above design criteria include:

- The design speed for the strategic design is 90 km/h. There is potential to assess a 100 km/h design speed to improve the vertical and horizontal alignment in order to provide a higher standard road
- The shoulder width for the strategic design is 2.5 metres. Since the 2007 display, the *Breakdown Safety Strategy* (TfNSW 2012) has been released. The policy requires consideration of a three-metre shoulder adjacent to safety barrier on new high speed roads. This is to provide sufficient width for a stopped vehicle to be positioned wholly in the shoulder and away from through traffic, to improve safety
- Ten per cent vertical grade is not in accordance with *Austroads Guide to Road Design: Part 3 Geometric Road Design* (Austroads, 2010), which has a maximum desirable grade of eight per cent for 100 km/h operating speed in steep and undulating terrain
- The six metre wide median requires a large footprint for the project. A narrower median would reduce the project footprint and the amount of existing vegetation required to be cleared.

3.2.3. Environmental and community impacts

The existing strategic design has a number of potential environmental and community impacts.

Key issues identified include:

- The alignment impacts on a substantial number of threatened flora species namely *Tetretheca juncea, Grevillia parviflora* and an endangered ecological community at the northern end of the alignment

- There would be impacts on threatened fauna including the loss of foraging habitat for the Grey Headed Flying Fox
- The central and northern sections of the alignment are in close proximity to a large number of residents resulting in potential noise and visual impacts
- The alignment results in fragmented areas with limited connectivity for fauna and people across the bypass and to/from the hospital
- The southern section of the alignment traverses steep topography and would impact an area with complex creek lines and gullies.
- The southern interchange does not provide ramps to access to/from McCaffrey Drive. Community members have raised concerns regarding potential impacts from the omission of these ramps.

4. Options development and assessment

This section summarises the key constraints and opportunities within the study area, provides an overview of the options development and assessment process and outlines the selection of the preferred option for the alignment and interchanges.

4.1. Overview

In developing the refined strategic design, Roads and Maritime sought to better meet the project objectives and enhance the traffic performance and functionality of the project.

The options development and assessment process for the project has been comprehensive and has involved field investigations, engineering designs, key stakeholder input and technical workshops. This process has enabled the identification of potential design refinements based on engineering, environmental, geotechnical, social, economic, constructability and functional considerations.

This process involved multi-disciplinary input including:

- Road design
- Bridge design
- Environmental
- Geotechnical
- Urban design
- Traffic and transport
- Cost estimation
- Constructability
- Drainage and flooding
- Utilities and services
- Stakeholder communications.

For the purposes of developing options, the development of the refined strategic design was broadly undertaken in two parts:

- Alignment options – includes investigating the need, form and function of a hospital access
- Interchange options – connections at the northern and southern extents of the project.

The range of design review activities included:

- Review the strategic design against current standards
- Review and confirm design criteria
- Review and update mapping of constraints and opportunities
- Undertake geotechnical and mining investigations within the bushland corridor to ascertain ground conditions and potential engineering constraints
- Undertake biodiversity surveys for both flora and fauna species for inclusion in constraints and opportunities mapping

- Preliminary assessment of temporary infrastructure requirements including identification of potential areas required for construction (site compounds, batching plant sites, sedimentation basins, construction access tracks, materials storage areas, temporary stockpile areas and areas for the disposal of unsuitable materials)
- Undertake a traffic study including traffic modelling to review the strategic design, identify design modifications, particularly the design layout of interchanges and to provide data to undertake economic analysis
- Prepare strategic cost estimates and economic analysis on the refined strategic design options
- Undertake community and stakeholder consultation to identify issues to be considered in the design refinement process
- Identify potential design modifications based on engineering, environmental, geotechnical, social, economic, constructability and functional considerations
- Undertake value management workshops to assist with refinement and selection of a refined strategic design
- Further design and assessment to allow the recommendation of a refined strategic design for public display.
- Recommendation of a preferred option for the refined strategic design.

Figure 4.1 provides an outline of the broad steps and iterative process undertaken to develop and implement the project.

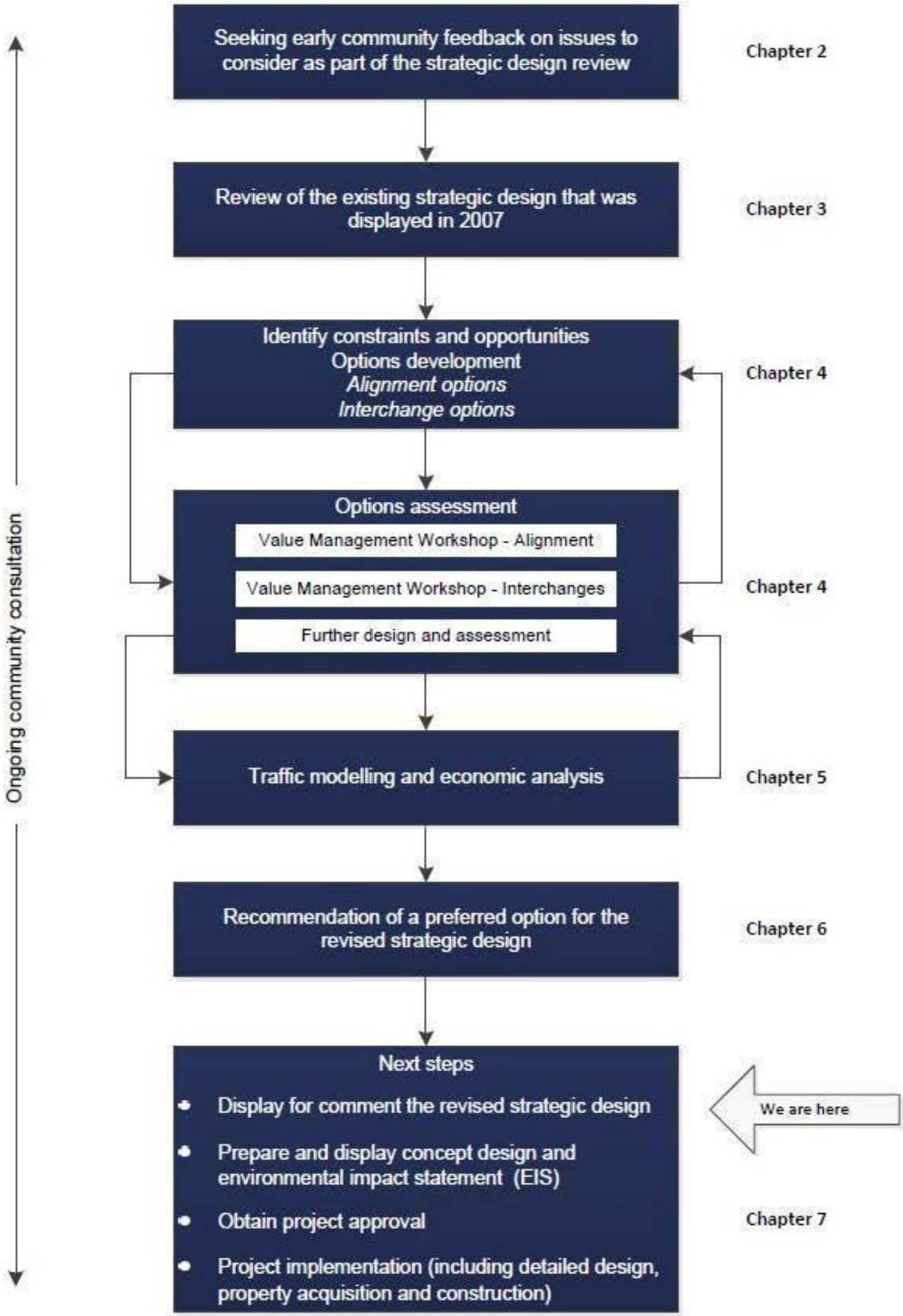


Figure 4.1 Project development and implementation

4.2. Constraints and opportunities

This section discusses the constraints and opportunities within the study area that have specifically influenced or informed the development of the refined strategic design.

Environmental constraints will be considered in further detail during the concept design and environmental assessment phase of the project as discussed in **Section 7.**

4.2.1. Biodiversity

Field Surveys

Parsons Brinckerhoff Australia Pty Ltd was engaged by Roads and Maritime to undertake comprehensive biodiversity surveys (including targeted surveys for threatened species) within the bushland corridor for the project. Previous ecological investigations of the study area were also undertaken by Umwelt Environmental Consultants in 2006.

The biodiversity surveys provide details of the ecological characteristics of the study area, providing the ecological constraints that are associated with the project. The ecological information has been gathered from a number of ecological surveys conducted for this assessment and from previous surveys conducted within the vicinity of the project.

The key objectives of the biodiversity surveys were to:

- Describe the existing environment and identify the significance of biodiversity within the study area
- Identify flora and fauna habitats and threatened ecological communities, populations and species listed under the *Threatened Species Conservation Act 1995* (TSC Act), *Fisheries Management Act 1994* (FM Act) and/or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) within the study area
- Develop maps detailing the locations of threatened flora and fauna, potential habitat features such as hollow bearing trees (HBTs) and any sensitive vegetation within the study area.

Existing environment

The vegetation contained within the study area consists of relatively undisturbed bushland and provides good quality habitat for threatened flora and fauna species. Minor disturbances present within the area include fire access, walking and mountain bike tracks and minor weed invasion within the creek lines and gullies dominated by the weed *Lantana Camara*. The condition of the vegetation communities within the study area is of moderate to good quality due to its limited history of disturbance and intact connectivity to reserves and parklands to the east such as Blackbutt Reserve. The connectivity is currently being dissected by Lookout Road, which fragments the larger areas of bushland to the east and west of the study area.

Native flora and fauna

The study area contains a large diversity of native flora and fauna. A total of 312 flora species were recorded in the study area of which 256 species (82 per cent) were native and 56 species (18 per cent) were exotic (including seven noxious weeds). A total of 79 fauna species were recorded in the study area comprised of 63 bird species (including one introduced species), 12 mammal species, two frog species and two reptile species.

Three threatened flora species and five threatened fauna species listed under the EPBC Act and TSC Act were recorded in the study area. Threatened flora and fauna species are discussed further below.

Vegetation communities and fauna habitat

Nine vegetation communities were identified within the study area (refer to **Figure 4.2**) which comprised of seven native and two exotic vegetation communities. All of the native vegetation communities were identified to be in moderate or good condition. Of the identified vegetation communities Spotted Gum Broad-leaved Ironbark Grassy Open Forest is listed as a threatened ecological community under the TSC Act. Threatened ecological communities are discussed further below.

Fauna habitat within the study area broadly aligns with the identified vegetation communities and is comprised of dry forest (typically associated with ridgelines), wet forest (typically associated with sheltered gullies), aquatic habitat (dams and creeks) and cleared land with scattered trees. The habitats associated with intact remnant vegetation are in good condition and provide suitable foraging, nesting and sheltering opportunities for a large range of native fauna. Other identified important habitat features include hollow bearing trees, stags and Powerful Owl roost and nest trees (refer to **Figure 4.3**).

Threatened ecological communities

The Spotted Gum Broad-leaved Ironbark grassy open forest vegetation community is commensurate with the TSC Act listed threatened ecological community, Lower Hunter Spotted Gum Ironbark Forest in the Sydney basin bioregion (refer to **Figure 4.2**). This threatened ecological community is listed as endangered under the TSC Act. This vegetation community occurs on the tops of ridges and the drier north-facing slopes within the northern section of the study area.

Threatened species of flora

Three threatened species of flora were recorded within, or in close proximity to the study area (refer to **Figure 4.4**).

These are:

- Black-eyed Susan (*Tetratheca juncea*) – listed as vulnerable under the EPBC Act and vulnerable under the TSC Act
- Small-flower Grevillea (*Grevillea parviflora subsp. parviflora*) – listed as vulnerable under the EPBC Act and vulnerable under the TSC Act
- Magenta Lilly Pilly (*Syzygium paniculatum*) – listed as vulnerable under the EPBC Act and endangered under the TSC Act.

A large population of Black-eyed Susan (*Tetratheca juncea*) was identified within and surrounding the study area (including Blackbutt Reserve) comprised of 10,381 plant clumps. Five sub-populations were identified consisting of three to the west of Lookout Road (8180 clumps) and two east of Lookout Road in Blackbutt Reserve (2201 clumps). This population is defined as an important population in accordance with the EPBC Act due to the number and density of plant clumps, rarity of habitat and proximity to a known population within a conservation area (Blackbutt Reserve).

Two small populations of Small-flower Grevillea (*Grevillea parviflora subsp. parviflora*) were recorded within the study area comprised of a total of 109 individuals.

A single Magenta Lilly Pilly (*Syzygium paniculatum*) was recorded on the western edge of the study area near residential areas. It is unknown if this individual is naturally occurring or has been dispersed by birds from nearby residential gardens. A Whalebone Tree (*Streblus pendulinus*) was also recorded however this species is listed as threatened in Norfolk Island only and therefore is not considered further.

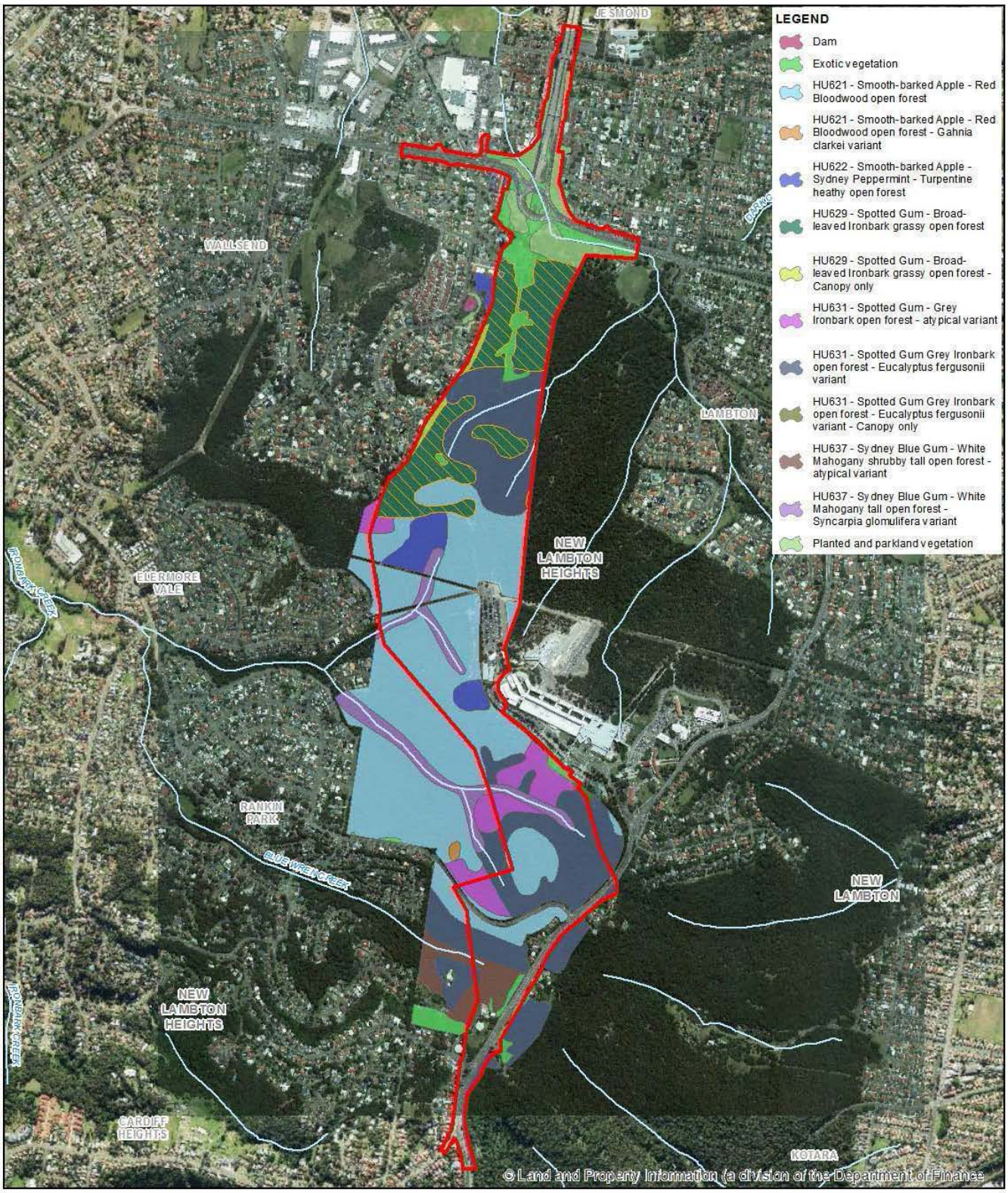
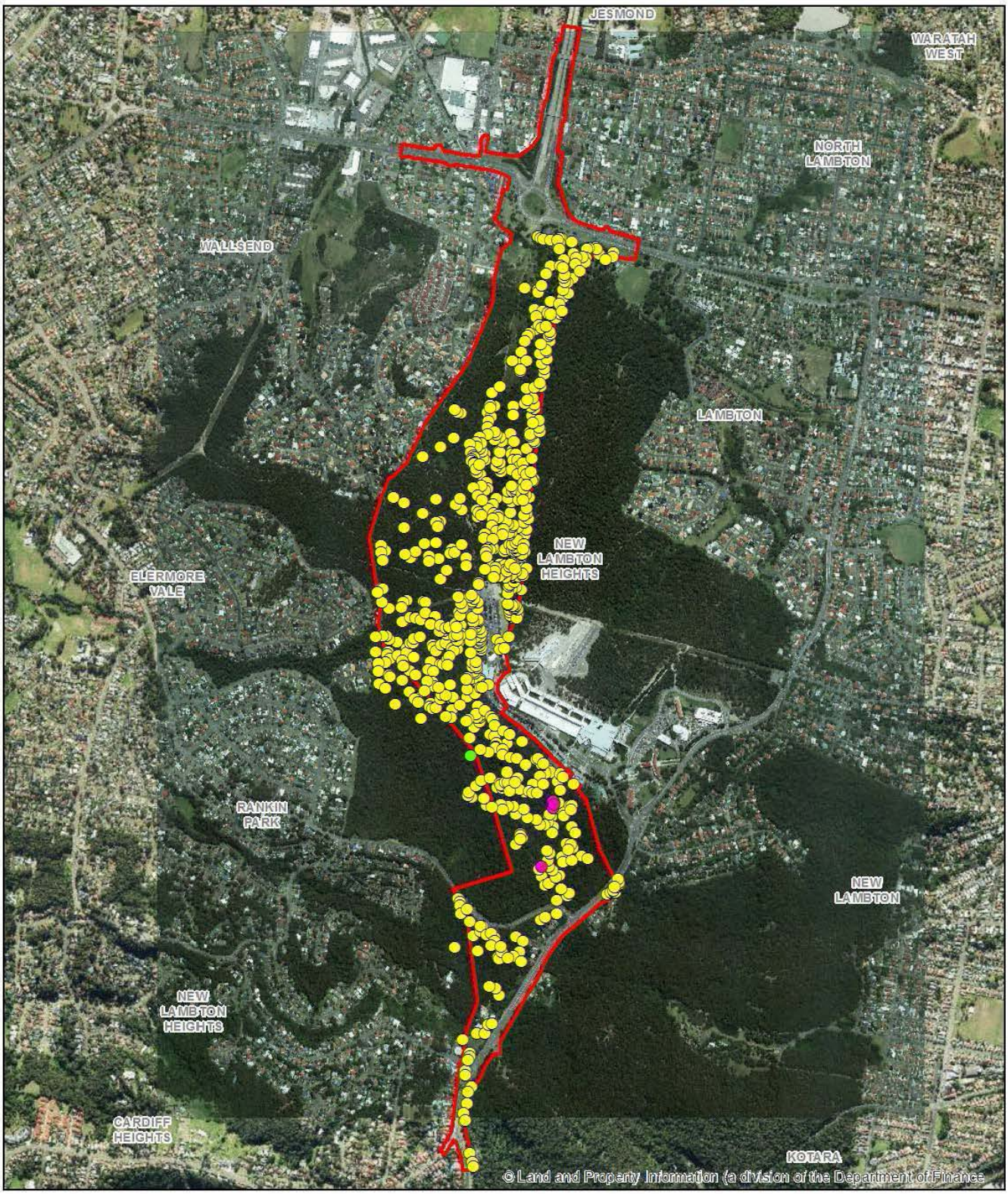


Figure 4.2 Vegetation communities within the study area



LEGEND

- Project corridor
- Powerful Owl Breeding Tree
- Powerful Owl roost trees
- Hollow Bearing Tree

Paper Size A4

0 65 130 260 390 520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

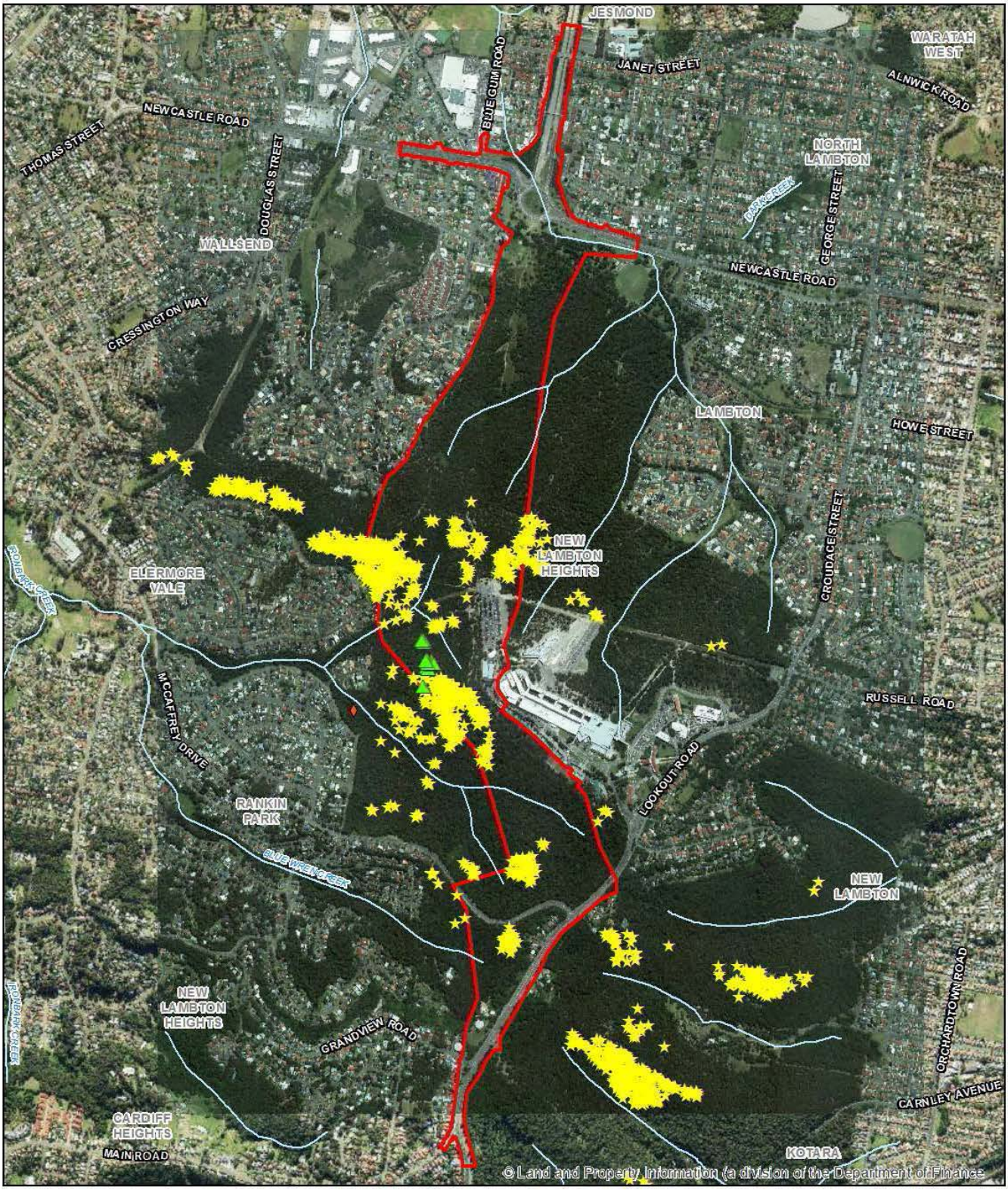
N

Rankin Park to Jesmond

Fauna habitat

G:\22\17656\GIS\Maps\Deliverables\SIDI\22217656_SIDI004_FaunaHabitat_0.mxd
Data source: Aurecon: Aerial Imagery / Assessment Corridor, 2015: PB: Fauna habitat, 2015.

Figure 4.3 Fauna habitat features



LEGEND

- Project corridor
- Grevillea parviflora
- Syzygium paniculatum
- Tetratheca juncea

Paper Size A4

0 65 130 260 390 520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Rankin Park to Jesmond

Threatened flora

G:\22\17656\GIS\Maps\Deliverables\SIDI\2217656_SIDI003_Th_Flora_0.mxd
Data source: Aurecon: Aerial Imagery / Assessment Corridor, 2015: PB: Threatened Species, 2015.

Figure 4.4 Threatened species of flora

A further six threatened flora species were identified by desktop assessments as having a moderate to high likelihood of occurrence within the study area. Targeted surveys were undertaken during the appropriate flowering periods for Nettled Bottle Brush (*Callistemon linearfolius*), Red Helmet Orchid (*Corybas dowlingii*), Thick Lip Spider Orchid (*Caladenia tessellata*), Rough Double Tail (*Diuris praecox*) and Heath Wrinklewort (*Rutidosis heterogama*) and none were identified as being present.

Threatened species of fauna

Twenty-one threatened fauna species were identified by desktop assessments as either being previously recorded within the study area, or as having a moderate to high likelihood of occurrence within the study area. No threatened frogs or other aquatic species listed under the FM Act have been identified within the study area. Field surveys have confirmed the presence of the following nine threatened fauna species:

- Grey-headed Flying-fox (*Pteropus poliocephalus*) – listed as vulnerable under the EPBC Act and vulnerable under the TSC Act
- Little Lorikeet (*Glossopsitta pusilla*) – listed as vulnerable under the TSC Act
- Little Bentwing Bat (*Miniopterus australis*) – listed as vulnerable under the TSC Act
- Powerful Owl (*Ninox strenua*) – listed as vulnerable under the TSC Act
- Squirrel Glider (*Petaurus norfolcensis*) – listed as vulnerable under the TSC Act
- Eastern Freetail-bat (*Micronomus norfolcensis*) – listed as vulnerable under the TSC Act
- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) – listed as vulnerable under the TSC Act
- Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) – listed as vulnerable under the TSC Act
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) – listed as vulnerable under the TSC Act.

Other threatened and migratory fauna species may utilise habitat within the study area on an opportunistic basis including Regent Honeyeater (Anthochaera phrygia (*syn. Xanthomyza phrygia*)), Swift Parrot (*Lathamus discolour*), Large-eared Pied Bat (*Chalinolobus dwyeri*) and Spotted-tailed Quoll (southern subspecies) (*Dasyurus maculatus maculatus*).

Targeted surveys for the Powerful Owl (*Ninox strenua*) have been undertaken and have identified a number of roost trees within the study area. A breeding pair of Powerful Owls was identified in July 2015 within the study area through monitoring of a nest tree.

One Squirrel Glider (*Petaurus norfolcensis*) was recorded during the field surveys for the project. The study area contains suitable foraging habitat for Squirrel Gliders and numerous hollow bearing trees suitable for nest sites. There are also a number of nest boxes located in proximity to John Hunter Hospital that are known to be actively used by Squirrel Gliders.

Grey-headed Flying-fox (*Pteropus poliocephalus*) were observed flying over the study area during the field surveys for the project. There is a known Grey-headed Flying-fox camp in Blackbutt Reserve suggesting that this species would use the study area regularly for foraging when suitable trees are flowering.

Koala (*Phascolarctos cinereus*) has not been recorded in the study area and the vegetation communities are not critical to the survival of the species.

Habitat connectivity and wildlife corridors

Wildlife corridors are generally links of native vegetation that join two or more areas of similar habitat and are critical for sustaining ecological processes, such as provision for animal movement and the maintenance of viable populations.

Habitat in the study area is largely intact and forms part of a large isolated patch of remnant bushland surrounded by broad scale urban development, including the John Hunter Hospital complex. This remnant patch includes Blackbutt Reserve, which is separated from the study area's eastern boundary by Lookout Road. Blackbutt Reserve contains known habitat for a number of threatened species including a locally significant Grey-headed Flying Fox camp and breeding sites for the Powerful Owl.

Connectivity between the study area and Blackbutt Reserve for these mobile species provides a larger area of foraging habitat. To the west, the study area has fragmented connectivity to Blue Gum Regional Park and areas of native bushland adjoining the Newcastle Link Road.

North of the study area the suburbs of Jesmond and the University of Newcastle separate the bushland from large wetland habitats associated with the Hunter River Estuary (including the Hunter Wetlands National Park).

To the north-east, the suburbs of Waratah and Mayfield separate the study area from the south arm of the Hunter River in which Kooragang Island estuarine habitats such as mangroves, saltmarsh and wetlands are located. The area south of the study area is fragmented urban bushland of Charlestown Recreation Reserve, Tingira Heights Nature Reserve and the large expanse of Lake Macquarie.

4.2.2. Water quality and hydrology

The study area is located within the Lower Hunter River Catchment and covers parts of the Ironbark Creek, Dark Creek and the Throsby, Styx, Cottage creeks sub-catchments. These sub-catchments include a number of named and unnamed creek lines. These creeks and any small drainage lines occurring in the vicinity of the study area drain to Ironbark Creek, which drains to the Hunter River at Hexham.

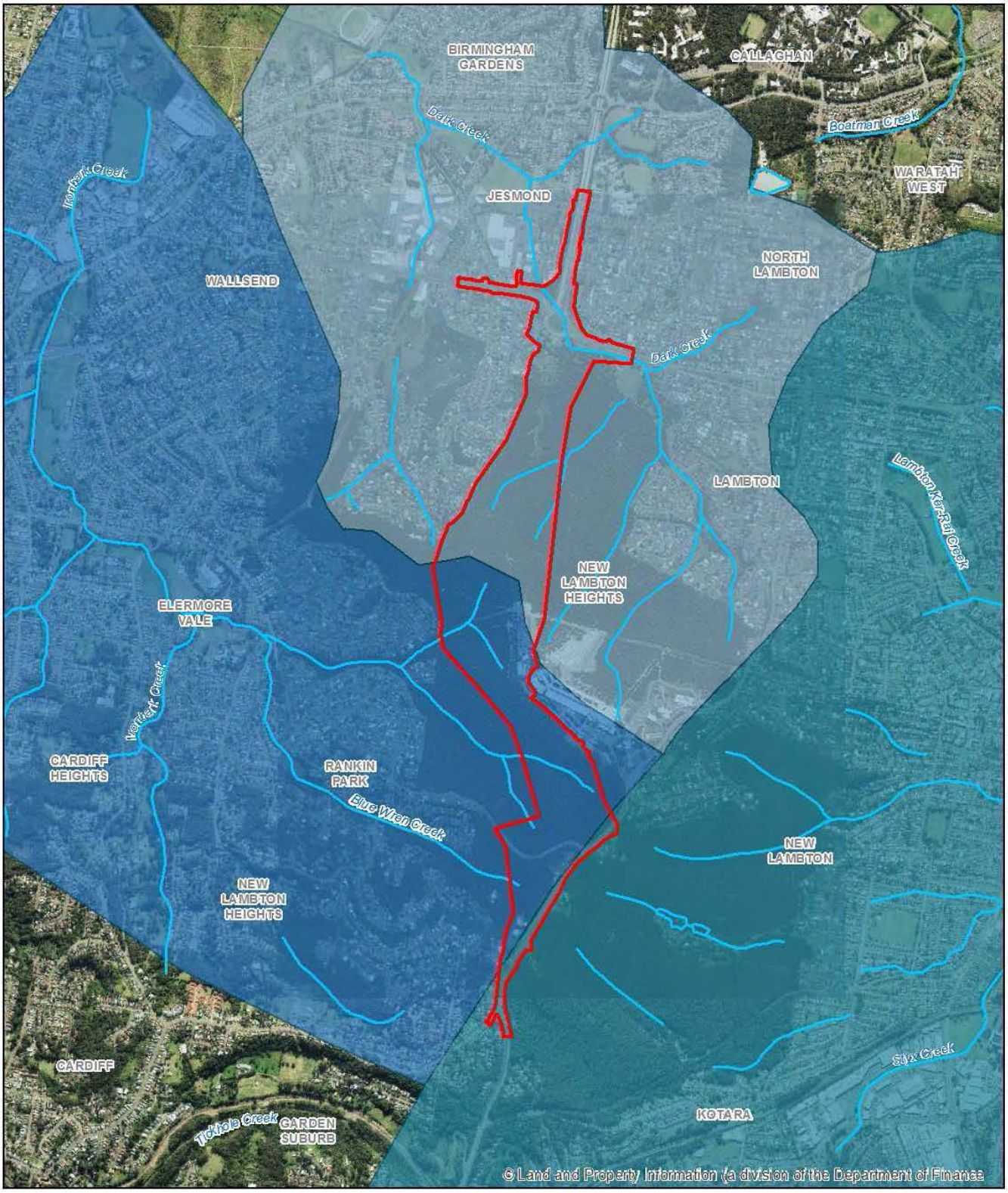
The key drainage feature of the study area is the ridgeline on which the John Hunter Hospital is located, which runs roughly north-west across the study area. The majority of the proposal is located on this ridgeline and therefore is high in elevation within the catchment. As such, there are no major watercourses present and the only upstream development is the John Hunter Hospital complex.

Catchment areas to the north-east of the ridge drain to several small creek lines in the study area, including Dark Creek. These drain to a small wetland area located to the south of Jesmond Park (refer to **Figure 4.5**), before draining to concrete-lined stormwater channels running adjacent to Newcastle Road and through Jesmond Park.

These channels drain to Ironbark Creek to the north of the study area. Several sections of these creeks were observed during site inspections to be either shallow, ephemeral depressions or more defined creeks, containing shallow pools and minor flows.

Dark and Ironbark creeks drain via urban and rural areas to the Hunter Estuary Wetlands (wetland of international importance), Hexham Swamp and Kooragang Nature Reserve (wetlands of national importance) and Hexham Swamp Nature Reserve about six kilometres downstream respectively.

Available flood mapping by Newcastle City Council shows that Dark Creek and its tributaries is subject to flooding, which extends across the existing project corridor in the northern portion of the study area.



LEGEND

- Project corridor
- Creeks
- Dark Creek Catchment
- Ironbark Creek Catchment
- Throsby, Styx and Cottage Creeks Catchment

Paper Size A4

0 90 180 360 540 720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Rankin Park to Jesmond

Drainage

G:\22\17656\GIS\Maps\Deliverables\SIDI\2217656_SIDI008_Drainage_0.mxd
Data source: Aurecon: Aerial Imagery / Assessment Corridor, 2015: PB: Drainage/Catchment, 2014.

Figure 4.5 Catchment areas

4.2.3. Aboriginal heritage

The Awabakal and Worimi peoples are recognised and acknowledged as the traditional custodians of the land and waters of the Newcastle area. The proposal area is situated within the boundary of the Awabakal Local Aboriginal Land Council (LALC). Abundant sources of marine and terrestrial resources were available for Aboriginal people in the Newcastle area and as such, the area was used extensively prior to European settlement. The study area contains land that has mostly been unmodified and contains a large area of remnant uncleared bushland. Archaeological investigations have been undertaken within the study area for the project by Brayshaw and Associates (1984) and Umwelt Environmental Consultants (2006). Field surveys were undertaken by Umwelt Environmental Consultants in 2004 and 2005 with representatives of Awabakal LALC. Further desktop assessments have been undertaken by Parsons Brinckerhoff in 2014 and a site inspection by Roads and Maritime in 2015. The nearest registered sites in the Aboriginal Heritage Information Management System (AHIMS) are located in Blackbutt Reserve. The investigations did not identify any Aboriginal heritage sites or potential archaeological deposits within the area likely to be affected by the project.

It was concluded that while Aboriginal people are likely to have used the area, they are likely to have done so from camps located along the shores of the nearby estuarine areas. The lack of major watercourses in the study area is likely to reduce the likelihood of previous occupation of the area. The archaeological significance of the study area was found to be low.

4.2.4. Non-Aboriginal heritage

The study area is situated in the western suburbs of the City of Newcastle, originally established as a penal settlement to utilise coal, timber and lime shell resources. The Hunter Valley was opened up to free settlement in 1820. The development of private colliery steam railways allowed the rapid development of colliery villages west of Newcastle with Lambton and New Lambton developed in the 1860s close to the study area.

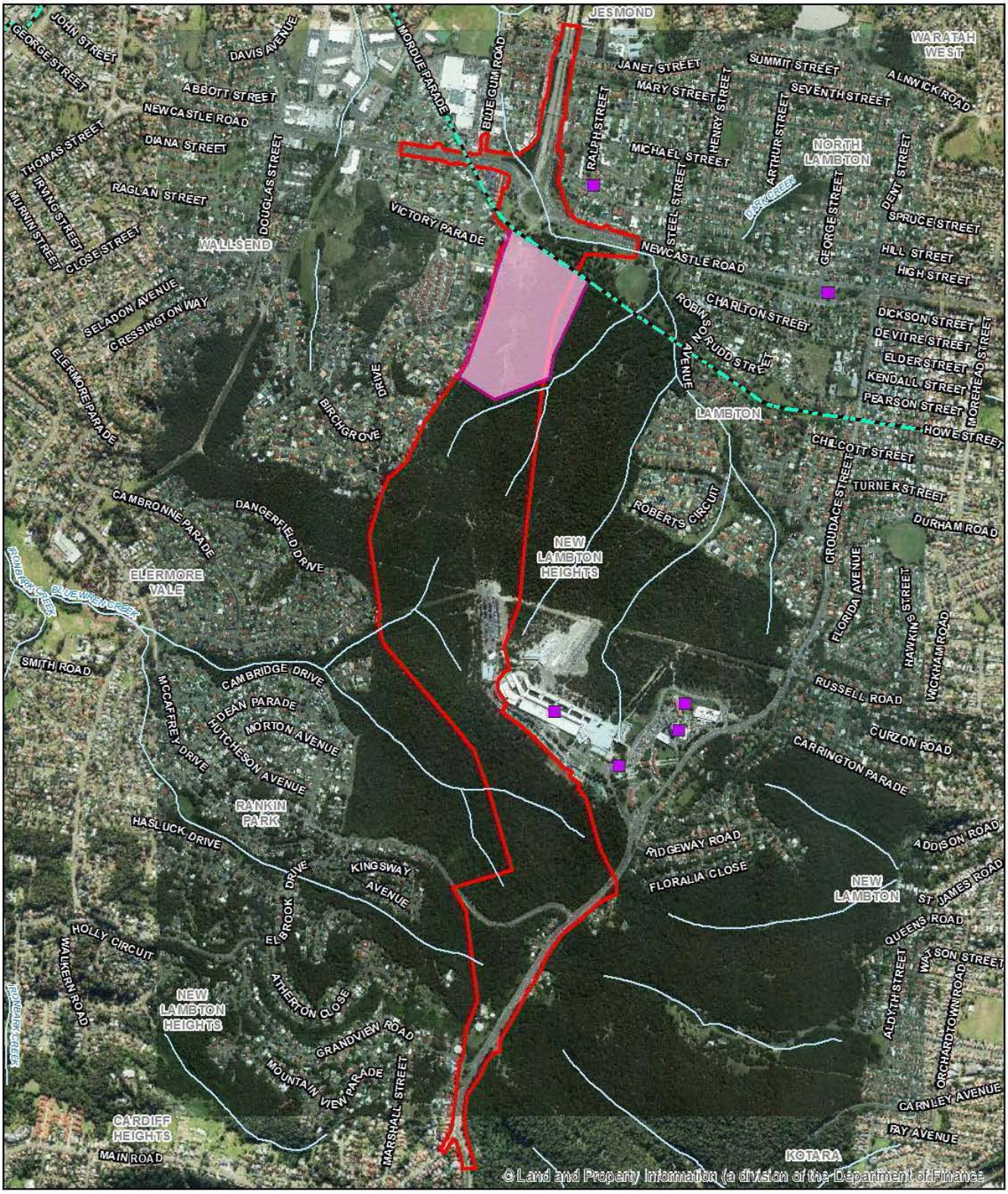
Development on the existing John Hunter Hospital site commenced in the mid-1800s with construction of buildings associated with Lambton Colliery, including the heritage listed Croudace House, which was constructed for the Lambton colliery manager, Thomas Croudace, in 1863. The site was known as Rankin Park Hospital until major redevelopment occurred in the 1980s and the John Hunter Hospital opened in 1991.

Historical heritage investigations have been undertaken within the study area for the project by DMR (1985), Umwelt Environmental Consultants (2006), Parsons Brinckerhoff (2014) and Baker Archaeology (2015).

Desktop assessments, database searches and field surveys conducted as part of these investigations have identified the following six listed heritage sites in the vicinity of the study area (refer to **Figure 4.6**):

- Croudace House and Garden – Newcastle Local Environment Plan (LEP) 2012
- Lambton Water Pump Station – State Heritage Inventory (section 170 Register, Hunter Water Corporation) and Newcastle LEP 2012
- Original building – State Heritage Inventory (section 170 Register, NSW Department of Health)
- Rankin Park Hospital – Newcastle LEP 2012
- Remnant Garden, Croudace House – Newcastle LEP 2012
- Marquis of Midlothian Hotel – Newcastle LEP 2012.

None of these listed sites are expected to be directly impacted by the project.



LEGEND

- Project corridor
- Non Aboriginal Heritage
- Newcastle Wallsend Tramline
- Possible Shanty Town location

Paper Size A4

0 65 130 260 390 520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Rankin Park to Jesmond

Heritage

G:\22\17656\GIS\Maps\Deliverables\SIDI\22217656_SIDI005_Heritage_0.mxd
Data source: Aurecon: Aerial Imagery / Assessment Corridor, 2015: AHIMS: Aboriginal Heritage Data, 2014; PB: NonAboriginal Heritage Data, 2014.

Figure 4.6 Heritage sites

There are also two unlisted historical site features in the study area (refer to **Figure 4.6**):

- A former shanty town known as Hollywood was located in the north of the site. This was established in the early 1930s and was totally removed in the 1950s. A site inspection of this area in 2015 has identified remnant material including corrugated iron sheets and kerosene tin fragments likely to be associated with the shanty town
- The former Newcastle-Wallsend Tram Line runs along the southern edge of Jesmond Park. The tram line was opened in 1887 and closed in 1951. The alignment is covered by the Lambton to Jesmond cycleway.

The project corridor has also been subject to historical underground mining. There is no known remaining surface infrastructure associated with this mining within the study area.

4.2.5. Landform, geology and soils

Existing environment

The geology of the study area is documented by the Newcastle Coalfield Regional 1:100,000 Geology Map (Hawley, Glen and Baker 1995). The underlying geology of the study area comprises Permian coals, tuffs, conglomerates, sandstones and shales of the Newcastle Coal Measures. A small extent of the study area in the north is also underlain by the Tomago Coal Measures, which comprise shale, mudstone, sandstone, coal, tuff and clay.

The landform and topography within and adjacent to the study area ranges from gently undulating hills with broad and rounded crests and ridges in the northern portion of the study area to steep gullies and grades in the southern portion. The project would traverse this landform in a general north-west to south-east direction and would comprise cut and fill batters at various locations along the project. The greater site area is characterised by north-west trending ridges and steep valleys. Off the ridgeline are a series of valleys and spurs running roughly perpendicular to the main ridge. A 120 metre elevation difference exists between Lookout Road (130 metre AHD) and Newcastle Road (10 metre AHD), with a 70 metre natural surface drop from Lookout Road at the southern end of the project. Gradients on existing adjacent roads such as Lookout Road and Croudace Street are up to 12 per cent.

Mining history and extraction

The study area is located within the Newcastle Mine Subsidence District and would require approval under Section 15 of the Mine Subsidence Compensation Act 1961. Previous geotechnical studies undertaken within the study area (DMR 1985, RTA 2006) determined that the study area has previously been undermined by coal mining operations from the former Lambton Colliery. The DMR study from 1985 determined that surface evidence of mining within the study area was minimal. Known sites of adits, drifts and vertical shafts in the area were inspected and all were found to have been infilled.

Within the study area, the Lambton Colliery extracted coal from both the Borehole and Victoria Tunnel Seams. Records of underground workings within these seams indicate that within the study area and surrounds, bord and pillar and total extraction mining methods were used. First workings in this area occurred between 1890 and 1895, with areas of total extraction being mined between 1912 and 1935. All other seams present are not known to have been commercially mined. However it is possible that illegal mining may have been undertaken where the seams outcrop or the seams are at a shallow depth. There is currently no further mining proposed within the project alignment.

The extensive historic mining has led to settlement from the collapse of the workings which has resulted in fractured and broken ground. The following sections describe the key seams that have been extensively mined over the years and therefore present a risk to the project from future settlement that will be addressed in the design.

The Borehole Seam forms part of the Lambton sub-group of rocks and underlies the majority of the proposed route corridor. The Borehole Seam is typically at depths greater than 100 metres around Lookout Road and about 15 metre to 35 metre depth at the northern end. The Borehole Seam was mined with bord and pillar methods across Newcastle and major surface subsidence of areas mined with this technique is known to have occurred; although, typically this occurred within a few years of mining.

Potential still remains for areas subject to bord and pillar mining to be subject to further surface subsidence. Areas subject to total extraction would have been affected by total collapse and infill of underground cavities at the time of mining. Any further subsidence in these areas is expected to have occurred within a few years of mining (DMR 1985). As the study area was subject to both these methods of mining, potential exists for further risk of surface subsidence within the study area.

The Victoria Tunnel Seam forms part of the upper Cardiff sub-group of rocks and appears to be confined predominantly to the southern part of the study area. The Victoria Tunnel Seam is typically 70-80 metres deep in this area. A previous study (RTA 2006) indicates that the only section of the project potentially affected by mining in this seam is the area affected by the proposed interchange with Lookout Road.

Geotechnical and mining investigations

Geotechnical investigations have been undertaken by the project team to assess the geotechnical and mining issues considered likely to affect the potential alignment and interchange options.

Past reports on geotechnical investigations within the study area were reviewed and formed the basis for developing a more detailed site investigation plan for the project.

The geotechnical and mine investigations were carried out between March and July 2015. The site investigations included the following elements:

- Sixty-six boreholes
- Thirty-one test pits
- Twenty-five pavement core holes
- Seventeen boreholes retained for groundwater monitoring
- Five seismic survey lines
- Forty borehole imaging.

A range of tests on the materials collected from site were undertaken to determine physical and chemical characteristics of the existing ground.

Design inputs

As indicated above the alignment would traverse underground mine workings in both the Victoria Tunnel Seam and the Borehole Seam. This provides constraints to the design to mitigate the potential risks associated with potential ground subsidence. Structures prone to ground subsidence along the alignment include the bridges, retaining walls and major embankments/cuts as well as general road assets such as pavements, culverts, verges, kerbs, drainage and services.

Extensive geotechnical investigations have been undertaken to establish potential remediation works for where these structures are proposed. Grouting of mine workings and/or an allowance for settlement included in the bridge design parameters may be required to mitigate potential ground subsidence. The design approach has been to use cut and fill batters to limit geotechnical issues in relation to mine subsidence, which are associated with bridging structures and retaining walls. The embankment foundation and cutting treatments will also need to address issues associated with exposure of coal seams.

4.2.6. Land use

Under the Newcastle Local Environment Plan (LEP) 2012, land within the study area is currently zoned (refer to **Figure 4.7**):

- SP2 – Infrastructure
- B2 – Local centre
- E3 – Environmental management
- R2 – Low density residential
- R3 – Medium density residential.

Land use within and surrounding the study area generally consists of:

- Bushland reserves and environmental management including George McGregor Park, Sygna Close Reserve and Blackbutt Reserve
- Infrastructure – John Hunter Hospital and the designated road corridor, which has been set aside for the project in relevant planning instruments since 1957
- A designated crown road corridor
- Residential areas
- Regional and local roads
- Public recreation – Jesmond Park.

Land within the study area is owned by Roads and Maritime, Newcastle City Council, Hunter New England Local Health District, Hunter Water Corporation, NSW Department of Trade and Investment (Crown Lands Division), Minister for Public Works and private owners (refer to **Figure 4.8)**.

A number of utilities are located within or adjacent to the study area including electricity, sewer, water, gas and telecommunications. An electricity easement traverses the study area from east to west immediately to the north of John Hunter Hospital. A high pressure underground gas pipeline and sewer pipeline also run along this easement. There are two Hunter Water reservoirs on the western side of Lookout Road, north of Grandview Road and associated major watermains.

Jesmond Park is located in the northern most section of the study area. This park includes a football oval, stand/clubhouse, car park, formal garden areas, public barbeque areas and playing equipment.

A paved, off-road pedestrian/cycleway owned by Newcastle City Council runs across the northern part of the study area which is part of a pedestrian/cycleway linking Lambton to Jesmond and Wallsend. A paved extension to this path runs from Jesmond Park to John Hunter Hospital.

There is informal use of parts of the bushland area for activities such as bike riding, bushwalking and for pedestrian access to John Hunter Hospital. There is also a network of fire trails throughout the study area and surrounds.

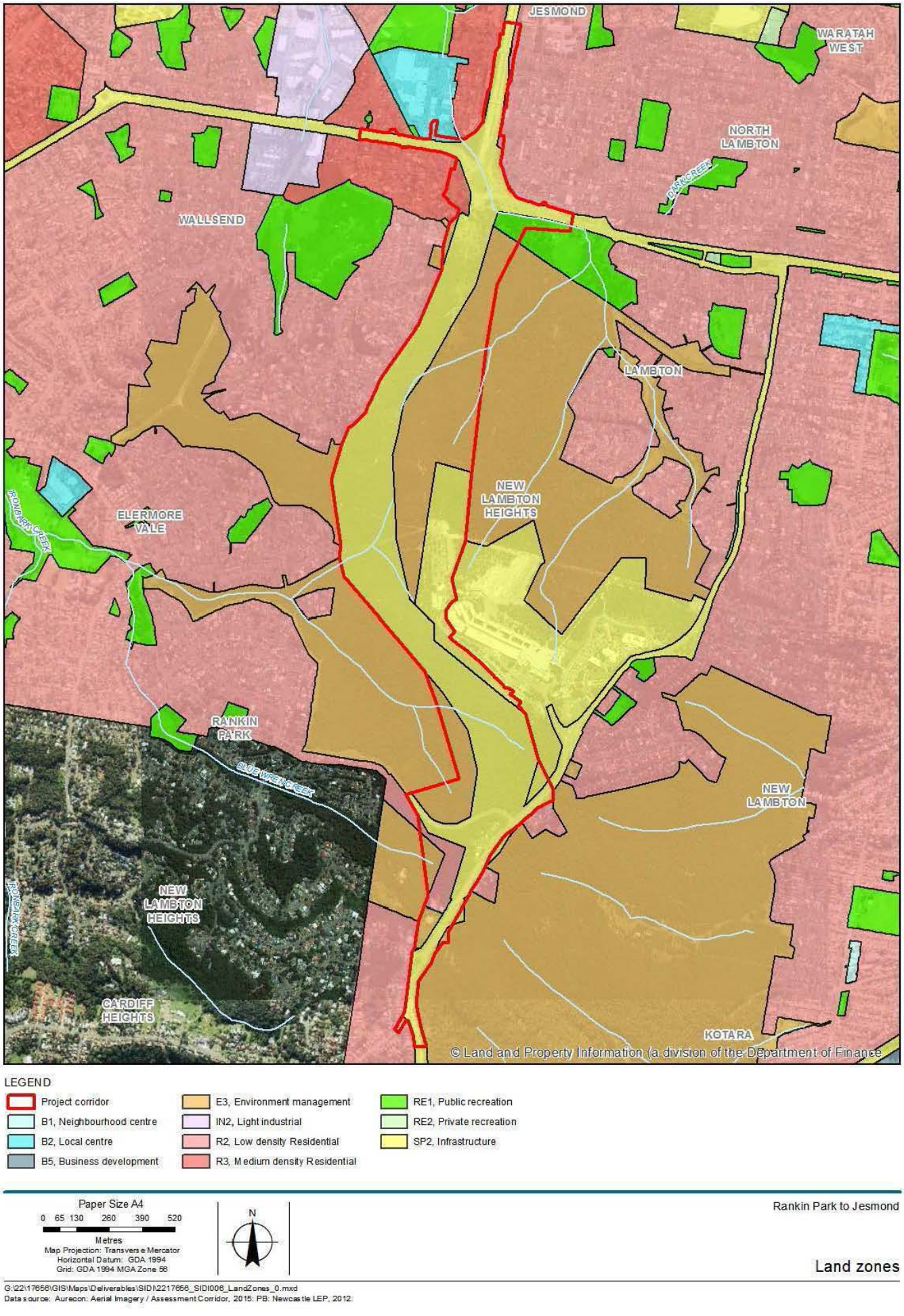
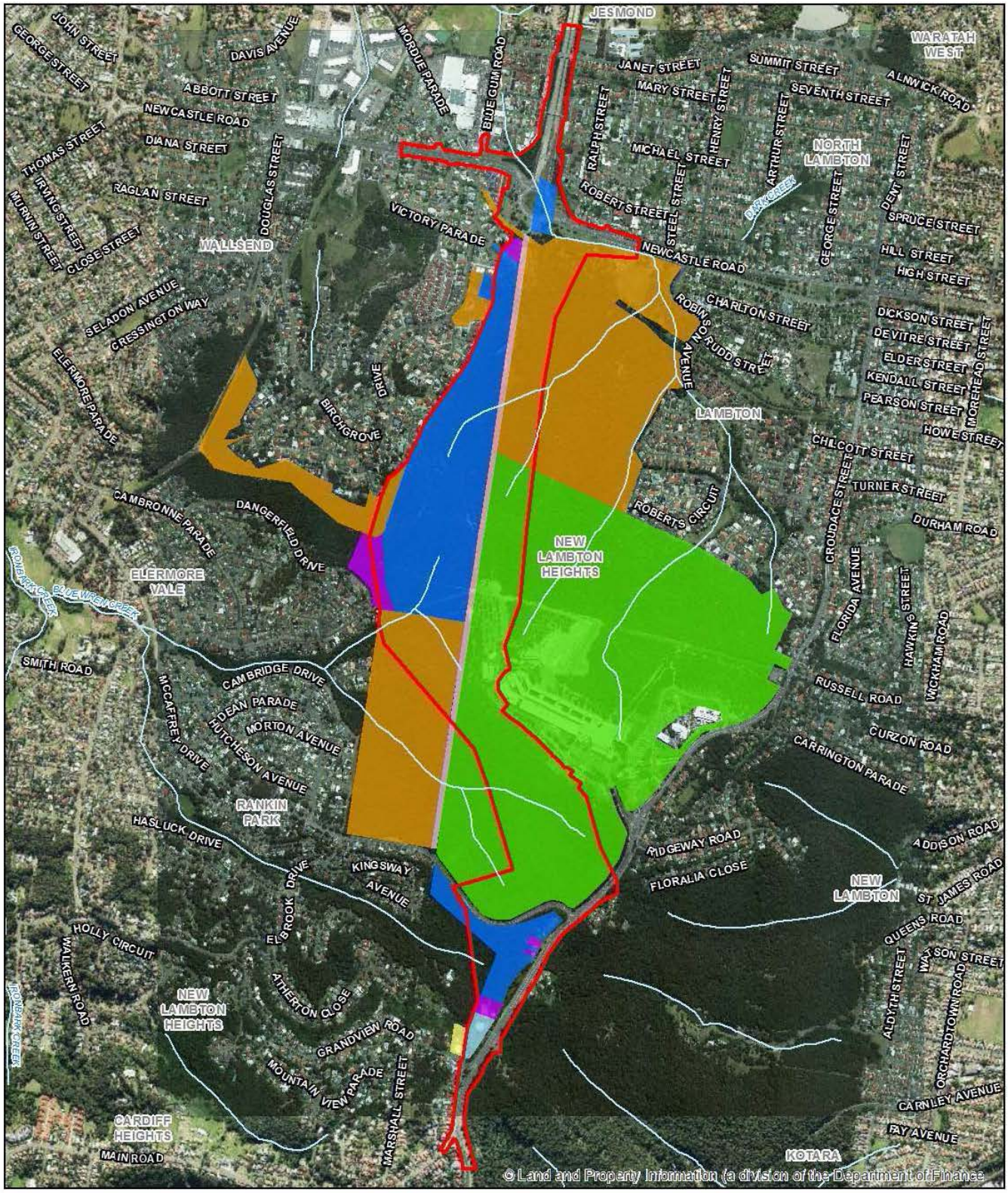


Figure 4.7 Land zones (Newcastle Local Environmental Plan 2012)



LEGEND

- Project corridor
- Crown road
- Privately owned
- Hunter New England Local Health District
- Newcastle City Council
- Roads and Maritime Services
- Hunter Water Corporation
- Minister for Public Works

Paper Size A4

0 65 130 260 390 520

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Rankin Park to Jesmond

Land ownership

G:\22\17656\GIS\Maps\Deliverables\SIDI\2217656_SIDI007_LandOwnership_0.mxd
Data source: Aurecon: Aerial Imagery / Assessment Corridor, 2015; PB: Land ownership, 2014.

Figure 4.8 Land ownership

4.2.7. Visual and landscape character

Several distinct landscape character types and visual catchments occur within and adjacent to the study area, each defined by factors such as built form, natural form and adjacent land use types.

Key landscape features occurring in the study area include:

- Topography – the landscape of the study area is very undulating and is characterised by a series of prominent ridgelines and deep gullies
- Vegetation – the study area is dominated by naturally occurring native vegetation
- Land use – the majority of the study area consists of vacant bushland. Adjoining land uses include the John Hunter Hospital, Lookout Road, Newcastle Road and residential suburbs such as New Lambton Heights, Wallsend, Elermore Vale, Rankin Park and Jesmond
- Built features – the study area contains few built features, although it is surrounded by residential suburbs, parklands and arterial roads. The John Hunter Hospital is the dominant built development within the surrounding area, which is located on a ridgeline that traverses the study area and is visible from a number of locations in the surrounding area.

The proposal would traverse a bushland environment surrounded by varied urban-residential areas. The project would be screened from some locations through a combination of topography and vegetation.

Visual catchments refer to areas which the proposal would potentially be visible from. Key visual catchments that may be affected by the proposal include John Hunter Hospital, Jesmond Park and surrounding residential areas.

4.2.8. Bushfire and emergency services

The project is located in a large bushland area, which is defined as a bushfire prone area in mapping by Newcastle City Council. The study area contains a network of existing fire trails that aid with management of bushfires and bushfire hazard reduction.

The project team has consulted with relevant fire authorities and land owners including Fire and Rescue NSW, Newcastle City Council and Hunter New England Local Health District to assess potential impacts of the project and develop mitigation options as part of the development of the refined strategic design.

Ensuring adequate provisions are identified for bushfire and emergency services is an important consideration in the development of the design for the project.

Figure 4.9 shows existing bushfire management trails within the bushland corridor.

4.2.9. Traffic, transport and access

The existing State road network relevant to the proposal comprises the following routes (refer to **Figure 4.10**):

- Newcastle Inner City Bypass (A37) – Newcastle Road, Jesmond to Pacific Highway, Sandgate
- Newcastle Inner City Bypass (A37) – Charlestown Road, Lookout Road and Croudace Street (between Charlestown Bypass and Newcastle Road)
- Newcastle Road (A15) – generally between Wallsend and Broadmeadow, specifically between Blue Gum Road, Jesmond and Croudace Street, Lambton.

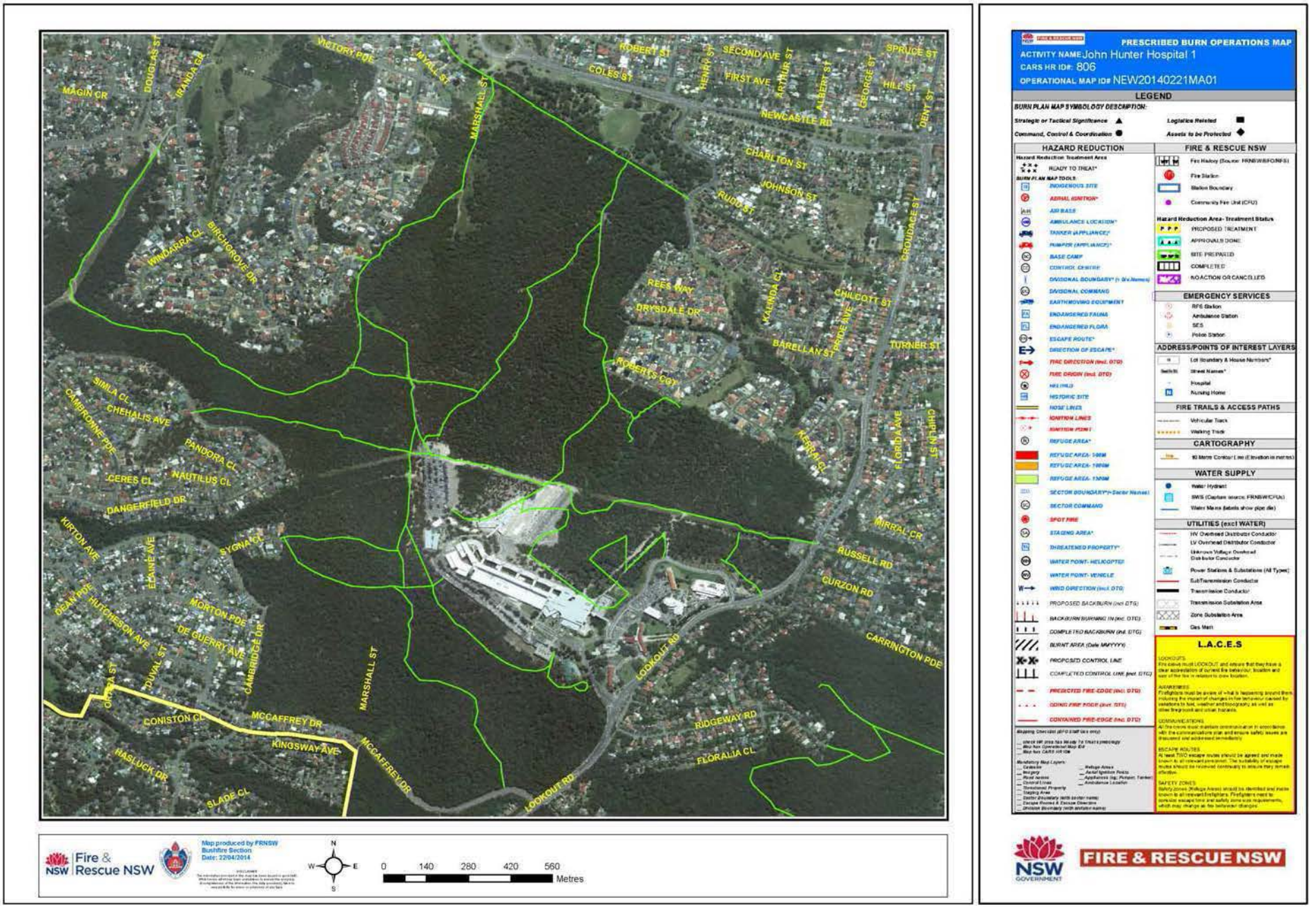


Figure 4.9 Bushfire management

LEGEND

Project corridor

Paper Size A4

0 70 140 280 420 560

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Rankin Park to Jesmond

Existing road network

G:\22\17656\GIS\Maps\Deliverables\SIDI\2217656_SIDI009_Exg_RoadNetwork_0.mxd
Data source: Aurecon: Aerial Imagery / Assessment Corridor, 2015: LPI: Road network, 2012.

Figure 4.10 Existing road network

Key regional roads within the study area include:

- Carnley Avenue
- Main Road/Cardiff Road
- McCaffrey Drive
- Russell Road
- Howe Street.

The project will also consider impacts on some local roads in the study area due to the potential redistribution of traffic with the project. This includes local roads such as Grandview Road and Marshall Street at the southern end of the project.

A brief description of each of these major traffic routes is provided below.

Charlestown Road/Lookout Road/Croudace Street (section of the A37)

The predominant north-south route through the study area, this section provides a link between Charlestown Road and Newcastle Road. It is intersected by various east-west connector roads and provides an important arterial road function for the western Newcastle road network.

The key features of this road are:

- The route varies between an undivided and divided four-lane configuration
- Generally good horizontal alignment along the Lookout Road ridgeline but major variability in vertical alignment, with steep grades on the Croudace Street section between New Lambton Heights and Lambton
- Main access route to John Hunter Hospital off Lookout Road.
- Signalised intersections with Carnley Avenue, Cardiff Road, McCaffrey Drive, Kookaburra Circuit, Jacaranda Close, Russell Road, Mitchell Street/Pride Avenue, Howe Street and Newcastle Road
- The route passes New Lambton Heights Infants School and Lambton Public School with associated 40 km/h school zones
- Numerous intersections (without traffic lights) associated with local road connections
- Numerous private property frontages and residential accesses over the full length.

Newcastle Road

Within the immediate study area the key features of this road are:

- Typically dual carriageway with two lanes in each direction
- Provides an east-west link between Newcastle and Wallsend and the M1 Pacific Motorway
- Major intersections with traffic lights with Croudace Street/Dent Street and with Blue Gum Road
- Numerous intersections without traffic lights with streets in North Lambton, the majority of which are left-in/left-out only
- Signalised pedestrian crossing on Newcastle Road around 300 metres east of the roundabout at Jesmond
- A large roundabout at the junction with A37 at Jesmond which is partially signalised on the north-west corner
- Typically the road has variable vertical and horizontal alignment, with a major hill immediately west of Croudace Street.

Newcastle Inner City Bypass – Jesmond to Sandgate

The existing section of Newcastle Inner City Bypass comprises typically of a four-lane divided carriageway with an interchange at University Drive about one kilometre north of Newcastle Road. The total length of this section of Newcastle Inner City Bypass is about five kilometres and represents an important component of the State road network in the Newcastle region.

Howe Street

Howe Street provides a connection between Lambton and New Lambton. The route is popular for travel between the inner western suburbs and the Jesmond/Wallsend area. It is a two-way suburban street with numerous residences and property accesses.

Russell Road

Russell Road together with McCaffrey Drive provides a major east-west route within the study area. It provides a link between Croudace Street at New Lambton Heights and New Lambton/Broadmeadow in the east. The route passes through the New Lambton Shopping district and the commercial area of Broadmeadow. With typically two lanes in each direction, the road passes through both residential and commercial properties.

McCaffrey Drive

McCaffrey Drive provides a connection to both Lake Road and Thomas Street through Rankin Park, Elermore Vale and Wallsend. The road is characterised by a two-lane single carriageway with residential properties and it passes Elermore Vale shopping centre. The route provides a major east-west route together with Russell Road. It also provides a regional road link between the section of the Newcastle Inner City Bypass south of McCaffrey Drive and suburbs to the north-west of the study area such as Fletcher, Maryland and further west.

Main Road/Cardiff Road

Main Road/Cardiff Road provides a connection to the suburbs of Cardiff, Glendale and Boolaroo to the west of Lookout Road. The road typically consists of a two-lane, undivided carriageway with some sections having variable vertical and horizontal alignment. This road services residential and commercial areas, as well as the Cardiff industrial complex.

Carnley Avenue

Carnley Avenue is a single carriageway with typically a single eastbound and two westbound lanes. It provides a connection between Charlestown Road at Kotara Heights and Bridges Road at New Lambton. It passes along the southern boundary of Blackbutt Reserve and provides a key link for travel between Newcastle and Lake Macquarie.

Crash history

The road network in the study area is subject to a high number of crashes. From 2010 to 2014 there were 315 crashes recorded on the existing route of Lookout Road, Croudace Street and Newcastle Road (refer to **Figure 4.11**).

The majority of crashes were rear-end, which typically occur at a higher rate in congested traffic. The project is expected to improve road safety on the existing route as a result of improved traffic flow. A detailed road safety assessment will be undertaken during the concept design phase.

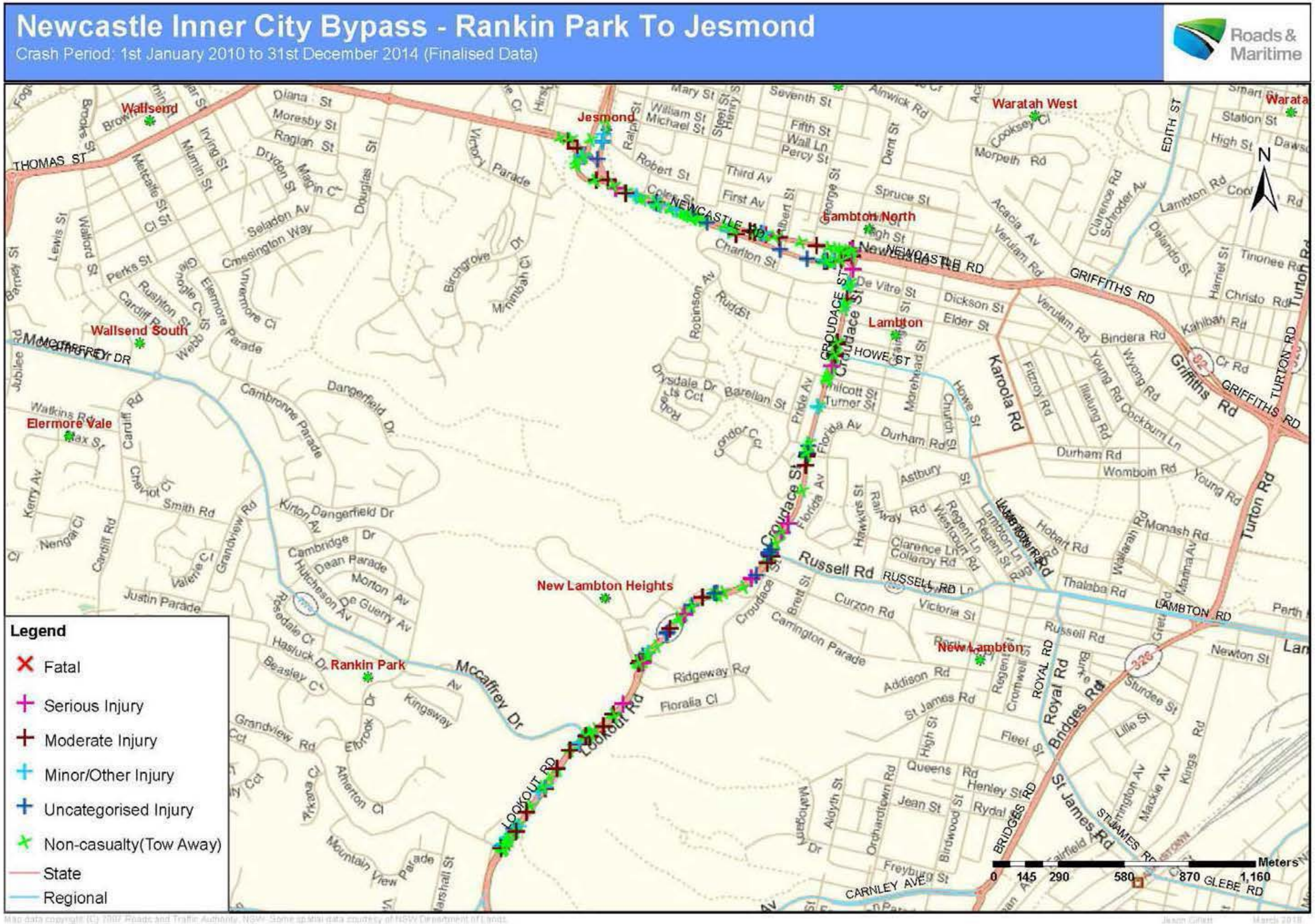


Figure 4.11 Crash history

Pedestrian and cyclist use

A paved east-west off-road shared path crosses the northern extent of the study area, linking the suburbs of Jesmond and Lambton. A branch of this path extends north-south to the John Hunter Hospital. Cyclists are able to use the 2 to 2.5 metre shoulders on the existing sections of the Newcastle Inner City Bypass. Footpaths are available for pedestrian use on roads such as Lookout Road and McCaffrey Drive. Existing tracks in the bushland corridor are used to provide access to John Hunter Hospital. Newcastle City Council's *Newcastle Cycling Strategy and Action Plan 2013* (Newcastle City Council 2013) identifies proposed off-road and on-road cycling routes within the study area. (refer to **Figure 4.12**).

Public transport

Several bus stops are located along the existing route utilised by numerous bus services and routes. The John Hunter Hospital is a key bus stop and is identified as a 'timing point' by Newcastle Buses.

Constructability access

Due to the location of the project in a bushland area, there are limited access points and routes within the corridor. This combined with the steep and undulating terrain, results in constructability constraints that need to be considered as part of the development of the project.

As the majority of the project would be constructed within the bushland corridor it is unlikely to cause substantial disruption to the local traffic network. However traffic disruptions would occur during works associated with modification of the intersections of the Newcastle Inner City Bypass with both Newcastle Road at the northern connection and McCaffrey Drive/Lookout Road at the southern connection.

Due to the existing high volumes of traffic using these intersections, the minimisation of traffic disruptions at these locations would need to be a consideration during the planning and design phases in terms of construction methodology and staging. In addition, access for road and bridge maintenance requirements once the project is in operation is a key consideration.

4.2.10. Hospital access

Background

The John Hunter Hospital is the principal tertiary referral centre and a community hospital for Newcastle, Lake Macquarie and northern New South Wales. It is also the main teaching hospital of the University of Newcastle, contains the only trauma centre in NSW outside of the Sydney Metropolitan Area and is the only children's hospital servicing northern NSW.

The facility has 550 adult beds with another 101 paediatric beds in the John Hunter Children's Hospital. The Royal Newcastle Centre (formerly Royal Newcastle Hospital) is located next to the John Hunter Hospital, providing another 144 beds. The campus is also the home of the Hunter Medical Research Institute, Forensic Medicine Facility and Hunter Area Pathology Service.

Patients from the Hunter Region and beyond are referred to John Hunter for treatment in a range of specialities including Anaesthesia and Intensive Care, Orthopaedics (elective and trauma), Cardiology and Cardiac surgery, Emergency Medicine, Renal Transplant, Endocrinology, Gastroenterology, Neonatal Intensive Care, Nephrology, Neurology, Obstetrics and Gynaecology, Oral and Maxillofacial surgery, Respiratory Medicine and Trauma. The hospital campus also contains the 171 bed Newcastle Private Hospital.

Access to and from the hospital campus is highly constrained. The primary and secondary access points for the campus currently cater for about 18,000 vehicles per day. The two access points are closely located to each other on Lookout Road. Due to access constraints during peak hours the internal hospital road network is highly congested and it can take over 45 minutes to navigate as a consequence.

Figure 4.12 Newcastle Cycling Strategy and Action Plan 2013

Western access off the bypass

The 2007 strategic design provided a potential access between the bypass and John Hunter Hospital allowing for left-in from the bypass to the hospital and left-out from the hospital to the bypass only. As part of the development of the refined strategic design, the need, form and function of a western hospital access has been reviewed and alternative access options assessed (refer to **Section 4.4**).

4.2.11. Freight

Heavy vehicle volumes on the existing route of Lookout Road, Croudace Street and Newcastle Road are currently low at about four per cent of all traffic.

In the study area, the existing B-Double routes include Newcastle Road and the northern section of the Newcastle Inner City Bypass between Jesmond and Sandgate.

The existing route of Lookout Road and Croudace Street and the existing sections of the Newcastle Inner City Bypass to the south through to the Pacific Highway at Bennetts Green are not approved for B-Double use.

The project would give potential for this section and existing sections of the Newcastle Inner City Bypass to the south to be approved for B-Double use, providing efficiency and safety improvements for freight on the road network.

4.2.12. Summary of key constraints and opportunities

The 2007 strategic design review has examined a range of community, environmental, engineering and traffic considerations. These have been developed based upon a range of inputs including:

- Stakeholder and community feedback (refer to **Section** 2)
- Review of the 2007 strategic design (refer to **Section** 3)
- Analysis of the constraints and opportunities within the study area (refer to **Sections 4.2.1** to **4.2.11**).

The key considerations for the development of the refined strategic design and subsequent concept design include:

- Proximity of residents including potential noise and visual impacts
- Access and connectivity across the corridor for both people and animals
- Access options for John Hunter Hospital
- Local ecology and environmental impacts
- Traffic performance of the interchanges and the surrounding road network
- Design layout of the southern interchange with Lookout Road, including a review of the need for a northbound on-ramp and/or southbound off-ramp with McCaffrey Drive
- Design layout of the northern Interchange at Newcastle Road and existing Jesmond to Sandgate section of the Newcastle inner City Bypass
- Provision for pedestrians and cyclists
- Steep, undulating terrain and designing the project to fit into the landform
- Geotechnical risks including mine subsidence
- Design features such as grades and design speed
- Constructability and future maintenance requirements.

Figure 4.13 shows some of the key considerations for developing the refined strategic design alignment within the bushland corridor.

4.3. Design criteria

Road geometry for the development of the refined strategic design has been designed in accordance with Austroads Guide to Road Design (2010) and where applicable Road and Maritime supplements.

The design criteria adopted for the project are summarised in **Table 2**.

Table 2 Design criteria – refined strategic design

Design element	Design criteria
Design speed	100 km/h horizontal 100 km/h vertical
Posted speed limit	90 km/h
Number of lanes	Two lanes per carriageway
Traffic lane width	3.5 m
Outside shoulder widths	2.5 m (with no safety barrier) or 3.0 m (with safety barrier)
Inside shoulder widths	1.0 m
Median width	2.6 m generally with barrier
Minimum horizontal radius	750 m minimum
Maximum vertical grade	Eight per cent maximum
Vertical clearance bridges to overhead	5.5 m desirable 5.3 m minimum
Design vehicle	19.5 m semi-trailer 26 m B-Double

The typical cross-section is shown in **Figure 4.14**.

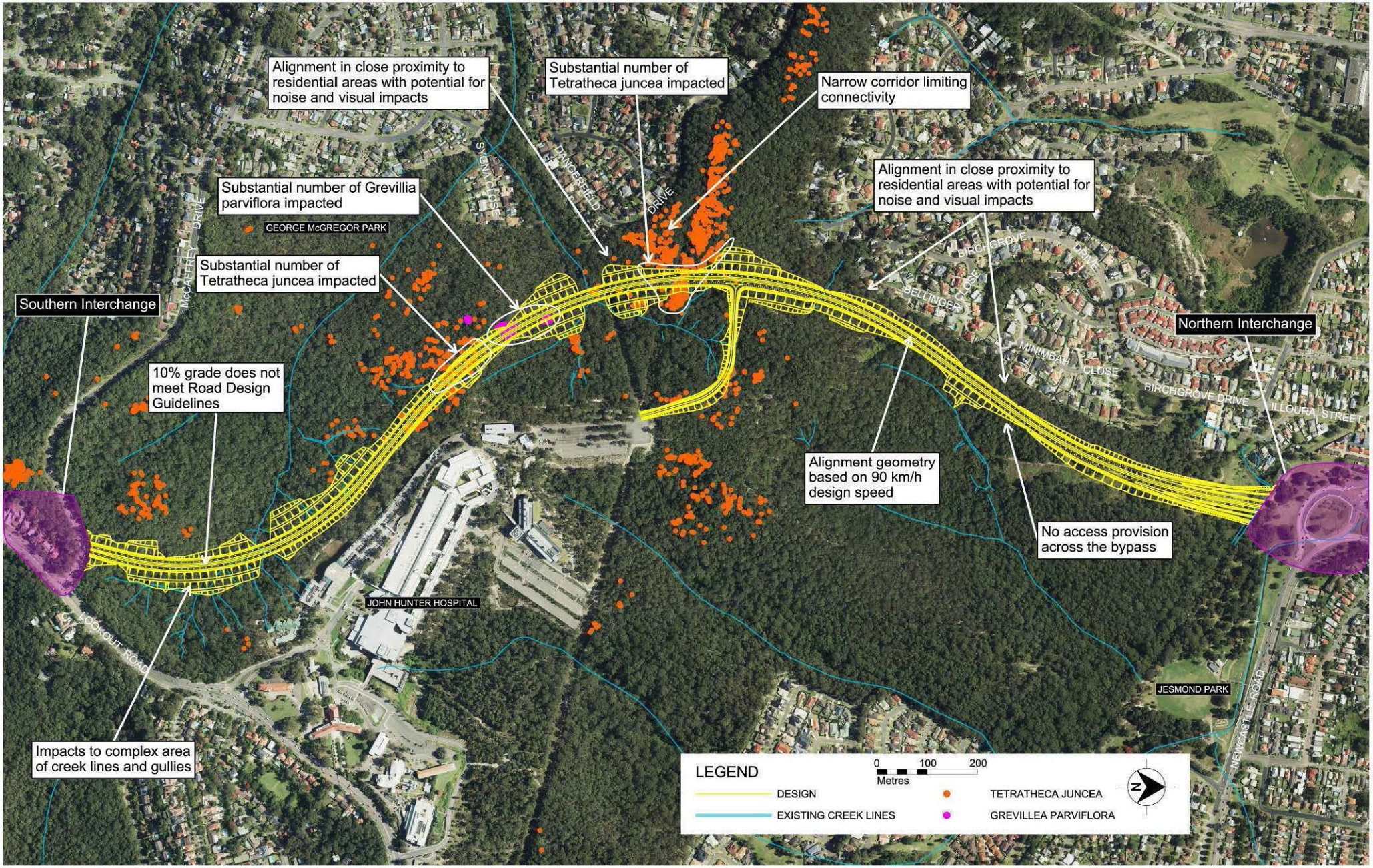


Figure 4.13 Key alignment considerations

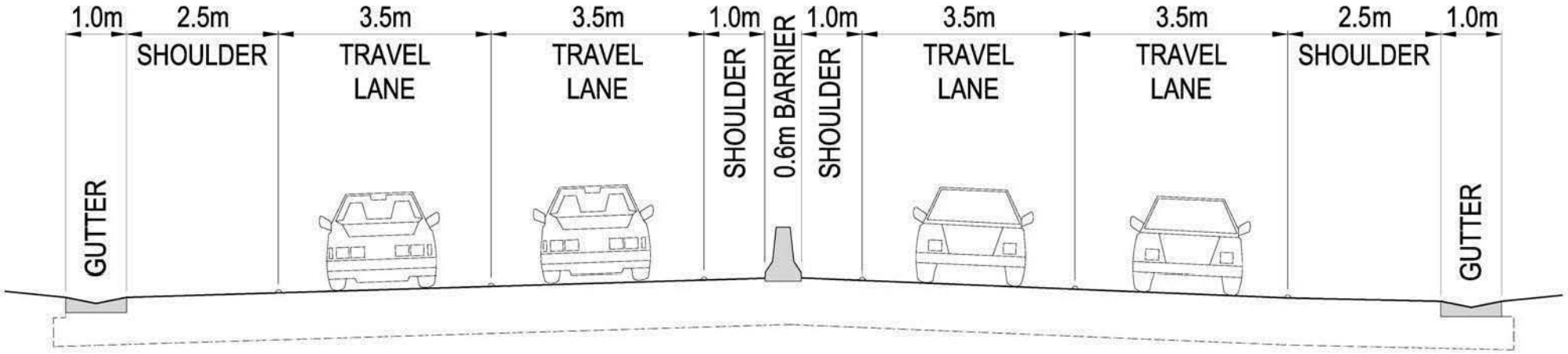


Figure 4.14 Typical cross section

4.4. Alignment – options description

This section outlines the development and assessment of alignment options for the project including access options to John Hunter Hospital off the bypass.

Several alternatives to the existing strategic design alignment were investigated. These were refined to two alignment options for comparison and assessment as detailed below.

For alignment comparison purposes only, the hospital connection with left-in and left-out configuration from the 2007 strategic design (refer to **Figure 4.16** Hospital Option 1) was replaced with a larger full interchange (refer to **Figure 4.17** Hospital Option 2). This was to allow any potential impacts due to the larger construction footprint (associated with the full interchange option) to be included in the assessment of the two short-listed alignment options. The assessment of access options for John Hunter Hospital was further developed and assessed separately at a later stage in the development of the project, with traffic impacts a key consideration (refer to **Section 4.4.3.2**)

4.4.1. Alignment Option 1

Alignment Option 1 generally refers to the 2007 strategic design alignment as described in **Section 3.1.1** and is illustrated in **Figure 4.15**. As detailed above, the hospital connection with the left-in and left-out configuration (refer to **Figure 4.16** Hospital Option 1) was replaced with a full interchange (refer to **Figure 4.17** Hospital Option 2) for the purposes of alignment options assessment. This provides an additional northbound off-ramp and northbound on-ramp to allow northbound traffic to enter and exit the hospital.

4.4.2. Alignment Option 2

Alignment Option 2 is illustrated in **Figure 4.18.** Heading north to south, the alignment starts at the southern end of the existing Jesmond to Shortland section of the Newcastle Inner City Bypass.

The alignment bridges over Newcastle Road and diverges to the east away from Alignment Option 1. As a result the alignment retains between around 50 metres to 250 metres of bushland buffer to residential properties.

A bridge is provided over a gully and associated creek line about 650 metres south of Newcastle Road. The bridge would reduce vegetation clearing and allow for access under the bypass.

The alignment is on an upgrade from Newcastle Road, climbing to the south where it crosses and cuts into an east-west ridgeline. As detailed above, a full-interchange (refer to **Figure 4.17** Hospital Option 2) was adopted for the purposes of alignment options assessment and is located at this ridgeline with the alignment moved closer to the hospital than Alignment Option 1. This results in greater separation to residential properties to the west and a reduction in the length of roadway required to connect to the hospital.

South of the hospital interchange the alignment curves to the left in a south-easterly direction in close proximity to the western extent of the hospital complex with the alignment being relatively flat in grading through this section.

The alignment then curves to the right diverging away from the southern extent of the hospital and Alignment Option 1. A culvert is provided across the alignment about 300 metres north of McCaffrey Drive to allow for access under the bypass for fauna in the bushland corridor.

The alignment is on a steep upgrade in this section passing under McCaffrey Drive at about eight per cent grade before connecting onto Lookout Road north of Grandview Road.

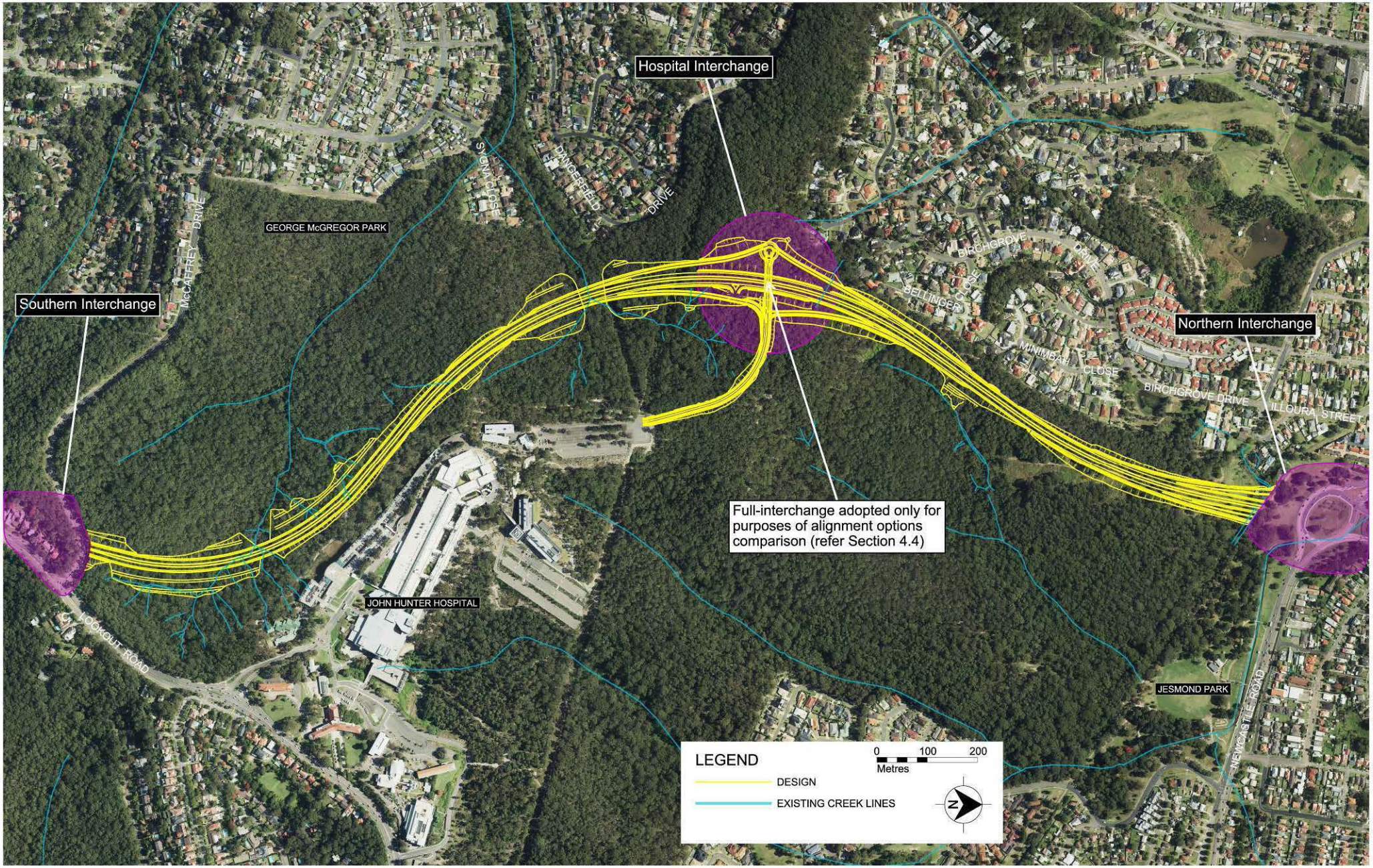


Figure 4.15 Alignment Option 1

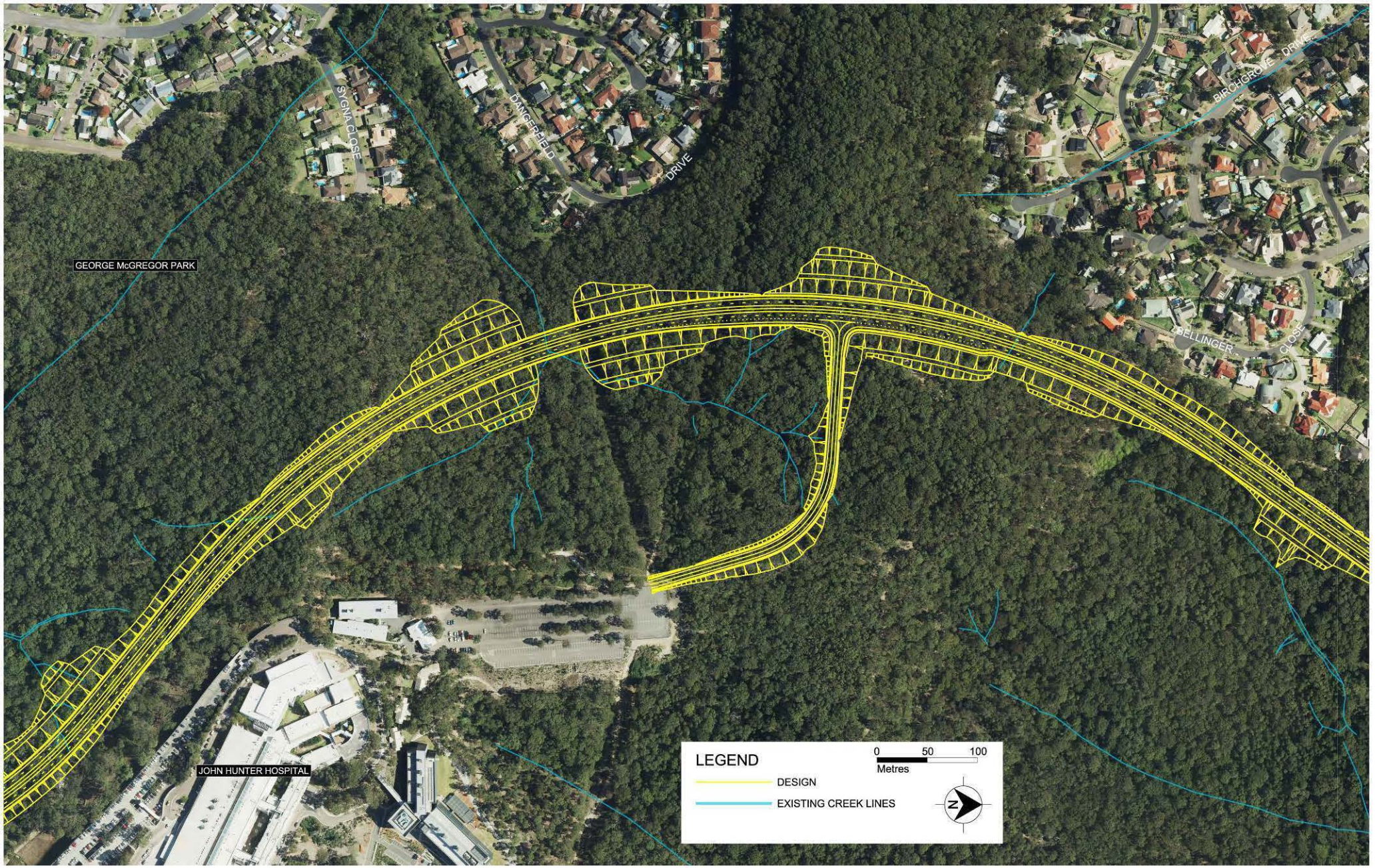


Figure 4.16 Hospital Option 1: left-in and left-out access to John Hunter Hospital

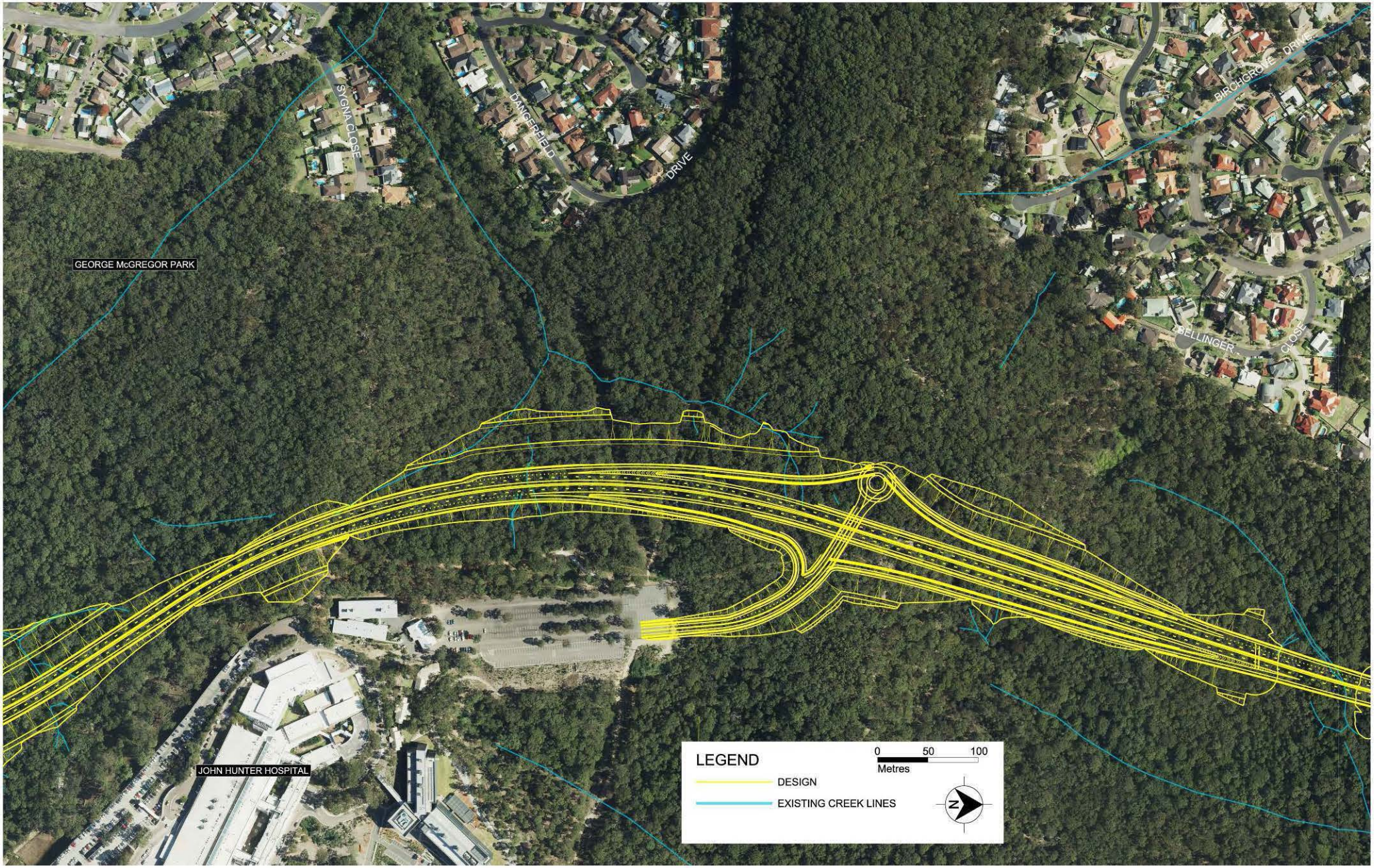


Figure 4.17 Hospital Option 2: Full-interchange access for John Hunter Hospital

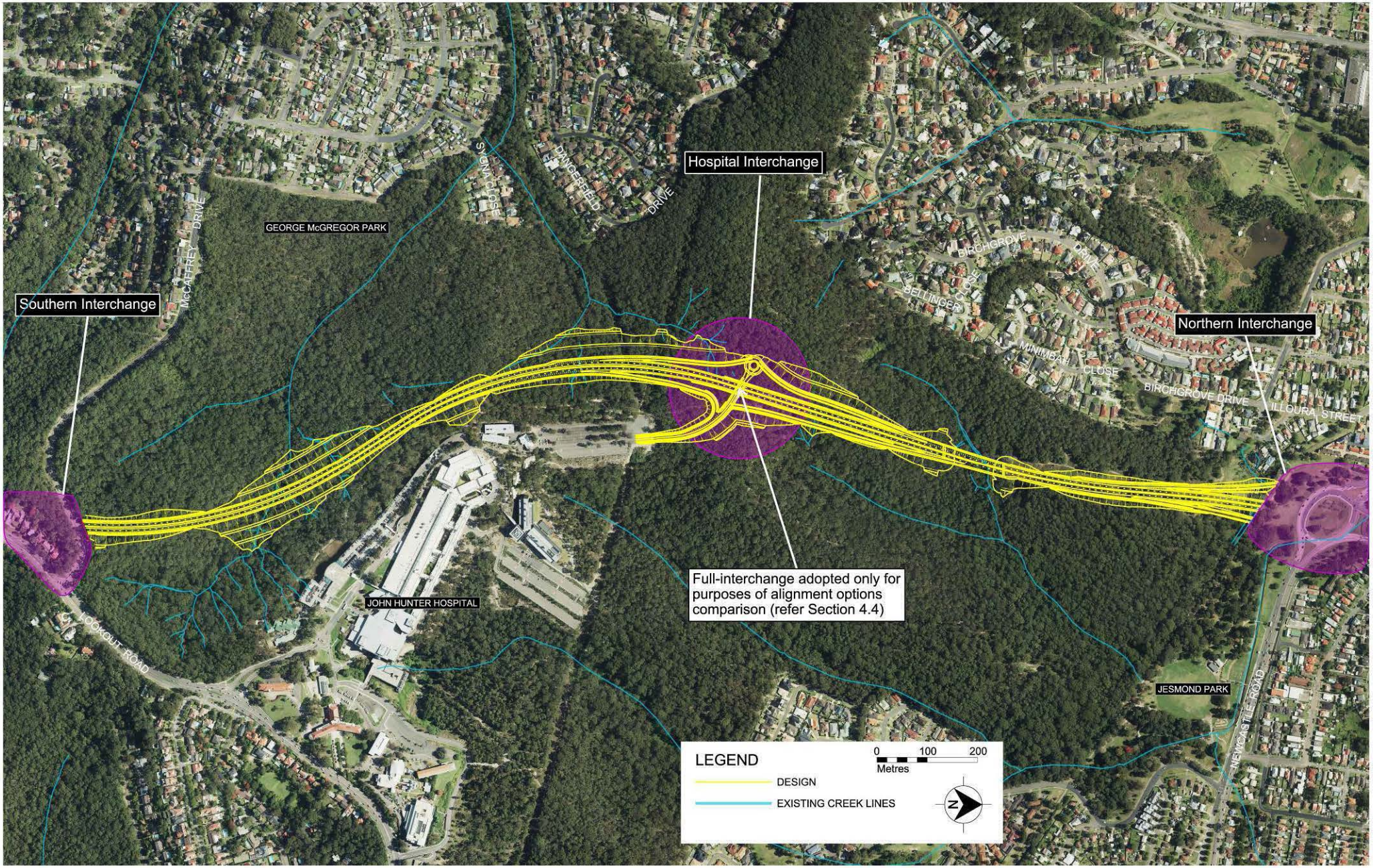


Figure 4.18 Alignment Option 2

4.4.3. Alignment – assessment of options

4.4.3.1 Value Management Workshop

A process known as Value Management was used to carry out the options assessment process for the project. Values important to the project were identified through investigations, community consultation, technical workshops and meetings with key stakeholders. These values informed the assessment criteria which were used to identify a preferred alignment option.

The value management process of comparing and assessing these options enabled key constraints and opportunities to be considered and addressed throughout the design process. The value management process captures the detailed specialist knowledge, experiences and perspectives of the participant stakeholders to generate value and improve ideas.

A Value Management Workshop to assess the alignment options was held with the project team, Roads and Maritime stakeholders and representatives from Newcastle City Council, Lake Macquarie City Council, NSW Health Infrastructure and Hunter New England Local Health District.

The purpose of the workshop group was to undertake a detailed review of the alignment options and gain a shared understanding of which option would provide the best balance across social, environmental, economic and engineering issues while also taking estimated costs into account. The outcome of the workshop was to recommend a preferred alignment option to progress for further design and assessment.

Two alignment options were assessed during the Value Management Workshop as described in **Sections 4.4.1 and 4.4.2**.

Assessment criteria were developed under six key categories and 10 sub-categories as outlined in **Table 3**.

Issues that did not change between alignment options were not included in this process as they did not assist in selecting an option. Further, as the cost of the two alignment options was considered to be of the same magnitude, it was not factored into the development of the assessment criteria.

The alignment options were reviewed in detail to ensure there was a common understanding of each option and the opportunities and risks likely to be associated with each.

Following this review, the performance of each option was evaluated against each of the assessment criteria. Once the qualitative evaluation was complete, the assessment was scored to establish a relative overall ranking for the two alignment options.

Based on this assessment, Alignment Option 2 was rated the best or equal best for all 10 categories, due to its strong environmental, community and technical benefits.

Based on this assessment, the Value Management Workshop findings included:

- Alignment Option 2 be progressed for further consideration
- Alignment Option 1 not proceed further.

Table 3 Assessment criteria for the Value Management Workshop

Perspective	Evaluation criteria	Measure (if applicable)
Environmental	Minimise bushland fragmentation and provide fauna connectivity.	Viability of remaining patches of vegetation and fauna connectivity.
	Minimise impacts to threatened species and endangered communities.	Number of threatened species impacted, area of Endangered Ecological Community (EEC) impacted and loss of habitat.
	Minimise area of vegetation clearing.	Area of vegetation clearing.
Community	Minimise community amenity impacts including noise.	Buffer distance to sensitive receivers (residential, hospital and recreational).
	Provide connectivity for pedestrians and cyclists.	Location and form of crossing points.
Urban design	Integrate the project with the surrounding landform.	Impact on ridges, valleys and watercourses.
	Minimise visual impacts.	Impacts of the scale, form and location of the proposal from key viewpoints and receivers.
Constructability	Minimise constructability risks.	Accessibility for construction traffic and construction safety on steep terrain.
Geotechnical and mine subsidence	Minimise geotechnical risks, including mine subsidence.	Complexity of remediation works required.
Road design	Best meets road design and safety guidelines.	Bypass length, design speed (e.g. horizontal and vertical alignment, stopping sight distance etc) and maximum grades and lengths thereof.

4.4.3.2 Alignment – further design and assessment

Further development and assessment of access options to John Hunter Hospital was undertaken.

A refinement of Hospital Option 2 was carried out to address road safety concerns by increasing the distance between the northbound on-ramp from the hospital and the northbound off-ramp to Newcastle Road. This reduces potential merge and diverge weaving conflicts between traffic using these ramps. This produced Hospital Option 3 (refer to **Figure 4.19**).

The Hospital Option 3 interchange refinements included:

- Replacing the northbound on-ramp with a loop taking the ramp to the south and under the interchange bridge before connecting with the bypass
- Eliminating the need for the pedestrian footpath on the northern side of the interchange bridge to cross the northbound on-ramp, therefore improving pedestrian safety.

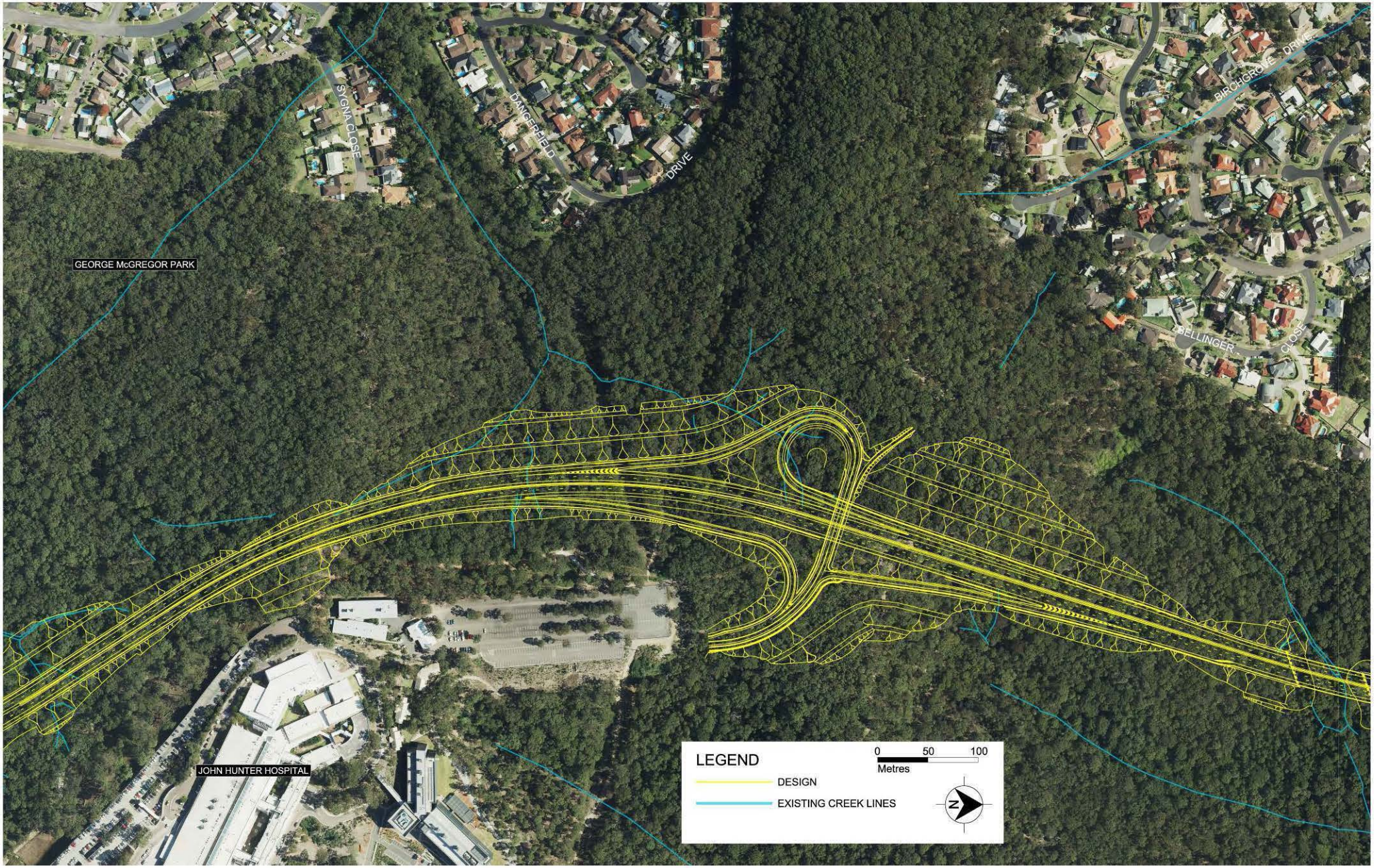


Figure 4.19 Hospital Option 3: Full-interchange access for John Hunter Hospital

To assist with options comparison, traffic modelling was undertaken to assess the benefits of the various hospital access options (refer to **Section 5**).

For Hospital Option 3 (full interchange) traffic modelling results using existing traffic volumes (2014/15) predicted that:

- About 1,100 vehicles per day would use each of the south facing ramps at the western hospital interchange. This is a total of 2,200 vehicles per day. This compares with about 7,300 vehicles per day that would use the north facing ramps.
- A further 3,800 vehicles per day from the south are forecast to continue to use the existing eastern main hospital access off Lookout Road, which provides a shorter travel distance (one kilometre versus 2.5 kilometres) albeit that motorists would need to pass through two sets of traffic lights on the existing route.
- In contrast, the provision of north facing ramps at the hospital interchange would substantially reduce travel times and travel distance (1.5 kilometres versus four kilometres) for hospital trips to/from the north with eight sets of traffic lights bypassed on the existing route.

Subsequently a sub-option of Hospital Option 3 was developed with the south facing ramps deleted. This produced Hospital Option 4 (half-interchange, refer to **Figure 4.20**).

The Hospital Option 4 (half-interchange) configuration includes:

- A northbound on-ramp from the hospital to the bypass
- A southbound off-ramp from the bypass to the hospital.

For Hospital Option 4 (half-interchange) traffic modelling results predicted that:

- Given the lower volumes of traffic forecast to use the south facing ramps, the shorter alternative route (via the existing eastern main hospital entrance) and the forecast reduction of traffic along Lookout Road north of McCaffrey (35 per cent reduction), the modelling indicates that the omission of south facing ramps from the western hospital interchange would have a low impact on traffic flow on the short section of Lookout Road between McCaffrey Drive and the existing eastern main hospital entrance.
- A forecast traffic split of about 50/50 between the new western hospital interchange and the existing eastern main hospital entrance.

4.4.3.3 Preferred option – western hospital access (John Hunter Hospital)

In analysing access options, Hospital Option 4 in the form of a half-interchange was assessed as providing the best value for money with substantial benefits for traffic flow on the surrounding road network and substantial reduction in traffic using the existing main hospital entrance on Lookout Road. Works required to integrate the western access within the John Hunter Hospital internal road network would be assessed, designed and implemented by NSW Health Infrastructure and Hunter New England Local Area Health District.

Further consultation with NSW Health Infrastructure is being carried out to finalise the configuration of the interchange near the hospital.

It is noted that the proposed half-interchange design (north facing ramps only), does not preclude the south facing ramps from being added at a future stage. In the future, should the John Hunter Hospital campus expand its facilities and/or change its internal configuration (eg relocation of facilities and/or parking) there may be additional traffic which would switch from using the existing eastern main hospital access to the new western access, which would increase the use of the south facing ramps if they were installed. This would require further assessment by NSW Health Infrastructure and Hunter New England Local Area Health District at that time.

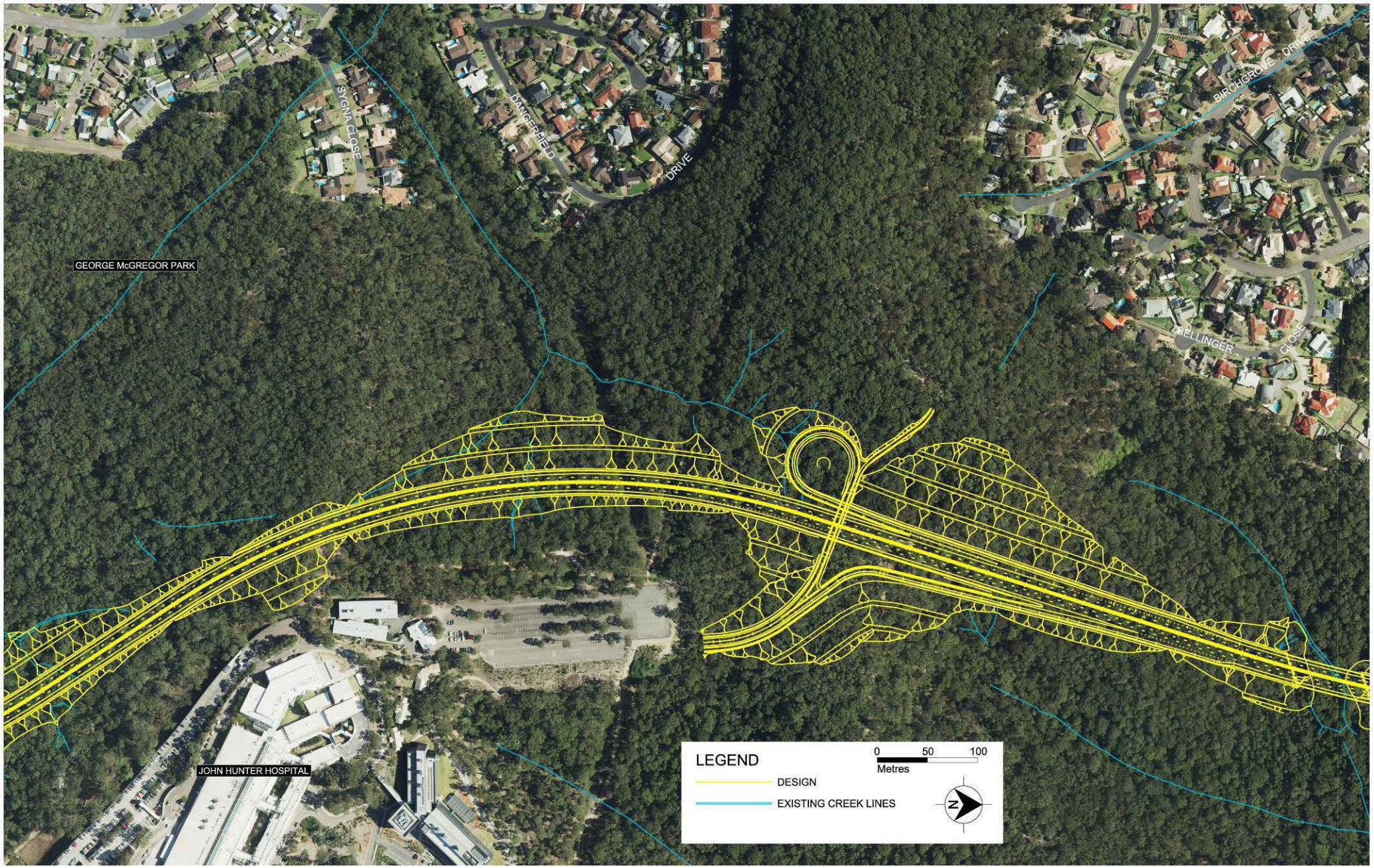


Figure 4.20 Hospital Option 4: Half-interchange access for John Hunter Hospital

4.4.3.4 Alignment – preferred option selection

In summary, based on the Value Management Workshop findings and subsequent further design and assessment, Alignment Option 2 was selected as the preferred alignment option with Hospital Option 4 as the preferred hospital interchange (refer to **Figure 4.20**).

Figure 4.21 shows some of the key improvements for the refined strategic design alignment.

Key changes to the alignment and hospital access from the 2007 strategic design include:

Alignment

What it provides	Key changes
• Two lanes in each direction • Median with barrier between carriageways to separate northbound and southbound traffic • Provision for on-road cyclists with minimum 2.5 metre shoulders.	• The alignment has moved substantially to the east, increasing the distance from residences and increasing the bushland buffer to reduce potential noise, traffic and visual impacts • The alignment has moved substantially to the east, reducing fragmentation and improving connectivity to remaining bushland areas • The alignment has moved to avoid or reduce impacts on threatened flora and fauna within the bushland corridor • Alignment moved to the west near McCaffrey Drive to avoid an area of creek lines and steep gullies.

Hospital Interchange (John Hunter Hospital)

What it provides	Key changes
• A half-interchange providing access to the western side of John Hunter Hospital • A northbound on-ramp for traffic exiting the hospital and entering the bypass • A southbound off-ramp for traffic exiting the bypass to enter the hospital • Bridge over the bypass to separate traffic on the bypass from vehicles exiting the hospital.	• Provision of a half-interchange to access the hospital • Ramps provided to allow traffic to and from the north to enter and exit the hospital, improving access for public, staff and emergency services.

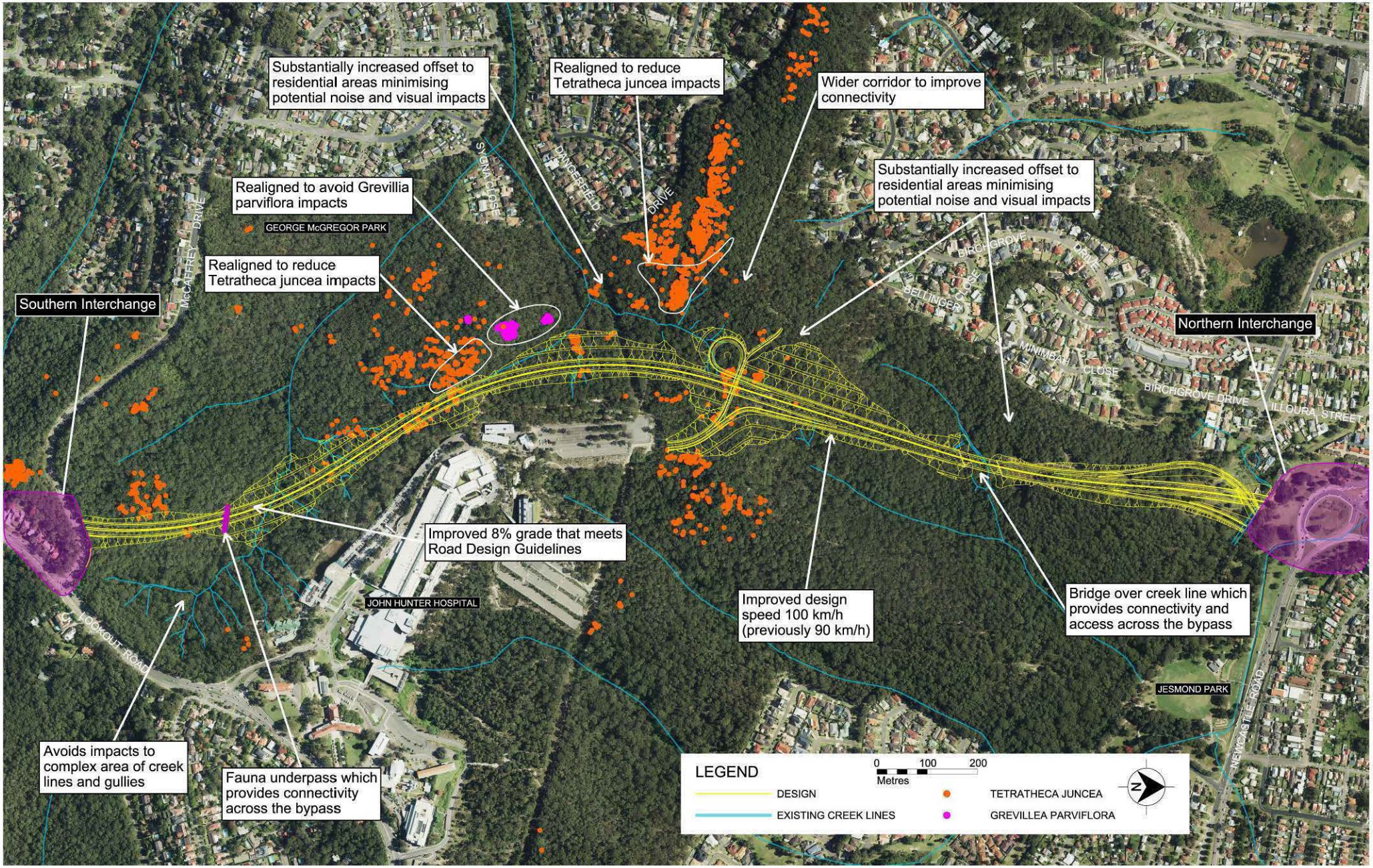


Figure 4.21 Key alignment improvements

4.5. Interchange – options description

This section outlines the development and assessment of interchange options at the northern and southern ends of the project.

4.5.1. Northern Interchange

Several alternatives to the 2007 Northern Interchange (strategic design) were investigated. These were initially refined to four short-listed interchange options.

4.5.1.1. Northern Option 1

Northern Option 1 is the strategic design displayed in 2007. It utilises the existing four lanes on Newcastle Road and the two lane roundabout. A new four lane bridge over Newcastle Road with on and off-ramps to the south of Newcastle Road connecting the new bypass with the existing Newcastle Inner City Bypass (refer to **Figure 4.22).**

4.5.1.2. Northern Option 2

Northern Option 2 provides an intersection controlled by traffic lights with six lanes on Newcastle Road. On and off-ramps with turning lanes are provided together with a new four lane bridge over Newcastle Road connecting the new bypass with the existing Newcastle Inner City Bypass. (refer to **Figure 4.23**).

4.5.1.3. Northern Option 3

Northern Option 3 provides a combination of traffic lights and grade separated movements. Six lanes are provided east-west along Newcastle Road with northbound and southbound right turn lanes and two free flow on and off-ramps. A new four lane bridge over Newcastle Road connects the new bypass with the existing Newcastle Inner City Bypass (refer to **Figure 4.24**).

4.5.1.4. Northern Option 4

Northern Option 4 provides a combination of traffic lights and a grade separated loop for the northbound right turn from Newcastle Road. Six lanes are provided east-west on Newcastle Road plus on and off-ramps with turning lanes. A new four lane bridge over Newcastle Road connects the new bypass to the existing Newcastle Inner City Bypass (refer to **Figure 4.25**).

4.5.2. Northern Interchange – assessment of options

4.5.2.1 Value Management Workshop

Similar to the process described in **Section 4.4.3**, a Value Management process was used to carry out the comparison and assessment process for the interchange options. The Value Management Workshop was held with the project team, Roads and Maritime stakeholders and representatives from Newcastle City Council and Lake Macquarie City Council.

Assessment criteria were developed under four key categories and 10 sub-categories as outlined in **Table 4.** Issues that did not change between interchange options were not included in this process as they did not assist in selecting an option. Further, as cost and economic benefits was considered separately, it was not factored into the development of the non-price assessment criteria.

Figure 4.22 Northern Option 1

Figure 4.23 Northern Option 2

Figure 4.24 Northern Option 3

Figure 4.25 Northern Option 4

Table 4 Assessment criteria for the Value Management Workshop

Criteria	Descriptive aspects
Functionality (traffic efficiency and user safety)	• Impacts on travel times/travel performance • Road user safety/legibility • Road/bridge maintenance safety • Community expectation of connectivity • Pedestrian/cyclist connectivity • Allows freight/oversized vehicles access.
Constructability and timing	• Timeframe for constructing various elements • Ease of construction/safety in design • Impacts/disruption to traffic during construction.
Community impacts	• Impact on Jesmond Park • Integration into the landform (impacts on sensitive receivers and urban design) • Visual impacts • Noise impacts.
Environmental impacts	• Impact on EECs, sensitive flora and fauna, water quality and flooding.

Northern Interchange assessment

The interchange options were reviewed in detail to ensure there was a common understanding of each option and the opportunities and risks likely to be associated with each.

After discussion the group agreed that Northern Option 1 (Strategic Design Option) did not warrant further assessment primarily because it did not meet the key functional objectives of the project and had a very poor traffic performance.

Subsequently the performance for the three remaining interchange options of each option was evaluated against each of the assessment criteria. Once the qualitative evaluation was complete, the assessment was scored to establish a relative overall ranking for the three short-listed options.

The workshop group was then presented with relative cost estimates and economic performance for the three interchange options, so that the workshop group could draw some conclusions as to which option provided best value for money.

Based on this comparison the Value Management Workshop findings included:

- Northern Option 4 be progressed for further consideration subject to a review and resolution of some road safety aspects
- Northern Option 2 rated the next best option
- Northern Option 3 would not proceed further.

4.5.2.2 Northern Interchange – further design and assessment

Following the Value Management Workshop, additional design and assessment was undertaken for the two short-listed Northern Interchange options.

A key component was the undertaking of a road safety review for Northern Option 4 and Northern Option 2.

Potential risks to road safety were reported with key findings as detailed below:

- For Northern Option 4, risks to road safety were identified with the development of the entry to the northbound loop ramp
- The review identified there is potential safety risks associated with delineation of this movement. Drivers heading westbound on Newcastle Road may not be adequately aware of the need to get into the left lane to enter the entry loop ramp in order to head northbound onto the Newcastle Inner City Bypass
- In addition, associated crash risks were raised with respect to the speed that vehicles might enter this loop
- An area reviewed for both options was the weave movements for northbound traffic between the Northern Interchange at Newcastle Road and the University Drive Interchange
- The road safety issue is due to the relatively short distance between interchanges and the high volume of traffic that wishes to exit the bypass to University Drive
- The assessment concluded that Northern Option 2 is superior to Northern Option 4 for this safety issue by better managing the weave movements and reducing the risk to road safety
- The main advantage with Northern Option 2 is both the left and right northbound turns onto the bypass from Newcastle Road do not occur concurrently as they are controlled by traffic lights. This reduces potential conflict between traffic entering the bypass from Newcastle Road and traffic exiting to University Drive from the new bypass to the south.

Additional design refinements were undertaken for Northern Option 2 for the large bridge structure over Newcastle Road. Updated cost estimates were prepared with the estimated cost of Northern Option 2 being reduced to a similar level as Northern Option 4.

The project team subsequently held an additional workshop to reassess the two short-listed Northern Interchange options based on a review of the additional findings of the road safety review and the updated cost estimates.

The functionality assessment criteria for each option was re-evaluated in more detail against all six sub-categories (refer to **Table 4**) with the previous scoring for the other five assessment criteria remaining the same.

Once the qualitative evaluation was complete, the assessment was re-scored to establish a relative overall ranking for each option.

The workshop group then considered the updated cost estimates for the two interchange options, so that the workshop group could draw some conclusions as to which option provided best value for money.

The group assessed that both options were comparable in traffic performance and cost, with Northern Option 2 having road safety advantages. Based on this assessment it was proposed that Northern Option 2 be progressed for further consideration.

Additional design development was undertaken for Northern Option 2 to investigate options to further refine and reduce the size of the signalised intersection below the bypass. This produced Northern Option 5 (refer to **Figure 4.26**).

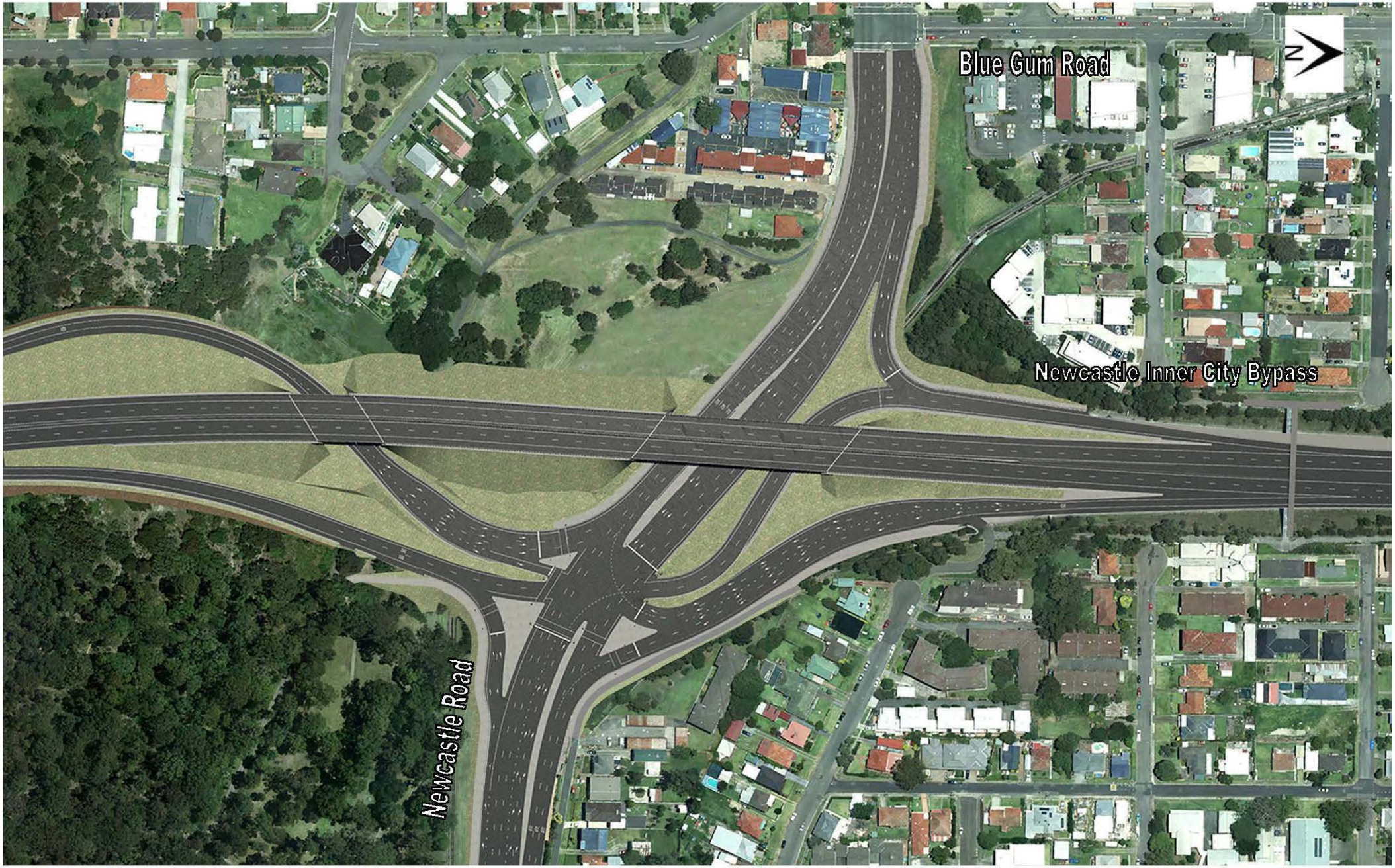


Figure 4.26 Northern Option 5

The Northern Option 5 refinements included relocating the signalised intersection below the bypass further to the east, which provided the following key benefits:

- Reducing the size of the intersection which improves traffic flow through the intersection
- Reducing the size of the bridge on the bypass road over Newcastle Road which provides cost savings and improves constructability with a less complex bridge type
- Increases the distance to the adjacent Blue Gum Road Intersection which improves traffic flow along Newcastle Road.

4.5.2.3 Northern Interchange – preferred option selection

In analysing options, Northern Option 5 was assessed as providing the best value for money with substantial benefits for traffic flow both on the bypass and Newcastle Road.

While Northern Option 2 and Northern Option 5 both allow all traffic movements (controlled by traffic lights) below the bypass, Northern Option 5 was assessed as providing improved traffic flow and reduced cost.

In summary, based on the Value Management Workshop results and subsequent further road safety review, design and assessment, Northern Option 5 was selected as the preferred Northern Interchange option.

Key changes to the Northern Interchange from the 2007 strategic design include:

Northern Interchange (Jesmond)

What it provides	Key changes
• An interchange with Newcastle Road with a bridge over Newcastle Road for northbound and southbound movements on the bypass • Intersection below the bypass to the east on Newcastle Road controlled by traffic lights • All traffic movements provided to enter and exit both Newcastle Road and the bypass.	• Existing roundabout replaced with an intersection controlled by traffic lights to improve traffic flow • Additional lanes provided on Newcastle Road to improve traffic flow with three lanes in both directions • Crossings controlled by lights for pedestrians and cyclists, to improve safety across Newcastle Road.

4.5.3. Southern Interchange

Several alternatives to the 2007 Southern Interchange strategic design were investigated. However due to a variety of constraints at the southern end of the project, these were refined to one single viable interchange option. In addition, as part of the development process for the southern interchange, north-facing ramps were investigated to determine whether the on-ramp and/or off-ramp at McCaffrey Drive should be included in the project.

4.5.3.1 Southern Option 1

Southern Option 1 is the strategic design option displayed in 2007 (refer to **Figure 4.27**). The option consists of a half-interchange with south-facing ramps to/from Lookout Road, together with two intersections controlled by traffic lights for connections to McCaffrey Drive and Lookout Road. As detailed further in **Section 5**, this option was deemed not viable primarily due to its poor traffic performance.

4.5.3.2 Southern Option 2

Southern Option 2 consists of a northbound off-ramp/flyover bridge over the bypass that connects to the existing signalised intersection at McCaffrey Drive. A two lane southbound on-ramp from Lookout Road joins into two lanes from the bypass and merges downstream to three lanes (refer to **Figure 4.28**). The option includes upgrade works to increase the capacity of McCaffrey Drive with two right turn lanes and an extended left slip-lane provided out of McCaffrey Drive.

4.5.4. Southern Interchange – assessment of options

For the Southern Interchange, the objective of the Value Management Workshop was to:

- Test and confirm the preferred southern interchange configuration
- Recommend whether north-facing ramps at McCaffrey Drive should be included in the project.

4.5.4.1 Southern Interchange review

Southern Option 1 and Southern Option 2 were reviewed in detail to ensure there was a common understanding of the option and the opportunities and risks likely to be associated with it.

A summary of key points raised with information added by the workshop group includes:

- Traffic modelling indicates that the Southern Option 1 (2007 strategic design) would fail from a traffic performance perspective due to the lack of capacity for a variety of traffic movements including the strong northbound movement on Lookout Road, the right turn out of McCaffrey Drive and the left turn out of McCaffrey Drive
- As Southern Option 1 had unacceptable traffic performance, it failed to meet the functionality project objectives and therefore was not considered a viable option
- A number of alternative southern interchange options were investigated however none were found to satisfactorily meet the project objectives with the exception of Southern Interchange Option 2
- Traffic modelling indicates that the Southern Option 2 provides superior traffic performance with increased capacity for a variety of traffic movements, including the strong northbound movement on Lookout Road, the right turn out of McCaffrey Drive and the left turn out of McCaffrey Drive

Southern Option 2 was confirmed as the preferred option for the Southern Interchange.

Figure 4.27 Southern Option 1

Figure 4.28 Southern Option 2

4.5.4.2 McCaffrey Drive north-facing ramps

The outcomes of the McCaffrey Drive north-facing ramps investigation were reviewed in detail to ensure there was a common understanding of the options and the opportunities and risks likely to be associated with each ramp. A summary of key points raised with information added by the workshop group is outlined below.

2007 Strategic design review

In the 2007 strategic design, north-facing ramps at the Southern Interchange were not provided.

North-facing ramps include:

- Northbound on-ramp from McCaffrey Drive to the bypass
- Southbound off-ramp from the bypass to McCaffrey Drive.

The north-facing ramps were not in the 2007 strategic design provided due to:

- The combination of steep grade of the bypass (10 per cent) and undulating topography on the northern side of McCaffrey Drive made the design/construction of the ramps difficult and costly
- Traffic modelling predicted low use of both ramps (if they were provided) and therefore their inclusion in the project could not be economically justified.

Community members have raised concerns relating to the omission of north-facing ramps. The concern is primarily that the omission of these ramps would result in additional traffic having to use Grandview Road and/or Marshall Street to enter/exit the bypass. These are both local roads with steep and undulating topography and contain existing traffic calming devices (speed humps), as well as an infant school and primary school.

Refined strategic design development

The development of the refined strategic design included review of the design and functionality of the southern interchange and the need and justification for providing north-facing ramps.

This review included:

- Developing designs for the on-ramp and off-ramp to estimate their cost and to assess potential traffic performance benefits and environmental impacts. The designs are compatible with Southern Option 2 which is the recommended southern interchange design
- Assessing the predicted usage of the ramps based on updated traffic surveys and traffic modelling. This includes assessing the results of two origin-destination surveys undertaken in October 2014 and May 2015
- Assessing predicted traffic impacts on the surrounding road network including Grandview Road and Marshall Street, for the scenarios with and without the ramps.

Northbound on-ramp from McCaffrey Drive

This design option would provide an on-ramp for eastbound traffic on McCaffrey Drive to be able to enter the bypass to travel northbound (refer to **Figure 4.29**).

Key points of the design are as follows:

- The on-ramp would need to have a maximum down grade of nine per cent which is the maximum desirable grade in accordance with Austroads Road Design Guidelines
- To not exceed the maximum grade, the ramp would need to start about 400 metres to the west of the Lookout Road/McCaffrey Drive intersection and join the bypass about 280 metres north of McCaffrey Drive.

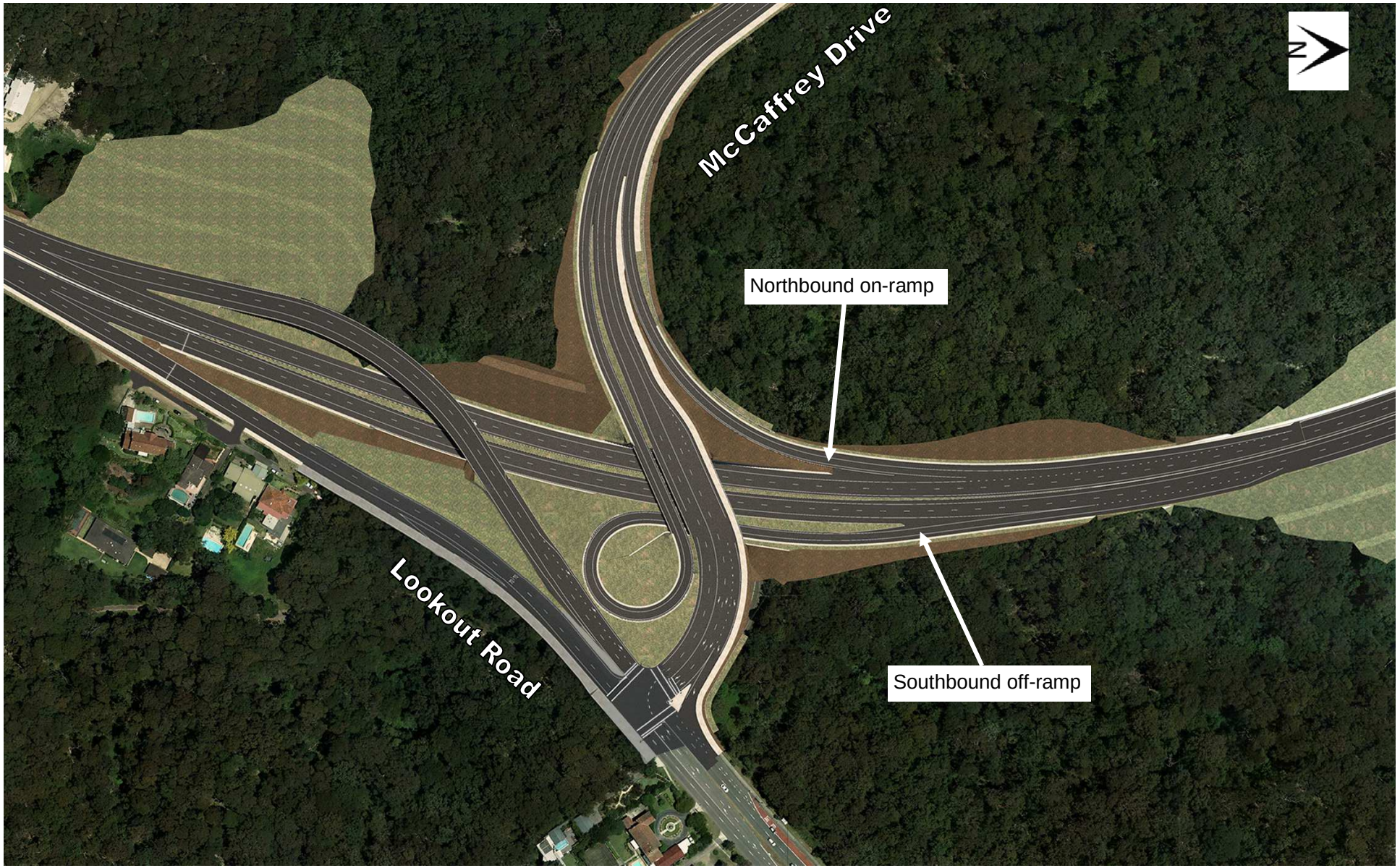


Figure 4.29 McCaffrey Drive ramps

- The length of the on-ramp would be about 650 metresThe on-ramp would require large sections of retaining walls to minimise environmental impacts including the amount of vegetation clearing required.

A summary of key points raised with information added by the workshop group is outlined below:

- Based on existing traffic volumes, traffic modelling predicts low usage of the north-facing ramps with less than one per cent of existing traffic on McCaffrey Drive forecast to use the ramps per day if they were provided
- Based on existing traffic volumes, traffic modelling predicts low usage with about 75 vehicles per day forecast to use the northbound on-ramp from McCaffrey Drive. In comparison, traffic modelling predicts that the southbound on-ramp from Lookout Road would have high usage with about 14,700 vehicles per day
- Strategic cost estimate is about $7 million.

Southbound off-ramp to McCaffrey Drive

This design option would provide an off-ramp for southbound traffic on the bypass to be able to exit to McCaffrey Drive to travel westbound (refer to **Figure 4.29**).

Key points of the design are as follows:

- The ramp would need to start about 280 metres north of McCaffrey Drive and be about 850 metres in length
- The off-ramp would need to pass under McCaffrey Drive which requires the McCaffrey Drive bridge to be lengthened to accommodate the off-ramp
- The off-ramp then would need to loop anti-clockwise before running westbound parallel to McCaffrey Drive. A large 16 metre high retaining wall would be required to accommodate the loop due to level differences with Lookout Road at this location
- The off-ramp then would pass over the bypass via an additional bridge. The off-ramp would then be on a down grade before merging with westbound traffic on McCaffrey Drive.

A summary of key points raised with information added by the workshop group is outlined below:

- Based on existing traffic volumes, traffic modelling predicts low usage with around 75 vehicles each day using a southbound off-ramp to McCaffrey Drive. In comparison, traffic modelling predicts that the northbound off-ramp to Lookout Road would have high usage with about 13,800 vehicles each day using the ramp
- Complex area with steep topography resulting in difficulties in providing a feasible design for this ramp from a constructability and cost perspective. A complex retaining structure would be required with a maximum wall height of about 16 metres between the off-ramp loop and Lookout Road
- Off-ramp requires McCaffrey Drive bridge to be lengthened to allow the off-ramp to pass under McCaffrey Drive
- Off-ramp requires an additional bridge over the bypass to connect with McCaffrey Drive for westbound traffic
- Potential road safety issues with a high speed 90 km/h road leading into a tight loop ramp to exit the bypass
- Strategic cost estimate is about $18 million.

Impacts on surrounding road network

Traffic modelling undertaken to assess traffic impacts on the surrounding road network (including Grandview Road, Marshall Street and McCaffrey Drive) indicates:

- A reduction in traffic is predicted on McCaffrey Drive by about 15 to 20 per cent from about 19,000 to 16,000 vehicles per day in 2020. This is primarily due to traffic from the north-west portion of the study area (suburbs such as Wallsend, Maryland and Fletcher) being forecast to switch routes to use the new bypass for trips to and from south of McCaffrey Drive
- The bypass is predicted to have a minor increase in traffic on Grandview Road by approximately seven per cent from 2,800 to 3,000 vehicles each day in 2020
- The inclusion of north-facing ramps would have negligible impact on the level of traffic forecast to use the local road network (including Grandview Road and Marshall Street) compared to the bypass with no ramps in place.

Further details of the traffic modelling undertaken for the project are provided in **Section** 5**.**

Economic analysis – McCaffrey Drive ramps

Economic analysis has been undertaken as part of the options assessment process to determine whether the addition of north-facing ramps at the southern interchange would provide value for money.

An economic indicator used for the options assessment is the calculation of an incremental benefit-cost ratio (IBCR) for each option. The IBCR measures the incremental benefits received per dollar of incremental costs when comparing one option to another.

An option with a IBCR greater than one means that the present value of additional benefits exceeds the present value of additional costs and is considered to provide value for money.

The economic analysis found that the extra $25 million for the addition of the McCaffrey Drive ramps offers minimal benefits and does not offer value for money with a IBCR of less than one (compared to the Southern Interchange option with south-facing ramps only).

Further details of the economic analysis undertaken for the project are provided in **Section** 5**.**

Summary – Southern Interchange

While the McCaffrey Drive north-facing ramps are technically feasible to design and construct, the low forecast usage of both ramps and their relatively high cost means they do not represent value for money. As a result, north-facing ramps have not been included in the refined strategic design.

As a result of the review, the Value Management Workshop findings included:

- Confirmation that the preferred Southern Option 2 be progressed for further consideration
- Southern Option 1 would not proceed further
- A northbound on-ramp from McCaffrey Drive to the bypass is not recommended to be included as part of the project
- A southbound off-ramp from the bypass/to McCaffrey Drive is not recommended to be included as part of the project.

4.5.4.2 Southern Interchange – further design and assessment

Following the Value Management Workshop, additional design and assessment was undertaken for the southern interchange.

Potential risks to road safety were identified for Southern Option 2 in relation to the connection of the two southbound lanes on the bypass with the two southbound lanes on Lookout Road.

This option provides a central zip merge which requires the left lane of the bypass and the right lane on Lookout Road to merge into a single lane resulting in three southbound lanes. Risks to road safety identified for this merge treatment included:

- Concern regarding the safe operation of a central zip merge treatment due to risks associated with conflicts from connecting two high volume traffic streams
- Required weave over a short distance for traffic from Lookout Road wishing to turn right at Grandview Road or Cardiff Road. Traffic undertaking these movements would be required to make multiple lane changes, including a central zip merge within a short distance.

To address the above road safety risks, alternative options for the southern connection of the two volume streams were investigated. This produced Southern Option 3 (refer to **Figure 4.30**).

The option of providing traffic lights for controlling southbound traffic where the bypass connects to Lookout Road was adopted as the preferred option for the southern connection. Benefits of this option include:

- Improved safety by eliminating the merging of southbound traffic from the bypass and Lookout Road which would both be high volume movements
- Improved safety for southbound traffic from Lookout Road accessing existing right turns at Grandview Road and Cardiff Road.

Preferred option selection – Southern Interchange

In summary, based on the Value Management Workshop results and subsequent further design and assessment, Southern Option 3 was selected as the preferred option for the southern interchange with the following changes:

- Removing the central zip merge at the southbound connection between the bypass and Lookout Road and replacing with traffic lights to safely manage this connection.

Key changes to the southern interchange from the 2007 design include:

Southern Interchange (McCaffrey Drive)

What it provides	Key changes
• An interchange with Lookout Road • A bridge takes northbound traffic on Lookout Road over the bypass • Bypass would travel under McCaffrey Drive • Southbound traffic on Lookout Road would join southbound traffic from the bypass, south of McCaffrey Drive. Both streams of traffic would be controlled by traffic lights.	• Improved traffic flow with a bridge on Lookout Road to take northbound traffic over the bypass and connect into the existing traffic lights at McCaffrey Drive • Traffic lights for southbound traffic where the bypass connects to Lookout Road. This would improve safety for connecting traffic and allow traffic to safely access the existing right turns at Grandview Road and Cardiff Road.

In addition, upgrades are provided for McCaffrey Drive: • Two right turn lanes out of McCaffrey Drive • Extension of the right and left turn lanes on McCaffrey Drive to Lookout Road • Extension of the left turn merge out of McCaffrey Drive onto Lookout Road • All existing traffic movements retained at the McCaffrey Drive intersection with Lookout Road.	McCaffrey Drive changes: • Provision of a second right turn lane out of McCaffrey Drive to improve traffic flow • Lengthening of the left turn lane on McCaffrey Drive to improve traffic flow • Lengthening of the left turn merge out of McCaffrey Drive to improve traffic flow with Lookout Road.

Figure 4.30 Southern Option 3

4.6. Pedestrian and cyclist provisions

As detailed in **Section 4.2.9** existing off-road cycleway connections exist at the northern end of the project, including:

- East-west cycleway to the south of Newcastle Road
- North-south cycleway from John Hunter Hospital to the University of Newcastle.

The 2007 strategic design provided 2.5 metre shoulders for on-road cyclists. A range of additional improved pedestrian and cyclist provisions are proposed as part of the refined strategic design (refer to **Figure 4.31**).

Key changes include:

- Provision of a new off-road cycleway on the eastern side of Lookout Road from the southern side of Ridgeway Road linking with the pedestrian underpass on Lookout Road near Grandview Road
- Replacing the existing mid-block traffic lights on Newcastle Road with a footbridge linking to the existing off-road facilities either side of Newcastle Road
- Traffic lights would control pedestrian and cyclist movements at the northern interchange to improve pedestrian safety across Newcastle Road
- At the proposed Hospital Interchange a bridge over the bypass would include a shared path for pedestrians and cyclists, providing a connection between the hospital and residential areas to the west.

The proposed changes improve connections to the existing off-road shared paths in the study area and enhance options for walking and cycling. Further consultation is required with NSW Health Infrastructure and Newcastle City Council to enable the location and future management of any proposed off-road facilities to be finalised.

4.7. Bushfire and emergency services provisions

As detailed in **Section 4.2.8**, the study area contains a network of existing fire trails that aid with management of bushfires and bushfire hazard reduction.

Construction of the project would create a substantial bushfire firebreak between residential areas and John Hunter Hospital. This would reduce the risk of bushfire to these areas.

The bypass would also improve access to the bushland corridor for emergency services in particular ambulance services to and from the hospital via the proposed hospital interchange.

The project team has worked with Fire and Rescue NSW, Newcastle City Council and Hunter New England Local Health District to identify impacts to existing fire trails. Where the network of existing fire trails are impacted by the project, additional fire trails have been proposed as part of the refined strategic design in consultation with the relevant fire authorities.

Figure 4.32 shows the proposed bushfire management trails to be included as part of the project.

The proposed bushfire trail work includes:

- At the southern end of the project, a new fire trail would be provided off McCaffrey Drive. The fire trail would be about 200 metres in length and connect to an existing fire trail on the western side of the bypass. Due to the topography in this location, the fire trail would have a steep vertical grade and its design would only be suitable for off-road and bush fire management vehicles

- In the central section of the project, a new fire trail would be provided off the bypass from the north-west corner of the hospital interchange. The fire trail would be about 100 metres in length and connect to an existing fire trail on the western side of the bypass
- At the northern end of the project, an existing informal track off Birchgrove Road would be reclassified as a fire trail. The fire trail would be about 300 metres in length and connect to an existing fire trail on the western side of the bypass.

The proposed works ensure bushfire access is maintained within the bushland corridor. Further consultation with the relevant fire authorities will be undertaken during the concept design phase.

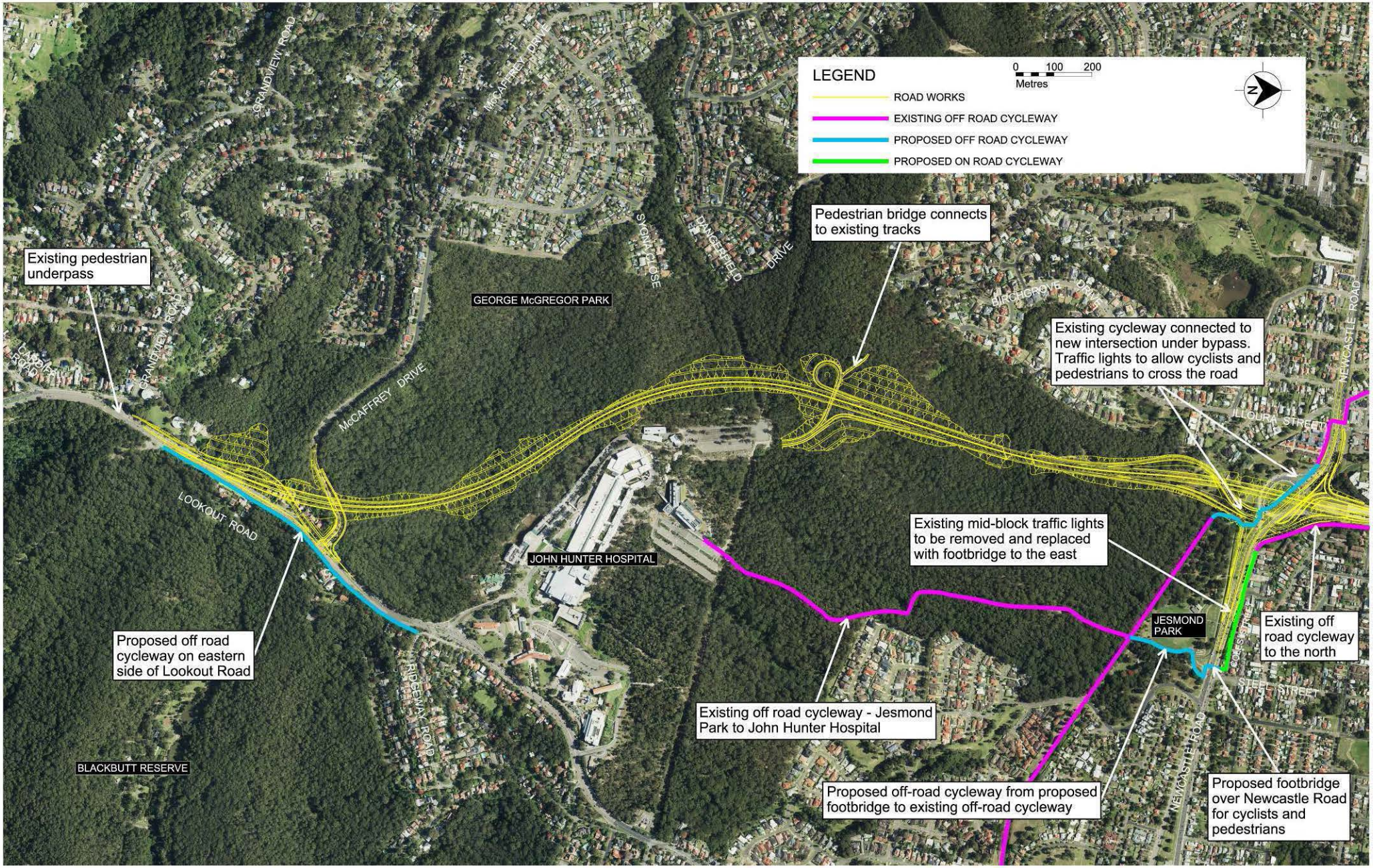


Figure 4.31 Pedestrian and cyclist provisions

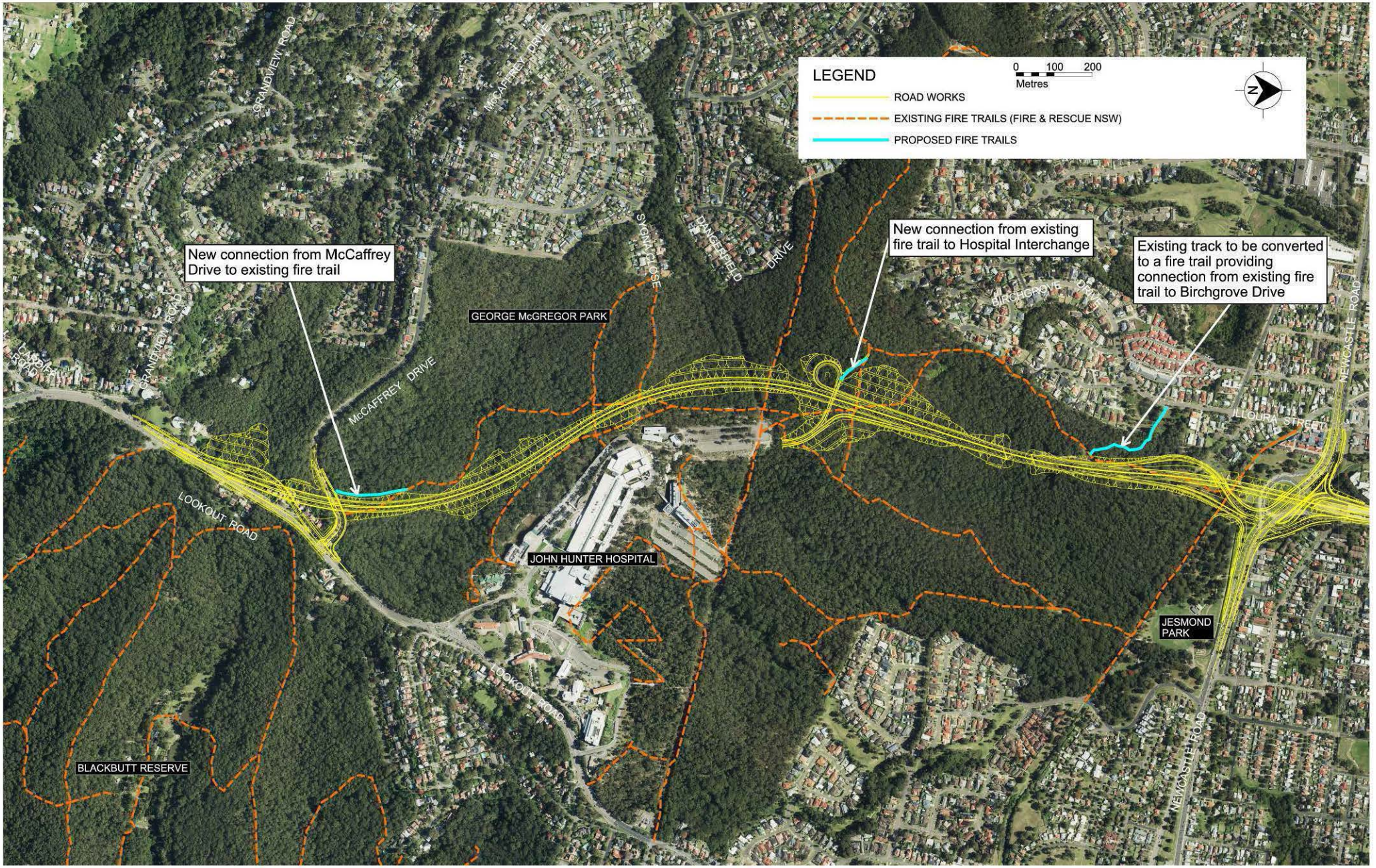


Figure 4.32 Proposed new fire trails

5. Traffic modelling and economic analysis

This section summarises the methodologies and results for both the traffic modelling and economic analysis undertaken for the options assessment and development of the refined strategic design.

5.1. Overview

Traffic modelling has been undertaken to primarily assess the predicted traffic performance of the project and the forecast redistribution of traffic on the road network within the study area. In addition, economic analysis has been undertaken on the options developed in order to assess value for money from a comparison of the estimated costs to the projected savings for motorists in terms of travel time, vehicle operating costs and safety benefits.

5.2. Traffic modelling

5.2.1. Methodology

As illustrated in **Figure 5.1** the adopted traffic modelling methodology has followed a two-tier structure with the Roads and Maritime regional strategic traffic model being used to provide forecast traffic demand information for use in a more detailed microsimulation model for operational assessment of options and for providing outputs for economic analysis.

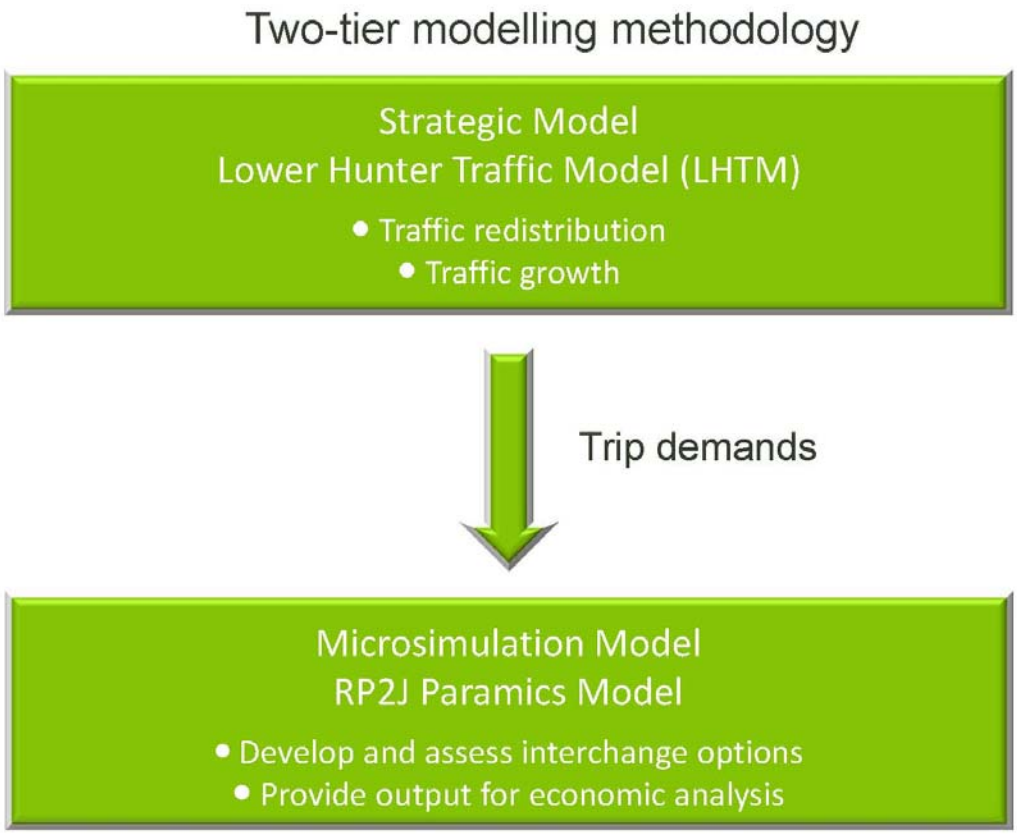


Figure 5.1 Two-tier traffic modelling structure

5.2.2. Strategic model – Lower Hunter Traffic Model (LHTM)

Roads and Maritime's Lower Hunter Traffic Model (LHTM) comprises a road network model of the entire Lower Hunter region. It covers the six statistical local areas – inner and outer Newcastle, Lake Macquarie, Cessnock, Maitland and Port Stephens. It also includes a portion of the northern section of Wyong to ensure that the M1 Pacific Motorway is included in the model area.

The LHTM was developed in TransCAD transportation planning software. The LHTM network includes motorways, highways, main roads and key local roads in the Lower Hunter. Travel zones in the model are based on those developed by the Bureau of Transport Statistics. The modelling approach for updating the LHTM follows a conventional four step modelling process by which the number of daily trips is estimated, distributed among origin and destination zones, divided according to mode of travel and assigned to the road network. Under the current form, the LHTM can produce a daily forecast, representing the total 24 hour traffic volumes for an average weekday.

Traffic volume forecasts for the LHTM are based on land use assumptions and forecast population and employment growth as predicted in the Lower Hunter Regional Strategy (2006). The Lower Hunter Regional Strategy applies to the five local government areas of Newcastle, Lake Macquarie, Port Stephens, Maitland and Cessnock and is one of a number of regional strategies prepared by the NSW Department of Planning. The LHTM has been updated for the study area using actual origin-destination (OD) survey data and mid-block traffic counts. The process and methodology of this update is detailed in the Arcadis report *Newcastle Inner City Bypass Rankin Park to Jesmond, Traffic Modelling Report – Lower Hunter Traffic Model, April 2016* (refer **Appendix B**).

The LHTM has been used to assess the forecast traffic redistribution with the bypass on the movement of traffic through the study area and to provide forecast traffic demand for future years while taking into account forecast traffic growth in the study area, for scenarios both with and without the project in place, for use in the detailed microsimulation modelling.

5.2.3. Microsimulation model – Rankin Park to Jesmond Paramics Model

A microsimulation traffic model has been developed to assess the operational performance of the proposed options for the bypass and associated interchanges. Relative to strategic models, microsimulation models provide a greater level of geometric and operational detail. The model is focussed on a much smaller area, covering the project extents and immediate road network. Individual vehicles and the interactions between them are modelled allowing for detailed replication of traffic conditions.

The model was developed using Quadstone Paramics (Paramics) software platform. Paramics represents traffic flows within a network, by simulating individual vehicles and their interactions with other vehicles and the surrounding road environment.

Paramics represents the behavioural characteristics of drivers by assuming a range of values for aggression and awareness attributes. These influence aspects of model operation such as gap acceptance, lane changing and vehicle following distances. As with real life traffic conditions, these interactions can vary for each time the traffic model is run, resulting in a unique set of results.

The microsimulation traffic modelling has been undertaken to meet the following objectives:

- Assess operational performance and identify constraints or issues with design options
- Support other project disciplines in option development and refinement
- Provide quantitative metrics for comparison and evaluation of options
- Provide outputs for economic analysis.

An integral element of the traffic assessment relates to the development of a base model representing existing traffic conditions in the two hour morning (7am to 9am) and two hour evening (4pm to 6pm) peak periods. The model was calibrated and validated to 2014/15 traffic survey data. The development of this base model is detailed in the Aurecon report *Traffic Microsimulation Model Calibration and Validation Report, October 2015* (refer **Appendix C**).

The base traffic model was then used to develop future year scenarios for the assessment of bypass options against retention of the existing road network configuration. The overall study methodology for the microsimulation modelling study is shown in **Figure 5.2**. These stages will be further refined during the concept design and environmental assessment phase.

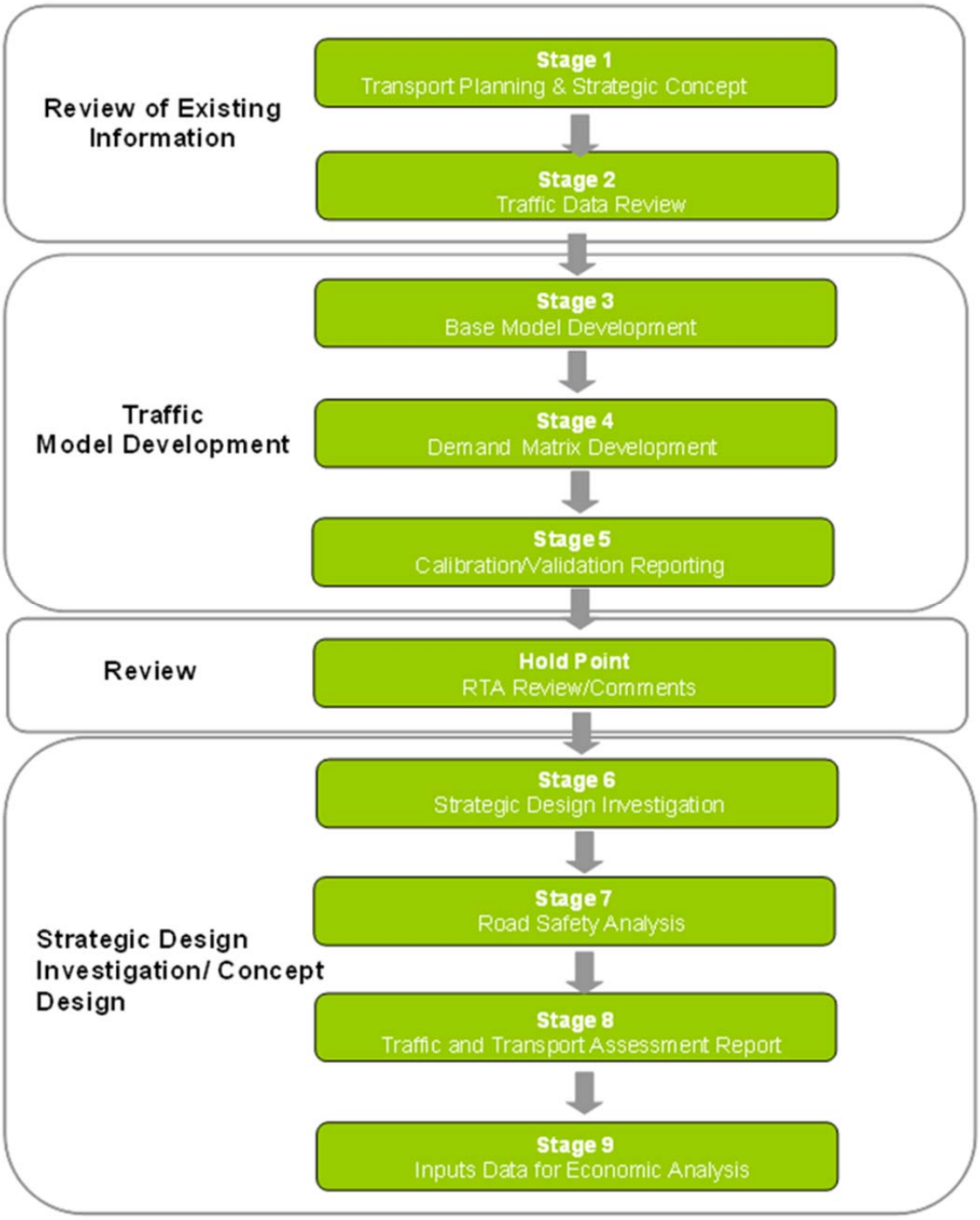


Figure 5.2 Study methodology

With the two-tier modelling methodology, the Paramics model utilises trip demand forecasts from the LHTM model for modelling of future year scenarios with and without the bypass. Statistical outputs of network performance from the option models are then used as part of the economic analysis of the project options.

Figure 5.3 illustrates the primary components of the microsimulation model methodology.

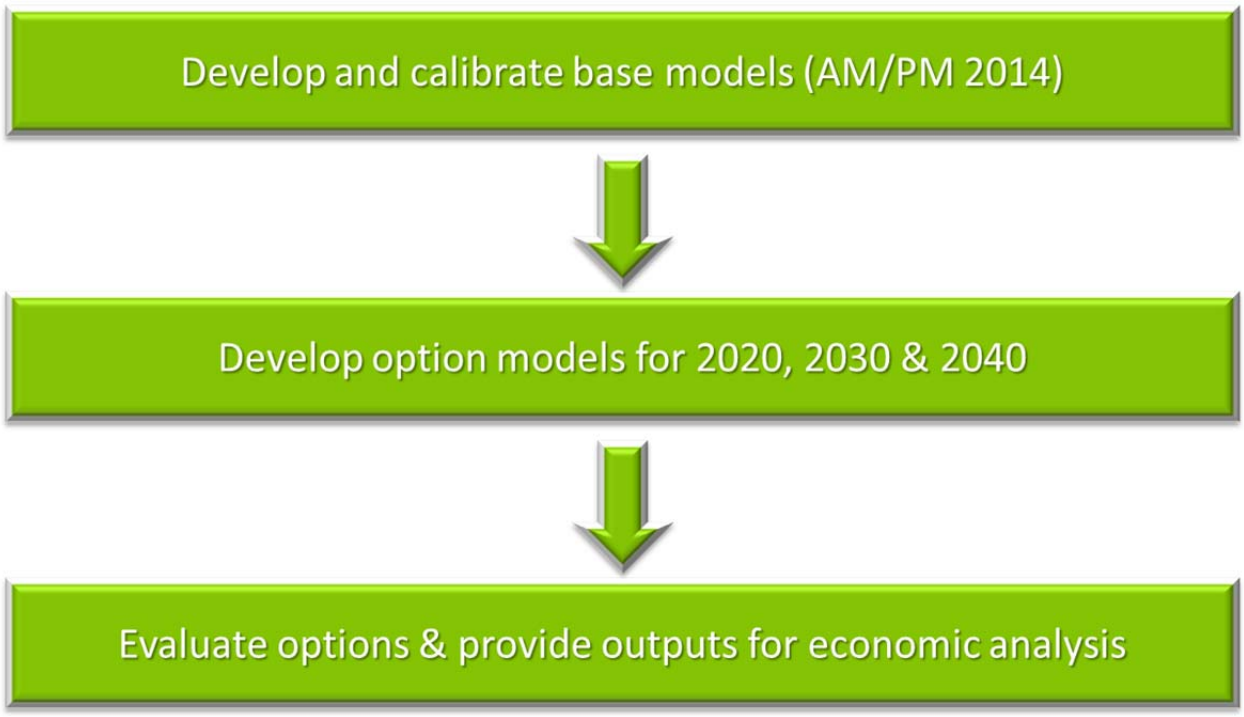


Figure 5.3 Outline of microsimulation model methodology

5.2.4. Existing conditions – traffic data collection

To satisfy the modelling requirements, Roads and Maritime has carried out an extensive traffic data collection in the study area involving origin-destination surveys, midblock traffic counts and intersections turning counts.

Two traffic survey data sets were collected in October 2014 and May 2015, both of which form the basis for developing and calibrating the LHTM and microsimulation traffic models.

The information provided in the subsequent pages includes:

- **Figure 5.4** shows the traffic survey types and locations within the study area
- **Table 5** summarises the existing average weekday daily traffic volumes at 19 locations
- **Figure 5.5** shows the existing average daily weekday traffic volume flows within the study area.

Further details of the traffic data collection, including the outputs of the surveys, are detailed in the Arcadis report *Newcastle Inner City Bypass Rankin Park to Jesmond, Traffic Modelling Report – Lower Hunter Traffic Model, April 2016* (refer **Appendix B**).

.

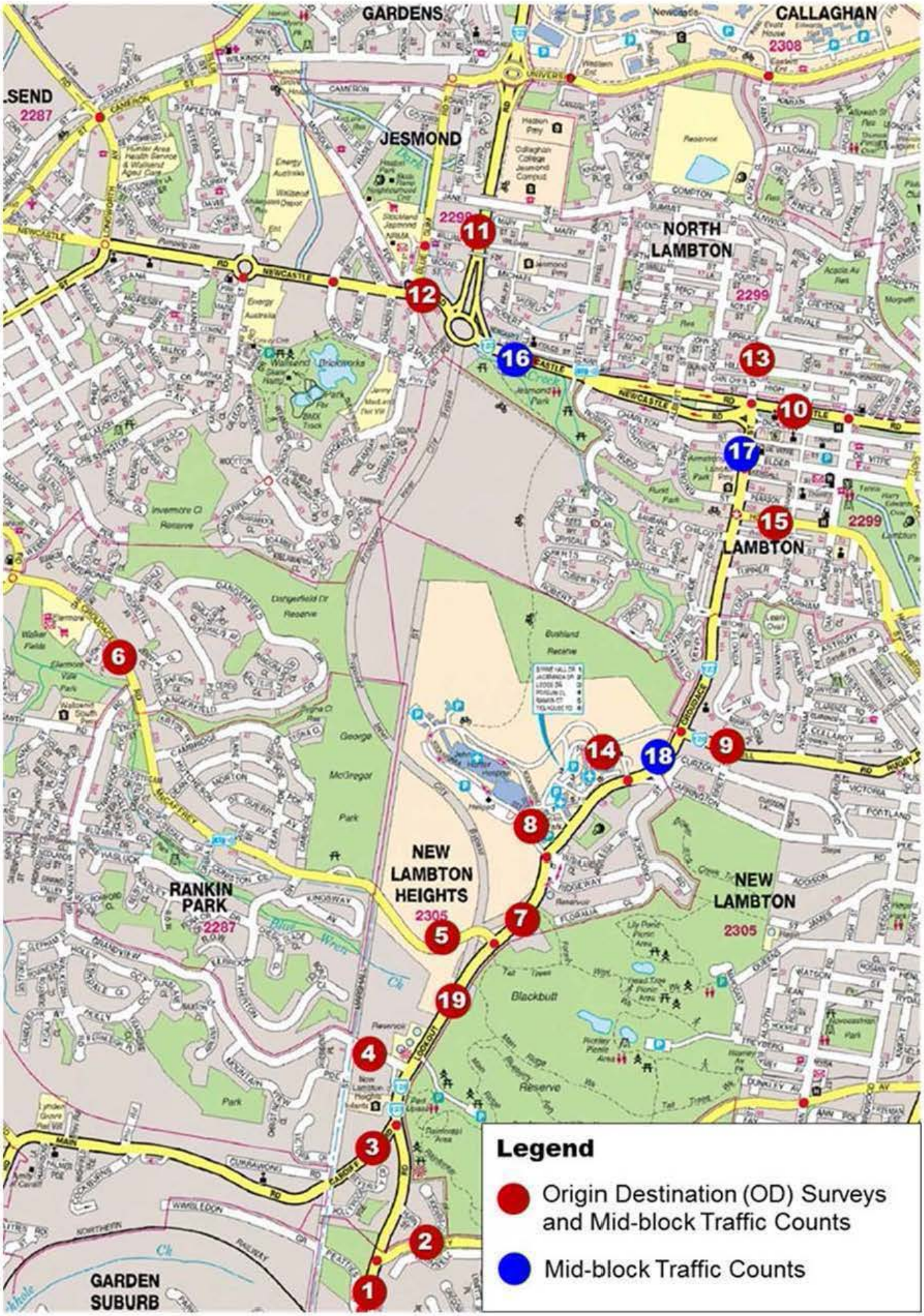


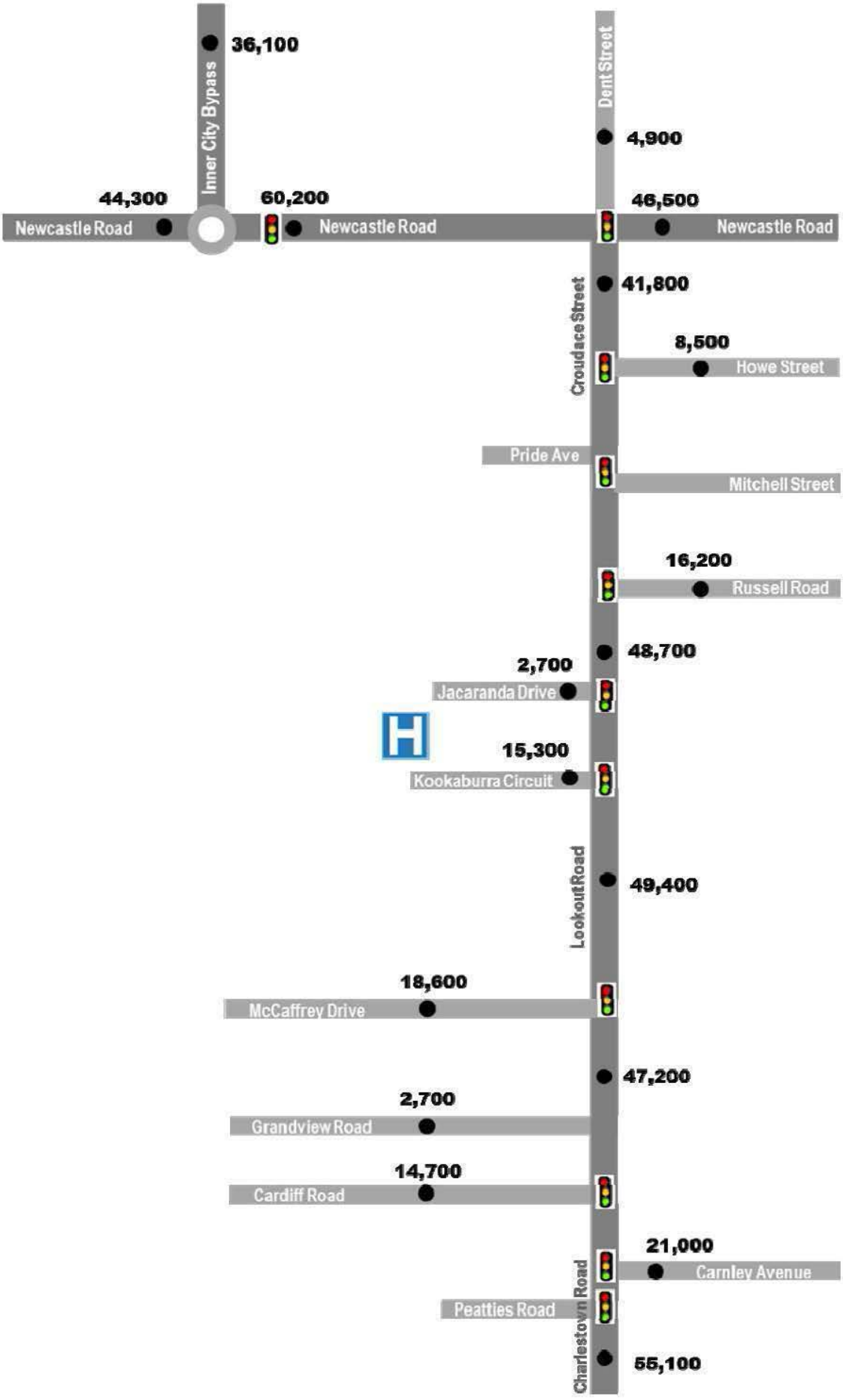
Figure 5.4 Traffic survey types and locations

Table 5 Average daily weekday traffic volumes on key roads (2014/15)

ID	Road/location	Average weekday daily traffic (two way in vehicles)
1	Charlestown Road, south of Carnley Avenue[2]	55,100
2	Carnley Avenue, east of Charlestown Road[2]	21,000
3	Cardiff Road, west of Lookout Road[2]	14,700
4	Grandview Road, west of Lookout Road[2]	2,700
5	McCaffrey Drive, west of Lookout Road[1]	18,600
6	Croudace Road, west of Grandview Road[2]	19,900
7	Lookout Road, north of McCaffrey Drive[2]	49,400
8	Kookaburra Circuit (John Hunter Hospital access)[1]	15,300
9	Russell Road, east of Lookout Road[1]	16,200
10	Newcastle Road, east of Croudace Street[1]	46,500
11	Newcastle Inner City Bypass, north of Newcastle Road[1]	36,100
12	Newcastle Road, west of Newcastle Inner City Bypass[1]	44,300
13	Dent Street, north of Newcastle Road[1]	4,900
14	Jacaranda Drive (John Hunter Hospital access) [1]	2,700
15	Howe Street, east of Croudace Street[1]	8,500
16	Newcastle Road, east of Newcastle Inner City Bypass [1]	60,200
17	Croudace Street, north of Elder Street[1]	41,800
18	Lookout Road, south of Russell Road[1]	48,700
19	Lookout Road, south of McCaffrey Drive[1]	47,200

Note: Average Weekday Daily Traffic (two-way in vehicles).

Source: (1) October 2014 survey data, (2) May 2015 survey data.

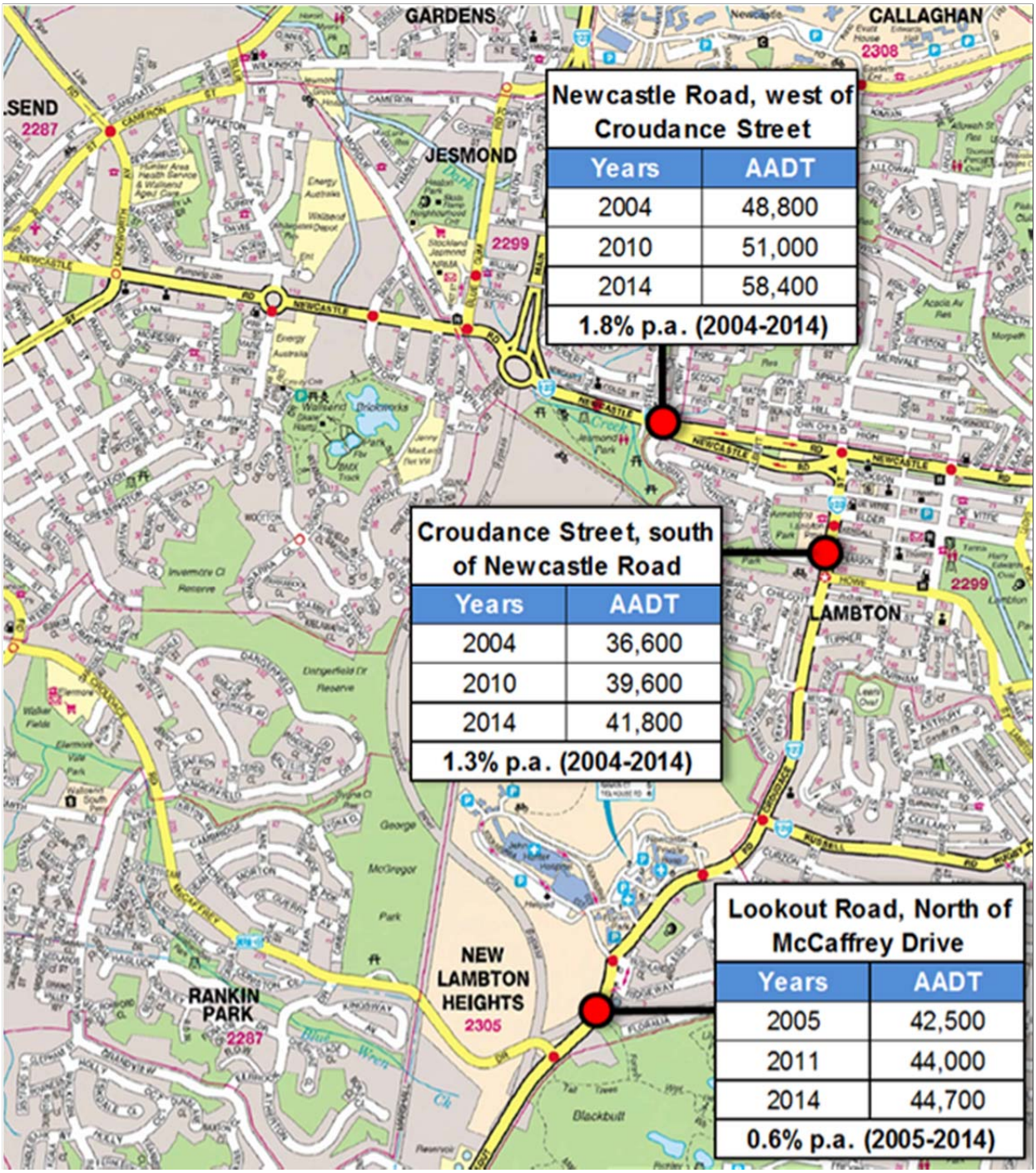


Note: Average Weekday Daily Traffic (two-way in vehicles)

Figure 5.5 Existing average daily weekly traffic flows (2014)

5.2.5. Historical traffic growth

The historical traffic data between 2004 and 2014 indicates that in the last 10 years traffic on the existing route of Lookout Road, Croudace Street and Newcastle Road has grown by about 0.6 to 1.8 per cent per annum (refer to **Figure 5.6**).



Source: Roads and Maritime

Figure 5.6 Historical traffic volumes on existing route

5.2.6. Future traffic growth

The LHTM has been updated for the study area using the origin-destination (OD) survey data and mid-block traffic counts.

Future forecast traffic volumes for the study area considered population and employment increases projected in the Lower Hunter Regional Strategy (NSW Department of Planning, 2006).

Table 6 shows the forecast daily traffic volumes and traffic growth rates at 19 locations for 2014, 2020, 2030 and 2040 without the project.

Table 6 Forecast daily volumes from LHTM – without the project

ID	Road/location	2014	2020	2030	2040	Annual growth rate (per cent) 2014-2040
1	Charlestown Road, south of Cardiff Road	55,100	55,500	56,300	57,100	0.1%
2	Carnley Avenue, east of Charlestown Road	21,000	21,100	21,400	21,700	0.1%
3	Cardiff Road, west of Lookout Road	14,700	15,100	15,800	16,600	0.5%
4	Grandview Road, west of Lookout Road	2,700	2,800	3,000	3,100	0.5%
5	McCaffrey Drive, west of Lookout Road	18,600	19,100	20,000	20,900	0.4%
6	Croudace Road, west of Grandview Road	19,900	20,100	20,600	21,000	0.2%
7	Lookout Road, north of McCaffrey Drive	49,400	52,500	57,700	63,100	0.9%
8	Kookaburra Circuit (John Hunter Hospital access)	15,300	16,200	17,900	19,800	1.0%
9	Russell Road, east of Lookout Road	16,200	17,600	20,100	22,600	1.3%
10	Newcastle Road, east of Croudace Street	46,500	51,600	60,100	68,500	1.5%
11	Newcastle Inner City Bypass, north of Newcastle Road	36,100	41,700	51,000	60,300	2.0%
12	Newcastle Road, west of Newcastle Inner City Bypass	44,300	48,200	54,700	61,200	1.3%
13	Dent Street, north of Newcastle Road	4,900	5,400	6,300	7,200	1.5%
14	Jacaranda Drive (John Hunter Hospital access)	2,700	2,700	2,800	2,900	0.3%
15	Howe Street, east of Croudace Street	8,500	9,600	11,400	13,300	1.7%
16	Newcastle Road, east of Newcastle Inner City Bypass	60,200	66,200	76,200	86,200	1.4%
17	Croudace Street, north of Elder Street	41,800	43,900	47,300	50,800	0.8%
18	Lookout Road, south of Russell Road	48,700	51,500	56,400	61,300	0.9%
19	Lookout Road, south of McCaffrey Drive	47,200	48,300	50,200	52,200	0.4%
	Total study area					1%

5.2.7. Traffic volume forecasts with the project

In addition to background traffic growth, it is expected there would be changes to the pattern of traffic demand within the study areas road network due to the improvements provided by the project.

There are two main mechanisms of change in trip demand as a result of improvements provided by the project:

- Redistribution of existing trips within the modelled network from use of one particular route to use of another route within the network
- Redistribution of existing trips from other parts of the Newcastle road network, attracted to travel through the modelled area due to improved travel conditions.

Table 7 and **Figure 5.7** to **Figure 5.10** show forecast daily traffic at 19 locations for 2014, 2020, 2030 and 2040 with the project.

Existing daily traffic volumes (2014/15) have been used to compare and examine predicted changes on the road network with the project based on current traffic conditions.

The key changes predicted with the project are:

- The project is predicted to carry between about 21,600 and 29,400 vehicles per day. The northern section between Newcastle Road and the new hospital access is expected to carry higher traffic volumes
- The new hospital access road is predicted to carry about 7,300 vehicles per day
- The project is predicted to increase traffic on Lookout Road south of McCaffrey Drive by about 10 per cent
- The project is expected to increase traffic on the Newcastle Inner City Bypass north of Newcastle Road by about 10 to 15 per cent
- The project is expected to reduce traffic from the existing route (Lookout Road, Croudace Street and Newcastle Road) by about 25 to 45 per cent depending on the location. This would substantially improve traffic flow and reduce travel times along the existing route
- The project is expected to reduce traffic on McCaffrey Drive by about 15 to 20 per cent
- The project is expected to marginally increase traffic on Grandview Road and Carnley Avenue by about 200 vehicles per day
- The new western hospital access is expected to substantially reduce traffic on the existing eastern access via Kookaburra Circuit by about 50 per cent
- The project would primarily redistribute traffic in the study area and surrounding road network for north-south and south-west movements.

In future years 2020, 2030 and 2040, similar traffic redistribution from the project on the surrounding road network are expected.

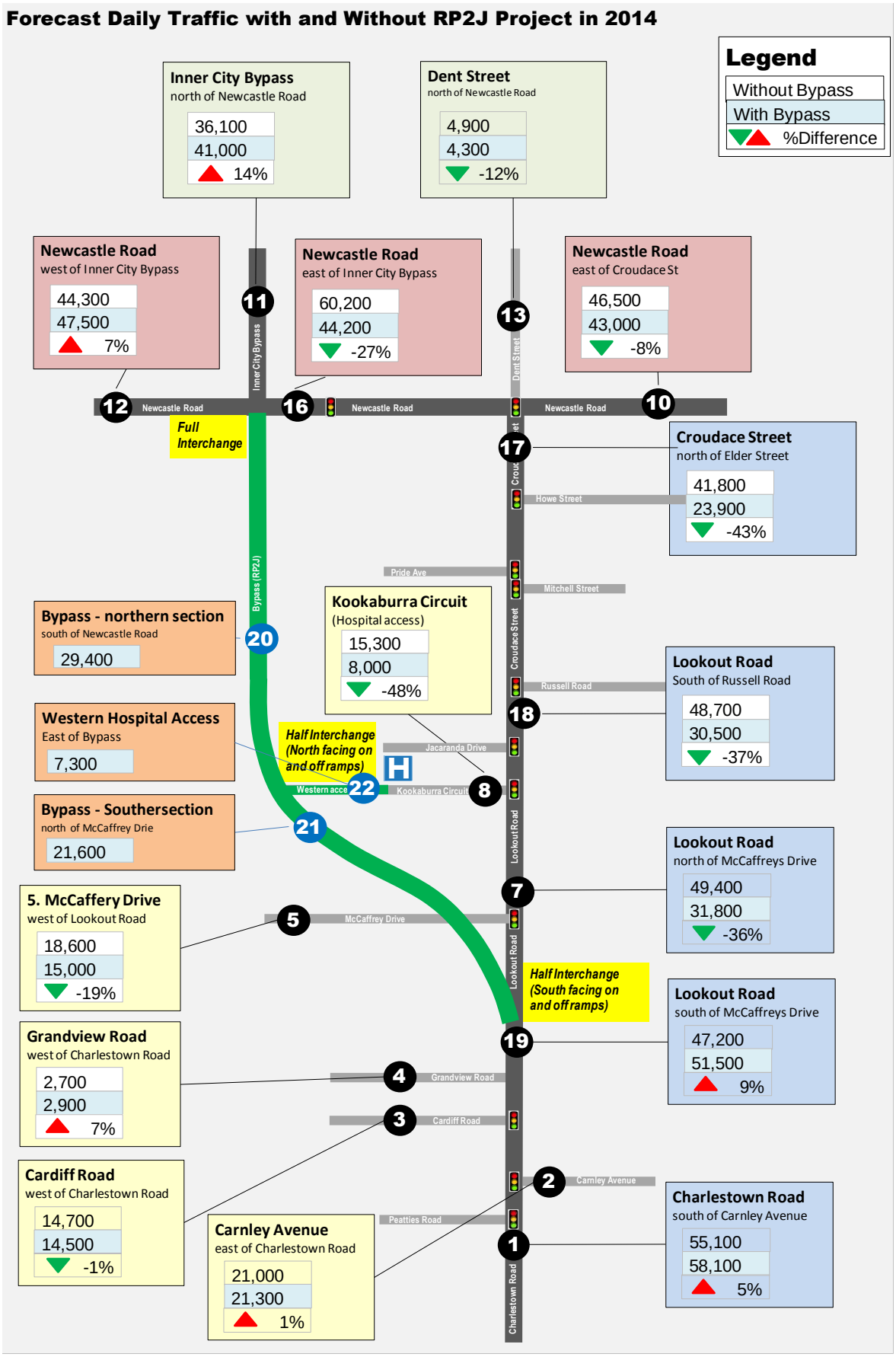
Table 7 Forecast daily volumes on key locations for 2014, 2020, 2030 and 2040 with the project

ID	Road/location	2014			2020			2030			2040		
		No RP2J	with RP2J	Change	No RP2J	with RP2J	Change	No RP2J	with RP2J	Change	No RP2J	with RP2J	Change
1	Charlestown Road, south of Cardiff Road	55,100	58,100	3,000	55,500	59,400	3,900	56,300	61,700	5,400	57,100	64,000	6,900
2	Carnley Avenue, east of Charlestown Road	21,000	21,300	300	21,100	21,400	300	21,400	21,600	200	21,700	21,900	200
3	Cardiff Road, west of Lookout Road	14,700	14,500	-200	15,100	14,700	-400	15,800	15,100	-700	16,600	15,500	-1,100
4	Grandview Road, west of Lookout Road	2,700	2,900	200	2,800	3,000	200	3,000	3,200	200	3,100	3,400	300
5	McCaffrey Drive, west of Lookout Road	18,600	15,000	-3,600	19,100	15,800	-3,300	20,000	17,000	-3,000	20,900	18,200	-2,700
6	Croudace Road, west of Grandview Road	19,900	16,100	-3,800	20,100	16,600	-3,500	20,600	17,500	-3,100	21,000	18,500	-2,500
7	Lookout Road, north of McCaffrey Drive	49,400	31,800	-17,600	52,500	34,100	-18,400	57,700	38,000	-19,700	63,100	42,300	-20,800
8	Kookaburra Circuit (John Hunter Hospital access)	15,300	8,000	-7,300	16,200	8,500	-7,700	17,900	9,300	-8,600	19,800	10,300	-9,500
9	Russell Road, east of Lookout Road	16,200	15,300	-900	17,600	16,800	-800	20,100	19,400	-700	22,600	21,900	-700
10	Newcastle Road, east of Croudace Street	46,500	43,000	-3,500	51,600	47,800	-3,800	60,100	55,900	-4,200	68,500	64,000	-4,500
11	Newcastle Inner City Bypass, north of Newcastle Road	36,100	41,000	4,900	41,700	46,900	5,200	51,000	56,800	5,800	60,300	66,900	6,600
12	Newcastle Road, west of Newcastle Inner City Bypass	44,300	47,500	3,200	48,200	51,600	3,400	54,700	58,500	3,800	61,200	65,300	4,100
13	Dent Street, north of Newcastle Road	4,900	4,300	-600	5,400	4,900	-500	6,300	5,900	-400	7,200	6,800	-400
14	Jacaranda Drive (John Hunter Hospital access)	2,700	2,700	0	2,700	2,700	0	2,800	2,800	0	2,900	2,900	0
15	Howe Street, east of Croudace Street	8,500	8,600	100	9,600	9,700	100	11,400	11,700	300	13,300	13,600	300

ID	Road/location	2014			2020			2030			2040		
		No RP2J	with RP2J	Change	No RP2J	with RP2J	Change	No RP2J	with RP2J	Change	No RP2J	with RP2J	Change
16	Newcastle Road, east of Newcastle Inner City Bypass	60,200	44,200	-16,000	66,200	49,400	-16,800	76,200	58,200	-18,000	86,200	67,100	-19,100
17	Croudace Street, north of Elder Street	41,800	23,900	-17,900	43,900	25,100	-18,800	47,300	27,100	-20,200	50,800	29,100	-21,700
18	Lookout Road, south of Russell Road	48,700	30,500	-18,200	51,500	32,500	-19,000	56,400	36,000	-20,400	61,300	39,500	-21,800
19	Lookout Road, south of McCaffrey Drive	47,200	51,500	4,300	48,300	53,400	5,100	50,200	56,600	6,400	52,200	59,800	7,600

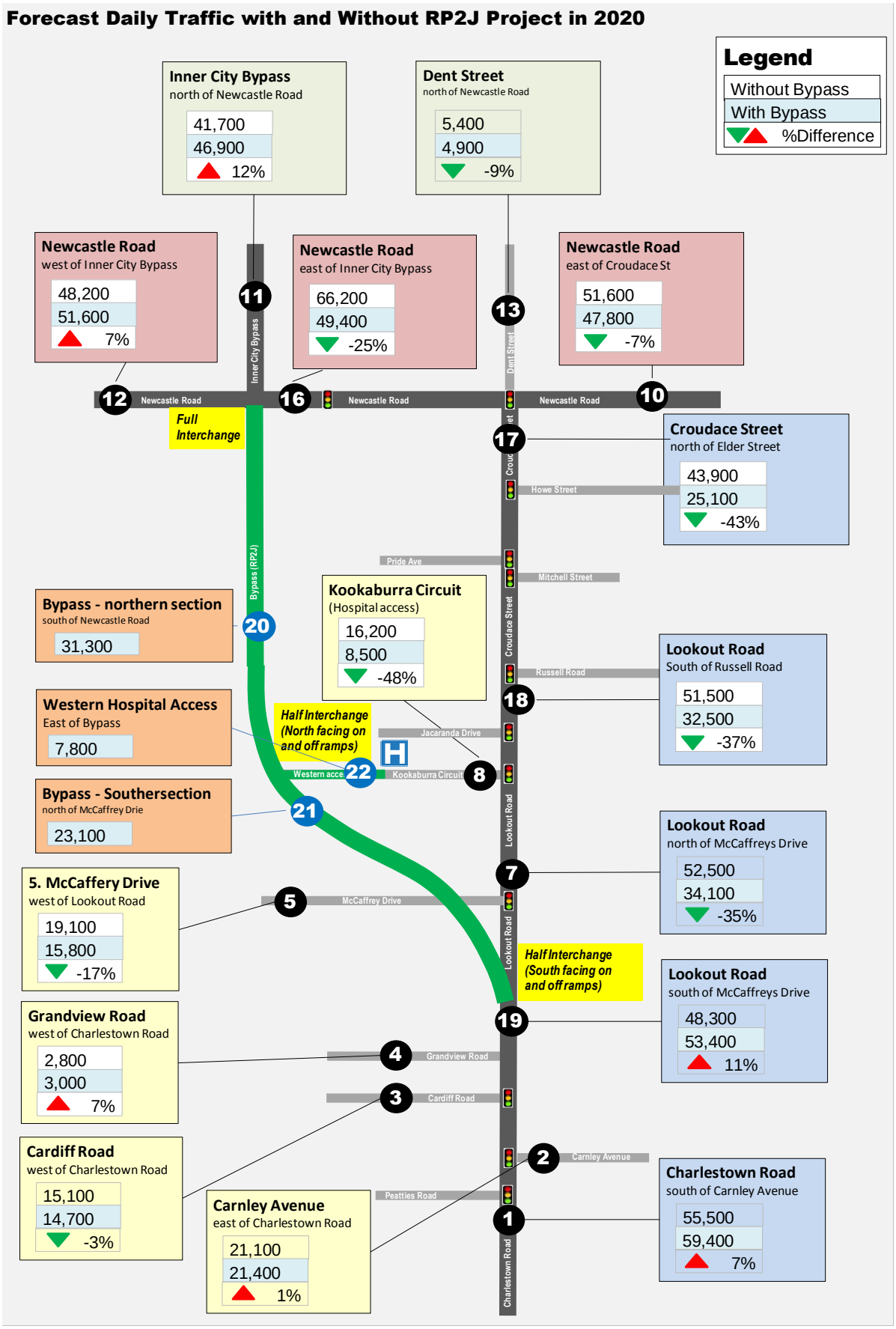
Note: Average Weekday Daily Traffic (two-way in vehicles); Rankin Park to Jesmond Project (RP2J).

Source: Lower Hunter Traffic Model (LHTM).



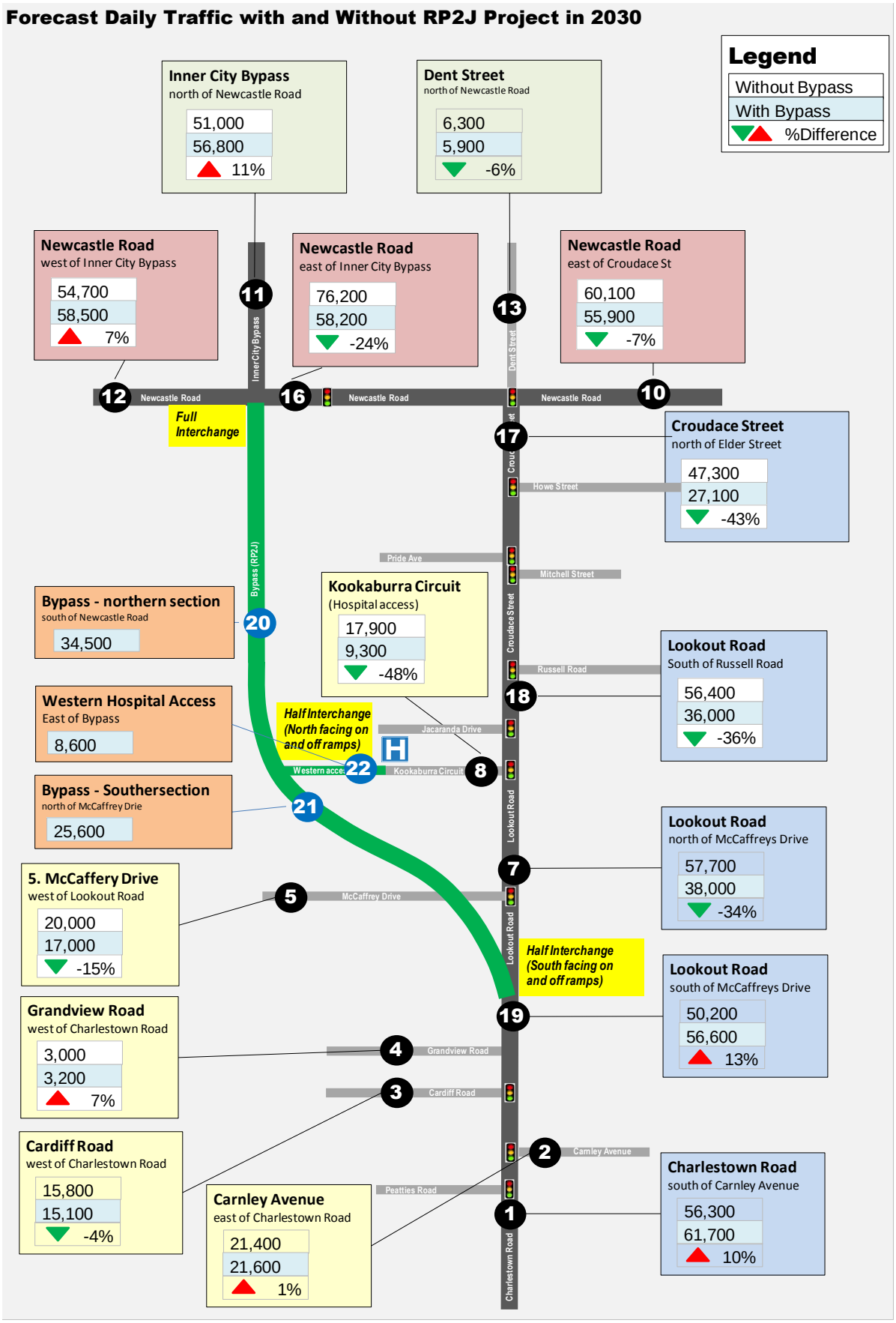
Note, Average Weekday Daily Traffic (two-way in vehicles).
Source: Lower Hunter Traffic Model (LHTM).

Figure 5.7 Forecast daily traffic with and without the Project in 2014



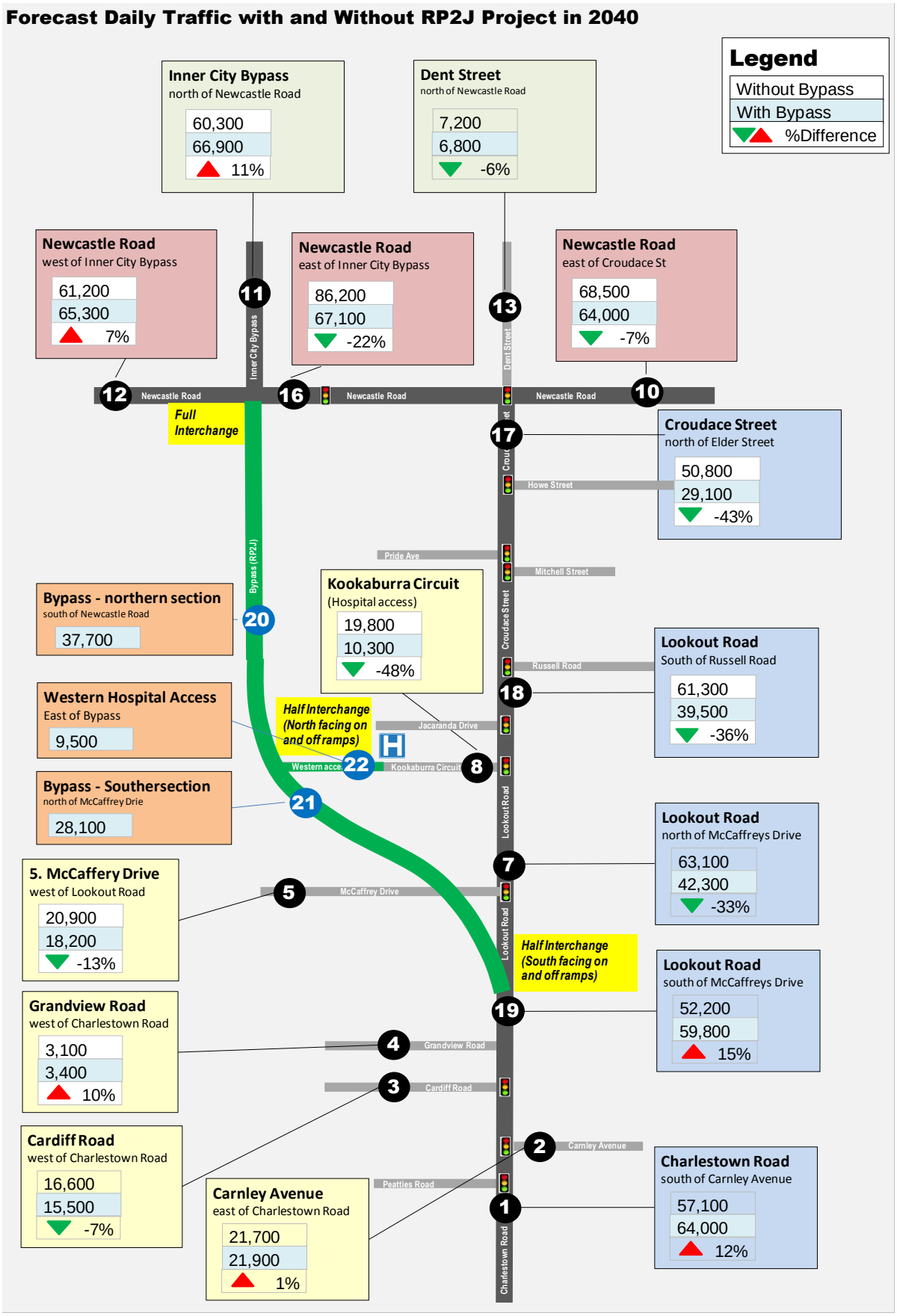
Note, Average Weekday Daily Traffic (two-way in vehicles).
Source: Lower Hunter Traffic Model (LHTM).

Figure 5.8 Forecast daily traffic with and without the Project in 2020



Note, Average Weekday Daily Traffic (two-way in vehicles).
Source: Lower Hunter Traffic Model (LHTM).

Figure 5.9 Forecast daily traffic with and without the Project in 2030



Note, Average Weekday Daily Traffic (two-way in vehicles).
Source: Lower Hunter Traffic Model (LHTM).

Figure 5.10 Forecast daily traffic with and without the Project in 2040

5.2.8. Traffic modelling of McCaffrey Drive ramps at the Southern Interchange

Traffic modelling was carried out to investigate forecast traffic redistribution from the provision of north-facing ramps at the southern interchange, which comprise of:

- Northbound on-ramp from McCaffrey Drive to the bypass
- Southbound off-ramp from the bypass to McCaffrey Drive.

Existing traffic distribution at McCaffrey Drive

As detailed in **Section 4.2.9**, McCaffrey Drive connects to both Lake Road and Thomas Street through Rankin Park, Elermore Vale and Wallsend. As well as serving adjacent residential areas of Rankin Park and Elermore Vale, McCaffrey Drive provides a major east-west route together with Russell Road. It also provides a regional road link between the section of the Newcastle Inner City Bypass south of McCaffrey Drive and suburbs to the north-west of the study area such as Fletcher, Maryland and further west.

Origin-destination (OD) surveys (refer to **Section 5.2.4**) of existing traffic at McCaffrey Drive were analysed to provide a forecast of the traffic that would use the project via north-facing ramps based on existing traffic distributions. The traffic that was predicted to use the project was traffic on McCaffrey Drive that had an origin or destination at either:

- Newcastle Inner City Bypass, North of Newcastle Road (refer to **Table 7 ID11**)
- Newcastle Road, West of Newcastle Inner City Bypass (refer to **Table 7 ID12**).

Figure 5.11 shows the existing daily traffic distributions at McCaffrey Drive.

Figure 5.12 and **Figure 5.13** show respective morning and afternoon peak hour existing traffic distributions at McCaffrey Drive.

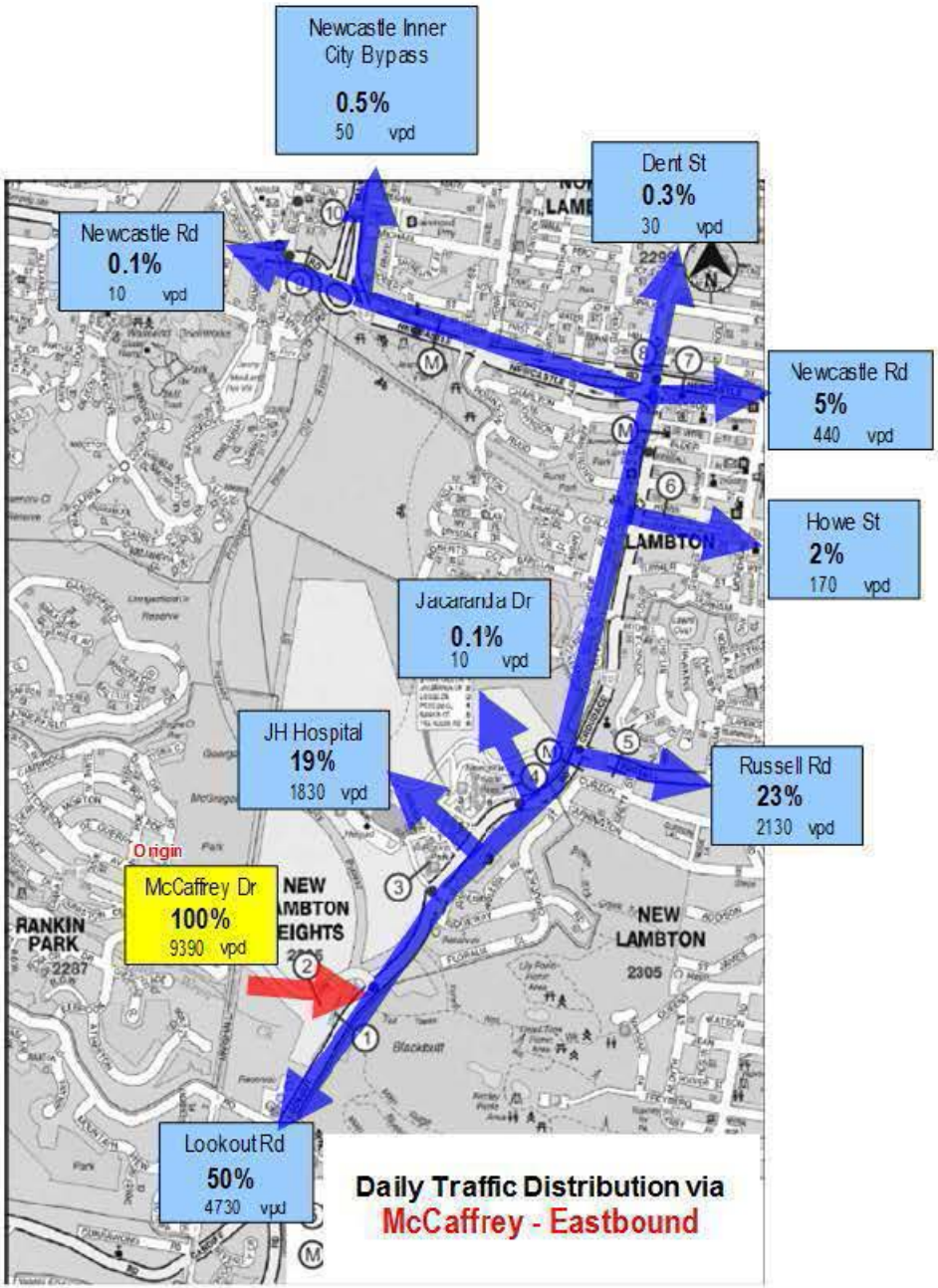
Of the 18,600 daily vehicles observed at McCaffrey Drive the traffic distribution results from the daily OD survey (October 2014) indicate the following:

- About 99 per cent of McCaffrey Drive traffic had an origin or destination such that it would not use the project and therefore would not use the north-facing ramps if they were provided:
  - About 52 per cent (9650 vehicles) had an origin or destination south of McCaffrey Drive via Lookout Road
  - About 25 per cent (4660 vehicles) had an origin or destination to the east via Russell Road
  - About 16 per cent (3050 vehicles) had an origin or destination at the John Hunter Hospital
  - About 6 per cent (1080 vehicles) had an origin or destination to the east via Howe Street or Newcastle Road.
- About 0.5 per cent (100 daily vehicles) had an origin or destination that would use the project (ID11 or ID12) and therefore would use the north-facing ramps if they were provided.

Similar patterns were observed during the morning and afternoon peak OD (May 2015):

- The morning peak distributions at McCaffrey Drive show about one per cent (13 vehicles) would use the project (ID11 or ID12) and therefore would use the north-facing ramps if they were provided
- Similarly, the afternoon peak distributions at McCaffrey Drive show about one per cent (17 vehicles) would use the project (ID11 or ID12) and therefore would use the north-facing ramps if they were provided.

In summary, the existing traffic distributions indicate very low volume of traffic would use the north-facing ramps to access the project to and from McCaffrey Drive.



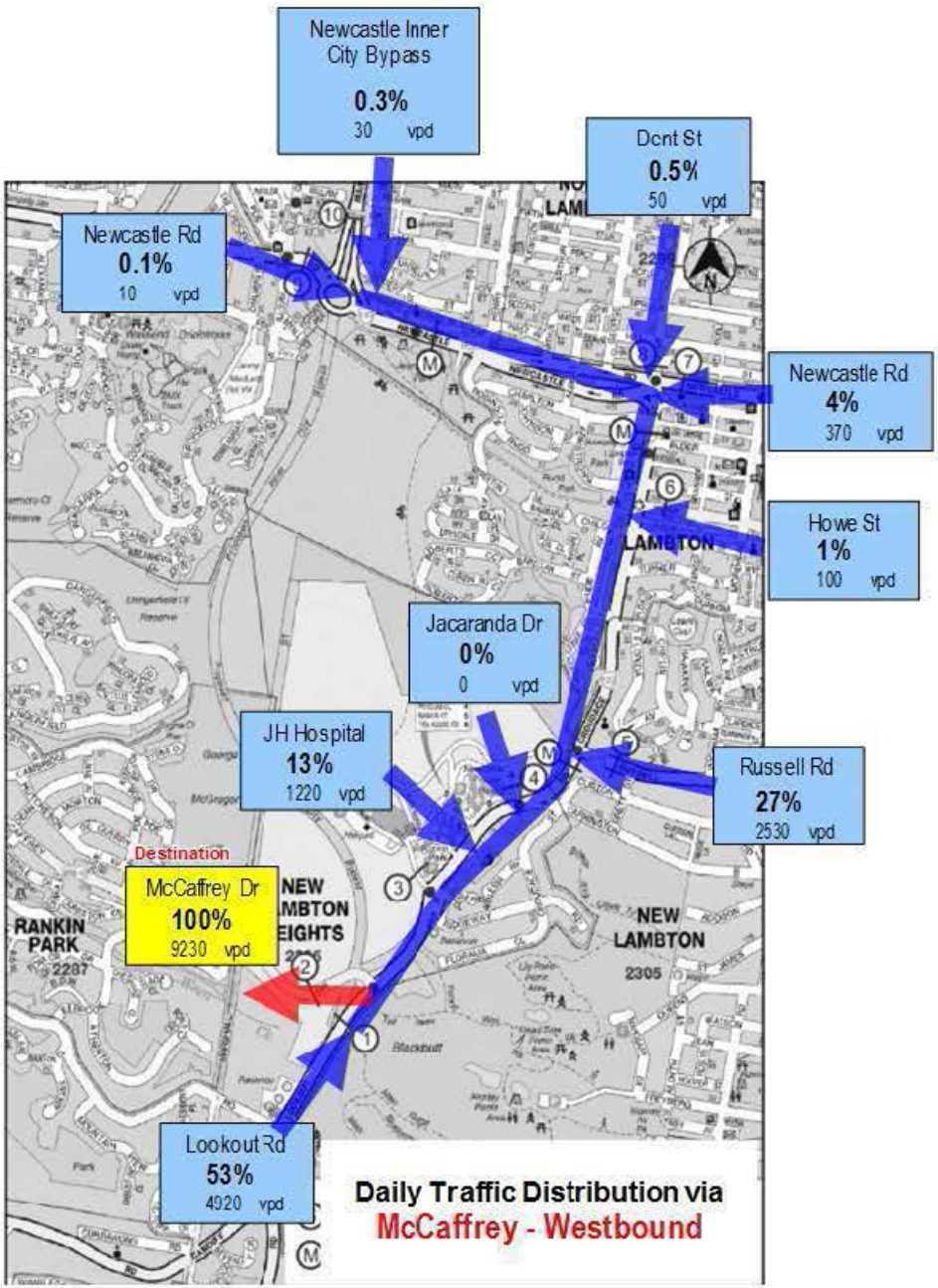
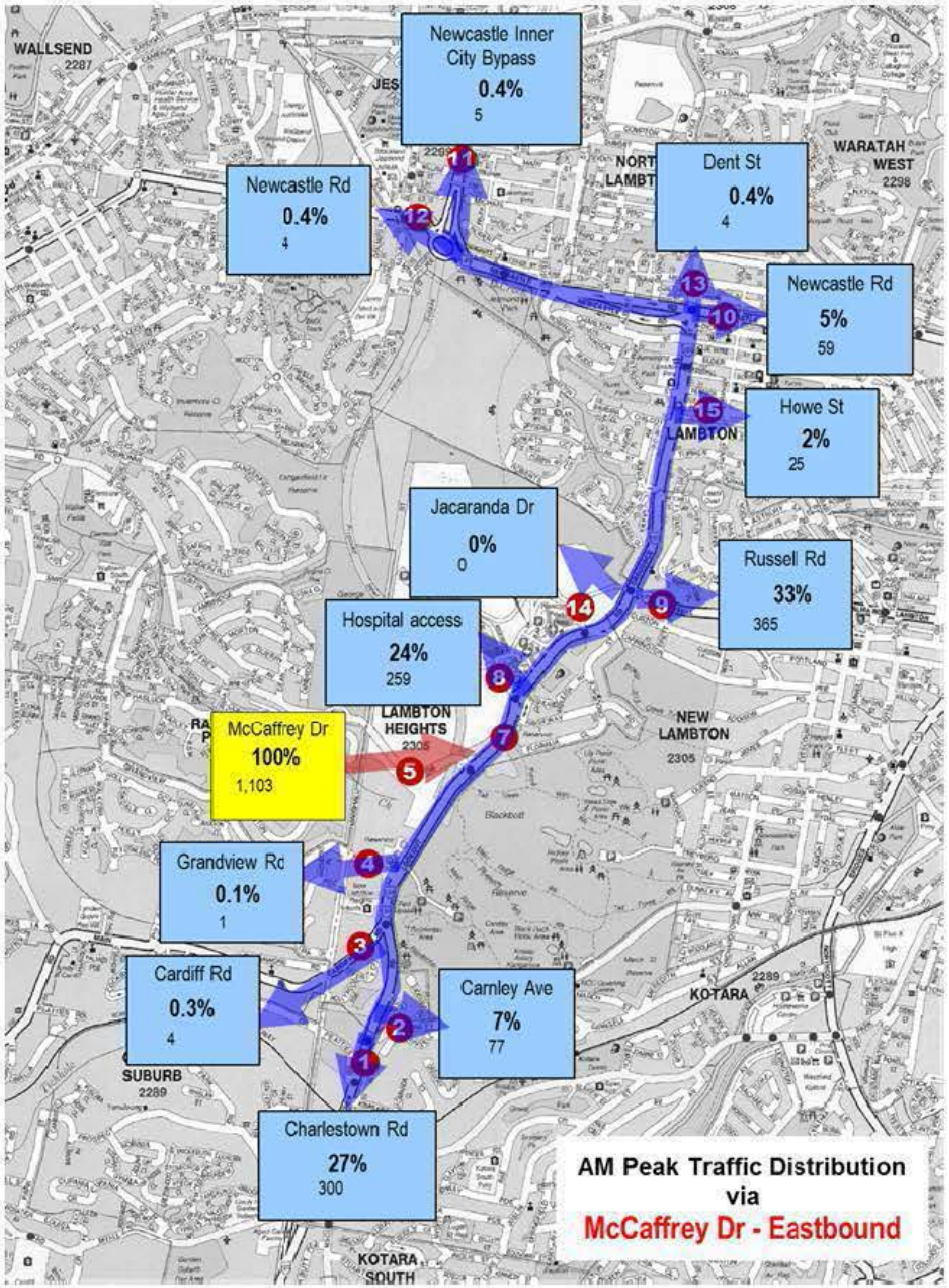


Figure 5.11 Daily OD distribution via McCaffrey Drive west of Lookout Road (October 2014)



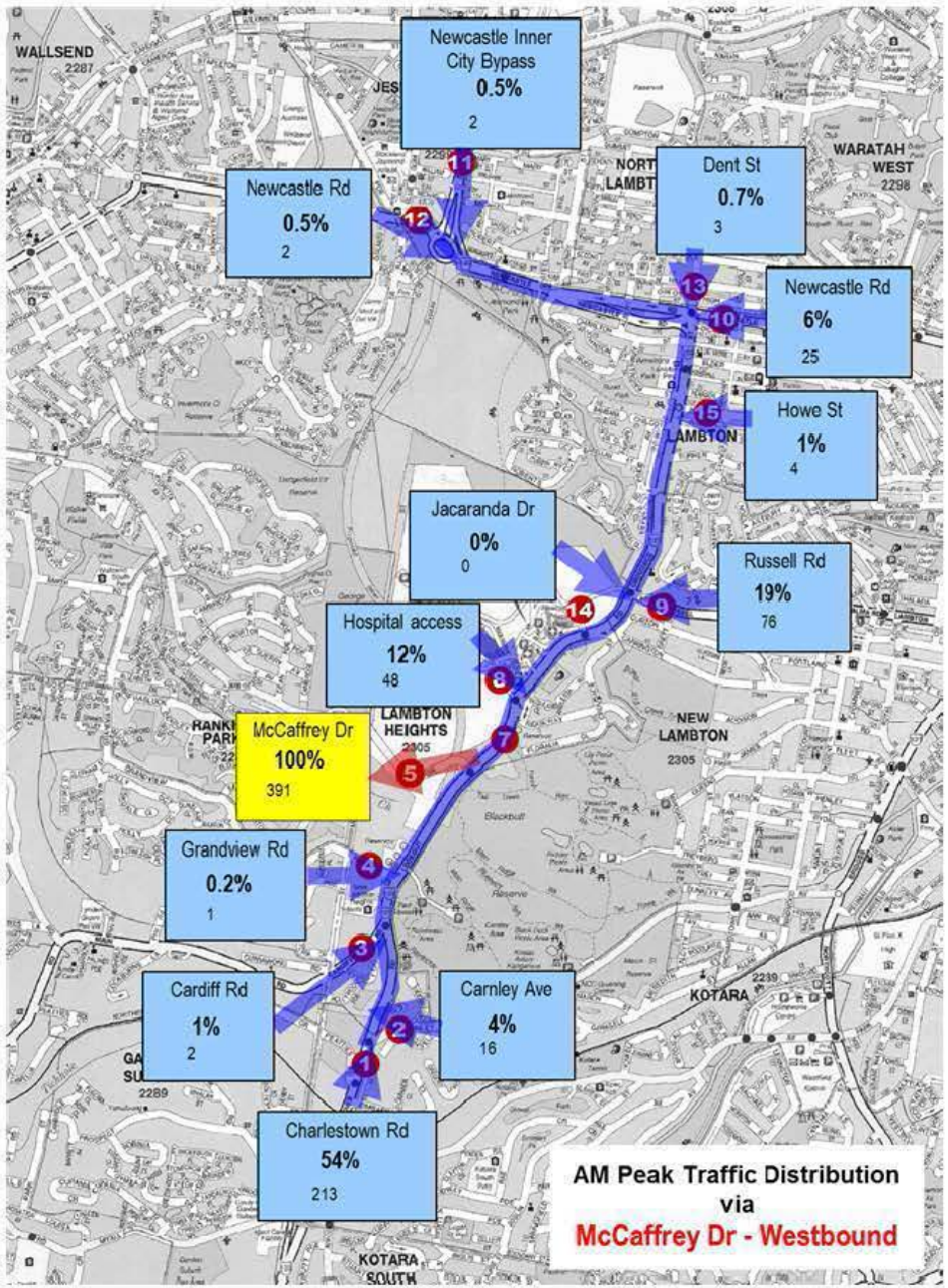
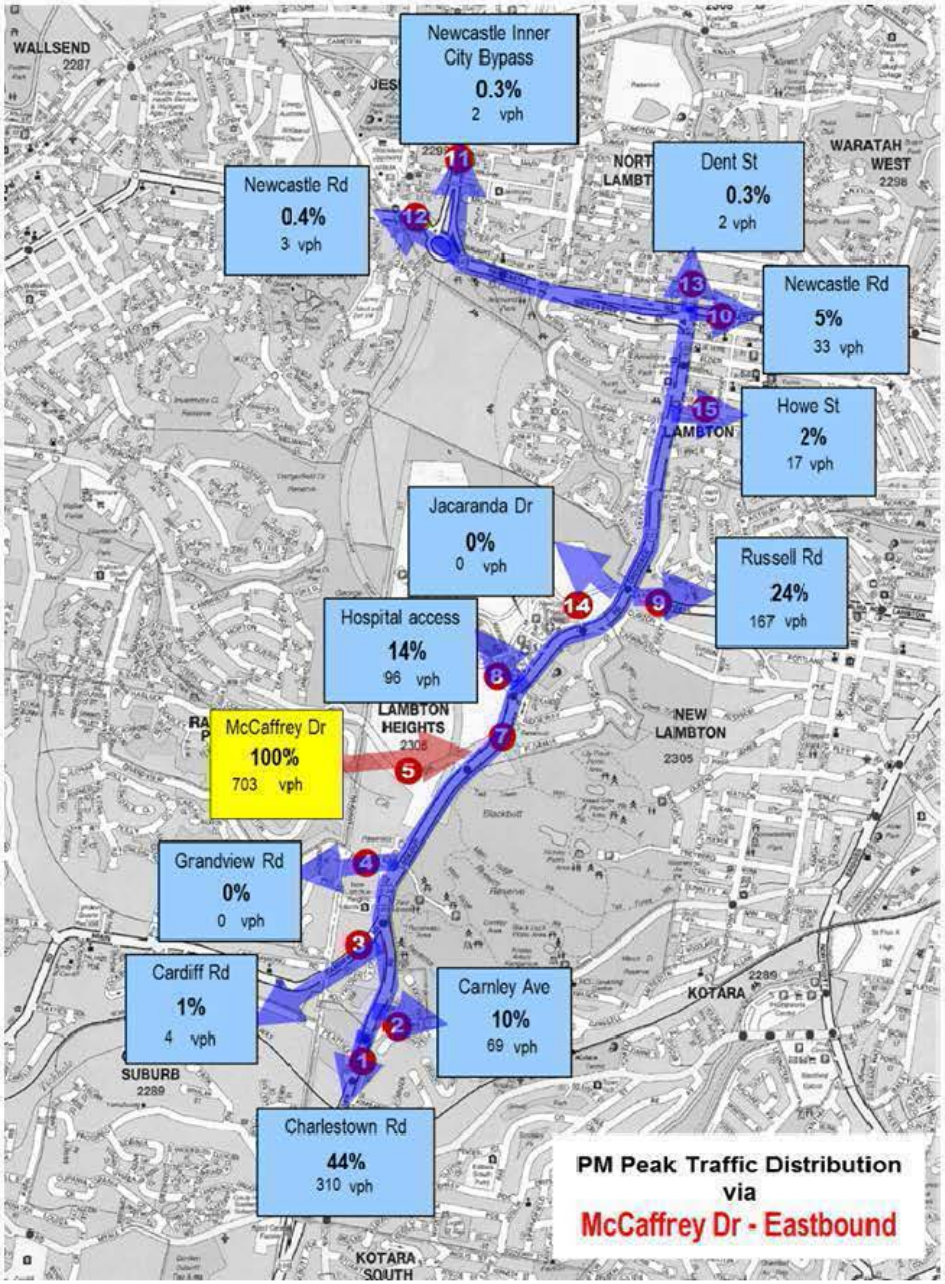


Figure 5.12 AM peak OD distribution via McCaffrey Drive west of Lookout Road (May 2015)



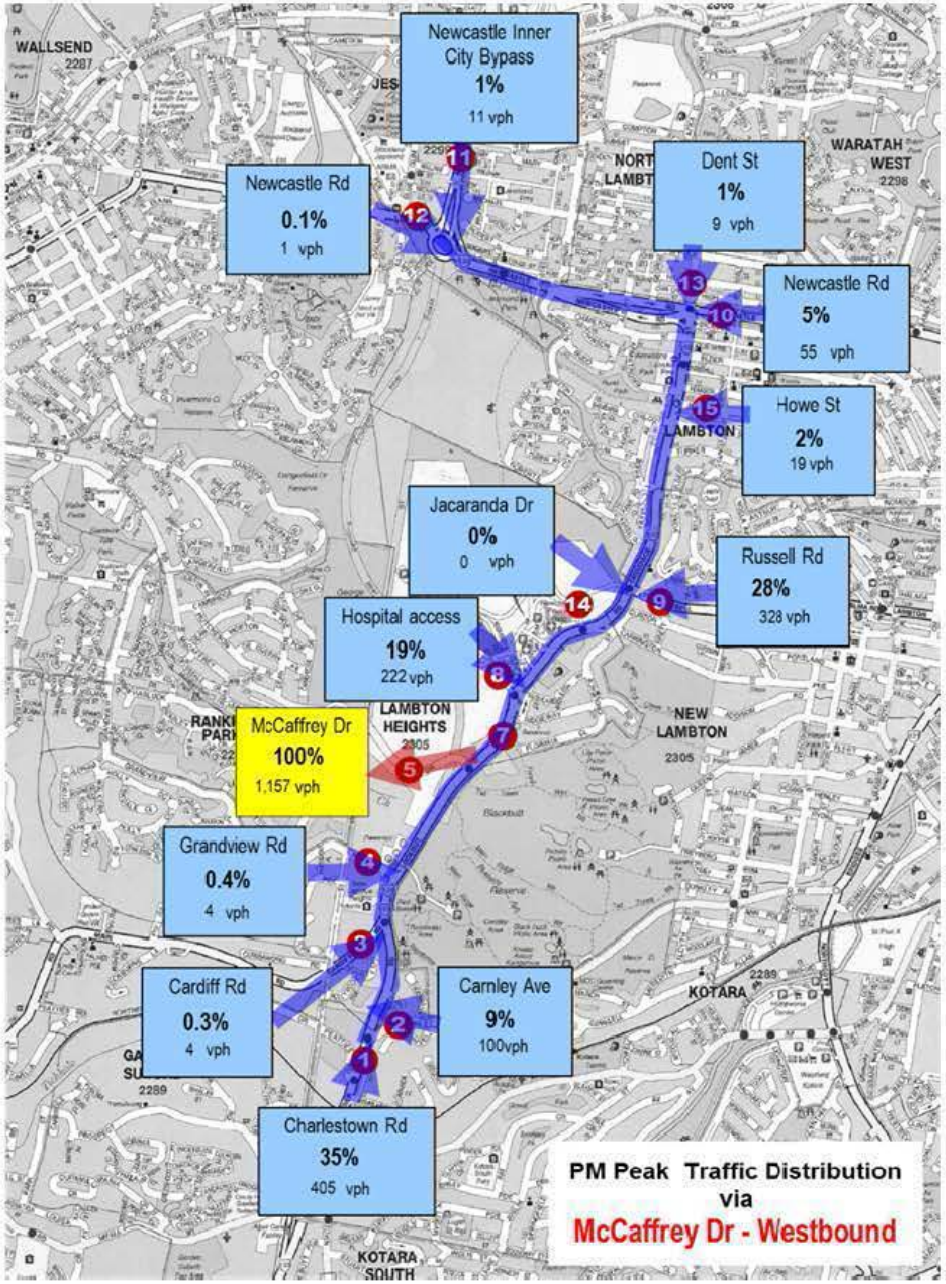


Figure 5.13 PM peak OD distribution via McCaffrey Drive west of Lookout Road (May 2015)

Forecast traffic distribution – Southern Interchange

Using the LHTM, forecast traffic distribution from the provision of north-facing ramps at the southern interchange were investigated based on existing traffic volumes (2014) and for future forecast traffic volumes for 2020, 2030 and 2040.

Table 8 and **Figure 5.14** show forecast daily traffic volumes (2014) with and without north-facing ramps.

Based on existing traffic volumes (2014), the traffic modelling predicts that:

- About 75 vehicles per day would use each of the north-facing ramps at the southern interchange. This is a total of 150 vehicles per day, which represents about one per cent of traffic predicted to use the southern section of the bypass
- In 2020, the north-facing ramps (if provided) are forecast to carry about 175 daily vehicles increased to 200 in 2030 and 225 in 2040.

Given the predicted low volumes of traffic forecast to use the north-facing ramps, the modelling indicates that the omission of north-facing ramps from the southern interchange would have negligible traffic volume impacts on local roads including Grandview Road and Marshall Street. Traffic volumes predicted to use Grandview Road and Marshall Street are essentially the same with or without the north-facing ramps with local residents the primary users of these local roads.

The modelling outcomes are supported by examination of the surrounding road network to the west of the southern interchange, namely:

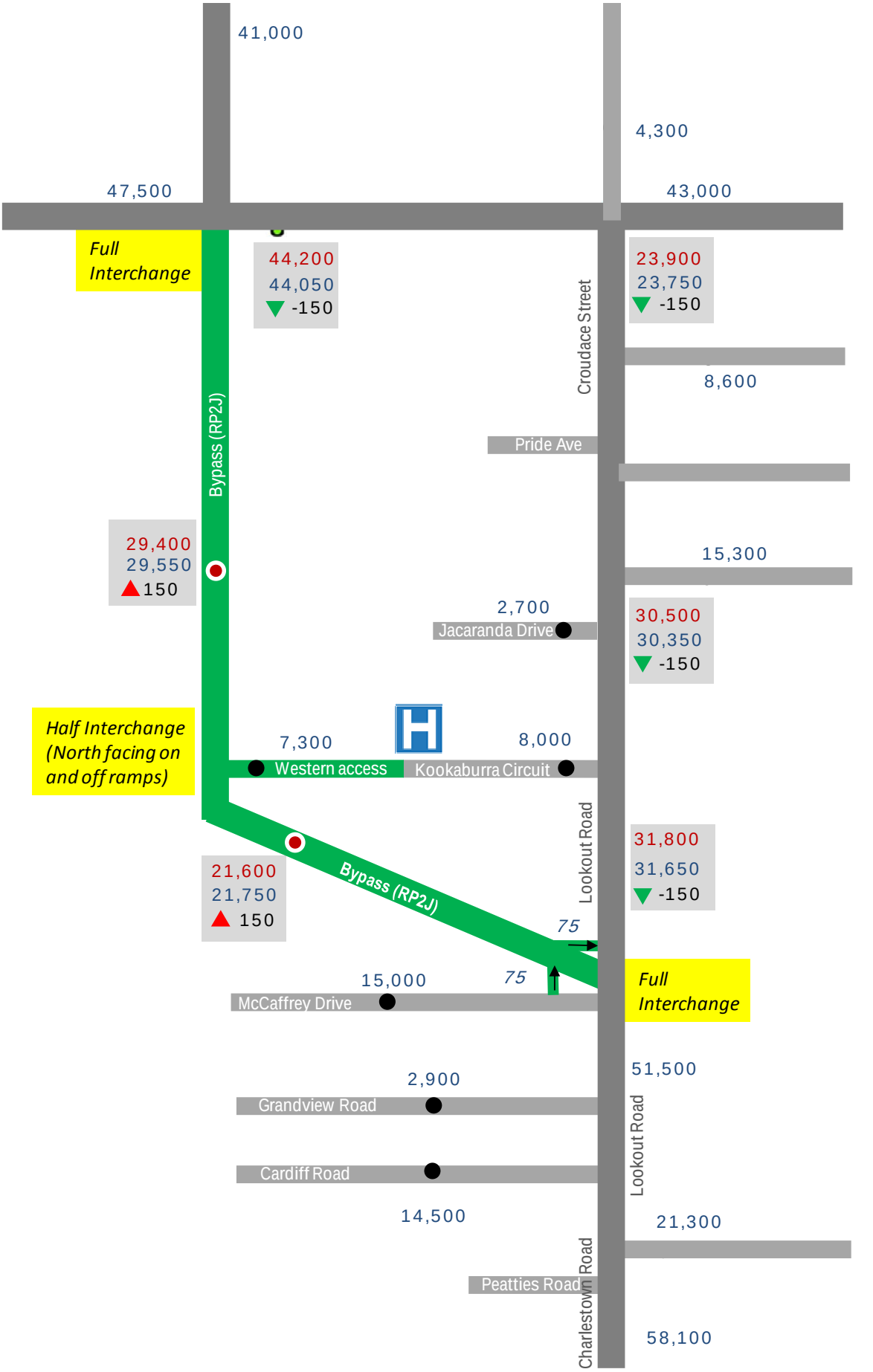
- The winding and undulating nature of Grandview Road together with numerous traffic calming devices (speed humps) make Grandview Road an unattractive alternate option for vehicles to re-route from McCaffrey Drive in order to be able to access the project to and from the catchment areas to the west
- Traffic generated from the immediate north-west portion of the study area off-roads such as Douglas Street and Birchgrove Road, are predicted to continue to use Newcastle Road to travel either to/from the Newcastle Inner City Bypass north of Newcastle Road or to/from the hospital
- Traffic generated from the immediate south-west portion of the study area off Grandview Road, are expected to continue to use Grandview Road to travel either to/from the Newcastle Inner City Bypass north of Newcastle Road or to/from the hospital.

Table 8 Forecast daily traffic volumes (2014 with the project) with and without north-facing ramps at the Southern Interchange

ID	Road/location	Without north-facing ramps	With north-facing ramps	Change
	Southern Interchange – North-facing ramps:			
23	Northbound on-ramp	n/a	75	
24	Southbound off-ramp	n/a	75	
	The project:			
20	Northern section, south of Newcastle Road	29,400	29,550	150 ▲
21	Southern section, north of McCaffrey Drive	21,600	21,750	150 ▲
22	New Western Hospital Interchange	7,300	7,300	No change
	Key locations:			
1	Charlestown Road, south of Cardiff Road	58,100	58,100	No change
2	Carnley Avenue, east of Charlestown Road	21,300	21,300	No change
3	Cardiff Road, west of Lookout Road	14,500	14,500	No change
4	Grandview Road, west of Lookout Road	2,900	2,900	No change
5	McCaffrey Drive, west of Lookout Road	15,000	15,000	No change
6	Croudace Road, west of Grandview Road	16,100	16,100	No change
7	Lookout Road, north of McCaffrey Drive	31,800	31,650	-150 ▼
8	Kookaburra Circuit (John Hunter Hospital access)	8,000	8,000	No change
16	Newcastle Road, east of Newcastle Inner City Bypass	44,200	44,050	-150 ▼
17	Croudace Street, north of Elder Street	23,900	23,750	-150 ▼

Note: Average Weekday Daily Traffic (two-way in vehicles).

Source: Lower Hunter Traffic Model (LHTM).



Note, Average Weekday Daily Traffic (two-way in vehicles).
Source: Lower Hunter Traffic Model (LHTM).

Figure 5.14 Forecast daily traffic (2014) with and without north-facing ramps at the Southern Interchange

Figure 5.16 shows the daily traffic volumes predicted to use the Southern Interchange with both south-facing ramps and north-facing ramps based on 2014 traffic volumes.

Key points include:

- About 28,500 vehicles per day are predicted to use the south-facing ramps comprising:
  - About 13,800 vehicles per day would use the northbound off-ramp to Lookout Road
  - About 14,700 vehicles per day would use the southbound on-ramp to join with the Newcastle Inner City Bypass south of McCaffrey Drive on Lookout Road.
- About 150 vehicles per day would use the north-facing ramps, which represents about 0.5 per cent of the traffic volumes predicted to use the south-facing ramps.

In summary, the forecast traffic distribution with the project indicates very low volumes would use the north-facing ramps to access the project to and from McCaffrey Drive if they were provided.

5.2.9. Option scenario modelling

Figure 5.15 shows the methodology for undertaking modelling of option scenarios for the project.

As illustrated the traffic modelling is part of an iterative process in parallel with option design development based on model observation, optimisation, issue identification and feedback into refinement of the design.

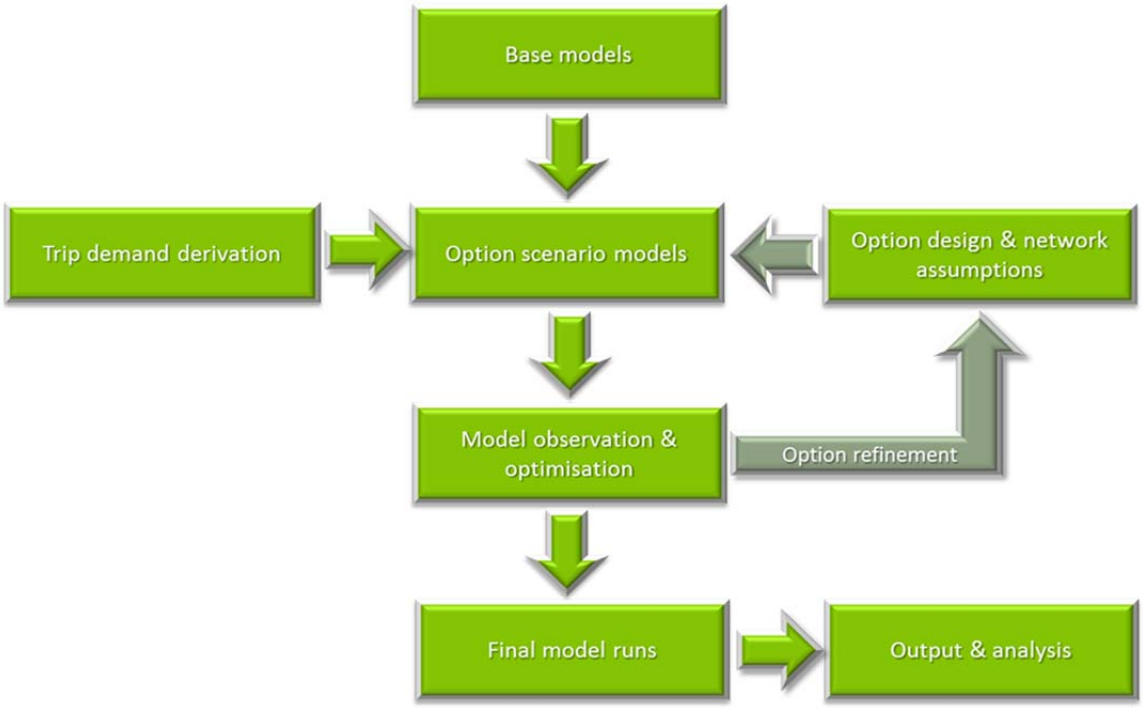


Figure 5.15 Option scenario model development methodology

Once a design option has been finalised from this iterative process, final model runs are undertaken to produce outputs for use in further assessment of options, such as economic and traffic performance analysis. (Refer Aurecon report *Refined Strategic Design Microsimulation Traffic Modelling Report, April 2016,* **Appendix D**).

Modelling is broadly undertaken for two scenarios; without the project (Do Minimum) and with the project options. The Do Minimum scenario assumes there are no substantial changes to the road network in future years. This forms the basis for economic and traffic performance comparisons of the project options.

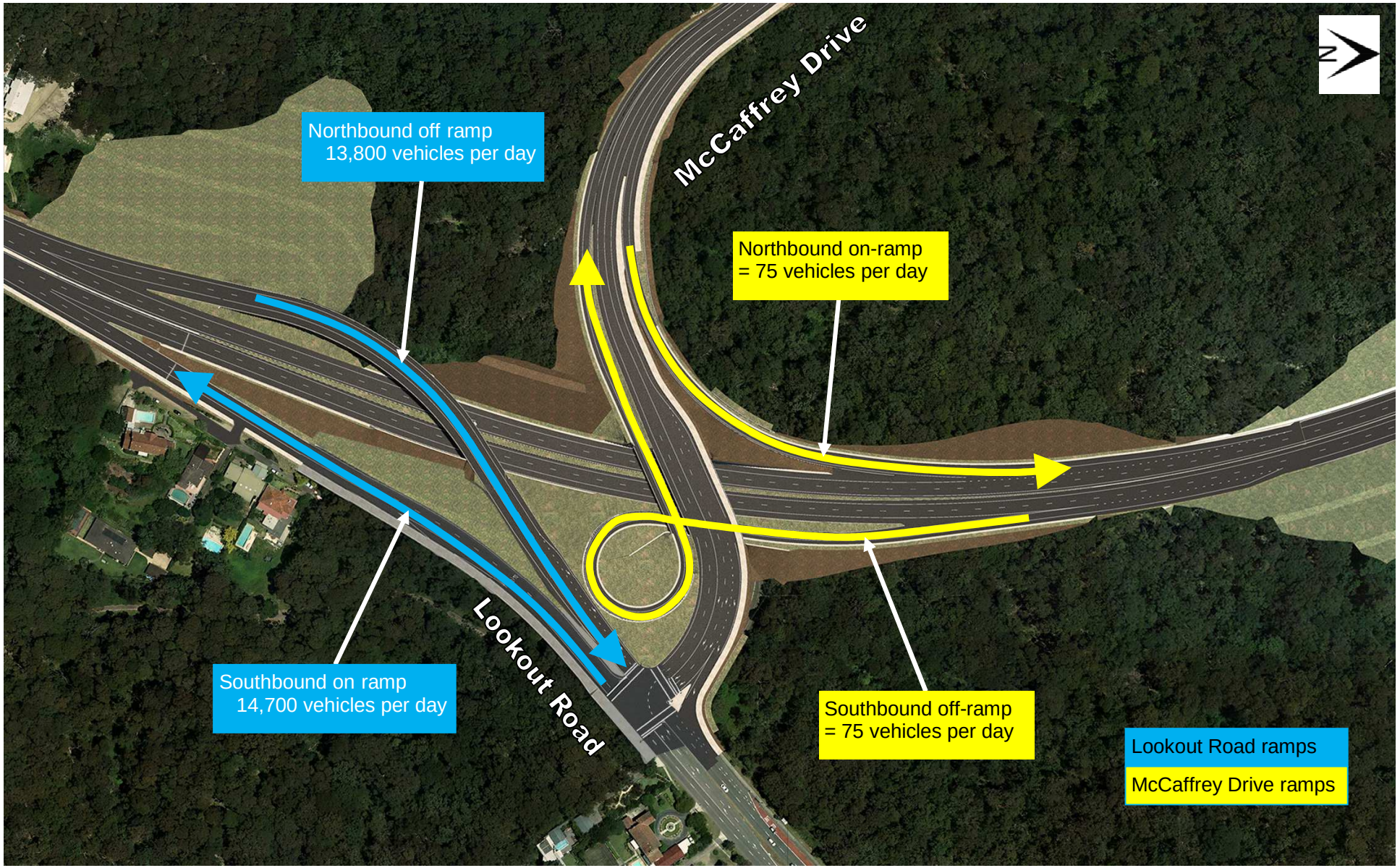


Figure 5.16 Predicted Southern Interchange daily traffic volumes (2014)

5.2.10. Option scenarios

The traffic modelling has considered five scenarios as follows:

Scenario 1 – Do Minimum:

- Represents the existing road network without improvements.

Scenario 2 – 2007 strategic design (with hospital left in/left out):

- Alignment Option 1 for the bypass
- Southern Interchange: Southern Option 1 being an interchange at McCaffrey Drive with south-facing ramps and a single lane southbound connection from Lookout Road merging with a single southbound lane from the bypass
- Hospital Option 1: Left-in/left-out intersection for the hospital access.
- Northern Interchange: Northern Option 1 being the existing roundabout with an additional leg to the south allowing for on-ramp and off-ramp connections to the bypass. A bridge over the roundabout for north-south movements.

Scenario 3 – Refined strategic design with hospital left-in/left-out:

- Alignment Option 2 for the bypass
- Southern Interchange: Southern Option 3 consisting of a northbound off-ramp connecting to existing intersection at McCaffrey Drive. Two southbound lanes from Lookout Road (southbound on-ramp) would tie-in with two lanes of bypass under control of traffic lights to form two southbound lanes downstream on Lookout Road
- Hospital Option 1: Left-in/left-out intersection for the hospital access
- Northern Interchange: Northern Option 5 being a full-interchange allowing for all movements to and from ramps under control of traffic lights. A bridge over the intersection for north-south movements.

Scenario 4 – Refined strategic design with half-interchange for hospital access:

- Alignment Option 2 for the bypass.
- Southern Interchange: Southern Option 3 consisting of a northbound off-ramp connecting to the existing intersection at McCaffrey Drive. Two southbound lanes from Lookout Road (southbound on-ramp) would tie-in with two lanes of bypass under control of traffic lights to form two southbound lanes downstream on Lookout Road
- Hospital Option 4: Half-interchange for the hospital access, with a southbound off-ramp to the hospital and a northbound on-ramp from the hospital (i.e north facing ramps only)
- Northern Interchange: Northern Option 5 being a full interchange allowing for all movements to and from ramps under control of traffic lights. A bridge over the intersection for north-south movements.

Scenario 5 – Refined strategic design with full-interchange hospital access:

- Alignment Option 2 for the bypass.
- Southern Interchange: Southern Option 3 consisting of northbound off-ramp connecting to existing intersection at McCaffrey Drive. Two southbound lanes from Lookout Road (southbound on-ramp) tie-in with two lanes of bypass under control of traffic lights to form two southbound lanes downstream on Lookout Road/Newcastle Inner City Bypass.
- Hospital Option 3: Full-interchange for the hospital access.

- Northern Interchange: Northern Option 5 being a full interchange allowing for all movements to and from Newcastle road and the bypass under control of traffic lights. A bridge over the intersection for north-south movements.

Scenario 6 - Refined strategic design with with half interchange for hospital access and McCaffrey Drive ramps

- As per Scenario 4 however this option has the addition of two north facing ramps at the southern interchange to provide connections between the bypass and McCaffrey Drive for northbound traffic (on-ramp) and southbound traffic (off-ramp).

5.2.11. Traffic modelling results

Model scenarios have been run in accordance with Roads and Maritime traffic modelling guidelines. Observations of traffic performance were undertaken of the traffic models for each scenario during both the morning and afternoon peak periods.

Key observations for each scenario are as follows:

Scenario 1 – Do minimum

- In future years with predicted traffic growth the existing network becomes increasingly congested as constraints on traffic capacity at existing bottlenecks worsen.
- Capacity issues at the Croudace Street/Dent Street/Newcastle Road intersection are particularly evident for westbound through movements on Newcastle Road with queues extending off the model extents in the evening peak. The right turn movements from both the eastbound and northbound approaches are inhibited by lack of capacity at the intersection.
- In the morning peak, at Jesmond roundabout queues for the southbound approach right turn movement extend back onto the Newcastle Inner City Bypass. Congestion on the eastbound approach is evident in the morning period with queues on Newcastle Road extending back to the model extents.
- In the evening peak, queues from southbound movements on Croudace Street at its intersection with Russell Road extend back through the Croudace Street/Dent Street/Newcastle Road intersection and inhibit turning movements from Newcastle Road due to lack of available space on the departure side of the intersection.

Scenario 2 – 2007 strategic design (with hospital left in/left out):

- There are capacity constraints at the northern interchange where the two-lane roundabout shows significant congestion, particularly in the evening peak period. This is due to the imbalance of flows at the roundabout through introduction of additional movements, primarily the right turn movement from the west and the limited traffic capacity of the two-lane roundabout.
- Resulting queues forming on the Newcastle Road westbound approach to the roundabout extend back to and inhibit the flow of traffic through the Croudace Street/Dent Street/Newcastle Road intersection with similar issues in the eastbound direction.
- The southern interchange design also presents similar capacity issues due to the interchange arrangement which has two sets of traffic lights and lack of sufficient capacity for the strong:
  - Right turn movement from McCaffrey Drive onto Lookout Road southbound
  - Single lane northbound off-ramp movement through to Lookout Road northbound.

Scenario 3 – Refined strategic design with left-in/left-out hospital access

- General observations as per Scenario 4 below, however the left-in/left-out arrangement at the hospital access requires traffic wanting to turn right out of the hospital to travel north onto the bypass to instead have to use the existing route of Lookout Road, Croudace Street and Newcastle Road. This requires additional travel distance (four kilometres versus 1.5 kilometres), travel time and an increased number of stops. This traffic also mixes with other traffic on the existing route increasing delays for other motorists.
- Traffic from the south heading to the hospital would be less inhibited by the left-in/left-out arrangement at the western hospital access, as they can continue to use the existing eastern hospital main entrance off Lookout Road which is a shorter distance (one kilometre versus 2.5 kilometres) although it has to pass through two intersections controlled by traffic lights.

Scenario 4 – Refined strategic design with half-interchange for hospital access

- This scenario addresses traffic capacity and priority issues at the northern interchange through replacement of the existing two lane roundabout with a larger intersection below the bypass (immediately to the east) controlled by traffic lights to improve traffic flow. The intersection has three lanes in both directions on Newcastle Road and two turning lanes in most directions to improve traffic capacity and traffic flow through the intersection.
- The half- interchange provides a southbound off-ramp to enter the hospital and a northbound on-ramp to exit the hospital. As such motorists from the north would use the proposed new western connection off the bypass to access the hospital. This substantially reduces travel times and distance (1.5 kilometres versus four kilometres) for hospital trips to/from the north, with eight sets of traffic lights bypassed on the existing route. This provides additional traffic flow improvements along the existing route of Lookout Road, Croudace Street and Newcastle Road in the northbound direction, compared to Scenario 3 left-in/left-out connection.
- The half-interchange design provides northern access via a new western entrance to the hospital and southern access via the existing eastern entrance to the hospital, with a forecast 50/50 split of traffic between the western and eastern hospital accesses.
- At the southern interchange, the provision of a two-lane off-ramp bridge on Lookout Road to take northbound traffic over the bypass provides substantial improvements to traffic flow
- Upgrade works in McCaffrey Drive to provide a second right turn lane out onto Lookout Road increases traffic capacity and improves traffic flow on both McCaffrey Drive and Lookout Road
- Extending the left turn merge out of McCaffrey Drive improves traffic flow with Lookout Road
- Extension of the right and left turn lanes on McCaffrey Drive provides increased capacity and traffic flow for eastbound traffic.

Scenario 5 – Refined strategic design with full-interchange hospital access:

- General observations as per Scenario 4 above.
- The addition of the south facing ramps at the western hospital access reduces the amount of traffic wanting to use the two-lane off-ramp bridge on Lookout Road to go over the bypass and enter the hospital via the existing eastern main entrance off Lookout Road. However, due to the relatively low volumes forecast to use the south facing ramps and the shorter travel distance to the existing eastern main hospital entrance, the ramps provide minimal benefit to the surrounding road network on Lookout Road.

- Motorists from the south can continue to use the existing eastern hospital access off Lookout Road, which provides a shorter travel distance than the proposed full interchange (one kilometre versus 2.5 kilometres) although motorists would need to pass through two sets of traffic lights on the existing route.

Scenario 6 – Refined strategic design with half interchange hospital access and McCaffrey Drive ramps

- The modelling shows less than 10 vehicles per hour using each ramp in the morning peak and the same in the afternoon peak.
- On observation the model operation appears very similar to the refined strategic design (Scenario 4) due to the low volume of traffic using each ramp.
- Due to the low volumes on each ramp, this traffic has negligible effect on the operation of the McCaffrey Drive/Lookout Road intersection, and the rest of the existing route.

5.3. Economic appraisal

5.3.1. Overview

Economic analysis has been conducted as part of the options assessment process to help determine whether the six modelled scenarios would provide value for money. The appraisal measures the economic benefits generated and compares them to the expenditure required to implement.

The analysis has been conducted in accordance with Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives (March 2015).

5.3.2. General economic appraisal parameters

The general economic parameters that have been assumed for the project for the purposes of the analysis are set out in **Table 9.**

Table 9 General economic appraisal parameters

Parameter	Value
Price year	2015/16
Discount year	2015/16
Real discount rate	7 %
Construction years	2017/18 to 2020/21[(b)]
First full year of benefits	2021/22[(b)]
Last year of benefits	2050/51
Appraisal period	30 years
Annual benefits expansion factor [(a)]	1,923

Note:

(a) Derived from TfNSW (2013) Appendix 4 (March 2015 update) Table 65.

(b) Timing of construction is for comparative purposes only and is subject to project approval and further detailed assessment of construction methodology timeframes during the concept design phase as site conditions and design inputs are confirmed.

5.3.3. Network statistics – traffic modelling outputs

In assessing and comparing the network performance levels of each scenario, the following outputs from the traffic modelling were used as inputs into the economic analysis:

- **Vehicle kilometres travelled (VKT)** - measures the total distance travelled by all vehicles in the network during the modelled peak period
- **Vehicle hours travelled (VHT)** - is similar to VKT. The VHT measures the total travel time of all vehicles on the network during the modelled peak period. VHT corresponds to the delay and congestion in a network and as such a lower VHT correlates to lower congestion
- **Total number of stops** - corresponds to congestion, delay and travel time and measures the total stops for all vehicles within the modelled peak period. It is used to calculate the additional vehicle operating costs associated with stopping and accelerating from rest. In an uncongested network, the number of stops is infrequent as higher proportions of vehicles travel at free flow with lower occurrences of stopping behind queued vehicles.
- **Average network speed** - recorded for all traffic in the network over the modelled period. It is calculated by dividing the vehicle kilometres travelled (VKT) by the vehicle hours travelled (VHT). Average network speed correlates to congestion and delay – higher average network speeds are indicative of a network in which traffic is able to flow more readily

5.3.4. Project costs

Table 21 shows the strategic cost estimates prepared for the six scenarios. They cover all project related costs including such items as design, land acquisition, site investigations, environmental assessment, community consultation, project management and construction.

The strategic cost estimates are for comparative purposes only. During the concept design phase as site conditions, design inputs and construction methodology are confirmed, the project estimate will be further refined.

Table 10 Strategic cost estimates (P50 Out-turn dollars)

Scenario	Strategic cost estimate (P50)
1. Do Minimum	Not applicable
2. 2007 strategic design with left-in/left-out only	$250 million
3. Refined strategic design with hospital left-in/left-out only	$270 million
4. Refined strategic design with hospital half-interchange	$280 million
5. Refined strategic design with hospital full-interchange	$290 million
6. Refined Strategic Design with hospital half-interchange and with McCaffrey Drive ramps	$305 million

Incremental maintenance costs of the new four-lane bypass road have been allowed for in the analysis using an annual maintenance cost of $12,000 per lane-kilometre, i.e. $163,000 per year for the additional 13.6 lane-kilometres, rounded up to be $170,000 per year. The current cost of maintaining roads on the existing route has been assumed to continue in both the base case (do minimum) and the project case. However, savings could be expected in the project case due to a reduction of traffic on the existing route.

5.3.5. Project benefits

The valuation of road user benefits has used the parameter values as outlined below.

Travel time cost savings

The weighted average value of travel time was calculated as $28.05 per vehicle hour for all time periods. This value is applied to the difference between vehicle hours of travel in the base case (Do Minimum) and the project case multiplied by the annual benefits expansion factor.

Vehicle operating cost savings

Vehicle operating costs relate to the speeds travelled on the road. The weighted average value of vehicle operating cost was calculated as 41 cents per kilometre. These values were applied to the modelled average travel speeds and vehicle kilometres of travel for the base case (Do Minimum) and the project case.

Vehicle stopping cost savings

The weighted average vehicle cost per stop was calculated as 17 cents per vehicle stop. This value is applied to the difference between the number of vehicle stops in the base case (Do Minimum) and the project case multiplied by the annual benefits expansion factor.

Crash cost savings

The average cost per crash for use in the appraisal was calculated as $98,000. This value is applied to the estimated annual reduction in crashes with the project case. For the purposes of the analysis, for the project case the reduction in crashes was assumed to be about half the reduction in traffic volumes on the existing route. A more detailed road safety analysis will be undertaken during the concept design phase with specific crash types assessed based both the proposed changes in the road network and traffic redistribution across the network.

5.3.6. Economic analysis results – options

Table 11 shows the results of the economic analysis for the scenarios compared to the base case (Do Minimum) scenario.

The results are presented in terms of two key economic indicators:

- **Benefit-cost ratio (BCR)** – BCR measures the benefits received per dollar of project cost and is used to indicate value for money. BCR is calculated by dividing the present value of all benefits by the present value of all costs (including recurring operating and maintenance). A project with a BCR greater than one means that the present value of benefits exceeds the present value of costs and is considered to provide value for money
- **Incremental Benefit-cost ratio (IBCR)** – IBCR measures the incremental benefits received per dollar of incremental costs when comparing one option over another. An option with an IBCR greater than one means that the present value of additional benefits exceeds the present value of additional costs and is considered to provide value for money.

The economic analysis is based on benefits for the surrounding road network and does not consider additional traffic performance benefits within the hospital's internal road network as a result of the project, nor any other economic benefits for the hospital. As such the economic analysis for this project should thus be considered conservative.

Table 11 Economic analysis results for options scenarios

Scenario	Strategic cost estimate (P50, Out-turn dollars)	BCR		
2. 2007 strategic design with left-in/left-out only	$250 million	<1.0		
3. Refined strategic design with hospital left-in/left-out only	$270 million	4.7	**IBCR**	**Comment of IBCR**
4. Refined strategic design with hospital half-interchange	$280 million	4.6	3.7 (compared to Scenario 3)	Additional $10 million for Scenario 4 provides strong economic benefits for the surrounding road network with a high IBCR of 3.7
5. Refined strategic design with hospital full-interchange	$290 million	4.5	0.4 (compared to Scenario 4)	Additional $10 million for Scenario 5 provides low economic benefits for the surrounding State road network with IBCR <1.0
6. Refined Strategic Design with hospital half-interchange and with McCaffrey Drive ramps	$305 million	4.3	0.1 (compared to Scenario 4)	Additional $25 million for Scenario 6 provides very low economic benefits with IBCR <1.0

In reviewing the economic analysis results the following conclusions can be derived:

- The 2007 strategic design (Scenario 2) does not provide value for money with a BCR less than one. This is primarily due to poor traffic performance of its northern and southern interchange layouts (refer to **Section 5.2.11**)
- Scenario 4 with a half-interchange for the hospital offers strong economic benefits with a BCR of 4.6. This is primarily due to its substantially improved traffic performance of the three interchanges (refer to **Section 5.2.11**)
- Scenario 4 with a half-interchange for the hospital offers strong economic benefits with an IBCR of 3.7 compared to the hospital access compromising of left-in/left-out only (Scenario 3). This is primarily due to the northbound on-ramp which provides substantial travel time savings compared to this movement having to use the existing route (refer to **Section 5.2.11**)
- The extra $10 million for the addition of the south facing ramps to Scenario 4 is not considered to offer value for money for the surrounding road network with a IBCR of less then one. There may however be additional economic benefits for the hospital internal road system which have not been considered in the economic analysis.
- The extra $25 million for the addition of the McCaffrey Drive ramps to Scenario 4 offers minimal benefits and does not offer value for money with an IBCR of less than one (compared to the Southern Interchange with south-facing ramps only).

Based on the options assessment process including input from value management workshops, traffic modelling and economic analysis, Scenario 4 with a half interchange for the hospital access is considered the preferred option providing the best value for money with a strong BCR of 4.6

5.3.7. Economic analysis results – refined strategic design (Scenario 4)

Table 12 shows the results of the economic analysis for the refined strategic design compared to the base case (Do Minimum -Scenario 1).

The results are presented in terms of five key economic indicators:

- **Benefit-cost ratio (BCR)** – BCR measures the benefits received per dollar of project cost and is used to indicate value for money. BCR is calculated by dividing the present value of all benefits by the present value of all costs (including recurring operating and maintenance). A project with a BCR greater than one means that the present value of benefits exceeds the present value of costs and is considered to provide value for money
- **Net present value (NPV)** – NPV measures the difference between benefits and costs, while accounting for their varying timing. Net cash flows are discounted at a specified discount rate, reflecting the concept that future benefits and costs have less value compared to current benefits and costs. A project with a NPV greater than zero means that the present value of benefits exceeds the present value of costs and is considered economically worthwhile
- **Net present value per dollar of investment (NPVI)** – NPVI measures the benefit received per dollar of investment or capital outlay and is used to indicate capital efficiency. NPVI is calculated by dividing the net present value by the present value of capital costs (those used to initially complete the project). A project with a NPVI greater than zero means that the net economic benefit of the project exceeds its requirement for initial capital expenditure
- **First year rate of return (FYRR)** – FYRR measures the benefits received in the first full year of a project's operation per dollar of capital cost. It is used to indicate the best start date for a project's implementation. FYRR is calculated by dividing the present value of first year benefits by the present value of capital costs (those used to initially complete the project). The timing of a project which has a FYRR greater than the specified discount rate is considered to be economically appropriate. The implementation of a project which has a FYRR less than the specified discount rate should be deferred until the FYRR exceeds the discount rate
- **Internal rate of return (IRR)** – IRR is the discount rate at which the present value of benefits equals the present value of costs. An IRR greater than the discount rate indicates an economically worthwhile project.

Table 12 Results of cost-benefit analysis for refined strategic design [(a)]

Present Value	
Costs ($'000)	
Capital cost	215,550
Incremental maintenance cost	1,500
Total costs	**217,060**
Benefits ($'000)	
Travel time savings (79 per cent)	793,531
Vehicle operating cost savings (20 per cent)	20,894
Crash cost savings (1 per cent)	10,045
Total benefits	**1,004,470**

Economic indicators	
Net present value ($ million)	787,410
Net present value/Capital cost	3.65
Benefit-cost ratio	4.6
First year rate of return	25%
Internal rate of return	26%

(a) Discounted to 2015/16 at 7 per cent real discount rate and incremental to the Do Minimum Base Case.

In reviewing the economic analysis outputs for the refined strategic design the following conclusions can be derived:

- The project would provide high value for money with a benefit-cost ratio of 4.6
- The project would provide strong economic benefits and generate a net present value of $787 million
- The first year rate of return (FYRR) of 25 per cent is high which indicates that the proposed timing of the project is economically appropriate
- The primary benefits of the project are travel time savings which provide about 79 per cent of the project benefits.

It is noted that the above economic analysis results are likely to understate the totality of benefits from this project due to the following reasons:

- The analysis does not include the value of reduced emissions and other environmental benefits
- The analysis does not estimate wider economic benefits. These could include the benefits of increased competiveness and productivity of local firms from an improved road network, as well as broader road network benefits of completing a major road link in an urban environment.

This project would generate some of these benefits and as such the economic analysis for this project should thus be considered conservative.

5.3.8. Traffic modelling outputs – refined strategic design (Scenario 4)

As outlined in **Section 5.3.3,** two of the key traffic modelling outputs which measure the network performance benefits of the project on the surrounding road network are vehicle hours travelled (VHT) and total number of stops. Both of these are a measure of the total delay and congestion in a network. As such a lower VHT and lower number of stops, correlates to lower congestion and improved traffic flow. Conversely, the higher the average network speed the less congestion and improved travel times.

Figure 5.17 to Figure 5.20 show the morning and afternoon peak network performance outputs for the modelled road network for the refined strategic design (Scenario 4) compared to the Do Minimum (Scenario 1) in 2020 and 2030.

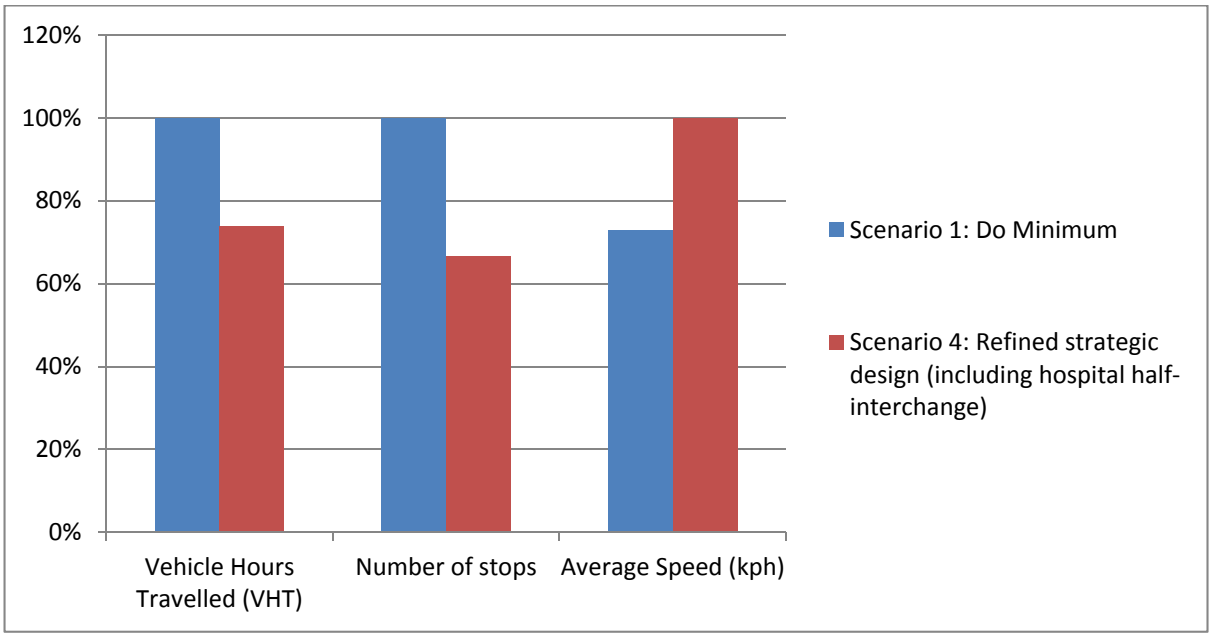


Figure 5.17 Network performance outputs – Morning Peak 2020

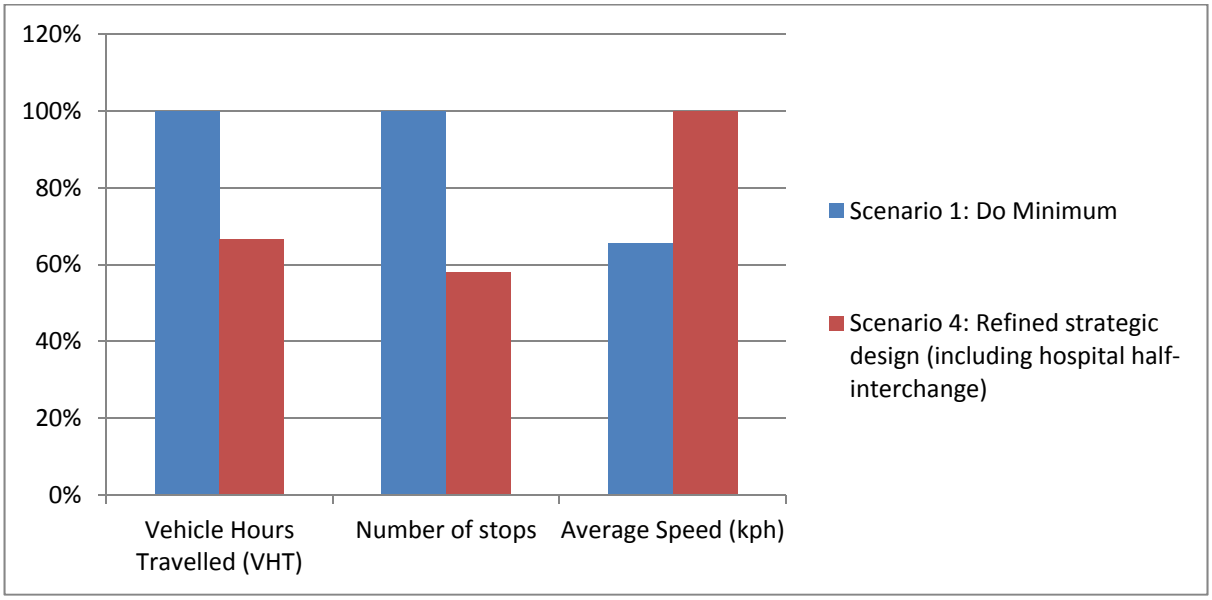


Figure 5.18 Network performance outputs – Afternoon Peak 2020

In reviewing the network performance data for 2020 the following conclusions can be derived:

- Congestions levels are predicted to reduce with VHT reduced by about 26 per cent in the morning peak and 33 per cent in the afternoon peak
- Similarly, the number of stops are reduced by about 33 per cent in the morning peak and 42 per cent in the afternoon peak
- Travel times are predicted to improve with the average travel speed to increase by about 27 per cent in the morning peak and 34 per cent in the afternoon peak

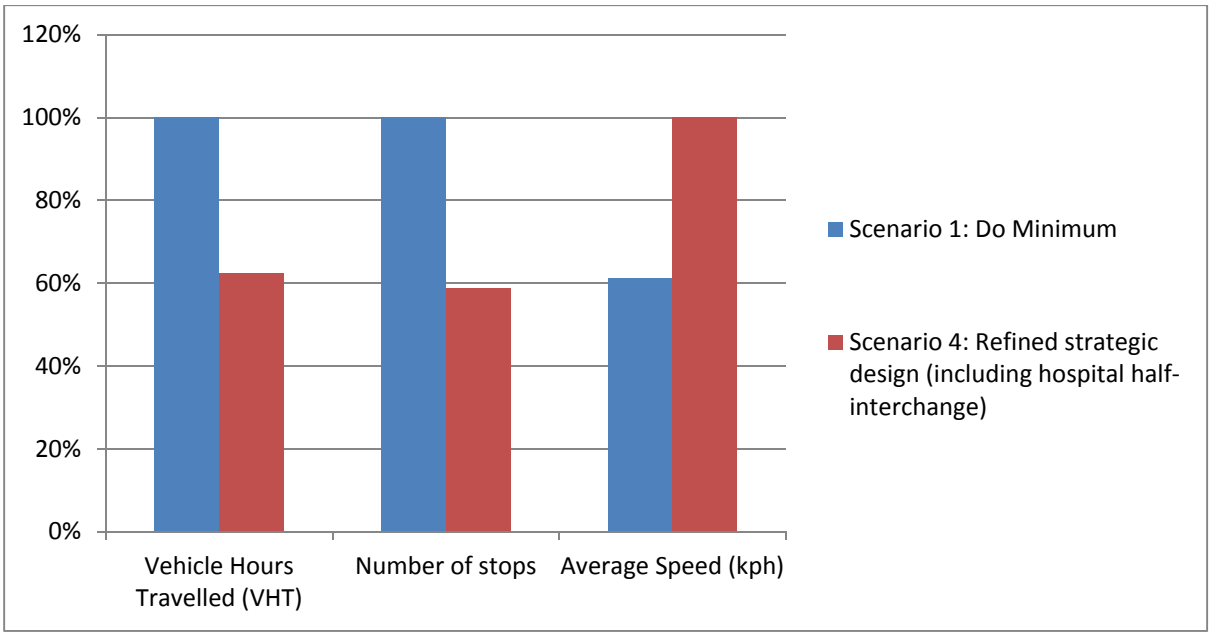


Figure 5.19 Network performance outputs – Morning Peak 2030

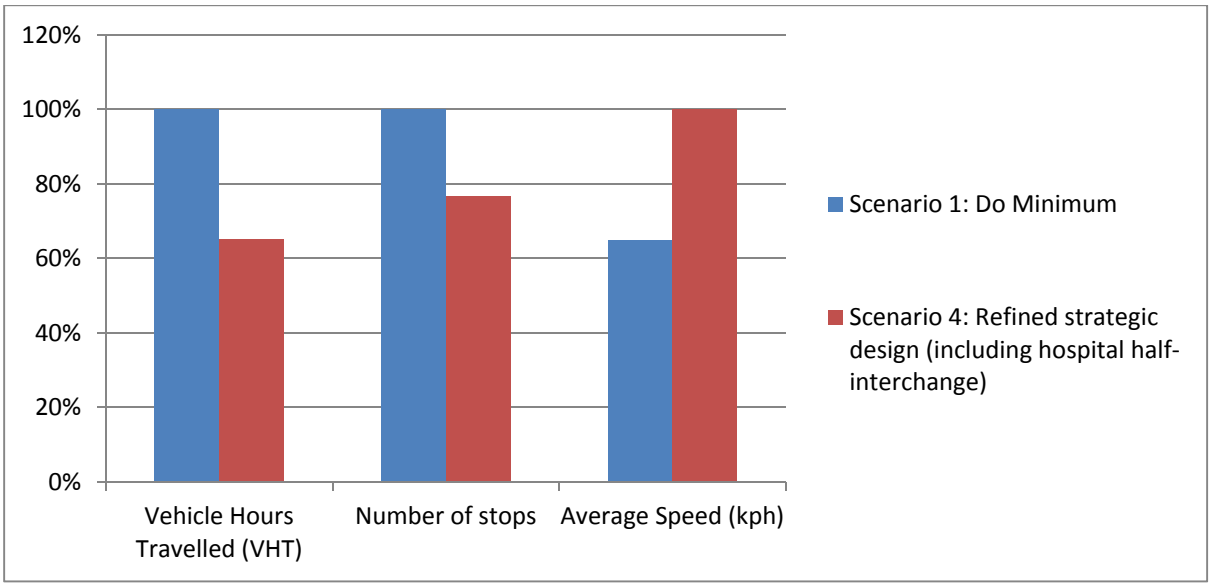


Figure 5.20 Network performance outputs – Afternoon Peak 2030

In reviewing the network performance data for 2030 the following conclusions can be derived:

- Congestions levels are predicted to further reduce relative to the Do Minimum case with VHT reduced by about 38 per cent in the morning peak and 35 per cent in the afternoon peak
- Similarly, the number of stops are reduced by about 42 per cent in the morning peak and 41 per cent in the afternoon peak
- Travel times are predicted to further improve relative to the Do Minimum case with average travel speed to increase by about 39 per cent in the morning peak and 35 per cent in the afternoon peak

In summary, in reviewing traffic modelling results and economic analysis, the following conclusions can be derived about the recommended refined strategic design (Scenario 4):

- The project is predicted to provide major benefits for motorists using the bypass with substantial improvements in travel time for both northbound and southbound journeys, relative to the Do Minimum case.
- The project is also predicted to improve travel times for north-south trips on the existing route and for east-west trips on Newcastle Road.

As such, the recommend refined strategic design meets the primary objectives for the project which are to:

- Reduce travel times and improve traffic flow on the Newcastle Inner City Bypass
- Provide traffic relief on key parts of the surrounding road network.
- Provide continuity of the Newcastle Inner City Bypass between Bennetts Green and Sandgate

6. Recommendation

This section provides a detailed description of the preferred option recommended to be adopted as the refined strategic design.

6.1. Recommended refined strategic design

As outlined in the preceding sections, the preferred option for the refined strategic design was identified through an extensive assessment and review process to ensure the project best meets its project objectives and provides value for money.

Table 13 outlines the preferred options for the various sections which make up the recommended refined strategic design.

Table 13 Recommended refined strategic design components

Component	Preferred option
Alignment	Alignment Option 2
Hospital Access	Hospital Option 4
Southern Interchange	Southern Option 3
Northern Interchange	Northern Option 5

Figure 6.1 shows the recommended refined strategic design.

The key benefits of the refined strategic design include:

- Improved traffic performance of the northern and southern interchanges
- Improved traffic flow for motorists using the Newcastle Inner City Bypass
- Improved traffic flow on key parts of the surrounding road network, in particular the existing route of Lookout Road, Croudace Street and Newcastle Road
- Improved connectivity to John Hunter Hospital with provision of a half-interchange with access to and from the north
- Minimises environmental impacts including impacts on threatened species
- Reduction in potential noise and visual impacts on adjacent residential areas
- Provides an overall design that better meets the project objectives.

A detailed description of these options and improvements compared to the 2007 strategic design are outlined in **Section 6.2** below.

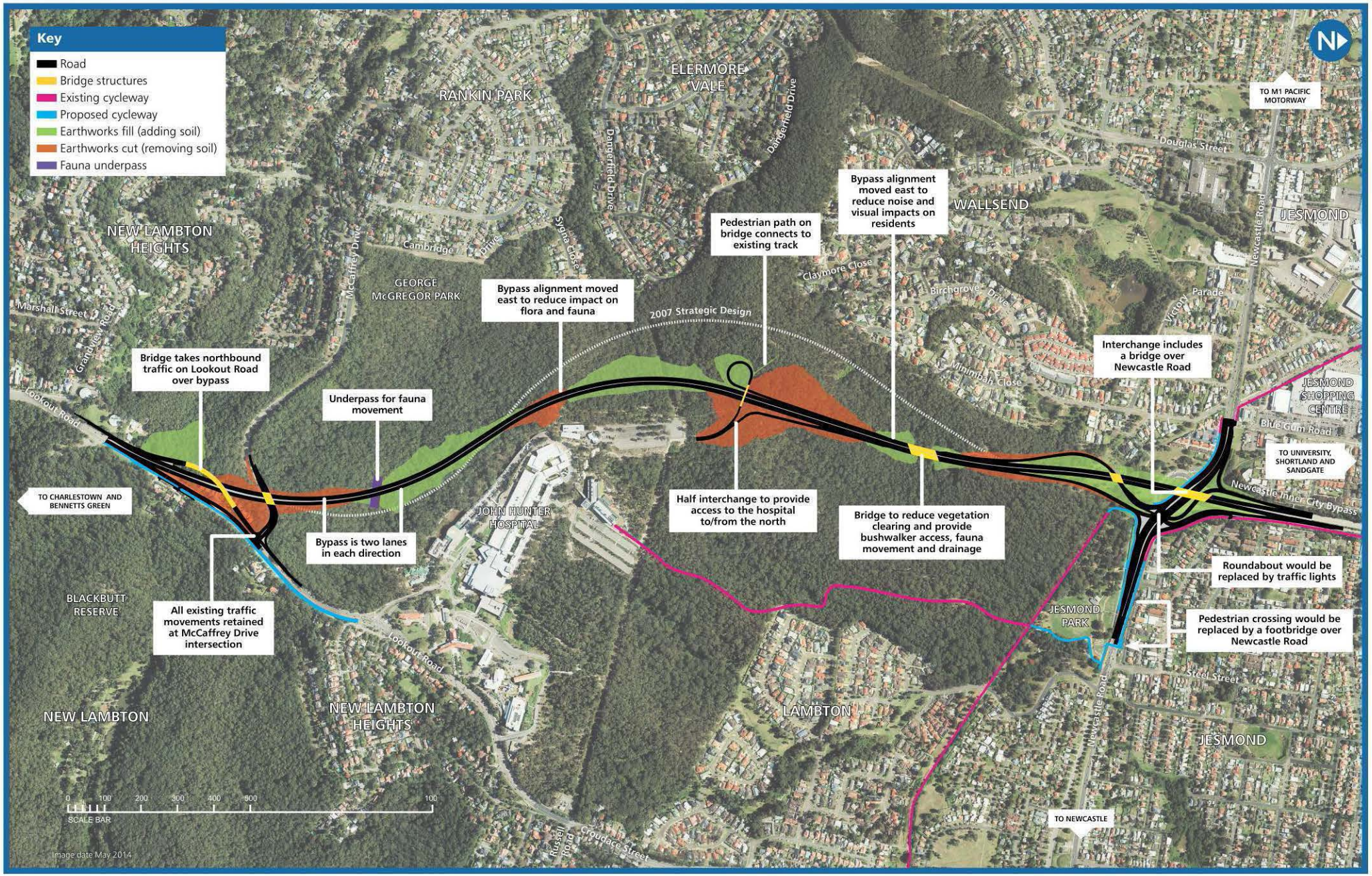


Figure 6.1 Refined strategic design

6.2. Alignment – Alignment Option 2

One of the substantial improvements of the refined strategic design is the location of the new road within the bushland corridor. The majority of the refined alignment has been moved to the east to be further away from the residential areas of Rankin Park, Elermore Vale and Wallsend. The northern section in particular has moved substantially to the east increasing the distance between the bypass and residential properties in Minimbah Close, Bellinger Close, Dangerfield Drive and Sygna Close. The bypass alignment is now about 100 metres to 220 metres from these properties, achieving a larger bushland buffer to reduce potential noise and visual impacts.

Another key improvement is that the revised alignment minimises environmental impacts including impacts on threatened species. The refined alignment reduces impact on *Tetratheca juncea* and avoids impacting on *Grevillea Parviflora*, which was impacted by the 2007 strategic design.

The refined alignment also provides improved connectivity across the bypass and reduced fragmentation of bushland areas. The refined alignment includes three structures for connectivity across the bypass. A fauna underpass about 300 metres north of McCaffrey Drive providng connectivity for animals. A footpath on the northern side of the half-interchange hospital bridge providing access for pedestrians and cyclist. The third structure is in the form of an 80 metre long bridge about 700 metres south of Newcastle Road. The bridge reduces vegetation clearing and would provide improved connectivity across the bypass.

Geometrically the refined alignment has improved both horizontally and vertically, with the key improvements as follows:

- Design speed increased from 90 km/h to 100 km/h
- Maximum vertical grade reduced from 10 per cent to eight per cent
- Refined alignment is around 200 metres shorter
- Minimum horizontal radius has increased from 460 metres to 750 metres.

6.3. Hospital interchange – Hospital Option 4

The refined strategic design includes a half-interchange to link the bypass to the western side of John Hunter Hospital. The interchange would provide access to and from the north for use by all hospital users including public, staff and emergency services.

The interchange would include a road bridge over the bypass with a shared path on the northern side which provides a connection for pedestrians between the hospital and residential areas to the west.

NSW Health Infrastructure would undertake road works within the hospital internal road system to accommodate traffic movements to and from the new western access. Further consultation with NSW Health Infrastructure is being carried out to finalise the configuration of the interchange near the hospital.

Figure 6.2 shows the recommended hospital interchange.

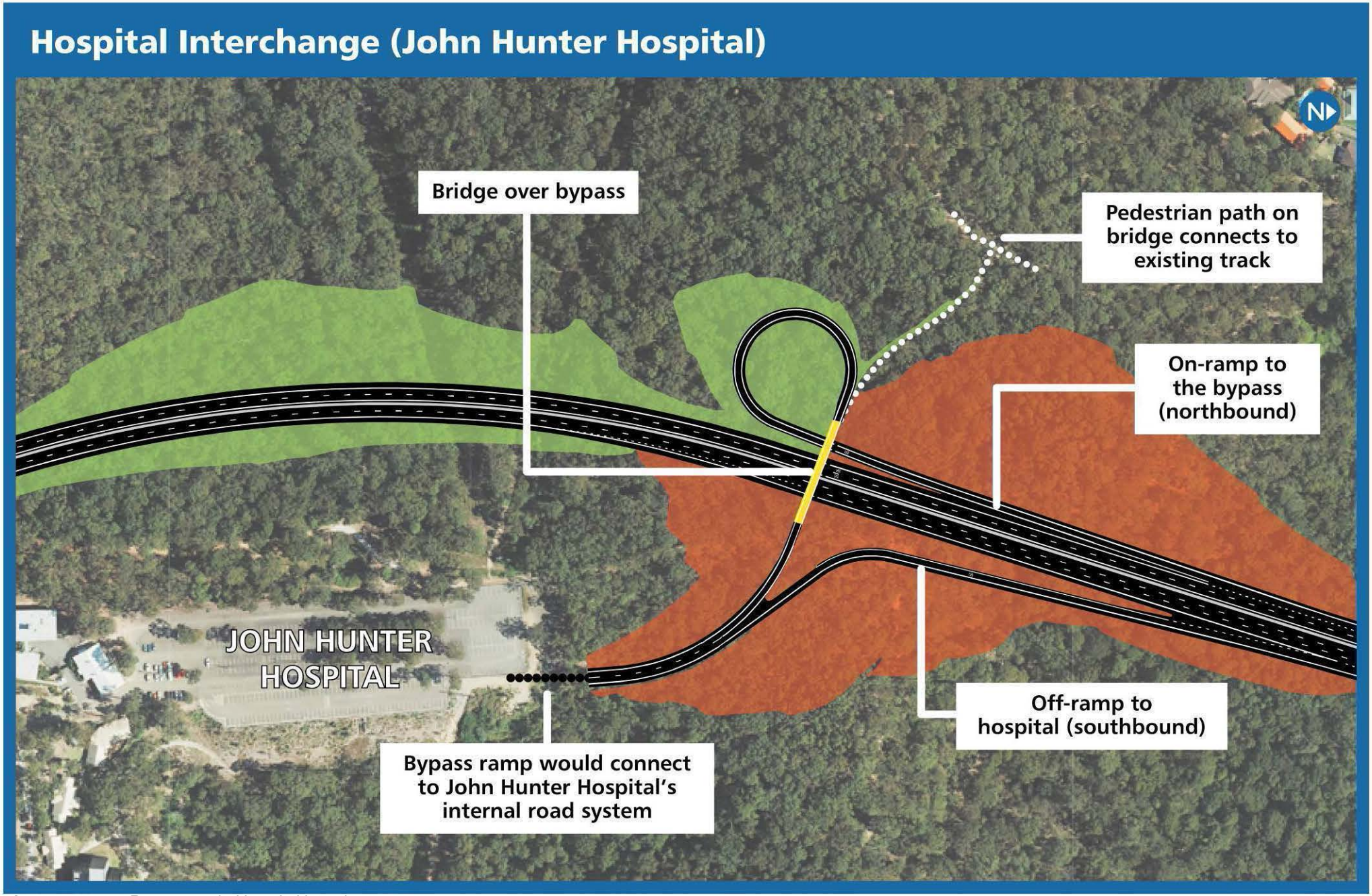


Figure 6.2 Recommended hospital interchange

6.4. Southern Interchange – Southern Option 3

The refined strategic design includes a number of improvements at the southern interchange. This includes improved traffic performance for northbound traffic on Lookout Road and for traffic exiting McCaffrey Drive. The interchange would include a bridge for traffic continuing to head northbound on Lookout Road to take this traffic over the top of the bypass and connect to the existing traffic lights at McCaffrey Drive. This is a major improvement over the 2007 strategic design, which required this traffic to take a single lane off-ramp up to a right turn movement at an intersection controlled by traffic lights with a realigned McCaffrey Drive.

The bypass would travel under McCaffrey Drive. All existing movements would be retained at the McCaffrey Drive intersection. Upgrade works would be undertaken on McCaffrey Drive to improve traffic capacity and traffic flow. This includes the addition of a second right turn out of McCaffrey Drive and improvements to the left turn lane out of McCaffrey Drive with the merge lane with Lookout Road lengthened. Left and right turn lanes in McCaffrey Drive would also be lengthened to improve traffic flow particularly in peak hours.

Traffic travelling south on Lookout Road would continue to use the existing two southbound lanes and connect with the two southbound lanes from the bypass, north of Grandview Road. Traffic lights would be provided for the connection of southbound traffic on the bypass and Lookout Road. This is to allow traffic to safely connect at this location and safely access the right turn lanes at both Grandview Road and Cardiff Road.

As part of Roads and Maritime's inner Newcastle traffic study, further investigations are being undertaken to determine the priorities for future upgrades to the south of the Rankin Park to Jesmond connection with Lookout Road. This study is investigating options to improve traffic flow on this section and other key parts of the inner Newcastle road network.

In assessing options for the Southern Interchange, a detailed review was undertaken of the need and justification for providing a northbound on-ramp from McCaffrey Drive and/or southbound off-ramp to McCaffrey Drive. The investigations found that while design and construction of the ramps is technically possible, the low forecast usage of the ramps and their high cost to build makes the ramps not economically viable. As a result north-facing ramps have not been included in the refined strategic design.

Figure 6.3 shows the recommended southern interchange.

6.5. Northern Interchange – Northern Option 5

The refined northern interchange design has substantial traffic performance improvements over the 2007 strategic design, which involved retaining the existing two-lane roundabout on Newcastle Road.

A bridge over Newcastle Road and would allow for free flow movement of traffic for northbound and southbound vehicles on the bypass. Newcastle Road would be realigned and straightened, with traffic below the bypass controlled by traffic lights at an intersection just east of where the bypass passes over Newcastle Road. All movements would be allowed for traffic to enter or exit both Newcastle Road and the Newcastle Inner City Bypass. Three lanes in each direction would be provided on Newcastle Road to improve the traffic carrying capacity for this high volume road, which currently has only two lanes in each direction.

All pedestrian crossings at the intersection below the bypass on Newcastle Road would be controlled by traffic lights to improve safety for pedestrians and cyclists. To assist both traffic flow on Newcastle Road and enhance provision for pedestrians and cyclists, a footbridge is proposed over Newcastle Road near Steel Street which would replace the existing mid-block traffic lights on Newcastle Road. The footbridge would be linked to the existing off-road facilities either side of Newcastle Road.

Figure 6.4 shows the recommended northern interchange.

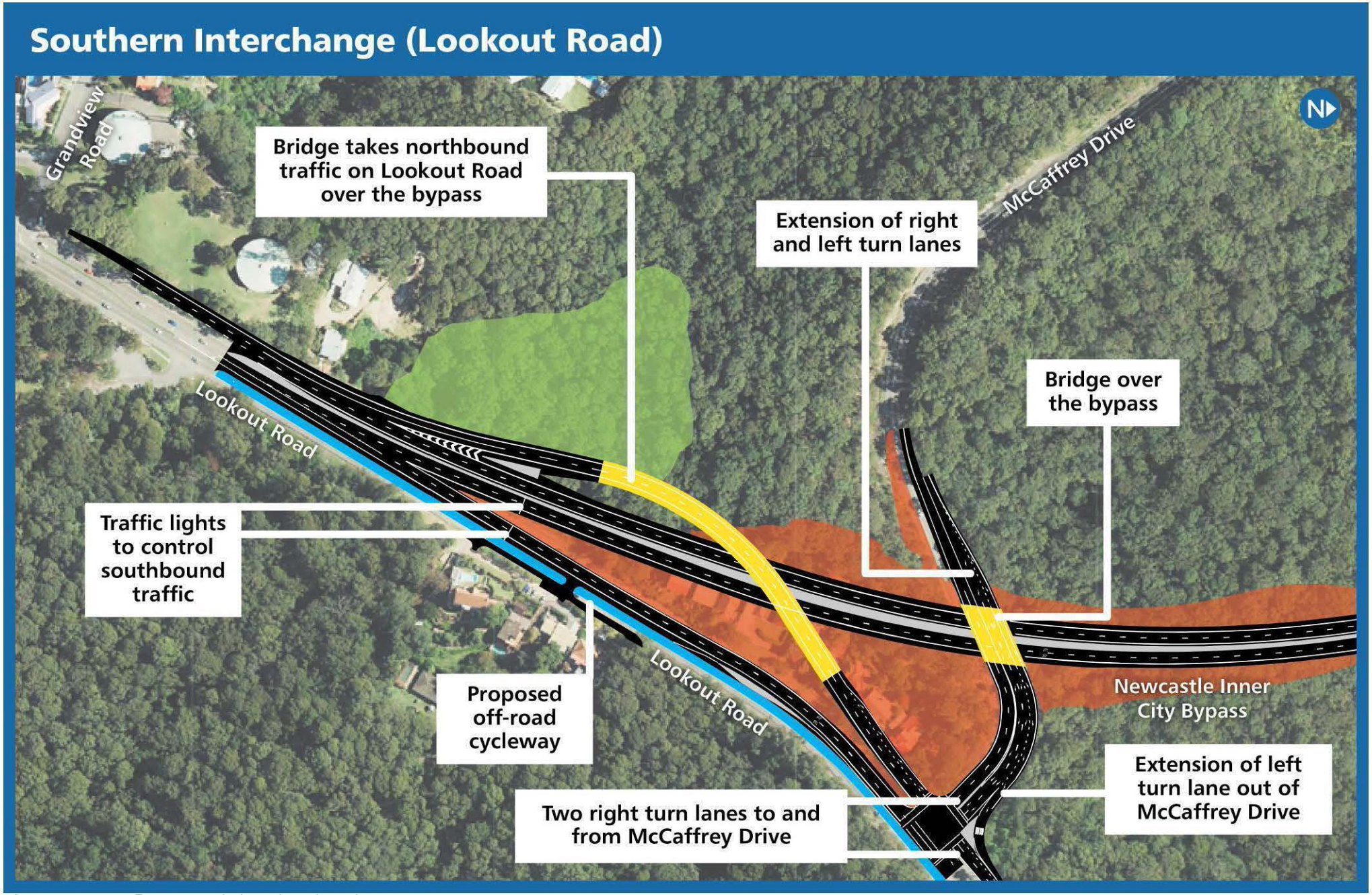


Figure 6.3 Recommended southern interchange

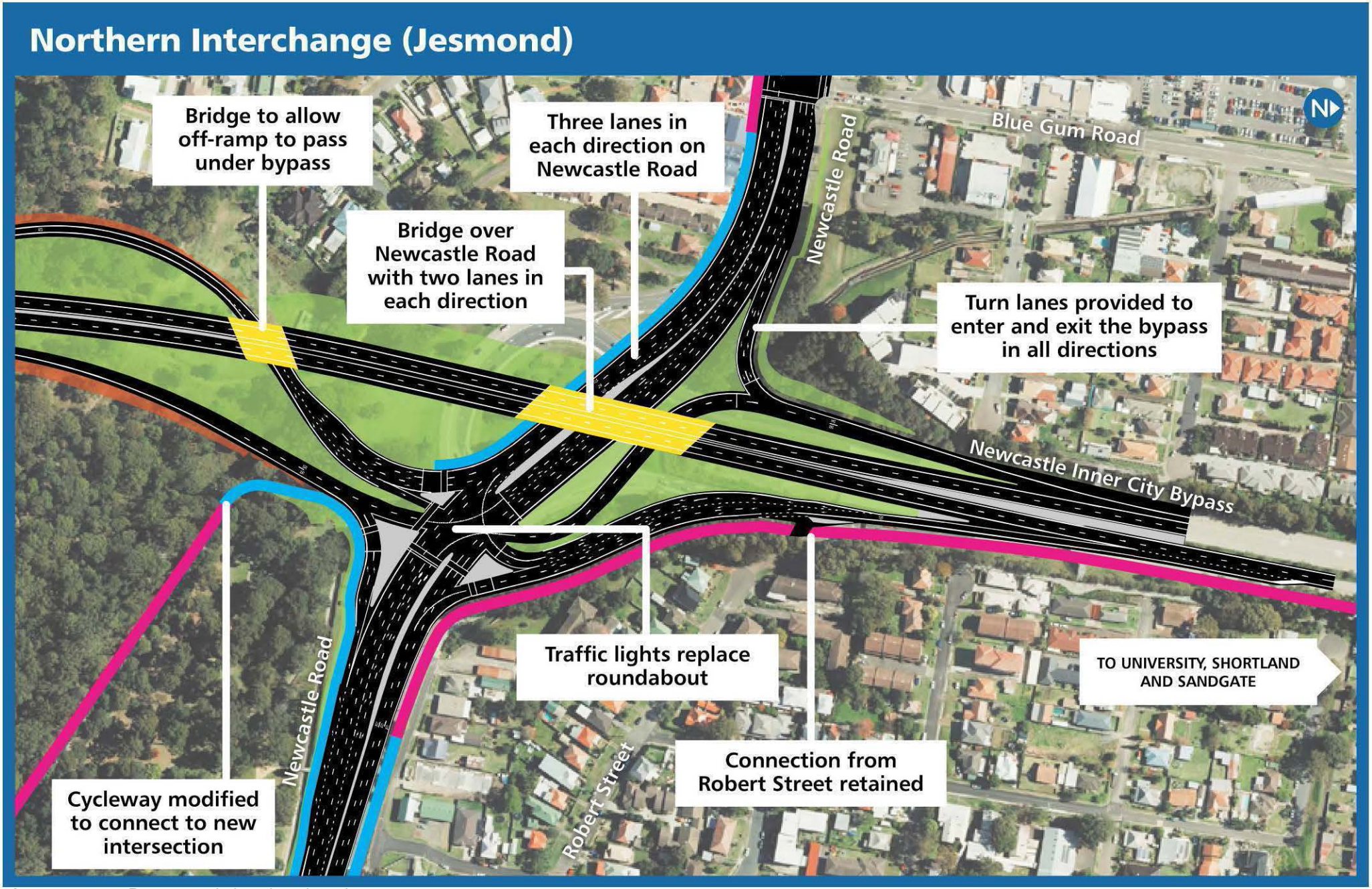


Figure 6.4 Recommended northern interchange

7. Next steps

This section discusses the next steps for the project.

7.1. Project process

7.1.1. Display of refined strategic design

The refined strategic design will go on display for community comment during May and June 2015. This will provide an opportunity for the community to review the refined strategic design and give feedback. Roads and Maritime will use this information to further refine and develop the concept design.

7.1.2. Prepare concept design and environmental assessment

Roads and Maritime will conduct an environmental assessment for the project, following the requirements of the Environmental Planning and Assessment Act 1979 and the Environment Protection and Biodiversity Conservation Act 1999.

The environmental assessment will involve further development of the refined strategic design into a concept design, based on detailed input from technical investigations and community consultation. The environmental assessment will consider potential environmental impacts including:

- Biodiversity
- Traffic and road safety
- Operational and construction noise
- Visual amenity
- Air and water quality
- Hydrology and flooding
- Property acquisition and land use
- Aboriginal and European heritage.

The environmental assessment will be prepared in the form of an environmental impact statement (EIS). The EIS will include detailed information about the design features of the project and will outline the likely environmental impacts of the project and the commitments and mitigation measures in managing those impacts.

7.1.3. Display concept design and environmental impact statement

The EIS will be displayed for comment by the NSW Department of Planning and Environment. This is expected to occur in late 2016 at which point further community feedback will be encouraged.

7.1.4. Obtain project approval

The objective is to develop and ultimately obtain project approval from the Minister for Planning for the project's concept design and EIS.

7.1.5. Project implementation

If the project is approved, the following step is project implementation which would include the following:

- Detailed design: The creation of detailed specification and working drawings of the approved concept design which can be used for detailed costing and construction
- Land acquisition: Property that would be affected by the project and is not owned by Roads and Maritime would need to be acquired before construction. Acquisition would be carried out in accordance with the Land Acquisition (Just Terms Compensation) Act 1991 and following the process outlined in Roads and Maritime Services Land Acquisition Information Guide (Roads and Maritime 2014)
- Construction: Subject to project approval being obtained construction would be expected to commence once detailed design and property acquisition had been completed.

7.2. Ongoing consultation

Consultation and community involvement will continue through the concept design development and environmental assessment phases of the project. Future consultation for the project would include:

- Public exhibition of the EIS. This will be for a minimum of 30 days. Advertisements will be placed in newspapers advising of the public exhibition and where the EIS can be viewed. These will also provide advice about making a submission on the project and will outline how these submissions will be considered and responded to during the planning process. The EIS will be displayed for comment by the NSW Department of Planning and Environment
- Written communication to all property owners within the vicinity of the proposed alignment which will advise of the environmental assessment process and the public display of the EIS
- Community information sessions will be held during the public display periods.

The Roads and Maritime project website will be updated with new information throughout the planning process and will promote community comment periods.

Glossary and terms

Acronym	Definition
Aboriginal cultural Heritage	The tangible (objects) and intangible (dreaming stories, songlines, places) cultural practices and traditions associated with past and present day Aboriginal communities.
Alignment	The geometric layout (eg of a road) in plan (horizontal) and elevation (vertical).
Arterial road	The main or trunk roads of the State road network that carry predominantly through traffic between regions.
At-grade	A road at ground level, not on an embankment or in a cutting.
AUSTROADS	Formerly the National Association of Australian State Road Authorities (NAASRA).
Base case	Also known as 'Do Minimum' case. Used in evaluating projects to compare the cost and benefit of the existing road (the base case) with another or a number of other projects or options.
BCR	Benefit cost ratio. The ratio of the monetary benefits to the costs of a project as a measure of worth to the community.
Biodiversity	Biodiversity is the variety of life forms, including flora and fauna, the genes they contain and the ecosystems in which they live.
Borehole	A hole produced in the ground by drilling for the investigation and assessment of soil and rock profiles.
Capacity	The nominal maximum number of vehicles that can travel along a road in a given time.
Carriageway	The portion of a roadway used by vehicles including shoulders and auxiliary lanes.
Catchment	The area from which a surface watercourse or a groundwater system derives its water.
Concept design	Initial functional layout design for a road or road system, to establish feasibility, to provide a basis for estimating and to determine further investigations needed for detailed design.
Concrete barrier	A concrete structure, usually about 0.8 metres high, designed to deflect out of control vehicles back on to the road without overturning.
Constraint	Something that limits or restricts the project design, development or construction.
Constructability	Refers to the ease in which a project can be built.
Culvert	One or more adjacent enclosed channels for conveying a stream below formation level.
Cut	The material excavated from a cutting.
Cutting	Formation resulting from the construction of the road below existing ground level – the material is cut out or excavated.
Design speed	A nominal speed which determines the geometric design features of a road.
Detailed design	The detailed design details the final project. It includes designs, plans and construction drawings for all elements, including: - Road alignment and geometry - Retaining wall, pavements and traffic signals - Urban design, landscaping and street lighting - Construction staging and traffic management - Drainage and utilities.

Divided road	A road with a separate carriageway for each direction of travel created by placing a median between the opposing traffic directions.
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
Earthworks	All operations involved in loosening, excavating, placing, shaping and compacting soil or rock.
Economic analysis	An economic based approach that considers the merits of a project from the viewpoint of the community at large rather than that of the organisation responsible for the project.
Ecology	The relationship between living things and the environment.
Embankment	An earthen structure where the road sub grade level is above the natural surface.
Endangered ecological community (EEC)	An ecological community identified by relevant legislation that is likely to become extinct or is in immediate danger of extinction.
Environment	All aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings (from EP&A Act).
Environmental assessment (process)	Process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of proposals prior to major decisions being taken and commitments made.
Environmental Impact Statement (EIS)	A focussed analysis undertaken for the purposes of approval applications under Part 5.1 of the Environmental Planning and Assessment Act 1979, written generally to comply with the requirements issued by the Department of Planning and Environment.
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW).
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth). Provides for the protection of the environment, especially matters of national environmental significance and provides a national assessment and approvals process.
Ephemeral	Existing for a short duration of time.
2007 strategic design	Refers to the strategic design displayed to the community in 2007.
Fauna	Animals
Fill	The material placed in an embankment.
Flora	Plants
Footpath	An area open to the public designated for the movement of pedestrians or has one of its main uses for pedestrians.
Footprint	The extent (or area in plan) of a development on the land.
Functionality	A term that describes the effectiveness of an element of the project.
Grade	The rate of longitudinal rise (or fall) with respect to the horizontal expressed as a percentage or ratio.
Grade separated	The separations of road, rail or other traffic so that crossing movements at intersections are at different levels.
Gutter	A drain which is lined or paved, along the side of the road.
Habitat	The place where a species, population or ecological community lives (whether permanently, periodically or occasionally). Habitats are measurable and can be described by their flora and physical components.
Heavy vehicle	A heavy vehicle is classified as a Class 3 vehicle (a two axle truck) or larger, in accordance with the Austroads Vehicle Classification System.
Hydrology	The study of rainfall and surface water runoff processes.

Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
Interchange	A grade-separated junction between roads where a road passes over or under the highway via a bridge or underpass structure with one or more interconnecting roadways.
Intersections at-grade	An intersection where carriageways cross at a common level.
Kerb	An edge stone or concrete shape used for bordering a road and defining the footway.
Landscape	A tract of land. Also a prospect or piece of scenery or land which may include villages, towns, cities and infrastructure.
Landscape character	The aggregate of built, natural and cultural aspects that make up an area and provide a sense of place. Includes all aspects of a tract of land – built, planted and natural topographical and ecological features.
Lane	A portion of the carriageway for the use of a single line of vehicles.
Level of service (LOS)	A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers.
LEP	Local environmental plan.
LGA	Local government area.
Local road	Roads that have a low speed limit, have a small footprint, serve local communities and that are generally conducive to walking and cycling. A road or street used primarily for access to abutting properties.
Median	A central area separating traffic travelling in the opposite directions.
Merge	The converging of separate streams of traffic into a single stream
Methodology	A method for analysis and evaluation of subject matter.
Mid-block	The road between intersections.
Mitigation	Methods employed to limit the impact of activities that have been identified as being potentially detrimental to the environment.
Mode	A type or method of movement – including for the road corridor: cars, buses, bikes and pedestrians.
Origin-Destination (OD survey)	An origin-destination (OD) study is used to determine where and how much traffic is travelling during a typical day for a particular road network. Trips are defined as one-way movement, from where a trip starts (origin) to where the trip is going (destination).
Out-turn Dollars	Is the estimated dollar value for which the project would be completed assuming a given delivery period. Out-turn dollars are calculated by escalating the estimated project cash flow for each year of the project to represent the actual project cost in future year dollars.
P50/P90 Value	Determined by probabilistic analysis, P50/P90 values are established to provide a level of confidence (50% confident/90% confident) that the estimated cost at these respective levels will not be exceeded at project completion.
Pavement	The portion of a carriageway placed above the sub grade for the support of and to form a running surface for vehicular traffic.
Property	In the context of the project, property acquisition refers to purchasing property from owners to provide land for the project.
Project approval	Refers to approval of the projects environmental assessment
Probabilistic Analysis	The process by which risk is quantified through an assessment of potential variable outcomes in inputs (both probability of occurrence and consequence) resulting in an outcome that is expressed as a potential range or distribution of values.

Refined Strategic Design	Refers to the refined strategic design displayed to the community in 2016, which is the subject of this report.
Regional road	Regional roads perform an intermediate function between the main arterial network of State Roads and council controlled Local Roads. Due to their network significance RMS provides financial assistance to councils for the management of their Regional Roads.
Roads and Maritime	Roads and Maritime Services (formerly Roads and Traffic Authority)
Roundabout	An intersection where all traffic travels in one direction around a central island.
Sight distance	The distance that motorists need to see ahead to drive safely
Shared path	A pathway used for both cyclists and pedestrians, usually located on the side of the road.
Shoulder	The portion of the carriageway beyond the traffic lanes adjacent to and flush with the surface of the pavement.
Sight distance	The distance measured along the carriageway over which objects of defined height are visible to a driver whose eyes are at a specified height above the pavement surface level.
Site compound	Area enclosing construction machinery, stockpiles, site offices and other ancillary facilities.
Stakeholder	Organisations, parties and/or special interest groups likely to have an interest in the proposal.
State Significant Infrastructure	Refers to major infrastructure, in particular linear infrastructure such as roads, railway lines or pipes which often cross a number of council boundaries, or where development may have a significant environmental impact (in the meaning of the EP&A Act).
State Significant Infrastructure Application	An application to the NSW Department of Planning and Environment to demonstrate that a project meets the criteria for State Significant Infrastructure (as outlined in the State Environmental Planning Policy (State and Regional Development (2011) and to request Secretary's environmental assessment requirements (SEARs). The application is also accompanied by a report that details the proposal and its likely environmental impacts.
Study area	The study area encompasses the proposal area and the area that may be indirectly impacted by the proposal.
TEC	Threatened Ecological Communities. For the purposes of this report this includes ecological communities listed or nominated under the EPBC Act and ecological communities listed or nominated under the TSC Act.
Threatened	As defined under the NSW *Threatened Species Conservation Act 1995*. A species, population or ecological community that is likely to become extinct or is in immediate danger of extinction.
Topography	The physical appearance of the natural features of an area of land, especially the shape of its surface.
Traffic calming	The means by which local streets are kept relatively free of through traffic by the implementation of traffic management devices and/or by private vehicle demand management.
Traffic efficiency	Measured by savings (and delays) in travel time.
TSC Act	*Threatened Species Conservation Act 1995*
Typical cross section	A cross section of a carriageway showing typical dimensional details, furniture locations and features of the pavement construction.
Underpass	A grade separation where the subject carriageway passes under an intersecting carriageway (or railway). A tunnel constructed for the use of pedestrians, cyclists, fauna and/or stock under the carriageway.

Undulating	Follows a wavelike course, often going up and down, in and out of gullies.
Urban design	The process and product of designing human settlements and their supporting infrastructure, in urban and rural environments.
Verge	That portion of the formation not covered by the carriageway or footpath. Defined area of the formation in rural roads, outside the shoulder at the top of a batter slope.
Vulnerable	As defined under the Threatened Species Conservation Act 1995, a species that is likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate.
Weaving	The undesirable situation where traffic merging and diverging must cross paths within a limited distance, usually before an intersection.
Wetland	A swamp or marsh in which the soil is frequently or permanently saturated with water, or under water.
Wildlife corridors	Wildlife corridors are links of native vegetation that join two or more areas of similar habitat and are critical for sustaining ecological processes, such as provision for animal movement and the maintenance of genetically viable populations.

References

Department of Planning (2006) Lower Hunter Regional Strategy, Sydney October 2006

NSW Government (2012a) State Infrastructure Strategy

NSW Government (2012b) NSW Long Term Transport Master Plan

NSW Government (2014) Hunter Strategic 2013 Infrastructure Plan

Roads and Maritime (2014) Land Acquisition Information Guide

Parsons Brinckerhoff (PB) (2015) Newcastle Inner City Bypass: Rankin Park to Jesmond – Biodiversity Survey Report, 18 March 2015

Parsons Brinckerhoff (PB) (2015) Newcastle Inner City Bypass: Rankin Park to Jesmond, Additional Powerful Owl and Hollow-bearing Tree Surveys, 21 August 2015

Parsons Brinckerhoff (PB) (2015) Newcastle Inner City Bypass: Rankin Park to Jesmond, Corybas dowlingii and Diuris praecox targeted surveys, 2015

Umwelt Environmental Consultants (2006) Aboriginal Archaeological Survey and Assessment of the Proposed State Highway 23 Realignment from Rankin Park to Jesmond, NSW: An Examination of Four Alternative Routes, May 2006.

Umwelt Environmental Consultants (2006) Ecological Constraints Analysis for a Proposed New Route for State Highway 23 between Rankin Park and Jesmond, February 2006.

Umwelt Environmental Consultants (2006) Non-Indigenous Heritage – Preliminary Assessment of the Proposed State Highway 23 Realignment from Rankin Park to Jesmond, NSW, April 2006.

Eastcoast Flora Survey (2015) Lower Hunter Spotted Gum-Ironbark Forest: Verification Survey, Proposed Newcastle Inner City Bypass (Rankin Park to Jesmond), Newcastle LGA, 18 March 2015

Baker Archaeology (2015) Newcastle Inner City Bypass Rankin Park to Jesmond, Historic Heritage Assessment, Draft Report, 3 June 2015.

Arcadis (2016) Newcastle Inner City Bypass Rankin Park to Jesmond, Traffic Modelling Report – Lower Hunter Traffic Model, April 2016.

Aurecon (2016) Traffic Microsimulation Model Calibration and Validation Report, October 2015

Aurecon (2016) Refined Strategic Design Microsimulation Traffic Modelling Report, April 2016

rms.nsw.gov.au/rp2j

13 22 13

Customer feedback
Roads and Maritime
Locked Bag 928,
North Sydney NSW 2059

April 2016

RMS 16.59
ISBN:978-1-925507-16-4