



Garfield Road East Upgrade

Review of Environmental Factors

Transport for NSW | October 2020

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Executive summary

The proposal

Transport for NSW (TfNSW) proposes to upgrade about 3.4 kilometres of Garfield Road East between Piccadilly Street, Riverstone and Windsor Road, Box Hill (the proposal). The proposal is in Sydney's North West primarily within the Blacktown local government area (LGA). The eastern extent of the proposal extends into The Hills LGA. Garfield Road East connects the Riverstone, Riverstone East and Box Hill precincts of the North West Growth Area (NWGA).

The proposal would tie into the existing section of Garfield Road East west of Piccadilly Street at about George Street and East of Windsor Road at about Alan Street. The proposal would include widening Garfield Road East to four lanes with two lanes in each direction and a central median along the length of the road which would accommodate a possible future upgrade to a six lane configuration with three lanes in each direction.

The delivery of additional lanes in the central median to meet future demand in the area, if required, would be the subject of a future separate environmental assessment under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Key features of the proposal would include:

- Widening Garfield Road East between Piccadilly Street and Windsor Road and upgrading the existing two-lane road to a four-lane divided road. The proposal would tie into the existing section of Garfield Road East west of Piccadilly Street, at about George Street and East of Windsor Road at about Alan Street.
- Providing an upgraded crossing over First Ponds Creek
- Upgrading the existing intersections at:
 - Piccadilly Street
 - Hamilton Street / McCulloch Street
 - Edmund Street
 - Windsor Road
- Providing left-in and left-out access to existing roads:
 - Junction Road
 - Galluzzo Street
- Clarke Street would be permanently closed at Garfield Road East with the upgrading of the intersection at Edmund Street
- Providing new intersections at:
 - About 200 metres north-east of Junction Road
 - About 500 metres south-west of Windsor Road
- Providing new left-in and left-out access at:
 - About 200 metres south-west of Windsor Road
 - About 200 metres south-west of Junction Road
- Providing bus priority lanes at key intersections
- Providing a shared user path along the southern side for the length of the proposal.

Construction is expected to take about three years to complete.

Need for the proposal

Garfield Road East is a key east-west corridor between Richmond Road and Windsor Road. Currently the road is subject to congestion and delays are common during peak periods. Congestion is expected to increase due to a substantial growth in residential population as when fully developed, the NWGA would potentially accommodate around 90,000 homes.

The proposal is needed to improve performance and trip reliability along the road corridor. The proposal would support local urban renewal initiatives planned in the area by providing access and improved road infrastructure.

Proposal objectives

The objectives of the proposal include:

- Improve road infrastructure to support the estimated growth within the NGWA, by increasing capacity and improving traffic flow for all road users
- Provide a road corridor that is safe for all road users
- Promote public transport by providing better access to Riverstone railway station
- Reduce travel times between Richmond Road and Windsor Road
- To ensure that the road asset and infrastructure is designed to support flood evacuation requirements
- Encourage and improve active transport use by providing facilities for walking and cycling.

Options considered

Three options were considered in developing this proposal.

Option 1 – ‘Do nothing’

The ‘do nothing’ option involves no work along the proposal. The road would remain in its existing alignment and arrangement. Work within the proposal would be limited to ongoing maintenance to maintain the condition of the road.

Option 2 - Upgrade Garfield Road East to four lanes within a 43 metre wide corridor from Piccadilly Street to Windsor Road

Option 2 would include upgrading Garfield Road East between Piccadilly Street, Riverstone and Windsor Road, Box Hill to four lanes with two lanes in each direction. The proposal would be upgraded within a 43 metre wide corridor over the entire length of the proposal.

A shared path would be accommodated along the southern side of the Garfield Road East and alignment of the McCulloch Street and Hamilton Street intersections. This option would include the provision for the proposal to be upgraded to six lanes in the future.

Option 3 - Upgrade Garfield Road East to four lanes within a 32 metre wide corridor west of Hamilton Street and a 43 metre corridor east of Hamilton Street

Option 3 would include upgrading Garfield Road East between Piccadilly Street, Riverstone and Windsor Road, Box Hill to four lanes with two lanes in each direction. This option includes:

- Widening Garfield Road East within a 32 metre wide corridor between Piccadilly Street and Hamilton Street
- Widening Garfield Road East within a 43 metre wide corridor between Hamilton Street and Windsor Road.

A shared path would be accommodated along the southern side of Garfield Road East and alignment of the McCulloch Street and Hamilton Street intersections. This option would include the provision for the proposal to be upgraded to six lanes in the future.

The preferred option is Option 3, the widening of Garfield Road East to four lanes within a 32 metre wide corridor west of Hamilton Street and a 43 metre corridor east of Hamilton Street. The preferred option addresses NSW Government's priorities and the North West Growth Centre Road Network Strategy (NSW Government, 2019) by improving traffic efficiency and addressing specific traffic congestion issues along Garfield Road East.

In developing the preferred option, ecologically sustainable development considerations such as economic and environmental have been considered to minimise environmental risks. The preferred option minimises vegetation clearance, with particular consideration of sensitive areas. The preferred option minimises potential impacts on existing residential properties and other existing land uses compared to Option 2, while also taking into consideration potential impacts on proposed future land use. In addition, Option 3 best minimises or avoids potential damage to known items or areas of cultural significance.

Statutory and planning framework

The proposal is for a road and is to be carried out by TfNSW and can therefore be assessed under Division 5.1 of the *Environmental Planning and Assessment Act 1979*. Development consent from council is not required.

Clause 94 of State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) permits development on any land for the purpose of a road to be carried out by or on behalf of a public authority without consent.

TfNSW has formed the view that the proposal is not likely to significantly impact the environment and would not require the preparation of an Environmental Impact Statement (EIS). This review of environmental factors (REF) has been prepared as part of the assessment process.

Community and stakeholder consultation

In late 2013 and early 2014, Roads and Maritime Services (now TfNSW) invited community feedback on the removal of the rail level crossing on Garfield Road. In late 2014 and early 2015 the community was invited to comment on the proposed road network strategy.

In July 2019 community consultation was carried out on for the whole of North West Growth Area to inform future road plans in the area. As part of this Garfield Road East and West were included and a community update was distributed at the time and made available on the project website, which provided an overview of the key features of the upgrades to Garfield Road with an update on the project and more information on projects in the surrounding area. Following the community consultation sessions and the feedback received, meetings were held with some individual property owners requesting further information.

The feedback from the consultation carried out to date was concerned with the following broad themes:

- Delay and congestion
- Intersection design
- Safety
- Property and access
- Traffic issues including lane configurations.

While the focus of the communication activities so far was to explain the environmental investigations, the community have raised questions or made comments about increased safety. These issues have been addressed in the REF.

TfNSW has formally consulted with Blacktown City Council, The Hills Shire Council, Department of Planning, Industry and Environment and other public authorities in accordance with the requirements of the ISEPP.

TfNSW would continue to consult with the community and stakeholders during future development of the proposal and invites comments on this REF. Submissions received during the public display period for the

REF would be addressed in a formal submissions report and, if a decision is made to proceed with the proposal, would be considered during detailed design of the proposal.

Environmental impacts

The main environmental impacts of the proposal are:

Traffic and transport

Traffic modelling indicates the performance of the existing Garfield Road East corridor would deteriorate over future years, with a number of intersections operating significantly above capacity or with an average delay in excess of five minutes.

Operation of the proposal would result in a significant reduction in average intersection delays and improved intersection performance. The proposal would also potentially reduce the risk of right turn related crashes at minor intersections and reduced congestion related crashes along the proposal.

During construction travel delays would affect commuter, bus and heavy vehicle traffic. There may also be temporary restrictions on property access for residents and businesses.

To mitigate impacts to traffic, businesses and residents, construction is proposed using lane closures and detours with night works as required. TfNSW would consult with affected residents along the corridor about property access before the start of construction.

Noise and vibration

Predicted worst-case exceedances of the established construction Noise Management Levels (NML) and vibration criteria for nearby sensitive receivers indicate that feasible and reasonable mitigation measures are likely to be required during the construction phase of the proposal. The ranges of NML exceedances indicate that preference should be given to conducting work during standard construction hours where feasible and reasonable to do so. Should work be required outside of standard hours, the scheduling of high-intensity construction work should be avoided.

The proposal alignment is located adjacent to six buildings/structures that has been identified as being heritage listed or of significance from a heritage perspective. It is recommended that a review of the vibration sensitivity of these structures be completed as part of the detailed design or pre-construction planning phases to confirm the appropriateness of the minimum working distance assessment and apply management protocols if required.

The noise and vibration assessment has identified that during operation 121 sensitive receivers along the proposal are expected to experience a 2 dB increase in total traffic noise levels above that of the corresponding no build option. This is due to the reduction in distance between the proposal and nearby receivers and the potential increase in traffic that is expected along the proposal.

Noise mitigation measures in the form of noise barriers have been assessed at two locations along the proposal where they have been considered feasible. The barriers would be located on the southern side of Garfield Road East between McCulloch Street and Clarke Street. The barriers were modelled at a design height of about three metres. Remaining affected properties along the proposal would potentially qualify for consideration of alternative noise mitigation measures. Further assessment of operational noise impacts and consultation with affected property owners would be required to identify the preferred operational acoustic treatments to be applied for the proposal.

Hydrology and flooding

Construction works have the potential to impact on surface water quality during construction. The main risk is from sediment-laden runoff caused by excavation, vegetation removal and other surface work, particularly before or during periods of heavy rainfall. Erosion and sedimentation control measures are proposed to manage potential surface water quality issues.

Existing groundwater levels and flow paths could be affected during construction such as excavation, including groundwater drawdown from dewatering, and the installation of new road related infrastructure.

A flood assessment was carried out for the proposal. The flood model indicated that there would be negligible flood level changes for a 1 in 500 year and 1 in 100 year storm event.

For more frequent flooding events, minor impacts on some commercial and residential properties and/or buildings around the proposal would be experienced. Refinement of the proposed design, including floor level survey, would be used to potentially further reduce and mitigate these impacts during the detailed design phase. If required, flood mitigation options for affected properties would be investigated in consultation with property owners.

The proposal would result in minor increases in flood velocities which has the potential to result in increased scouring along the banks of the local tributaries. Measures to manage potential scour impacts would be considered as part of the detailed design.

Aboriginal cultural heritage

An assessment of impacts to Aboriginal heritage has been undertaken in accordance with stage two of Roads and Maritime Services' (Roads and Maritime) Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI).

The proposal would potentially impact on four previously recorded items under the Aboriginal Heritage Information Management system (AHIMS). The proposal would impact areas of high archaeological significance.

Potential harm to Aboriginal objects or places are considered likely to occur because of the proposal. It is recommended the statutory consultation process take place and a Cultural Heritage Assessment Report be prepared.

A Stage 3 PACHCI process is currently being prepared for the proposal.

Non-Aboriginal heritage

There are a number of heritage items that are located along Garfield Road East and in the vicinity of the proposal including:

- Windsor Road , an item of state significance
- House and shop located at 76-78 Garfield Road East, an item of local significance
- Riverstone Public School, an item of local significance
- St John Evangelist Parish, listed under the Growth Centres SEPP
- St Clare's Convent, listed under the Growth Centres SEPP
- Rosebank, listed under the Growth Centres SEPP
- Bicentennial Museum (formerly public school, then Masonic Hall), an item of local significance
- St Andrews Uniting Church, an item of local significance.

Construction of the proposal would impact on the archaeological potential of two sites, as follows:

- The unlisted 169 Garfield Road East weatherboard cottage site.
- S170 Register listed Old Windsor Road and Windsor Road Heritage Precincts.

The entirety of the footprint of the demolished pre-1925 weatherboard cottage falls within the proposal. Based on the significance assessment for the structure as being significant at a local level, the proposed works would likely result in archaeological impacts.

The proposal would not impact the awning at the shop located at 76-78 Garfield Road East, which currently extends onto the existing footpath. Overall, the proposed design would have a minor impact on the House

and Shop. Impacts to the aesthetic value and character of the streetscape surrounding the heritage item as a result of the proposal would impact on the general presentation of the shop.

Expanding Garfield Road East into the boundary of the Riverstone Public School (former) and removing the existing landscape buffer around the main school building will eliminate existing plantings and the space between the roadway and the main building. The proposal would have a moderate impact on the Riverstone Public School.

Cutting into the existing landscaping of St John's Catholic Church and at St Clare's Convent would alter the spacing and proportions of both sites. However, the works would not physically impact the church and/or convent, which are the focus of the heritage significance of both sites. Overall, this would result in a moderate impact to St John's Catholic Church and St Clare's Convent.

The heritage curtilage for Rosebank continues to include the former property boundary for the site, including its former landscaping. As the landscaping has already been impacted by subdivision works, any impact as a result of the proposal would be inconsequential. Therefore, impact on the built heritage values of the site is nil.

Socio-economic

The proposal would have both wider regional and local benefits through reduced delays, improved reliability for public transport, improved safety for all road users and improved access due to the provision of new pedestrian infrastructure.

During construction, the community and local businesses in the area would likely experience temporary traffic delays, noise and air quality and visual amenity impacts. In addition, construction would be expected to have an impact on community values, particular local areas such as the Casuarina School and Riverstone Swimming Centre which have outdoor spaces. Relocation and adjustment of utility services such as sewerage, gas, electricity and telecommunication networks would potentially occur as part of the proposal. Minor disruptions to these utility services may occur. Property owners likely to be impacted by any disruptions and access restrictions would be notified before work starts.

About 86,280 square metres of land would be acquired to build the proposal. TfNSW would also need to temporarily lease or negotiate access for an additional 67,380 square metres of land during construction. The property impact anticipated as part of the proposal include full or partial acquisition of properties which can lead to:

- Loss of land and infrastructure
- Property severance
- A feeling of loss.

TfNSW would undertake all acquisitions in accordance with current acquisition guidelines and the *Land Acquisition (Just Terms Compensation) Act 1991*.

An assessment of the impact on businesses due to the loss of on-street and/or off-street parking was undertaken. Moderate impacts are expected at the Riverstone Veterinary Hospital due to the loss of parking because of the proposal. TfNSW would investigate options to mitigate the loss of parking spaces as part of detailed design.

At all other businesses located along Garfield Road East it was determined that the proposal would result in a low impact even with proposed changes in parking conditions. Businesses in many locations along the proposal would be likely to experience either no or negligible impact to customer or staff parking due to the proposal.

Landscape character and visual impact

Visual and landscape impacts would occur during the proposal's construction and operation. Temporary construction impacts would result from construction plant, equipment, temporary compounds and stockpiles.

Permanent visual and landscape changes would mainly result from the removal of street trees.

In order to mitigate these impacts and help reinstate the character of the area, new street trees would be planted in accordance with the proposed urban design recommendations and in consultation with key stakeholders including Blacktown City Council and The Hills Shire Council.

Biodiversity

The proposal would remove about 5.67 hectares of communities listed under the *Biodiversity Conservation Act 2016* (BC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Of the above 5.67 hectares, 0.47 hectares of BC Act listed vegetation would be removed from non-biocertified land. Several trees would be removed during construction, which potentially support roosting and nesting for breeding birds, microbats and arboreal mammals.

An assessment of significance has been carried out for threatened species and ecological communities that are likely to occur in the proposal. With appropriate safeguards, the proposal is not likely to significantly impact threatened species or ecological communities or their habitats, within the meaning of the BC Act or the FM Act and therefore a Species Impact Statement (SIS) or Biodiversity Development Assessment Report (BDAR) is not required. The proposal is not likely to significantly impact threatened species, ecological communities or migratory species, within the meaning of the EPBC Act.

Justification and conclusion

As the proposal is for a road and road infrastructure facilities and is to be carried out on behalf of TfNSW, it can be assessed under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). TfNSW is the determining authority for the proposal. This Review of Environmental Factors (REF) fulfils Transport for NSW's obligation under Section 5.5 of the EP&A Act including to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

The proposal would be unlikely to cause a significant impact on the environment. Therefore, it is not necessary for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning and Public Spaces under Division 5.2 of the EP&A Act. A Biodiversity Development Assessment Report or Species Impact Statement is not required. The proposal is subject to assessment under Division 5.1 of the EP&A Act. Consent from Council is not required.

The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*. A referral to the Australian Department of Agriculture, Water and the Environment is not required.

While there would be some impacts to the environment as a result of the proposal, they have been avoided or minimised wherever possible through the design process and site specific safeguards.

The proposal is considered consistent with state and local transport strategies to improve the road safety and efficiency, and would help to meet ongoing and future road network needs. The proposal would support improved access through the area and facilitate pedestrians, cyclists and vehicle access to urban renewal projects. On balance, the proposal's long-term benefits outweigh its impacts, and the proposal is considered to be justified.

Display of the review of environmental factors

This REF is on display for comment for 28 days.

The public display period will be advertised in the community update which will be distributed to the local community and also in the local newspaper, The Hawkesbury Gazette and Hawkesbury Courier. You can access the documents in the following ways:

Internet

The documents are available as pdf files on the Transport for NSW website at nswroads.work/GarfieldRd.

Online community consultation will be carried out via Facebook.

Copies by request

Copies of the REF are available by contacting our project team on 1300 367 561.

How can I make a submission?

To make a submission about this proposal, please send your written comments to:

- Garfield Road upgrade, Transport for NSW, PO Box 973 Parramatta CBD NSW 2124
- NWGC@transport.nsw.gov.au.

Submissions must be received before the close of display of the REF. Submissions will be managed in accordance with the Transport for NSW Privacy Statement which can be found here <https://www.transport.nsw.gov.au/about-us/transport-privacy> or by contacting privacy@transport.nsw.gov.au for a copy.

What happens next?

Transport for NSW will collate and consider the submissions received during public display of the REF.

After this consideration, Transport for NSW will determine whether or not the proposal should proceed as proposed and will inform the community and stakeholders of this decision.

If the proposal is determined to proceed, Transport for NSW will continue to consult with the community and stakeholders prior to and during construction.

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1. Introduction

This chapter introduces the proposal and provides the context of the environmental assessment. In introducing the proposal, the objectives and project development history are detailed and the purpose of the report provided.

1.1 Proposal identification

Transport for NSW (TfNSW) proposes to upgrade about 3.4 kilometres of Garfield Road East between Piccadilly Street, Riverstone and Windsor Road, Box Hill (the proposal). The proposal is located in Sydney's North West primarily within the Blacktown local government area (LGA). The eastern extent of the proposal extends into The Hills Shire LGA. Garfield Road East connects the Riverstone, Riverstone East and Box Hill precincts of the North West Growth Area (NWGA).

The proposal would tie into the existing section of Garfield Road East west of Piccadilly Street at about George Street and East of Windsor Road at about Alan Street. The proposal would include widening Garfield Road East to four lanes with two lanes in each direction and a central median along the length of the road which would accommodate a possible future upgrade to a six lane configuration with three lanes in each direction.

The delivery of additional lanes in the central median to meet future demand in the area, if required, would be the subject of a future separate environmental assessment under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Key features of the proposal would include:

- Widening Garfield Road East between Piccadilly Street and Windsor Road and upgrading the existing two-lane road to a four lane divided road. The proposal would tie into the existing section of Garfield Road East west of Piccadilly Street, at about George Street and East of Windsor Road at about Alan Street.
- Providing an upgraded crossing over First Ponds Creek
- Upgrading the existing intersections at:
 - Piccadilly Street
 - Hamilton Street / McCulloch Street
 - Edmund Street
 - Windsor Road
- Providing left-in and left-out access to existing roads:
 - Junction Road
 - Galluzzo Street
- Clarke Street would be permanently closed at Garfield Road East with the upgrading of the intersection at Edmund Street
- Providing new intersections at:
 - About 200 metres north-east of Junction Road
 - About 500 metres south-west of Windsor Road
- Providing new left-in and left-out access at:
 - About 200 metres south-west of Windsor Road
 - About 200 metres south-west of Junction Road
- Providing bus priority lanes at key intersections
- Providing a shared user path along the southern side for the length of the proposal.

The area east of McCulloch Street is characterised by rural residential land that is in transition to low and medium density urban development and associated urban land uses. West of McCulloch Street is characterised by Riverstone town centre. First Ponds Creek crosses the central part of the proposal near Edmund Street.

The location of the proposal is shown in Figure 1-1 and an overview of the proposal is provided in Figure 1-2. Chapter 3 describes the proposal in more detail.

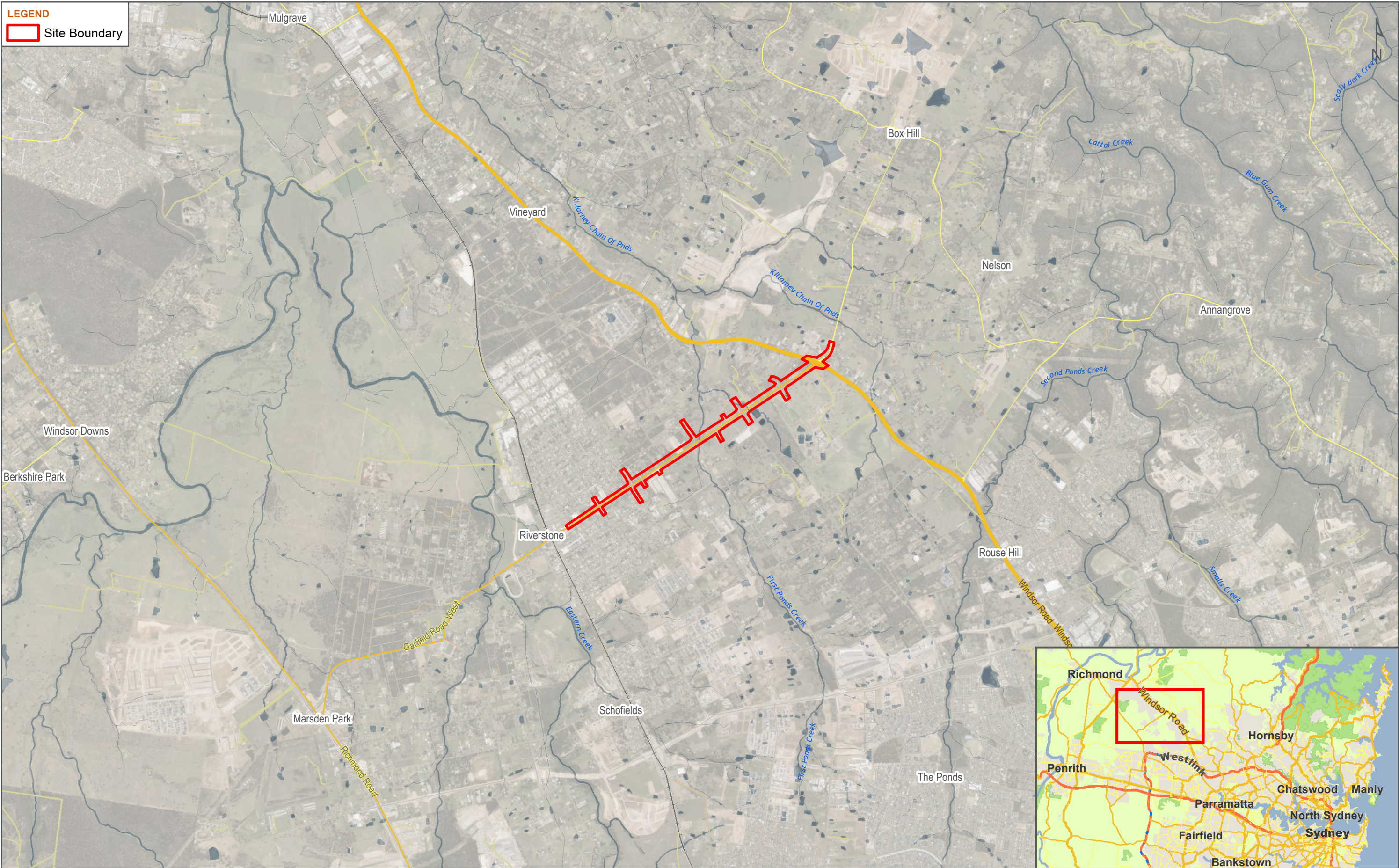
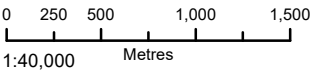


Figure 1-1: Location of the proposal



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**COORDINATE
SYSTEM**
GDA 1994 MGA Zone 56

PROJECT NO. 30012746

PROJECT TITLE Garfield Road East

CREATED BY FA13847

SOURCES Roadnet MDS 2019, public_NSW_Imagery:
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Construction footprint
 Road design

Garfield Road East 30012746

Figure 1-2: The proposal

0 0.175 0.35
 Km

1.2 Purpose of the report

This review of environmental factors (REF) has been prepared by SMEC on behalf of Transport for NSW Western Sydney Project Office. For the purposes of these works, Transport for NSW is the proponent and the determining authority under Division 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of the REF is to describe the proposal, to document the likely impacts of the proposal on the environment, and to detail mitigation and management measures to be implemented.

The description of the proposed work and assessment of associated environmental impacts has been undertaken in the context of clause 228 of the Environmental Planning and Assessment Regulation 2000, the factors in *Is an EIS Required? Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979* (Is an EIS required? guidelines) (DUAP, 1995/1996), *Roads and Related Facilities EIS Guideline* (DUAP 1996), the *Biodiversity Conservation Act 2016* (BC Act), the *Fisheries Management Act 1994* (FM Act), and the *Australian Government's Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In doing so, the REF helps to fulfil the requirements of:

- Section 5.5 of the EP&A Act including that Transport for NSW examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity

The findings of the REF would be considered when assessing:

- Whether the proposal is likely to have a significant impact on the environment and therefore the necessity for an environmental impact statement to be prepared and approval to be sought from the Minister for Planning and Public Spaces under Division 5.2 of the EP&A Act
- The significance of any impact on threatened species as defined by the BC Act and/or FM Act, in section 1.7 of the EP&A Act and therefore the requirement for a Species Impact Statement or a Biodiversity Development Assessment Report
- The significance of any impact on nationally listed biodiversity matters under the EPBC Act, including whether there is a real possibility that the activity may threaten long-term survival of these matters, and whether offsets are required and able to be secured.

The potential for the proposal to significantly impact any other matters of national environmental significance or Commonwealth land and the need, subject to the EPBC Act strategic assessment approval, to make a referral to the Australian Government Department of Agriculture, Water and the Environment for a decision by the Commonwealth Minister for the Environment on whether assessment and approval is required under the EPBC Act.

2. Need and options considered

This chapter describes the need for the proposal in terms of its strategic setting and operational need. It identifies the various options considered and the selection of the preferred option for the proposal.

2.1 Strategic need for the proposal

Garfield Road East is a key east-west corridor along with Garfield Road West between Windsor Road and Richmond Road. Currently the road is subject to congestion and delays are common during peak periods. Congestion is expected to increase due to a substantial growth in residential population as when fully developed, the NWGA would potentially accommodate around 90,000 homes.

The proposal is needed to improve performance and trip reliability along the road corridor. The proposal would support local urban renewal initiatives planned in the area by providing access and improved road infrastructure.

2.1.1 NSW Premiers and State priorities

The New South Wales (NSW) Government is working to achieve 12 Premier's priorities and 18 state priorities to grow the economy, deliver infrastructure, protect the vulnerable, and improve health, education and public services across NSW.

The proposal specifically addresses or supports the following Premier's priority:

- Building infrastructure - Key infrastructure projects to be delivered on time and on budget across NSW.

The proposal specifically addresses or supports the following state priority:

- Improving road travel reliability - 90 per cent of peak travel on key road routes is on time
- A safe transport system for every customer with the aim for zero deaths or serious injuries on the network by 2056
- Increase housing supply across NSW - Deliver more than 50,000 approvals every year.

2.1.2 Future Transport Strategy 2056

The *NSW Future Transport Strategy 2056* (TfNSW, 2018) outlines a clear framework to address transport challenges in NSW over the next 40 years and is an update of the NSW Long Term Transport Master Plan released in 2012. It integrates planning for roads, freight and all other modes of transport and sets out initiatives, solutions and actions to meet NSW transport challenges.

By increased road capacity constructed to current design standards, the proposal would directly support the following Greater Sydney transport customer outcomes:

- Efficient, reliable and easy-to-understand journeys for customers, enabled by a simple hierarchy of services. A safe transport system for every customer with the aim for zero deaths or serious injuries on the network by 2056
- Transport services and infrastructure are delivered, operated and maintained in a way that is affordable for customers and the community.

2.1.3 Greater Sydney Region Plan

The *Greater Sydney Region Plan - A Metropolis of Three Cities* (Greater Sydney Commission, 2018) envisages three cities where most residents live within 30 minutes of their jobs, education and health facilities, services and leisure opportunities. The plan includes a framework that emphasises how the principal spatial elements of the city are interconnected and integrated to best deliver in four critical areas:

- Integration of the mass transit network with the economic corridors, centres, transit-oriented development, urban renewal and health and education precincts
- Connectivity between the rail, freight and strategic road networks and the trade gateways and industrial areas
- Integration of the green grid network with residential neighbourhoods
- Retention of the integrity of the values of the Metropolitan Rural Area and the Protected Natural Area.

The plan includes ten directions with related objectives, strategies and actions. The proposal directly aligns with the direction of 'A city supported by infrastructure' and the following related objectives:

- Objective 1 - Infrastructure supports the three cities
- Objective 2 - Infrastructure aligns with forecast growth – growth infrastructure compact
- Objective 3 - Infrastructure adapts to meet future needs.

The proposal also supports the following identified directions

- A city supported by infrastructure
- A well-connected city.

The Central City District covers the Blacktown, Cumberland, Parramatta and The Hills local LGAs. The *Central City District Plan* (Greater Sydney Commission, 2018) is a 20-year plan to manage growth in the context of economic, social and environmental matters to achieve the 40-year vision of Greater Sydney. It is a guide for implementing the *Greater Sydney Region Plan – A Metropolis of Three Cities*, at a district level and is a bridge between regional and local planning.

The proposal directly aligns with Planning Priority N1 Planning for a city supported by infrastructure.

2.1.4 Road Safety Plan 2021

The *Road Safety Plan 2021* (Transport for NSW, 2018) outlines how the NSW Government will work towards the State Priority Target of reducing fatalities by 30 per cent by 2021 (compared to average annual fatalities over 2008–2010). It also aligns the Towards Zero vision with Future Transport 2056, which aims to have NSW transport network with zero trauma by 2056.

The proposal is consistent with the directions set out in *Road Safety Plan 2021* because it would provide a better standard of road with improved safety through the separation of carriageways and provision of improved intersections and active transport links.

2.1.5 North West Land Use and Infrastructure Implementation Plan

The *North West Priority Growth Area - North West Land Use and Infrastructure Implementation Plan* (Department of Planning and Environment (DPE), 2017) outlines that the NWGA when fully developed will accommodate approximately 90,000 homes, 20,000 more than were forecast in 2006. In this context the Implementation Plan provides a framework to facilitate the delivery of over 33,000 of these homes over the next ten years and identifies the infrastructure needed to support this growth.

The Implementation Plan identifies upgrades to Garfield Road East as key infrastructure required to 2026, with anticipated delivery by 2027 to 2029, to support new homes.

2.1.6 Special Infrastructure Contribution Scheme

The proposal development is funded from the Special Infrastructure Contribution (SIC) scheme. This scheme has been established by the NSW Department of Planning, Industry and Environment (DPIE) through levies paid by developers to share the cost of infrastructure required to support growing communities.

SIC help fund the delivery of some of the key pieces of State and regional infrastructure required to support a growing population, such as:

- State and regional roads
- Transport facilities such as bus shelters and interchanges
- Regional open space, pedestrian links and cycleways
- Social infrastructure such as schools, healthcare and emergency services.

2.1.7 North West Growth Area Road Network Strategy

The area surrounding Riverstone is an integral part of the NWGA and the expected increase in population and development associated with the *North West Land Use and Infrastructure Implementation Plan* will mean significantly more traffic in the area. As part of the planning development for the NWGA, over the next ten years, 33,000 homes will be provided in the area and once fully developed, the area will be home to around 250,000 people. A fundamental aspect of the regional development is the provision of safe, reliable infrastructure. The proposal would support the objectives of the Strategy.

Upgrading the Garfield Road corridor is part of the North West Growth Centre Road Network Strategy (NSW Government, 2019) long term works. This includes the proposal and Garfield Road West. The upgrades to Garfield Road West are being assessed under a separate REF. The DPIE has granted SIC for TfNSW to undertake the planning of Garfield Road East.

2.2 Limitations of existing infrastructure

Garfield Road East currently forms an important east-west transport corridor along with Garfield Road West between Richmond Road and Windsor Road. Precinct planning for the NWGA shows Garfield Road corridor extending as far west as Stony Creek Road at Shanes Park and linking into Terry Road at Box Hill in the East.

Garfield Road East is a two-lane undivided urban road with a posted speed limit of 50 kilometres per hour at the western end of the proposal. East of Edmund Street, it transitions to a two-lane semi-rural road with a posted speed limit of 80 kilometres per hour.

Network Performance Measures and Network Planning Targets (Roads and Maritime Services, 2010) classifies Garfield Road East as a Class 3 Urban Road. Garfield Road East is an approved B-double route. None of the intersecting roads within the proposal are approved B-double routes.

Parking is permitted along Garfield Road East, the majority of which occurs in residential areas near the intersection of Piccadilly Street.

2.2.1 Connecting roads and intersections

The proposal includes a number of intersections, two are signalised, and four are priority controlled intersections as shown in Table 2.1. All roads have left and right turn access to Garfield Road East, except for Galluzzo Street which has left turn access only, and there are no major intersections along the alignment between Junction Road and Windsor Road. In the existing configuration, Clarke Street connects to Garfield Road East.

Table 2.1: Intersections within the proposal alignment

ID	Intersection	Control type
1-1	Garfield Road East and Piccadilly Street	Signalised intersection
1-2	Garfield Road East and McCulloch Street	Priority controlled intersection
1-3	Garfield Road East and Hamilton Street	Priority controlled intersection
1-4	Garfield Road East and Galluzzo Street	Priority controlled intersection
1-5	Garfield Road East and Edmund Street	Priority controlled intersection
1-6	Garfield Road East and Clarke Street	Priority controlled intersection
1-7	Garfield Road East and Junction Road	Priority controlled intersection
1-8	Garfield Road East and Windsor Road	Signalised intersection

2.2.2 Traffic islands and road furniture

There are three existing traffic islands along Garfield Road East. These are located at:

- The intersection of Garfield Road East and Windsor Road
- The intersection of Garfield road East and Galluzzo Street
- St John's Primary school zone at about 161 Garfield Road East.

Within the proposal there are three intersections that provide dedicated turn lanes:

- The intersection of Garfield Road East and McCulloch Street - right turn only
- The intersection of Garfield Road East and Hamilton Street - right turn only
- The intersection of Garfield Road East and Windsor Road- left and right turn.

2.2.3 Pedestrian and cyclist facilities

The existing footpaths within the proposal are single lane and inconsistent. Footpaths are located along the northern and southern sides of Garfield Road East in the residential areas near the Piccadilly Street intersection at the western extent of the proposal. There are footpaths on the northern side of Garfield Road East fronting St John the Evangelist Parish/ St John's Primary School near the McCulloch Street intersection. There are also footpaths at intersections and connecting streets within the proposal. The details of existing pedestrian infrastructure are provided in Section 6.6 of this REF. There is no formal pedestrian or bicycle infrastructure east of St John's Primary School, except the intersection infrastructure at Windsor Road.

2.2.4 Design structures

There are four existing culverts within the proposal:

- A four-cell box culvert providing a drainage path for First Ponds Creek under Garfield Road East was observed at about Edmund Street
- A box culvert allowing a tributary of First Ponds Creek to cross Garfield Road East was observed at about 250 metres east of the Junction Road intersection
- A pipe culvert was observed near the toe of a fill embankment forming part of Garfield Road East at about 500 metres west of the Windsor Road intersection
- A box culvert was observed running under Garfield Road East at about 200 metres west of the Windsor Road intersection.

Details of drainage structures is provided in Section 6.3 of this REF.

2.2.5 Bus routes and services

There are 15 bus stops along the existing Garfield Road East alignment. The existing bus services in the study area are limited to five bus routes and they are:

- Route 746: Riverstone to Rouse Hill Town Centre
- Route 747: Marsden Park to Rouse Hill via Riverstone
- Route 671: Riverstone to Windsor via McGraths Hill and Vineyard
- Route 742: Marsden Park to Rouse Hill
- Route 608: Windsor to Rouse Hill.

There are up to 20 special school bus services which operate within the study area. There are no existing indented bus bays or priority bus lane facilities along Garfield Road East.

2.3 Proposal objectives and development criteria

The following section outlines the objectives of the proposal and the development criteria for the proposed designs.

2.3.1 Proposal objectives

The objectives of the proposal include:

- Improve road infrastructure to support the estimated growth within the NGWA, by increasing capacity and improving traffic flow for all road users
- Provide a road corridor that is safe for all road users
- Promote public transport by providing better access to Riverstone railway station
- Reduce travel times between Richmond Road and Windsor Road
- To ensure that the road asset and infrastructure is designed to support flood evacuation requirements
- Encourage and improve active transport use by providing facilities for walking and cycling.

2.3.2 Development criteria

The development criteria for the proposal include:

- Travel efficiency: the performance of the option with reference to average travel speed, vehicle kilometres travelled, vehicle hours travelled, level of service

- Roads safety: the potential of the option to contribute to improved road safety or conversely any identified safety issues
- Environmental impacts: the potential impacts of the proposal on the environment having regard to biodiversity, waterways, heritage, and other relevant aspects e.g. Aboriginal Land Claim areas and flood prone areas
- Utility impacts: the impact of the option on utilities and the extent of required relocation and/or protection
- Property impacts: the extent of property acquisition required for the option
- Access to existing and future development: the ability of the option to accommodate access to existing and future development
- Bus prioritisation: the ability of the option to accommodate bus prioritisation at intersections with primary arterial roads
- Alternate transport: the ability of the option to accommodate pedestrians and cyclists
- Design standards: the alignment of the option with contemporary design standards
- Urban design outcomes: the alignment of the option with the urban design objectives and the principles set for the proposal.

2.3.3 Urban design objectives

Urban design objectives for the proposal include:

- Protect and enhance existing views, character and cultural values of the corridor
- Contribute to the accessibility and connectivity of people within regions and communities
- Provide a flowing road alignment that is responsive to, and integrated with the natural and built landscape
- Facilitate the provision of good urban design outcomes for areas adjoining the road
- Develop a simple and unified palette of elements and details that are attractive and easily maintained.

2.4 Alternatives and options considered

A number of alternatives and options were identified and considered in developing the proposal and selecting the preferred option. They are summarised in this section.

2.4.1 Methodology for selection of preferred option

The options development process leading to the selection of a preferred option began with the NSW Governments North West Growth Centre and Riverstone Corridor Traffic Study (Roads and Maritime Services, 2014). In 2016 Roads and Maritime Services (now TfNSW) developed a strategic design for Garfield Road East.

As part of the road design report a number of objectives for the proposal were identified. These options were evaluated against the identified proposal objectives outlined in Section 2.3.1 and are explained further below.

2.4.2 Identified options

Option 1 – ‘Do nothing’

The ‘do nothing’ option involves no work along the proposal. The road would remain in its existing alignment and arrangement. Work within the proposal would be limited to ongoing maintenance to maintain the condition of the road.

Option 2 - Upgrade Garfield Road East to four lanes within a 43 metre wide corridor from Piccadilly Street to Windsor Road

Option 2 would include upgrading Garfield Road East between Piccadilly Street, Riverstone and Windsor Road, Box Hill to four lanes with two lanes in each direction. The proposal would be upgraded within a 43 metre wide corridor over the entire length of the proposal.

A shared path would be accommodated along the southern side of the Garfield Road East and alignment of the McCulloch Street and Hamilton Street intersections. This option would include the provision for the proposal to be upgraded to six lanes in the future.

Option 3 - Upgrade Garfield Road East to four lanes within a 32 metre wide corridor west of Hamilton Street and a 43 metre corridor east of Hamilton Street

Option 3 would include upgrading Garfield Road East between Piccadilly Street, Riverstone and Windsor Road, Box Hill to four lanes with two lanes in each direction. This option includes:

- Widening Garfield Road East within a 32 metre wide corridor between Piccadilly Street and Hamilton Street
- Widening Garfield Road East within a 43 metre wide corridor between Hamilton Street and Windsor Road.

A shared path would be accommodated along the southern side of Garfield Road East and alignment of the McCulloch Street and Hamilton Street intersections. This option would include the provision for the proposal to be upgraded to six lanes in the future.

2.4.3 Analysis of options

Option 1 - ‘Do nothing’

The ‘do nothing’ option would result in ongoing performance issues as currently experienced along the proposal. Projected future traffic growth associated with the NWGA could worsen performance issues, including increasing the potential for:

- Increased congestion
- Reduced travel time reliability
- Reduced freight efficiency
- Increased safety concerns and road incidents.

The assessment of Option 1 against the development criteria is as follows:

- Development criteria 1 - Travel efficiency. Option 1 would not improve performance with reference to average travel speed, vehicle kilometres travelled, vehicle hours travelled and level of service for projected future traffic growth in the area
- Development criteria 2 - Road safety. There would be no change to current road safety

- Development criteria 3 - Environmental impacts. The 'do nothing' option would have lower cost and construction impacts on the community and environment as there would be no property impacts or loss of vegetation through clearing. Option 1 would increase the operational impacts from congestion
- Development criteria 4 - Utility impacts. There would be no utility impacts outside of regular maintenance of existing utilities for Option 1
- Development criteria 5 - Property impacts. There would be no property impacts for Option 1
- Development criteria 6 - Access to existing and future development. Option 1 would have the least integration with future Council and developer works on land and roads directly next to the proposal
- Development criteria 7 - Bus prioritisation. Option 1 does not provide for bus prioritisation at existing intersections along Garfield Road East within the proposal
- Development criteria 8 - Alternate transport. Option 1 would not provide a new three metre wide shared path along the westbound carriageway from Piccadilly Street to the eastern limit of the proposal
- Development criteria 9 - Design standards. The alignment of the proposal for Option 1 would remain unchanged
- Development criteria 10 - Urban design outcomes. The urban design of the proposal would remain unchanged for Option 1.

The 'do-nothing' option does not meet the objectives and/or development criteria of the proposal and is therefore not considered a feasible alternative.

Option 2 - Upgrade Garfield Road East to four lanes within a 43 metre wide corridor from Piccadilly Street to Windsor Road

Option 2 would improve congestion, travel time reliability and safety issues along the route, meeting the proposal objectives and development criteria as follows:

- Objective 1 - improve road infrastructure to support the estimated growth within the NWGA, by increasing capacity and improving traffic flow for all road users by widening the road to two travel lanes in each direction
- Objective 2 - provide a road corridor that is safe for all road users on Garfield Road in relation to the number and severity of crashes, and reducing road safety risk through improved horizontal and vertical alignment over the existing road
- Objective 4 - reduce travel times between Windsor Road and Richmond Road by widening the road to two lanes in each direction which would provide more consistent travel times
- Objective 5 - ensure that the road asset and infrastructure is designed to support flood evacuation requirements through raised road levels and drainage upgrades
- Objective 6 - encourage and improve active transport use by providing facilities for walking and cycling by providing a new shared path along the southern side of the Garfield Road East and alignment of the McCulloch Street and Hamilton Street intersections.

The assessment of Option 2 against the development criteria is as follows:

- Development criteria 1 - Travel efficiency. Option 2 would improve performance with reference to average travel speed, vehicle kilometres travelled, vehicle hours travelled, level of service
- Development criteria 2 - Roads safety. Option 2 would improve road safety through the upgrade from unsignalised priority intersections to signalised intersections at McCulloch/Hamilton St and Edmund St
- Development criteria 3 - Environmental impacts. The potential impacts of Option 2 on the environment having regard to biodiversity, waterways, heritage, and other relevant aspects would

be greater compared to Option 1 and potentially greater compared to Option 3 to accommodate the new 43 metre wide corridor

- Development criteria 4 - Utility impacts. All potential utilities impacted by the proposal would be accommodated within the behind the new kerb within the footway
- Development criteria 5 - Property impacts. Option 2 would require more properties to be acquired in the proposal to accommodate the new 43 metre wide corridor, particularly at the western end, which is the more built up part of Riverstone
- Development criteria 6 - Access to existing and future development. Option 2 would integrate with existing and future Council and developer works on land and roads directly next to the proposal such as at Edmund Street to minimise redundant future works and future subdivision impacts
- Development criteria 7 - Bus prioritisation. Option 2 provides bus prioritisation at all signalised intersections along Garfield Road East within the proposal
- Development criteria 8 - Alternate transport. A three metre wide shared path along the westbound carriageway from Piccadilly Street to the eastern limit of the proposal, catering for the active movement of pedestrians and cyclists would be provided
- Development criteria 9 - Design standards. The alignment of Option 2 would comply with contemporary design standards
- Development criteria 10 - Urban design outcomes. Option 2 would align with the urban design objectives and the principles set for the proposal.

Option 3 - Upgrade Garfield Road East to four lanes within a 32 metre wide corridor west of Hamilton Street and a 43 metre corridor east of Hamilton Street

Option 3 would improve congestion, travel time reliability and safety issues along the route, meeting the proposal objectives as follows:

- Objective 1 - improve road infrastructure to support the estimated growth within the NWGA, by increasing capacity and improving traffic flow for all road users by widening the road to two travel lanes in each direction
- Objective 2 - provide a road corridor that is safe for all road users on Garfield Road in relation to the number and severity of crashes, and reducing road safety risk through improved horizontal and vertical alignment over the existing road
- Objective 4 - reduce travel times between Windsor Road and Richmond Road by widening the road to two lanes in each direction which would provide more consistent travel times
- Objective 5 - ensure that the road asset and infrastructure is designed to support flood evacuation requirements through raised road levels and drainage upgrades
- Objective 6 - encourage and improve active transport use by providing facilities for walking and cycling by providing a new shared path along the southern side of the Garfield Road East and alignment of the McCulloch Street and Hamilton Street intersections.

The assessment of Option 3 against the development criteria is as follows:

- Development criteria 1 - Travel efficiency. Option 3 would improve performance with reference to average travel speed, vehicle kilometres travelled, vehicle hours travelled, level of service
- Development criteria 2 - Roads safety. Option 3 would improve road safety through the upgrade from unsignalised priority intersections to signalised intersections at McCulloch/Hamilton St and Edmund St
- Development criteria 3 - Environmental impacts. The potential impacts of Option 3 on the environment having regard to biodiversity, waterways, heritage, and other relevant aspects would reduce compared to Option 2 to accommodate the reduced 32 metre wide corridor. Option 3 would

have greater impacts to the environment compared to Option 1, however Option 3 would reduce some social impacts such as travel efficiency and road safety compared to Option 1

- Development criteria 4 - Utility impacts. All potential utilities impacted by the proposal would be accommodated within the behind the new kerb within the footway
- Development criteria 5 - Property impacts. Option 3 would require fewer properties to be acquired in the proposal to accommodate the new 32 metre wide corridor compared to Option 2
- Development criteria 6 - Access to existing and future development. Option 3 would integrate with existing and future Council and developer works on land and roads directly next to the proposal such as at Edmund Street to minimise redundant future works and future subdivision impacts
- Development criteria 7 - Bus prioritisation. Option 3 provides bus prioritisation at all signalised intersections along Garfield Road East within the proposal
- Development criteria 8 - Alternate transport. A three metre wide shared path along the westbound carriageway from Piccadilly Street to the eastern limit of the proposal, catering for the active movement of pedestrians and cyclists would be provided
- Development criteria 9 - Design standards. The alignment of Option 3 would comply with contemporary design standards
- Development criteria 10 - Urban design outcomes. Option 3 would align with the urban design objectives and the principles set for the proposal.

Overall Option 3 was preferred over Option 2 due to the reduced environmental and social impacts on existing properties by adopting a narrower 32 metre corridor at the western end, which is the more built up part of Riverstone. Option 3 would better meet the development criteria of the proposal for current and future road users such as improved travel efficiency and road safety compared to Option 1.

2.5 Preferred option

The preferred option is Option 3, the widening of Garfield Road East to four lanes within a 32 metre wide corridor west of Hamilton Street and a 43 metre corridor east of Hamilton Street.

The preferred option addresses NSW Government's priorities and the North West Growth Centre Road Network Strategy (NSW Government, 2019) by improving traffic efficiency and addressing specific traffic congestion issues along Garfield Road East. Key intersections at Windsor Road and Piccadilly Street would be improved through upgrades to the existing signalised traffic controls. Improved connectivity between Richmond Road and Windsor Road would be provided through intersection upgrades and reduced congestion.

Residential growth would be supported particularly new urban development and subdivisions east of Galluzzo Street, Riverstone. Garfield Road East would continue to support employment growth and serve employment growth areas by providing increased access to Riverstone town centre and increase public transport facilities from Windsor Road to Riverstone town centre.

The upgrade to Garfield Road East would improve freight productivity, support freight and long distance travel important to the NSW economy through improvements to heavy vehicle and haulage routes (Windsor Road). The new vertical and horizontal alignment of the road would improve road safety and flood immunity.

Upgrades to existing bus stop facilities along Garfield Road East would support public transport use and improve road based public transport. In addition, the proposal would provide priority bus lanes which would encourage commuter public transport use in Riverstone and the NWGA. Active transport would be encouraged through the inclusion of pedestrian paths and cycleways. Improved amenity would be supported through urban design and landscaping.

In developing the preferred option, ecologically sustainable development considerations such as economic and environmental have been considered to minimise environmental risks. The preferred option minimises vegetation clearance, with particular consideration of sensitive areas. The preferred option minimises potential impacts on existing residential properties and other existing land uses compared to Option 2, while also taking into consideration potential impacts on proposed future land use. In addition, Option 3 best minimises or avoids potential damage to known items or areas of cultural significance.

2.6 Design refinements

A number of design refinements have been made following community consultation and a series of meetings and workshops. These refinements are explained in the sections below.

2.6.1 Number of carriageways along Garfield Road East

Due to future considered population growth and development in the proposal and the surrounding Riverstone area, traffic in the area is expected to increase. Two options were considered within the road corridor:

- Option 1 - four lane carriageway with future provision for six lanes
- Option 2 - six lane carriageway with three lanes in each direction.

Through a series of meetings and traffic modelling, option 2 was discounted because the traffic modelling indicated six lanes would not be required at Garfield Road East between Piccadilly Street and Windsor Road until after 2036.

2.6.2 Design speed

The strategic design included a 70 km/h design speed and 60 km/h posted speed between Pitt Street and Terry Road. As the design progressed, design speeds were developed as follows:

- 60 km/h posted speed west of about CH1300, including the existing crest
- 70 km/h posted speed from Windsor Road to about CH1300, east of the existing crest.

2.6.3 Bus facility East of Piccadilly Street

Through a series of meetings and workshops, the bus bay located west of the intersection at Garfield Road East and Piccadilly Street was relocated to the approach-side of the intersection to avoid acquisition to the Riverstone Petroleum service station.

2.6.4 Shared path

The proposed shared path for the proposal was further refined during the design. The shared path were reduced in width to avoid acquisition of properties along Garfield Road East and tie-in with existing infrastructure.

3. Description of the proposal

This chapter describes the proposal and provides descriptions of existing conditions, the design parameters including major design features, the construction method and associated infrastructure and activities.

3.1 The proposal

Transport for NSW proposes to upgrade about 3.4 kilometres of Garfield Road East between Piccadilly Street, Riverstone and Windsor Road, Box Hill (the proposal). The proposal is located in Sydney's North West primarily within the Blacktown LGA. The eastern extent of the project extends into The Hills LGA. Garfield Road East connects the Riverstone, Riverstone East and Box Hill precincts of the NWGA.

The proposal would tie in to the existing section of Garfield Road East road west of Piccadilly Street at about George Street and East of Windsor Road at about Alan Street. The proposal would include widening Garfield Road East to four lanes with two lanes in each direction and a central median along the length of the road which would accommodate a possible future upgrade to a six lane configuration with three lanes in each direction.

The delivery of additional lanes in the central median to meet future demand in the area, if required, would be the subject of a future separate environmental assessment. The proposal is shown in Figure 1-2.

Key features of the proposal would include:

- Widening Garfield Road East between Piccadilly Street and Windsor Road and upgrading the existing two-lane road to a four lane divided road. The proposal would tie into the existing section of Garfield Road East west of Piccadilly Street, at about George Street and East of Windsor Road at about Alan Street.
- Providing an upgraded crossing over First Ponds Creek
- Upgrading the existing intersections at:
 - Piccadilly Street
 - Hamilton Street / McCulloch Street
 - Edmund Street
 - Windsor Road
- Providing left-in and left-out access to existing roads:
 - Junction Road
 - Galluzzo Street
- Clarke Street would be permanently closed at Garfield Road East with the upgrading of the intersection at Edmund Street
- Providing new intersections at:
 - About 200 metres north-east of Junction Road
 - About 500 metres south-west of Windsor Road
- Providing new left-in and left-out access at:
 - About 200 metres south-west of Windsor Road
 - About 200 metres south-west of Junction Road
- Providing bus priority lanes at key intersections
- Providing a shared user path along the southern side for the length of the proposal.

3.2 Design

3.2.1 Design criteria

The design criteria and reference documents have been applied in the concept design, in the following order of precedence:

- The project specifications
- TfNSW technical direction and quality alerts
- TfNSW Supplements to Austroads Guides and Australian Standards
- Austroads Guide to Road Design (AGRD) and Australian Standards
- Other current TfNSW publications.

The design criteria specific to the proposal is provided in Table 3.1. Indicative cross sections are presented in Figure 3-1 to Figure 3-3.

Table 3.1: Design criteria

Design element	Minimum design criteria
Posted speed	Established residential area west of about Edmund Street 60 km/h Semi-rural area east of about Edmund Street 70 km/h
Design speed	Established residential area west of about Edmund Street 70 km/h Semi-rural area east of about Edmund Street 80 km/h
Land widths	West of McCulloch Street 3.5 m kerbside (including 0.5 m gutter) / 3.3 m median side East of McCulloch Street 3.5 m (plus 0.5 m gutter)
Left turn auxiliary lane widths	3.5 m (plus 0.5 m gutter)
Right turn auxiliary lane widths	West of Piccadilly Street 3.3 m, East of Piccadilly Street 3.5 m
Median width: <ul style="list-style-type: none">• Raised• Depressed	Varies with a minimum 1.5 m with traffic control signal (TCS) post Varies with minimum 7.2 m
Nearside (outside) shoulder	0 metres
Offside (median) should	0 m (0.5 m adjacent to depressed median)
Minimum pedestrian crossing length	In accordance with the TCS Design Manual Section 11
Minimum median widths for staged pedestrian crossings	In accordance with the TCS Design Manual Section 11
Footpath width	1.2 m
Shared path width	3 m

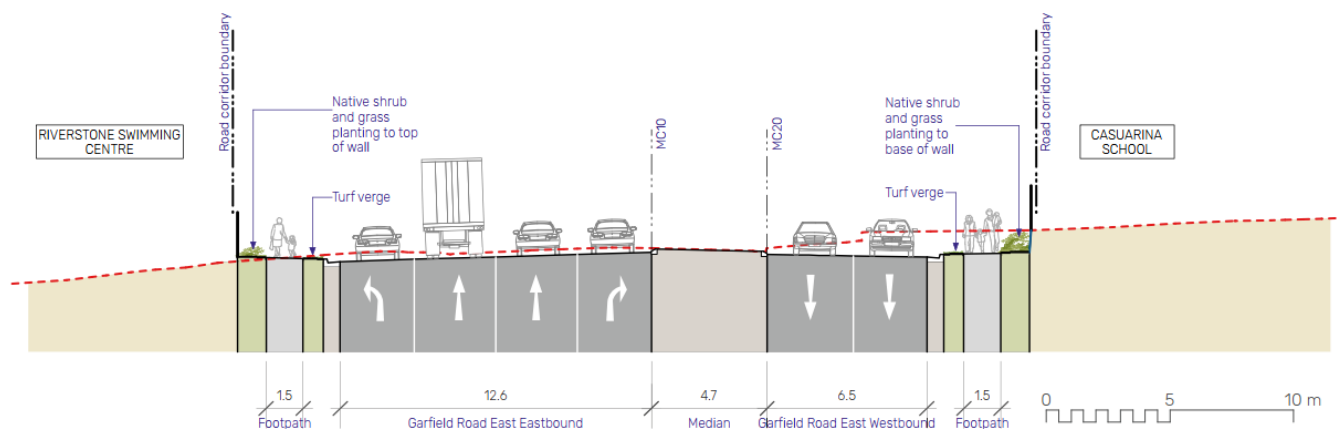


Figure 3-1: Typical cross-sections of the proposed Garfield Road East at change 600 (source: SMM, 2020)

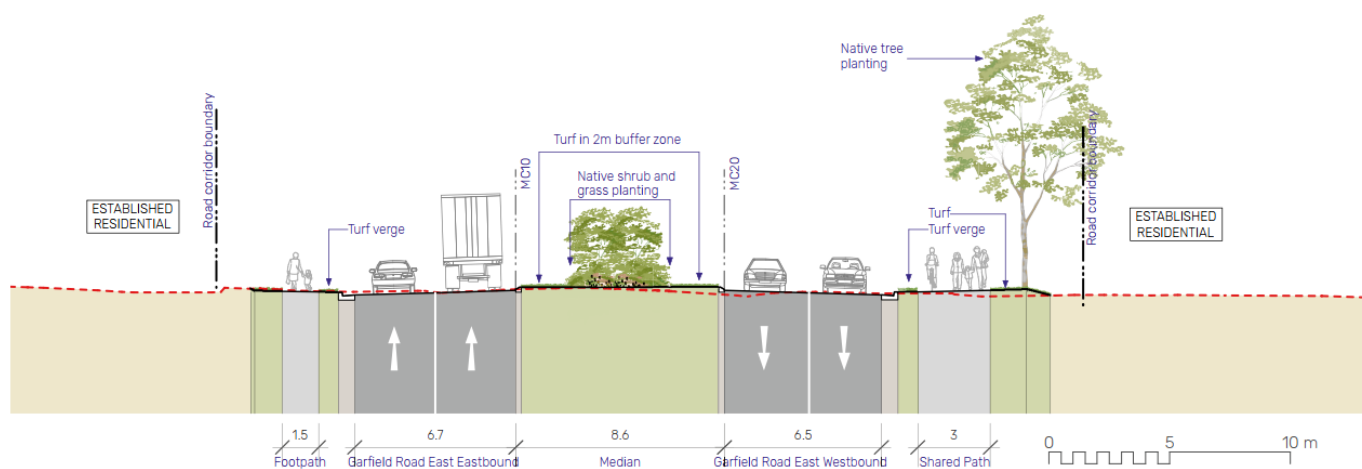


Figure 3-2: Typical cross-section of the proposed Garfield Road East at chainage 900 (source: SMM, 2020)

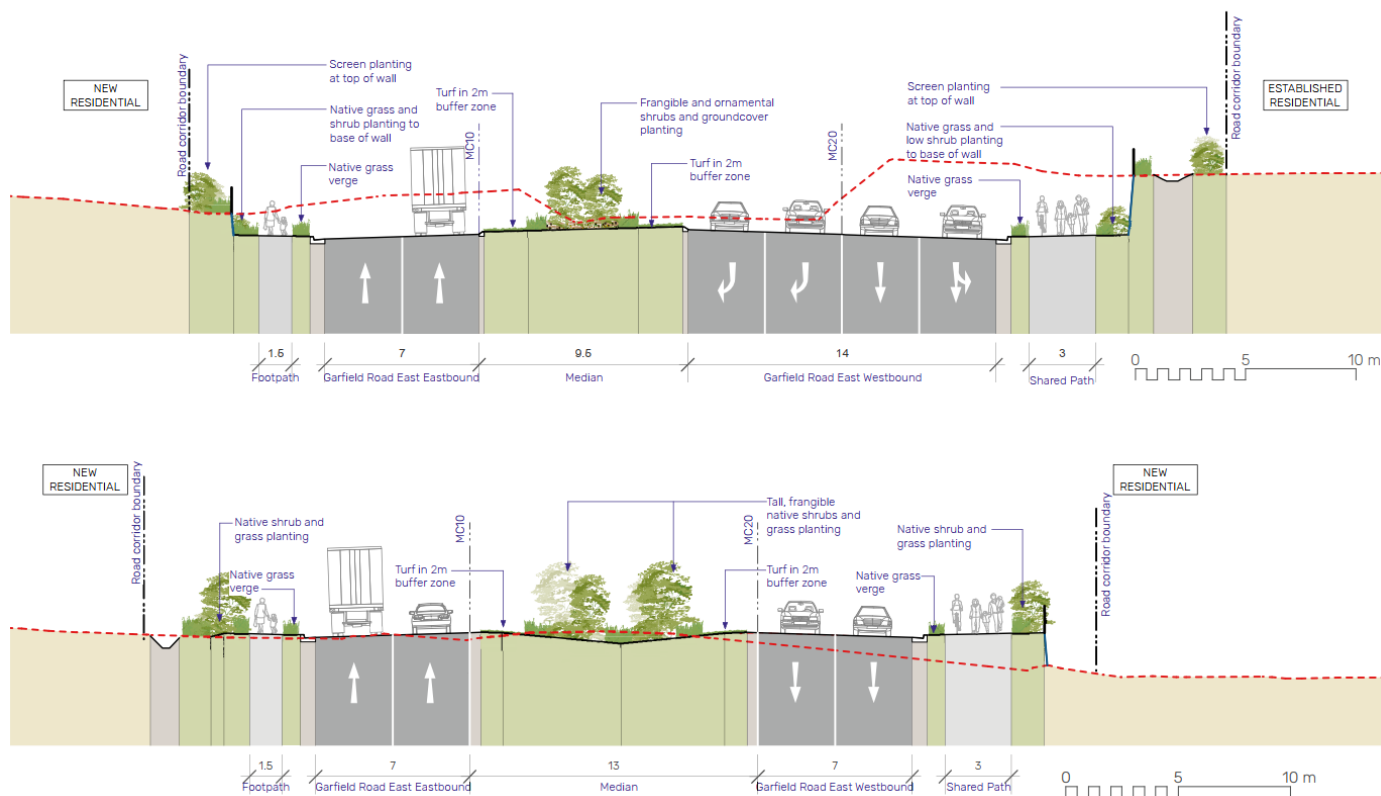


Figure 3-3: Typical cross-section of the proposed Garfield Road East at chainage 1200 and 1700 (source: SMM, 2020)

3.2.2 Engineering constraints

The proposal exists in a brownfield environment with existing adjoining roads and as such is inherently constrained geometrically. Key engineering constraints relating to the road alignment include:

- Existing road geometry along Garfield Road East and adjacent roads
- Future six-lane design due to road carriageway extents, kerb locations and intersection configurations
- Tie-ins to existing side and adjacent roads, including horizontal and vertical geometry as well as carriageway width and features
- Existing and future land use characteristics including residential / urban at the western extent of the proposal, and semi-rural / future residential at the eastern extent
- Public utilities which cannot be readily relocated
- Environmental factors such as flooding levels and key watercourses including First Ponds Creek
- Road reserve and property boundaries, which influence extent of acquisition, new and amended property accesses, provision of earthworks or retaining walls, and width of footways
- Future subdivisions in eastern portion of the proposal, which influence the extent of property acquisition and the size and location of new or upgraded intersections
- Heritage items such as the Riverstone Historical Museum and Casuarina School, which influence geometry and proposal corridor width
- Soils, geology and erosion associated with the soil landscapes on which the proposal is located.

3.2.3 Major design features

Major design feature 1 - Widening of Garfield Road East between Piccadilly Street and Windsor Road

The proposal would primarily involve widening of the existing two-lane configuration of Garfield Road East between Piccadilly Street and Windsor Road to a four-lane divided carriageway with a capacity to widen to six lanes in future, if needed. The widening works would involve:

Major design feature 2 - Bridge over First Ponds Creek

A key design feature of the proposal is a proposed bridge over First Ponds Creek for greater hydraulic efficiency and low risk to blockage. The depositional sediment blockage potential is assessed to be negligible for the proposed bridge. Further details are provided at Appendix G.

Major design feature 3 - Access 2 and Access 3

Two new intersections, Access 2 and Access 3, would be constructed at about 200 metres north-east of Junction Road and about 200 metres south-west of Windsor Road respectively, to provide access to future residential developments areas north and south of Garfield Road East. These two roads have been designed to simply terminate after the tangent point of the intersection corner, or high-entry angle lane, with no formal tie-ins or U-turn facilities. These stubs batter down existing surface levels and it is intended for future developers to connect into them.

Major design feature 4 - Provision of bus stops and bus priority lanes

A number of bus facilities would be developed as part of the proposal. A summary of these bus facilities is provided in Table 3.2.

Table 3.2: Summary of proposed bus facilities

Intersection	Direction	Bus bay requirements	
		Approach side	Departure side
Piccadilly Street	Eastbound	Bus priority lane (with left turn lane)	Kerbside bus stop (within bus only lane)
	Westbound	NA	NA
Hamilton Street	Eastbound	Bus priority lane (within left turn lane)	Indented bus bay (Arrangement 1)
McCulloch Street	Westbound	NA	Indented bus bay (Arrangement 2)
Edmund Street	Eastbound	Bus priority lane (within left turn lane)	Indented bus bay (Arrangement 1)
	Westbound	NA	Indented bus bay (Arrangement 2)
Access 2	Eastbound	Bus priority lane (adjacent to high-entry angle left turn lane)	Indented bus bay (Arrangement 1)
	Westbound	Bus priority lane (adjacent to high-entry angle left turn lane)	Indented bus bay (Arrangement 1)
Access 3	Eastbound	Bus priority lane (within left turn lane)	Indented bus bay (Arrangement 1)
	Westbound	Bus priority lane (within left turn lane)	Indented bus bay (Arrangement 1)
Windsor Road	Eastbound	Bus priority lane (adjacent to high-entry angle left turn lane)	NA

The typical arrangements for bus shelters along the eastbound carriageway, where a footpath is accommodated is presented in Figure 3-4, and along the westbound carriageway, where a shared path is accommodated is presented in Figure 3-5. A number of new bus bays have been proposed at each of the upgraded intersections as per the previous report sections, and existing bus stops will be decommissioned where they are now made redundant either by an upgraded facility or an altered bus route.

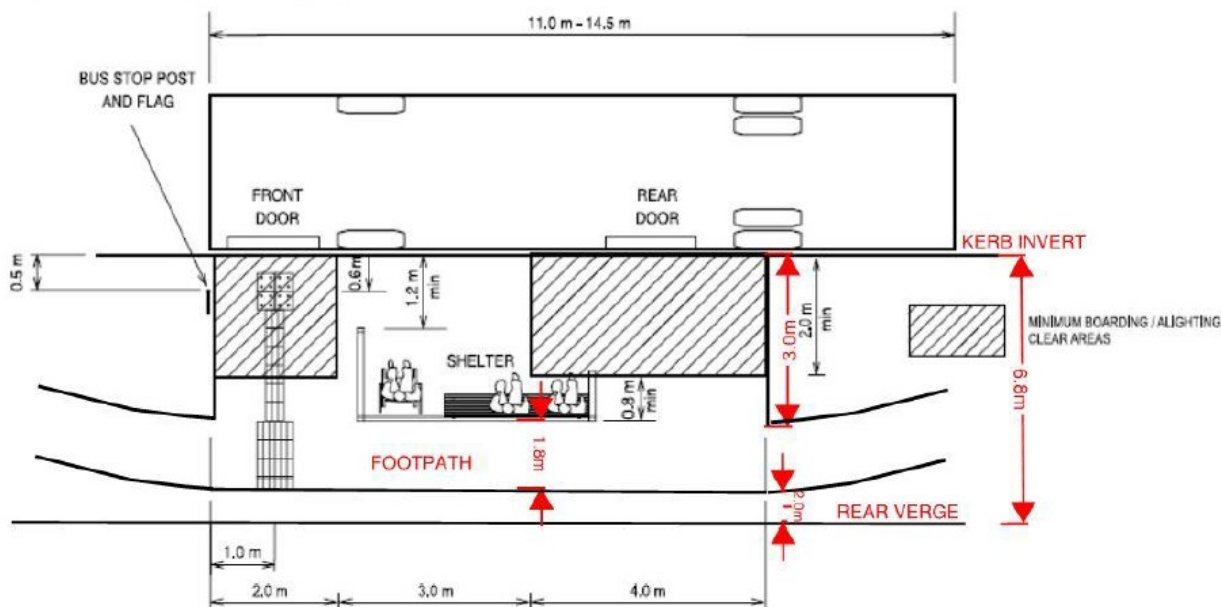


Figure 3-4: Typical bus shelter space proofing - footpath along eastbound carriageway

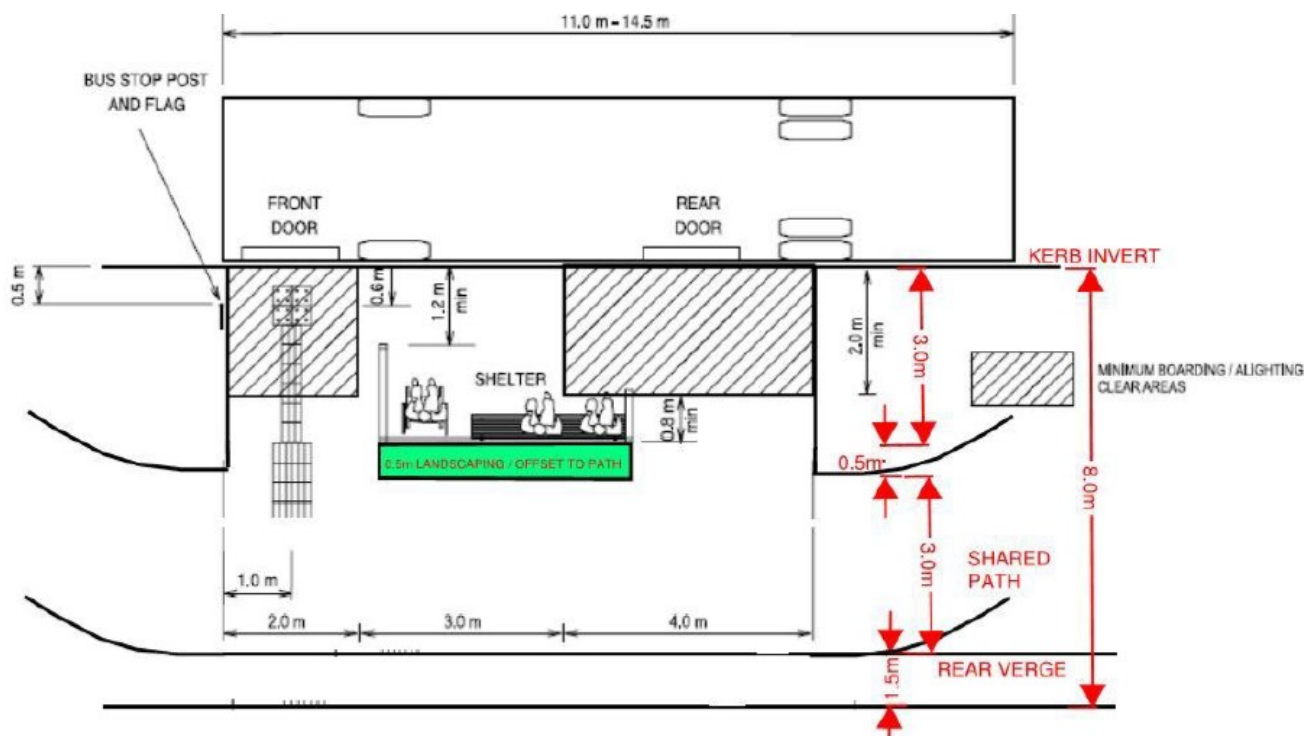


Figure 3-5: Typical bus shelter space proofing - shared path along westbound carriageway

Major design feature 5 - Footways and pedestrian and cyclist infrastructure

The footway along Garfield Road East ranges from 3.65 metres wide in the western portion of the proposal to up to seven metres wide in the eastern portion of the proposal. The eastbound footway typically adopts a footpath of varying width between 1.2 m to 1.8 m, due to matching existing path widths or spatial constraints, and the westbound footway typically adopts a three metre shared path, which terminates at Piccadilly Street and the eastern extent of Terry Road.

Table 3.3 summarises the various footway arrangements and types of pedestrian and cyclist infrastructure adopted on the proposal.

Table 3.3: Typical footway arrangements throughout the proposal

Location	Typical footway width	Type of infrastructure	Additional comments
Eastbound footway (west of Edmund St)	3.65 m	Footpath (1.2 m to 1.5 m)	1.2 m footpath to match existing on Piccadilly Street, Hamilton Street and McCulloch Street. 1.5 m where constrained by properties or retaining walls
Eastbound footway (east of Edmund St)	4.8 m	Footpath (1.8 m)	
Westbound footway (west of Piccadilly St)	3.65	Footpath (1.2 m)	1.2 m footpath to match existing at proposal extent
Westbound footway (Piccadilly St to Edmund St)	5.5 m	Shared path (3 m)	
Westbound footway (east of Edmund St)	7 m	Shared path (3 m)	

Major design feature 6 - Retaining walls

Typically, non-structural walls of less than 1.2 metres in height are provided west of Hamilton Street / McCulloch Street, and structural walls greater than 1.2 metres in height are provided on and east of Hamilton Street / McCulloch Street.

3.3 Construction activities

The likely method, staging, work hours, plant and equipment requirements needed to build the proposal are described in this section. An indicative work plan and method are also provided.

At this stage, TfNSW needs to finalise the detailed design for the proposal. If approved, TfNSW would then appoint a contractor to undertake construction of the works.

The contractor appointed to build the proposal would prepare a detailed construction plan and method once the proposal's design is finalised. The work plan and method may allow for several activities to be undertaken at the same time. It would also account for the need to minimise the traffic impact on the major roads in the area, particularly during peak periods. The actual work method may vary from the description provided in this section due to the identification of additional constraints before work starts, ongoing detailed design refinements, feedback from community and stakeholder consultation, and contractor requirements/limitations.

3.3.1 Work methodology

The proposal is anticipated to be built over a three year period with a tentative commencement mid-2022, subject to funding.

The proposal would be built under TfNSW construction specifications under a construction environmental management plan (CEMP). These specifications cover environmental performance and management including vegetation removal, stockpile management, and erosion and sediment control.

The concept construction staging has been strategised to allow for Garfield Road East to remain operational during work activities to carry out the proposal. Worker safety during construction would be considered prior to the commencement of work such as installing a safety traffic barrier system to improve working safety on the construction site.

The proposal would generally involve a sequence of work activities as follows:

- Site establishment and environmental protection
- Utility adjustment/installation, earthwork and drainage work
- Road removal, building and/or repair of the road and installing new road infrastructure
- Amenity, landscaping and urban design work
- Finalisation work
- Site demobilisation.

Table 3.4 describes the likely work activities that would be undertaken to build the proposal. It is likely the following activities would take place across all work stages in all sections of the construction footprint.

Table 3.4: Proposed construction staging

Stage	Activity	Description
1	Site establishment and environmental protection	<ul style="list-style-type: none">• Setup environmental, safety and traffic management controls (refer to Chapter 7)• Pre-clearance surveys and obtaining any permits or licences• Establish site compounds, designated storage areas, stockpile areas and stabilised access to work zones across the proposal footprint• Site demarcation, exclusion fencing and barrier establishment, identification and

Stage	Activity	Description
		<p>protection of sensitive areas i.e. habitat zones, trees</p> <ul style="list-style-type: none"> • Land clearance including vegetation removal, clearing and grubbing, and any property adjustments • Install temporary site drainage controls, as required.
2	Utilities, earthworks and drainage	<p>Utilities:</p> <ul style="list-style-type: none"> • Protect existing utilities • Adjust and relocate existing utilities • Install and test new utilities • General utility work would vary depending on whether the utility was being protected, adjusted or installed, and would include a combination of: <ul style="list-style-type: none"> ○ Trench and/or under-boring excavation ○ Bedding material installation ○ Pipeline and conduit installation ○ Cable pulling to install new power and communications cables ○ Pit and cutover excavation ○ Valve, switch and other infrastructure installation to allow the transfer of utilities to the new alignment ○ Service testing and commissioning ○ Backfill and compaction ○ Ground surface restoration. <p>Earthwork:</p> <ul style="list-style-type: none"> • Sequentially strip and excavate top soil and sub soil • Grade and compact areas, where required. <p>Drainage lines and general drainage work. Drainage work would vary depending on whether the drainage was being relocated, removed or installed. Typically, it may involve:</p> <ul style="list-style-type: none"> • Temporary diversions and erosion and sediment control measures • Excavating overburden on existing structures and protect, cap, seal and remove any existing infrastructure • Trench excavation for the new structures and inclusion of measures to protect any retained drainage structures • Installing foundation and bedding material • Installing and connect infrastructure • Integrity and flow testing

Stage	Activity	Description
		<ul style="list-style-type: none"> • Backfill and compaction with excavated materials or import new clean fill • Ground surface restoration work.
3	Road removal, Building and/or repair, installation of new road furniture	<ul style="list-style-type: none"> • Implement diversions and traffic management controls as needed • Remove materials to support the new work and depth (referred to as boxing out) • Milling the road surface • Prepare and level the subgrade • Lay and compact new road surface layers • Install new road infrastructure.
4	Amenity, landscaping and urban design work	<ul style="list-style-type: none"> • Carry out final grading, levelling and compaction • Landscape and final treatments and finishes.
5	Finalisation of work	<ul style="list-style-type: none"> • Paint permanent line markings etc.
6	Demobilisation	<ul style="list-style-type: none"> • Demobilise the site compounds • Remove temporary traffic management controls • Remove environmental, safety and traffic controls.

3.3.2 Construction hours and duration

TfNSW plans to carry out the proposal over a period of about three years. Construction is expected to commence in mid-2022, subject to funding.

Construction would normally be limited to between the following standard work times:

- 7am to 6pm Monday to Friday
- 8am to 1pm Saturday.

Work outside of standard hours would be required throughout the proposal in order to minimise the traffic impact in the area, particularly during peak periods.

Appropriate impact investigation prior to implementation, mitigation measures and community consultation would be carried out for work proposed outside of the standard working hours. All required approvals, including road occupancy licences (ROL) from Service NSW, would be obtained prior to the work being carried out.

3.3.3 Plant and equipment

The indicative plant and equipment for the construction of each stage of the proposal is provided in Table 3.5.

Table 3.5: Indicative plant and equipment

Stage	Activity	Description
1	Site establishment and environmental protection	<ul style="list-style-type: none"> • Site office, site shed and amenities • Light and heavy vehicles • Generator • Hand held tools
2	Utilities, earthworks and drainage	<ul style="list-style-type: none"> • Light and heavy vehicles • Excavator • Grader • Loader • Roller • Concrete truck • Generator • Hand held tools
3	Road removal, Building and/or repair, installation of new road furniture	<ul style="list-style-type: none"> • Light and heavy vehicles • Asphalt profiling machine • Asphalt paver • Vibratory roller • Generator
4	Amenity, landscaping and urban design work	<ul style="list-style-type: none"> • Light and heavy vehicles • Excavator • Loader • Generator • Hand tools
5	Finalisation of work	<ul style="list-style-type: none"> • Line marking truck • Hand tools • Light vehicles
6	Demobilisation	<ul style="list-style-type: none"> • Light and heavy vehicles • Hand tools • Generator

3.3.4 Earthworks

Materials would be sourced from local areas where practicable. This section also describes how surplus material and water use would be managed.

Excavations would be required to carry out the safety improvements. The ability to reuse the material would depend on its physical and chemical properties. Material unsuitable for construction use would need to be transported offsite by a licensed contractor for disposal at a licensed waste management facility following testing and classification. In summary, it is estimated that to build the proposal approximately:

- 125,000 cubic metres of material is to be cut
- 140,000 cubic metres of material is to be filled.

The net volume of material is approximately 15,000 cubic metres of fill. Imported material will most definitely be required, also considering not all cut material will be suitable.

Earthwork materials and estimated quantities would be further refined prior to the start of construction. Any unsuitable or surplus material would be managed in accordance with resource management hierarchy principles. This includes, in order of preference:

- Reuse as engineered fill onsite
- Transfer:
 - To another TfNSW project for reuse in accordance with the NSW Environment Protection Authority (EPA) Excavated Public Road Material resource recovery exemption
 - To an approved TfNSW stockpile site for future re-use, only if a specific project has been identified before stockpiling and the Protection of the Environment Operations Act 1997 (POEO Act) waste regulatory requirements have been met. If a project cannot be identified the material would not be stockpiled within the proposal
 - Off site for reuse by a third party in accordance with a relevant EPA resource recovery exemption or planning approval
 - To a licenced waste recovery site
 - For disposal at a licenced facility
 - As otherwise provided for by the relevant waste legislation.

3.3.5 Source and quantity of materials

Natural resources required for construction of the proposal would include aggregates and sand for use in concrete. The type of aggregate and sand would be specified by concrete designers during detailed design. Pavement materials may include heavily bound sub-base (HBB) and asphalt concrete (AC). Manufactured items, including steel and precast components would also be required.

Materials would be sourced from appropriately licensed facilities. Wherever possible, materials would be sourced from commercial suppliers in nearby areas or other viable sources such as other nearby infrastructure planning proposals. No materials currently proposed to be used for the proposal are considered to be in short supply.

If additional fill material is required, that cannot be sourced from within the construction footprint, it would be imported from a suitably licensed nearby quarry. Surplus material that cannot be used within the construction footprint would be reused on other projects or disposed of in the order of priority as outlined in section 3.3.4.

3.3.6 Traffic management and access

Vehicle movements

Road traffic would be impacted throughout the construction period. The majority of construction activities would generally be carried out during day time in order to minimise disruption to nearby sensitive receptors. However, there would be the need for some night work to minimise the impact to traffic. Lane closures and detours would be detailed in the Traffic Management Plan (TMP) for the proposal.

Construction traffic movements would occur on the surrounding road network with around 50 heavy vehicle and 50 light vehicle movements per day during peak construction times. Access to the site would be restricted to left-in-left-out only where practical and feasible to do so.

Heavy vehicles would be used to deliver construction material to the construction footprint and transfer construction materials to nominated stockpile sites. These would be managed in accordance with the management measures outlined in the TMP for the proposal.

Traffic management, control and signage

Where possible, construction would be programmed to minimise the impact on traffic using the local and regional road network.

Standard traffic management measures would be used to minimise the traffic impact expected during construction. These measures would be identified in a TMP for the proposal and would be developed in accordance with the TfNSW's *Traffic Control at Work Sites Manual* (Roads and Maritime 2018) and TfNSW *Specification G10 - Traffic Management* (Roads and Maritime, 2015).

The TMP would provide details of traffic management to be implemented during construction. Impact to the public, including traffic and cyclists, during construction would be managed through the TMP and detailed traffic control plans. During all stages of construction, access to businesses and to work areas would be maintained.

Road and lane closures

Traffic delays may occur as a result of the proposal being built and would be managed through the provisions of a TMP. Traffic management would be designed to ensure the flow of traffic throughout the periods of lane closures while the proposal is being built.

The impact of construction worker vehicle parking would be managed through measures identified in the TMP. Further details on the potential traffic impact as a result of the proposal are provided in section 6.1 of this REF.

3.4 Ancillary facilities

At the time of preparation of this REF, four potential ancillary facilities had been identified within properties to be acquired for the construction footprint, as shown in Figure 3-6. Potential compounds outside of the construction footprint have not been identified at this stage as the land adjacent to the proposal is expected to be developed in future. The potential compounds currently identified are:

- Potential compound 1 is around 3,100 metres squared at the corner of Hamilton Street and Garfield Road East
- Potential compound 2 is around 1,150 metres squared at the corner of McCulloch Street and Garfield Road East
- Potential compound 3 is around 5,300 metres squared on the southern side of Garfield Road East between Piccadilly Street and McCulloch Street
- Potential compound 4 is around 3,270 metres squared on the northern side of Garfield Road East at about Access 2.

Potential compounds 1, 2 and 3 may not be viable as they are located within 100 metres of residential dwellings. However, the land adjacent to the proposal is expected to be developed in the future. Given the expected development of the area it may not be possible to locate a site at least 100 metres away from residential dwellings and other land uses that may be sensitive to noise. This will need to be considered during detailed design and construction.

Potential compound 4 may not be viable as it is within 40 metres of a waterway. However, the land in this area may be developed in future and the waterway may be sufficiently separated from the proposed ancillary facility.

The proposal would require about two ancillary facilities at the eastern end and western end of the proposal of 5,000 metres squared each. Final location of ancillary facilities would need to be identified during detailed design, once greater certainty of the timing of future developments adjacent to the proposal is known. Principles to be adopted, where practical, when selecting alternative sites may include:

- At least 40 metres away from the nearest waterway
- Of low ecological and heritage conservation significance
- At least 100 metres away from residential dwellings and other land uses that may be sensitive to noise
- Of relatively level ground
- Outside the 1 in 10 year ARI floodplain.

Ancillary facilities will be selected during detailed design based on the above principles. Where it is not feasible to achieve all the principles, environmental mitigations and safeguards will be implemented.

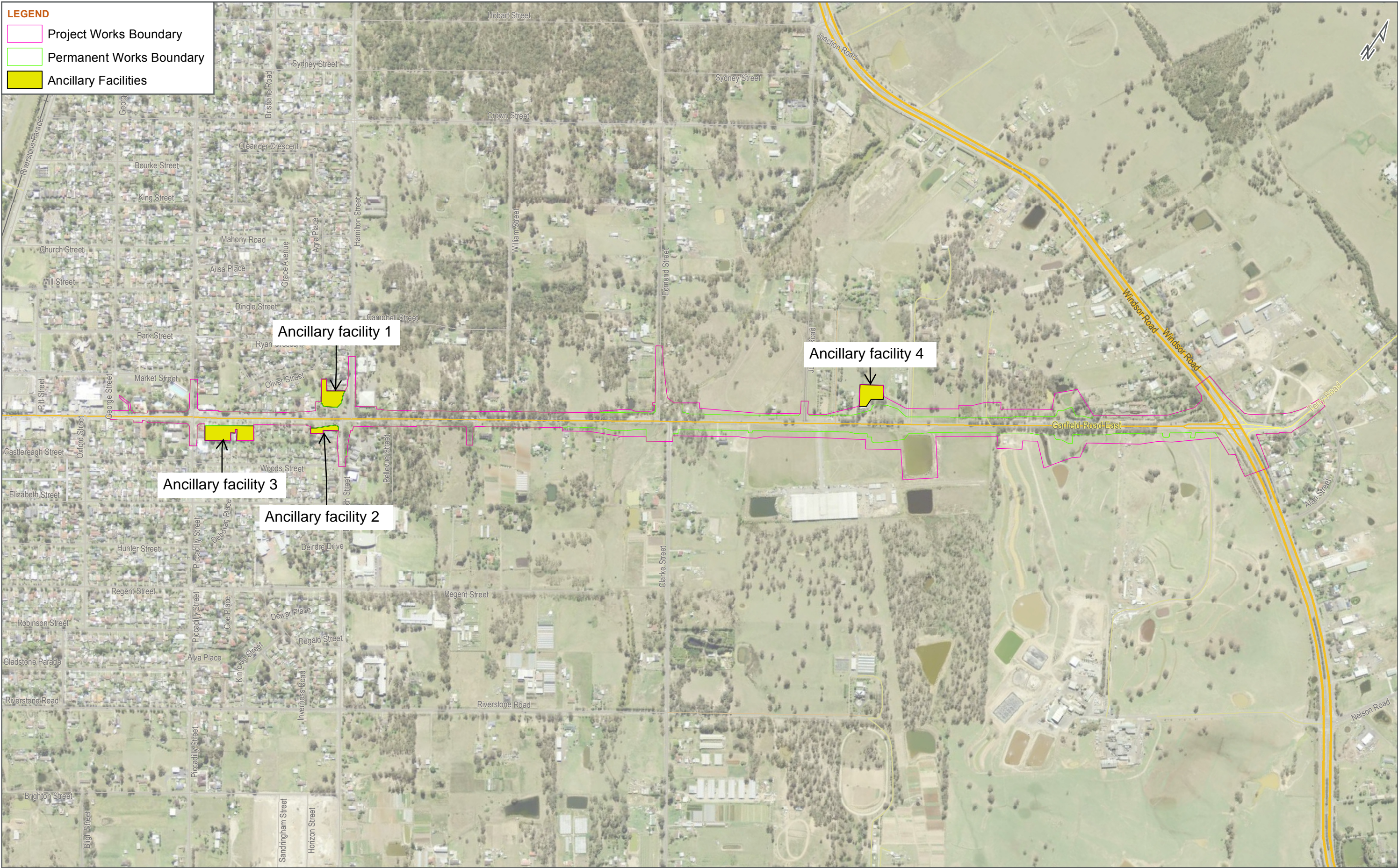
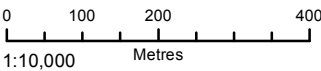


Figure 3-6: Proposed potential locations for ancillary facility



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3.5 Public utility adjustment

A Utility Strategy was developed and the following approach was adopted:

- Avoid or minimise impacts on utility services, where practicable, by adjusting the proposal and construction methodology
- Retain and protect services, where practicable
- Relocate utilities, which would include removing existing and constructing new services in agreed allocation corridors
- All redundant utilities to be removed or exhumed where possible and as agreed with utility providers, as leaving existing utilities underground can cause confusion during construction in future
- Identify any future utility requirements with providers, including upsizing and new proposed mains, to be accommodated in space proofing for the proposal.

A summary of the utilities relevant to the proposal are provided in the following sections.

3.5.1 Water

There are number of existing water mains relevant to the proposal varying in material and in size from 100 millimetre to 800 millimetre diameter pipes. Some pipes have been discontinued and left underground. It will be reconfirmed by leaving this information on current plans when Sydney Water is to review the concept design. It is also noted that a large number of water mains East of Edmund Street are either concrete encased, in a steel casing or under bored and grouted. This indicates these have been recently constructed and installed to be maintenance free for the duration of their lifespan. Sydney Water provided work as constructed (WAC) plans for the water main constructed in 2014 between Edmund Street and Windsor Road.

Some of the smaller water mains are old and the joints on these are relatively unstable particularly when construction traffic is traversing over these. Hence these would most likely require relocation as opposed to protection. There is also an existing 500 millimetre cast iron cement lined (CICL) pipe at Piccadilly Street across Garfield Road East. Sydney Water Operations Branch has requested this main be replaced with a new maintenance free steel cement lined (SCL) concrete encased main over the affected section.

3.5.2 Sewer

There are existing sewer assets within the study area which consist mainly of 150 millimetre, 225 millimetre and 300 millimetre vitreous clay (VC) gravity pipes. These most likely would not be impacted with the exception of existing manholes requiring adjustments to new proposed levels. However, checks would be carried out in relation to any future proposed drainage structures that could impact these.

There is a 525 millimetre Glass Reinforced Pipe (GRP) inside a Steel Jacking pipe sleeve crossing south west under Edmund Street and Garfield Road East. At this location the proposal will be raised in excess of two metres. Confirmation from Sydney Water will be required to confirm additional fill loading on their asset would not impact this sewer main. As this sewer main is inside a steel pipe sleeve this would be considered as maintenance free and the additional fill over this pipe may have minimal impact.

3.5.3 Gas

Existing Jemena gas assets have been identified within the study area. These assets consist of mainly minor nylon mains; however, a secondary gas steel 200 millimetre main from Hamilton Street to Clarke

Street would need to be relocated as it is currently located adjacent to the existing road which will be widened and a new main located in a new verge at correct allocation.

The secondary 200 millimetre gas main will need to be relocated and positioned on the southern side of Garfield Road East due to congestion of other utilities on the northern side. The gas main crosses west of Edmund Street providing connection to the main located on Edmund Street.

3.5.4 Electricity

Existing Endeavour Energy underground electrical assets are located within the study area. These mainly consist of a bank of conduits of various combinations. The proposed road impact on these is still being analysed together with all existing documented overhead infrastructure. Consultation with Endeavour Energy is required to determine how existing overhead assets are to be relocated underground. During Detail Design relocation of electrical assets would be further developed including street lighting design.

There are high voltage (HV) Endeavour Energy transmission power lines crossing Garfield Road East, east of Junction Road. The clearance to the overhead powerlines from proposed road has been verified and the clearance is well above the required minimum clearance.

Following consultation with Endeavour Energy, a future proposed zone substation has been identified on the southern side of Garfield Road East, about 100 metres east of Access 2. Provision has been made in the design for future transmission lines consisting of three conduits placed within the travel lane to connect in to the future proposed zone substation.

3.5.5 Telecommunications

Telstra

There are existing Telstra underground assets identified within the study area. These mainly consist of single polyvinyl chloride (PVC) conduits varying in sizes. Some conduits are asbestos, and a special Asbestos Management Plan (AMP) would be required if these are to be relocated. The AMP, if required, would be developed during detail design.

There is also some overhead Telstra infrastructure utilising their own or Endeavour Energy timber poles. There are other Telstra owned conduits being utilised by other providers including NBN and Optus to Conway optic fibre cables.

Optus

Optus underground asset optic fibre is contained in Telstra PVC conduits are located in the construction footprint. At the time of preparation of this REF, further investigation is in progress as there are also existing Optus overhead assets.

National Broadband Network

Existing National Broadband Network underground asset optic fibre is contained in single 100 millimetre conduits or in several banks of conduits. There are some conduits which are asbestos, and a special AMP would be required to be developed in detailed design if these are to be relocated.

Intelligent Transport Systems

Existing TfNSW electrical and communication Intelligent Transport Systems (ITS) underground assets have been identified within the construction footprint. These consist of one or two orange electrical 80 millimetre

heavy duty (HD) PVC conduits, while the communications are located in one or two white 100 millimetre PVC conduits.

The ITS backbone is to consist of two 100 millimetre diameter communication conduits and two 100 millimetre diameter electrical conduits for the entire length of Garfield Road East. This will be located on the southern verge and is proposed to have a crossing from the southern side to the northern side at every intersection.

3.6 Property acquisition

About 77,860 square-metres of land would need to be acquired to build the proposal. TfNSW would also need to temporarily lease or negotiate access for an additional 76,200 square-metres of land during construction. Table 3.6 describes the proposed acquisition of land required for the proposal.

Table 3.6: Proposed property acquisition

Area ID	Lot and Deposited Plan	Total area		Acquisition type
		To be leased	To be acquired	
1	11/DP217724	0	99.5	Partial
2	1/DP523552	20,568.20	7,514.10	Partial
3	20/DP30458	54.9	9	Partial
4	19/DP30458	49.8	4.2	Partial
5	16/DP30458	9.7	3,434.90	Partial
6	18/DP30458	272	33.3	Partial
7	8/DP1076228	4925.8	2,832.70	Partial
8	10/DP30458	2,784.10	1,931.00	Partial
9	5/DP656967	0	756.1	Full
10	30/DP135216	330.9	0	Partial
11	42/DP865167	31.5	29.9	Partial
12	8/DP252313	0	61.5	Partial
13	20/N/DP712	502.6	1,352.00	Partial
14	2/28/DP1459	1534.3	781.10	Partial
15	4/27/DP1459	472.6	931.9	Partial
16	1/DP1234723	601.2	123.1	Partial
17	6/DP229296	1833.4	403.80	Partial
18	3/DP229291	82.2	45.2	Partial
19	2/DP229291	272.3	341.6	Partial
20	7/DP229296	1523.6	352.20	Partial
21	1/28/DP1459	1,338.40	3,998.50	Partial

Area ID	Lot and Deposited Plan	Total area		Acquisition type
		To be leased	To be acquired	
22	136/DP1224886	0	869.2	Full
23	15/DP30458	188.7	2,575.60	Partial
24	3/DP1238721	362.7	57.2	Partial
25	2/DP786801	14,020.50	6,904.30	Partial
26	12/DP30458	2,437.10	13.60	Partial
27	11/DP30458	2,657.30	5.20	Partial
28	13/DP30458	1607.4	25.30	Partial
29	14/DP30458	1589.2	36.70	Partial
30	21/DP30458	133.5	15.2	Partial
31	23/DP30458	256.4	0.8	Partial
32	22/DP30458	143.9	3.7	Partial
33	39/DP1105173	0	109	Full
34	6/DP1076228	2,275.60	837.1	Partial
35	7/DP1076228	1,369.60	4,350.00	Partial
36	7/DP30458	25.5	0	Partial
37	26/DP1444	0	90.9	Partial
38	24/DP1444	0	90.4	Partial
39	23/DP1444	0	90.2	Partial
40	/SP77868	146.6	16.2	Partial
41	14/DP217724	0	95.2	Partial
42	18/DP217724	0	97.9	Partial
43	13/DP217724	0	96.6	Partial
44	17/DP217724	0	97.6	Partial
45	15/DP217724	0	95.5	Partial
46	12/DP217724	0	96.4	Partial
47	16/DP217724	0	95.7	Partial
48	6/DP656968	0	895.7	Full
49	2/DP252313	0	666.1	Full
50	1/DP252313	0	886.2	Full
51	1/DP35722	0	912.9	Full
52	3/DP35722	0	836.7	Full

Area ID	Lot and Deposited Plan	Total area		Acquisition type
		To be leased	To be acquired	
53	25/DP1444	0	90.7	Partial
54	5/DP252313	0	17.1	Partial
55	E/DP402604	0	42.6	Partial
56	79/DP1444	0	587.2	Full
57	19/DP217724	11.8	112.9	Partial
58	4/DP252313	0	16.2	Partial
59	2/DP656966	0	820.2	Full
60	3/DP252313	0	56.7	Partial
61	7/DP252313	0	91.1	Partial
62	5/D/DP337	0	290.4	Partial
63	342/DP752061	68.7	17.4	Partial
64	1/DP552220	0	74.6	Partial
65	22/DP1444	0	87.5	Partial
66	27/DP1444	27.1	126.6	Partial
67	41/DP865167	0	376.2	Full
68	43/DP865167	0	97.4	Full
69	7/DP656969	0	767.5	Full
70	21/DP1444	0	81	Partial
71	1/DP1136295	0	265.6	Partial
72	10/DP238054	0	79.5	Full
73	37/DP1444	0	28.4	Partial
74	44/DP865167	0	24.8	Full
75	1/DP843306	0	22.2	Partial
76	4/DP843306	0	31.4	Partial
77	78/DP1444	0	596.6	Full
78	1/DP135832	0	1,464.50	Full
79	1/DP1076210	0	1,880.80	Full
80	8/DP227249	0	85.5	Partial
81	1/26/DP1459	0	1,446.40	Partial
82	7/DP250397	0	481.1	Partial
83	10/DP227249	0	942.5	Full

Area ID	Lot and Deposited Plan	Total area		Acquisition type
		To be leased	To be acquired	
84	9/DP227249	0	942.2	Full
85	2/DP1003771	0	38.4	Partial
86	3/DP1003771	0	38.3	Partial
87	12/DP238054	0	161.5	Full
88	1/DP1003771	0	38.6	Partial
89	101/DP1218237	0	251.3	Full
90	3/28/DP1459	793.3	733.40	Partial
91	10/DP788571	0	501.3	Full
92	8/DP788571	0	174.1	Full
93	102/DP1218237	0	739.5	Full
94	1/DP359496	0	143.7	Partial
95	255/DP1225982	0	2,206.80	Full
96	203/DP1222718	0	2,867.20	Full
97	122/DP1240910	0	2,369.30	Partial
98	121/DP1240910	0	352.9	Partial
99	146/DP1225981	0	952.5	Full
100	1/DP135228	0	37.2	Partial
101	4/DP135228	0	37.4	Partial
102	3/DP135228	0	38	Partial
103	6/DP135228	0	36.3	Partial
104	9/DP788571	0	200	Full
105	4/28/DP1459	551.9	689.20	Partial
106	4/DP1003771	0	38.2	Partial
107	5/DP1003771	0	38	Partial
108	17/DP30458	1112.9	219.20	Partial
109	6/DP1003771	0	38	Partial
110	2/DP135228	0	38.7	Partial
111	5/DP135228	0	36.8	Partial
112	13/N/DP712	0	1,949.10	Partial
113	11/N/DP712	0	5,049.30	Partial
114	145/DP1225981	0	138.4	Full

Area ID	Lot and Deposited Plan	Total area		Acquisition type
		To be leased	To be acquired	
115	2/27/DP1459	0	879.7	Partial
116	1020/DP1237323	0	760	Full
117	123/DP10157	83.5	294.9	Partial
118	37/DP1105173	0	299	Partial
119	139C/DP10157	27.3	89.2	Partial
120	11/DP1035500	305.9	1,600.30	Partial
121	38/DP1105173	0	4,163.10	Partial

Adjustment of the road alignment would be further investigated during detailed design to minimise impact to these properties and/or to potentially retain them.

As a consequence of the proposed acquisitions, 14 households would be expected to be required to relocate. This has the potential to cause stress and anxiety to those property owners. A number of mitigation measures have been proposed to manage the social impact of the proposal, including the development and implementation of dedicated services and assistance measures to assist with the relocation of affected property owners. Socio-economic impact associated with property acquisitions are discussed further in section 6.6 of the REF.

TfNSW will continue to consult directly with affected property owners throughout the detailed design phase. All property acquisition will be carried out in accordance with the Land Acquisition Information Guide (Roads and Maritime, 2014b), the Land Acquisition (Just Terms Compensation) Act 1991 and the NSW Government Land Acquisition Reform 2016.

TfNSW will examine the opportunities for reuse of parcels of residual land along the proposal in more detail during detailed design.

Full property acquisition plans are planned to be provided with the Concept Design. The proposed acquisitions are shown in Figure 3-7.

While the final land purchase requirements would be confirmed during the detailed design, all land acquisition would be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* and its supporting policy along with the *Land Acquisition Guide* (Roads and Maritime 2012).

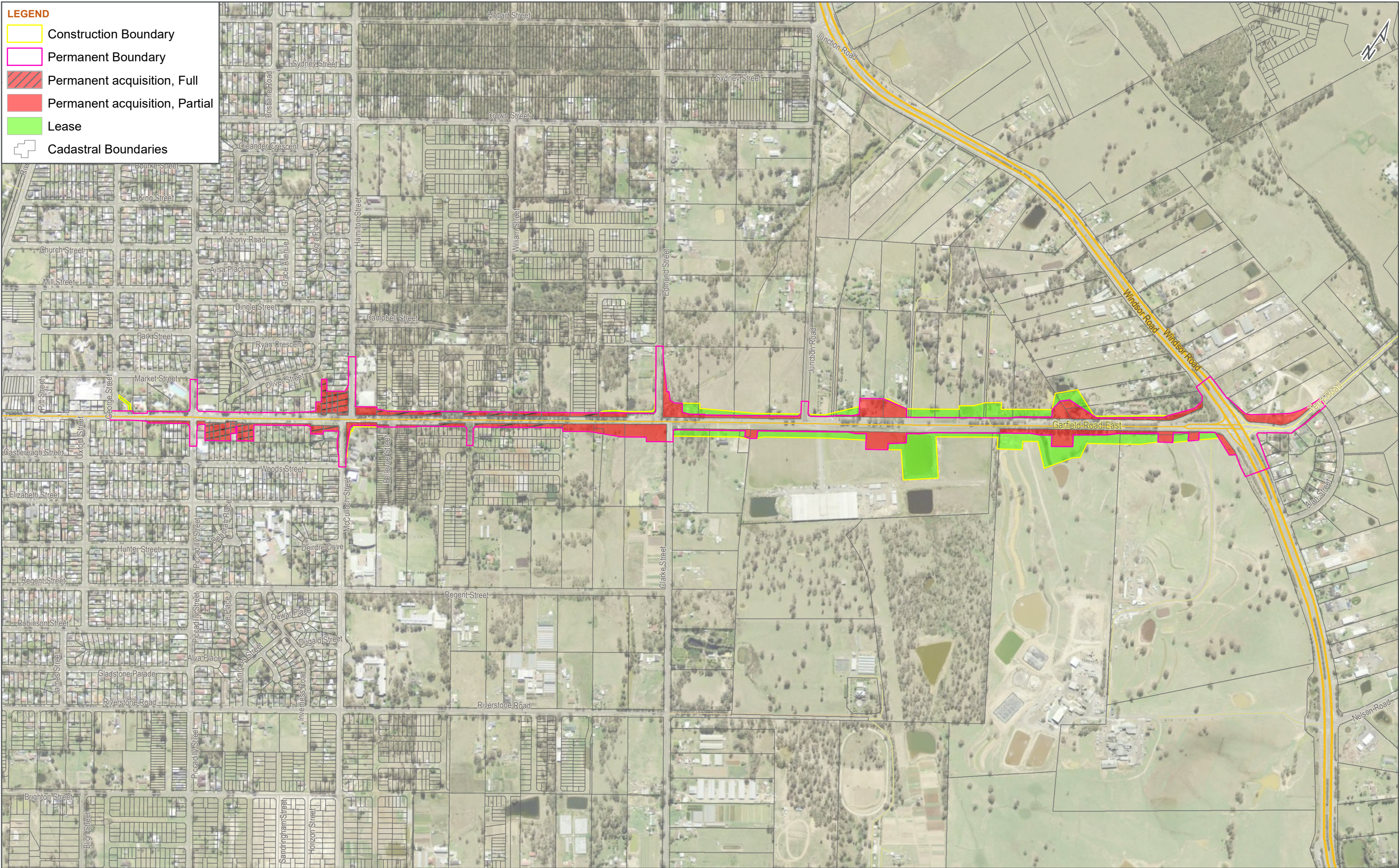


Figure 3-7: Proposed areas to be leased and acquired for the proposal		<div><div><div>0100200400</div><div>1:10,000Metres</div></div><div>PAGE SIZE A3</div><div>COORDINATE SYSTEM GDA 1994 MGA Zone 56</div></div>		<div>Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, this map contains data from a number of sources - no warranty is given that the information contained on this map is free from error or omission. Any reliance placed on such information shall be at the sole risk of the user. Please verify the accuracy of all information prior to using it. This map is not a design document.</div>
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4. Statutory and planning framework

This chapter provides the statutory and planning framework for the proposal and considers the provisions of relevant state environmental planning policies, local environmental plans and other legislation.

4.1 Environmental Planning and Assessment Act 1979

4.1.1 State Environmental Planning Policies

State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across the State.

Clause 94 of ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent.

As the proposal is for a road or road infrastructure facilities and is to be carried out by TfNSW, it can be assessed under Division 5.1 of the EP&A Act. Development consent from council is not required.

The proposal is not located on land reserved under the *National Parks and Wildlife Act 1974* (NPW Act) and does not require development consent or approval under State Environmental Planning Policy (Coastal Management) 2018, State Environmental Planning Policy (State and Regional Development) 2011 or State Environmental Planning Policy (State Significant Precincts) 2005.

Part 2 of ISEPP contains provisions for public authorities to consult with local councils and other public authorities prior to the commencement of certain types of development. Consultation, including consultation as required by ISEPP, where applicable, is discussed in Chapter 5 of this REF.

Part 2 of ISEPP contains provisions for public authorities to consult with local councils and other public authorities prior to the commencement of certain types of development. Consultation, including consultation as required by ISEPP (where applicable), is discussed in Chapter 5 of this REF.

State Environmental Planning Policy (Sydney Region Growth Centres) 2006

State Environmental Planning Policy (Sydney Region Growth Centres) 2006 (Growth Centres SEPP) is the environmental planning instrument which sets controls for the NWGA and South West Growth Areas of Sydney. The north west extent of the study area is within the NWGA.

Clause 18A of the Growth Centres SEPP confirms that public utility undertakings, which would include the proposal, may be undertaken without development consent. Clause 18A also requires notification of the DPIE in relation to the clearing of native vegetation on land within a growth area but not subject to biodiversity certification. The proposal would require the removal of 0.47 hectares of BC Act listed vegetation from non-biocertified land.

Under the Growth Centres SEPP, the investigation area traverses the Riverstone, Riverstone East and Box Hill precincts. Those parts of the investigation area within the western part of the Riverstone East precinct, and within the Box Hill precinct, are subject to development controls set out in Appendix 11 and Appendix 12 of the Growth Centres SEPP. The investigation area traverses the following Marsden Park precinct plan zones, refer to map 04.0 in Appendix A:

- B7 Business Park

- R4 High Density Residential
- SP2 Local Road.

Development for the purposes of roads is permitted with development consent in all the above zones. The ISEPP operates to remove those consent requirements.

The State Government started planning for the Growth Centres in 2003 to streamline the supply of greenfield land for urban development in Sydney. The strategic vision for the Growth Centre is set out in the *North West Structure Plan*, which was adopted by the NSW Government in 2006.

Under the Growth Centres SEPP, the proposal involves areas of the Riverstone, Riverstone East and Box Hill precincts. The Riverstone precinct has three centres within it: Riverstone, Schofields and Vineyard. The Riverstone local centre is outside the land covered by this DCP but will be the main focus of retail and commercial activity local centre and daily life for the precinct, providing for community interaction and delivering services and facilities to meet the need of all residents.

The precincts will be integral parts of the Blacktown LGA and the NWGA. It will be linked to surrounding suburbs and to major regional destinations such as Rouse Hill Regional Centre and Blacktown City Centre.

Areas within the western end of the Riverstone East precinct and within the Box Hill precinct are subject to development controls set out in Appendix 11 and Appendix 12 of the Growth Centres SEPP.

Development for the purpose of roads is permitted with development consent in all the above zones. The ISEPP operates to remove those consent requirements.

4.1.2 Local Environmental Plans

Blacktown Local Environmental Plan 2015

The study area is primarily located within the Blacktown LGA. Land use and development within this LGA is regulated by the Blacktown Local Environmental Plan 2015 (LEP).

The study area is located within the following land use zones under the Blacktown LEP:

- SP2 Infrastructure, including Classified Road, Local Road, Education Establishment.
- RU4 Primary Production Small Lots
- R2 Low Density Residential
- B2 Local Centre
- RE1 Public Recreation

The objectives of the applicable land use zonings are discussed in Table 4.1.

Table 4.1: Relevant provision of the Blacktown LEP

Provision description	Relevance to the proposal
SP2 Infrastructure	<p>The objectives of zone SP2 include:</p> <ul style="list-style-type: none"> • To provide for infrastructure and related uses • To prevent development that is not compatible with or that may detract from the provision of infrastructure • To ensure that development does not have an adverse impact on the form and scale of the surrounding neighbourhood <p>The proposal is consistent with the objectives of zone SP2 as it would provide upgraded road related infrastructure, to improve travel times, safety within the area and improved connectivity during flood events</p>

Provision description	Relevance to the proposal
RU4 Primary Production Small Lots	<p>The objectives of zone RU4 include:</p> <ul style="list-style-type: none"> • To enable sustainable primary industry and other compatible land uses • To encourage and promote diversity and employment opportunities in relation to primary industry enterprises, particularly those that require smaller lots or that are more intensive in nature • To minimise conflict between land uses within this zone and land uses within adjoining zones • To ensure that development does not prejudice the orderly and economic development of future urban land • To ensure that development is sympathetic to the ecological attributes of the area. <p>The proposal is consistent with the objectives of zone RU4. It would provide required infrastructure for the community in the form of works to improve travel times and safety for motorists and other road users travelling on the Garfield Road East</p>
R2 Low Density Residential	<p>The objectives of zone R2 include:</p> <ul style="list-style-type: none"> • To provide for the housing needs of the community within a low density residential environment • To enable other land uses that provide facilities or services to meet the day to day needs of residents • To enable certain activities to be carried out within the zone that do not adversely affect the amenity of the neighbourhood. <p>The proposal is consistent with the objectives of zone R2 as it would improve access to and from residential areas in the proposal. It would maintain the efficiency of the road network and help to enable other land uses by providing additional capacity</p>
B2 Local Centre	<p>The objectives of zone B2 include:</p> <ul style="list-style-type: none"> • To provide a range of retail, business, entertainment and community uses that serve the needs of people who live in, work in and visit the local area • To encourage employment opportunities in accessible location • To maximise public transport patronage and encourage walking and cycling • To encourage the development of an active local centre that is commensurate with the nature of the surrounding area. <p>The proposal has been designed to minimise its impact on local centre land of the area. Refer to section 6.6 for socio-economic impact because of the proposal</p>
RE1 Public Recreation	<p>The objective of zone RE1 include:</p> <ul style="list-style-type: none"> • To provide a range of recreational settings and activities and compatible land uses • To protect and enhance the natural environment for recreational purposes <p>The proposal would require the upgrading of the existing intersection at Garfield Road East and Piccadilly Street. There would be the need to acquire some land on the northwest corner of George Street and Garfield</p>

Provision description	Relevance to the proposal
	Road East zoned RE1 to build the proposal. The proposal would have a negligible impact on land zoned public recreation.

Development for the purposes of roads is permitted with development consent in all of the relevant zones under the Blacktown LEP. The ISEPP operates to remove consent requirements and/or prohibitions that would otherwise apply.

Hills Local Environmental Plan 2019

The north west portion of the study area is located within the Hills Shire LGA. The part of the study area located within the Hills LGA is subject to the Growth Centres SEPP. Refer Section 4.1.1 for more detail.

4.2 Other relevant NSW legislation

Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) provides the legal framework for the management of air, noise, water and waste pollution. Under Part 3.2 of the POEO Act, the carrying out of scheduled development work as defined in Schedule 1- road construction (meaning the construction, widening, or re-routing of roads) is relevant to the proposal.

Road construction is a scheduled activity under Schedule 1 of the POEO Act if it results in four or more traffic lanes (not including bicycle lanes or lanes used for entry or exit), where the road is classified or proposed to be classified as a main road for at least three kilometres of its length in the metropolitan area.

Based on the concept design and construction methodologies proposed (refer to Section 3.3) an Environment Protection Licence (EPL) would be required as the proposal would involve widening about 3.4 kilometers of Garfield Road East from a two lane to a four lane road. This would be confirmed during detailed design.

Heritage Act 1977

The *Heritage Act 1977* (Heritage Act) provides for the conservation of buildings, works, archaeological, relics and places of heritage value. It principally achieves this by listing, and therefore protecting, heritage values under a number of registers. This includes the State Heritage Register (SHR), the Heritage and Conservation Register (HCR), LEP heritage schedules, public authority heritage and conservation registers, termed section 170 registers, and interim Heritage Orders (IHOs).

The Heritage Act requires TfNSW to assess the proposal's impact on historic buildings, places, objects, works, relics and archaeological sites, and to ensure their cultural heritage value is protected. Refer to section 6.5 and Appendix I for more detail.

The Heritage Act sets out provisions that require a heritage impact assessment to be prepared where the proposal has the potential to impact on any values that are protected under the Heritage Act. Finally, the Heritage Act sets out a process for obtaining permission from the NSW Heritage Council, as administrators of the Heritage Act, to investigate, excavate and/or impact on a heritage-listed item.

The proposal would have impacts ranging from minor to moderate and further approval will be required under the Heritage Act prior to works commencing. Impacts to heritage items are discussed further in section 6.5.

National Parks and Wildlife Act 1979

There is no reserved land under the *National Parks and Wildlife Act 1997* (NPW Act) within the construction footprint. The harming or desecrating of Aboriginal objects or places is an offence under section 86 of the NPW Act. Under section 90, an Aboriginal heritage impact permit may be issued in relation to a specified Aboriginal object, Aboriginal place, land, activity or person or specified types or classes of Aboriginal objects, Aboriginal places, land, activities or persons.

The Office of Environment and Heritage (OEH) has published the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (Department of Environment, Climate Change and Water (DECCW), 2010).

In summary:

- Section 86 - Prohibits both knowingly and unknowingly causing harm or desecration to any Aboriginal object or place without either an Aboriginal Heritage Impact Permit (AHIP), or other suitable defence from the NPW Act.
- Section 87 - Allows for activities carried out under an AHIP or following due diligence to be a defence against harm of an Aboriginal object.
- Section 89A - Requires the DPIE to be notified of any Aboriginal objects discovered, within a reasonable time.
- Section 90 - Requires an application for an AHIP in the case of destruction of a site through development or relocation, to allow harm or desecration of an object or site.

The due diligence process and the *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (Roads and Maritime, 2011) would need to be followed during detailed environmental assessment to determine whether an Aboriginal Heritage Impact Permit is required.

An Aboriginal Archaeological Survey Report (AASR) was prepared to assess the potential impact of the proposal on Aboriginal heritage. The predicted impact of the proposal to the archaeological resource present would impact four known sites of Aboriginal cultural material, including the additional one which was recorded on the survey, as well as areas of high archaeological significance.

An AHIP would be required pursuant to Section 90 of the NPW Act for the areas of sensitivity as well as any sites of potential archaeological significance.

Water Management Act 2000 and Water Act 1912

The investigation area is covered by the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011 and the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources. It is subject to the provisions of the *Water Management Act 2000* (WM Act). Potentially relevant WM Act approval requirements are reviewed in Table 4.2.

The *Water Act 1912* remains relevant for aquifer interference activities such as construction dewatering because the requirement for aquifer interference approvals under the WM Act has not yet commenced. Localised dewatering of construction excavations is expected to benefit from a Crown exemption under section 112 of the *Water Act 1912*.

Table 4.2: Water Management Act 2000 approvals

Provision description	Application to the proposal
Water access licences (s.56 & s.60A)	Exemption for roads authorities in relation to water required for road construction and road maintenance under clause 21 and Schedule 4 of the Water Management (General) Regulation 2018.

Provision description	Application to the proposal
Water use approval (s.89 & s.91A)	Exemption for roads authorities in relation to water required for road construction and road maintenance under clause 34 and Schedule 5 of the Water Management (General) Regulation 2018.
Water supply work approval	Water supply works generally not proposed. Limited exemptions in clause 39 and Schedule 1 of the Water Management (General) Regulation 2018
Controlled activity approval	Exemption in clause 41 of the Water Management (General) Regulation 2018.
Required for carrying out controlled activities including works on waterfront land (s.91 and s.91E)	Impacts on the riparian zone of watercourse within the investigation area should be considered as part of the environmental assessment.

Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) provides for the protection of fishery resources and values for current and future generations. Under the FM Act it is an offence to harm fisheries and resources without an appropriate assessment, inclusion of safeguards and/or the appropriate permissions to carry out certain work.

Part 7A of the FM Act require that the significance of the impact on threatened species and threatened ecological communities (TECs) is assessed using a five-part test of significance. Where a significant impact is likely to occur, a SIS must be prepared in accordance with the Secretary's requirements or a BDAR must be prepared by an accredited assessor in accordance with the Biodiversity Assessment Method (BAM). A Biodiversity Assessment Report (BAR) was prepared for the proposal, which is provided in Appendix L of this REF.

Section 219 of the FM Act includes a prohibition on the blocking of fish passage. Neither First Ponds Creek nor the unnamed creek running through the study area have been identified as Key Fish Habitat by the NSW Department of Primary Industries (DPI). Neither waterway nor any of the dams or ponds occurring in the study area have been declared as aquatic reserves under the FM Act. As such, an aquatic ecology site investigation was not undertaken as part of the BAR.

Observations were made however, of aquatic flora and fauna around the waterways and dams in the study area for the BAR.

Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) sets out the assessment framework for threatened species and ecological communities for activities subject to assessment under Part 5 of the EP&A Act amongst other types of development.

Under Part 7 of the BC Act, a SIS or BAR in relation to an activity likely to significantly affect threatened species, which is defined to include ecological communities, or their habitats, and the concurrence of the Environment Agency Head may be required.

Under Part 8 of the BC Act an activity proposed to be carried out on biodiversity certified land is taken to be an activity not likely to significantly affect any threatened species. The Growth Centres SEPP has received biodiversity certification and the biocertified area covers most of the investigation area.

A BAR was prepared for the proposal, which is provided in Appendix L of this REF.

Aboriginal Land Rights Act 1983

Through the *Aboriginal Land Rights Act 1983* (ALR Act) vacant Crown land not lawfully used or occupied or required for an essential purpose or for residential land, is returned to Aboriginal people and vested in Aboriginal Land Councils. In accordance with Section 42B of the ALR Act, land vested in an Aboriginal Land Council can only be acquired by TfNSW through an Act of Parliament.

There are claims over two land parcels within the investigation area under the ALR Act. The parcels are Lot 342 and Lot 343 in DP752061 which is the Riverstone Swimming Centre on Piccadilly Street. The proposal would not impact these land parcels.

Crown Lands Management Act 2016

The *Crown Lands Management Act 2016* (Crown Lands Act) replaces the *Crown Lands Act 1989* from 1 July 2018. The Crown Lands Act is intended to ensure that Crown land is managed for the benefit of the people of NSW and to provide for the proper assessment and management of Crown land in accordance with the principles of the Act. The Act sets out the conditions under which Crown land is permitted to be occupied, used, sold, leased, licensed or otherwise dealt with.

Riverstone Swimming Centre is located at the intersection of Garfield Road East and Piccadilly Street, Riverstone at Lot 372 DP 752061 and is Crown land. The area of Crown land is shown in Figure 1-2. The waterways within the proposal area are not listed as Crown land.

In accordance with the Crown Lands Act, work proposed to be carried out on Crown land requires a permit from the Department of Industry (Crown Lands Division)

4.3 Commonwealth legislation

4.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) a referral is required to the Australian Government for proposed actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land. These are considered in Appendix A and chapter 6 of the REF.

A referral is not required for proposed road activities that may affect nationally listed threatened species, endangered ecological communities and migratory species. This is because requirements for considering impacts to these biodiversity matters are the subject of a strategic assessment approval granted under the EPBC Act by the Australian Government in September 2015.

Potential impacts to these biodiversity matters are also considered as part of chapter 6 of the REF and Appendix A.

Findings - matters of national environmental significance

The assessment of the proposal's impact on matters of national environmental significance and the environment of Commonwealth land found that there is unlikely to be a significant impact on relevant matters of national environmental significance or on Commonwealth land. Accordingly, the proposal has not been referred to the Australian Government Department of Agriculture, Water and the Environment under the EPBC Act.

Findings - nationally listed biodiversity matters (where the strategic assessment applies)

The assessment of the proposal's impact on nationally listed threatened species, endangered ecological communities and migratory species found that there is unlikely to be a significant impact on relevant matters of national environmental significance. Chapter 7 of the REF describes the safeguards and management measures to be applied.

Strategic Assessment – road and traffic management works

On 14 August 2014, the Australian Government entered into an agreement with the Roads and Maritime to undertake a strategic assessment of road and traffic management works assessed under Part 5 of the EP&A Act. The strategic assessment, including program commitments, was endorsed by the Australian Government Minister for the Environment and received final approval in September 2015 (the endorsed program). Actions undertaken in accordance with the endorsed program do not require separate referral, assessment or approval under the EPBC Act.

Strategic assessment – Western Sydney Growth Centres

To enable development to proceed in the Sydney Growth Centres while protecting the environment, the NSW Government undertook a Strategic Assessment of the Growth Centres under the EPBC Act. The Commonwealth Environment Minister subsequently endorsed the Sydney Growth Centres Strategic Assessment Program, and approved all actions associated with development of the Sydney Growth Centres as described in the Program Report.

Sections of the proposal are located in a biocertified site and sections are non-certified. Any proposal on land certified under the Growth Centres Biodiversity Certification is in accordance with the endorsed program.

Any proposal on non-certified land must be in accordance with the Relevant Biodiversity Measures (RBM) of the Growth Centres Biodiversity Certification. Further assessment of the existing environment relating to biodiversity are provided at section 6.8 of this REF.

In addition to the above, RBM 11 does allow offsets to be located outside of the Growth Centres, but within the Cumberland Plain of Western Sydney, if it can be established that there are no practicable offset options within the Growth Centres and all other requirements of RBM 8 will be met.

A proposal involving clearing of Existing Native Vegetation will therefore be in accordance with the endorsed Program if offsets required by RBM 11 have been provided, and where necessary, the requirements of RBM 12 relating to the priority conservation lands have been satisfied.

Actions undertaken in accordance with the endorsed program do not require separate referral, assessment or approval under the EPBC Act.

4.3.2 Native Title Act 1993

The *Native Title Act 1993* (Native Title Act) recognises and protects native title. The Native Title Act covers actions affecting native title and the processes for determining whether native title exists and compensation for actions affecting native title. It establishes the Native Title Registrar, the National Native Title Tribunal, the Register of Native Title Claims and the Register of Indigenous Land Use Agreements, and the National Native Title Register. Under the Native Title Act a future act includes proposed public infrastructure on land or waters affecting native title rights or interest.

A search of the following was carried out on 26 February 2019 for the Blacktown and The Hills LGAs:

- Register of Native Title Claims
- Native Title Register

- Register of Indigenous Land Use Agreements
- Native Title applications and determinations database.

The results indicated no current native title claims, determinations of native title or Indigenous Land Use Agreements affecting the proposal.

TfNSW would provide notice of the proposal to NTSCORP (NTSCORP Limited is the Native Title Service Provider for Aboriginal Traditional Owners in New South Wales and the Australian Capital Territory) under section 24KA of the Native Title Act and would invite comment on the proposal.

4.4 Confirmation of statutory position

The proposal is categorised as development for the purpose of a road and is being carried out by or on behalf of a public authority. Under clause 94 of ISEPP the proposal is permissible without consent. The proposal is not State significant infrastructure or State significant development. The proposal can be assessed under Division 5.1 of the EP&A Act.

TfNSW is the determining authority for the proposal. This REF fulfils TfNSW's obligation under section 5.5 of the EP&A Act including to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the activity.

5. Consultation

This chapter discusses the consultation undertaken to date for the proposal and the consultation proposed for the future.

5.1 Consultation strategy

A Communications Engagement Plan (CEP) has been prepared for the proposal. The CEP identifies activities for the consultation process involving TfNSW, other relevant government agencies, organisations, community representatives and residents.

The objective of the plan is to inform key stakeholders, immediate residents and businesses, road users and the broader community of the proposal. A number of communication tools have been used to inform the local and broader community, key stakeholders, local and state government. These included:

- A dedicated project website, telephone and email address
- Meetings and briefings
- Community information sessions
- Media coverage
- Print and digital communication materials such as flyers, community updates, postcards
- Road signage using portable variable message signs (VMS).

The engagement objectives are to:

- Engage and inform key stakeholders and the community about the proposal planning process and timeframes, proposed concept design and environmental impact assessment
- Consult with stakeholders and community during the concept design, environmental assessment and formal exhibition phases of the proposal
- Incorporate local participation into planning decisions and outcomes related to the proposal
- Generate awareness of opportunities for feedback, accessible proposal information and timely problem solving.

5.2 Community involvement

Communication and consultation with the community has so far involved the following activities:

- In November 2014, the NWGA Road Network Strategy was released for public consultation. A community update was distributed to residents and businesses that provided an update of the proposed road network improvements
- In July and August 2019, TfNSW held three community information sessions to help inform future road plans in the NWGA. Information on the TfNSW website was updated to reflect these plans and included project background, latest news and TfNSW contract information for the community. Stakeholders were invited to provide feedback until the 16 August 2019
- In late 2019 and early 2020, TfNSW contacted a number of property owners and requested property access for site investigations to inform this REF.

At the time of the preparation of this REF, TfNSW were undertaking follow up consultation with applicable stakeholders where relevant.

Table 5.1: Summary of issues raised by the community

Group	Issue raised	Response / where addressed in REF
Residents	<ul style="list-style-type: none"> Safety concerns regarding Garfield Road East where the road is higher than the surrounding land. The road backs onto houses and there is no protection of those houses in the event of a vehicle running off the road down the slope and into those properties. Perhaps there can be consideration of safety barriers 	<ul style="list-style-type: none"> While the focus of the communication activities so far was to explain the environmental investigations, issues raised about safety are addressed in section 3.2

5.3 Aboriginal community involvement

Aboriginal community consultation is an integral part of the assessment of Aboriginal cultural heritage significance. Consultation was carried out in accordance with the TfNSW PACHCI Stage 2 (Roads and Maritime, 2011). A summary of the PACHCI process is provided in Table 5.2.

Table 5.2: Summary of Transport for NSW Procedure for Aboriginal Cultural Heritage Consultation and Investigation

Stage	Description
Stage 1	Initial Transport for NSW assessment
Stage 2	Site survey and further assessment
Stage 3	Formal consultation and preparation of a cultural heritage assessment report
Stage 4	-

Steven Randall of DLALC reported no cultural material identified within the road easement, aside from the presence of unworked silcrete which was revealed by a cut in bedrock made to lower the road, and would, without modern construction, not be visible. Further details are provided at Appendix H of this REF.

The DLALC agrees with further testing around Eastern Creek and First Ponds Creek, and recommends further investigation is carried out before any development of Garfield Road East.

5.4 ISEPP consultation

Clauses 13 to 16 of the State Environmental Planning Policy (Infrastructure) (ISEPP) specify the requirements for consultation with councils and other public authorities for infrastructure development carried out by or on behalf of a public authority. Consultation is required in relation to specified development or development that impacts on:

- Council related infrastructure or services (clause 13)
- Local heritage (clause 14)
- Flood liable land (clause 15)
- Public authorities other than councils (clause 16).

Blacktown City Council and Hills Shire Council have been consulted about the proposal. Appendix B contains an ISEPP consultation checklist that documents how ISEPP consultation requirements have been considered.

Issues that have been raised as a result of this consultation are outlined below in Table 5.3.

Table 5.3: Issues raised through ISEPP consultation

Agency	Issue raised	Response / where addressed in REF
The Hills Shire Council	<ul style="list-style-type: none"> Option 3 is Council's preferred option for the location of the future overbridge over Windsor Road. Land required for the overbridge will be reserved in the planning instruments for the future land release of this area. The future overbridge will be identified in the Review of Environmental Factors (REF) for the Garfield Road (East) proposal when it is exhibited. Councils assumes that TfNSW will be acquiring the land for road widening along Terry Road between Windsor Road and Alan Street as part of the Garfield Road (east) proposal. Proposed land acquisition to be in accordance with Council's road design plans for Terry Road between Windsor Road and Alan Street and that land acquisition will be undertaken to suit the ultimate road widening up to Alan Street. 	<ul style="list-style-type: none"> The design will not suit the ultimate Terry Road design (by others) as it is not possible to achieve this whilst also needing to tie into existing Terry Road prior to Alan Street. The ultimate arrangement should however be catered for at the intersection with Windsor Road. Further details are provided at section 3.2 and section 3.6
Blacktown City Council	<ul style="list-style-type: none"> Tree planting within road reserve 	<ul style="list-style-type: none"> Maintaining a wide cross section east of Hamilton/McCulloch Street to facilitate space required for tree planting and landscaping <p>Urban design objectives are provided at section 2.3.3 and an assessment of the landscape character and visual impact are provided at section 6.7</p>

5.5 Growth Centres SEPP consultation

Clause 18A of State Environmental Planning Policy (Sydney Growth Centres) 2006 requires a public authority proposing to carry out a public utility undertaking (including road transport) comprising clearing of native vegetation within non-certified land, must give written notice to DPIE of the intention to carry out the development and consider any response received within 21 days of the notice.

As the proposal will result in clearing of native vegetation on non-certified land, consultation was carried out with DPIE under clause 18A of Growth Centres SEPP on 26 August 2020. Appendix B contains a Growth Centres SEPP consultation checklist that documents how the Growth Centres SEPP consultation requirements have been considered for the proposal.

Table 5.4: Issues raised through Growth Centres SEPP consultation

Agency	Issue raised	Response / where addressed in REF
DPIE	<ul style="list-style-type: none"> DPIE raised no issues with the proposal 	<ul style="list-style-type: none"> NA

5.6 Government agency and stakeholder involvement

As discussed in section 5.4 above various government agencies and stakeholders have been consulted about the proposal. Additional government agency consultation included:

- Department of Planning, Industry and Environment
- The NSW State Emergency Service (SES)

TfNSW facilitates quarterly meetings to brief the Department of Planning, Industry and Environment (DPIE), Blacktown City Council and Hills Shire Council on all development projects in the NWGC. In addition to these quarterly meetings, TfNSW provides monthly updates to DPIE on project progress. Further consultation with councils is carried out with each design submission during the concept design phase.

Consultation and meetings with utility providers was carried out in February/March 2020 to determine what had to be relocated, protected any future requirements.

Issues that have been raised as a result of consultation with these agencies and stakeholders are outlined below in Table 5.6.

Table 5.5: Government agency and stakeholder consultation

Stakeholder	Consultation carried out
Sydney Water	<ul style="list-style-type: none"> Meeting held 2 March 2020, 10 March 2020 ISEPP letter issued 21 February 2020
Jemena	<ul style="list-style-type: none"> Meeting held 27 February 2020
Telstra	<ul style="list-style-type: none"> Meeting held 13 February 2020
National Broadband Network (NBN)	<ul style="list-style-type: none"> Meeting held 20 March 2020
Optus	<ul style="list-style-type: none"> Meeting held 20 March 2020
Endeavour	<ul style="list-style-type: none"> Meeting held 11 March 2020 ISEPP letter issued 20 February 2020

Table 5.6: Issues raised through stakeholder consultation

Agency	Issue raised	Response / where addressed in REF
Sydney Water	<ul style="list-style-type: none"> Relocation of existing DN500 Cast Iron Cement Lined (CICL) pipe across Garfield Rd East at intersection of Piccadilly Street on eastern verge which is old and the joints on this pipe will not be able to withstand construction traffic in forming a new pavement To eliminate multiple service water crossings across Garfield Rd East in a section between Piccadilly and McCulloch Streets it is proposed locate a new DN100 watermain on the southern verge to provide house services for existing properties Sydney Water has indicated that their strategic plan for the area is to construct DN450 mm trunk main in Garfield Rd East between Piccadilly and Edmund Streets. The timing on this is 2026 Existing sewer main crossing diagonally Garfield Rd East at Edmund Street where the road will need to be raised approximately two metre 	<ul style="list-style-type: none"> Relocating the away from intersection as requested by Sydney Water and making the main across the road maintenance free (concrete encased Steel Cement Lined (SCL) pipe) Design and approval from Sydney Water for this additional watermain will be required as will further coordination with other utilities. At this stage space proofing on the northern verge (east bound) has been made for this main. Further discussion will be required with Sydney Water and coordination depending when the road construction will be undertaken Sydney water to confirm that additional fill on top of existing maintenance free main constructed inside a steel sleeve is acceptable
Jemena	<ul style="list-style-type: none"> Relocating 200mm secondary steel gas main between Hamilton and Clarke Streets to be on the southern verge (westbound) 	<ul style="list-style-type: none"> New location for gas main has been provided to Jemena who are yet to provide comments on the proposal
Telstra	<ul style="list-style-type: none"> Telstra infrastructure is affected on both sides of Garfield Rd East and relocation will be required 	<ul style="list-style-type: none"> TfNSW has commissioned Telstra to provide a design to relocate their assets
Optus	<ul style="list-style-type: none"> Impacts to Optus assets to be considered during design 	<ul style="list-style-type: none"> Optus provided a relocation plan on 16 March 2020 that covers the second area of Garfield Road East near Windsor Road, where new pits and conduits will need to be constructed. Coordination of this relocation with other utilities is still required during design and prior to construction

Agency	Issue raised	Response / where addressed in REF
NBN	<ul style="list-style-type: none"> Interactions between Telstra design and NBN design 	<ul style="list-style-type: none"> Telstra design to be provided to NBN before any discussion takes place with NBN as an assessment of the NBN requirements would need to be considered during design and prior to construction
Endeavour Energy	<ul style="list-style-type: none"> Location of future Zone Substation located at CH2700 along Garfield Road East Relocation of overhead EE assets to underground 	<ul style="list-style-type: none"> Provision has been made in the design for the future 132 KVA transmission lines consisting of three 125 mm conduits placed within the travel lane (1.5 m from face of kerb and 1.8 m deep) to connect in to the future substation

5.7 Ongoing or future consultation

If the REF is determined, community engagement would be required for activities in the next phases of the proposal. If the proposal is approved, and funding becomes available for the next stage of the project these activities may include:

- Property acquisitions
- Property adjustments
- Start construction
- Construction of the project
- Completion and opening to traffic.

The engagement techniques would include:

- Media release for start of construction, notifications, webpage updates, VVMS
- Traffic alerts, notifications, doorknocking, webpage updates and media release, webpage updates, traffic alerts and notifications.

Other consultation activities that would be carried out include the following:

- Consultation with key stakeholders to help in managing impact during construction
- Follow-up meetings to discuss access arrangements with directly affected landholders
- On-going meetings with the relevant Councils, utility providers, nearby landowners and community stakeholders, as required
- If the proposal is approved, ongoing updates of the project website as required.

6. Environmental assessment

This section of the REF provides a detailed description of the potential environmental impacts associated with the construction and operation of the proposal. All aspects of the environment potentially impacted by the proposal are considered. This includes consideration of:

- Potential impacts on matters of national environmental significance under the EPBC Act
- The factors specified in the guidelines *Is an EIS required?* (DUAP 1995/1996) as required under clause 228(1) of the Environmental Planning and Assessment Regulation 2000 and the *Roads and Related Facilities EIS Guideline* (DUAP 1996). The factors specified in clause 228(2) of the Environmental Planning and Assessment Regulation 2000 are also considered in Appendix A.

Site-specific safeguards and management measures are provided to mitigate the identified potential impacts.

6.1 Traffic and transport

6.1.1 Methodology

A Traffic and Assessment report (Appendix E) has been prepared to support the REF. The Traffic and Transport report has been informed by design reports, desktop investigations, traffic modelling and traffic performance studies undertaken for the proposal.

The assessment comprised of:

- An assessment of the existing traffic and transport conditions in the study area including the local road network, traffic flows, active transport services, pedestrian and cycle facilities and road safety
- Modelling of existing and forecast traffic scenarios at completion (2026) and 10 years (2036) after completion of the proposal to evaluate impacts
- An assessment of the impacts of the construction and operation of the proposal on existing roads, pedestrians, cycling and active transport infrastructure and road safety
- The identification of mitigation measures required to minimise these impacts.

The study area for the proposal is about 3.4 kilometres of Garfield Road East between Piccadilly Street, Riverstone and Windsor Road, Box Hill. The study area includes all the existing intersections listed below:

- Garfield Road East and Piccadilly Street
- Garfield Road East, Hamilton Street and McCulloch Street
- Garfield Road East and Hamilton Street
- Garfield Road East and Galluzzo Street
- Garfield Road East and Edmund Street
- Garfield Road East and Clarke Street
- Garfield Road East and Junction Road
- Garfield Road East and Windsor Street.

6.1.2 Existing environment

Road hierarchy

The proposal is made of one State Road comprising Windsor Road, one arterial road which is Garfield Road East, and minor collector roads. The characteristics and hierarchy of each road is discussed in Table 6.1.

Table 6.1: Existing road summary

Road name	Classification	Posted speed (km/hr)	Lanes per direction	Function
Windsor Road	State Road	80	2	Key corridor linking Sydney metropolitan area
Garfield Road East	Arterial Road	60/80	1	Major corridor connecting adjacent local collector roads within Riverstone
Piccadilly Street	Collector Road	50	1	Provides connectivity for local residents to access Garfield Road East then to access the wider road network
McCulloch Street	Local Road	50	1	Provides connectivity for local residents to access Garfield Road East then to access the wider road network
Hamilton Street	Local Road	50	1	Provides connectivity for local residents to access Garfield Road East then to access the wider road network
Galluzzo Street	Local Road	50	1	Provides connectivity for local residents to access Garfield Road East then to access the wider road network
Edmund Street	Local Road	60	1	Provides connectivity for local residents to access Garfield Road East then to access the wider road network
Clarke Street	Local Road	60	1	Provides connectivity for local residents to access Garfield Road East then to access the wider road network

Garfield Road East is classified as a Class 3 Urban Road under the Network Performance Measures and Network Planning Targets (Roads and Maritime 2010). Garfield Road East is key heavy vehicle route as shown in Figure 6-1.

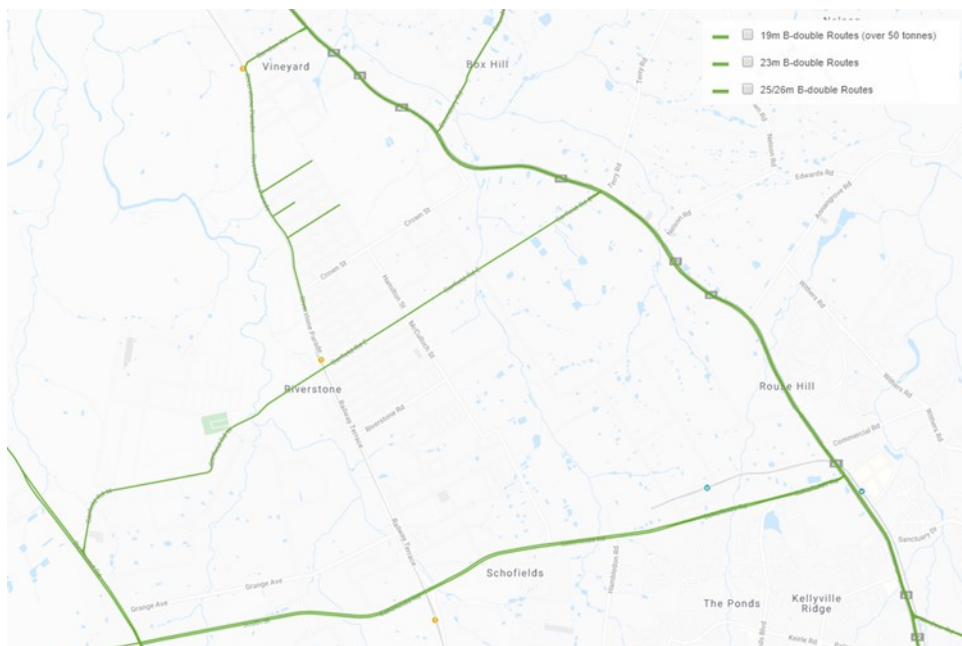


Figure 6-1: Heavy vehicle route map (source: Transport for NSW)

Major intersections

The proposal is a two-lane undivided road with a posted speed limit of 50 kilometres per hour at the western end of the proposal, which is the more built up part of Riverstone. West of about Edmund Street, Garfield Road East transitions to a posted speed limit of 80 kilometres per hour. About 200 metres west of the intersection of Garfield Road East and Windsor Road, the posted speed limit transitions to 60 kilometres per hour as vehicles approach Windsor Road.

Intersecting streets with Garfield Road East include:

- Piccadilly Street - classified as a collector road. It has one lane each way with a posted speed limit of 50 km/hr. It provides connectivity for local residents to access Garfield Road East then to access the wider road network
- Hamilton Street / McCulloch Street - classified as a local road. It has one lane each way with a posted speed limit of 50 km/hr. It provides connectivity for local residents to access Garfield Road East and the wider road network
- McCulloch Street - classified as a local road. It has one lane each way with a posted speed limit of 50 km/hr. It provides connectivity for local residents to access Garfield Road East and the wider road network
- Galluzzo Street - classified as a local road. It has one lane each way with a posted speed limit of 50 km/hr. It provides connectivity for local residents to access Garfield Road East and the wider road network
- Edmund Street - classified as a local road. It has one lane each way with a posted speed limit of 60 km/hr. It provides connectivity for local residents to access Garfield Road East then to access the wider road network
- Clarke Street - classified as a local road. It has one lane each way with a posted speed limit of 60 km/hr. It provides connectivity for local residents to access Garfield Road East and the wider road network
- Windsor Road - an important corridor in The Hills area, northwest of Sydney. It links the area with the Sydney metropolitan area and its motorway network, and it is classified as a State Road with four-lane divided carriageway with a posted speed of 80 km/h.

The proposal includes two signalised and six priority-controlled intersections between Piccadilly Street and Windsor Road as shown in Table 6.2 and Figure 6-2

Table 6.2: Key intersections

ID	Intersection	Control type
1-1	Garfield Road East and Piccadilly Street	Signalised intersection
1-2	Garfield Road East and McCulloch Street	Priority controlled intersection
1-3	Garfield Road East and Hamilton Street	Priority controlled intersection
1-4	Garfield Road East and Galluzzo Street	Priority controlled intersection
1-5	Garfield Road East and Edmund Street	Priority controlled intersection
1-6	Garfield Road East and Clarke Street	Priority controlled intersection
1-7	Garfield Road East and Junction Road	Priority controlled intersection
1-8	Garfield Road East and Windsor Road	Signalised intersection

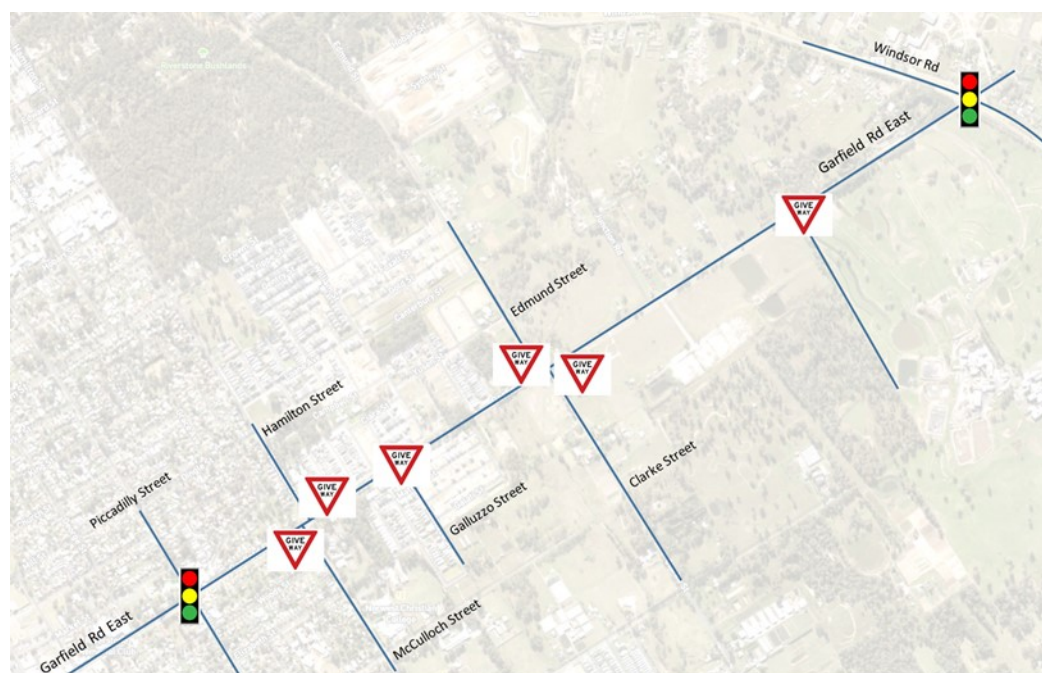


Figure 6-2: Key intersections

Parking

Garfield Road East is principally identified as a movement corridor which provides for the movement of general traffic, freight and buses in an east-west direction. In the future there would be new precincts

developed along the corridor. The local centre of Riverstone represents an important destinations within the urban setting and is a high place value. Existing conditions along the corridor indicate some areas of congestion during the peak periods in particular at the locations of Piccadilly Street and Hamilton Street.

Existing parking in the proposal identified a total of around 80 on-street parking spaces distributed as follows:

- Piccadilly Street to Hamilton Street - about 20 spaces
- Hamilton Street to Galluzzo Street - about 10 spaces
- Galluzzo Street to Windsor Road - about 30 spaces.

Additional in formal on-street parking areas are available along Garfield Road East between Galluzzo Street and Windsor Road. On street parking within the proposal are identified as being no time restrictions parking. Typically parking within the proposal shows varied levels of occupation and utilisation.

Pedestrian and cycling facilities

There are pedestrian pathways along both sides of Garfield Road East. Pedestrian pathways in the proposal include:

- Along the southern side of Garfield Road East from Alan Street to around 85 metres east of McCulloch Street
- Along the northern side of Garfield Road East from Alan Street and Piccadilly Street.

Pedestrian pathways located at Piccadilly Street run either side of the Garfield Road East intersection. These footpaths are associated with access to the Casuarina School to the south and the Riverstone Swimming Centre and residential properties to the north. Other pedestrian pathways within the proposal are provided at McCulloch Street and the eastern side of Hamilton Street. Terry Road, Box Hill located east of the Windsor Road intersection includes pedestrian and cycle crossing facilities at the intersection of Windsor Road.

There are one signalised pedestrian crossing at the corner of Piccadilly Street and Garfield Road East, and a pedestrian safety island located near the veterinary hospital on Garfield Road East. There are no other pedestrian crossing facilities until Windsor Road, including traffic islands and/or pedestrian refuge points.

There are no dedicated cycleways along Garfield Road East. Located at the intersection of Windsor Road and Garfield Road East is the associated Windsor Road cycle path that runs in a north to south direction. Figure 6-3 shows existing and future proposed cycling routes for Riverstone. Garfield Road East is recommended has a future state link on as shown by the light blue dashed line.

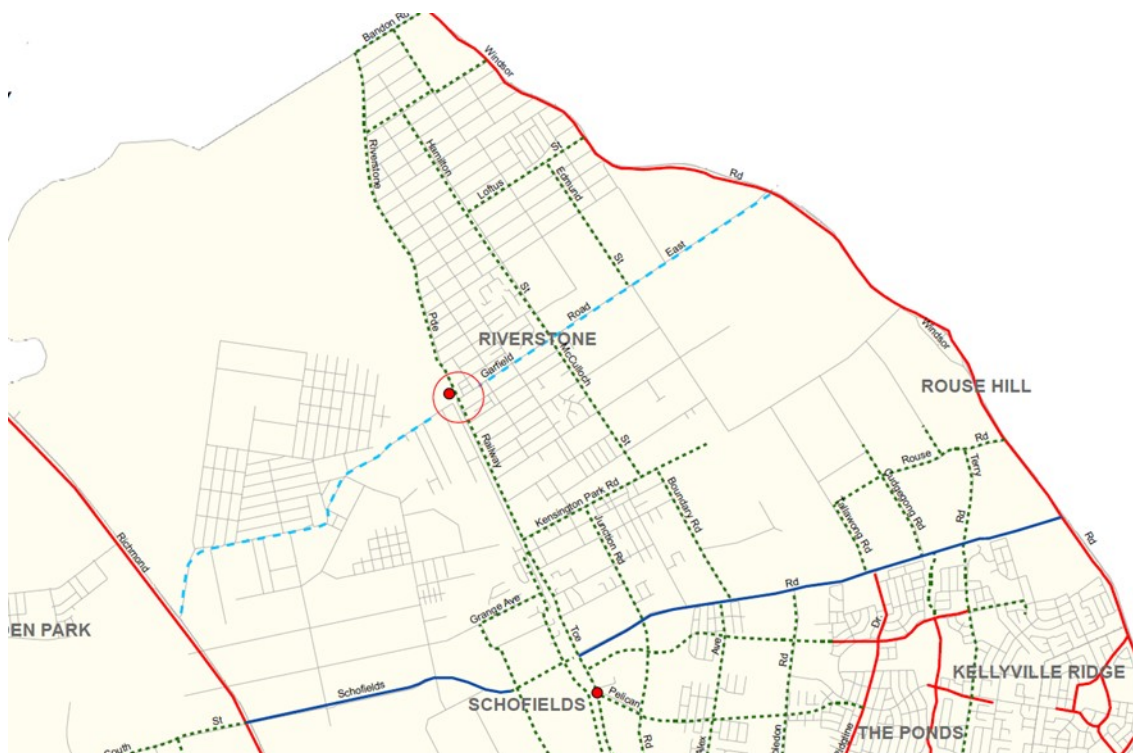


Figure 6-3: Riverstone area existing cycle way and plan (source: Blacktown City Council, 2016)

Public transport

There are 15 existing bus stops located along Garfield Road East within or in close proximity to the study area. Bus services in the study area are limited and only five bus routes were noted travel within the study area as outlined in Table 6.3 and Figure 6-4.

Table 6.3: Public transport (bus) services

Bus service	Description of service	Number of AM peak services	Number of PM peak services
746	Riverstone to Rouse Hill Town Centre	2	4
747	Marsden Park to Rouse Hill via Riverstone	6	5
671	Riverstone to Windsor via McGraths Hill & Vineyard	2	1
742	Marsden Park to Rouse Hill	3	3

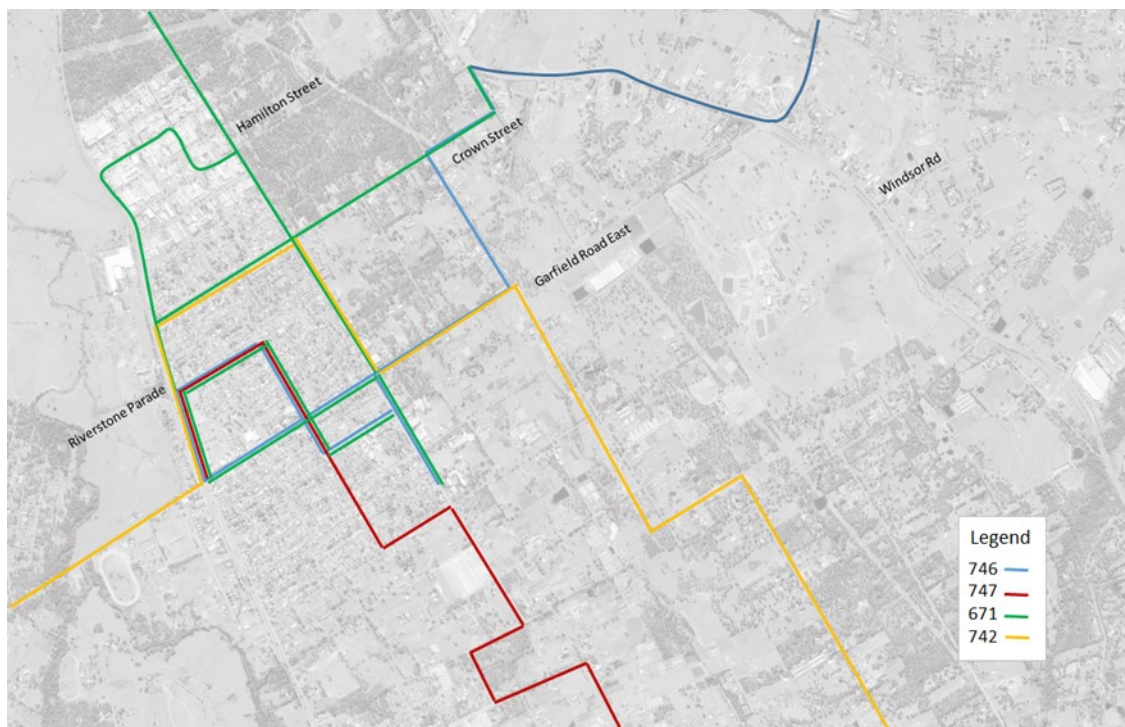


Figure 6-4: Existing bus routes

Riverstone Railway Station is located at the western end of Garfield Road East, about 500 metres west of the proposal. Riverstone Station is serviced by T1 Western Line and T5 Cumberland Line services. Schofields Railway Station is located about 1,600 metres south west of the study area.

Crash data analysis

Crash data sourced from TfNSW for the period 2014 to 2019 found there were 32 crashes along Garfield Road East within the study area. The crashes included one fatal, eight non-casualty, four minor injuries, 13 moderate injuries, four serious injuries and two uncategorised injuries.

The majority of recorded crash data occurred at intersections, most of which occurred at the Garfield Road East and Windsor Road intersection. The large number of rear end crashes along the Garfield Road East is an indication congestion itself may present a significant safety issue. Fluctuations in average speed, due to congestion; particularly during peak commute hours, can create a 'start and stop' driving environment for motorists. This increases the likelihood of rear end collisions during periods of congestion when there may be relatively little headway between vehicles.

Peak hour identification

Based on available traffic data, AM peak and PM peak hours in the study area were identified to occur between 6am to 10am and 3pm to 7pm.

Travel times

Travel time data captured the travel time along Garfield Road from Windsor Road to Richmond Road for the AM peak period from 6:00 am to 10:00 am and for the PM peak period from 3:00 pm to 7:00 pm for both directions. The travel time along the corridor was captured through 18 runs in total for both directions. Each run is a vehicle travelling the entire distance and recording the travel time on each section of the corridor. Results from the travel time survey were analysed and summarised in Table 6.4.

Table 6.4: Travel time survey results for Garfield Road between Windsor Road and Richmond Road

Direction	Period	Average (min)	Maximum (min)	Minimum (min)
Eastbound	6:00 am-10:00 am	10:31	17:12	6:47
	3.00 pm to 7.00 pm	10:30	19:07	6:41
Westbound	6:00 am-10:00 am	9:56	17:55	6:54
	3.00 pm to 7.00 pm	10:30	17:33	7:07

Intersection performance

Existing intersection performance was assessed by considering the peak hour volumes for the AM and PM peak hours for the surveyed data collected 20 August 2019 and peak hour volumes for all typical weekdays for which SCATS data were used to validate surveyed traffic volumes. The 2019 base case intersection performance is shown in Table 6.5.

Table 6.5: 2019 AM peak hour intersection performance

Intersection	DOS	Average delay (sec)	LOS	Average back queue (m)
AM peak period				
Garfield Rd E and Piccadilly St	0.50	11	A	17 (North-eastern approach)
Garfield Rd E and McCulloch St	0.27	14	A	3 (South-eastern approach)
Garfield Rd E and Hamilton St	0.39	18	B	6 (North-western approach)
Garfield Rd E and Galluzzo St	0.26	6	A	1 (south-eastern approach)
Garfield Rd E and Edmund St	0.29	14	A	2 (north-western approach)
Garfield Rd E and Clarke St	0.34	14	A	5 (south-western approach)
Garfield Rd E and Garfield Rd	0.28	11	A	2 (south-western approach)
Garfield Rd E and Windsor Rd	0.85	38	C	122 (south-eastern approach)
PM peak period				
Garfield Road East and Piccadilly Street	0.54	11	A	17 (south-western approach)
Garfield Road East and McCulloch Street	0.31	14	A	4 (South-eastern approach)
Garfield Road East and Hamilton Street	0.41	19	B	6 (North-western approach)
Garfield Road East and Galluzzo Street	0.26	6	A	1 (south-eastern approach)

Intersection	DOS	Average delay (sec)	LOS	Average back queue (m)
Garfield Road East and Edmund Street	0.33	16	B	4 (North-eastern approach)
Garfield Road East and Clarke Street	0.32	13	A	4 (south-western approach)
Garfield Road East and Garfield Road	0.33	11	A	2 (South-western approach)
Garfield Road East and Windsor Road	0.93	33	C	151 (south-eastern approach)

The above overall intersection performance results shows the intersections are performing under capacity. However, some of the approaches are performing above capacity, especially at the Garfield Road East, Windsor Road and Terry Road intersection.

6.1.3 Potential impacts

Construction

The construction period would be around 36 months. During construction it is anticipated that the majority of works would require lane closures on Garfield Road East. Lane closures would be undertaken under a Road Occupancy Licence (ROL). All routes on Garfield Road East would remain open during construction with no complete road closures. Potential lane closures would use traffic controls during the works. Users of Garfield Road East and the intersecting local streets are likely to experience increased traffic delays and congestion during construction. With effective management, including minimising traffic impacts during peak travel periods, the short term impact on traffic is not expected to be significant.

Public transport routes would not be directly impacted during construction as there are no public transport routes through the proposal area. However, there could be minor delays to public bus movements as a result of indirect traffic delays to services in the vicinity of the proposal. Any bus stops affected by works would have temporary stops erected close to the existing bus stops. Other services such as school bus routes would not change.

The community and stakeholders impacted by these impacts would be notified prior to construction.

During construction, additional traffic movements would be occurring from a variety of truck movements used for the proposal. The number is expected to increase by 100 to 150 movements per day. However, truck movements may increase by 200 to 250 movements per day at certain stages of construction such as during cut and fill work associated with the large fill embankment west of Access 3, to allow for flood immunity. Additional vehicles may potentially be required for specific construction activities and for delivery of materials:

Currently Garfield Road is an approved B-Double routes that connects between Richmond Road and Windsor Road. Additional vehicle movements from construction vehicles is expected to have a negligible to minor impact on traffic. Construction vehicles would access the proposal area via arterial roads wherever possible. However, given that these roads already carry high volumes of traffic it is not anticipated that the proposal would result in a significant increase above what is currently experienced, as this additional construction traffic would be well within the range of daily variation in traffic on these routes.

As part of the construction management plan, it is expected that heavy vehicle traffic would be constrained, as much as possible, to the regional and arterial road network and that the impact on local roads would be

minimised. Any disruption to access to side streets and properties would be minimised and would only be undertaken following consultation with the community and with individual property owners affected by the works.

The movement of materials would be managed through the scheduling of deliveries and availability of fleet and would aim to minimise the number of haulage and delivery vehicles required during peak periods and weekends.

Pedestrian footpath impacts would occur during construction as a result of the proposal and tie-in works. Footpaths would be demolished before being fully reconstructed where required. Where existing footpaths are impacted, alternative paths or routes would be established to ensure safe passage of pedestrians through the proposal area during construction.

Properties which have direct access to construction activities within the proposal area may require temporary access adjustments during the construction phase. If restrictions are required, for example during utility work or driveway adjustments, this would be for short durations and organised in consultation with the affected property owner(s) and businesses. Emergency services and pedestrian access to properties would be maintained at all time

A Traffic Management Plan (TMP) will be prepared and implemented to manage traffic and access impacts during construction.

Operation

Intersection performance

Without the upgrade to Garfield Road East, the traffic modelling assessment shows the performance of the existing road would significantly deteriorate in the future years without the proposal, with a number of intersections operating significantly above capacity or with an average delay in excess of five minutes.

The year 2026 results show with the proposal performance results would improve relative to the base case results. Some of the improvements include reducing the significant DOS and excessive delays observed in the base case scenario, in particular, the Garfield Road East and McCulloch Street, and the Garfield Road East and Windsor Road intersections, which had more than 200 seconds average delay in the base case PM peak models.

Table 6.6 and Table 6.7 shows the future year 2026 SIDRA network intersection performance in the AM and PM peak hours.

Table 6.6: 2026 AM peak level of service

Intersection	2026 AM Peak					
	Without proposal			With proposal		
	DOS	Avg delay (sec)	LOS	DOS	Avg delay (sec)	LOS
Garfield Road East and Piccadilly Street	1.06	76	F	0.71	26	B
Garfield Road East and McCulloch Street	2.06	>500	F	0.86	35	C
Garfield Road East and Galluzzo Street	0.35	7	A	0.23	6	A

Intersection	2026 AM Peak					
	Without proposal			With proposal		
	DOS	Avg delay (sec)	LOS	DOS	Avg delay (sec)	LOS
Garfield Road East and Edmund Street	0.44	22	B	0.23	6	A
Garfield Road East and Access 1	NA	NA	B	0.20	6	A
Garfield Road East and Junction Road	1.03	83	NA	0.20	6	A
Garfield Road East and Access 2	NA	NA	NA	0.84	37	C
Garfield Road East and Access 3	NA	NA	NA	0.39	23	B
Garfield Road East and Access 4	NA	NA	NA	0.19	6	A
Garfield Road East and Windsor Road	0.99	73	F	0.95	42	C

NA = intersection does not exist without the proposal

Table 6.7: 2026 PM peak level of service

Intersection	2026 PM Peak					
	Without proposal			With proposal		
	DOS	Avg delay (sec)	LOS	DOS	Avg delay (sec)	LOS
Garfield Road East and Piccadilly Street	0.96	45	D	0.81	28	B
Garfield Road East and McCulloch Street	1.15	243	F	0.84	41	C
Garfield Road East and Galluzzo Street	0.33	8	A	0.22	7	A
Garfield Road East and Edmund Street	0.42	18	B	0.65	14	A
Garfield Road East and Access 1	NA	NA	NA	0.18	6	A
Garfield Road East and Junction Road	1.11	140	F	0.18	6	A
Garfield Road East and Access 2	NA	NA	NA	1.11	78	F

Intersection	2026 PM Peak					
	Without proposal			With proposal		
	DOS	Avg delay (sec)	LOS	DOS	Avg delay (sec)	LOS
Garfield Road East and Access 3	NA	NA	NA	0.90	37	C
Garfield Road East and Access 4	NA	NA	NA	0.20	7	A
Garfield Road East and Windsor Road	1.24	214	F	1.02	70	E

NA = intersection does not exist without the proposal

Similar to the year 2026 with proposal performance, the 2036 proposal results show a significant reduction in the average intersection delays and improved performance, particularly in the PM peak hour, where the base case results were suggesting some delays averaging 300 seconds or five minutes per vehicle

Once operational, the proposal shows all intersection performance improves except for Galluzzo Street in the 2036 PM peak intersection performance. Galluzzo Street reduces the LOS from an A in the base case scenario to a C under the with proposal scenario. The LOS C is caused by traffic turning left from Galluzzo Street onto Garfield Road East. The LOS for this movement is due to queuing to McCulloch Street/ Hamilton Street/ Garfield Road East intersection.

The McCulloch Street/ Hamilton Street/ Garfield Road East intersection is converted from two separate T-intersections to one signalised intersection under the proposal. This has significant benefits for the operation and safety of the network. The benefits gained across the network are seen to outweigh the negative impact to Galluzzo Street. While the LOS is reduced, the LOS is still acceptable as a LOS C.

The impact to Galluzzo Street was minimised through the use of staged crossings to incrementally clear traffic, facilitating spare capacity. In addition, to minimise the modelled impact under the 2036 scenario, the road will incorporate “keep-clear” line marking to ensure traffic can still exit Galluzzo Street when traffic is queued. This behaviour is not modelled and is expected to improve the actual LOS, particularly considering the low level of demand.

On balance, the proposal would provide benefit to the wider network.

Table 6.8 and Table 6.9 list the future year 2036 SIDRA network intersection performance in the AM and PM peak hours.

Table 6.8: 2036 AM peak level of service

Intersection	2036 AM Peak					
	Without proposal			With proposal		
	DOS	Avg delay (sec)	LOS	DOS	Avg delay (sec)	LOS
Garfield Road East and Piccadilly Street	1.14	108	F	0.92	34	C
Garfield Road East and McCulloch Street	>3	>800	F	0.90	38	C

Intersection	2036 AM Peak					
	Without proposal			With proposal		
	DOS	Avg delay (sec)	LOS	DOS	Avg delay (sec)	LOS
Garfield Road East and Galluzzo Street	0.46	8	A	0.33	7	A
Garfield Road East and Edmund Street	1.24	274	F	0.77	15	B
Garfield Road East and Access 1	1.44	422	F	0.33	6	A
Garfield Road East and Junction Road	NA	NA	NA	0.40	7	A
Garfield Road East and Access 2	NA	NA	NA	1.02	61	E
Garfield Road East and Access 3	NA	NA	NA	0.54	36	C
Garfield Road East and Access 4	NA	NA	NA	0.25	7	A
Garfield Road East and Windsor Road	1.19	159	F	1.06	99	F

NA = intersection does not exist without the proposal

Table 6.9: 2036 PM peak level of service

Intersection	2036 PM Peak					
	Without proposal			With proposal		
	DOS	Avg delay (sec)	LOS	DOS	Avg delay (sec)	LOS
Garfield Road East and Piccadilly Street	1.14	108	F	0.94	39	C
Garfield Road East and McCulloch Street	>3	>800	F	1.01	75	F
Garfield Road East and Galluzzo Street	0.46	8	A	0.98	39	C
Garfield Road East and Edmund Street	1.24	274	F	0.79	17	B
Garfield Road East and Access 1	1.44	422	F	0.30	6	A
Garfield Road East and Junction Road	NA	NA	NA	0.30	6	A

Intersection	2036 PM Peak					
	Without proposal			With proposal		
	DOS	Avg delay (sec)	LOS	DOS	Avg delay (sec)	LOS
Garfield Road East and Access 2	NA	NA	NA	1.00	62	E
Garfield Road East and Access 3	NA	NA	NA	1.00	55	D
Garfield Road East and Access 4	NA	NA	NA	0.25	7	A
Garfield Road East and Windsor Road	1.19	159	F	1.19	197	F

NA = intersection does not exist without the proposal

6.1.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Traffic and transport	<p>A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Transport for NSW <i>Traffic Control at Work Sites Manual</i> (RTA, 2010) and <i>QA Specification G10 Control of Traffic</i> (Transport for NSW, 2008). The TMP will include:</p> <ul style="list-style-type: none"> • Confirmation of haulage routes • Measures to maintain access to local roads and properties • Site specific traffic control measures (including signage) to manage and regulate traffic movement • Measures to maintain pedestrian and cyclist access • Requirements and methods to consult and inform the local community of impacts on the local road network • Access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads. • A response plan for any construction traffic incident 	Contractor	Detailed design / Pre-construction	Standard safeguard TT1 Section 4.8 of QA G36 <i>Environment Protection</i>

Impact	Environmental safeguards	Responsibility	Timing	Reference
	<ul style="list-style-type: none"> • Consideration of other developments that may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • Monitoring, review and amendment mechanisms. 			

6.2 Noise and vibration

6.2.1 Methodology

A noise and vibration impact assessment (Resonate, 2020) was prepared to quantify the potential noise impacts on sensitive receivers associated with the construction and operation of the proposal. The noise assessment was undertaken in accordance with the *Noise Criteria Guideline and Noise Mitigation Guideline*. The assessment of construction noise and vibration impacts was undertaken in accordance with *Construction Noise and Vibration Guideline* and the Department of Environment and Climate Change's *Interim Construction Noise Guideline* and other supporting standards.

The full assessment is provided at Appendix F.

The specialist noise and vibration assessment carried out to assess the impacts of the proposal comprised:

- Identifying noise and vibration sensitive receivers within the study area
- Determining the background noise levels within the study area
- Predicting how building and operating the proposal would impact on noise and vibration-sensitive receivers
- Identifying those adverse impacts that would need safeguarding or managing under the proposal.

The methodology undertaken in the noise and vibration impact assessment are outlined below.

Background noise modelling

Ambient noise monitoring and traffic counts were undertaken within the proposal in November 2019. Attended noise measurements were also undertaken to determine the nature of the local noise environment. Weather data recorded during the noise monitoring survey periods was obtained from the Bureau of Meteorology weather station at Richmond RAAF Base.

Unattended and attended ambient noise monitoring was undertaken at three locations as outlined in Table 6.10 and shown in Figure 6-5. Results were processed in accordance with the procedures contained in the NSW Environmental Protection Authority's (EPA) NSW Road Noise Policy (RNP). Traffic counts were taken concurrently to verify the operational noise model.

Table 6.10: The location of unattended noise monitoring

ID	Address	Monitoring period	Location description	Approximate setback distance from the edge of the nearest road
U1	70 Garfield Road	21 Nov 2019 to 2 Dec 2019	Logger installed on front balcony	20
U2	172 Garfield Road	21 Nov 2019 to 2 Dec 2019	Free field in yard	15
U3	271 Garfield Road	21 Nov 2019 to 2 Dec 2019	Fence located on the front yard	75
U4	793 Windsor Road	21 Nov 2019 to 2 Dec 2019	Free-field near neighbour's wire fence	40

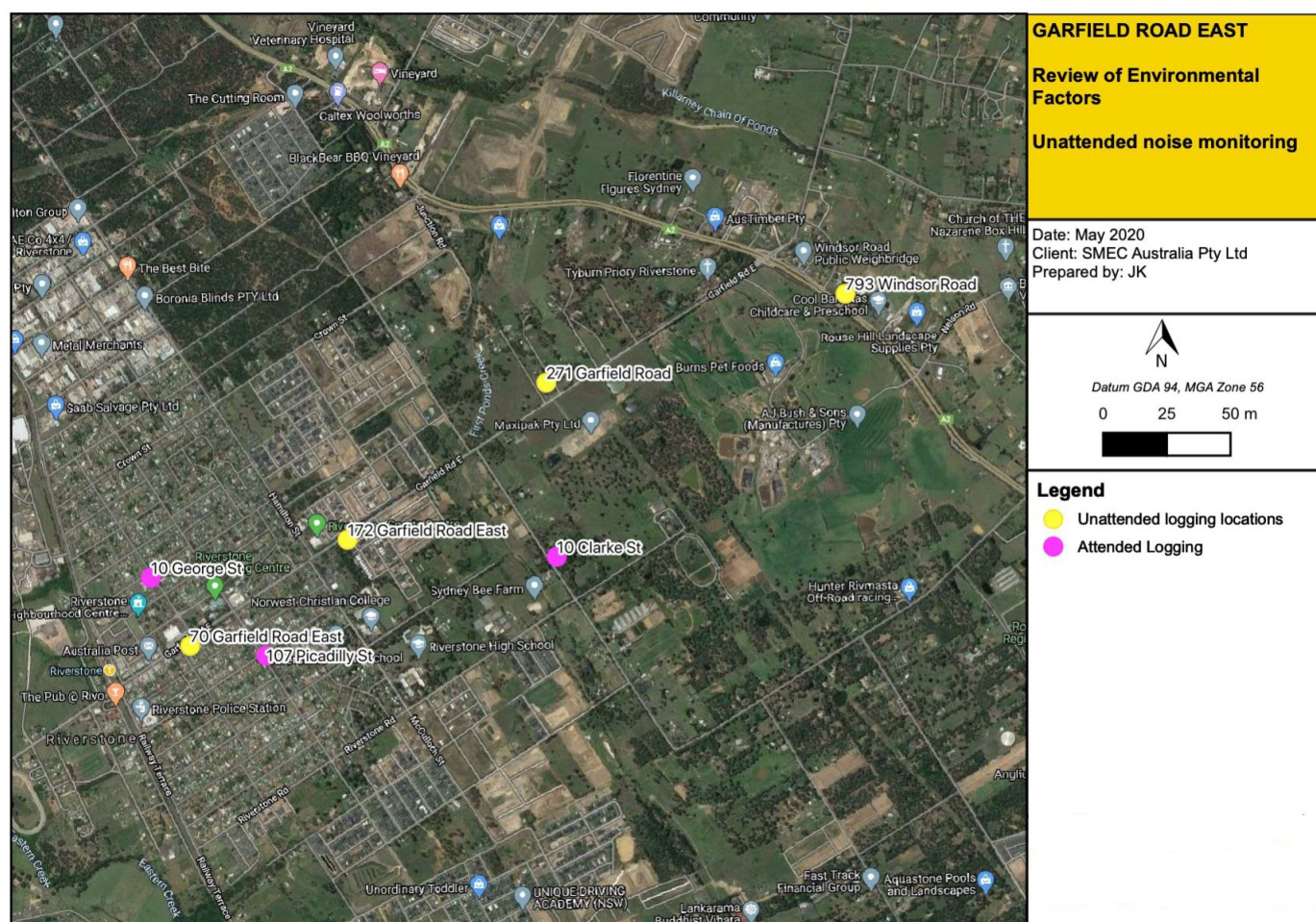


Figure 6-5: Location of unattended noise monitoring

Construction noise

Based on the proposal features, six construction scenarios have been identified. These scenarios are presented in the noise and vibration assessment report in Appendix F. The construction equipment and associated sound power levels typically used in these construction scenarios are also identified. The

monitoring data was used to validate the operational road traffic noise model and establish construction noise management levels.

Noise levels due to the construction activities have been predicted at nearby noise sensitive receivers using SoundPLAN noise modelling software v8.1. The modelling used the CONCAWE algorithm and includes ground topography, buildings, structures and representative construction noise sources.

Construction vibration

The minimum working distances as presented in the Roads and Maritime CNVG were applied to the proposed vibration intensive construction activities. A buffer zone was created and marked out to indicate receivers which may be impacted by vibration during construction.

Operational noise

An operational road traffic noise assessment has been completed in accordance with the RNP NCG and NMG. An existing road traffic noise model was developed incorporating the existing traffic flows and alignment for validation with road traffic noise measurements. The CoRTN algorithm was utilised to calculate road traffic noise. For a proposal corridor of 600 metres either side of the roadway, this algorithm has a well-documented accuracy of ± 2 dB(A). If the differences between measured and predicted road traffic noise levels fall within this margin, then the model is considered to have a suitable level of accuracy for that location.

The existing road traffic noise model was then updated with the proposed alignment and future traffic flows and used to predict future road traffic noise levels. These road traffic noise levels were assessed in accordance with the RNP and the NMG.

Noise assessment study area

The study area as comprising locations within a distance of 600 metres from the proposal alignment.

To facilitate the assessment of noise impacts from the proposal, noise sensitive receivers within the study area have been divided into Noise Catchment Areas (NCAs). NCAs extend as far back from the proposal as is required to ensure all areas of lower background noise are included and therefore, worst case construction noise impacts would be identified. This ensures the determined mitigation measures would address impacts at all receivers.

A total of eight NCAs have been identified for the noise sensitive areas surrounding the proposal. The summary and location of the NCAs for the proposal are detailed in Table 6.11 and shown in Figure 6-6.

Table 6.11: Description of noise catchment areas surrounding the proposal

ID	Receiver description	Minimum distance from the nearest road to the worst affected receiver (m)
NCA1	<ul style="list-style-type: none"> Low density residential Windsor Road passes through this NCA East of the proposal area 	10
NCA2	<ul style="list-style-type: none"> Low density residential Windsor Road passes through this NCA North of the proposal area 	40
NCA3	<ul style="list-style-type: none"> Low density residential and farmland 	50

ID	Receiver description	Minimum distance from the nearest road to the worst affected receiver (m)
	<ul style="list-style-type: none"> South of the proposal alignment located between Edmund Street and Windsor Road 	
NCA4	<ul style="list-style-type: none"> Medium density residential Located north of the proposal alignment between Hamilton Street and Edmund Street 	20
NCA5	<ul style="list-style-type: none"> Medium density residential Located south of the proposal alignment between McCullough Street and Edmund Street 	10-15
NCA6	<ul style="list-style-type: none"> Medium density residential Located to the north of Garfield Road East between Railway Terrace and Hamilton Street 	10-15
NCA7	<ul style="list-style-type: none"> Medium density residential Located to the south of Garfield Road East between Railway Terrace and McCullough Street 	10-15
NCA8	<ul style="list-style-type: none"> Low density residential Located west of the proposal alignment, west of Railway Terrace 	10

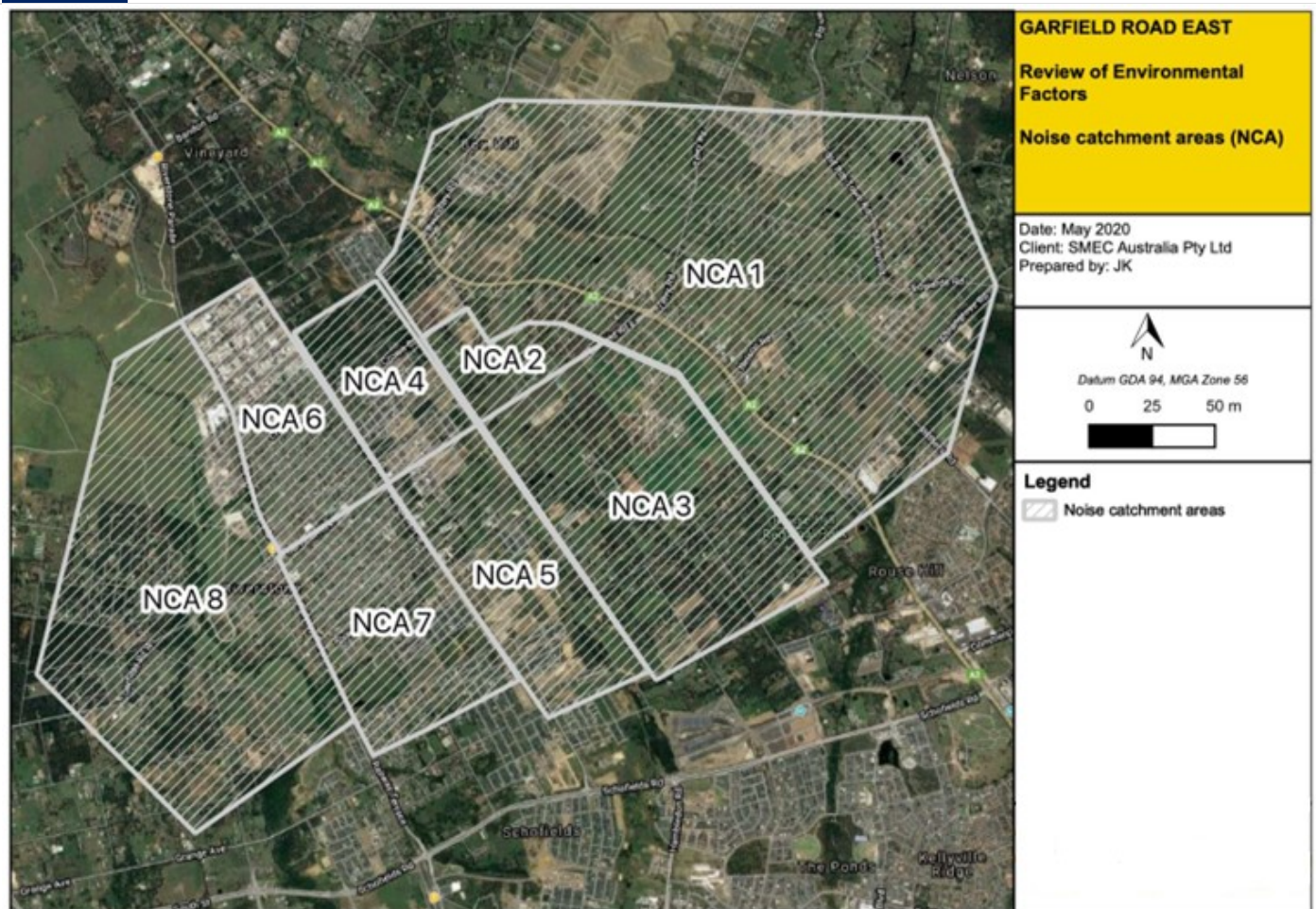


Figure 6-6: Noise catchment area map for the proposal

6.2.2 Existing environment

Surrounding land use and receivers

The acoustic environment within and around the proposal area is considered to be urban at the western end and gradually transitions to rural properties at the eastern end of the proposal. The proposal is dominated by road traffic noise from the existing Garfield Road East. Other key movements include railway movements at Riverstone Station.

Noise sensitive receivers within the proposal and directly next to the proposal have been divided into Noise Catchment Areas (NCAs). NCAs extend as far back from the proposal as is required to ensure all areas of lower background noise are included and therefore, worst case construction noise impacts would be identified. This ensures that the determined mitigation measures would address impacts at all receivers.

As discussed above, a total of eight NCAs have been identified for the noise sensitive areas surrounding the proposal. The summary and location of the NCAs for the proposal are detailed in Table 6.11.

Background noise levels

The existing rating background levels (RBL) and ambient (road traffic) noise levels as determined from unattended noise monitoring are presented in Table 6.12.

Noise levels have been predicted in the form of noise contours assessed at 1.5 metres above the ground level for each assessment scenario.

Table 6.12: Unattended ambient and background noise levels

ID	Location	Noise level dB(A)							
		Day		Evening		Night		Day 15 hour (7am-10pm)	Night LA90, 15 min
		RBL	Leq	RBL	Leq	RBL	Leq	LAeq - 15 hour	LAeq - 9 hour
U1	70 Garfield Road	49	63	47	60	39	59	62.4	58.5
U2	172 Garfield Road	46	58	42	54	30	53	57.2	52.5
U2	271 Garfield Road	44	54	43	53	33	54	53.4	51.4
U4	793 Windsor Road	48	59	48	58	36	56	58.7	56.5

Note: day; 7am to 6pm, evening; 6pm to 10pm; night; 10pm to 7am

6.2.3 Criteria

Construction noise

Noise management levels

The CNVG outlines methodology for determining NMLs for construction work based on classification of potentially noise affected receiver land use type.

The NMLs for residential and aged care receivers for both standard working hours and periods outside of the standard working hours are presented in Table 6.13. The NMLs would apply at the property boundary most exposed to construction noise. If the residence is more than 30 metres from the boundary, the NML applies to the most noise affected position within 30 metres of the residence.

The ICNG also establishes NMLs for other noise sensitive land uses. The NMLs for those other sensitive land uses identified for the proposal are presented in Table 6.14.

Table 6.13: Noise Management Levels for residential land uses (ICNG)

Time of day	Noise management level, LAeq (15 minute)	Actions
Standard hours: Monday to Friday: 7am to 6pm Saturday: 8 am to 1 pm,	Noise affected RBL +10 dB(A)	<p>May be some community reaction to noise.</p> <p>Where the predicted or measured construction noise level exceeds the noise-affected level, all feasible and reasonable work practices should be applied to meet the noise affected level.</p> <p>All residents potentially impacted by the works should be informed of the nature of the works, the expected noise levels and duration, and provided with site contact details</p>
	Highly noise affected >= 75 dB(A)	<p>May be strong community reaction to noise.</p> <p>Where construction noise is predicted or measured to be above this level, the relevant authority may require respite periods that restrict the hours that the very noisy activities can occur.</p> <p>Respite activities would be determined taking into account times identified by the community when they are less sensitive to noise, and if the community is prepared to accept a longer period of construction to accommodate respite periods</p>
Out of Hours Work (OoHW)	Noise affected RBL +5 dB(A)	<p>Strong justification typically required for these works. All feasible and reasonable work practices should be adopted. Where all feasible and reasonable work practices have been adopted and noise level is more than 5 dB(A) above the NML, negotiation should be undertaken with the community.</p>

Table 6.14: Noise Management Levels for other land uses

Land use	Noise management level, LAeq(15 minute)
Classrooms at schools and other educational institutions	Internal noise level – 45 dB(A)
Places of worship	Internal noise level – 45 dB(A)
Active recreation areas (characterised by sporting activities and activities that generate their own noise or focus for participants, making them less sensitive to external noise intrusion).	External noise level – 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion (i.e. reading and meditation).	External noise level – 60 dB(A)
Community centres	Dependent on the intended use. Refer to the recommended 'maximum' internal levels in AS/NZS 2107.
Industrial premises	75 dB
Commercial premises	70 dB

Note: Noise management levels only apply when premises are in use

Road noise

Guidance from the RNP for the assessment of noise arising from construction traffic on public roads was used to assess noise impacts from construction traffic. An initial screening test has been undertaken by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A). Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion, then noise mitigation should be considered for those receivers affected.

Sleep disturbance

The CNVG considers night works exceeding an external L_{Amax} sound pressure level at a receiver of 65 dB to impact upon occupant sleep amenity.

Construction vibration

Ground vibration generated by construction can have a range of effects on buildings and building occupants, with the main effects generally classified as:

- Human disturbance - disturbance to building occupants: vibration which inconveniences or interferes with the activities of the occupants or users of the building
- Effects on building structures – vibration that may compromise the condition of the building structure itself

Human comfort criteria are more stringent than structural damage criteria as humans are able to detect vibration at lower levels than at levels that would pose a risk of damage to a building or its contents. Therefore, the human comfort criteria are aimed at avoiding human annoyance.

Standards or guidelines used to assess construction vibration are as follows:

- Cosmetic and structural damage to buildings: *German Standard DIN 4150-33*
- Cosmetic damage to buildings: *British Standard BS 7385 Part 2-19934*
- Human comfort: EPA's Assessing Vibration - a technical guideline.

Table 6.15: DIN 4150-3 vibration cosmetic and structural damage criteria

Structure type	Peak particle velocity (PPV) mm/s			
	Foundation of structure			Vibration at horizontal plane of highest floor at all frequencies
	<10 Hz	10-50 Hz	50-100 Hz	
Buildings used for commercial, industrial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwelling and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in rows 1 and 2, and are of great intrinsic value (e.g. heritage-listed buildings)	3	3 to 8	8 to 10	8

Table 6.16: VDV management levels for intermittent vibration

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		Frequency range	
		4-15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

(1) Values referred to are at the base of the building.

(2) For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded

Table 6.17: Daytime Root-Mean-Square vibration velocity levels management levels for continuous and impulsive vibration

Receiver	Continuous vibration Root-Mean-Square vibration velocity levels, mm/s		Impulsive vibration Root-Mean-Square vibration velocity levels, mm/s	
	Preferred	Maximum	Preferred	Maximum
Residences – daytime	0.2	0.4	6	12
Residences – night-time	0.14	0.28	2	4
Offices, schools, place of worship	0.4	0.8	13	26
Workshops	0.8	1.6	13	26

Table 6.18: Vibration Dose Value management levels for intermittent vibration

Receiver	Vibration Dose Value - Intermittent vibration, m/s ^{1.75}	
	Preferred	Maximum
Residences – daytime	0.2	0.4
Residences – night-time	0.13	0.26
Offices, schools, place of worship	0.4	0.8
Workshops	0.8	1.6

Operational noise

Road traffic noise

Noise criteria are assigned to sensitive receivers using TfNSW's Noise Criteria Guideline (NCG). The NCG provides guidance on how to implement the RNP. The assessment timeframes for the criteria are in the year of opening and 10 years after opening.

Residences may be assigned new, redeveloped, transition zone or relative increase criteria depending on how the proposal influences noise levels. For each facade of the residence the most stringent applicable criteria have been used in the assessment.

The area surrounding the proposal is under development and that there is the potential for an increase in the number of receivers within the proposal study area. The receivers assessed within this assessment have been based upon the receivers that have been noted using high-resolution aerial images from March 2020. The receivers should be further reviewed during detailed design.

Criteria are based on the road development type a residence is affected due to the proposal. In some instances, residences may be exposed to noise from both new and redeveloped roads.

Table 6.19: NCG criteria for residential land use

Road category	Type of proposal/land use	Assessment criteria (dB)	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	LAeq(15hour) 55 (external)	LAeq(9hour) 50 (external)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	LAeq(15hour) 60 (external)	LAeq(9hour) 55 (external)
	3. Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments		
Local roads	4. Existing residences affected by noise from new local road corridors	LAeq(1hour) 55 (external)	LAeq(1hour) 50 (external)

Road category	Type of proposal/land use	Assessment criteria (dB)	
		Day (7am-10pm)	Night (10pm-7am)
	5. Existing residences affected by noise from redevelopment of existing local roads 6. Existing residences affected by additional traffic on existing local roads generated by land use developments		

The relative increase criterion is designed to account for large increases in traffic noise levels that may impact residential receivers that currently experience low levels of traffic noise. This is achieved by having a criterion that is set 12 dB above the existing traffic noise levels during the daytime or night-time periods. No minimum criterion is set for the relative increase criterion in order to capture residences where the existing road traffic noise level is sufficiently low that the minimum criterion from Table 6.20 would not be exceeded even with a 12 dB increase. The relative increase criteria are as shown in

Table 6.20: Relative increase criteria for residential land uses

Road category	Type of proposal/land use	Total traffic noise level increase	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial roads and transitways	New road corridor/ redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic LA _{eq} (15hour) +12 dB (external)	Existing traffic LA _{eq} (9hour) +12 dB (external)

Cumulative noise

The cumulative limit applies when the total noise level in the design build year is 5 dB(A) or more above the NCG criterion. The cumulative limit does not apply where the proposal roads (new road or redeveloped section of road) adds less than 2 dB(A) to the total noise level at a given facade for the design build year.

Acute

Where predicted noise levels at residential receivers exceed 65 dB(A) Leq,15h (daytime) or 60 dB(A) Leq,9h (night-time), then road traffic noise levels are considered to be 'acute'. Residential receivers exposed to 'acute' noise levels as part of a road proposal are considered for mitigation regardless of the increase associated with the proposal, as long as the dominant noise at the receiver is due to the proposal.

Table 6.21: NCG criteria for non-residential sensitive land uses

Existing sensitive land uses	Assessment criteria (dB(A))		Assessment criteria (dB)
	Day (7am-10pm)	Night (10pm-7am)	
1. School classrooms	LAeq(1hour) 40 (internal)	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2016 (Standards Australia 2016)
2. Hospital wards	LAeq(1hour) 35 (internal)	LAeq(1hour) 35 (internal)	
3. Places of worship	LAeq(1hour) 40 (internal)	LAeq(1hour) 40 (internal)	The criteria are internal, i.e. the inside of a church. Areas outside the place of worship, such as a churchyard or cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what is in these areas that may be affected by road traffic noise
4. Open space (active use)	LAeq(15hour) 60 (external) when in use	-	For example, if there is a church car park between a church and the road, compliance with the internal criteria inside the church may be sufficient. If, however, between the church ^[1] and the road are areas where outdoor services may take place such as weddings and funerals, external criteria for these areas are appropriate. As issues such as speech intelligibility may be a consideration in these cases, the passive recreation criteria (see point 5) may be applied. Active recreation is characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion
5. Open space (passive use)	LAeq(15hour) 55 (external) when in use	-	
6. Isolated residences in commercial or industrial zones	-	-	Passive recreation is characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, e.g. playing chess, reading
7. Mixed use development	-	-	Each component of use in a mixed use development should be considered separately.
8. Child care facilities	Sleeping rooms LAeq (1hour), 35 (internal)	-	Multipurpose spaces, e.g. Shared indoor play/sleeping rooms should meet the lower of the respective criteria.

Existing sensitive land uses	Assessment criteria (dB(A))		Assessment criteria (dB)
	Day (7am-10pm)	Night (10pm-7am)	
	Indoor play areas LAeq (1hour), 40 (internal) Outdoor play areas LAeq (1hour) 55 (external)		Measurements for sleeping rooms should be taken during designated sleeping times for the facility, or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.
9. Aged care facilities	-	-	Residential land use noise assessment criteria should be applied to these facilities, see Table 6.19.

Note: Land use developers must meet internal noise goals set for sensitive developments alongside busy roads as identified in the Infrastructure SEPP

6.2.4 Potential impacts

Construction

Construction noise levels

Six representative construction noise scenarios were identified for the proposal. Construction noise modelling was based on construction equipment and associated sound power levels that would typically be used in these construction scenarios. The construction equipment and associated sound power levels (SWL) typically used in these construction scenarios are also identified in Table 6.22.

The following scenarios have been assumed for the construction noise assessment.

Table 6.22: Relative increase criteria for residential land uses

Stage	Plant and equipment of proposal/land use	Lw(dB(A))
Site establishment	Dump truck	110
	Generator	103
	Ute/crew truck	103
	Excavator	110
	Chainsaw	107
	Chipper/mulcher	116
	Water cart	107
	Franna crane	98
	Total Lw	119
	Total Lw including operating times	116
Main components	Front end loader	111
	Excavator	110
	Compressor 8.5 m3/min	102
	Franna crane	98
	Roller (vibratory)	109
	Generator	103
	Total Lw	115
	Total Lw including operating times	115
Demolition	Excavator	110
	Excavator with hammer	122
	Bulldozer D9	116

Stage	Plant and equipment of proposal/land use	Lw(dB(A))
	Dump truck	110
	Total Lw	123
	Total Lw including operating times	121
Earthworks and drainage	Dump truck	110
	Bulldozer D9	116
	Excavator	110
	Concrete pump truck	109
	Concrete agitator	109
	Total Lw	119
	Total Lw including operating times	117
Pavement construction	Chainsaw	107
	Pavement profiler	117
	Backhoe with auger	111
	Dump truck	110
	Water cart	107
	Roller (vibratory)	109
	Excavator	110
	pavement profiler	117
	Total Lw	122
	Total Lw including operating times	119
Finishing work	Dump truck	110
	Generator	103
	Ute/crew truck	103
	Franna crane	98
	Total Lw	112
	Total Lw including operating times	110

Work practices and equipment used in each of the scenarios may change during detailed design and construction, however the conservative approach adopted for noise predictions means that actual noise levels are unlikely to be appreciably higher than the predictions. Modelling using SoundPLAN v8.1 was undertaken, which includes topography, buildings, structures and representative noise construction sources.

The predicted construction noise impacts to residential receivers are presented in Table 6.23.

Table 6.23: Relative increase criteria for residential land uses

ID	Logger	Noise management levels (NMLs)			
NCA1	U4	Day standard hours	Day OOHW	Evening OOHW	Night OOHW
NCA2	U3	58	53	53	41
NCA3	U3	54	49	48	38
NCA4	U2	54	49	48	38
NCA5	U2	56	51	47	35
NCA6	U1	56	51	47	35
NCA7	U1	59	54	53	44
NCA8	U1	59	54	53	44

OOHW = Out of hours work

A summary of the construction impacts at each NCA are discussed below.

NCA 1

Noise levels at residential receivers within NCA 1 would range between no exceedance of the NML to the highly noise affected level, with noise levels ranging between less than 35 dB(A) to greater than 80 dB(A).

Sensitive receivers within 50 metres of the proposal are expected to be highly noise affected during stages of construction where high noise intensive plant would be used such as during the demolition of the road. Impacts would vary and be depended on the stage of work and the proximity of the work to the receivers.

Standard construction hour NML exceedances are predicted at receiver locations up to about 250 metres, with noise levels exceeding 58 dB(A). Other sensitive land uses such as commercial receivers are expected to comply with construction NML's.

Where OOHW works are required within NCA 1, NML exceedances would range between no exceedance to exceedances greater than 39 dB are expected.

NCA 2

Noise levels at residential receivers within NCA 2 would range between no exceedance of the NML to the highly noise affected level, with noise levels ranging between less than 45 dB(A) to greater than 80 dB(A).

Sensitive receivers within 50 metres of the proposal are expected to be highly noise affected during stages of construction where high noise intensive plant would be used such as during the demolition of the road. Impacts would vary and be depended on the stage of work and the proximity of the work to the receivers.

Standard construction hour NML exceedances are predicted at receiver locations up to about 250 metres, with noise levels exceeding 54 dB(A).

Where OOHW works are required within NCA 2, NML exceedances ranging from no exceedance to exceedances greater than 34 dB are expected.

NCA 3

Noise levels at residential receivers within NCA 3 would range between no exceedance of the NML to the highly noise affected level, with noise levels ranging between less than 35 dB(A) to greater than 80 dB(A).

Residential receivers within 50 metres of the proposal are expected to be highly noise affected during stages of construction where high noise intensive plant would be used such as during the demolition of the road. Impacts would vary and be depended on the stage of work and the proximity of the work to the receivers.

Standard construction hour NML exceedances are predicted at receiver locations up to about 200 metres, with noise levels exceeding 54 dB(A). Other sensitive land uses such as commercial receivers are expected to comply with construction NML's.

Where OOWH works are required within NCA 3, NML exceedances ranging from no exceedance to exceedances greater than 37 dB are expected.

NCA 4

Noise levels at residential receivers within NCA 4 would range between no exceedance of the NML to the highly noise affected level, with noise levels ranging between less than 35 dB(A) to greater than 80 dB(A).

Residential receivers within 50 metres of the proposal are expected to be highly noise affected during stages of construction where high noise intensive plant would be used such as during the demolition of the road. Impacts would vary and be depended on the stage of work and the proximity of the work to the receivers.

Standard construction hour NML exceedances are predicted at receiver locations up to about 250 metres, with noise levels exceeding 56 dB(A).

Other sensitive land uses located in the NCA 4 are places of worship. Kingdom Hall of Jehovah's Witnesses is located about 600 metres from the works on Garfield Road East. External construction noise levels are predicted to exceed 45 dB(A). Criterion for external noise levels for a place of worship is 55 dB(A).

Riverstone Community Church of Cristian Brethren is located about 20 metres from the works on Garfield Road East. Construction noise levels at the place of worship are predicted to exceed 80 dB(A) as an external level. This would be an exceedance of 25 dB for works in the vicinity of the church.

Commercial receivers are expected to comply with the NML for NCA 4.

Where OOWH works are required within NCA 1, NML exceedances ranging from no exceedance to exceedances greater than 45 dB are expected.

NCA 5

Noise levels at residential receivers within NCA 5 would range between no exceedance of the NML to the highly noise affected level, with noise levels ranging between less than 35 dB(A) to greater than 80 dB(A).

Residential receivers within 50 metres of the proposal are expected to be highly noise affected during stages of construction where high noise intensive plant would be used such as during the demolition of the road. Impacts would vary and be depended on the stage of work and the proximity of the work to the receivers.

Standard construction hour NML exceedances are predicted at receiver locations up to about 250 metres, with noise levels exceeding 56 dB(A).

Other sensitive land uses with this NCA include educational facilities, places of worship and commercial receivers.

Riverstone High School is located about 650 metres from the proposal. Noise levels are expected to be above 45 dB(A) depending on the location and the type of works taking place along the proposal. Noise levels are predicted to exceed the NML for educational facilities but is not the NML criteria for NCA 5.

Norwest Christian College is located about 300 metres from the proposal. Noise levels are expected to be above 55 dB(A) depending on the location and the type of works taking place along the proposal. Noise levels are predicted to exceed the NML by 5 dB for works taking place in closest proximity to the school.

St John's Primary School is located about 100 metres from the proposal. Noise levels are expected to be above 75 dB(A) at the school depending on the location and the type of works taking place along the proposal. Construction noise at this level is in the category of highly noise affected. Exceedance would be around 25 dB for works in close proximity to the school.

Saint John the Evangelist Parish is located close to the proposal and noise levels at the church are predicted to exceed 80 dB(A). This would be a 25 dB exceedance of the NML for works carried out in closest proximity to the church.

Commercial receivers are expected to comply with the NML

Where OOWH works are required within NCA 5, NML exceedances ranging from no exceedance to exceedances greater than 45 dB are expected.

NCA 6

Noise levels at residential receivers within NCA 6 would range between no exceedance of the NML to the highly noise affected level, with noise levels ranging between less than 35 dB(A) to greater than 80 dB(A).

Residential receivers within 50 metres of the proposal are expected to be highly noise affected during stages of construction where high noise intensive plant would be used such as during the demolition of the road. Impacts would vary and be depended on the stage of work and the proximity of the work to the receivers.

Standard construction hour NML exceedances are predicted at receiver locations up to about 200 metres, with noise levels exceeding 59 dB(A).

Other land uses in the NCA include outdoor recreation, places of worship and commercial receivers.

Riverstone Swimming Centre outdoor pool is located within about 50 metres of the proposal. Noise levels are expected to be above 80 dB(A) during some construction activities. Noise levels are predicted to exceed with the NML for active outdoor recreational facilities. This would be a 15 dB exceedance for works in closest proximity to the pool.

Hosanna World Harvest Church/Voice of Victory Church is located in close proximity of the proposal. Noise levels at the church are predicted to be 60 dB(A). This would be a 5 dB exceedance for works undertaken in closest proximity of the church.

Predicted noise levels at the closest commercial receiver is about 85 dB(A) and represents an NML of 15 dB. Other commercial receivers in NCA 6 are expected to comply with the NML.

Where OOWH works are required within NCA 1, NML exceedances ranging from no exceedance to exceedances greater than 36 dB are expected.

NCA 7

Noise levels at residential receivers within NCA 7 would range between no exceedance of the NML to the highly noise affected level, with noise levels ranging between less than 35 dB(A) to greater than 80 dB(A).

Residential receivers within 50 metres of the proposal are expected to be highly noise affected during stages of construction where high noise intensive plant would be used such as during the demolition of the road. Impacts would vary and be depended on the stage of work and the proximity of the work to the receivers.

Standard construction hours NML exceedances are predicted for sensitive receivers located up to about 200 metres, with noise levels exceeding 59 dB(A).

Other sensitive receivers located within NCA 7 include education facilities, places of worship and commercial receivers.

Casuarina School is located about 20 metres from the proposal. Noise levels above 80 dB(A) are predicted at the school depending on the location and type of work undertaken. The school comprises of numerous buildings at varying offset distances from the proposal alignment and noise impacts would vary at each building. Noise levels are predicted to exceed with the NML for educational facilities by 25 dB during works undertaken in close proximity to the school.

Riverstone Public School is located approximately 250 metres from the construction footprint. Noise levels up to 60 dB(A) are predicted at this location depending on the location and type of work undertaken. Noise levels are predicted to exceed the NML for educational facilities by 5 dB during works undertaken in close proximity to the school.

Ready 2 Learn Riverstone is located about 70 metres from the proposal. Noise levels above 80 dB(A) are predicted at school depending on the location and type of construction activity. Noise levels are predicted to exceed the NML for educational facilities by 25 dB exceedance from works in closest proximity

St Andrews Uniting Church is located close to works on Garfield Road East. Noise levels at the church are predicted to be approximately 70 dB(A). This would be an approximate 15 dB exceedance during works undertaken in close proximity to the church.

Predicted noise levels at the closest commercial receiver are expected to be 90 dB(A). This is an exceedance of the NML by 20 dB. Other commercial receivers in NCA 7 are expected to comply with the NML.

Where OOWH works are required within NCA 7, NML exceedances ranging from no exceedance to exceedances greater than 36 dB are expected.

NCA 8

Noise levels at residential receivers within NCA 8 would range between no exceedance of the NML to the highly noise affected level, with noise levels ranging between less than 35 dB(A) to greater than 50 dB(A).

There would be no exceedance of the NML at sensitive receivers within NCA 8 during stages of construction of the proposal.

Other sensitive land uses within NCA 8 include commercial receivers. Predicted noise levels at these receivers are expected to comply with the NML.

Where OOWH works are required within NCA 1, NML exceedances ranging from no exceedance to exceedances greater than 5 dB are expected.

Construction vibration

The CNVG provides guidelines for minimum working distances for vibration-intensive activities. Minimum distances for the proposal range up to 55 metres.

Separation distance from the nearest receivers to the proposal would be sufficient to mitigate potential impacts. As such it is considered that structural or cosmetic damage impacts from vibration intensive works are generally unlikely for most of the adjacent receivers. Where work is proposed to be carried out within the safe working distances the mitigation measures outlined in section 6.2.5 should be implemented to reduce the impacts as far as practicable.

The proposal alignment is located adjacent to buildings and structures that have been identified as being heritage listed or of significance from a heritage perspective. Table 6.24 shows an estimate of the minimum distance to the proposal.

Table 6.24: Minimum distance to works for heritage listed items

Name	Address	Minimum distance to works
The Riverstone Museum	81 Garfield Road East	5 m
Riverstone Public School	100 Garfield Road East	3 m
St John The Evangelist Parish	164 Garfield Road East	4 m
Saint Clare's Convent	166 Garfield Road East	5 m
-	213 Garfield Road East	55 m

Heritage listed items and/or buildings and structures of historical value should not be assumed to be more vibration sensitive and therefore, compliance with the minimum distances provided in Table 6.24 above would result in low risk cosmetic damage to the building or structure. However, vibration intensive plant such as large vibratory rollers and hydraulic hammers have the potential to exceed the most stringent DIN4150 criterion of three millimetres per second for vibration sensitive structures.

It is recommended that a review of the vibration sensitivity of these structures be completed as part of the detailed design or pre-construction planning phases in order to confirm the appropriateness of the minimum working distance assessment and apply management protocols if required.

Operation

As part of the operational noise assessment, the measured noise levels were compared to the predicted noise levels from the noise model for validation purposes. A summary of the validation model parameters are provided in Table 6.25.

Table 6.25: Validation of model parameters

Parameter	Comments	Correction
Existing roads	Dense graded asphalt or equivalent	+0 dB
Proposed roads	Dense graded asphalt or equivalent	+0 dB
Truck corrections	25% for tyre noise 60% for engine noise 15% for exhaust noise	-
Australian Road Research Board correction	1 m from façade	-1.7 dB
Australian Road Research Board correction	Free field	-0.7 dB
Facade Correction	For predictions at 1 m from building façade +2.5 dB	-
Vehicle correction	-	-
Traffic volumes	-	-

The predicted noise levels were compared to measured noise levels at unattended noise monitoring locations as presented in Table 6.26.

The unattended monitoring location U4 was used as a background noise logger for the noise assessment and therefore is not included in the road traffic noise model validation table presented below.

Table 6.26: Validation of model parameters measured compared to predicted noise levels

Reference	Location	Daytime road noise level (dB(A))			Night-time road noise level (dB(A))		
		Measured	Predicted	Difference	Measured	Predicted	Difference
U1	70 Garfield Rd East	62.4	63.0	0.6	58.5	58.3	-0.2
U2	172 Garfield Rd East	57.2	59.0	1.8	52.5	54.3	1.8
U3	271 Garfield Rd East	53.4	55.0	1.6	51.4	49.9	-1.5
Mean difference				1.6			- 0.2

A comparison of the modelled versus measured noise levels showed the following:

- A median prediction of 1.6 dB during the daytime period
- A median prediction of -0.2 dB during the night-time period.

The predicted and measured road traffic noise levels agree within a median tolerance of ± 2 dB, which is considered a suitable level of accuracy for road traffic noise proposals. Due to the good correlation between the measured and predicted noise levels, no additional calibration factors were required.

Predicted noise levels

Noise levels for the proposal were predicted in the form of noise contours assessed at 1.5 metres above the ground level for each assessment scenario. These noise contours are presented in the Noise Assessment at Appendix F.

Noise levels have been predicted at every facade at every floor of each potentially affected noise sensitive receivers.

The predicted noise levels for each location are tabulated as follows:

- Build (BLD) and No-Build (NBLD)
- Noise levels for each scenario
- An assessment of noise sensitive receiver locations at which noise mitigation should be considered.

A summary of the noise levels predicted is provided below:

- 121 properties along the proposal alignment have triggered for consideration of noise mitigation.

These properties triggered for consideration of noise mitigation are predominantly exceeding a greater than 2 dB increase between the No-Build and Build scenarios. This is due to the reduction in distance between Garfield Road East and the nearby receivers and also the increase in traffic that is expected along the proposal roads in the Build scenarios.

- Exceedances have been noted along McCulloch Street extending past the proposal alignment. This is due to the expected increase in traffic between the No-Build and Build scenarios that generates a greater than 2 dB increase in noise levels.

6.2.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Noise and vibration	<p>A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the Interim <i>Construction Noise Guideline</i> (ICNG) (DECC, 2009) and identify:</p> <ul style="list-style-type: none"> • All potential significant noise and vibration generating activities associated with the activity • Feasible and reasonable mitigation measures to be implemented, taking into account <i>Beyond the Pavement: urban design policy, process and principles</i> (Transport for NSW, 2014). • A monitoring program to assess performance against relevant noise and vibration criteria • Arrangements for consultation with affected property owners and sensitive receivers, including notification and complaint handling procedures • Contingency measures to be implemented in the event of non-compliance with noise and vibration criteria. 	Contactor	Detailed design / Pre-construction	Standard safeguard NV1 Section 4.6 of QA G36 <i>Environment Protection</i>
Noise and vibration	<p>All sensitive receivers such as schools and local residents likely to be affected will be notified at least seven days prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification will provide details of:</p> <ul style="list-style-type: none"> • The project • The construction period and construction hours • Contact information for project management staff • Complaint and incident reporting 	Contactor	Detailed design / Pre-construction	Standard safeguard NV2

Impact	Environmental safeguards	Responsibility	Timing	Reference
	<ul style="list-style-type: none"> How to obtain further information. 			
Construction noise	<ul style="list-style-type: none"> Work will be undertaken in accordance with the <i>Construction Noise and Vibration Guideline</i> (Roads and Maritime, 2016a) Stationary and directional noise sources will be orientated away from sensitive receivers Vehicles, obstacles and stockpiles will be utilised on site to provide shielding to receivers, especially for static noise sources Equipment that has noise levels equal to or less than the sound power levels will be used The simultaneous use of high noise generating equipment will be limited. The use will also be limited to standard hours where possible Plant will be switched off when not in use Plant, tools and equipment will be used such that noise is reduced to the minimum required. 	Contractor	Construction	Additional Safeguard NV3
Construction traffic noise	<p>The NVMP would include provisions to reduce the potential impact of construction traffic noise including:</p> <ul style="list-style-type: none"> Restricting travel routes to and from the project site to using the main roads and to avoid local roads and roads where residential receivers are potentially impacted Prohibiting the use of engine/compression brakes in or near residential areas 	Contractor	Construction	Additional Safeguard NV4

Impact	Environmental safeguards	Responsibility	Timing	Reference
	<ul style="list-style-type: none"> Promoting driving behaviour that reduces potential noise impacts Prohibiting idling of plant and equipment engines near residential receivers when not in use Strategic positioning of site accesses to minimise the chance of trucks passing by residential receivers, especially at night. 			
Construction vibration	<ul style="list-style-type: none"> Lower powered equipment will be used when working in close proximity to vibration sensitive receivers where possible Building condition /dilapidation surveys will be completed both before and after the work and attended vibration monitoring undertaken when work is proposed within the specified safe working distances Where work is required within the nominated safe working distance, additional vibration mitigation measures will be considered to avoid impact to buildings and/or human comfort. 	Contractor	Construction	Additional Safeguard NV5
Noise and vibration complaints	<ul style="list-style-type: none"> Attended noise and/or vibration monitoring will be undertaken following a complaint. Report the monitoring results as soon as possible. In the case that exceedances of the management levels are recorded, review the situation and identify means to reduce the impacts to noise and vibration sensitive receivers. This is to include revision to the CNVMP where required. 	Contractor	Construction	Additional Safeguard NV6

Impact	Environmental safeguards	Responsibility	Timing	Reference
Operational noise	<p>Mitigation measures to minimise operational noise will be investigated, including:</p> <ul style="list-style-type: none"> Quieter pavement surfaces and suitability of such pavement types for through lanes and areas of acceleration, deceleration and turning movements Noise barriers Property treatments for residually affected receivers. 	TfNSW	Detailed design	Additional Safeguard NV7
Property treatments	Where at property treatments are identified, consider implementing these at the commencement of construction. These treatments would alleviate any noise concerns/complaints during the construction period.	TfNSW	Construction	Additional Safeguard NV8

6.3 Hydrology and flooding

This section details the potential impact on hydrogeology, hydrology and flooding likely to occur or associated with construction and operation of the proposal. A Hydrological and Hydraulics Assessment (SMEC, 2019e) was prepared for the proposal to assess the potential impacts of the proposal on flooding, hydrology and drainage. The full assessment is provided in Appendix G of this REF.

The findings of the Hydrology and Hydraulics Assessment are provided in the following section.

6.3.1 Methodology

The assessment of surface water and flooding was completed in general accordance with relevant policy and guidelines. The assessment included a review of publicly available information to determine:

- Surface water characteristics of the proposal footprint
- The current drainage arrangements and discharge pathways across the study area, focusing on the proposal
- Potential flood risk potential across the proposal footprint
- Key activities that could potentially impact surface water and need safeguarding or managing under the proposal.

Central to the assessment was assessing the likelihood for the proposal to impact on the local surface waters and the wider catchment. The likelihood for the proposal to impact on the local surface waters and the wider catchment and therefore impact on the value of these resources, and to what extent these values would be likely affected by the proposal, has been considered as part of this assessment.

Exposure, contamination, migration, flood risk and change in quality were also considered in undertaking the assessment.

6.3.2 Study area

The study area considered the impact across the proposal, within the local surface water catchment of the South Creek sub-catchment of Hawkesbury Nepean catchment. Regional characteristics were used to provide a wider context and reference for the proposal.

6.3.3 Existing environment

Regional and local hydrology

The study area is located on the eastern most portion of the Eastern Creek floodplain, passing through First Ponds Creek and one of its tributaries; and several tributaries which form the Killarney Chain of Ponds.

The catchment of Eastern Creek is about 128 square kilometres and covers a minor portion of the proposal. The upstream catchment comprises largely of rural area with a moderate portion of urban land use. The proposal is situated on the outer limits of the Eastern Creek Catchment and is not affected by major catchment flow paths.

The catchment of First Ponds Creek is about 24 square kilometres and stretches across a major portion of the proposal. The upstream catchment comprises largely of rural area with little urban land use. Several major and minor tributaries of the First Ponds Creek Catchment pass through the proposal which have a total effective upstream catchment area of around nine square kilometres.

Flood risk

Flood producing mechanisms from the sub-catchments that form part of First Ponds Creek and Eastern Creek vary based on several characteristics including:

- Catchment size
- Slope
- Land use
- Surface roughness.

Three potential flooding mechanisms for the two catchment areas are:

- Local flooding
- Major and/or minor tributary flooding
- River flooding.

Local flooding

The proposal between George Street and just east of Hamilton Street are located along several flow paths belonging to smaller sub-catchments of Eastern Creek. This section of Garfield Road East can be affected by smaller sub-catchment flows. Response flows from these smaller urban sub-catchments can be faster than major tributary flooding. The critical storm duration for local flooding corresponds to about a 25 minute storm event.

Major and minor tributary flooding

Larger and more rural sub-catchments surrounding the proposal can affect Garfield Road East between Hamilton Street and Windsor Road. Upstream flows from the First Ponds Creek catchment to the proposal may contribute to potential flood impacts within the proposal. This results in longer flow response times for major tributaries during storm events with durations between two and six hours.

Three tributaries are located near the proposal:

- A single tributary forming part of First Ponds Creek, identified as Tributary First Ponds Creek No.1 (Tributary FPC No. 1)
- Two tributaries forming part of the Killarney Chain of Ponds, identified as Tributary Killarney Chain of Ponds No. 1 (Tributary KCP No. 1) and Tributary Killarney Chain of Ponds No.2 (Tributary KCP No. 2).

Figure 6-7 shows the major and minor tributary flow paths produced by the sub catchments of First Ponds Creek.

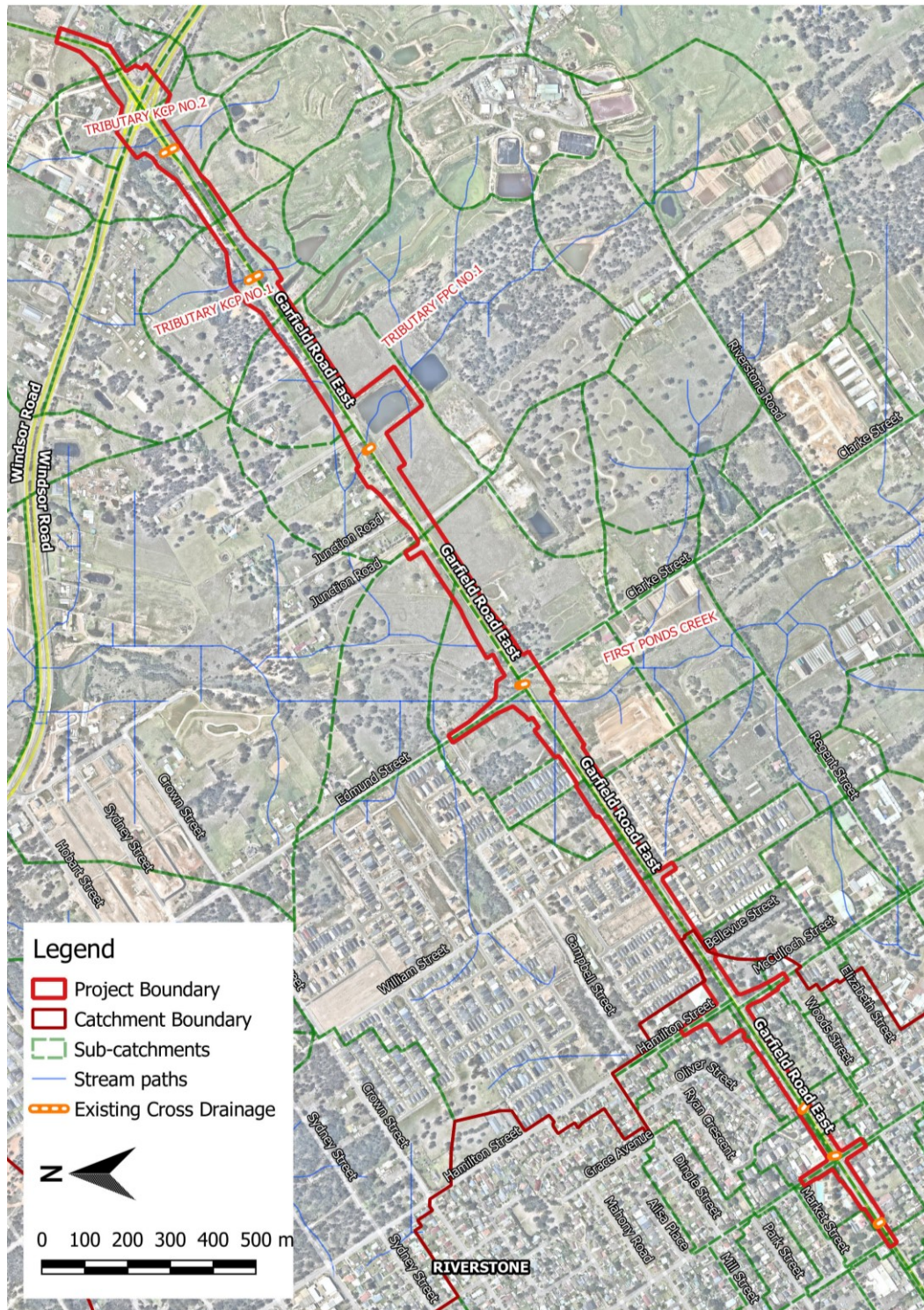


Figure 6-7: Regional and local hydrology

River flooding

Backwater flooding resulting from Eastern Creek and South Creek can arise during long duration events, typically greater than a 24 hour storm. For the 0.2 per cent Annual Exceedance Probabilities (AEP) flood event, a design flood level of 20.2 metres Australian Height Datum (AHD) is set out for the extent of the proposal.

The lowest section is 21 metres AHD at the western end tie-in. This section is not affected by river flooding.

Culvert and pipe (transverse) drainage

Table 6.27 summarises the existing drainage structures that would be affected along the road because of the proposal.

Table 6.27: Existing transverse drainage structures

Tributary ID	Chainage	Structure type	Approximate upstream catchment area (ha)
Eastern Creek	CH510	1 x 600 reinforced Concrete Pipe (RCP)	10.9
	CH0700	1 x 675 RCP	0.5
	CH0840	1 x 900 RCP	7.5
First Ponds Creek	CH2025	5 x 2400 x 1200 reinforced concrete box culvert (RCBC)	786
Tributary to First Ponds Creek	CH2685	2 x 1200 x 450 RCBC	74.2
Tributary to Killarney Chain of Ponds (1)	CH3175	1 x 525 pipe	10.3
Tributary to Killarney Chain of Ponds (2)	CH3540	1 x 1800 x 900 RCBC	13.6

Modelled flood behavior

Stormwater runoff from urban catchments readily flows onto Garfield Road East between Alan Street and McCulloch Street in events as frequent as the five per cent Annual Exceedance Probabilities (AEP) and extends to several private properties. Flooding is observed on the Hamilton Street and McCulloch Street flood evacuation routes in the existing scenario in events less than the five per cent AEP. Piccadilly Street north experiences flood depths up to 0.5 metres.

Flooding from First Ponds Creek overtops Garfield Road East in events as frequent as the five per cent AEP. Flood depths up 0.6 metres in the one per cent and 0.2 per cent are experienced at this crossing. Garfield Road East at First Ponds Creek is blocked by inundation depths greater than 0.15 metres for 65 metres, 170 metres and 190 metres for the five per cent, one per cent and 0.2 per cent AEP floods respectively. The depth of ponded water behind Garfield Road East at First Ponds Creek exceeds two metres in flood events as frequent as the five per cent AEP.

Flooding from Tributary First Ponds Creek No. 1 overtops Garfield Road East in events as frequent as the five per cent AEP by depths up to 0.10 metres, 0.15 metres and 0.2 metres for the five per cent, one per cent and 0.2 per cent AEP floods respectively. About 100 metres of Garfield Road East at about Tributary First Ponds Creek No. 1 is affected by flooding for the aforementioned flood events.

Tributary Killarney Chain of Ponds No. 1 ponds against Garfield Road East at a natural detention basin which allows low flows through the road from a 525 pipe. At this location, Garfield Road East is not overtopped in events as rare as the 0.2 per cent AEP flood.

Flooding from Tributary Killarney Chain of Ponds No. 2 extends onto Garfield Road East on south bound lanes in events as frequent as the five per cent AEP. Overtopping of the crown section of Garfield Road East occurs in the one per cent AEP.

Flood evacuation routes

Sections of Garfield Road East form part of the Hawkesbury Valley Way Evacuation Route. The primary route from Windsor directs traffic along Hamilton Street, continuing to McCulloch Street with an alternative route through Garfield Road East to Windsor Road. State Emergency Services currently indicate that in the event Garfield Road East is affected by local flooding, traffic are directed to continue through to McCulloch Street.

6.3.4 Potential impacts

Construction

Groundwater

Existing groundwater levels and flow paths may be affected by construction activities such as excavation works, including groundwater drawdown from dewatering, and the building of new road related infrastructure. No impacts to groundwater quality or groundwater resources are anticipated during construction of the proposal.

Flooding

The proposal is located within flood liable land. Potential localised flood risks would be considered prior to and during construction. With the implementation of appropriate mitigation measures as described in section 6.3.5, the potential for impacts from flooding is not considered to be significant.

Operation

Groundwater

Once the proposal becomes operational, there would be no net change in how the road impacts on groundwater levels, flows, recharge, quality or other values.

Flooding

The flood model indicates properties which currently experience flooding under existing conditions would no longer be subject to flooding for the same flood events as a result of the Proposal. Road corridors affected by increase in flood levels and extents are considered minimal and localised to George Street between Market Street and Garfield Road East for the 10 per cent AEP flood events. The Proposal over First Ponds Creek would convey flows from First Ponds Creek through Garfield Road East, providing improved hydraulic efficiency for achieving a 0.2 per cent AEP road immunity.

The flood model indicated the Proposal would result in negligible downstream impacts beyond the construction footprint as a result of the Proposal. No buildings would be impacted because of increased flood levels. Minor upstream impacts and impacts to the west of Edmund Street would be contained within vegetated parklands.

The Proposal would be trafficable for the one per cent AEP flood event along portions of Garfield Road East which do not form part of a flood evacuation route and achieve flood immunity for the 0.2 per cent AEP flood event for portions which form part of a flood evacuation route. Flooding to existing roads would not worsen as result of the proposal.

The modelled results indicate the Proposal may result in a flood impact to the following buildings. Further flood assessment during detailed design, including floor level survey may be required to confirm the potential impact for an increase in above floor inundation to occur as a result of the proposal. The floor level survey would also be used to confirm the scope of measures that are aimed at mitigating the impact of the proposal on an increase in flood impacts at the following affected buildings:

- Riverstone Men's Shed, Lot 7/8/9 DP2158 during the 50 per cent AEP flood event
- Kids Early Learning Riverstone, Lot 1 DP1140952 during the 50 per cent AEP flood event
- Tributary FPC No. 1 - Garfield Road East near Access 2:
 - Lot 15/16 DP30458, yard shed only during a 50 per cent, 10 per cent, five per cent, one per cent AEP flood event
- Tributary KCP No. 1 - Garfield Road East near Access 3
 - Lot 3/4/5/6/7 DP30458, yard shed only during a 10 per cent, five per cent, one per cent AEP flood event
- Tributary KCP No. 2 - Garfield Road East near Access 4:
 - Lot 8 DP27170 during a 10 per cent, five per cent, one per cent AEP flood event.

The modelled results indicate the proposal may result in a flood impact not affecting buildings on the following lots:

- Riverstone Public Swimming Pool - Lot 342 DP752061 during the one per cent and five per cent AEP flood event
- First Ponds Creek between Edmund Street and Garfield Road East :
 - Lot 11 DP712 and Lot 122 DP1240910 during a 50 per cent AEP flood event
 - Lot 1 DP1234723 during a 50 per cent, 10 per cent, five per cent, one per cent AEP flood event
- Tributary FPC No. 1 – Garfield Road East near Access 2:
 - Lot 17/19/20 DP30458 during a 50 per cent AEP flood event

- Lot 18 DP30458 during a 50 per cent and one per cent AEP flood event
- Tributary KCP No. 2 – Garfield Road East near Access 4:
 - Lot 35/36 DP1105173 during a 50 per cent, 10 per cent, five per cent, one per cent AEP flood event.

Flood velocity impact

The velocity impact is measured by per cent change in peak flood velocity. Percentage changes in velocities less than one metre per second are not considered significant as:

- Absolute velocity changes are minimal, particularly around edges of the flood extents
- Increase in velocities less than one metre per second will not increase scour risk.

As such, percentage changes in velocities less than one metre per second are hatched in dark shading in flood mapping. Per cent changes in velocities greater than one metre per second are potentially more prone to scour risk and are clearly displayed in flood mapping. Areas hatched in pink represent velocities greater than two metres per second in the existing environment. High velocities present in existing flood conditions are already prone to scour and remain in this state regardless of velocity increase from the proposal.

Velocity increases within the proposal which may cause scour would be managed by solutions such as rip-rap.

Flood evacuation route

The proposal would achieve a 0.2 per cent flood level immunity for this portion of Garfield Road East. This greatly improves the movement of traffic evacuating the Riverstone region as travellers would no longer travel through to McCulloch Street from Hamilton Street.

Probable maximum flood (PMF) impact assessment

The PMF impact assessment outlines the effect the proposal has on flood behaviour in the most extreme flood event.

The PMF flood event is critically dictated by the height of road level embankment which causes a dam-like flood response. The proposal road crossing at First Ponds Creek would be raised to achieve a 0.2 per cent AEP immunity. A direct consequence of achieving immunity for flood evacuation is increased flood levels and widened flood extents at the upstream reach of the proposal at First Ponds Creek.

The PMF impact assessment outlines the risk to existing and future zoned dwellings at risk of flooding. The hazard category “H3” indicates the upper limit combination of flood depth and flood velocity that can be tolerated without risk to life. Regarding this category, it is noted attention is focused on dwellings where occupants may be trapped due to a flooding event.

Under existing conditions a single dwelling located immediately upstream of the proposal may be affected by the PMF flood event (as detailed in Appendix G). Under post-proposal conditions, the dwelling would remain within the safe flood hazard.

While the increase in area of unsafe floodwater during a PMF would have only a minor impact on existing development, it has the potential to increase the flood risk to future development.

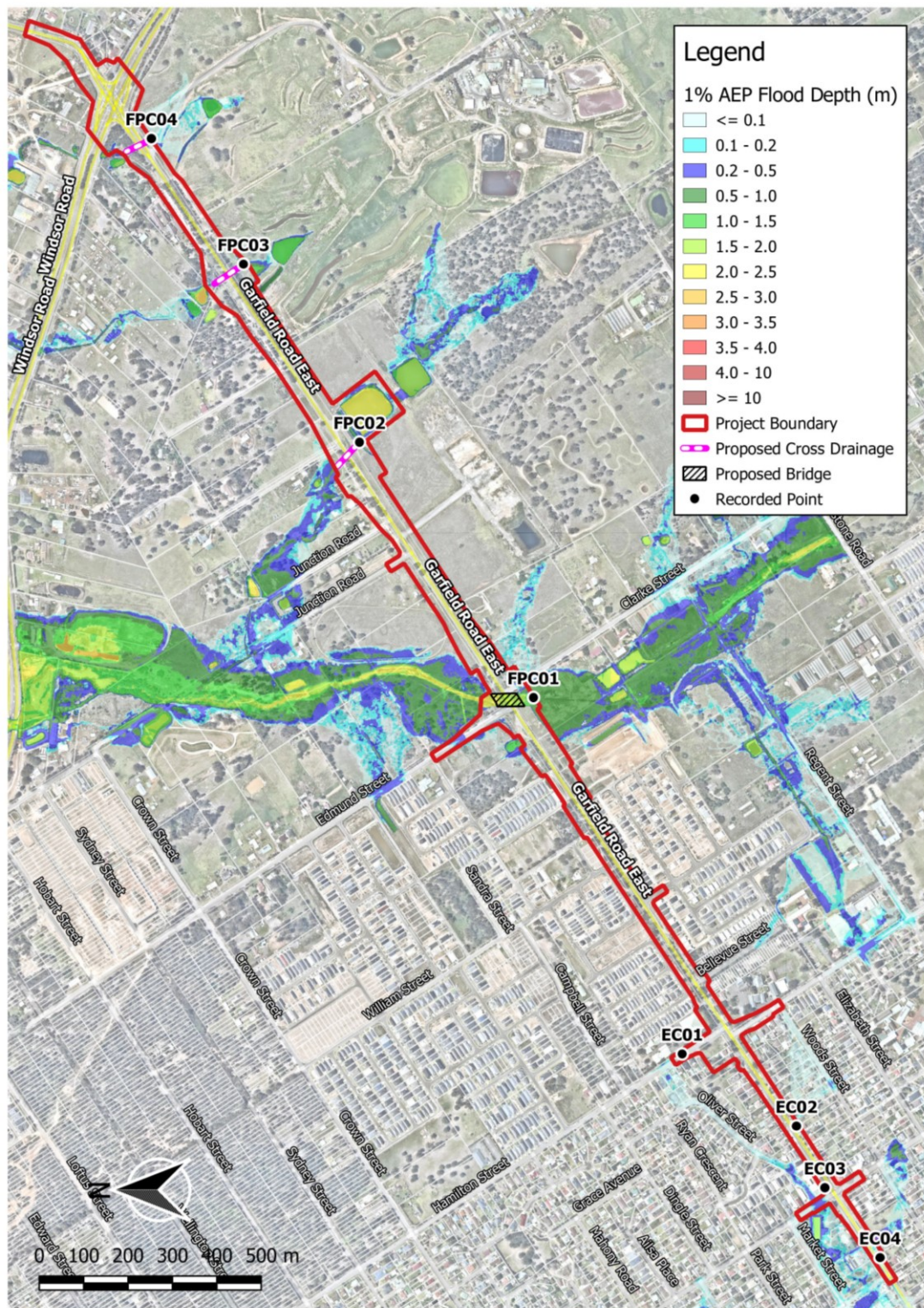


Figure 6-8: Flood Level spot IDs - one per cent AEP flood depth map

6.3.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Hydrology and Flooding	A contingency and evacuation plan will be prepared for a potential flood event while the	Contractor	Pre-construction/ Construction	Additional safeguard: HF1

Impact	Environmental safeguards	Responsibility	Timing	Reference
	<p>proposal is being built. The plan will:</p> <ul style="list-style-type: none"> • Evaluate what flood event would trigger the plan • Include evacuation procedures • Include a map indicating the area that is flood prone and the locations of where to evacuate. 			
Hydrology and Flooding	The layout and detail of the drainage system including water quality treatments, discharge points, swale design and scour protection will be refined during detailed design in consultation with the TfNSW Environment Branch	TfNSW	Detailed design	Additional safeguard: HF2
Hydrology and Flooding	Floor level survey should be conducted to properties experiencing adverse flood level impacts to determine the risks to above flood inundation.	TfNSW	Detailed design	Additional safeguard: HF3
Hydrology and Flooding	Changes to existing surface water flows will be minimised through detailed design.	TfNSW	Detailed design	Additional safeguard: HF4

6.4 Aboriginal cultural heritage

6.4.1 Methodology

The TfNSW Procedure for Aboriginal and Cultural Heritage Consultation and Investigation (PACHCI) (Roads and Maritime, 2011) defines a four-stage process for investigating potential impacts to Aboriginal cultural heritage as a result of TfNSW activities. These TfNSW activities include road planning, development, construction and maintenance. The PACHCI includes a process for community consultation to ensure the role, function, view and beliefs of Aboriginal people are considered and respected in the assessment process. The PACHCI process has been followed in the assessment of the proposal's potential impacts to Aboriginal culture and heritage.

Aboriginal community consultation is an integral part of the assessment of Aboriginal cultural heritage significance. Stage 2 of the TfNSW PACHCI must be carried out where there is potential for Aboriginal heritage objects to be impacted by the proposal, and requires initial engagement with key Aboriginal community stakeholders, an archaeological survey of the study area, and preparation of an archaeological survey report.

An Aboriginal cultural assessment (Austral Archaeology, 2019) has been prepared for this proposal and is presented in Appendix H. The assessment was prepared in accordance with the Stage 2 requirements of the TfNSW PACHCI Stage 2 (Roads and Maritime, 2011) and the OEH Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010). The AASR is consistent with the principles of the Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance, 2013. The assessment of Aboriginal heritage significance has been undertaken in accordance with the requirements of the OEH guidelines as specified in the Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales 2010 (DECCW, 2010), and the requirements of PACHCI Stage 2.

The Stage 2 PACHCI assessment methodology involved:

- A review of available data, including previous studies/investigations from around the study area;
- Consultation with the local Aboriginal community
- Search and review of the Office of Environment and Heritage (now Department of Environment, Energy and Science) Aboriginal heritage information management system (AHIMS) database was undertaken 25 June 2019 to determine the location and nature of any Aboriginal heritage sites recorded within, or in the vicinity of the study area
- Review of relevant previous archaeological reports specific to the area, to determine the extent of past Aboriginal archaeological research in the region
- Field survey with local Aboriginal community representatives, to allow identification and assessment of Aboriginal heritage values present in the study area
- Preparation of an AASR describing the results of the background research, the extent and significance of heritage items recorded in the study area, and management recommendations and mitigation measures for any Aboriginal heritage resources, including constraints and opportunities.

An archaeological survey of the study area was undertaken 4 July 2019 by members of Austral Archaeology and the Deerubbin Local Aboriginal Land Council (DLALC).

6.4.2 Existing environment

The original Aboriginal group present around the study area were tribes of the Darug (Daruk) language group (Tindale 1974). The Darug language group extended from Botany Bay, north to the Hawkesbury River, spanning from the coastal fringes of the Eastern Suburbs to the Nepean River in the west. Other archaeological and historical records indicate three culturally separate groups of Darug rather than many sub-groups; mountain, coastal, and hinterland, the latter of which would have occupied the study area

(Attenbrow, 2010). Archaeological investigations of the Cumberland Plains (where the proposal is located) have been conducted in direct response to the spread of urban development

There are at least 94 sites within a two-kilometre buffer of the study area. As the area around Garfield Road East has been widely developed, a multitude of studies are located within a two-kilometre buffer, most from past survey and excavation completed prior to development.

Four Aboriginal archaeological sites have been previously recorded within the study area. A multitude of sites surround the study area, with the majority close to tributaries and streams.

Description of the study area

The study area consists of land which surrounds, crosses, and encompasses Garfield Road East, including over 100 separate lots as well as crown land. The area investigated for the AASR is comprised of a 50 to 300 metre buffer around the existing Garfield Road East, and is bounded to the west by Windsor Road, and to the west by the intersection of Garfield Road East and the Riverstone Railway Station.

Heavy residential development has occurred and is planned to the south and east of the study area, and commercial as well as residential farming has taken place throughout the study area. While portions of the study area have been highly developed, there is still land which is undisturbed, namely to the north of Garfield Road East.

The main impacts on the subject land relate to extensive land clearance, fences and vehicle tracks, and sub-surface utility services and ongoing residential development surrounding the study area, plus construction of the road itself.

These activities would have contributed to the removal of the original native vegetation as evidenced by the recent regrowth in the study area, reducing the possibility of remaining scar trees.

Regional archaeological context

Archaeological investigations of the Cumberland Plains have been conducted in direct response to the spread of urban development. The limited ethnographic accounts of early settlers and explorers were once considered the primary source for archaeological enquiry. However, with the recent spread of urban development within the Campbelltown environs, archaeological investigations have undergone a corresponding increase.

Archaeological sites in the Cumberland Plains region are considered to relate to the distance of the site from permanent water sources and stream order modelling can provide a good framework for site prediction. A coagulation of studies and research from throughout the Cumberland Plains completed in 1989 found 307 recorded sites at that time, of which 297 were open artefact scatters and isolated finds, and the remainder were scarred trees and grinding grooves (Smith, 1989). The most likely site types to exist in the study area would be open artefact scatters and grinding grooves, as much of the vegetation has been impacted and/or destroyed at this point, decreasing the chance of scar tree survival.

The environment of the study area was likely used in the traditional lifestyle of Aboriginal inhabitants. The location of water, namely high-order streams, largely defines where sites and Aboriginal archaeology is found, due to the abundance of resources. The study area contains a few locations with suitable resources and as such has qualities which would have made it suitable for long term habitation.

Based on the presence of suitable landforms in the study area for archaeological sites, it is considered that portions of the study area have some potential to contain Aboriginal heritage objects.

Heritage database results

Four Aboriginal archaeological sites have been previously recorded within the study area. A multitude of sites surround the study area, with the majority close to tributaries and streams. These sites are:

- 45-5-4066: located 60 metres south of the current Garfield Road East
- 45-5-447: Isolated artefact recorded along First Ponds Creek within the study area, located on an extensive flat near the creek bed with minimal disturbance
- 45-5-4065: Recorded along First Ponds Creek
- 45-5-5028: Isolated artefact within 300 metres of First Ponds Creek.

A search of the DPIE AHIMS database was undertaken on 25 June 2019 (Client Service ID 429774). The results from the AHIMS search identified 94 previously recorded sites within two kilometres of the study area, with four sites recorded within the study area (denoted above).

Of the 94 previously recorded sites registered on AHIMS, the highest percentage site type, or sites most commonly found in the area, are artefact sites, including isolated finds, artefact scatters and undefined artefact sites. The second highest percentage are axe grinding grooves. If aboriginal material is therefore present in the study area, it is almost certain, about 80 per cent, to be stone artefacts. The majority of sites, about 75 per cent, are within 200 metres from water. The likelihood of the study area to contain Aboriginal heritage is dependent on extent of disturbance within the study area and presence of high-order streams.

A summary of the AHIMS sites relevant to the proposal is provided in Table 6.28. The location of AHIMS records is provided in Appendix H.

Table 6.28: Summary of AHIMS Sites within two kilometres of the study area

Site features	Number	Percentage
Artefact n = 1, artefact scatter, Artefact (unlisted number)	76	81.7
Scar tree, Potential Archaeological Deposit (PAD), Artefact	1	1.0
PAD	12	12.7
PAD, Artefact	5	5.3
Total	94	100

Aboriginal stakeholder consultation

A representative of DLALC reported no cultural material identified within the road easement, aside from the presence of unworked silcrete which was revealed by a cut in bedrock made to lower the road, and would, without modern construction, not be visible.

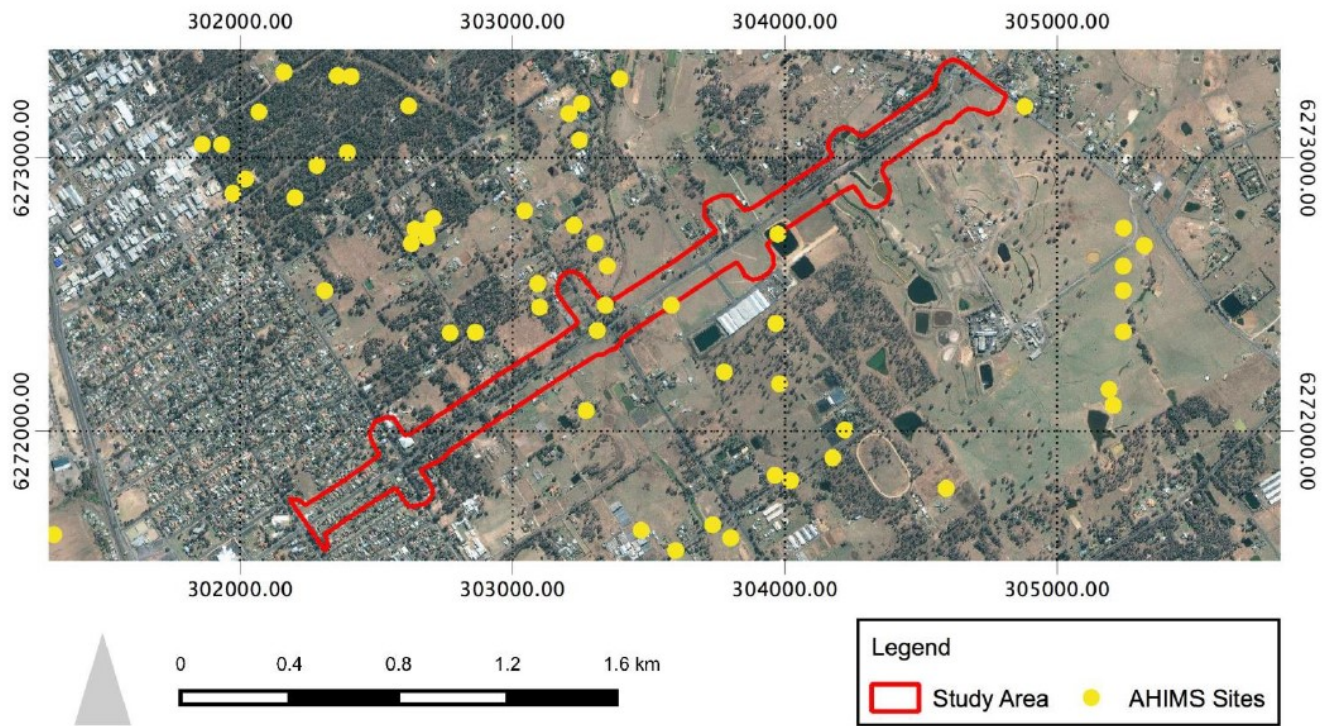


Figure 6-9: AHIMS records

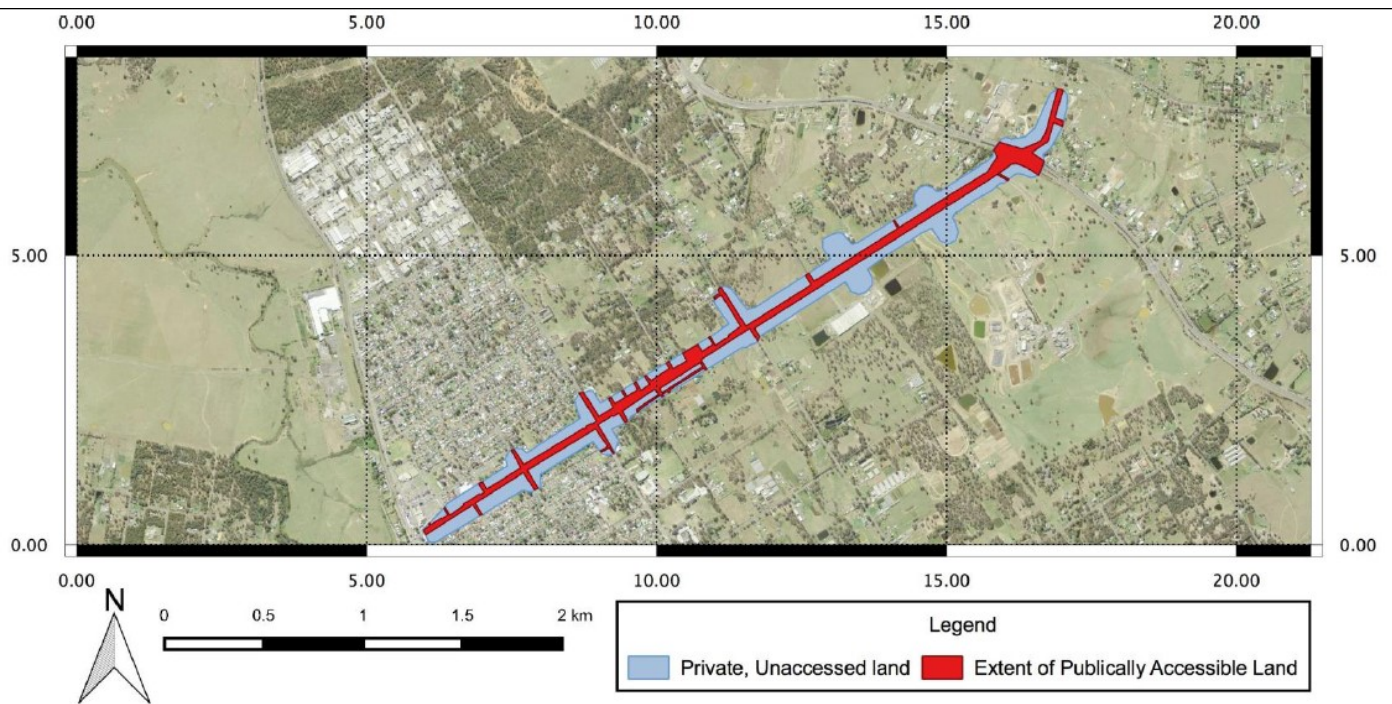


Figure 6-10: Surveyed Property and Unsurveyed Property for the AASR

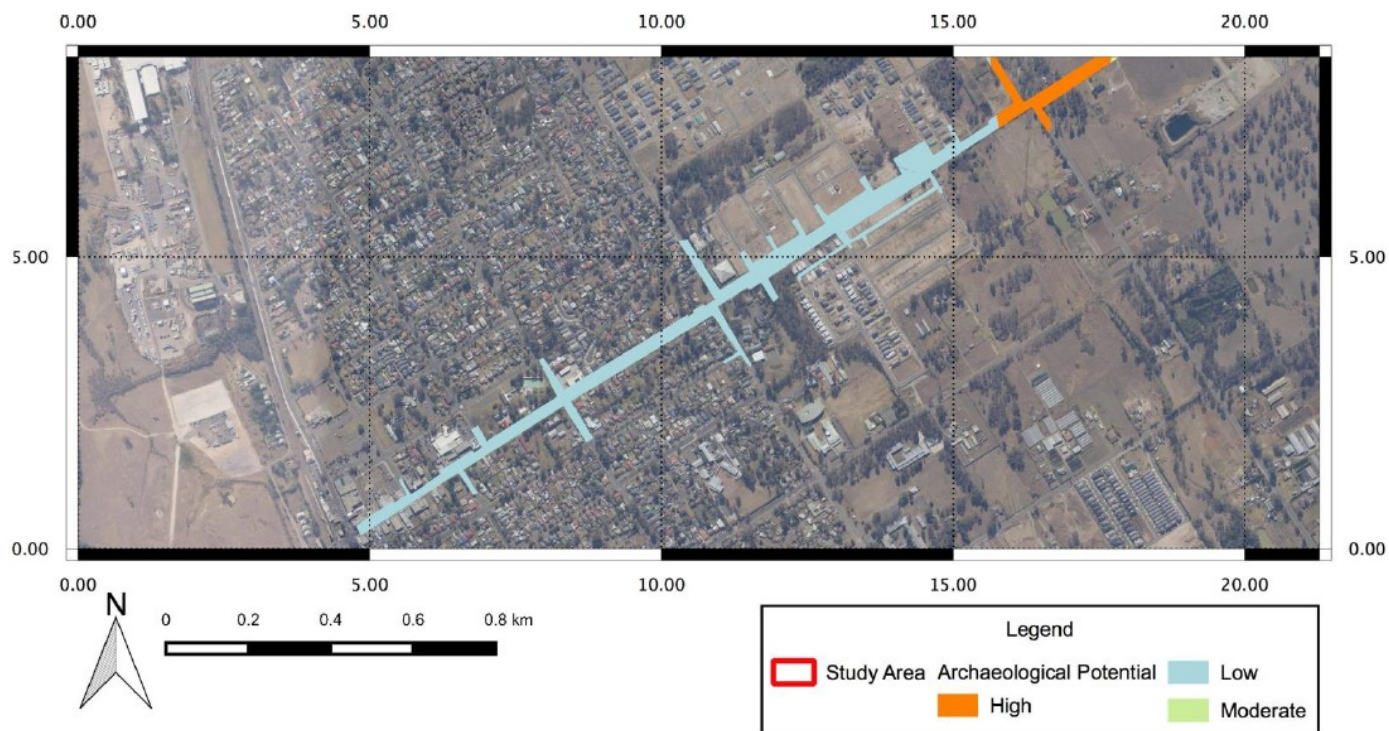


Figure 6-11: Archaeological Potential Part 1

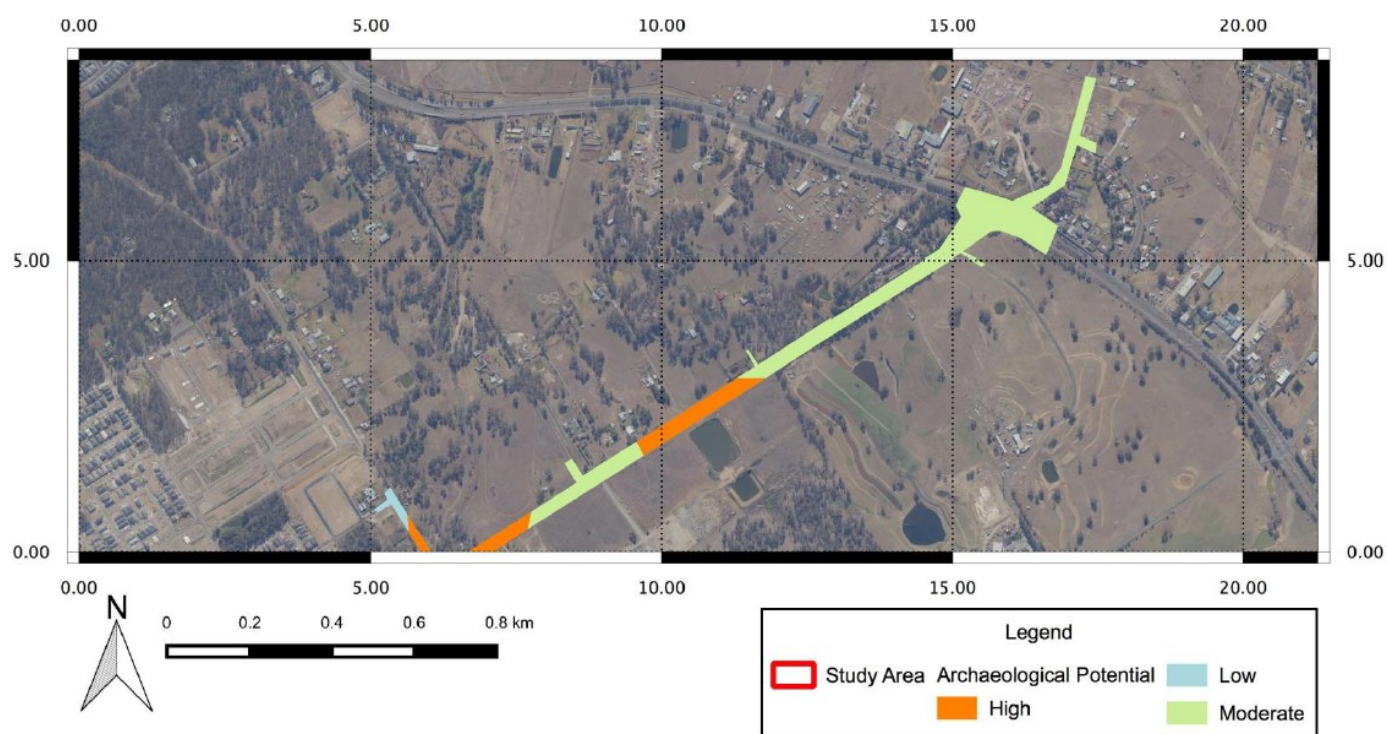


Figure 6-12: Archaeological Potential Part 2

6.4.3 Potential impacts

Construction

Potential impacts to known sites within the study area include possible destruction and/or movement during the installation of a four lane road, the planned area of which would most likely be directly in the path of the five sites.

There may be Aboriginal heritage items located on private land within the construction footprint that were not identified during the investigations due to limited access to some properties.

While disturbance has clearly occurred in the majority of the study area, potential for sub-surface deposits can still be relatively high in regions close to high-order streams.

TfNSW are currently preparing a PACHCI Stage 3 assessment for the proposal.

Direct impacts

An AHIP is required for impact to land and identified sites/objects prior to the commencement of pre-construction or construction activities associated with the proposal that would affect the sites.

Four Aboriginal archaeological sites have been previously recorded within the study area, three which will require an AHIP and one which is outside the area of impact and will require a buffer.

Indirect impacts

Additional impact, specifically the construction of a bridge over Eastern Creek, may damage areas of high archaeological potential. Further investigation around Eastern Creek and First Ponds Creek is recommended. TfNSW are currently preparing a PACHCI Stage 3 assessment for the proposal.

Operation

Once operational, the proposal would not impact Aboriginal heritage.

6.4.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Aboriginal heritage	An Aboriginal Heritage Management Plan (AHMP) will be prepared in accordance with the <i>Procedure for Aboriginal cultural heritage consultation and investigation</i> (Transport for NSW, 2012) and <i>Standard Management Procedure - Unexpected Heritage Items</i> (Transport for NSW, 2015) and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented for managing impacts on Aboriginal heritage. The AHMP will be prepared in consultation with all relevant Aboriginal groups.	Contactor	Detailed design / Pre-construction	Standard safeguard AH1 Section 4.9 of QA G36 <i>Environment Protection</i>
Aboriginal heritage	<ul style="list-style-type: none"> <i>The Standard Management Procedure - Unexpected Heritage Items</i> (Transport for NSW, 2015) will be followed in the event that an unknown or 	Contactor	Detailed design / Pre-construction	Standard safeguard AH2 Section 4.9 of QA G36 <i>Environment Protection</i>

Impact	Environmental safeguards	Responsibility	Timing	Reference
	<p>potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Transport for NSW does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place.</p> <p>Work will only re-commence once the requirements of that Procedure have been satisfied.</p>			
Aboriginal heritage	Additional survey on the private land identified as containing areas with moderate to high archaeological potential should be undertaken.	TfNSW	Detailed design/Pre-construction	Additional safeguard AH3
Aboriginal heritage	To ensure known sites not directly impacted from the proposal a 10 metre exclusion zone must be established around this site during construction works. This must be a hard barrier to ensure personnel or equipment does not impact on this site during project works.	Contractor	Pre-construction / Construction	Additional safeguard AH4
Aboriginal heritage	All contractors undertaking earthworks in the study area should be briefed on the protection of Aboriginal heritage objects under the NPW Act and the penalties for damage to these items and should undergo an induction on identifying Aboriginal heritage objects. Any unexpected finds should be handled in accordance with the TfNSW Standard Management Procedure for Unexpected Heritage Items (Roads and Maritime, 2015).	Contractor	Pre-construction/ Construction	Additional safeguard AH5
Aboriginal heritage	If there are any changes to the proposal, then a re-analysis of	TfNSW	Detailed design	Additional safeguard AH6

Impact	Environmental safeguards	Responsibility	Timing	Reference
	Aboriginal heritage constraints should be undertaken by a qualified archaeological consultant.			
Aboriginal stakeholder comment	The DLALC agrees with further testing around Eastern Creek and First Ponds Creek, and recommends further investigation is undertaken before any development of Garfield Road East in the future	TfNSW	Detailed design / Pre-construction	Additional safeguard AH7

6.5 Non-Aboriginal heritage

A Heritage Assessment was prepared to assess the potential impacts of the proposal on non-Aboriginal heritage. An assessment of impacts was undertaken to listed heritage items, as well as impacts to areas of archaeological potential. The following section is a summary of the key findings of the Heritage Assessment. The full Heritage Assessment is provided in Appendix I of this REF.

6.5.1 Methodology

The HAIS has been prepared in accordance with principles contained in The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance, 2013; and NSW Heritage Manual guidelines including:

- Statements of Heritage Impact (Heritage Office & Department of Urban Affairs and Planning 2002)
- Archaeological Assessments: Archaeological Assessment Guidelines (Department of Urban Affairs and Planning 1996)
- Assessing Significance for Historical Archaeological Sites and 'Relics' (Heritage Branch, Department of Planning, 2009)
- Historical Archaeology Code of Practice (Heritage Office, Department of Planning 2006).

Relevant heritage registers were searched to provide an overview of the historical development of the study area and identify items/sites within, and in the vicinity of the study area. The registers included the Australian Heritage Database (including the National Heritage List; the Commonwealth Heritage List and the Register of the National Estate); the NSW SHR; the State Heritage Inventory (SHI); the National Trust of Australia (NSW) register; Growth Centres SEPP; and relevant government agency Heritage and Conservation (Section 170) Registers.

For the purposes of this assessment, the study area included the proposal and the area needed to construct the proposal. The study area is provided at Appendix A of the Heritage Assessment provided at Appendix I.

6.5.2 Existing environment

The proposed Garfield Road East upgrade (the study area) is located on Garfield Road between the intersections of Piccadilly Street (Riverstone) to the south-west, and Windsor Road (Rouse Hill) to the north-east. Garfield Road East is orientated on a north-east south-west access and is a main connecting road between the suburb of Riverstone and Windsor Road. The current road is an asphalted, two-way road, undivided for most of its length. The immediate landscape of the study area changes from low-density residential to primary-production small lots between Riverstone and Windsor Road.

Site history

The following historical overview of the study area has been prepared to provide context to the cultural significance of the study area. It provides a rationale for historical developments in Riverstone and assists in identifying historical archaeological potential within the study area.

In May 1810, Governor Macquarie granted Maurice Charles O'Connell a 2,500-acre block of the land to mark his marriage to Mary Putland, widowed daughter of deposed Governor Bligh.⁸ The grant was all the land now bounded by the Windsor Road, Bandon Road Vineyard, Eastern Creek and Kensington Park Road Schofields. O'Connell named the land Riverston' Farm after his birthplace in Ireland.

In 1842, a plan of Windsor and surrounding districts was surveyed by J Mulgrave. The plan showed little change to the Riverston' Estate at this time. The only presence of activity is an informal track between the Riverstone Homestead and the Schofield Homestead. The rest of the estate is shown to be, as yet, uncleared.



Figure 6-13: Extract of the Mulgrave 1842 plan of Riverstone Estate. The approximate area of the Garfield Road East upgrade is indicated in red

The Riverstone area, like many small towns in the surrounding area, started to go grow slowly during the period between the 1850s and 1880s. The 1864 subdivision included the official gazettal of a parish roadway between the boundary of the former Mount Macquarie Farm and former Riverstone farm. The roadway was aligned from Windsor Road, intersecting with the new Riverstone Railway Station, and connecting through to Richmond Road. This parish roadway would later become the present day Garfield Road East and West.

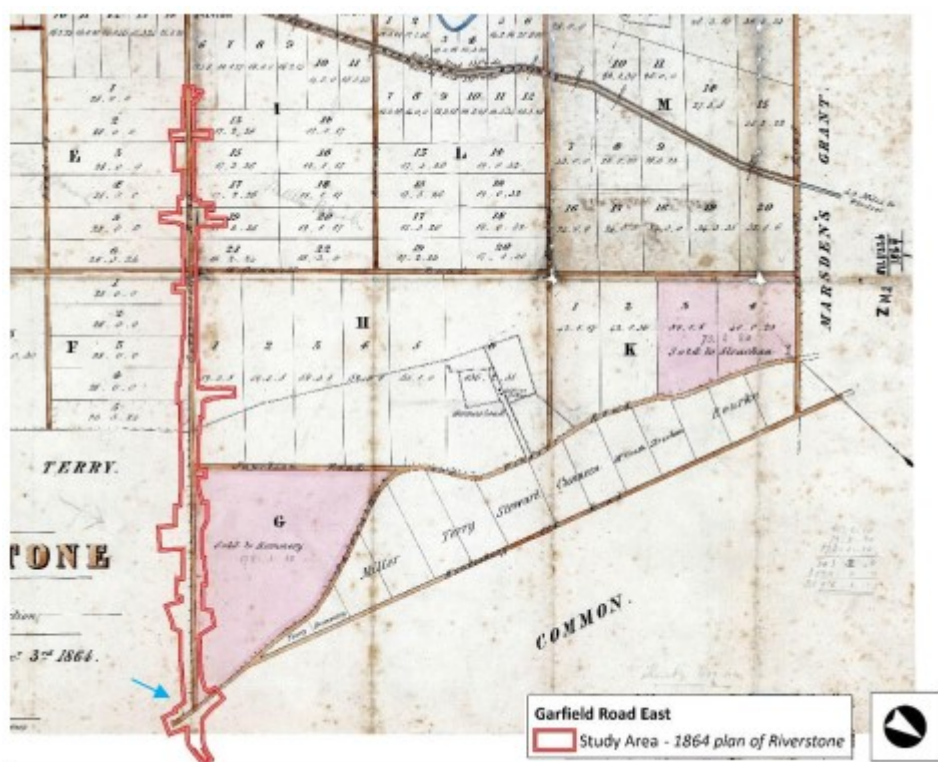


Figure 6-14: Subdivision plan of Riverstone Estate 1864

By 1900s industry such as a poultry farm and a small number of market gardeners started in the area. This soon changed as there was a significant increase in small-scale agriculture over the following years. Despite this boom in agriculture, Riverstone remained a relatively sparsely populated area over this period. Following the First World War and the increasing use of motor vehicles works to the Old Windsor Road began and a bitumen coating was laid down in 1925-26 and renewed in 1928-29. It is unclear what changes were made to Garfield Road East at this time, but as a major connection between Richmond Road, Riverstone Railway Station, Riverstone township and the Windsor to Parramatta Road, it is likely that the road underwent upgrades with increased traffic. Riverstone was connected to the Metropolitan Water Supply in 1933 and electrical services in 1934.

Aerial photography from 1994 indicates the expansion of the Riverstone area with that the study area remaining relatively undeveloped at the eastern end with most of development concentrated at the western end of the study area surrounding Riverstone Station.



Figure 6-15: 1994 aerial of Riverstone marked with the study area

Heritage listings and assessment of significance

There are a number of heritage items located within the Garfield Road East study area and in its vicinity. The following section provides a summary of the significance of the identified heritage listings located in and within the vicinity of the proposal.

Windsor Road

Name	LEP number	SHR number	Significance
Windsor Road	-	4301011	Section 170 State Agency Heritage and Conservation Register

In 1794 Hawkesbury Road (later renamed Windsor Road) was constructed. The road established an important route of communication and trade between farms on the Hawkesbury River and Parramatta, effectively opening up the country in between for settlement.

The 1796 plan showed the 'Road to the Hawkesbury' commencing at the more northerly branch of the Toongabbie Creek, with a track connecting the road to Toongabbie and Parramatta beyond. Former plans showed the road probably as surveyed, with straight lines connecting points of the route. By the time Grimes produced the c.1806 map of NSW, the Old Windsor Road is shown with some minor deviations, probably caused by the practicalities of hill and river crossings. These deviations include the kink in the road to the east of Box Hill Estate, and the re-routing of the road enabled by the construction of the bridge at South Creek in 1802. The line of the Old Windsor Road prior to this deviation is indicated by the present location of the Hawkesbury Road between the intersections of Chapman Road and Pitt Town Road. Both deviations enabled the Old Windsor Road to avoid the low-lying land along the Killarney Chain of Ponds.

The undated plan of the County of Cumberland appears to record the configuration of the Old Windsor Road during the 1820s. In this plan the deviation at Box Hill is clearly shown, but is less pronounced than the 1806 to 1813 deviation.

By 1827, G B White's survey showed a relatively major change in the route of the Windsor Road near Box Hill, where the road is aligned along a broad curve at Riverstone, near the intersection with Garfield Road East as shown in Figure 6-16. The survey removed the characteristic kink in the road previously evident near Box Hill. The reason for this realignment is not clear at present. The 1827 plan does not include the route of the Old Windsor Road south of Kellyville, and therefore does not indicate any changes to the Parramatta end of the road at this time.

Mackenzie's 1885 survey noted several locations where the original alignment of the Old Windsor Road differed from the 1885 route, with the earlier alignments frequently marking the boundaries between civil parishes.



Figure 6-16: View to the east across Windsor Road, Garfield Road and Terry Road intersection

The Windsor and Old Windsor Roads, as first laid out in 1794 and re-aligned in 1812-1813, are of state and national significance. They incorporate the second road to be laid out in the colony and played an important role in the settlement of the Hawkesbury region and the development of the colony of NSW.

House and shop at 76-78 Garfield Road East

Name	LEP number	SHR number	Significance
House and shop (76-78 Garfield Road East)	180	-	Local

The combined residence and shop, at 76-78 Garfield East shown in Figure 6-17 is located on the eastern side of the T-Section between George Street and Garfield Road East. The shop is built to the street frontage, and consists of a simple gable ended structure with front awning. The cottage is set back from the street and has a bull-nosed verandah with twin gabled roof sections. The cottage is a typical example of late Victorian / early-twentieth century architecture in Riverstone. Several sections of the shop front and cottage appear to have been replaced with new materials, or extended over the life of the building, including the gable ends verandah posts; roof sheets, fenestrations; steps; and doorways



Figure 6-17: Shop front awning extending to the road reserve, adjoining cottage setback within the residential lot

67-78 Garfield Road East is of historical significance to Riverstone as a remaining late Victorian early twentieth century shop and residence remaining from the early village centre of Riverstone.

Riverstone Public School (former)

Name	LEP number	SHR number	Significance
Riverstone Public School (former)	181	-	Local

Riverstone public school (former) is located on the corner of Garfield Road East and Piccadilly Street, Riverstone. Figure 6-18 shows the main school building, facing Garfield Road East. A range of associated structures and school grounds form part of the school.

The main school building is a highly ornate, symmetrical structure built in a distinctive interwar Spanish mission/Georgian style. The centre of the building is made prominent by a large decorative parapet and series of large arched windows over the main entrance. The structure is built in brick and has a rendered surface.

The area identified to have had a structure present in the 1956 aerial photograph was observed to be vacant and grassed, with some raised vegetable garden beds present. The front of the school, along Garfield Road East, had several concrete pathways and some small trees and shrubs.



Figure 6-18: View to the south of the front of the Riverstone Public School (former)

The school building is considered significant in being an unusual design for a public and shows Spanish Mission influence.

St John Evangelist Parish

Name	LEP number	SHR number	Significance
St John Evangelist Parish	-	-	Growth Centres SEPP

St John Evangelist Parish shown in Figure 6-19 is located on the corner of McCulloch Street and Garfield Road East. The complex includes a primary school and incorporates a number of features including buildings, perimeter fencing, sports courts, landscaping, internal roadways, and the church. The formal entry to the property boundary is accessed from a brick gateway located on the Garfield Road East.

Located on the highest point of the site, the church is primarily built in brick and has thick wall buttresses with a gabled slate roof. The building is accessed from a gabled front entrance porch with large timber doors. The building has a neo-gothic style that is reflected in the overall form of the structure as well as details on the roof, entrances and fenestration.



Figure 6-19: Perimeter brick gate leading up to the Church

The church has been the centre of Catholic worship in Riverstone since 1904. It is a fine example of

the Federation Gothic style and an important landmark in Riverstone.

Pre-1925 weatherboard (demolished 2018) at 169 Garfield Road East

Name	LEP number	SHR number	Significance
Pre-1925 weatherboard	-	-	Local

Located on the opposite corner to St John Evangelist Parish and School, 169 Garfield Road East is bounded by Garfield Road East to the south, Hamilton Street to the east, and other residential blocks with low-set houses to the north and west. The site itself is flat, with Garfield Road East on a rise to the south. The ground is grassed with some patches of ground showing through, particularly in the vicinity of where the house was positioned until its demolition in 2018.

St Clare's Convent

Name	LEP number	SHR number	Significance
St Clare's Convent	-	-	Growth Centres SEPP

St Clare's Convent shown in Figure 6-20 is located in the northern parcel of land, adjacent to St John Evangelist Parish. The convent consists of a single, two-storey Georgian Revival style building constructed in brick. Seminal details include the hipped terracotta roof tile and brick column veranda surrounding the building on three sides. The convent is boarded on all sides by a tall perimeter fence with brick entry gates. The corner bricks on the gate piers are bull-nosed, giving the gates a refined form.



Figure 6-20: Hipped terracotta roof tile visible from the road reserve

The convent is a twentieth century example of a Georgian Revival architecture. The building is used as a convent in association with the Catholic Primary School of St. Johns.

Rosebank

Name	LEP number	SHR number	Significance
Rosebank	-	-	Growth Centres SEPP

Rosebank is a property that previously extended to Garfield Road East from a ridgeline overlooking the road as shown in Figure 6-21. The homestead and ancillary farm buildings atop the ridge remain extant, however the property between the homestead and Garfield Road East has been developed with three houses constructed and another under construction when the site was inspected in February 2020. The land located within the study area, along Garfield Road East, was observed to be sparsely vegetated and recently disturbed, likely by the construction of new houses in the vicinity



Figure 6-21: Image of Rosebank at 213 Garfield Road before construction of the extant row of houses. The Rosebank homestead is visible at the top of the hill

Rosebank is considered to be an excellent example of a late Victorian country homestead.

Bicentennial Museum (formerly public school, then Masonic Hall)

Name	LEP number	SHR number	Significance
Bicentennial Museum (formerly public school, then Masonic Hall)	182	-	Local

Located at 81 Garfield Road East, the Bicentennial Museum. As shown in Figure 6-22 the site is a collection of nineteenth century and late twentieth century structures. It is bounded by the Riverstone Swimming Centre to the east, a carpark to the north and Riverstone Lions Park to the west.

The main school building, later the Masonic Hall is laid out in a T shape and presents a gabled brickwork form with a parapet fronting toward Garfield Road East. Adjacent to the main school building is an additional school classroom building that incorporates a cottage and further classroom. A large galvanised shed is positioned at the rear of the complex.

Just to the west of the extant structures are in situ brick footings that are described as being associated with the original teacher's residence built in 1883.



Figure 6-22: View to the north looking across Garfield Road East to the Bicentennial Museum

The Blacktown Bicentennial Museum building is an item of local significance. Originally constructed in 1883 as a school, its original classroom and teacher's house and is now visible in foundation only. The site is an early example of a small school building.

St Andrews Uniting Church

Name	LEP number	SHR number	Significance
St Andrews Uniting Church	197	-	Local

Presbyterian services at Riverstone were first held in 1882 in a cottage (the home of John Greig) at Garfield Road East. The present weatherboard church was built in 1884 on three allotments purchased for the church in Regent Street.

In 1913 the church was relocated to the present site. The church was recognised as 'St Andrews Presbyterian Church' in 1935, initially as a Mission Station of the Richmond church district and then of the Ebenezer Pitt Town Congregation. Prior to 1935 it had been recognised as a preaching station of the Windsor Congregation.

In 1946 St Andrews was recognised as its own Session of the Presbyterian Church and purchased a Manse for a student minister.

The Presbyterian and Methodist congregations at Riverstone combined in 1967, well before the establishment of the Uniting Church in Australia, and the first ordained minister was appointed in 1970.

The Church became formally part of the Uniting Church in 1978 as part of the Blacktown Parish, and in 1998 again became an independent Uniting Congregation when the Uniting Church moved to recognise individual congregations as opposed to parishes. The Church retained an ordained minister until 2008.

This building served as the focus of Presbyterian worship in Riverstone from 1884. Since 1967 it has been the place of Presbyterian and Methodist and later Uniting Church worship. St Andrew's Uniting Church is a good example of a rural Victorian Carpenter Gothic Style church.

The location of the heritage items identified above are shown in Figure 6-23, Figure 6-24 and Figure 6-25.

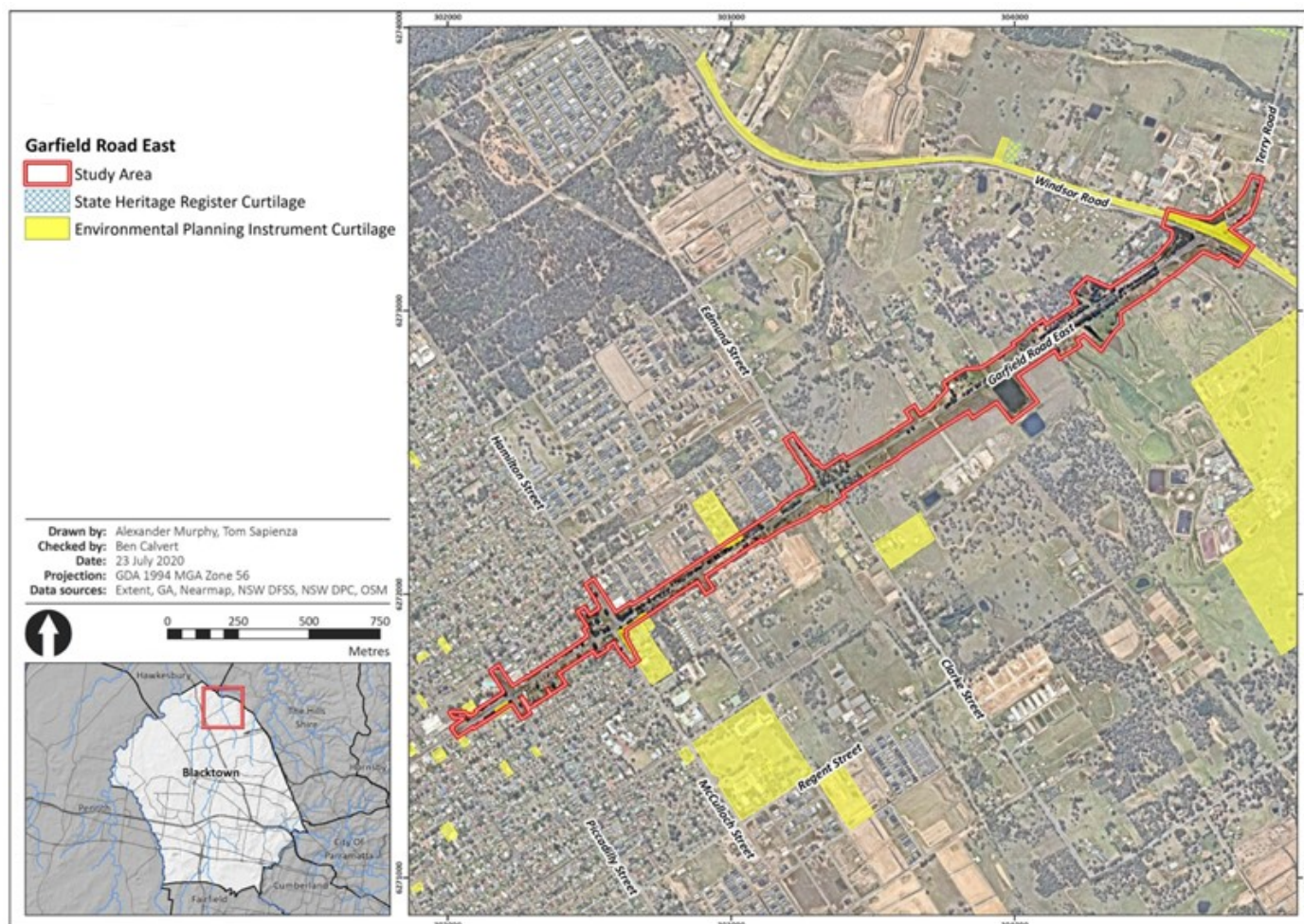
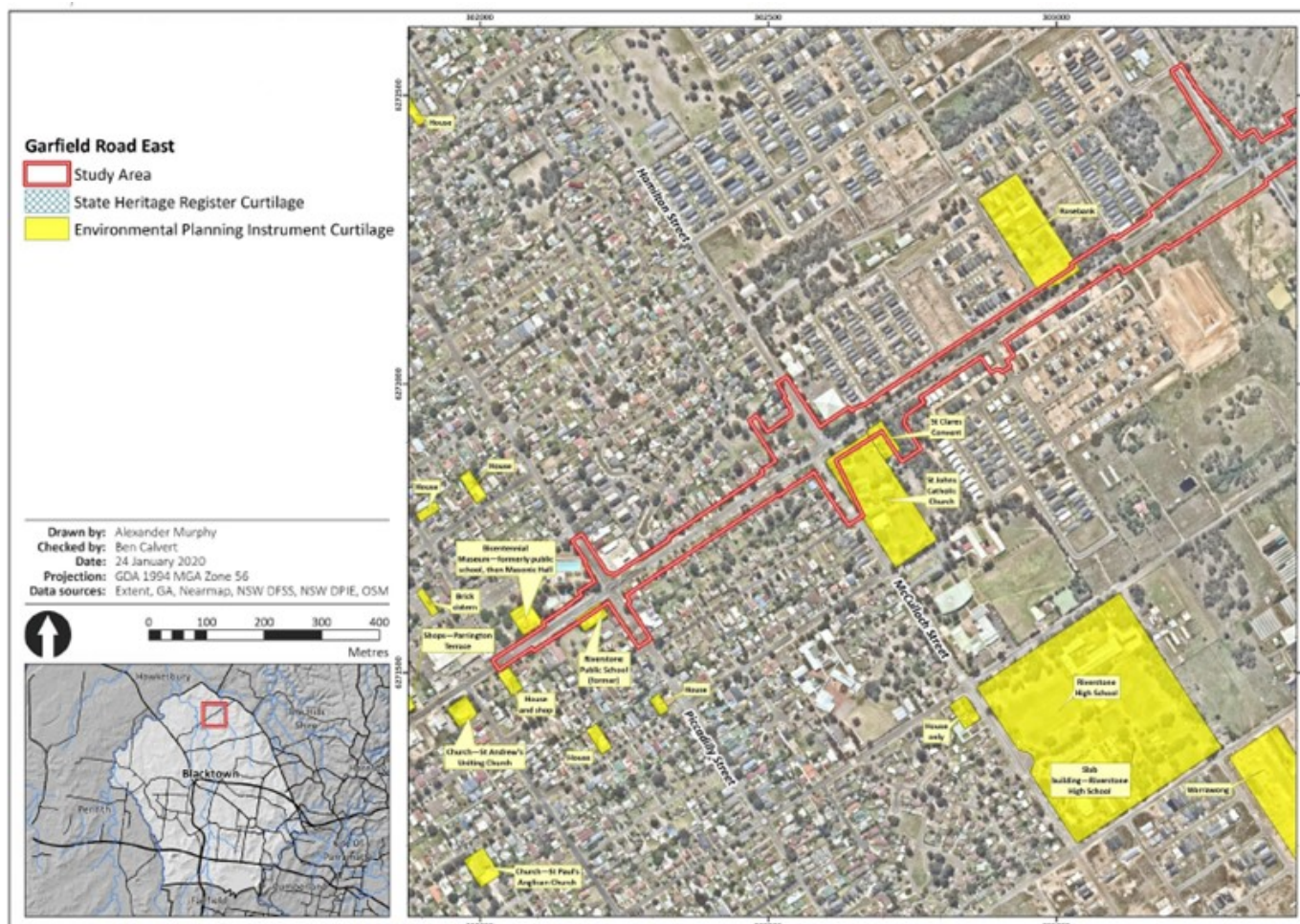


Figure 6-23: Location of non-Aboriginal heritage items



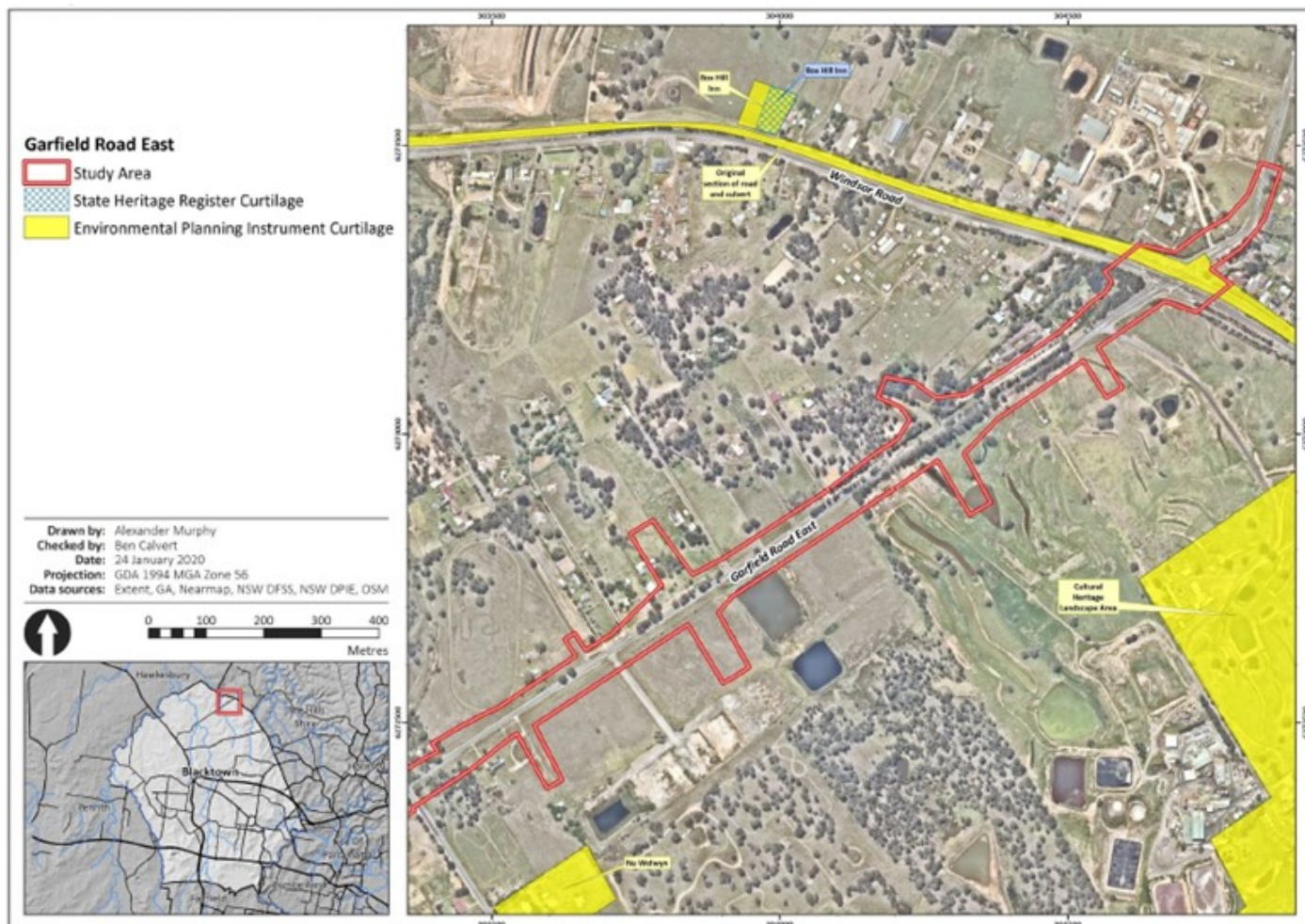


Figure 6-25: Location of non-Aboriginal heritage items (eastern extent of the proposal)

6.5.3 Assessment of archaeological potential

Based on the information presented in the historical context, previous heritage assessments, and an analysis of historical aerial photographs and maps, it is possible to make some general observations regarding the likely extent and integrity of relics associated with archaeological sites identified within the study area of archaeological relics.

Table 6.29 shows the identified archaeological resources, their potential archaeological significance, and the likelihood of survival of archaeological relics.

Table 6.29: Summary of historical archaeological potential

Site features or activities	Phase	Listing	Potential significance	Level or likelihood of survival
Early development and surfacing of Windsor Road	Early European settlement and land grants (1790-1855)	TfNSW S170 Register	Road surfacing materials, cuts and fills associated with construction and drainage	Nil-low
Residential and commercial development	2: Subdivision and the arrival of the railway (1855-1918)	-	Access pathways and driveways, yard surfaces and features, fence lines, services, sporadic artefacts	Low
Construction of Rosebank Homestead and clearing, cultivation of surrounding land	Subdivision and the arrival of the railway (1855-1918)	Growth Centres SEPP - (Appendix 4, Alex Avenue and Riverstone Precinct Plan 2010, Schedule 5)	Tree boles, plant roots, charcoal and scorched clay from burning, remains of fence lines, such as postholes, signs of cultivation such as plough lines and orchard lines. Roadways or pathways at entry to property	Nil-Low
Construction of house at 169 Garfield Rd East	Inter-war migration and settlement (1918-1945)	-	Structural remains such as stone, brick footings, yard surfaces, service pipes. Artefacts and deposits associated with occupation of the house.	Moderate
			Surfaces and structural remains of outbuildings	Nil-low
Continued use and regrading of Windsor Road	Inter-war migration and settlement (1918-1945)	TfNSW S170 Register	Surfacing events, cuts and fills associated with modifications and drainage.	Low

Site features or activities	Phase	Listing	Potential significance	Level or likelihood of survival
Construction of Riverstone Public School (former) and associated buildings and yard areas	Post-war development (1945-present)	Blacktown LEP 2015, Schedule 5	Structural remains such as brick, concrete, timber, yard surfaces. Artefacts and deposits associated with the use of the school and school building.	Moderate
			Yard areas, pathways or entranceways	Nil-low

Based on the information presented in the historical context, previous heritage assessments, and an analysis of historical aerial photographs and maps, it is possible to make some general observations regarding the likely extent and integrity of relics associated with archaeological sites identified within the study area.

6.5.4 Potential impacts

Construction

Construction of the proposal would impact on the archaeological potential of two sites, as follows:

- The unlisted 169 Garfield Road East weatherboard cottage site.
- S170 Register listed Old Windsor Road and Windsor Road Heritage Precincts.

The entirety of the footprint of the demolished pre-1925 weatherboard cottage is located within the proposal. Based on the significance assessment of the site there may be the potential for archaeological remains such as remnant footings of the structure and potentially deposits associated with the occupation of the house. As the site is significant at a local level, the proposed works may result in unexpected finds, depending on the method of demolition used in 2018.

The proposal area overlaps with a heritage item identified as Windsor Road listed on the TfNSW S170 register. This heritage item is partially located within the eastern side of the proposal. The proposal would not impact on items of archaeological potential at Windsor Road and as such the proposal is considered to have no impact to the heritage listed item.

Archaeological remains surrounding the proposal at Windsor Road such as access paths/driveways, fence posts, services, sporadic artefacts and other features may be impacted by the construction works. Any potential heritage item which is identified during construction activities would be managed in accordance with an appropriate unexpected finds protocol detailed in the CEMP.

Operation

There are five heritage listed buildings within the study area, as follows:

- House and Shop at 76-78 Garfield Road East
- Riverstone Public School (former)
- St John Evangelist Parish
- St Clare's Convent
- Rosebank.

The proposal would continue the road corridor in the vicinity of the shop front. Despite the adjacent roadway corridor, the proposal would not require the removal of the shopfront awning, which currently extends onto the existing footpath. Overall, the proposed design will have a minor impact to the House and Shop.

Expanding Garfield Road East into the boundary of the Riverstone Public School (former) and removing the existing landscape buffer around the main school building would eliminate existing plantings and the space between the roadway and the main building. The proposal would have a moderate impact on the Riverstone Public School (former).

Cutting into the existing landscaping of the site of St John Evangelist Parish would alter the spacing and proportions of the site, de-emphasising the prominence of the main church building within the context of the site. However, the works would not physically impact the church, which is the focus of the sites heritage significance. Overall, this would result in a moderate impact to St John Evangelist Parish.

The proposal would require the expansion of the roadway at St Clare's Convent, involving the removal of the perimeter boundary fence and some landscape features at St Clare's Convent. Cutting into the existing landscaping of the site would alter the spacing and proportions of the site, de-emphasising the prominence of the convent within the context of the site. However, the works would not physically impact the building, which is the focus of the sites heritage significance. Overall, this would result in a moderate impact to St Clare's Convent.

The heritage curtilage for Rosebank continues to include the former property boundary for the site, including its former landscaping. As the landscaping has already been impacted by subdivision works, any impact from the proposal would be inconsequential. Therefore, impact on the built heritage values of the site is nil.

Heritage items in the vicinity of the proposal including St Andrews Uniting Church and Bicentennial Museum would not result in physical impacts to these heritage items. However, the proposal would result in altering the surrounding context of St Andrews Uniting Church and the Bicentennial Museum. Therefore, the proposal would result in a minor impact to both places.

6.5.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Non-Aboriginal heritage	A Non-Aboriginal Heritage Management Plan (NAHMP) will be prepared and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented to avoid and mitigate impacts to Non-Aboriginal heritage. [The NAHMP will be prepared in consultation with the Office of Environment and Heritage] <i>[delete if consultation not required]</i> .	Contactor	Detailed design / Pre-construction	Standard safeguard NAH1 Section 4.10 of QA G36 <i>Environment Protection</i>
Non-Aboriginal heritage	<ul style="list-style-type: none"> <i>The Standard Management Procedure - Unexpected Heritage Items</i> (Transport for NSW, 2015) will be followed in the event that any unexpected heritage items, archaeological remains or potential relics of Non-Aboriginal origin are encountered. Work will only re-commence once the requirements of that Procedure have been satisfied. 	Contactor	Detailed design / Pre-construction	Standard safeguard NAH2 Section 4.10 of QA G36 <i>Environment Protection</i>
Non-Aboriginal heritage	An application for an Excavation Exception under s139 of the Heritage Act will be required for groundworks at Riverstone Public School (former) corner of Garfield Road and Piccadilly Street; the weatherboard house site at 169 Garfield Road East.	TfNSW	Detailed design / Pre-construction	Additional safeguard NAH3

Impact	Environmental safeguards	Responsibility	Timing	Reference
Non-Aboriginal heritage	All items identified as being negatively impacted should undergo photographic archival recording, prior to the commencement of works.	Contractor	Detailed design / Pre-construction	Additional safeguard NAH4
Non-Aboriginal heritage	A Statement of Heritage Impact (SoHI) will be required to undertake an assessment of any impacts arising from the detailed design.	TfNSW	Detailed design / Pre-construction	Additional safeguard NAH5
Archaeological potential	Depending on the precise location and extent of the proposal, a structure at the Riverstone Public School (former) corner of Garfield Road East and Piccadilly Street; and the weatherboard house site at 169 Garfield Road East should be the subject of archaeological investigations prior to ground disturbance works commencing. Archaeological investigations may include test excavation and/or archaeological salvage excavation depending on the full extent of development impacts.	TfNSW	Detailed design / Pre-construction	Additional safeguard NAH6

6.6 Socio-economic

A socio-economic impact assessment (SEIA) was prepared to assess the potential socio-economic impacts of the proposal. This section describes the socioeconomic impacts associated with the proposal. The assessment considered the community, business and industry impacts of the construction and operational stage of the proposal. The SEIA report is provided in Appendix J of this REF.

6.6.1 Methodology

The SEIA was prepared in accordance with the TfNSW Environmental Impact Assessment Practice Note Socio-economic assessment (January, 2020).

The methodology used to assess the potential socio-economic impacts of the proposal included:

- Preparing a profile of demographic characteristics, community infrastructure, key industries and businesses, and recreational areas that may be influenced by the proposal
- Preparing a description of the regional context in which the proposal sits
- Characterising the existing local amenity, such as noise and air quality
- Identifying the scope of the likely changes and social and economic impacts that may occur as a result of the proposal
- Conducting an analysis of potential negative and positive impacts, both direct and indirect, during construction and operation
- Assessing the significance of the potential impacts by considering the sensitivity of the receptor and the magnitude of the proposed works
- Identifying safeguards and management measures to mitigate the impacts during construction and operation.

The information used in this SEIA was drawn from a variety of both primary and secondary sources which included:

- Meetings and workshops with TfNSW and SMEC project teams
- Observations from site visits
- Stakeholder consultation
- Data from the Australian Bureau of Statistics (ABS) such as 2016 Census data
- Data from the Department of Employment
- Blacktown City Council planning documentation such as:
 - Schedule 8 of the Blacktown Development Control Plan (Blacktown City Council, 2015)
 - The Riverstone Town Centre Master Plan (Blacktown City Council, 2017)
 - Our Blacktown 2036 – Blacktown City Council's Community Strategic Plan (Blacktown City Council, 2017a)
- The Hills Shire Council planning documentation such as:
 - Hills Future 2036 – The Hills Shire Council's Local Strategic Planning Statement (Hills Shire Council, 2019)
- State Government planning documentation, including A Metropolitan of Three Cities (Greater Sydney Commission, 2018)
- The NWGA Planning website
- Other technical reports prepared for the proposal.

6.6.2 Existing environment

Garfield Road East is located within Riverstone, which is part of the Blacktown LGA of Greater Western Sydney. The suburb is within the NWGA which is undergoing significant infrastructure development as part of Sydney's precinct planning.

Population

The NWGA is about 656 hectares and is bounded by Schofields Road to the south, Windsor Road to the north east and First Ponds Creek to the west.

North Western Sydney has experienced very high levels of growth over the past two decades. New housing development and ongoing planning for the NWGA have created demands for shops, infrastructure, community facilities and services, employment lands, open space and recreational areas. In addition, upgraded roads and improved transport networks i.e. Windsor Road, M2, M7, Transitways and the North West Rail Link (NWRL), have attracted greater concentrations of business and industrial employment opportunities to this region (EC, 2015).

Garfield Road East is a local arterial road which provides access to the Riverstone Town Centre from the key intersection of Windsor Road, at the eastern end of the study area.

Demography

At the time of the 2016 ABS Census, the population of Riverstone was 7,247 people. Around two thirds of Riverstone as well as Blacktown and the Hills Shire LGA's population, 66.9 per cent, 67 per cent 65.1 per cent respectively, are of working age between 15-64 years, which is consistent with the overall State's working age percentage of 65 per cent.

Less than five per cent of the residents of Riverstone identified as being from Aboriginal or Torres Strait Island decent, and about a quarter of the Riverstone population were not born in Australia. About 19 per cent of Riverstone residents spoke a language other than English at home, which is less than the State of NSW with 26 per cent.

Families and households

According to the 2016 Census, there were 2,511 dwellings in Riverstone. The overwhelming majority of these dwellings were separate at about 93 per cent and only three per cent were semi-detached dwellings. About eight per cent of these dwellings were unoccupied at the time of the 2016 Census. There is an average of 2.9 people per household in Riverstone.

In 2016, there were 1,988 families living in Riverstone; 46.9 per cent of these were classified as couple families with children, which is consistent with the State of NSW with 45.7 per cent but is less than the Blacktown LGA with 55.5 per cent and Hills Shire LGA with 60.4 per cent.

Housing cost and tenure

Of the dwellings in Riverstone, around 26.6 per cent are owned and 38.0 per cent are being purchased. Compared with 22.5 per cent and 41.9 per cent in Blacktown LGA, 34.5 per cent and 45.7 per cent for the Hills Shire LGA and 32 per cent each in the State of NSW.

The average monthly mortgage repayment data for Riverstone was \$2,191, which was slightly higher than the repayments of residents in the wider Blacktown LGA of \$2,150 and lower than the Hills Shire LGA of \$2,500. The average monthly mortgage repayment for the State of NSW for the same period was \$1,986.

Those renting in Riverstone paid an average of \$400 per week, which was slightly higher than rents in the Blacktown LGA and State of NSW which were both \$380. Comparatively, the weekly rent for the Hills Shire was higher at \$562.

Socio-Economic indexes for areas and need for assistance

The Socio-Economic Indexes for Areas (SEIFA) is an index provided by the ABS that summarises different aspects of the socio-economic conditions of people living in an area based on a set of socio-economic data from the Census such as income, educational attainment, unemployment and dwellings without motor vehicles. It provides a more general measure of socio-economic status than is given by measuring income or unemployment alone. SEIFA for the 2016 Census has been used for this report. The SEIFA index for the State of NSW for 2016 was 1001.

In 2016, the SEIFA index for Riverstone-Vineyard was 989.1, which was slightly higher than the Blacktown LGA of 986. The Hills Shire SEIFA index for 2016 was less disadvantaged, with a SEIFA index of 1107.

According to the 2016 Census, 4.7 per cent of in the Riverstone-Vineyard area identified a need for assistance with daily living, which is comparable with Blacktown LGA with 5.1 per cent.

Travel behavior

According to the 2016 ABS Census, motor vehicle ownership within the Riverstone area was:

- 137 households or 5.9 per cent do not own a motor vehicle
- 683 households or 29.6 per cent own a single motor vehicle
- 897 households or 38.8 per cent own two or more motor vehicles
- There is an average number of 1.9 vehicles per dwelling in Riverstone.

According to the 2016 ABS Census, approximately 73.6 per cent of people in Riverstone travel to work by car, with 66.1 per cent of these people as the driver. Only 11.6 per cent of people in the Riverstone reported travelling to work via public transport, 7.5 per cent of these via train.

Three Busways bus services operate within the study area to access the suburbs of Box Hill, Riverstone, including Riverstone, Vineyard, Marsden Park and Rouse Hill.

The bus routes that use the study area include:

- Busways route 746 operates along Garfield Road East, which services Riverstone to Rouse Hill Town Centre
- Busways route 747 operates along Piccadilly Street and services Marsden Park to Rouse Hill via Riverstone
- Busways route 742 operates along Edmund Street and Clarke Street and intersections Garfield Road East and services Marsden Park to Rouse Hill
- Busways route 671 operates along Hamilton Street and McCulloch Street, and intersects Garfield Road East. This route services Riverstone to Windsor via McGraths Hill and Vineyard.

Economic characteristics

The median weekly household income within the study area was \$1,667 at the time of the 2016 ABS Census. The NSW State median was slightly lower at \$1,486, while the Blacktown LGA and Hills Shire LGA medians were higher at \$1,711 and \$2,363 respectively.

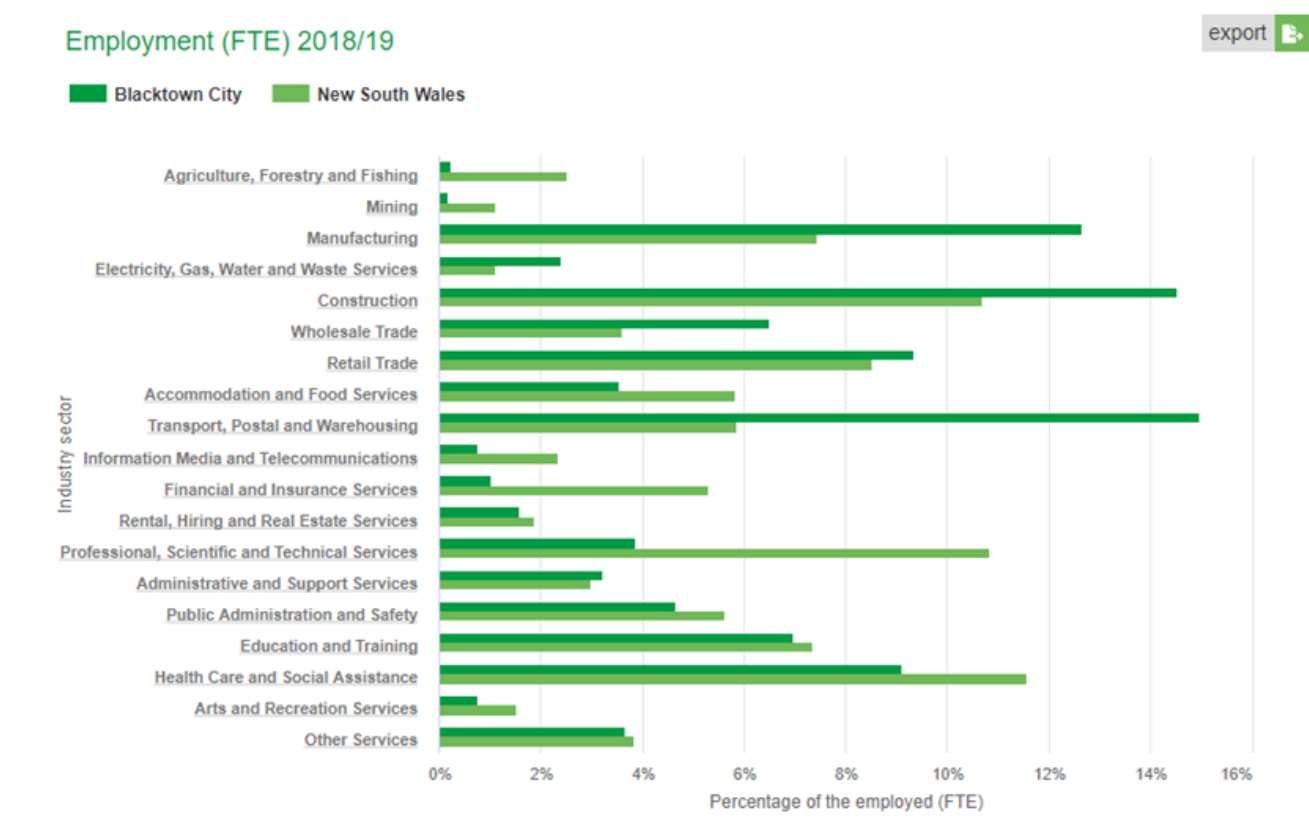
An analysis of the jobs held by the resident population in Riverstone - Vineyard in 2016 shows the three most popular industry sectors were:

- 505 people or 14.9 per cent working in construction
- 362 people or 10.7 per cent working in retail trade
- 300 people or 8.8 per cent working in health care and social assistance

In combination, these three industries employed 1,167 people in total or 34.4 per cent of the total employed resident population. In comparison, Blacktown LGA employed 8.0 per cent in Construction; 10.6 per cent in Retail Trade; and 12.7 per cent in Health Care and Social Assistance.

Riverstone forms one of four precincts of the Blacktown LGA. Each precinct is serviced by a strategic centre, and each has its own economic, social and environmental characteristics that will influence how it grows and develops (BCC, 2019).

Figure 6-26 illustrates the number of registered businesses by industry in the Blacktown LGA for the 2018/2019 period.



Source: National Institute of Economic and Industry Research (NIEIR) ©2019 Compiled and presented in economy.id by .id the population experts.

.id
the population
experts

Figure 6-26: Registered businesses by industry (source: Economic ID, 2019)

A snapshot of the economic profile for Blacktown and The Hills LGAs is provided in Table 6.30.

Table 6.30: Gross regional product year ending 2019 (Community ID, 2020)

LGA	Gross regional product	Local jobs	Local businesses	Largest industry
Blacktown	\$18.81 billion	143,259	23,340	Construction
The Hills	\$11.81 billion	-	-	Retail trade

Social infrastructure and community facilities

The following sections provide an overview of the social infrastructure and values in the study area and its surrounds. Social infrastructure is shown in Figure 6-27.

Schools

There are a number of schools within the study area or within one kilometre of the study area. These schools relevant to the study area are provided in Table 6.31.

Table 6.31: Schools relevant to the study area

School	Location	Proximity to proposal
St John's Primary School	5 McCulloch Street, Riverstone	Within
Casuarina School	Corner of Piccadilly Street and Garfield Road East, Riverstone	Within (partially)
Genius Kids	197 Garfield Road East, Riverstone	30 m north
Riverstone Pre-Public School	Garfield Road East, Riverstone	40 m south
Ready 2 Learn Riverstone	117 Piccadilly Street, Riverstone	60 m south
Riverstone Public School	Elizabeth Street, Riverstone	190 m south
Norwest Christian College	Corner of Regent Street and McCulloch Street, Riverstone	390 m south
Noree – Riverstone Public School	144 Regent Street, Riverstone	450 m south
Riverstone High School	71 McCulloch Street, Riverstone	630 m south

Open space and recreation

The Riverstone Reserve can be accessed by pedestrians from Garfield Road East, immediately east of the Riverstone Veterinary Hospital located at 157A Garfield Road East. There is green space and park facilities located at the intersection of Garfield Road East and George Street. This open space area is associated with the Riverstone and District Historical Society and Museum.

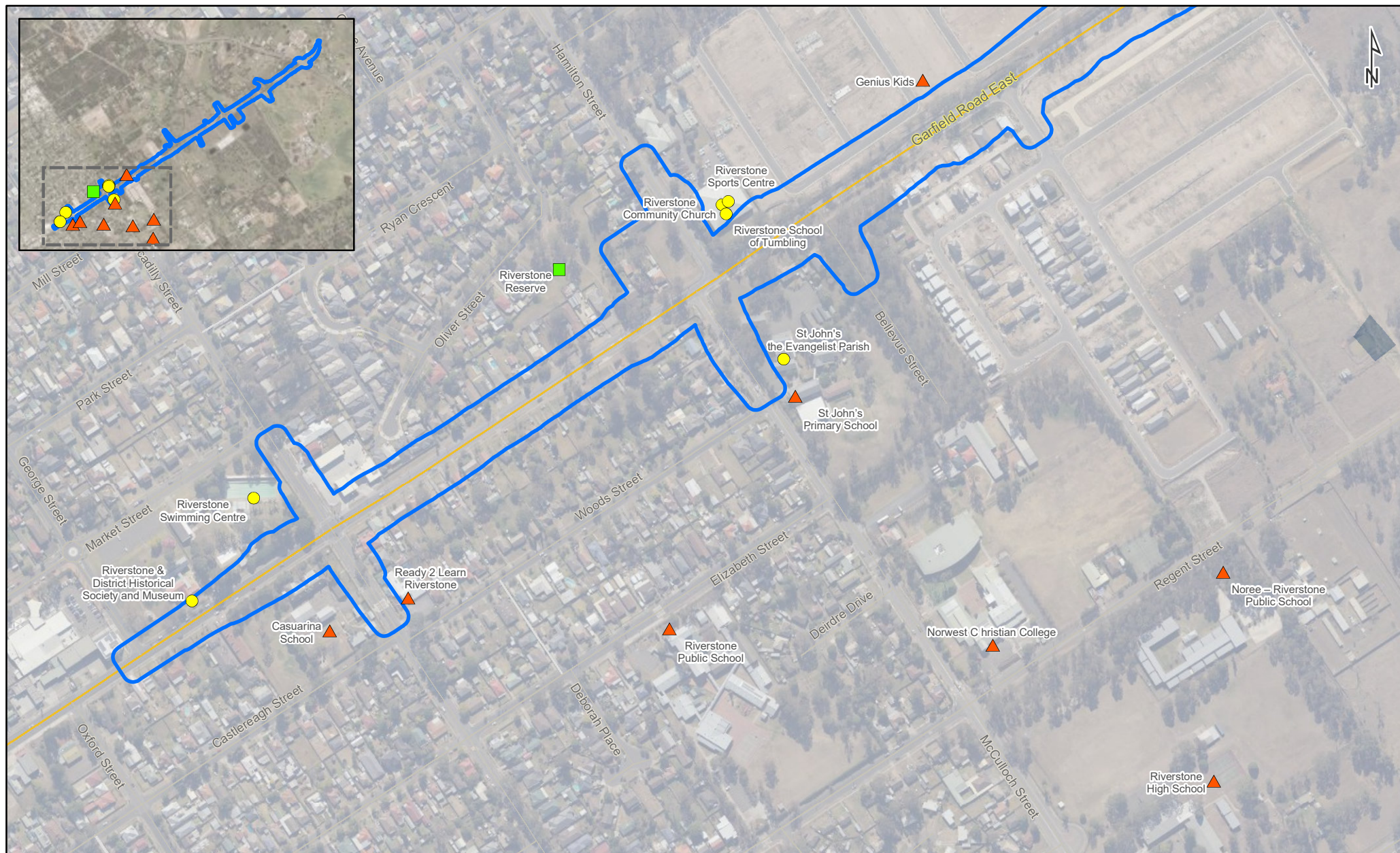
There are no other formal open space or recreational areas within the study area. However, there are large areas of undeveloped rural land east of the Galluzzo Street intersection.

Community facilities

Community facilities either within or adjacent to the study area are described in the following section.

- Riverstone School of Tumbling - is a performance school apart of Gymnastics NSW. Classes run on a Monday and Friday from 4pm to 6pm
- Riverstone Sports Centre - is an ancillary facility to the Riverstone Community Church which runs soccer for all ages during the week. The sports centre is also available as a venue for private bookings
- Riverstone Community Church - The church is located on the corner of Hamilton Street and Garfield Road, in Riverstone and is within the study area. The church shares the same premises as the Riverstone Sports Centre. The building has been paid for via community donations
- St John the Evangelist Parish - associated with St John's Primary School

- Riverstone Swimming Centre - is situated at the intersection of Piccadilly Street and Garfield Road East. It features a seven lane Olympic size pool, a novelty/leisure pool as well as learn to swim and baby pools, a picnic area and playground facilities and disabled facilities. The Riverstone swimming centre is also the home of the Riverstone Dolphins Youth Swimming Club. The centre is open from 9am to 6pm daily. Entry is free for children under four years old and for pensioners who are residents of the Blacktown LGA
- Riverstone and District Historical Society and Museum - The Society was formed in 1980. It operates the Riverstone and District Historical Museum which opened in 1988 and was originally known as the Blacktown City Bicentennial Museum. The Society is a non-profit organisation, operated purely by dedicated volunteers. It meets at 10:30 am on the last Sunday of every second month, at the museum.

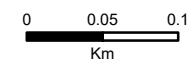


- Study area
- Community facilities
- Open Space
- ▲ Schools

Garfield Road East 30012746

Figure 6-27: Location of social infrastructure within the proposal

Roadnet MDS 2019, Imagery © Department of Finance, Services & Innovation 2018



6.6.3 Potential impacts

Construction

Acquisition of property and changes to land use

The proposal has been designed to minimise the need for property acquisition. Where possible the proposal utilises the existing road corridor, however some partial and full property acquisition is required for the proposal. Both residential and commercial properties would be impacted, as detailed in section 3.6. Land for ancillary facilities would be located on land to be acquired by TfNSW for the proposal.

The property impact anticipated as part of the proposal include full or partial acquisition of properties which can lead to:

- Loss of land and infrastructure
- Property severance
- A feeling of loss.

Acquisition and relocation processes as a result of full acquisition would generate demand on time for residents and their families. Partial acquisition may reduce resident's enjoyment of spaces, decreasing a residents pride in their properties and a loss of privacy during construction.

The potential property impact would primarily be focused around areas of full acquisition at the western end of the proposal. TfNSW would work directly with landholders and residents expected to be impacted by the proposal.

TfNSW would undertake all acquisitions in accordance with current acquisition guidelines and the *Land Acquisition (Just Terms Compensation) Act 1991*.

Amenity

Construction activities related to the proposal are expected to have some impact on amenity in and directly next to the proposal. Construction of the proposal has the potential to affect amenity as a result of changes to levels of noise and vibration, traffic, air quality and visual impacts.

The following sections describe potential impacts to amenity and community wellbeing during construction of the proposal.

Noise and vibration

Receivers in proximity to the proposal primarily comprise of residential receivers, with some commercial receivers and social infrastructure. There are a number of construction activities where construction noise and vibration impacts are expected. Construction activities such as demolition and excavation, construction of retaining walls, pavement works and overlay would affect sensitive receivers in proximity to the proposal.

While changes to noise amenity as described above would be restricted to the construction period the magnitude is considered to be high due to the predicted noise levels and number of receivers affected by the proposal.

The sensitivity of receptors within this area are considered to be moderate due to the proximity of sensitive receivers to the proposal, which includes a large number of residential residents, and some businesses and social infrastructure. As such the socio-economic impact of changes to noise amenity associated with the construction of the proposal is considered to be moderate.

The socio-economic impact of changes to noise amenity associated with the construction of the proposal would be high-moderate.

Vibration from the construction work is not likely to adversely impact on sensitive receivers if safe working distance recommendations are followed. As such the socio-economic impact associated with vibration impacts during construction would be negligible. Where vibration-generating works are required to occur within the safe working distances close to sensitive receivers, additional mitigation measures would be implemented.

Construction traffic

Construction traffic has the potential to affect amenity, with increased traffic levels potentially impacting noise and air quality, as well as the visual presence of additional vehicles within the proposal. An increase in traffic volume may impact trip duration, wait times at intersections, road safety, access to properties and community infrastructure during construction.

Heavy vehicle movements, which are likely to have the largest impact, would mainly be related to earthworks or spoil movement, but would also include other movements such as plant and machinery delivery. The estimated 50 to 100 heavy vehicle movements per day associated with the proposal would be temporary and would not result in a substantial increase on existing vehicle numbers. Heavy vehicles would only access sites from approved heavy vehicle routes.

Based on the relatively small increase in overall traffic volumes, the magnitude of the impact to traffic is considered to be low. The sensitivity of affected receivers is considered to be low given the existing heavy vehicle movements on Garfield Road East as an approved B-double route. As such, the socio-economic significance of construction traffic impact for the proposal would be low.

Air quality

There is the potential for dust generation associated with the following construction activities:

- Stripping of topsoil
- Clearing of vegetation
- Earthworks
- Stockpiling
- Transport and handling of soils and materials
- Traffic movements on unpaved roads.

The potential air quality impact to nearby residential receivers and social infrastructure surrounding the proposal as part of the construction works would include dust and exhaust emissions from plant and equipment. The overall impact to air quality is considered to be negligible. The potential impact would be readily managed through the implementation of standard safeguards and mitigation measures. Once operational the proposal would have a negligible impact on air quality.

Visual amenity

The Landscape Character, Visual Impact Assessment (LCVIA) (Spackman Mossop Michaels (SMM), 2019) assessed eight key viewpoints across three land character zones (LCZ) within the proposal. During construction, visual amenity would be affected by factors such as:

- Removal of established vegetation
- Installation of construction ancillary facilities
- Presence of construction equipment.

Construction activities would be temporary in nature and only be visible to those with direct views of the proposal.

The proposal would see the road widening and removal of a large amount of existing mature native trees along both sides of the Garfield Road East impacting on views, and amenity for motorists and the adjacent residential areas. The removal of a number of important groupings of native roadside trees in the eastern

portion of the proposal would have a substantial impact on the rural setting of this character zone as seen by motorists on Garfield Road East and some residents.

Overall the visual impact would range from moderate-low, moderate-high to high across the proposal. Proposed shrub and tree planting along the proposal across each of the LCZ in the proposal would help to re-establish a mature tree canopy, however these would take time to mature.

Access and connectivity - roads network and access

Travel times would likely increase during construction of the proposal. These impacts would be temporary in nature. Construction activities may also cause temporary partial closure of the road network and changes to speed limits.

Once operational, the proposal would improve travel times, reduce congestion and reduce travel costs.

Some existing properties may experience short-term inconveniences because of these changes in access to their properties during construction. Most of the impact would be short term and alternate access arrangements, if required, would be provided in consultation with property owners.

The magnitude of the impact to the road network and property access are considered to be moderate given the number of properties that would be impacted. Temporary access arrangements would be implemented to ensure access is maintained during construction. The Impact to travel times are considered to be low. The sensitivity of receptors is considered to be moderate. On this basis the socio-economic significance of this impact would be moderate.

Access and connectivity - parking

On street parking would be impacted during construction of the proposal. The loss of on-street parking along Garfield Road East is likely to be accommodated by existing parking capacity on local side streets. Construction compounds would provide parking for both light and heavy vehicles, including sufficient parking for workers. Therefore, the impact to parking availability would be considered negligible.

Once operational, existing on street parking between Piccadilly Street and Hamilton Street would be removed. On street parking along Garfield Road East between Piccadilly Street and Hamilton Street is not typically associated with retail or commercial industry trade and is not associated with commuter parking for Riverstone Station. Parking availability in adjacent side streets to Garfield Road East would remain unchanged.

As parking in the proposal is largely associated with opportunistic residential parking/visitors or residential properties, it is not anticipated that the removal of these areas would likely result in a major impact because of the proposal.

Access and connectivity - public transport and active transport connectivity

Two bus stops on Garfield Road East between Piccadilly Street and Hamilton Street/McCulloch Street would be temporarily closed during construction to ensure the safety of the public. Passengers would temporarily utilise the existing bus stops located on Piccadilly Street as an alternative. Bus stops located on side streets may be temporarily relocated further away from the intersections and outside of construction activities of the proposal. The overall impact of the proposed changes are considered to be negligible. Consultation with bus companies and other key stakeholders will be undertaken prior to construction to inform them of the proposed changes.

During operation of the proposal bus routes which currently turn from Garfield Road East to Clarke Street will need to be rerouted permanently as access between Clarke Street and Garfield Road East would be removed as part of the proposal. The indicative layout plan (ILP) for the area indicates access from Garfield Road East to Clarke Street may be retained via Access 2 through future developments which do not form part of this proposal. The proposal is expected to improve the reliability of bus services. Formalised bus stops and bus bays would benefit traffic flow.

Existing pedestrian paths along Garfield Road East would be temporarily impacted during activities required for the construction of the proposal. Connectivity would be maintained through localised diversions where feasible. The overall impact on public and active transport networks are considered to be negligible.

A separated shared pedestrian and cyclist path would be provided along Garfield Road East as part of the proposal. This shared path would provide connectivity within the proposal.

Business and industry - local business

Businesses may be affected during construction by temporary increases in travel time to employees, customers, and deliveries. The impact on businesses would vary during construction of the proposal. Passing trade in the area from customers may be reduced during construction of the proposal because of amenity and access impacts and reduced parking.

Amenity impacts include any factors that affect the ability of customers, employees or business owners to enjoy their workplace and daily activities. These may include adverse change to noise and vibration levels, views or air quality. This may potentially be most notable at the western end of the proposal near the Riverstone Town Centre commercial area.

The potential impacts to business and industry associated with the construction phase of the proposal is provided in Table 6.32.

Table 6.32: Commercial businesses relevant to the study area

Business	Potential impacts
Riverstone Petroleum, 125/111 Garfield Road East	Increased patronage from construction vehicles fuelling up at the service station
Riverstone Veterinary Hospital, 159 Garfield Road East	Temporary parking and access impacts from construction activities may reduce patronage during construction of the proposal. There may be temporary changes to access during construction, however access would be maintained during construction
Mobile Mechanic Riverstone	Potential increase in patronage because of construction vehicles, plant and equipment on site during the construction which will need to be maintained and serviced throughout the duration of the work
Burns Pet Food	Impacts to employees, deliveries and pick up because of traffic and access impacts during construction of the proposal. Access would be maintained during construction

The proposal would be constructed in a way that would allow existing traffic arrangements to continue. Given existing traffic arrangements would continue, the overall magnitude is considered to be low. The sensitivity of businesses to the potential loss of customers is low given that some businesses do not rely on passing trade as a key source of revenue such as the Riverstone Veterinary Hospital. Overall socio-economic impacts to local businesses and industry is considered to be low.

Some businesses as a result of additional construction workers utilising the businesses in town such as food outlets and the service station etc. would result in increased customers.

Business and industry - regional industry

There is an opportunity for regional employment through the construction labour force required to build the proposal and wider indirect employment opportunities from professions such as building and construction professionals, drivers and suppliers. The workforce would most likely be sourced locally however, certain specialists may be employed from regional and areas across NSW.

Economy - expenditure and employment

Construction activity can directly benefit the economy through direct expenditure associated with on-site construction activities and direct and indirect employment and expenditure such as the provision of goods and services required for construction. Business likely to positively benefit would be those in the food service industry and ancillary services such as petrol stations.

Once operational, the proposal is expected to support the economic directives of the Riverstone Town Centre Master Plan and the One Blacktown Strategic Directive.

Community values

The construction phase of the proposal is likely to result in temporary negative impacts to community values. Perceived loss in local character may include temporary inconvenience and delay in access to facilities along Garfield Road East, including St John Evangelist Parish, Riverstone Community Church.

Social infrastructure

The potential impacts of the construction of the proposal on social infrastructure in the study area are detailed in Table 6.33. Impacts such as noise and vibration, and traffic, have been assessed in separate technical reports, as described in the REF, and specific safeguards and management measures have been proposed in the REF to manage and mitigate these.

A summary of the potential impacts of construction on social infrastructure is provided in Table 6.33.

Table 6.33: Construction impacts on social infrastructure within the study area

Social infrastructure	Potential impacts
St John's Primary School	Temporary access changes along Garfield Road East. There may be temporary changes to access during construction, however access to the school would be maintained Temporary noise levels above 75 dB(A) are predicted during construction Informal kiss and drop areas would be inaccessible/relocated during construction Dust generation may result in health impacts to school children Changes to school bus routes/bus stops/increased travel time Potential change in travel time due to additional traffic on alternative routes/local road
Riverstone Pre-Public School	Temporary access issues along Garfield Road East. Access to the school would be maintained. There may be temporary changes to access during construction Temporary noise levels above 45 dB(A) are predicted during construction Informal kiss and drop areas would be inaccessible/relocated during construction Dust generation may result in health impacts to school children Changes to school bus routes/bus stops/increased travel time Potential change in travel time due to additional traffic on alternative routes/local road
Riverstone Public School	Temporary access issues during construction of McCulloch Street intersection. Access to the school would be maintained. There may be temporary changes to access during construction Temporary noise levels above 65 dB(A) are predicted during construction

Social infrastructure	Potential impacts
	<p>Informal kiss and drop areas would be inaccessible/relocated during construction</p> <p>Dust generation may result in health impacts to school children</p> <p>Changes to school bus routes/bus stops/increased travel time</p> <p>Potential change in travel time due to additional traffic on alternative routes/local road</p>
Casuarina School	<p>Temporary access issues along Garfield Road East, particularly during construction of the Piccadilly Street intersection. Access to the school would be maintained. There may be temporary changes to access during construction</p> <p>Temporary noise levels above 80 dB(A) are predicted during construction</p> <p>Informal kiss and drop areas would be inaccessible/relocated during construction</p> <p>Dust generation may result in health impacts to school children</p> <p>Potential changes to school bus routes/bus stops/increased travel time</p> <p>Potential change in travel time due to additional traffic on alternative routes/local road</p>
Norwest Christian College	<p>Increased traffic volumes due to road closures/alternative routes. Access to the school would be maintained. There may be temporary changes to access during construction</p> <p>Temporary noise levels above 55 dB(A) are predicted during construction</p> <p>Potential changes to school bus routes/bus stops/increased travel time</p> <p>Potential change in travel time due to additional traffic on alternative routes/local road</p> <p>Impacts during construction of McCulloch Street intersection</p> <p>Noise and vibration impacts may be experienced at the school during construction</p>
Genius Kids	<p>Noise and vibration impacts may be experienced at the school during construction</p>
Noree - Riverstone Public School	<p>Noise and vibration impacts may be experienced at the school during construction</p>
Ready 2 Learn Riverstone	<p>Temporary access issues along Garfield Road East, particularly during construction of the Piccadilly Street intersection. Access to the centre would be maintained. There may be temporary changes to access during construction</p> <p>Temporary noise levels above 80 dB(A) are predicted during construction</p> <p>Dust generation may result in health impacts to school children</p>
Riverstone School of Tumbling	<p>Temporary access issues along Garfield Road East. Access to the school would be maintained. There may be temporary changes to access during construction</p> <p>Noise and vibration impacts may be experienced at the school during construction</p> <p>Increased traffic volumes due to road closures/alternative routes</p> <p>Potential change in travel time due to additional traffic on alternative routes/local road</p>

Social infrastructure	Potential impacts
	<p>Travel delays due to additional increased vehicle volumes along Garfield Road East from construction plant and equipment</p> <p>Travel delays due to temporary road closures or detours</p>
Riverstone Sports Centre	<p>Temporary access issues along Garfield Road East. Access to the centre would be maintained. There may be temporary changes to access during construction</p> <p>Noise and vibration impacts may be experienced at the school during construction</p> <p>Increased traffic volumes due to road closures/alternative routes</p> <p>Travel delays due to additional increased vehicle volumes along Garfield Road East from construction plant and equipment</p> <p>Potential change in travel time due to additional traffic on alternative routes/local road</p> <p>Travel delays due to temporary road closures or detours</p>
St John Evangelist Parish	<p>Temporary access issues along Garfield Road East. Access to the church would be maintained. There may be temporary changes to access during construction</p> <p>Temporary noise levels above 80 dB(A) are predicted during construction</p> <p>Increased traffic volumes due to road closures/alternative routes</p> <p>Travel delays due to additional increased vehicle volumes along Garfield Road East from construction plant and equipment</p> <p>Potential change in travel time due to additional traffic on alternative routes/local road</p> <p>Travel delays due to temporary road closures or detours</p>
St Clare's Convent	<p>Temporary access issues along Garfield Road East. There may be temporary changes to access during construction</p> <p>Noise and vibration impacts may be experienced at the convent during construction</p> <p>Noise and vibration impacts may be experienced at the convent during construction</p> <p>Travel delays due to additional increased vehicle volumes along Garfield Road East from construction plant and equipment</p> <p>Travel delays due to temporary road closures or detours</p> <p>Removal of existing wall along Garfield Road East</p> <p>Potential change in travel time due to additional traffic on alternative routes/local road</p> <p>Property and access adjustments to accommodate road widening. The access to the convent will be via Matthias Street or St John Evangelist Parish</p>
Riverstone Swimming Centre	<p>Dust generation and construction noise and vibration may negatively impact the existing amenity of the swimming centre</p> <p>Temporary noise levels above 80 dB(A) are predicted during construction</p> <p>Access to the pool from the Piccadilly Street and Garfield Road intersection impacted. Likely that patrons would need to access the swimming centre from the western approach</p> <p>Additional traffic impacting amenity at the swimming centre</p> <p>Potentially increased patronage/business during summer months</p> <p>Decreased water quality due to dust generation associated with construction activities</p>

Social infrastructure	Potential impacts
	Travel times to and from the swimming centre may be negatively impacted by traffic controls, road closures and use of alternative routes
Riverstone & District Historical Society and Museum	Noise and vibration impacts may be experienced at the museum during construction Impacts to amenity of the historical society The potential for opportunist tourism from pedestrians and cyclists will likely decrease due to the changes in access along Garfield Road East during construction Out of hours construction, if applicable, may impact the Society's monthly meetings
Tyburn Priory	Permanent access changes because of the proposal Noise and vibration impacts may be experienced at the school during construction Travel delays due to additional increased vehicle volumes along Garfield Road East from construction plant and equipment Potential change in travel time due to additional traffic on alternative routes/local road Travel delays due to temporary road closures or detours

Operation

Acquisition of property and changes to land use

The proposal requires the acquisition of land currently used for residential and some business purposes. No social infrastructure would be fully acquired. There may be partial acquiring of some land at the school. The full or partial acquisition of land may result in changes to the lives of those affected giving rise to a sense of anxiety or uncertainty, a loss of amenity and financial costs.

Owners may experience effects such as health wellbeing if required to sell their property and relocate as a result of the proposal. Acquisition has the potential to affect people with a connection to their property such as intergenerational family homes. In some instances, it may be difficult to find another property with equivalent facilities and amenity to that being acquired. Property acquisition may result in the fragmentation of social networks and interaction as people move away from friends and family.

The magnitude of partial acquisition on properties is considered to be moderate given the disruptions caused by possible changes to access and the number of receptors potentially impacted. The sensitivity of affected individuals is considered to be moderate given the importance of households and the connection people can hold with their land. As a result, the significance of partial acquisition of properties on the socio-economic environment is considered to be moderate.

The overall magnitude of the socio-economic impact of full property acquisition is considered to be moderate given the number of properties that would be acquired for the proposal. The overall sensitivity of affected residents is considered to be high given the emotional stress property acquisition can cause on individuals. On this basis the overall socio-economic significance of full property acquisition associated with the proposal would be high-moderate.

Amenity - noise

Operational noise impacts at sensitive receptors include residents, certain businesses, and users of social infrastructure in the vicinity of the proposal. The sensitivity of receptors within this area are considered to be moderate due to the proximity of sensitive receivers to the proposal. The magnitude is considered to be

high due to exceedances of the Road Noise Policy base criteria of more than 2 dB to properties surrounding the proposal.

Noise amenity impacts during operation of the proposal would be high-moderate. This is due to the reduced distance between the road and properties along Garfield Road East. Exceedances have been identified along McCulloch Street which extends past the proposal. This is due to the expected increase in future traffic in the area. Mitigation measures would be required to reduce operational impact and may include at property treatments to reduce noise impacts from the proposal.

Amenity - air quality

The air quality impact associated with the operation of the proposal is not considered to be negligible. Once operational the proposal would improve travel time reliability and efficiency.

Amenity - visual

The proposal would see the road widening and removal of a large amount of existing mature native trees along both sides of the Garfield Road East impacting on views, and amenity for motorists and the adjacent residential areas. The removal of a number of important groupings of native roadside trees in the eastern portion of the proposal would have a substantial impact on the rural setting of this LCZ as seen by motorists on Garfield Road East and some residents. Overall visual impacts would range from moderate-low, moderate-high to high across the proposal.

The proposal includes appropriate landscaping and design considerations to minimise these impacts as detailed in the LCVIA (SMM, 2019) such as proposed shrub and tree planting across each of the land character zones in the proposal.

Access and connectivity

All properties affected by changed access arrangements as a result of the proposal would be provided with restored or new permanent access during operation. The magnitude of the impact is considered to be moderate given that while the alignment of access arrangements to and from the proposal would be modified, all property access arrangements to and from the local road network would be restored.

Access arrangements for St Clare's convent is currently directly to and from Garfield Road East. Under the proposal, a new access would be provided either via the St John the Evangelist Parish entrance or from Mathias Street. Access arrangements for 172 Garfield Road East would be changed to Mathias Street. Access arrangements to and from the Priory would remain directly from Garfield Road East, however the existing arrangement would be modified as a result of the proposal.

The sensitivity of receptors is therefore considered to be moderate. On this basis the socio-economic significance of this impact would be moderate.

The proposal would provide:

- Additional through lanes and turning lanes northbound and southbound to improve traffic capacity
- Facilities for cyclists and pedestrians
- Safe left in/left out turning facilities at intersections
- A safer posted speed limit
- Traffic islands and pedestrian access
- Formalised bus stops
- Formalised pedestrian facilities
- Formalised shared paths.

The proposal would result in safety improvements such as the sub-standard crest would be improved. Further improvements would involve provision of traffic lights, improved stopping sight distances, improved traffic flow and more efficient travel times within the proposal and across the region. Congestion has

substantial socio-economic effects because it affects the ability of people to get to work, access educational facilities, access recreational opportunities and spend time with their families and friends.

The proposal would provide improved capacity for both through traffic and local traffic which would allow residents and business users to travel more efficiently to their destinations and spend less time held up in traffic.

Generally, it is expected the proposal would reduce overall travel times and improve congestion for public transport utilising Garfield Road East as a consequence of the proposal.

Parking

On street parking between Piccadilly Street and Hamilton Street would be removed. On street parking along Garfield Road East between Piccadilly Street and Hamilton Street is not typically associated with retail or commercial industry or associated with commuter parking for Riverstone Station.

Parking availability in nearby side streets to Garfield Road East would remain unchanged.

As the parking is largely associated with opportunistic residential parking and visitors or residential properties, it is not anticipated that the removal of these areas would likely result in major impact because of the proposal.

Public transport and active transport connectivity

About 70 per cent of journeys are made using private vehicles for residents living in the Blacktown LGA and about 78 percent for residents living in the Riverstone Town Centre area. This reflects the accessibility and use of public transport in many areas of the Blacktown Council and Riverstone area.

Bus routes which currently turn from Garfield Road East to Clarke Street will need to be rerouted permanently as access between Clarke Street and Garfield Road East would be removed as part of the proposal. The indicative layout plan (ILP) for the area indicates access from Garfield Road East to Clarke Street may be retained via Access 2 through future developments which do not form part of this proposal. The proposal is expected to improve the reliability of bus services. Formalised bus stops and bus bays would benefit traffic flow. Access to public transport and the usability of the services would be improved as a result of the proposal.

Overall impacts on public transport are considered to be negligible.

A separated shared pedestrian and cyclist path would be provided along Garfield Road East as part of the proposal. This shared path would provide connectivity within the proposal. The proposal would improve connectivity conditions for cyclists, allowing this section of the proposal to form part of on road cycle routes.

Business and industry

Local business

The Riverstone Town Centre contains many of the attributes of a successful centre as it is accessible by public transport, contains parking and has exposure to passing vehicular traffic. It, however, suffers from a poor layout and lacks a retail anchor which impedes its ability to attract other retailers, which in turn affects the amount of pedestrian foot traffic (EC, 2017). The proposal would support connectivity and provide necessary infrastructure to drive further developments in the retail sector.

Future expected population growth in the NWGA combined with the close proximity of the Riverstone train station would appear to present demand opportunities for retail/ commercial development in the Riverstone Town Centre.

Properties and subdivisions of undeveloped land is expected to increase in value due to the improved transport infrastructure in the area.

The proposal would increase access to businesses in the Riverstone Town Centre. There is the potential for an increase in pedestrians and cyclists in the area, which would positively affect the number of walk-ins and opportunist use of local business and industry.

The proposal would allow connectivity to surrounding areas, such as Schofields, Vineyard, Marsden Park and Box Hill. Business outside of the immediate study area would likely benefit from strengthened connectivity.

The proposal would remove the existing on street parking between Piccadilly Street and Hamilton Street. Business impacts because of the proposal would include the loss of parking at the Riverstone Veterinary Hospital. The veterinary hospital currently maintains four off-street parking spots. The proposal would result in the loss of two spots. The magnitude of the loss of parking is considered to be high and the sensitivity would be considered to be moderate.

Surrounding side streets would have the potential to accommodate lost parking in terms of peak demand, duration and utilisation and the ability to accommodate additional vehicles.

The overall level of significance is high-moderate.

Economy

Once operational, the proposal is expected to support the economic directives of the Riverstone Town Centre Master Plan and the One Blacktown Strategic Directives.

New housing and urban development currently underway in the Riverstone area is expected to continue in order to meet the infrastructure needs of a growing population.

The potential for growth will be primarily underpinned by local residential growth, supplemented by outside visitation and patronage. The unlocking of development opportunities in the Riverstone Town Centre would first and foremost be aimed at stimulating developer interest. As development activity and momentum begins to build, retailers would be the next category of private investment targeted. Initiatives to attract visitation and patronage from beyond the Riverstone local catchment will also contribute to sustaining a viable town centre. (EC, 2017).

Once operational, the proposal would result in increased access to and through the proposal.

Community values

Council's aspirations for the Riverstone Town Centre are reflected in its investment into the provision of community and recreational facilities and improving the quality of the public domain. This will undoubtedly result in a lifting of the Riverstone Town Centre's profile as well as making it an attractive place to visit and spend time in. The proposal would improve access to these facilities and further work to build community values.

The proposal would align with the One Blacktown Strategic Directions in the following ways:

- A Vibrant and Inclusive Community - the proposal would support urban development of the NWGA and Riverstone precinct. The proposal would improve access to the commercial district located about 500 metres west of the proposal in Riverstone. The proposal would also improve travel time and facility interconnection for residents and commuters
- A Clean, Sustainable and Healthy Environment - the proposal would formalise the road alignment and upgrade existing drainage structures. The materials would be sourced from local providers, where reasonable and practicable to do so. Lighting, urban design and landscaping would work to enhance the natural amenity of the area and healthy local environment
- A Smart and Prosperous Economy - the proposal would support the Riverstone Town Centre Master Plan

- A Growing City Supported by Accessible Infrastructure - The proposal would provide pedestrian access and cycleways
- A Sporting and Active City - cycleways pedestrian access
- A Leading City - NWGA future projections, Greater Sydney Commission, Three Cities access to Riverstone Railways Station.

Social infrastructure

A summary of the potential impacts to social-infrastructure during the operational phase of the proposal is provided below.

Table 6.34: Operational impacts on social infrastructure within the study area

Social infrastructure	Potential impacts
Riverstone School of Tumbling	Access from Garfield Road East would be formalised Amenity impacts during construction Safe pedestrian and cycle access
Riverstone Sports Centre	Amenity impacts during construction Safer turning in and out of the sports centre Loss of land along the Garfield Road frontage
St John Evangelist Parish	Increased road noise due to the proposal Traffic island would provide increased pedestrian safety within the area Provision for active transport along Garfield Road frontage
Riverstone Swimming Centre	Increased traffic volumes may generate increased use of the swimming centre Increased amenity impacts from the outlook of the pool from landscaping and urban design associated with the proposal Provision for active transport in the proposal along Garfield Road East may result in improved access and connectivity to the centre
Riverstone & District Historical Society and Museum	Provision for active transport in the proposal along Garfield Road East may result in improved access and connectivity to the museum

Cumulative impacts

Cumulative socio-economic impacts associated with transport and infrastructure proposals include:

- Periods of construction impacting local amenity, disruption to traffic and pedestrian networks
- Economic effects such as potential changes to business operation and revenues
- Construction traffic from approved projects and future proposals placing additional pressure on road networks and parking capacity
- Consultation and construction fatigue for local communities due to the concurrent or sequential planning with other projects.

Construction fatigue relates to receivers that experience construction impacts from a variety of proposals over an extended period of time with few or no breaks between construction periods. Construction fatigue may be brought on through traffic and access disruptions, increased noise and vibration, reduced air quality, reduced visual amenity, or any combination of these factors. An assessment of the degree of impact arising from both the proposal and other nearby projects is provided below.

Depending on the timing of construction activities of the proposal, the ongoing and cumulative impacts of multiple road projects being undertaken in the area may result in construction fatigue impacts on residents and businesses in the area. The impact is considered to be low.

No negative cumulative impacts are expected to occur as a result of the operation of both the proposal and other projects in the area. The operation of this proposal and other projects may assist in improving road user experience, such as improved travel time and reliability.

Other projects such as Vineyard to Rouse Hill Transmission Line, Sikh Grammar School Rouse Hill and Schofields Public School Redevelopment and NWGA Implementation Plan would be carried outside of the proposal. There would be the potential for some small and localised amounts of work involved with tying in the proposal to local roads. Proposed work as a result of these projects on trafficable roads would be minor. It is unlikely road users, residents and businesses would experience impacts from the proposal and these other projects.

6.6.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Socio-economic	<p>A Communication Plan (CP) will be prepared and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The CP will include (as a minimum):</p> <ul style="list-style-type: none"> • Mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions • Contact name and number for complaints. <p>The CP will be prepared in accordance with the <i>Community Involvement and Communications Resource Manual</i> (RTA, 2008).</p>	Contractor / TfNSW	Detailed design / Pre-construction	Standard safeguard SE1
Property acquisition	TfNSW will continue to consult directly with affected property owners throughout the detailed design phase	TfNSW	Detailed design	Additional Safeguard SE2
Property acquisition	All property acquisition will be carried out in accordance with the Land Acquisition Information Guide (Roads and Maritime, 2014b), the Land Acquisition (Just Terms Compensation) Act 1991 and the NSW Government Land Acquisition Reform 2016	TfNSW	Detailed design	Additional Safeguard SE3
Property acquisition	TfNSW will examine the opportunities for reuse of parcels of residual land in more detail during detailed design	TfNSW	Detailed design	Additional Safeguard SE4
Ancillary sites	All ancillary sites will be restored to pre-existing conditions or to a condition agreed with the land owner	Contractor	Pre-construction /	Additional Safeguard SE5

Impact	Environmental safeguards	Responsibility	Timing	Reference
Council infrastructure	TfNSW will continue to consult with Council regarding impacts to council infrastructure	TfNSW	Pre-construction / Construction	Additional Safeguard SE6
Parking	Consultation would be carried out with Council to identify alternative parking arrangements to replace car parking lost during construction	TfNSW	Pre-construction / Construction	Additional Safeguard SE7
Parking	The construction contractor will provide suitable off-street parking to accommodate workers that does not impact on local businesses, Council parking or visitor centre and entertainment centre parking. The Construction TMP will include appropriate measures to prevent construction staff from utilising these public parking areas	Contractor	Pre-construction / Construction	Additional Safeguard SE8
Public transport	Temporary bus stops would be relocated to safe and accessible areas during the construction phase of the work. New locations would be communicated to the public and bus service providers	Contractor	Pre-construction / Construction	Additional Safeguard SE9

Other safeguards and management measures that would address socio-economic impacts are identified in section 6.1, section 6.2, section 6.7 and section 6.11.

6.7 Landscape character and visual impacts

A Landscape Character and Visual Impact Assessment (LVCIA) for the proposed works was prepared by Spackman Mossop Michaels (SMM, 2019). A summary of the findings of the LCVIA are provided in the following section. The full LCVIA is provided in Appendix K of this REF.

6.7.1 Methodology

The method used to undertake LCVIA follows the Guideline for Landscape Character and Visual Impact Assessment (Roads and Maritime, 2018) ('the Guideline') and is summarised as follows:

- Site visit and review of concept design
- Developing an Urban Design Strategy
- Defining the landscape character and landscape character zones (LCZs), as well as assessing impacts to LCZs
- Identifying the visual catchments and assessing impacts at specific representative viewpoints (VPs)
- Developing an Urban and Landscape Concept Design
- Identifying urban design and landscape opportunities and methods of mitigating adverse visual impacts.

Landscape character

Landscape character can be defined as the combined value of built, natural and cultural aspects that make up an area and provide a distinct sense of place. The method to measure impact is based on the combination of sensitivity of the existing area or view to change and magnitude of the proposal on that area or view. Sensitivity and magnitude are defined by the Guideline as:

- Sensitivity: the qualities of an area, the number and type of receivers and how sensitive the existing character of the setting is to the proposed nature of change.
- Magnitude: the type of proposal and its compatibility with the exiting landscape character. The scale of elements, as well as location or setting

Visual impact assessment

The potential visual impact of the proposal is assessed in relation to a number of key VPs. Locations and directions of chosen VPs are representative of the range of VPs within the visual catchment of the proposal.

- Sensitivity: the measure of the visual importance of the view and is dependent on the distance between the viewer and the proposal, the category of the viewer and the elements of the proposal that are visible.
- Magnitude: the nature and scale of the proposal and the extent and proximity of the view to it. Magnitude represents the contrast in scale, form and type of proposal to the location and context to which it is to be placed.

The impact assessment grading matrix is provided in Figure 6-28.

		MAGNITUDE			
		HIGH	MODERATE	LOW	NEGLIGIBLE
SENSITIVITY	HIGH	HIGH	HIGH-MODERATE	MODERATE	NEGLIGIBLE
	MODERATE	HIGH-MODERATE	MODERATE	MODERATE-LOW	NEGLIGIBLE
	LOW	MODERATE	MODERATE-LOW	LOW	NEGLIGIBLE
	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE

Figure 6-28: Impact assessment grading matrix

6.7.2 Existing environment

Landform and topography

Natural undulating hills are the dominant landform feature of the study area. The landform is dissected by First Ponds Creek and two unnamed watercourses from the south to the north of the construction footprint.

There is an appreciable positive visual quality to the topography of the eastern section of the study area. When driving eastward, the current straight road traverses a number of crests offering views to the south east at multiple points. When driving westward, views are offered towards Riverstone as one passes the crest approaching Hamilton Street.

Geology and soils

The study area mainly consists of undulating hills on Wianamatta Group shales. The local relief is between 10 and 30 metres and slopes are generally less than five per cent, however, can be up to ten per cent. The eastern section is dominated by the cleared First Ponds Creek floodplain. Relating to the alluvial soil grouping along First Ponds Creek, due to topsoil consisting of more than 50 per cent fine sand, there is a moderate to severe risk of erosion in the context of vegetation removal or minor excavation work.

Further details on geology and soils is provided in section 6.10 of this REF.

Hydrology and drainage

The study area is predominately within the First Ponds Creek catchment, which ultimately flows to the Hawkesbury River. To the east of First Ponds Creek there are two smaller unnamed waterways. Currently the First Ponds Creek is bridged by a number of culverts. Scouring may occur at creek beds due to an increase in impermeable surfaces from the new road installation.

Flooding is an issue in the area, especially given the positioning of the future Edmund Street intersection directly above First Ponds Creek and its flood zone.

Further details of hydrology and drainage are provided in section 6.3 of this REF.

Vegetation

The roadway in its current form is defined by its seamless tree-lined transition between urban and rural landscapes. Vegetation plays a central role in the definition of place within the study area.

Due to residential development along the corridor, there has been a reduction in tree numbers in the vicinity of the study area. With planning for further development, there exists an urban design challenge in maintaining tree cover. The existing vegetation, for example mature *Eucalyptus microcarpa*, is a main driver of the landscape character.

Along the eastern expanse of Garfield Road East, there are many mature *Eucalyptus*. In the more residential western end, there is a variety of mature native species and mature introduced species. This also contributes to the landscape character of the study area.

The study area includes and is bordered by scattered coverings of Cumberland Shale Plain Woodland ecological communities. There are also areas of Alluvial Woodland and Shale/Gravel Transition Forest within the study area.

The existing ecological environment of the Garfield Road East study area is described in Section 6.8.2 of this REF.

Land use

The lack of arable land led early colonial settlers to seek more favourable farming conditions inland from the coastal settlements. Riverstone is one of the early inland townships, having been settled in 1803. The region has a long history in agriculture, from colonial holdings to contemporary market gardens and poultry houses.

Land use is further described in section 6.6.2 and section 6.5.2 of this REF.

Heritage

The study area sits on Darug land. The AHIMS has identified four sites within the study area. An additional 94 sites sit within two kilometres of the study area. (Austral Archaeological Survey, Oct. 2019)

First Ponds Creek is widely recognised as having high archaeological potential with several large sites located within 100 metres of [the creek]. (White and McDonald 2010).

A number of heritage properties are located within the study area, in proximity to the road reserve. These items, all of local significance, include:

- Convent (166 Garfield Road East)
- Riverstone Public School (former)
- Rosebank (213 Garfield Road East)
- St John Evangelist Parish (164 Garfield Road East)

Aboriginal and non-Aboriginal heritage impacts are assessed in this REF in Sections 6.4 and 6.5 respectively.

Transport

Garfield Road East is an important arterial road linking Marsden Park, Riverstone, Box Hill and Rouse Hill. State bus services 742 and 746 operate partially along Garfield Road East, connecting Marsden Park, Riverstone and Rouse Hill. Bus 608 runs along Windsor Road. Riverstone Station is at the western end of Garfield Road East and is serviced by T1 and T5 trains.

The existing pedestrian path is restricted to the southern side of Garfield Road East from Piccadilly Street to around 85 metres east of McCulloch Road. There is a signalised pedestrian crossing at the corner of Piccadilly Street and Garfield Road East, and a pedestrian safety island next to the veterinary hospital on Garfield Road East. There are no other pedestrian facilities until Windsor Road. There are no dedicated bicycle facilities, except for along Windsor Road.

Transport impacts are assessed in Section 6.1 if this REF.

6.10.2.8 Landscape character

The landform and vegetation, views and vistas, settlement patterns and built structures within and adjoining the study area combine to define the landscape character of the study area. Three LCZs have been identified within the study area:

- LCZ 1 - Riverstone established residential
- LCZ 2 - New residential
- LCZ 3 - Rural

The LCZs are shown in Figure 6-29. A description of each LCZ is provided in Table 6.35.

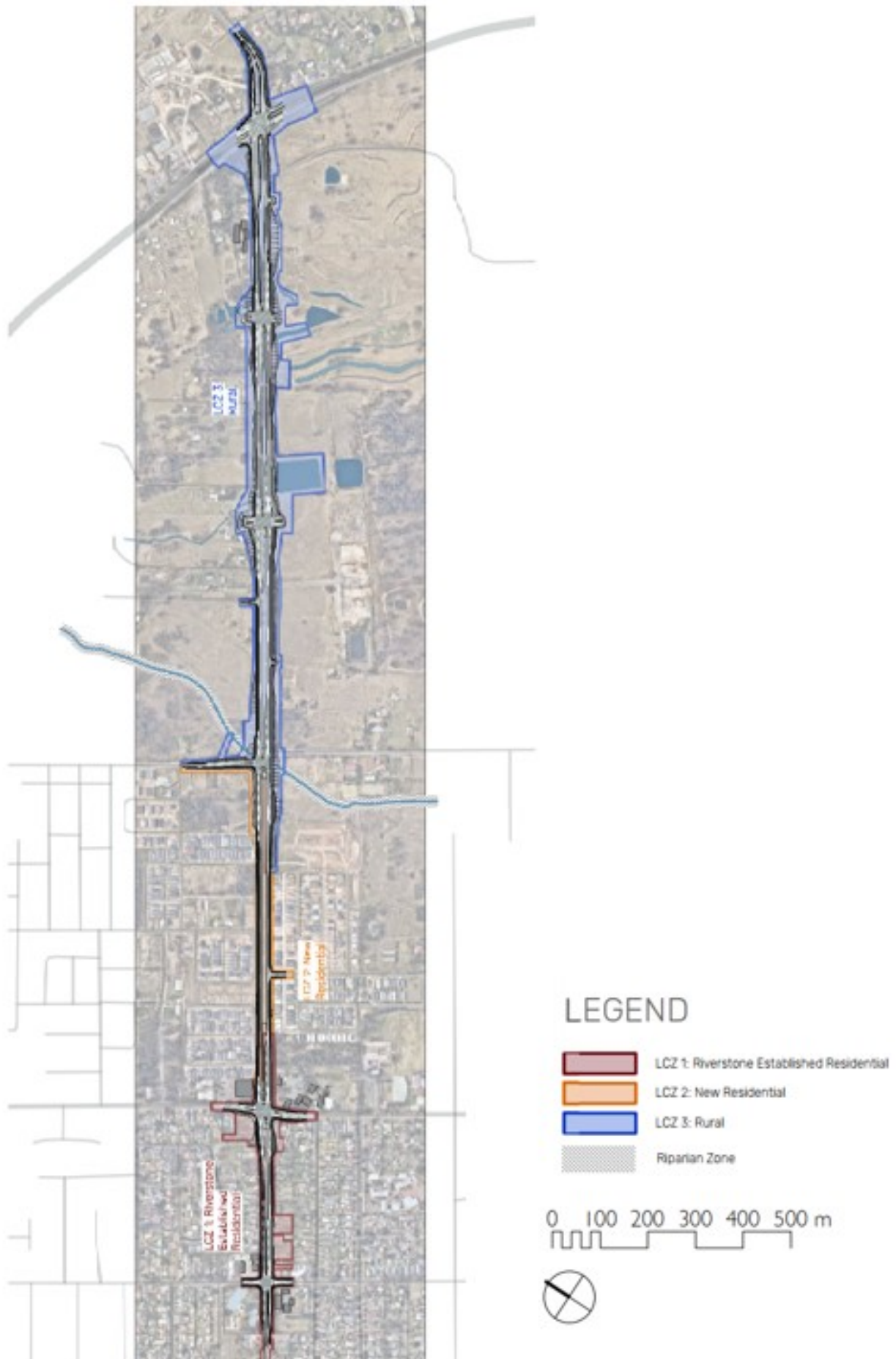


Figure 6-29: Landscape character zones

Table 6.35: Landscape character zones within the study area

LCZ	Description	Sensitivity to change
1	The Riverstone Established Residential LCZ encompasses the western portion of the study area. It sits to the east of Riverstone town centre. It includes the residential blocks bounded by Piccadilly Street in the west and the Riverstone Sports Centre in the east.	LCZ1 is an established residential area on the edge of the Riverstone town centre, with rural town character, therefore, the sensitivity to change is assessed as high
2	<p>The New Residential LCZ is situated east of the Riverstone Sports Centre, continuing along Garfield Road until Edmund Street. It is an area undergoing extensive urban transformation, with new dwellings and subdivisions comprising the immediate surroundings of the upgrade corridor.</p> <p>Currently there are many large trees, including Eucalyptus microcarpa and Eucalyptus tereticornis, on the northern side of the road. These trees act as a strong landscape buffer between the road corridor and residential areas. The trees also offer shade, cooling the roadway. Subdivisions do not directly access the proposal, instead have tall fences along the corridor border.</p>	LCZ2 is undertaking extensive modification from new residential development, therefore, the sensitivity to change is assessed as low
3	<p>The Rural LCZ is characterised by its undulating movement between hillside and floodplain. The area is characterised by open sky and expansive views in all directions.</p> <p>On the northern side of the corridor there are a number of small rural landholdings. On the southern side, there are larger landholdings. First Ponds Creek crosses Garfield Road East between Edmund Street and Clarke Street. Here there are a number of mature gums and Casuarina glauca. This small landscape area surrounding First Ponds Creek marks a contrast between the cleared lands throughout the majority of the LCZ.</p> <p>At the eastern edge of the LCZ, there is a large meat recycling facility that contains many water purifying swales. At the eastern edge of the LCZ, as the roadway cuts into the hillside, there are stands of trees which help reinforce the rural character of the area</p>	LCZ3 has been modified overtime, however the existing character of LCZ 3 is a generally cohesive landscape of rural residential properties, therefore, the sensitivity to change is assessed as moderate

Visual impact

The potential visual impact of the proposal is assessed in relation to a number of key viewpoints (VPs) as detailed in Table 6.36 and provided in Figure 6-30.

Visual impact is the combination of the magnitude and sensitivity rating in accordance with the Impact Assessment Grading Matrix.

Table 6.36: Landscape character zones within the study area

No	Location	LCZ	Direction of view	Visible elements	Potential viewers
1	Riverstone Swimming Pool	LCZ1	East	Garfield Road East including bus stop	Patrons / visitors to the swimming pool
2	144 Garfield Road East	LCZ1	West	Garfield Road East including shared path	Residents and shared path users
3	Riverstone Community Church	LCZ1	South east	Hamilton Street tie-in and intersection with Garfield Road East including associated embankments	Vehicles travelling south along Hamilton Street
4	Orlagh Circuit (New Residential area)	LCZ2	South east	Garfield Road East including associated embankments	Orlagh Circuit (New Residential area)
5	Garfield Road East (eastbound)	LCZ2	East	Garfield Road East including associated retaining walls	Vehicles travelling east along Garfield Road East
6	Garfield Road East (westbound)	LCZ2	North west	Garfield Road East including associated embankments and approach to Edmund Street Intersection	Vehicles travelling west along Garfield Road East
7	Garfield Road East (westbound)	LCZ3	North	Garfield Road East at about Access 4 including associated retaining wall	Vehicles travelling west along Garfield Road East
8	Garfield Road East (eastbound)	LCZ3	East	Garfield Road East alignment on approach to the Windsor	Vehicles travelling east along Garfield Road East

No	Location	LCZ	Direction of view	Visible elements	Potential viewers
				Road Intersection	

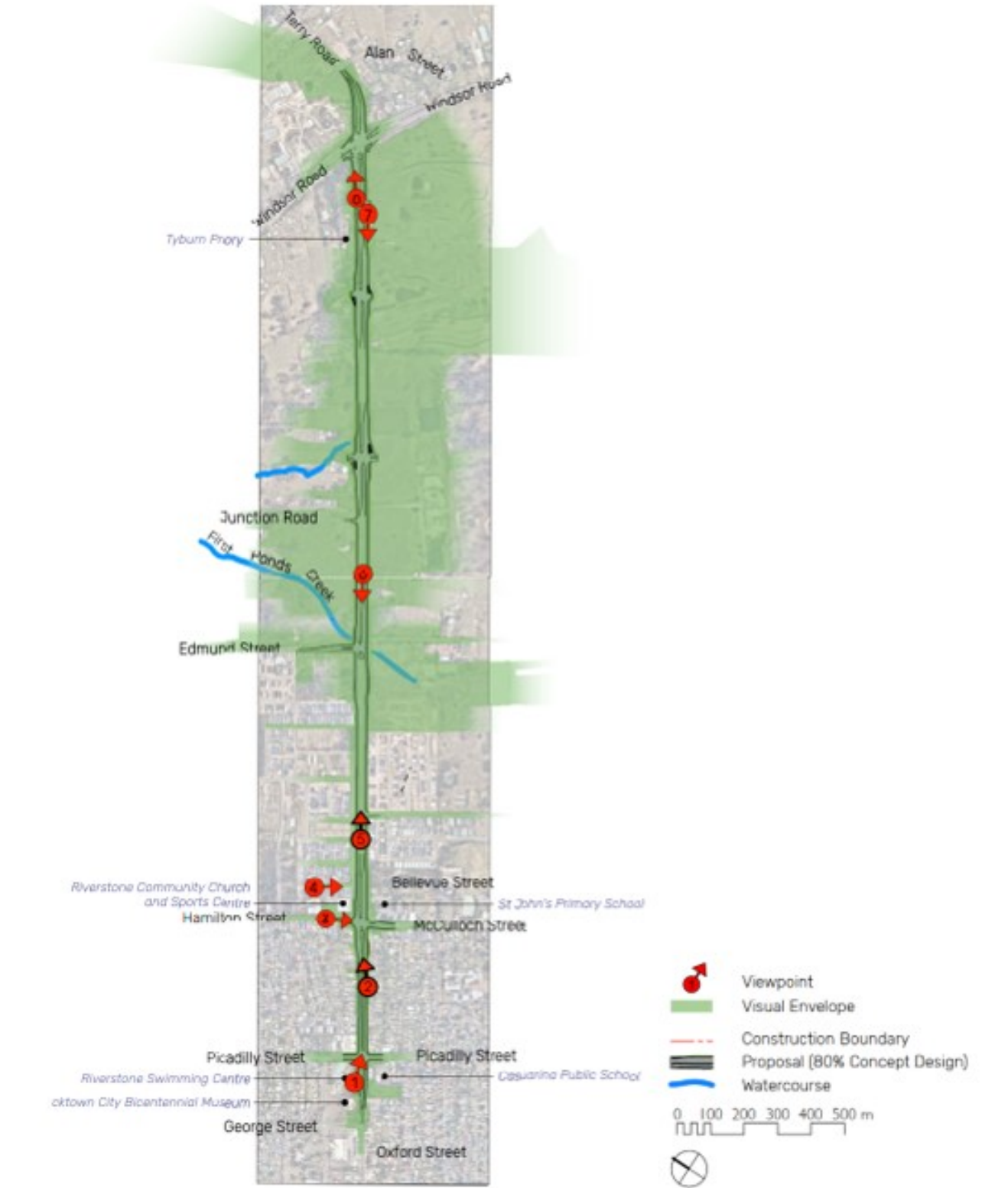


Figure 6-30: Visual envelope and viewpoint map for the proposal

6.7.3 Potential impacts

Construction

During construction, there would be some landscape and visual impacts that would occur initially mainly around the ancillary site and during works such as vegetation clearing, earthworks and ground disturbance. These impacts would include views of large earthmoving and construction equipment, construction activities, stored materials and stockpiles.

The proposal would have the greatest impact on the values associated with established and new residential areas within LCZ1 and LCZ2 and at green spaces along the proposal where the effects would be:

- Loss of the composition of the landscape character and its setting
- Removal of green components and the visual separation this offers
- Temporary introduction of machinery and equipment into the landscape, affecting the overall amenity and setting.

The proposal's construction would temporarily affect the visual amenity of receivers that would overlook the construction works. The magnitude of impact would depend on the stage of construction and proximity of the work. It is expected that the greatest amenity impacts would take place during the major earthworks. Once construction work is complete along the proposal, the impacted areas would be reinstated and landscaped. Over time, impacts would lessen, and the urban character of the proposal would be established.

Once a preferred construction compound is selected as detailed in section 3.4 above, the compound would potentially be used outside of standard construction hours to support specific activities which would be carried out during the night. The operation of the construction compound at night has the potential to result in visual impacts such as light spill on nearby residents. Construction activities would be temporary in nature and night time works would be minimised as far as practical.

Mitigation measures have been identified for temporary construction works to manage visual impacts and are discussed in section 6.7.4.

Operation

The proposal would include land acquisition for the length of the Garfield Road East to facilitate this upgrade and significantly impact on the existing character of the largely suburban road with large property setbacks.

Numerous large mature trees, many indigenous, would be removed to accommodate the upgrade impacting on the landscape context, spatial quality, setting and liveability within LCZ1 especially in relation to schools and availability of shade.

Proposed tree planting along the northern side of the Garfield Road East, McCulloch Street, Hamilton Street and Piccadilly Street in LCZ1 would help to re-establish a mature tree canopy, however these would take time to mature.

The proposal would see the road widening and removal of a large amount of existing mature native trees along both sides of the Garfield Road East impacting on views, and amenity for motorists and the adjacent residential areas.

Proposed shrub and tree planting are proposed between the road and private properties in LCZ2 to provide screening where needed and to re-establish a canopy, however these plantings would take time to mature.

The removal of a number of important groupings of native roadside trees in LCZ 3 would have a substantial impact on the rural setting of this character zone as seen by motorists on Garfield Road East and some residents. The removal of the trees to facilitate the upgrade and would compromise the positive and varied

driving experience and native roadside environment. Some areas of note where tree removal is to occur include; the Edmund Street/Clark Street intersection, close to First Ponds Creek and 500 metre length of road on approach to the Windsor Road intersection.

The impact assessment of the proposed works on the LCZs is provided in the Table 6.37.

Table 6.37: Landscape character zone impact assessment

Landscape character zone	Sensitivity	Magnitude	Impact
LCZ 1 Riverstone established	High	High	High
LCZ 2 New residential	Low	Moderate	Moderate-low
LCZ 3 Rural	Moderate	High	High -moderate

Visual impact

The proposal would result in a range of visual impact at selected viewpoints as follows:

- No viewpoints would have Low visual impact
- No viewpoints would have Moderate-Low visual impact
- Five viewpoints would have Moderate visual impact
- One viewpoint would have High-Moderate visual impact
- Two viewpoints would have High visual impact.

Ratings of High and High-Moderate impact occur in areas where:

- The landscape is the dominant or major element in the view or has little capacity to absorb the proposed changes
- Where the proposed changes are of a large scale
- Where the sensitivity of viewers to change in the visual environment is likely to be high.

The Moderate ratings occur in areas where viewers are less likely to be sensitive to visual changes in their environment, where the scale of the proposed changes is smaller, or where the proposal is located at some distance to the viewer.

Based on this assessment a series of landscape and urban design mitigation strategies have been developed, in order to assist in the mitigation of the proposed upgrade to Garfield Road East and associated elements.

The visual impact assessment is provided in Table 6.38.

Table 6.38: Landscape character zone impact assessment

VP	Sensitivity	Magnitude	Impact
1	Moderate	High	High-moderate
2	High	High	High
3	Moderate	Moderate	Moderate
4	Moderate	Moderate	Moderate

VP	Sensitivity	Magnitude	Impact
5	Moderate	Moderate	Moderate
6	Moderate	Moderate	Moderate
7	High	High	High
8	Moderate	Moderate	Moderate

6.7.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Landscape character and visual impact	<p>An Urban Design Plan will be prepared to support the final detailed project design and implemented as part of the CEMP.</p> <p>The Urban Design Plan will present an integrated urban design for the project, providing practical detail on the application of design principles and objectives identified in the environmental assessment. The Plan will include design treatments for:</p> <ul style="list-style-type: none"> • Location and identification of existing vegetation and proposed landscaped areas, including species to be used [cross-reference any relevant specified biodiversity safeguards] • Built elements including retaining walls, bridges and noise walls • Pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings • Fixtures such as seating, lighting, fencing and signs • Details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • Procedures for monitoring and maintaining landscaped or rehabilitated areas. 	Contactors	Detailed design / Pre-construction	Standard safeguard LCVI1

Impact	Environmental safeguards	Responsibility	Timing	Reference
	<p>The Urban Design Plan will be prepared in accordance with relevant guidelines, including:</p> <ul style="list-style-type: none"> • Beyond the Pavement urban design policy, process and principles (Transport for NSW, 2014) • Landscape Guideline (RTA, 2008) • <i>Bridge Aesthetics</i> (Transport for NSW 2012) • Noise Wall Design Guidelines (RTA, 2006) • Shotcrete Design Guideline (RTA, 2005). 			
Landscape character and visual impact	Detail design and documentation drawings would define the extent of all construction activity including temporary works in order to protect the area during construction	TfNSW	Pre-construction	Additional safeguard LCVI2
Landscape character and visual impact	Construction facilities should be contained within the construction footprint and occupy the minimum area practicable for their intended use	Contractor	Construction	Additional safeguard LCVI3
Landscape character and visual impact	Provide suitable barriers to screen views from adjacent areas during construction	Contractor	Construction	Additional safeguard LCVI4
Landscape character and visual impact	Once construction is complete, or progressively throughout the works where possible, return these sites to at least their pre-construction state	Contractor	Construction / Post-construction	Additional safeguard LCVI5
Air pollution	Keep pollution and dust emissions to a minimum and monitor throughout the project construction period	Contractor	Construction	Additional safeguard LCVI6
Pedestrian access	Divert or re-route footpaths affected by construction activities	Contractor	Construction	Additional safeguard LCVI7
Tree protection	Existing trees to be retained within construction facilities areas will be identified, protected and maintained	Contractor	Construction	Additional safeguard LCVI8
Light spill	Temporary lighting should be screened or diverted to reduce unnecessary light spill	Contractor	Construction	Additional Safeguard LCVI9

Impact	Environmental safeguards	Responsibility	Timing	Reference
Waste	Material used for temporary land reclamation will be removed once the works are complete.	Contractor	Post-construction	Additional Safeguard LCVI10

6.8 Biodiversity

6.8.1 Methodology

The Biodiversity Assessment Report (BAR) was prepared by SMEC (2020) and included a desktop review of available documents including NSW and Commonwealth records, data and literature to confirm the likely presence of threatened flora, fauna and endangered communities in the study area. Site surveys were undertaken in the study the area to confirm the findings of the desktop assessment.

Study area

The study area is defined as the area directly affected by the development and any additional areas likely to be affected by the development, either directly or indirectly (OEH 2014) and is shown in blue at Figure 1-2 of Appendix L and within the figures provided in the following sections.

The construction footprint shown in red provided in this report includes the specific work areas such as compound areas, access tracks and areas of de-watering to build the proposal.

Land certification was not taken into consideration when delineating the study area (refer to section 2.3 of Appendix L).

Desktop assessment

The biodiversity desktop assessment consisted of a desktop assessment of relevant databases as provided in Table 6.39. Commonwealth records and other data and literature were reviewed to confirm the likely presence of threatened flora and fauna species, and endangered communities in the study area and during site surveys.

Table 6.39: Threatened and protected species database searches

Database	Search data	Search area
BioNet Atlas	29 November 2019	10-kilometre buffer around the study area.
BioNet Vegetation Classification, vegetation information system (VIS)	29 November 2019	NA
Register of Declared Areas of Outstanding Biodiversity Value	12 March 2020	NA
Fisheries NSW Spatial Data	11 March 2020	10-kilometre buffer around the study area.
Database of Aquatic TECs	NA	No search area required
Department of the Environment and Energy's Protected Matters Search Tool	29 November 2019	10-kilometre buffer around the study area.
Bureau of Meteorology's (BoM's) Atlas of Groundwater Dependent Ecosystems (GDEs)	11 November 2020	Study area
Department of the Environment and Energy's Directory of Important Wetlands	11 March 2020	Study area

Database	Search data	Search area
Department of the Environment and Energy's National Flying-fox Monitoring Viewer	13/ February 2020	10-kilometre buffer around the study area.
State Environmental Planning Policy (Coastal Management) 2018	11 March 2020	study area
Koala Habitat Protection SEPP	11 March 2020	study area

Field survey

Flora and fauna surveys of the study area were carried out in December 2019, and between January and June 2020.

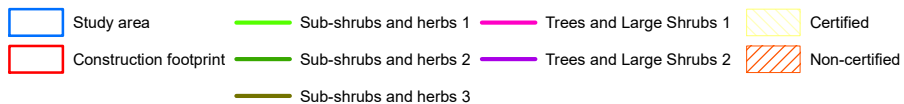
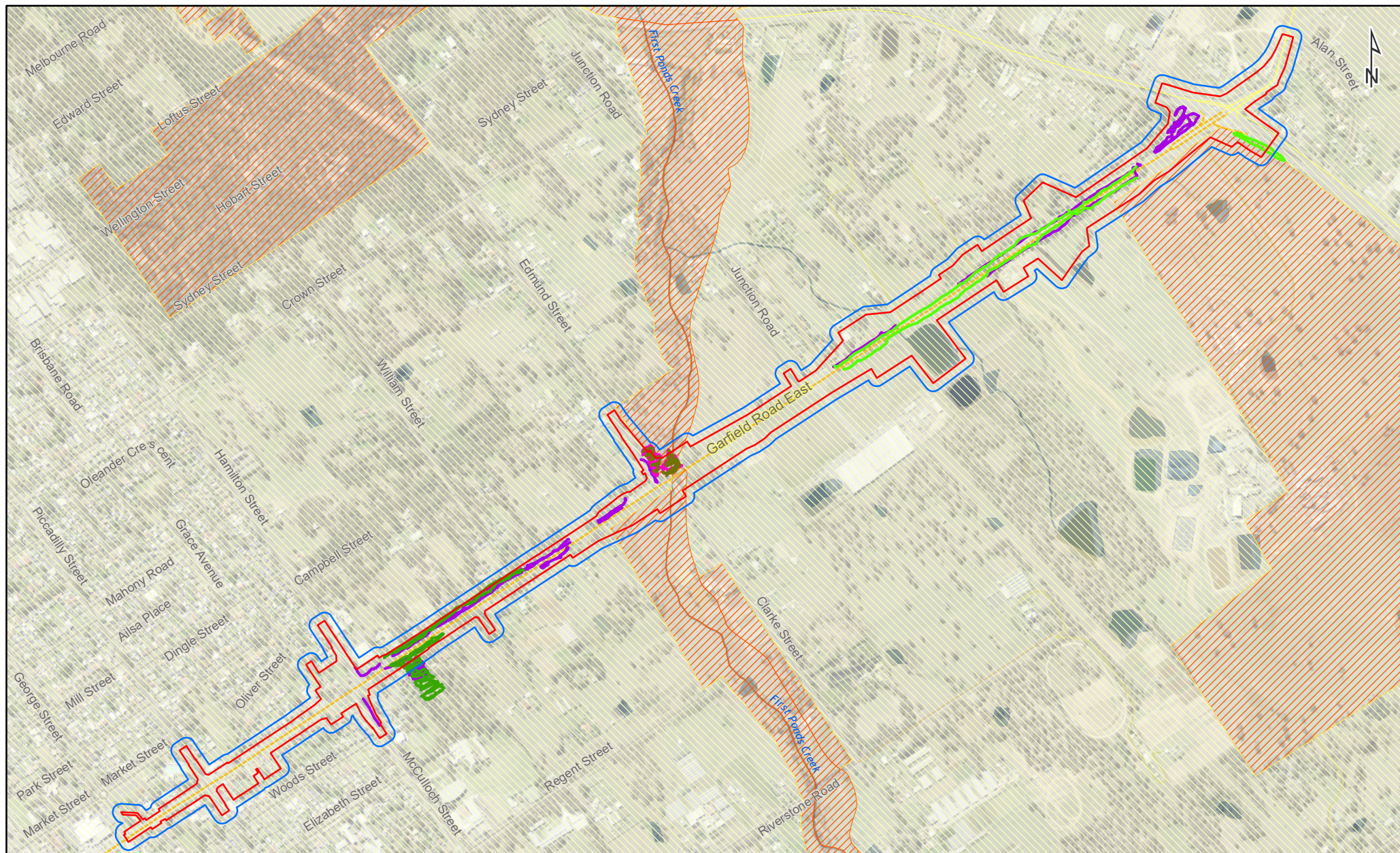
Flora surveys involved:

- Eight Biodiversity Assessment Method (BAM) vegetation integrity plots, following the methodology in the BAM (OEH, 2017)
- A total of about 10 Rapid Data assessment to assist in validating vegetation
- Targeted survey for threatened plants in addition to BAM plots and RDPs. The survey for threatened plants were carried out over four days and are discussed in more detail below

The fauna survey involved:

- Targeted searches were completed for the threatened fauna species identified as having a moderate or high likelihood of occurring in the study area
- Spotlighting, and Powerful Owl call playback over four nights at two locations
- Bat echolocation recording (Songmeter SM4BAT) at two sites over 30 nights
- Opportunistic searches for reptiles, birds and other visible species throughout the study area.

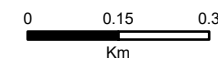
A detailed methodology for the biodiversity assessment is provided in Appendix L. Figure 6-31 and Figure 6-32 show the survey effort and methods.

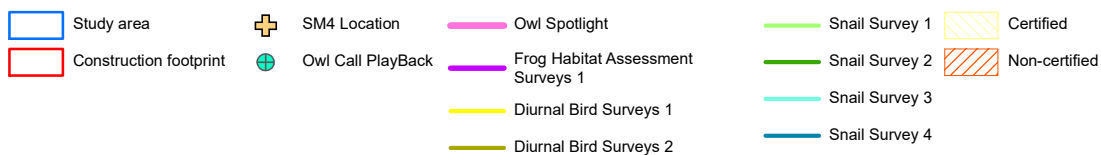
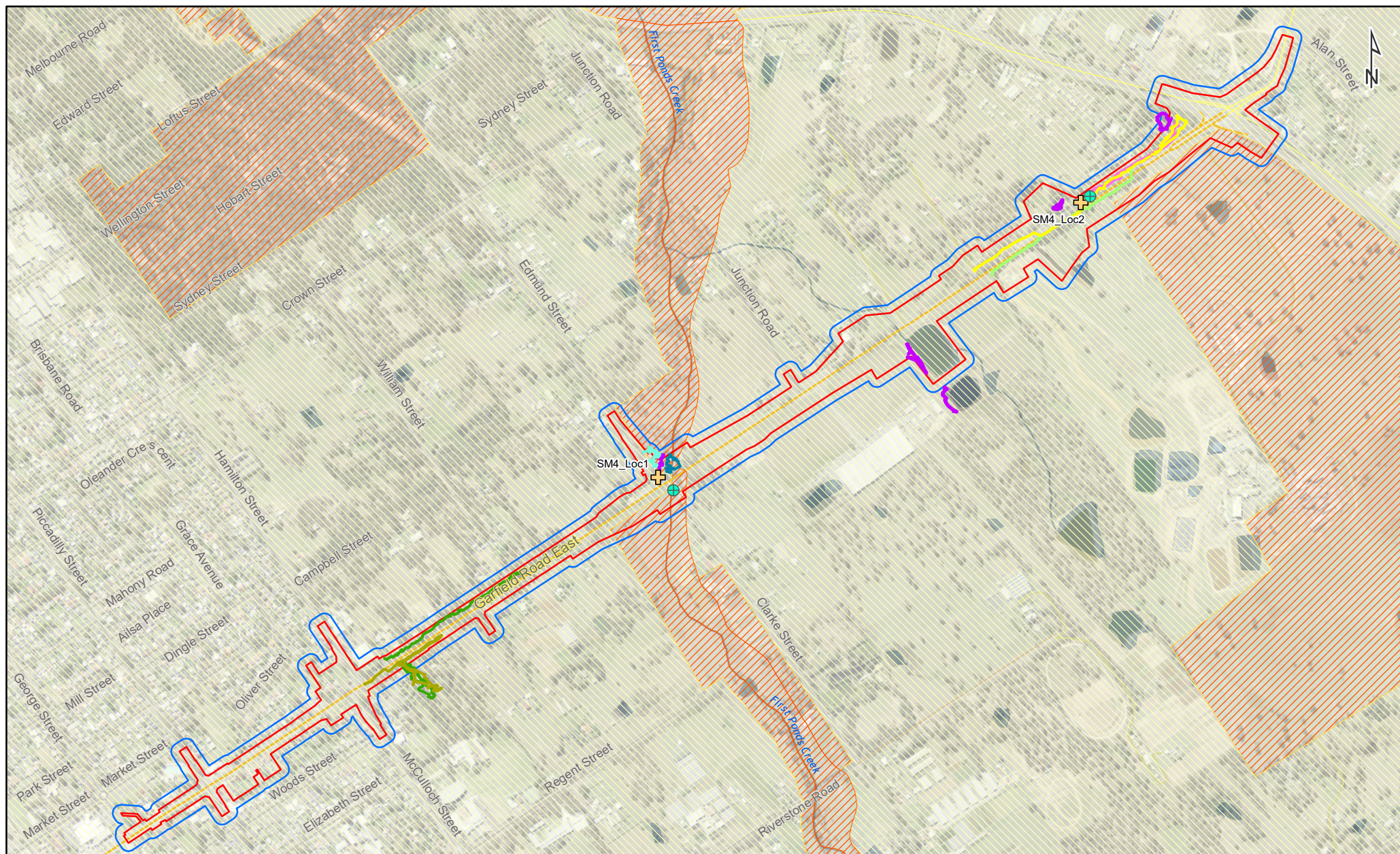


Garfield Road East 30012746

Figure 6-31: Threatened flora species survey locations

Roadnet MDS 2018, Imagery © Department of Customer Service 2020

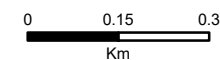




Garfield Road East 30012746

Figure 6-32: Threatened fauna species survey locations

Roadnet MDS 2018, Imagery © Department of Customer Service 2020



6.8.2 Existing environment

Much of the existing environment within the study area has been previously cleared for the earlier development of Garfield Road East. The environment surrounding the existing road transitions through medium and low-density commercial and residential development, light industrial areas, parks, conservation areas and small areas of native vegetation. Native vegetation within the proposal has been impacted by historical clearing.

A mapped native vegetation retention area under the Growth Centres SEPP is located on the western side of Clarke Street and eastern either side of Edmund Street where First Ponds Creek crosses the proposal and is shown as part of the non-certified area at First Ponds Creek in Figure 6-31 above.

Vegetation communities

Vegetation surveys were carried out to confirm the presence of vegetation communities within the study area. Recorded vegetation was classified according to the Plant Community Type (PCTs) in accordance with NSW BioNet Vegetation Information System (VIS).

Vegetation communities identified within the study area included the following:

- Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849)
- Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 835)
- Broad-leaved Ironbark - Grey Box - *Melaleuca decora* grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 724)
- Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter Valley (PCT 1800)
- Non-native vegetation
- Mixed planted exotics and natives.

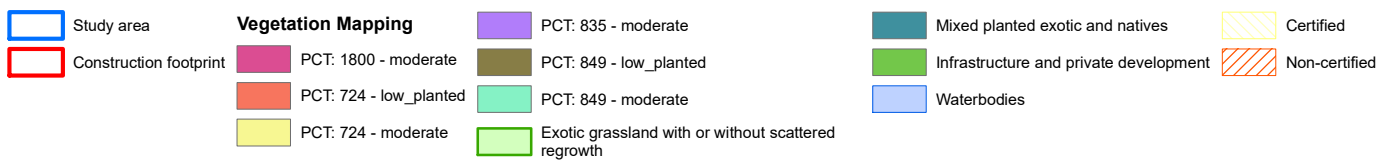
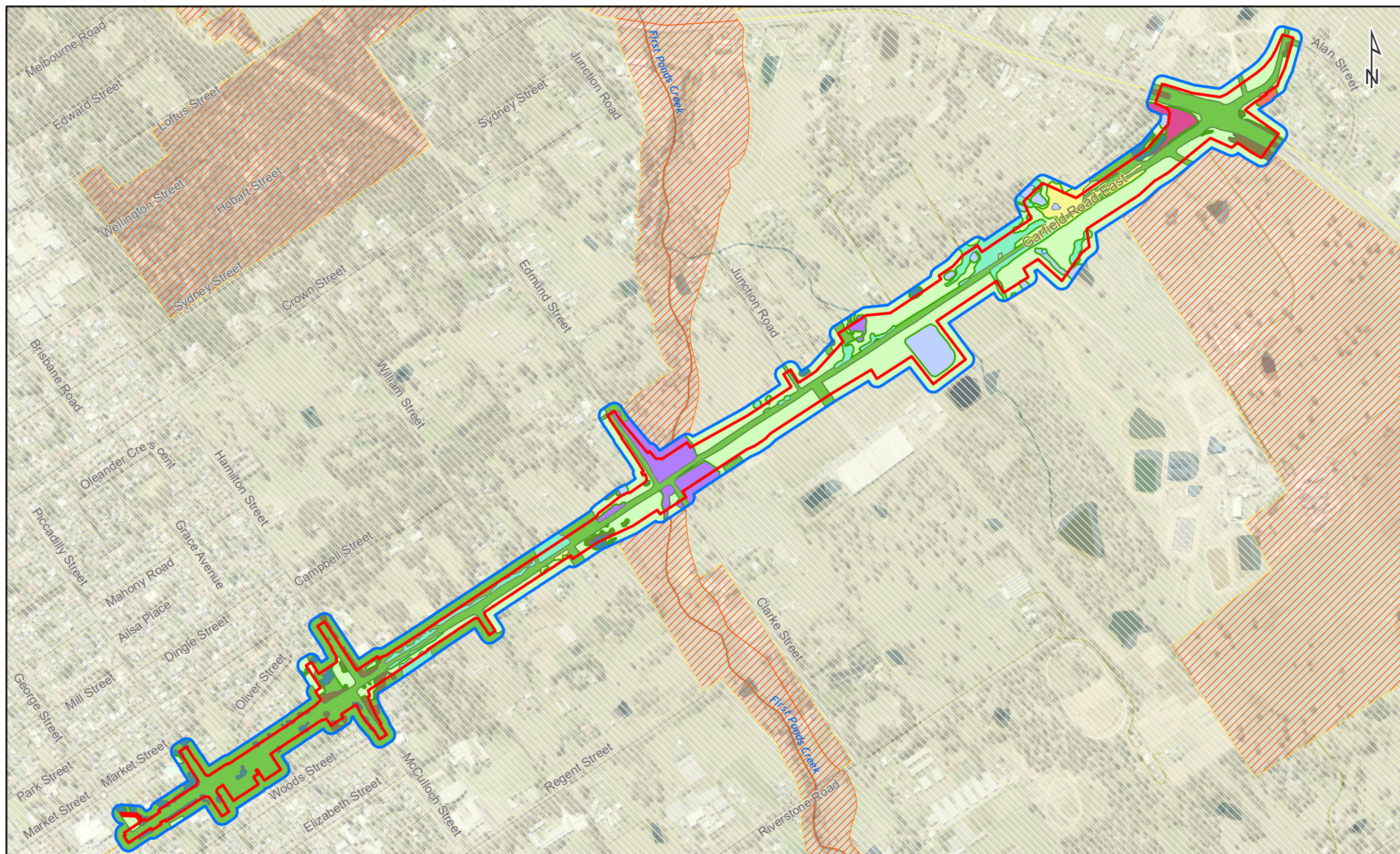
Table 6.40 summarises the six PCTs identified within the study area. A map of the delineated vegetation zones is provided in Figure 6-33.

Table 6.40: Plant community types

Plant community type (PCT) Name and number	Vegetation zone	Vegetation integrity score	Patch size (ha)	Threatened ecological community	Area (ha) in study area	
					Area (ha) biocertified	Area (ha) non-biocertified
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 849)	Grey Box -Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - moderate	52.8	>100	Cumberland Plain Woodland in the Sydney Basin Bioregion (BC Act) Cumberland Plain Shale Woodlands and Shale/Gravel Transition Forest (EPBC Act)	2.95	-
	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion - planted/low	-	>100	NA (did not meet scientific determination)	1.02	0.26
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT 835)	PCT 835: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney	100 (benchmark data)	>100	River-flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney	1.29	0.9

Plant community type (PCT) Name and number	Vegetation zone	Vegetation integrity score	Patch size (ha)	Threatened ecological community	Area (ha) in study area	
					Area (ha) biocertified	Area (ha) non- biocertified
	Basin Bioregion - moderate			Basin and South East Corner Bioregions (BC Act)		
Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT 724)	PCT 724: Broad- leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion - moderate	44.4	>100	Shale Gravel Transition Forest in the Sydney Basin Bioregion (BC Act) Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (EPBC Act)	0.99	-
	PCT 724: Broad- leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion - low/planted	-	>100	Shale Gravel Transition Forest in the Sydney Basin Bioregion (BC Act)	-	>100

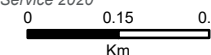
Plant community type (PCT) Name and number	Vegetation zone	Vegetation integrity score	Patch size (ha)	Threatened ecological community	Area (ha) in study area	
					Area (ha) biocertified	Area (ha) non-biocertified
PCT 1800: Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter Valley	PCT 1800: Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter Valley - low/planted	36.5	>100	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (BC Act)	0.52	-
Exotic grassland with or without scattered regrowth	Exotic grassland with or without scattered regrowth	-	-	No	18.62	2.09
Mixed planted native and exotic vegetation	Mixed planted native and exotic vegetation	-	-	No	1.42	-
Total					26.94	3.26



Garfield Road East 30012746

Figure 6-33: Vegetation zones

Roadnet MDS 2018,
Imagery © Department of Customer Service 2020



Groundwater dependent ecosystems

Groundwater Dependant Ecosystems (GDEs) are defined as:

'Ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater.' (Serov et al., 2012)

GDEs rely on the presence of groundwater to function and sustain the resident assemblage of species, populations and ecological communities. According to the GDEs Atlas, the study area is mapped as containing only terrestrial GDEs, located on the eastern side of the intersection between Garfield Road East and McCulloch Street. The Risk assessment guidelines for GDEs (Serov et al. 2012) identify the terrestrial GDEs fits the definition of a 'Baseflow Streams (surface ecosystems).

There are no stream or landform capable of supporting a semi-permanent stream in the mapped location of the identified GDE. This might be because most of the mapped GDE is currently developed and already impacted.

Threatened flora

A total of 13 species of threatened flora were considered to have the potential to occur within the locality of the study area. These were:

- *Acacia bynoeana* (Bynoe's Wattle) (Endangered BC Act, Vulnerable EPBC Act)
- *Acacia pubescens* (Downy Wattle) (Vulnerable BC Act, Vulnerable EPBC Act)
- *Allocasuarina glareicola* (Endangered BC Act, Endangered EPBC Act)
- *Dillwynia tenuifolia* (Vulnerable BC Act)
- *Eucalyptus sp. Cattai* (Critically endangered BC Act, Critically endangered EPBC Act)
- *Grevillea juniperina subsp. juniperina* (Juniper-leaved Grevillea) (Vulnerable BC Act)
- *Micromyrtus minutiflora* (Endangered BC Act, Vulnerable EPBC Act)
- *Persoonia nutans* (Nodding Geebung) (Endangered BC Act, Endangered EPBC Act)
- *Pimelea curviflora var. curviflora* (Vulnerable BC Act, Vulnerable EPBC Act)
- *Pimelea spicata* (Spiked Rice-flower) (Endangered BC Act, Endangered EPBC Act)
- *Pterostylis saxicola* (Sydney Plains Greenhood) (Endangered BC Act, Endangered EPBC Act)
- *Pultenaea parviflora* (Endangered BC Act, Vulnerable EPBC Act)
- *Marsdenia viridiflora subsp. viridiflora* endangered population (Endangered BC Act).

No threatened flora were recorded during the targeted field surveys.

The threatened orchid, *Pterostylis saxicola*, was assessed as having a moderate likelihood of occurrence however was not surveyed as it is not known to flower during the survey period. For the purposes of this assessment, these species have been assumed present in the non-biocertified land.

Weeds

A total of three weeds were recorded within study area, as follows:

- Asparagus Fern (*Asparagus aethiopicus*) - Prohibition on dealings and must not be imported into the State or sold
- Bridal creeper (*Asparagus asparagoides*) - Prohibition on dealings and must not be imported into the State or sold
- Lantana (*Lantana camara*) - Prohibition on dealings and must not be imported into the State or sold.

Threatened fauna

The desktop assessment identified 74 species of threatened fauna that have been previously recorded within or have the potential to occur within the locality.

Two threatened species of microchiropteran bat were recorded as potentially occurring within the study area:

- The Eastern Coastal Free-tailed Bat (*Mormopterus norfolkensis*)
- The Greater Broad-nosed Bat (*Scoteanax rueppellii*).

Based on the presence of suitable habitat, the Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*) and Swift Parrot (*Lathamus discolor*) were assessed as having a moderate likelihood of occurring within the study area. Both species of owl have large home ranges, and the study area supports both roosting habitat and hunting habitat for both species.

No threatened birds were found to occur in the study area.

In addition, Koala scat surveys were conducted at the bases of mature *Eucalyptus tereticornis* and *E. moluccana* to determine the likely presence of Koala in the study area. No scats likely to belong to koalas were found during the survey effort.

The highly isolated occurrence of the native vegetation stands in the study area provide further evidence that koalas are unlikely to utilise the study area.

Threatened amphibians

Green and Golden Bell Frog (*Litoria aurea*) was assessed as having a moderate likelihood of occurring within the study area. The study area was found to potentially support marginal Green and Golden Bell Frog habitat when conditions are favourable.

Artificial dams and most of the visited ponds within the study area were found to support the Plague Minnow (*Gambusia holbrooki*), an invasive species known to eat frog eggs, limiting the potential for the study area to support a breeding population of the Green and Golden Bell Frog.

Threatened invertebrates

The study area was surveyed for the presence of the Cumberland Plain Land Snail (*Meridolum corneovirens*) and its habitat. No individuals were recorded and much of the potential suitable habitat was disturbed. In the native vegetation communities such as PCTs 835, 849, 724 and 1800 the observed groundcover had either been removed and mulched, was covered in non-natives and weeds, or did not support the right habitat components such as fallen logs. Within PCT 724 and 849, the groundcover had been removed and mulched in large sections or was covered in weeds such as Mother of Millions. In PCT 1800, the groundcover consisted of a thick layer of *Casuarina glauca* needles which is unsuitable habitat for the Cumberland Plain Land Snail. While marginal habitat occurred in the stands of PCT 835 along First Ponds Creek no individuals were recorded from the survey effort.

Opportunistically threatened fauna surveys recorded a Grey-headed Flying-fox (*Pteropus poliocephalus*) flying over the study area, a listed as vulnerable under the BC Act and EPBC Act.

According to the National Flying-fox monitoring viewer, the nearest known camp occurs at Agnes Banks over 17 kilometres away from the study area. The Grey-headed Flying-fox is known however, to travel up to 50 kilometres in a single night to forage (Threatened Species Scientific Committee, 2001). A nectivorous species, the Grey-headed Flying-fox commonly feeds on trees from the *Eucalyptus*, *Melaleuca* and *Banksia* genera.

Eucalyptus tereticornis, *E. crebra*, *E. moluccana*, *Melaleuca nodosa* and *M. stipoides* were recorded in the study area confirming the presence of foraging habitat.

Wildlife connectivity

There are no regional biodiversity corridors located within or near the study area. The First Ponds Creek corridor offers limited habitat connectivity.

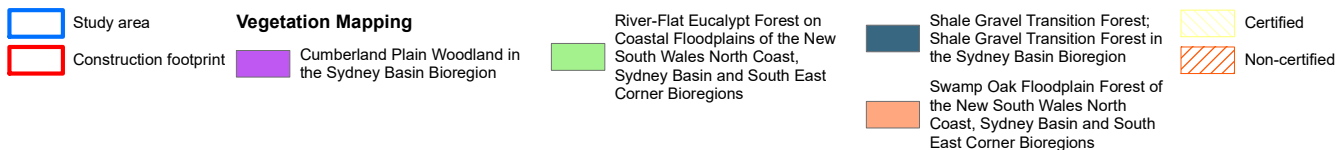
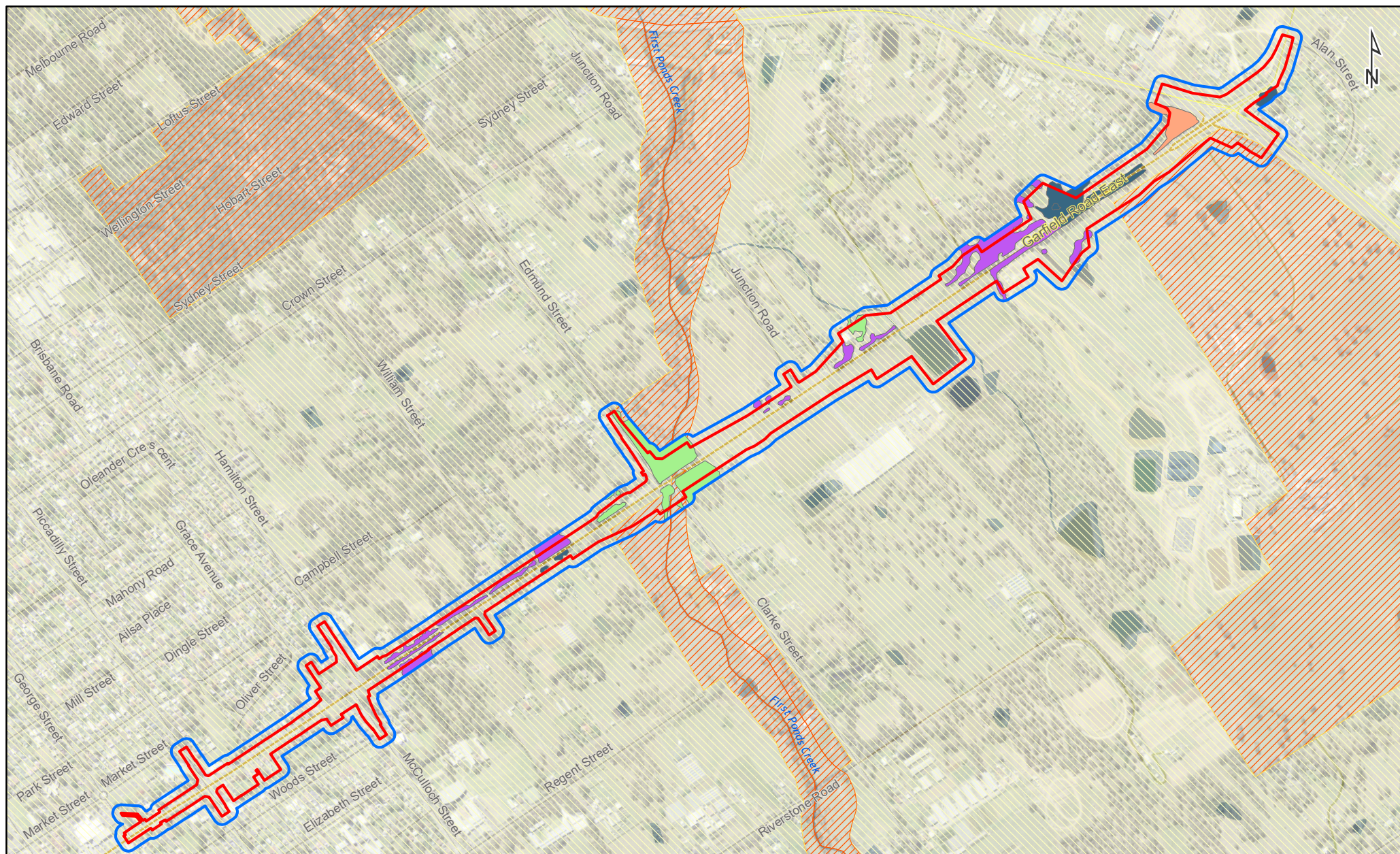
Aquatic and key fish habitat

First Ponds Creek is not identified as a key fish habitat by the DPI and is considered a Class 3 Minimal Fish Habitat within the meaning of Why do fish need to cross the road? Fish passage requirements for waterways crossings (Fairfull & Witheridge, 2003).

Biocertified and non-biocertified land

A large proportion of the study area is mapped as being a biocertified site. As such, the offsetting for all biocertified land has already been determined and is not subject to this assessment.

Areas of non-biocertified land within the proposal is about 1.71 hectares and is subject to guidelines for Biodiversity Offsets.

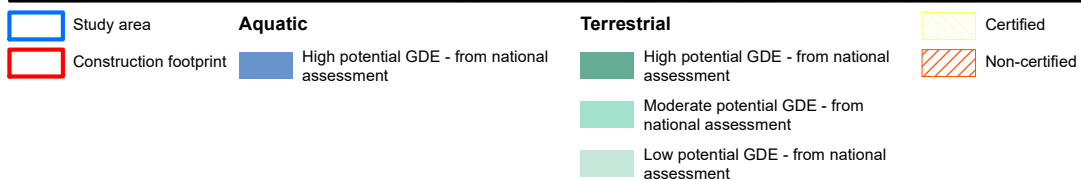
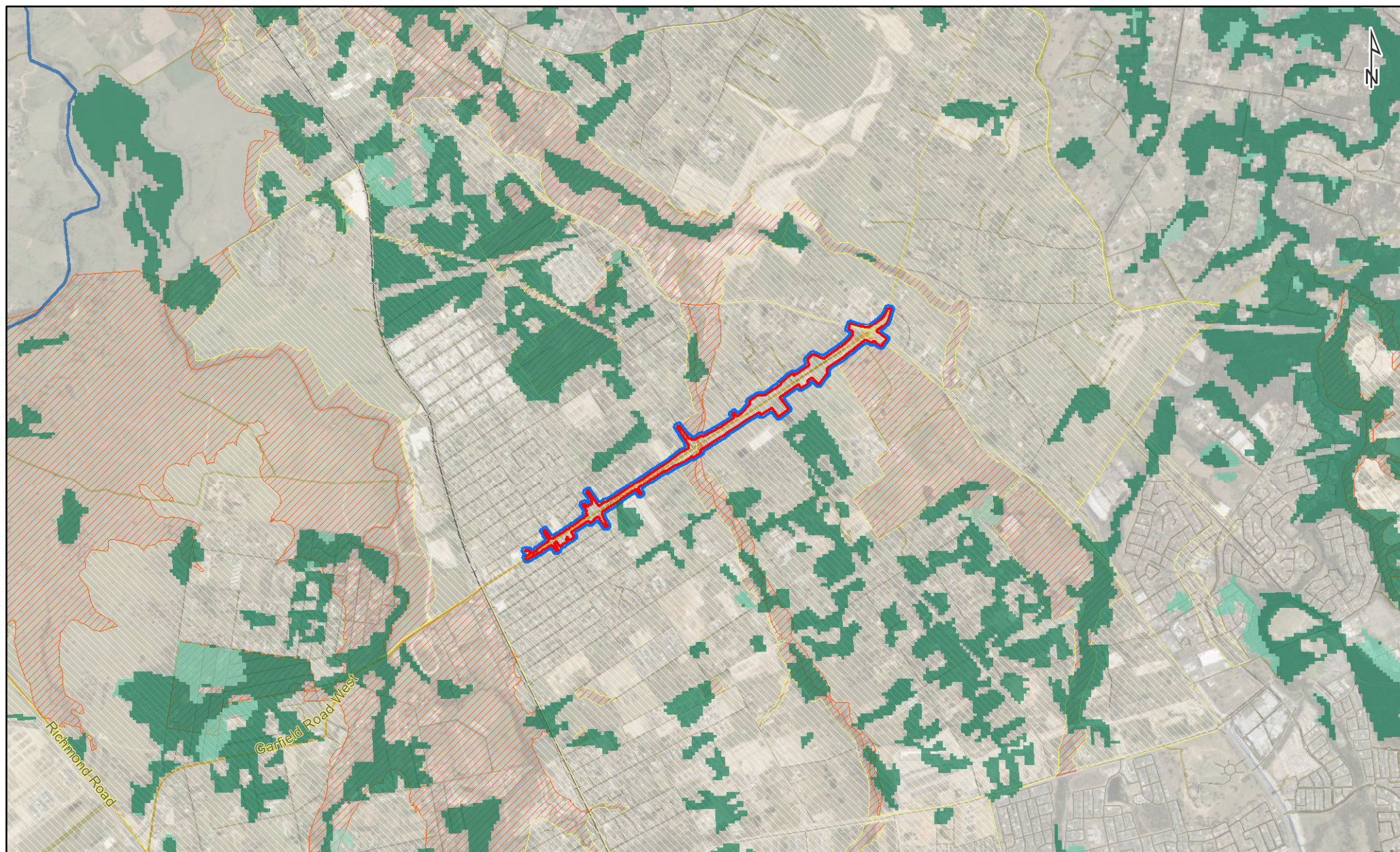


Garfield Road East 30012746

Figure 6-34: Threatened ecological communities

Roadnet MDS 2018,
Imagery © Department of Customer Service 2020

0 0.15 0.3
Km



Garfield Road East 30012746

Figure 6-35: Groundwater dependent ecosystems

Roadnet MDS 2019,
Imagery © Department of Customer Service 2020
0 0.25 0.5 1
Km

6.8.3 Potential impacts

Construction

Construction of the proposal may result in the following direct impacts to flora, fauna and ecology.

Removal of native vegetation

Construction of the proposal would require the clearing of areas mapped as threatened vegetation. Table 6.41 provides a summary of the impact of the proposal on PCTs recorded within the study area.

Table 6.41: Proposed vegetation clearing

Plant community type (PCT)	Status		Study area (ha)	Construction footprint (ha) ¹	Construction footprint (ha) non-biocertified ¹	Construction footprint (ha) biocertified ¹
	BC Act	EPBC Act				
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion Vegetation formation (PCT849) (Moderate)	Critically endangered	Critically endangered	2.95	2.10	-	2.10
Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion Vegetation formation (PCT849) (Low/planted)	-	-	1.28	0.87	0.22	0.65
Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT724) (Moderate)	Endangered	Critically endangered	0.99	0.84	-	0.84
Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion (PCT724) (Low/planted)	Endangered	-	0.13	0.02	-	0.02

Plant community type (PCT)	Status		Study area (ha)	Construction footprint (ha) ¹	Construction footprint (ha) non-biocertified ¹	Construction footprint (ha) biocertified ¹
	BC Act	EPBC Act				
Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (PCT835) (Moderate)	Endangered	-	2.19	1.42	0.47	0.95
Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter Valley (PCT1800)	Endangered	-	0.52	0.42	-	0.42
Exotic grassland with or without regrowth	-	-	20.71	11.87	2.09	9.78
Mixed planted exotic and natives	-	-	1.43	0.61	-	0.61
Total			30.20	18.15	2.78	15.37

¹ Area to be cleared as a result of the proposal

The proposal would remove about 5.67 hectares of communities listed under either the BC Act and EPBC Act.

Removal of habitat for threatened fauna - biocertified land

The threatened fauna habitat identified in the biocertified land includes native forests and woodlands, planted native and exotic vegetation, the natural ponds and artificial dams, the culverts/bridge over First Ponds Creek, and the airspace above the study area that supports flyways and prey such as insects for birds and bats. All of this habitat is expected to be directly impacted by the proposal and represents an example of the 'clearing of native vegetation', 'loss of hollow bearing trees' and 'removal of dead wood and dead trees' key threatening processes.

Within the biocertified land, the proposal would impact about 4.98 hectares of communities listed under either the BC Act and EPBC Act including PCTs 849, 835, 724 and 1800. This native vegetation supports foraging/hunting habitat for the assessed microchiropteran bats, such as the Little Bent-wing Bat, larger predatory birds, such as the Powerful Owl, the Cumberland Plain Land Snail and the Grey-headed Flying-fox. Roosting and nesting habitat for the assessed fauna is also likely to be supported by this native vegetation. The ecological surveys identified five large tree hollows, greater than 20 centimetres at the widest point, that have been assessed as providing habitat for non-threatened fauna such as Sulphur-crested Cockatoos (*Cacatua galerita*) and Brush-tailed Possums (*Trichosurus vulpecula*). Smaller hollows, less than 20 centimetres at the widest point, were assumed to occur within the study area and to be directly impacted by the proposal. One such smaller hollow within the construction footprint was found to support a native bee (*Tetragonula carbonaria*) nest. Additionally, some of the understory also supports sheltering habitat for the Cumberland Plain Land Snail and Green and Golden Bell Frog.

The tributaries of First Ponds Creek and not within the creek itself support marginal habitat for the Green and Golden Bell Frog, the Southern Myotis and other non-threatened fauna such as the Striped March Frog. While the proposal will maintain the passage of water through the tributaries of First Ponds Creek, the proposal will decrease the extent of the supported riparian habitat. The removal of this habitat will not only impact the area of foraging habitat but will impact the abundance of prey for both the Green and Golden Bell Frog and Southern Myotis.

There are several small ponds and artificial dams were recorded within biocertified areas of the proposal. These ponds and dams may support marginal habitat for the Green and Golden Bell Frog, the Southern Myotis and other non-threatened fauna. The proposal may directly impact on ponds and dams within the proposal.

Two dams located on the southern side of Garfield Road East at the eastern end of the proposal may require dewatering during construction. The temporary reduction in size of the dams may represent a permanent direct impact with the dewatering representing a temporary direct impact. As some of these ponds and dams have been mapped as Forested Wetland (PCT 835 and PCT 1800), their impact represents the key threatening process 'alteration of the natural flow regimes of rivers, streams, floodplains and wetlands'. Following construction of the proposal the pond would be restored in consultation with the land owner

Removal of habitat for threatened fauna - non-biocertified land

Within the non-biocertified land, the proposal would impact about 0.69 hectares of communities listed under either the BC Act and EPBC Act. Of the above 0.69 hectares, 0.47 hectares of BC Act listed vegetation would be removed from non-biocertified land. The direct impact to First Ponds Creek and its associated vegetation represents a loss of sheltering habitat for threatened and non-threatened frogs and other aquatic fauna such as turtles. Small patches of native aquatic vegetation - mapped as part of Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain would be directly impacted by the proposal, and supports species such as *Typha orientalis* and *Phragmites australis*, species associated with habitat for frogs. The direct impact to First Ponds Creek represents an example of the key threatening process, 'alteration of the natural flow regimes of rivers, streams, floodplains and wetlands'. It is

important to note that that proposal is expected to maintain the passage of water through First Ponds Creek during the construction phase.

The culverts/bridge over First Ponds Creek supports marginal roosting habitat for microchiropteran bats. While no bats were observed roosting in the culverts/bridge nor were there any signs of habitation, temporary roosting habitat may occur in the form of impressions left in the concrete from the formwork. The lack of permanently roosting bats is most likely because no large cracks were observed. Fairy Martins (*Petrochelidon ariel*), however, had made nests in the culverts and were actively using them, indicating that temporary bat-roosting is possible. The culvert/bridge habitat over First Ponds Creek will be directly impacted by the proposal however this impact is not in itself a key threatening process.

Large tree hollows occurring in the non-biocertified land along First Ponds Creek will be removed. While these hollows could potentially support hollow-roosting microchiropteran bat, they were recorded providing habitat for non-threatened birds during the surveys.

The stands of PCT 835 occurring along First Ponds Creek were assessed as providing marginal habitat for the Cumberland Plain Land Snail and the Green and Golden Bell Frog. This vegetation was also assessed as providing foraging habitat for the threatened microchiropteran bat and the Grey-headed Flying Fox.

Removal of habitat for threatened flora - biocertified land

No threatened plants are expected to be directly cleared by the proposal within the biocertified land surveyed during the current assessment. However, habitat for *Pimelea curviflora* var. *curviflora* and *Pimelea spicata* may occur in non-surveyed biocertified land. This habitat corresponds to 1.57 hectares of the Exotic grassland with or without scattered regrowth community.

The survey period for *Pterostylis saxicola* (October) fell outside the survey period for the proposal. As such, *P. saxicola* was assumed to occur in PCTs 849, 835 and 724. The proposal is expected to impact about 4.46 hectares assessed as supporting the occurrence of *P. saxicola*.

Removal of habitat for threatened flora - non-biocertified land

No threatened plants are expected to be cleared by the proposal within the non-biocertified land. *Pterostylis saxicola* has been assumed present in the study area however as it could not be surveyed for. Habitat for both *Pimealea* species have been assessed as occurring in the inaccessible grasslands of the non-biocertified land.

Table 6.42: Impact on threatened flora

Threatened species	Ecosystem or species credit species	Status		Habitat (biocertified) in the construction footprint (ha)	Habitat (non-biocertified) in the construction footprint (ha)	Habitat in the study area (ha)
		BC Act	EPBC Act			
<i>Marsdenia viridiflora</i> subsp. <i>viridiflora</i> endangered population	Species	Endangered	-	1.42	- ha	2.13
<i>Pimelea curviflora</i> var. <i>curviflora</i>	Species	Vulnerable	Vulnerable	1.57	0.24	2.46
<i>Pimelea spicata</i>	Species	Endangered	Endangered	1.57	0.24	2.46

Threatened species	Ecosystem or species credit species	Status		Habitat (biocertified) in the construction footprint (ha)	Habitat (non-biocertified) in the construction footprint (ha)	Habitat in the study area (ha)
		BC Act	EPBC Act			
<i>Pterostylis saxicola</i>	Species	Endangered	Endangered	4.46	0.69	7.54

Injury and mortality

Injury and mortality of fauna may occur during construction activities such as plant and machinery clearing vegetation, during excavation works, during the dewatering of dams and/or during the building of the new road infrastructure.

Nesting, roosting, non-flying, aquatic and semi-aquatic fauna are potentially at risk of injury or death from plant and machinery. Aquatic and semi-aquatic fauna may be at risk of injury or mortality during dewatering works.

Operation

The proposal includes some widening of the existing road and the removal of minor areas of edge affected vegetation. The removal of this vegetation may introduce new barriers to connectivity. The proposal may potentially increase the risk to terrestrial fauna crossing the road. No specific terrestrial species have been identified as likely to be impacted by a significant increase in barriers to connectivity either during construction or the operation of the proposal.

Connectivity requirements across Garfield Road East are generally limited with the few adjacent areas of intact native vegetation in the study area already fragmented through rural residential development, local roads and subdivisions. A regional wildlife corridor is however mapped outside the proposal and crosses Garfield Road West. Some terrestrial and aquatic connectivity across Garfield Road East is provided by bridge and/or culverts such as the one for First Ponds Creek, near the Edmund Street intersection.

Edge effects on adjacent native vegetation and habitat

Edge effects relate to where ecological processes and interactions are altered along the boundary of two or more different adjoining habitats. Often at these boundaries, such processes like air temperature, soil moisture or light intensity may be different to adjoining habitats. Clearing as a result of the proposal may facilitate the invasion and spread of exotic species into retained vegetation, reduce the resilience of native vegetation and change predator-prey relationships.

Invasion and spread of weeds

Exotic weeds are present in many areas of the proposal and the list of species and obligations for their control are listed section 6.8.2 above. High weed densities tend to occur in the disturbed areas adjacent to the existing roadway. There is a risk of increasing the impact of weeds through:

- Introduction of new weed species from soils on machinery or introduced fill
- Spread of weeds during construction works or runoff
- Colonisation of disturbed areas post construction
- Increased nutrient runoff particularly an elevation in phosphorus.

Invasion and spread of pests

The Mosquito fish (*Gambusia sp.*) is present in the dam to be dewatered. This dam is connected through streams to neighbouring waterbodies and the fish will almost certainly be ubiquitously present in these too. No processes that exacerbate the invasion or spread of pest fauna were identified.

Invasion and spread of pathogens and disease

Soil borne pathogens with the potential to infect plants e.g. Phytophthora, or fauna e.g. Chytrid fungus in frogs, could be introduced to the site by machinery or imported soils.

Changes to hydrology

Dewatering of the dam has the potential to create erosion and sedimentation at the point of discharge and introduce water of poor quality into nearby streams.

The proposal increases the area of impervious watershed which in most cases runs off into existing drainage lines. Increased flow rates, which may be further increased by new subdivisions, can impact bed and bank stability of creeks, leading to erosion and increase water turbidity. Two ordered streams will transect the site. Culvert placement and specifications will allow for forecast predicted flow rates without altering flow regimes.

The operational road surface runoff impact can act as a diffuse source of pollutants such as tyre dust and hydrocarbons. Accidental spills from vehicles remains a risk on roadways. The water quality treatment controls required to protect any environmentally sensitive receiving waterways would be incorporated in the proposal design and would address both accidental spills and chronic conditions from pollutant loads in surface rainfall runoff.

Noise, light and vibration

The study area is already subject to noise, light and vibration from traffic on Garfield Road East. Fauna habitat in the immediate vicinity of the study area is considered to be sub-optimal habitat for these reasons. The proposal is unlikely to further increase these effects such that the habitat would be unsuitable for the suite of fauna species that currently utilise it.

Groundwater dependent ecosystems

About 0.52 hectares of vegetation mapped as a subsurface groundwater dependant ecosystem would be directly cleared. Hydrological regimes, including groundwater levels and flooding regimes, are unlikely to be substantially altered by the proposal. It is considered unlikely there will be intersection of the water table or any groundwater drawdown as a result of the proposal, with required cuttings being relatively minor. The potential for contamination of groundwater, should groundwater intersection occur during construction, is low. Considering groundwater levels are unlikely to be altered by the proposal, the known and potential groundwater dependant ecosystem in the locality are considered unlikely to be subject to any indirect impact. It is important to note that this 0.14 hectares of vegetation occurs within biocertified land

Cumulative impact

The proposal is located within the NWGA and most of the surrounding land is under Biodiversity Certification. Land adjacent to the eastern half of Garfield Road East in the Riverstone and Riverstone East Planning Stage 2 precinct is planned to accommodate housing subdivisions, some of which are currently under construction. Under the Biodiversity Certification further impact assessment is not required for these developments and offsets have already been calculated. The development application for these areas do not allow for detailed impact to be obtained for practical quantitative analysis.

A portion of the proposal is located in an area not within biocertified land such as within the riparian corridor along First Ponds Creek. Direct impact from other projects affecting the First Ponds Creek corridor were not identified, however cumulative operational impact in the locality are considered for their impact on this riparian zone. There is unlikely to be a significant impact in the other uncertified area near Windsor Road.

Four projects were found on the DPIE's major projects register within two kilometres of the proposal and with potential cumulative impact. Table 6.43 provides an analysis of the contribution of the proposal in the locality to ecological impact in a local and regional context due to development. The Garfield Road West Upgrade is currently in the assessment stage and also covers both non-biocertified and biocertified land. It has been included in Table 6.43 however, details on the project's impacts cannot yet be provided.

Table 6.43: Past, present and future projects

Proposal	Biodiversity value impacted	Construction impact	Operational impact
Vineyard - Rouse Hill Transmission Line	Vegetation	Unknown – proposal at determination stage. Some vegetation clearing. No likely indirect impact to areas outside of biocertification	Vegetation can be retained in the easement with management of canopy growth.
Sikh Grammar School Rouse Hill	PCT 849	Removal of 0.07 ha of low quality PCT 849. (mostly canopy)	Increased storm water runoff.
Schofields Public School Redevelopment	Native trees from Cumberland Plain Shale woodland community however intact PCT not present.	46 trees removed, which is relatively insignificant compared to tree loss predicted for new housing in the district.	No operational impact would be anticipated.
NWGA Implementation Plan – Riverstone and Riverstone East	Native vegetation, EEC, threatened species habitat.	Most remnant vegetation is likely to be cleared in lots adjacent to Garfield Road East, East of Edmund Road and in the areas indicated in the Riverstone East Precinct Stage 2 plan. Impact is assessed and offset under biocertification.	It is not practical to calculate quantitative impact in biocertified land but cumulative impact to the riparian corridors not certified are likely to include additional:
Garfield Road West	Native vegetation, TECs, threatened species habitat.	TBC	TBC

Conclusion on significance of impacts

The proposal is not likely to significantly impact threatened species or ecological communities or their habitats, within the meaning of the *Biodiversity Conservation Act 2016* or *Fisheries Management Act 1994* and therefore a Species Impact Statement or Biodiversity Development Assessment Report is / is not required.

The proposal is not likely to significantly impact threatened species, ecological communities or migratory species, within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*.

6.8.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Biodiversity	<p>A Flora and Fauna Management Plan will be prepared in accordance with Transport for NSW's <i>Biodiversity Guidelines: Protecting and Managing Biodiversity on Projects</i> (RMS, 2011) and implemented as part of the CEMP. It will include, but not be limited to:</p> <ul style="list-style-type: none"> Plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas Requirements set out in the <i>Landscape Guideline</i> (RMS, 2008) Pre-clearing survey requirements Procedures for unexpected threatened species finds and fauna handling Procedures addressing relevant matters specified in the <i>Policy and guidelines for fish habitat conservation and management</i> (DPI Fisheries, 2013) Protocols to manage weeds and pathogens. 	Contractor	Detailed design / Pre-construction	Standard safeguard BAR1 Section 4.8 of QA G36 <i>Environment Protection</i>
Biodiversity	Measures to further avoid and minimise the construction footprint and native vegetation or habitat removal will be investigated during detailed design and implemented where practicable and feasible.	Contractor	Detailed design / Pre-construction	Standard safeguard BAR2
Biodiversity	Native vegetation will be re-established in accordance with <i>Guide 3: Re-establishment of native vegetation</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	Contractor	Pre-construction	Additional safeguard BAR3
Biodiversity	Habitat removal will be minimised through detailed design.	TfNSW	Detailed design	Additional safeguard BAR4

Impact	Environmental safeguards	Responsibility	Timing	Reference
Biodiversity	Habitat will be replaced or re-instated in accordance with Guide 5: Re-use of woody debris and bushrock and Guide 8: Nest boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011). This will include installation of nest boxes to replace lost hollows and salvage and re-use/installation of hollows from hollow-bearing trees that are removed.	TfNSW	Detailed design	Additional safeguard BAR5
Biodiversity	Clearing limits and exclusion zones clearly identified prior to work within the vicinity of the population of <i>Pimelea spicata</i> to ensure no impacts to the population.	Contractor	Construction	Additional safeguard: BAR6
Injury and mortality of fauna	Implementation of two stage clearing process to allow fauna to disperse from habitat voluntarily; inspection of hollows by experienced ecologist/fauna spotter/catcher prior to and after clearing of hollow-bearing trees/stags to safely remove and relocate any injured /displaced fauna.	Contractor	Construction	Additional safeguard: BAR7
Noise, light and vibration	Shading and artificial light impacts will be minimised through detailed design.	TfNSW	Detailed design / Pre-construction	Additional safeguard: BAR8

Other safeguards and management measures that would address biodiversity impacts are identified in section 6.3.5, section 6.9.4 and section 6.13.3.

6.8.5 Biodiversity offsets

TfNSW is committed to offsetting the impact associated with the proposal in line with its biodiversity offsetting guidelines (Roads and Maritime 2016) and in general accordance with the OEH (now DEES) principles for the use of biodiversity offsets in NSW.

The desktop assessment identified that a large proportion of the study area has been biocertified. As such, the offsetting for all biocertified land has already been determined and is not subject to this assessment.

The vegetation that has not been biocertified is about 0.47 hectares is still subject to the TfNSW *Guideline for Biodiversity Offsets* (Roads and Maritime 2016).

6.9 Surface water and groundwater

A surface water and groundwater specialist report was prepared for the proposal (SMEC, 2020). A summary of the surface water and groundwater report is provided in the following section. The full surface water and groundwater assessment is provided in Appendix M of this REF.

6.9.1 Methodology

The assessment of surface water and flooding was completed generally in accordance with relevant policy and guidelines. The assessment included a review of publicly available information to determine:

- Surface water characteristics of the proposal footprint
- The current drainage arrangements and discharge pathways across the study area, focusing on the proposal
- Confirmed any potential flood risk potential across the proposal footprint
- Key activities that could potentially impact surface water and need safeguarding or managing under the proposal.

Central to the assessment was assessing the likelihood for the proposal to impact on the local surface waters and the wider catchment. The likelihood for the proposal to impact on the local surface waters and the wider catchment and therefore impact on the value of these resources, and to what extent these values would be likely affected by the proposal, has been considered as part of this assessment.

Exposure, contamination, migration, flood risk and change in quality were also considered in undertaking the assessment.

6.9.2 Existing environment

Surface water

The proposal is located within Riverstone, NSW. Riverstone is situated within the South Creek sub-catchment of the Hawkesbury-Nepean River. The Hawkesbury-Nepean catchment spans from the regional city of Goulburn to Broken Bay in Sydney's North. Within Riverstone East, a main ridgeline runs in a north south direction through the centre of the precinct, with the two major natural drainage paths running parallel, First Ponds Creek to the west and the southern tributary of Killarney Chain of Ponds to the east (Mott MacDonald, 2016). The Eastern Creek catchment is located west of the study area.

The proposal crosses the First Ponds Creek at the intersection of Edmund Street and Clarke Street and Garfield Road East. Eastern Creek is a major waterway which is located about 1.2 kilometres west of the study area. The Killarney Chain of Ponds is located to the northeast of the study area. The general topography suggests the aforementioned creeks flow in a general southeast / northwest direction, and any surface water flow would follow the ground contours to these creeks.

Water quality

The quality of the water entering local waterways at the site would be largely a function of the contaminants on the road and adjacent areas. Common road runoff pollutants include gross pollutants and litter, sediment and suspended solids, toxic organics, nutrients, heavy metals and hydrocarbons. Runoff from agricultural land can carry large amounts of nitrogen, phosphorus, and sediment.

Water quality and quantity entering local watercourses will be affected with the development of the precincts including Riverstone East. The overall water management strategy for the Riverstone Precinct involves the following treatment:

- Rainwater tanks provided low density developed dwellings at source treatment and re-use of roof water;
- Gross pollutant traps and trash racks to capture larger pollutants and sediments before discharge into the watercourses
- Bioretention “raingardens” to provide online treatment for effective removal of finer sediments and nutrients.

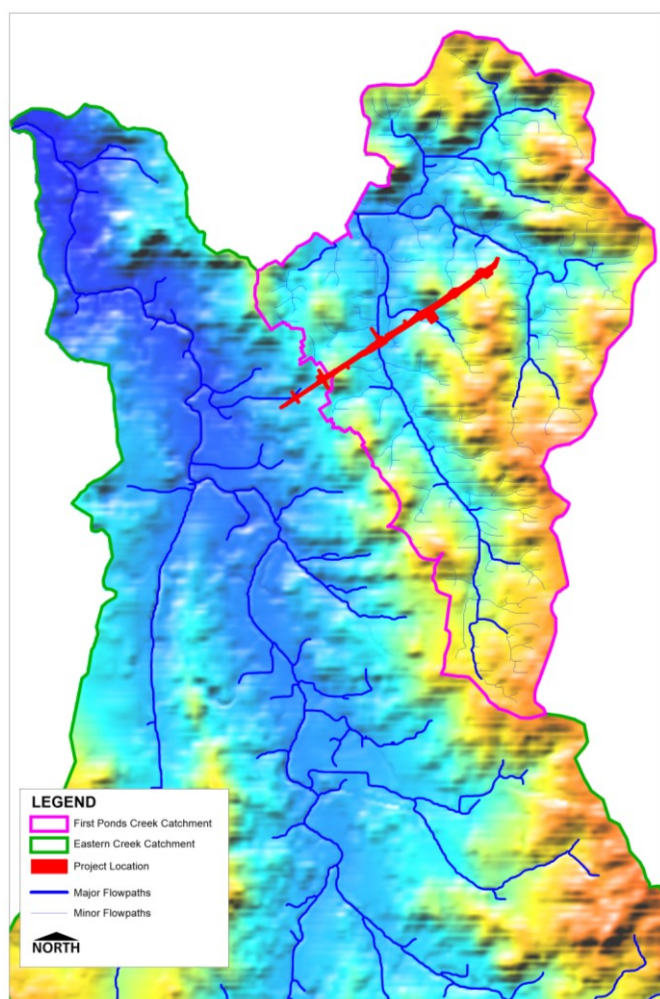


Figure 6-36: Catchments and stream paths impacting Garfield Road East

Baseline water quality testing was not carried out for the proposal. However, the majority of the Hawkesbury-Nepean is stressed, largely as a result of urban and agricultural practices and changes to flow with large amounts of water diverted for water supply and irrigation. Elevated nutrient levels and reduced river flows are the key contributing factors to stresses on the river.

The ANZECC water quality thresholds are provided in Table 6.44.

Table 6.44: ANZECC water quality thresholds

Water quality parameter	ANZECC/ARMCANZ Trigger values
pH	6.5-8.0
Electrical conductivity (salinity) (μScm^{-1})	125-2200
Dissolved oxygen (% saturation)	85-110

Water quality parameter	ANZECC/ARMCANZ Trigger values
Turbidity (NTU)	6-50
Hydrocarbons (oils and petroleum)	Insufficient data to derive a reliable trigger value.

The Blacktown City Council Development Control Plan (2015) (BCC DCP, 2015) Part J Water Sensitive Urban Design and Integrated Water Cycle Management ensures that all development manages adverse water quality impacts by requiring the post development average annual load reductions as presented in Table 6.45.

Table 6.45: Water Quality Pollutant Reduction Targets (BCC DCP, 2015)

Pollutant	Minimum removal rate
Gross Pollutants (GP)	90%
Total Suspended Solids (TSS)	85%
Total Nitrogen (TN)	45%
Total Phosphorus (TP)	65%

With regards to the water quality strategy of the Riverstone East and Riverstone Precincts it is noted that the Department of Planning commissioned the following two studies:

- *Water Cycle Management Report: Riverstone East* (NSW Department. of Planning and Environment, May 2016)
- *Report for Riverstone and Alex Avenue Precincts: Post Exhibition Flooding and Water Cycle Management including Climate Change Impact on Flooding* (NSW Department of Planning, May 2010).

Based on the studies above, a range of stormwater treatment measures such as rain gardens and bio-retention basins have been proposed as part of the precinct wide water quality strategies to cater for the substantial increase in catchment development.

Groundwater

According to the published 1:100000 Geological Map for Penrith (Sheet 9131) indicates the study area is underlain by Quaternary Alluvium Deposits along watercourses likely associated with the geomorphological evolution of the area. This unit is characterised by fine grained sand, silt and clay. This unit is particularly dominant at the intersection of Edmund Street, Clarke Street and Garfield Road East.

Underlying bedrock units within the vicinity of the proposal are part of the Wianamatta Group and include Ashfield Shale, Minchinbury Sandstone and Bringelly Shale to the east.

The primary groundwater system within the construction footprint is associated with the fluvial deposits of First Ponds and Killarney Chain of Ponds Creeks which flow generally from the north towards the south and south east. The creeks are associated with the Hawkesbury River system. On a wider scale, the aquifer system is contained within Bringelly Shale, Minchinbury Sandstone and Ashfield Shale.

Within the shallow fractured rock and weathered overburden, the local groundwater flow system is likely controlled by topography with flow towards natural drainage lines. Groundwater recharge occurs through direct rainfall infiltration and may also have a component of hard surface, e.g. roads, buildings, runoff

infiltration. The fluvial deposits, while receiving direct rainfall recharge, are expected to have a direct connection to creek flows and therefore be recharged by runoff to the creeks. In addition, there may be a component of base flow from the fractured rock. The creeks are expected to be both influent and effluent with water moving in and out of the fluvial deposits depending on the relative hydraulic head in the rock.

Groundwater discharge from the shallow weathered / fractured rock system will be as evapotranspiration, direct discharge at the break of slope where bedding plains are exposed, or to the creek alluvium. Discharge and recharge to each system will be rainfall dependent with potential short duration changes in the fractured rock / fluvial deposits flow direction.

The depth to water within the alluvial sediments can be variable, depending on the prevailing climatic conditions and depth to bedrock. Within the weathered / fractured rock, groundwater level fluctuations are expected to be very subdued due to the low permeability of these materials.

Three existing groundwater monitoring standpipes have been installed along the alignment. A summary of details relating to the standpipes is presented in Table 6.46. No further groundwater level/inflows readings have been obtained since 9 August 2019. Borehole locations are provided in Figure 6-37.

Table 6.46: Summary of installed groundwater monitoring standpipes

Location id	Approximate chainage	Groundwater standpipe depth	Response zone (m)	Depth to water from surface level*
BH03E	1260	7.80	3.80-7.80	Not measures
BH05E	1980	9.55	3.05-9.55	1.63
BH10E	3285	7.00	0.70-7.00	5.98

Groundwater quality

Groundwater quality data was not available for the alluvial groundwater system. However, Sydney Basin groundwater salinity mapping (Russel et al., 2009) in the region of the proposal indicates Wianamatta Group groundwater systems have salinity concentrations in the order of 3,000 to 5,000 mg/L, which is considered 'unpalatable' (ADWG, 2011) for humans but tolerable (ANZECC & ARMCANZ, 2000) for livestock with the exception of poultry and dairy cattle.

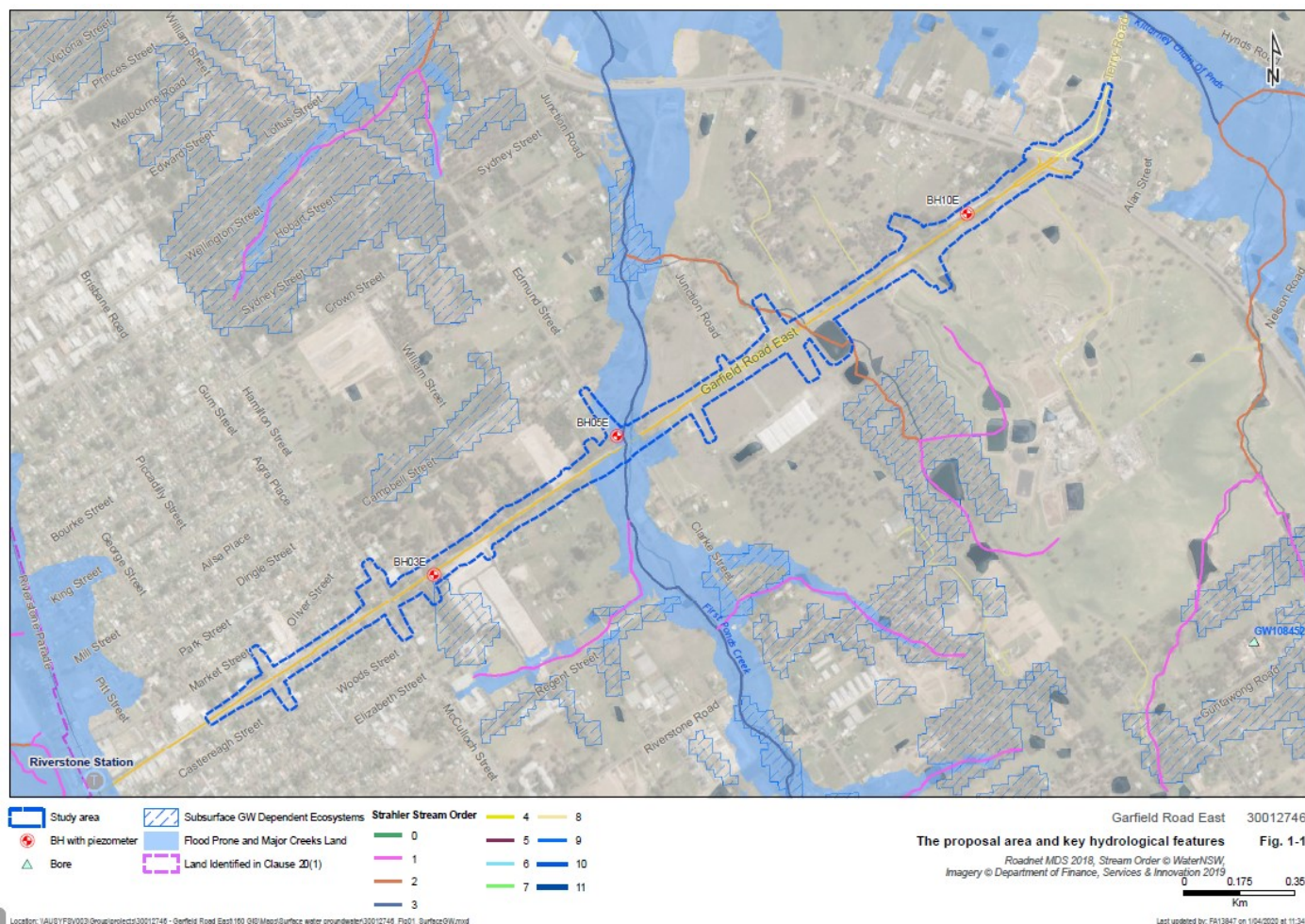


Figure 6-37: Hydrological features

6.9.3 Potential impacts

Construction

Water quality

The proposal would require the excavation of existing road/footpath surfaces and the clearing of some vegetation. During construction there is the potential for erosion and sedimentation to occur because of soil disturbance activities. These activities have the potential to impact on water quality if runoff is allowed to mobilise exposed soils particularly when located close to waterways. Dewatering activities may cause erosion and sedimentation impacts at the point of discharge. These are a potential source of turbid runoff which may impact water quality. During excavation and dewatering activities, the risk of water pollution would be low with the implementation of the safeguards.

Temporary stockpiling of topsoil and vegetation would be required for the proposal. Stockpile sites would include environmental protection measures to minimise impacts on receiving waters from erosion and sedimentation.

The proposal includes earthworks. These activities increase erosion and sediment deposition in the waterways. In particular, construction activities adjacent to First Ponds Creek could introduce contaminants such as oil or greases and disturb contaminated sediments, potentially having an adverse impact on water quality.

Construction activities, including temporary ancillary facilities, are a potential source of pollution from accidental spills, in particular hydrocarbon spills from construction plant. Spills and leaks have the potential to impact on water quality of downstream receiving waters. Contaminants could include acids and chemicals from washing down of vehicles, construction fuels, oils, lubricants, hydraulic fluids and other chemicals.

Groundwater

Groundwater levels: The proposal may involve the excavation of existing creek and drainage lines. For this reason, temporary changes in groundwater is anticipated. The depth to water within the alluvial sediments can be variable, depending on the prevailing climatic conditions and depth to bedrock. Within the weathered/fractured rock, groundwater level fluctuations are expected to be very subdued due to the low permeability of these materials. It is considered unlikely there will be intersection of the water table or any groundwater drawdown as a result of the proposal, with required cuttings being relatively minor.

Operation

Surface water

Minor increases in impervious surface areas associated with the proposal have the potential to result in increased runoff due to changes in the hydrological regime. This could lead to water quality impacts associated with increased erosion and sedimentation and increased concentrations or the introduction of pollutants into downstream waterways. Rain events typically flush road surface contaminants into stormwater infrastructure, which is then discharged to the local environment. These pollutants include:

- *Suspended sediments from impervious surfaces*
- *Oils, greases, heavy metals and hydrocarbons*
- *Litter from the road corridor*
- *Nutrients from biological matter.*

Any additional pollutant or sediment impact is considered unlikely during operation

Groundwater

Once operational, the proposal would have no net change in the impact the road has on groundwater levels, flows, recharge, quality or other values. The operational groundwater impact is considered to be negligible.

6.9.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Soil and water	A Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the CEMP. The SWMP will identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction.	Contractor	Detailed design / Pre-construction	Standard safeguard SW1 Section 2.1 of QA G38 <i>Soil and Water Management</i>
Soil and water	A site specific Erosion and Sediment Control Plan/s will be prepared and implemented as part of the Soil and Water Management	Contractor	Detailed design / Pre-construction	Standard safeguard SW2

Impact	Environmental safeguards	Responsibility	Timing	Reference
	<p>Plan <i>[delete reference to SWMP if one is not being prepared - and replace with reference to CEMP]</i>.</p> <p>The Plan will include arrangements for managing wet weather events, including monitoring of potential high risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather.</p>			Section 2.2 of QA G38 Soil and Water Management
Stockpiles	<p>Stockpiles of raw materials or spoil would be located as close as practical to the work area where they are proposed to be used and to permit any drainage off site so that there would not be any impact to water quality. Stockpile sites would also include environmental protection measures which may include sediment basins to minimise impacts on receiving waters from erosion and sedimentation. Stockpiles sites would be established and managed in accordance with Environmental Procedure Management of Wastes on TfNSW Land (Roads and Maritime, 2014).</p>	Contractor	Detailed design / Pre-construction	Standard safeguard SW3 Section 2.1 of QA G38 Soil and Water Management
Surface water	<p>Prior to construction, baseline water quality monitoring would be undertaken to identify parameters for monitoring during construction and to determine indicative existing water quality. Sampling locations and monitoring methodology would be determined during the detailed design stage. In accordance with the Guideline for Construction Water Quality Monitoring (RTA 2003) the following parameters are recommended to be monitored:</p> <ul style="list-style-type: none"> • pH, electrical conductivity, dissolved oxygen, turbidity and temperature • Total suspended solids • Hydrocarbons (oil and grease) <p>Data collected during the preconstruction monitoring would be used to develop site specific trigger values so that monitoring</p>	TfNSW	Pre-construction	Additional safeguard SW4

Impact	Environmental safeguards	Responsibility	Timing	Reference
	undertaken during the construction phase can be compared to these values. This would identify if any changes in water quality are a result of construction activities and demonstrate compliance with any monitoring requirements or targets (RTA 2003).			
Groundwater	At a minimum, groundwater quality is to be monitored over three sampling rounds at monitoring locations identified to provide baseline groundwater quality data for the proposal. The three sampling rounds should be undertaken at approximately quarterly intervals before construction works commence and analytes should comprise dissolved heavy metals, pH, electrical conductivity, total dissolved solids and major ions. It is recommended additional monitoring bores be installed along the 3.4 kilometre alignment, to adequately characterise the groundwater throughout the extent of the proposal.	Contractor	Construction	Additional safeguard SW5
Water quality controls	<p>Operational phase monitoring would be undertaken in order to:</p> <ul style="list-style-type: none"> Assess and manage impacts on the receiving waters as the site stabilises Assist in deciding when the site has stabilised Identify water quality conditions after development. <p>Monitoring would be undertaken in line with the TfNSW Guidelines for Construction Water Quality Monitoring (RTA 2003).</p>	TfNSW	Post-construction	Additional safeguard SW6
Surface water quality	Post- construction groundwater samples may be taken from any groundwater monitoring locations and analysed for the same analytes as tested for the baseline data (plus contaminant analytes where required), with results then compared to baseline data.	TfNSW	Post-Construction	Additional safeguard SW7

Impact	Environmental safeguards	Responsibility	Timing	Reference
Dewatering	Dam dewatering process will be prepared and implemented as part of the CEMP in accordance with the Technical Guideline Environmental Management of Construction Site Dewatering (RTA, 2011)	Contractor	Pre-construction / construction	Additional safeguard SW8

Other safeguards and management measures that would address surface water impacts are identified in section 6.3.5.

6.10 Geology and soils

6.10.1 Methodology

A geotechnical assessment was prepared for the works, the findings of which are discussed in this section of the REF.

6.10.2 Existing environment

Topography and landforms

Riverstone is located in western Sydney on the Cumberland Plain. Cumberland Plain landforms contain several types of raw material suitable for stone tool manufacture and use, including mudstone and silcrete from the St. Mary's formation and Cranebrook Formation (McDonald 1999). A silcrete quarry was located about two kilometres south of the western extent of Garfield Road West, and roughly four kilometres southwest of the study area (McDonald 2006).

The study area is comprised of gently rolling hills of less than five per cent slope. The existing Garfield Road East undulates between crests of shale bedrock and troughs formed by creek crossings which traverse the study area. Some shale outcrops were also observed during site investigations. Outcrops of shale were observed in cut batters at two locations to the western end of the study area.

Geology

The geology of the study area is identified by NSW DPE (Resources and Geoscience) data as comprising the following:

- Quaternary period fine-grained sand, silt and clay.
- Middle Triassic Period, Bringelly Shale – Shale, carbonaceous claystone, claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff
- Middle Triassic Period, Ashfield Shale – Dark-grey to black claystone-siltstone and fine sandstone - siltstone laminate
- Middle Triassic Period, Minchinbury Sandstone – Fine to medium-grained quartz-lithic sandstone.

The oldest deposits of the Sydney Basin include shales and mudstone underlying coal measures. The underlying geology of the Cumberland Plain is primarily shale-based, and the study area contains Bringelly and Ashfield shales as well as Minchinbury sandstone, all part of the Wianamatta group (Pickett and Alder 1997). The shales which underlie the Cumberland Plain form undulating to low hilly landscapes which characterise the subregion. Bringelly shale is formed of dark grey to black claystone, siltstone, laminate, sandstone, coal and tuff. Minchinbury sandstone is comprised mostly of quartz and quartzose rock. Ashfield shale consists of black sideritic claystone that grades into fine sandstone.

The geological units identified during the test pitting are provided in Table 6.47 and shown in Figure 6-38.

Table 6.47: Geological units within the study area

Unit	Name	Description
1a	Topsoil	Topsoil layers (0.10m to 0.50m thick) – dark brown to brown; clayey silt, silty clay and silty sand with roots and organic materials

Unit	Name	Description
1b	Existing cohesive fill	Fill encountered in existing road embankments, pavements, hardstand areas and placed material to raise ground levels.
1c	Existing granular fill	Fill encountered in existing road embankments, pavements, hardstand areas and placed material to raise ground levels.
2a	Fluvial soft to firm cohesive	Silty clay, clay; dark grey, brown; low plasticity
2b	Fluvial stiff to very stiff cohesive	Silty clay, sandy clay, clayey silt; brown, pale grey, grey, red-brown;
2c	Fluvial cohesive	Silty clay; pale brown, red-brown, yellow-brown, orange-brown, grey, pale grey; variable plasticity
3a/4a	Residual firm cohesive (from Bringelly or Ashfield Shale)	Silty clay; pale brown, red-brown, yellow-brown, orange-brown, grey, pale grey; variable plasticity, Silty clay, clayey silt, silt; pale grey, orange-brown, red-brown; generally medium to high plasticity
3b/4b	Residual stiff cohesive (from Bringelly or Ashfield Shale)	Silty clay; pale brown, red-brown, yellow-brown, orange-brown, grey, pale grey; variable plasticity, Silty clay, clayey silt, silt; pale grey, orange-brown, red-brown; generally medium to high plasticity
3c/4c	Residual very stiff to hard cohesive (from Bringelly or Ashfield Shale)	Silty clay; pale brown, red-brown, yellow-brown, orange-brown, grey, pale grey; variable plasticity
	New engineered general fill material	

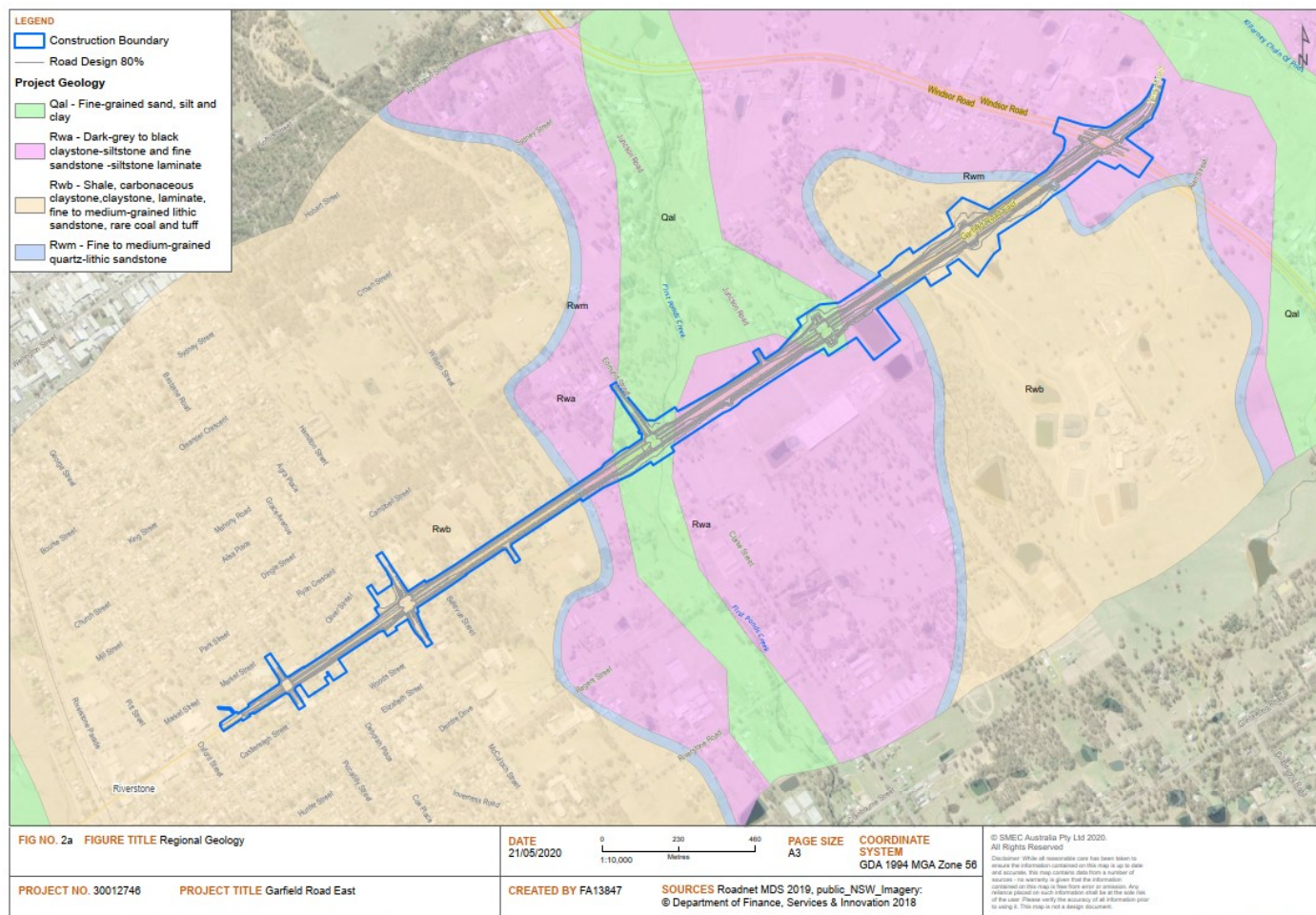


Figure 6-38 Regional geology

Soil landscapes

Garfield Road East is composed of three different landscape classifications under the Mitchell classification system (2002). Around 75 per cent of the study area is Cumberland Plain, while 25 per cent is Hawkesbury–Nepean Channels and Floodplains.

Reference to the 1:100 000 soil landscape map for Penrith (Soil Landscape Series – Sheet 9030, Edition 1 Reprint) from the DECCW indicates there are two major soil landscape units across Garfield Road East:

- Blacktown residual soil landscape
- South Creek fluvial soil landscape
- Berkshire Park alluvial soil landscape.

These soil landscapes are discussed in the following sections.

Blacktown

Most of the study area is located on the Blacktown soil landscape unit. This landscape comprises of gently undulating rises on Wianamatta Group shales with local reliefs to around 30 metres. Ground slopes and inclines are generally less than five degrees. Dominant land uses include, residential, light and heavy industry.

Silts and clays are the predominant soils within this soil landscape unit, typically being brown, red and yellow in colour with varying degrees of plasticity. Soils depths are expected to be shallower on top of

crests and ridge lines, with deeper soil profiles found in valleys and troughs. Soils near the surface are expected to be slightly reactive whilst deeper soils may tend towards being moderately reactive.

Soil erodibility is generally moderate, but where there are highly dispersible soils with the potential for higher erodibility. Erosion from water is generally considered to be moderate to high under significant flows. Poor soil drainage can also be expected in low lying, constrained areas. Localised areas of high shrink-swell potential may also be prevalent which impact on shallow foundations for structures.

South Creek

The South Creek soil landscape unit appears to be closely tied to the quaternary alluvial soil deposits associated with First Ponds Creek, Killarney Chain of Ponds Creek, and their tributaries. This landscape comprises of floodplains, valley flats and drainage lines and depressions. The terrain general comprises of flat to gently sloping alluvial plains, with a slope up to five degrees, and occasional terraces or levees providing low relief of less than 10 metres. Most of the land has been reserved for recreational use or left unused.

Soils are expected to widely range between silts, clays and sands. Deeper soil deposits are found towards existing creeks and drainage lines overlying relict soils and bedrock. Soils near the surface are expected to be slightly reactive whilst deeper soils may tend towards being moderately reactive.

Soil erodibility is generally high. Erosion from water is considered to be very high to extreme under significant flows. Soils are located in active flood plains and are being reworked by fluvial process. Flooding, seasonal waterlogging and fluctuating water levels can be expected within this landscape.

Berkshire Park soil landscape

The Berkshire Park soil landscape covers a wide area between the lower terraces of the Hawkesbury/Nepean River system and west of South Creek. It is dissected along the eastern edge by South Creek and its tributaries and overlain by the Agnes Banks sands at Agnes Banks and Pitt Town.

The soils of this landscape are the result of three depositional phases of Tertiary alluvial/colluvial origin. The lowest deposit is the St Marys formation. This is overlain by the Rickabys Creek gravel formation which is of varying thickness and, in turn, is topped by the Londonderry Clay formation. All of these formations are derived from sandstone and clay. Erosion of the surface has led to exposure of all three formations in different locations.

Soil landscapes relevant to the study area are summarised in Table 6.48 and shown in Figure 6-39.

Table 6.48: Soil landscapes within the study area

Soil landscape	Geology	Soils	Constraints
Blacktown			
Gently undulating rises on Wianamatta Group shales. Local relief to 30 m, slopes usually >5%. Broad rounded crests and ridges with gently inclined slopes. Cleared Eucalypt woodland and tall open-forest (dry sclerophyll forest).	Wianamatta Group - Ashfield Shale consisting of laminite and dark grey siltstone, Bringelly Shale which consists of shale with occasional calcareous claystone, laminite and infrequent coal, and Minchinbury.	Shallow to moderately deep (>100 cm) hardsetting mottled texture contrast soils, red and brown podzolic soils on crests grading to yellow podzolic soils on lower slopes and in drainage lines.	Localised seasonal waterlogging, localised water erosion hazard, moderately reactive highly plastic subsoil and localised surface movement potential.

Soil landscape	Geology	Soils	Constraints
South Creek			
Floodplains, valley flats and drainage depressions of the channels on the Cumberland Plain. Usually flat with incised channels; mainly cleared.	Quaternary alluvium derived from Wianamatta Group shales and Hawkesbury Sandstone.	Often very deep layered sediments over bedrock or relict soils. Where pedogenesis has occurred structured plastic clays or structured loams in and immediately adjacent to drainage lines; red and yellow podzolic soils are most common terraces with small areas of structured grey clays, leached clay and yellow solodic soils.	Flood hazard, seasonal waterlogging, localised permanently high watertables, localised water erosion hazard, localised surface movement potential.
Berkshire Park			
Dissected, gently undulating low rises on the Tertiary terraces of the Hawkesbury/Nepean	Tertiary alluvial/colluvial origin. overlain by the Rickabys Creek gravel. Erosion of the surface has led to exposure of all three formations in different locations	Weakly pedal orange heavy clays and clayey sands, often mottled. Ironstone nodules common. Large silcrete boulders occur in sand/clay matrix. Solods yellow podzolic soils	Very high wind erosion hazard if cleared. Gully, sheet and rill erosion on dissected areas. Localised seasonal waterlogging, localised flood hazard, impermeable subsoils, and low fertility.

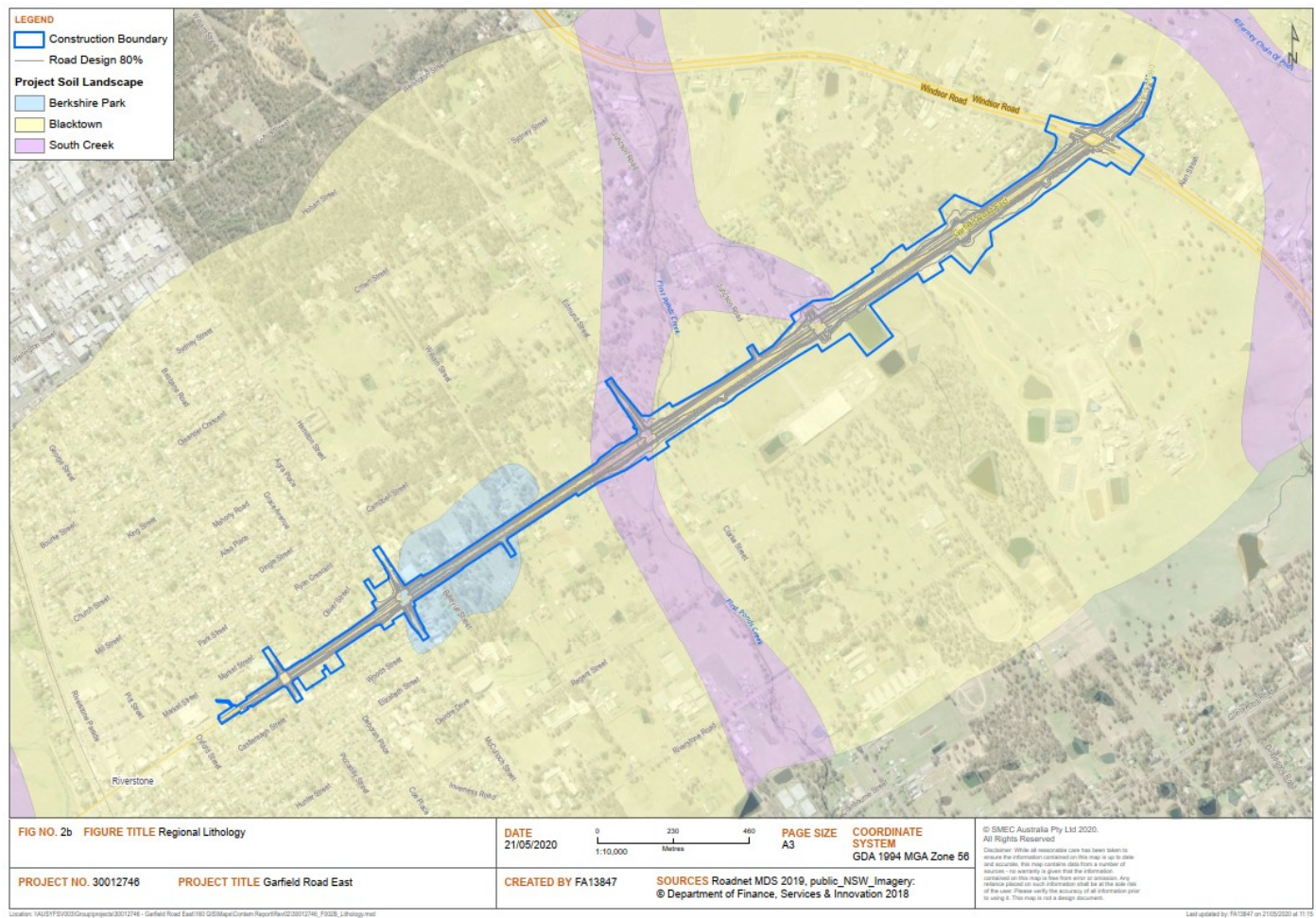


Figure 6-39: Soil landscapes

Salinity

Parts of the study area along the First Ponds Creek corridor and near Junction Road are mapped as high salinity potential (Department of Infrastructure, Planning and Natural Resources, 2003). These areas are predisposed to salinity due to soil, geology, topography and groundwater conditions. There is also a salt affected area near Junction Road. The remainder of the study area has a moderate salinity potential. Scattered areas of scalding and indicator vegetation have been noted but concentrations have not been mapped.

6.10.3 Potential impacts

Construction

The following key elements of the proposal are likely to impact geology:

- Fill embankments with a maximum fill height up to about 3.8 metres
- Cuttings with a maximum batter height up to about 3.9 metres
- Foundations for transverse culverts and the bridge
- New retaining walls
- New road pavement.

Geology

The proposed vegetation clearance, tree removal, earthworks and ground profiling would expose the natural soils.

Excavations would be required to carry out the safety improvements. The ability to reuse the material would depend on its physical and chemical properties. Material unsuitable for construction use would need to be transported offsite by a licensed contractor for disposal at a licensed waste management facility following testing and classification.

As outlined in section 3.3.4, the net volume of material is about 16,470 cubic metres of fill. Imported material will most definitely be required, also considering not all cut material will be suitable.

Construction activities would potentially result in:

- Washout, erosion and sediment discharge of exposed soils
- Erosion, leaching and dust generation from stockpiled materials
- Associated soil quality impacts through accidental spills caused by:
 - Use of chemicals outside of the contained areas
 - Traffic accidents, including loading and unloading risks
 - Leaks and drips from poorly maintained vehicles, machinery and equipment
 - The temporary storage and management of spoil and waste leading to leaching.
- Embankment instability: Embankments constructed over loose or soft soils may experience instability if not properly managed
- Embankment settlement: Embankments constructed on compressible soils are subject to immediate and long-term settlement which may occur during and after construction, or from ongoing long term creep settlement
- Cuttings: Cut slopes, especially those steeper than 50 per cent could be subject to potential instability, both during and post construction. This could be as a result of the material encountered in the cut, in particular the in-situ strength of the material, groundwater levels or from other factors such as weathering and erosion.

Soil landscapes

- Ground breaking activities and excavations have a high potential to result in erosion due to the soil landscapes associated with the study area. Removal of vegetation to allow for the proposal would temporarily increase erosion potential as the removal of established groundcover can destabilise soils.
- There is the potential for increased sedimentation and erosion along creek lines and streams during construction of new culverts and at the bridge and upgrades to culvert structures, particularly during activities at First Ponds Creek.

Salinity

While saline conditions may be encountered, for there to be an impact there would either need to be a notable change in groundwater chemistry, flows or conditions, or the creation of a migration pathway. Accordingly, the depth, scale and location of proposed ground excavation would be likely insufficient to cause such a change, meaning there would only be a remote risk of any associated impacts.

Operation

- The proposal would formalise the road surface. The implementation of new drainage structures would positively impact the movement of runoff along Garfield Road East and would reduce the occurrence and magnitude of erosion throughout the life of the proposal

- The proposal would be designed with regard to the geological limitations and constraints
- There is the potential for ongoing sedimentation and erosion impacts if the reinstatement is not successful
- Urban design and landscaping would result in the stabilisation of soils along the proposal. Landscaping and urban design would work to reduced erosion potential during the operational stage of the proposal
- There is the potential for a reduction in soil quality adjacent to the road corridor from direct and indirect runoff, including hydrocarbons and other vehicle related pollutants
- Scour at drainage discharge points has the potential to cause erosion and washout and the subsequent discharge of pollutants and sediment into the receiving waterways. Such impacts would only occur through poor maintenance.

6.10.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Erosion and sedimentation	Wet weather plans for a rain event would be included in the ESCPs outlining the controls to be implemented in preparation for a rain event	Contractor	Construction	Additional safeguard: GS1
Erosion and sedimentation	Any material transported onto road surfaces would be swept and removed at the end of each working day and before rainfall	Contractor	Construction	Additional safeguard: GS2
Erosion and sedimentation	Topsoil would be stockpiled separately for possible reuse in landscaping and rehabilitation	Contractor	Construction	Additional safeguard: GS3
Erosion and sedimentation	Control measures will be implemented at egress points to minimise dirt and mud tracking	Contractor	Construction	Additional safeguard: GS4
Sediment basins	With the catchments and the disturbed areas proposed there may be a triggered requirement for temporary construction phase basins, as per the Blue Book.	Contractor	Construction	Additional safeguard: GS5

Other safeguards and management measures that would address soil impacts are identified in section 6.9.4.

6.11 Air quality

6.11.1 Methodology

The potential air quality impact associated with the proposal has been evaluated by:

- Identifying key risks during construction and operations, as well as suitable criteria for the evaluation of these risks
- Characterising key features of the surrounding environment including the location of surrounding receivers and sensitive land use areas; prevailing climate and meteorological conditions; and background air quality
- Determining the potential for an impact to occur during construction and operations. Impact during construction was evaluated using metrics developed based on guidance from AS/NZS ISO 31000: 2009 Risk Management – Principles and Guidelines, whereas the potential for operational impact was quantitatively assessed using Tool for Roadside Air Quality (TRAQ) (Roads and Maritime Services) prediction model, with the impact evaluated by comparing predictions against criteria developed using guidance from the Approved Methods, (EPA, 2016)
- Recommending safeguards to effectively manage any risks to air quality during the proposed work, based on the outcomes of these reviews.

During construction the primary air quality-related risk is expected to be the generation of dust (including total deposited dust, total suspended particulates and fine particulate matter) during clearing and road construction activities. Exhaust emissions associated with plant and equipment would also be another key air quality risk during construction.

Regarding operations, changes to roadside combustion-related pollutant concentrations is the primary risk as a result of changes to traffic conditions expected as a result of the proposal. The Australia State of the Environment 2016: Atmosphere (SoE 2016) report (Keywood, Hibberd & Emmerson, 2017) lists carbon monoxide (CO), oxides of nitrogen (NO_x) including nitrogen dioxide (NO₂) and particulate matter (PM₁₀ and PM_{2.5}) as the primary pollutants associated with motor vehicle emissions. Volatile organic compounds (VOCs) are also noted to be a key species of pollutants associated with motor vehicle exhaust emissions.

The Approved Methods for the Modelling and Assessment of Air pollutants in New South Wales (Approved Methods), (NSW Environment Protection Agency [EPA], 2016) lists the 'impact assessment criteria' outlined in Table 6.49 for the purpose of evaluating the key emissions during construction and operations associated with the proposal.

Table 6.49: Approved methods of impact assessment criteria

Pollutant	Averaging period	Concentration (µg/m ³) unless stated	Source
Total suspended solids (TSP)	Annual	90	NHMRC, 1996
Deposited dust (DD)	Annual	4 g/m ² /month	NERDDC, 1988
	Maximum increase	2 g/m ² /month	NERDCC, 1988
	24 hours	50	DoE, 2016
Particulate matter with an aerodynamic diameter less than 10 microns (PM ₁₀)	Annual	25	DoE, 2016

Pollutant	Averaging period	Concentration (µg/m ³) unless stated	Source
Particulate matter with an aerodynamic diameter less than 2.5 microns (PM _{2.5})	24 hours	25	DoE, 2016
	Annual	8	DoE, 2016
Carbon monoxide (CO)	15 minutes	100 mg/m ³	WHO, 2000
	1 hours	30 mg/m ³	WHO, 2000
	8 hours	10 mg/m ³	NEPC, 1988
Nitrogen dioxide (NO ₂)	1 hour	246	NEPC, 1988
	Annual	62	NEPC, 1988
Volatile organic compounds (VOCs)	1 hour	29	VGG, 2001

6.11.2 Existing environment

Climate and meteorology

The nearest weather station with long-term historical records operated by the Bureau of Meteorology (BoM) is the Richmond RAAF automatic weather station (AWS - 06715). This station is located approximately 15 kilometres to the northwest of the proposal.

Data from Richmond RAAF automatic weather station indicates that the locality around the proposal experiences warm and wet summers with mean daily maximum temperatures of around 30 degrees Celsius. The driest period of the year is between July and September with an average monthly rainfall of around 34 millimetres per month during this period. It is during periods of dry, higher temperature conditions that the potential for dust generation is greatest. Winds blowing from the south and southwest are most common in the morning, with winds from the northeast dominant in the afternoon.

Background air quality

The nearest air quality monitoring station in relation to the proposal which monitors the pollutants of interest associated with the construction and operational phases of the proposal is located at Rouse Hill (around 2.5 kilometres to the southeast).

Data from Rouse Hill air quality monitoring station indicates that ambient concentrations generally range from very good to good and below the impact assessment criteria from the Approved Methods, with the exception of 24 hour averaged PM₁₀ and PM_{2.5} concentrations. This is typical with other observations from the OEH ambient air quality monitoring network throughout Sydney, and underlines the importance of managing the generation of dust including fine particulate matter during the proposal.

6.11.3 Potential impact

Construction

To evaluate the potential for air quality impact during construction a risk-based qualitative assessment method was applied. The likelihood (probability) and consequence (severity) of activities with the potential

to result in air quality impact were evaluated to develop initial risk ratings. This was completed using metrics developed based on guidance from AS/NZS ISO 31000: 2009 Risk Management – Principles and Guidelines.

Construction activities have the potential to increase airborne particulate matter and cause nuisance impact where construction is in proximity to sensitive receivers such as residential dwellings and community areas. The potential impact could include:

- Temporary increased windborne dust emanating from disturbed/exposed surfaces from clearing and grubbing
- Dust generation due to the disturbance, movement, storage, loading, transfer and transportation of soil for embankments and fill areas
- Temporary increase in air emissions from dust and products of combustion (from equipment operations).

Construction activities would be temporary in nature but still have the potential to impact on nearby receivers. Environmental management measures have been recommended including appropriate work practices and scheduling, equipment selection, monitoring and preventative controls and as such, the risk of potential air quality impact from construction has been identified as low to moderate.

Operation

The potential impact to air quality during the operational phase of the proposal is generally associated with motor vehicle emissions arising from changes in the volumes of motor vehicles, model of travel, such as free flow of congested and proximity to sensitive receptors. Key pollutants associated with exhaust fumes include carbon monoxide (CO) and nitrogen dioxide (NO₂).

The operational air quality impact was predicted for the proposal, year of opening 2026.

Predictions for were made relevant to the proposal where traffic conditions would change from the existing conditions. Pollutant concentrations were evaluated at the distances up to 200 metres.

The results from the TRAQ modelling show that incremental contributions at the nearest sensitive receiver location were predicted to be negligible and are not expected to result in any additional local exceedances. A summary of the predicted operational air quality impact from the TRAQ model are presented in Appendix N.

6.11.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Air quality	<p>An Air Quality Management Plan (AQMP) will be prepared and implemented as part of the CEMP. The AQMP will include, but not be limited to:</p> <ul style="list-style-type: none"> • Potential sources of air pollution • Air quality management objectives consistent with any relevant published EPA and/or OEH guidelines • Mitigation and suppression measures to be implemented 	Contractor	Detailed design	Standard safeguard AQ1 Section 4.4 of QA G36 <i>Environment Protection</i>

Impact	Environmental safeguards	Responsibility	Timing	Reference
	<ul style="list-style-type: none"> • Compliance with Stockpile Site Management Guidelines (Roads and Maritime, 2015) • Methods to manage work during strong winds or other adverse weather conditions • A progressive rehabilitation strategy for exposed surfaces 			

6.12 Contamination

A Phase 1 Contamination Assessment (Phase 1) was undertaken to assess the potential impacts of the proposal to contaminated land. The findings of the Phase 1 assessment are discussed in the following section. The full Phase 1 assessment is provided in Appendix O of this REF.

6.12.1 Methodology

The methodology for the Phase 1 assessment involved:

- A walkover of the study area by an experienced environmental engineer/ scientist to identify potentially contaminating activities and adjoining sensitive receptors
- A desktop review of relevant information, including:
 - Review of published information relating to the study area including geological, acid sulphate soil (ASS), hydrogeological, hydrological, soil types, topographical, and/or land use maps, state and local environmental planning maps, heritage mapping, and ecological constraints mapping
 - Review of previous environmental reports
 - Review of historical aerial photographs and mapping
 - Review of historical business activities at the study area
 - Review of NSW EPA contaminated land and Protection of the Environment Operations (POEO) licence online databases
 - Search of nearby registered groundwater bores.

The report was prepared with reference to relevant sections of the NSW EPA (1997) Guidelines for Consultants Reporting on Contaminated Sites and National Environmental (Assessment of Site Contamination) Protection Measures (NEPM, 2013).

6.12.2 Existing environment

Surrounding land use

The study area is presently surrounded by:

- Residential, commercial and industrial buildings to the southwest of First Ponds Creek, this includes associated infrastructure, schools, hospitals, veterinary practices, swimming pools and public open space
- To the northeast of First Ponds Creek the surrounding land use is probable rural/grazing land, with some associated farm buildings, some areas of commercial/ industrial use are also present
- The area surrounding the intersection between Garfield Road East, Terry Road and Windsor Road at the eastern end of the study area is predominantly farm land with some industrial and residential dwellings.

Regional geology and lithology

Regional geology and lithology relative to the study area is described in Section 6.10 of this REF

Acid sulphate soils

ASS include those where the sulfides in the soils have been exposed to air and acid is being generated (actual ASS) and those which may form actual ASS when drained or exposed to oxidation processes i.e.

the exposure of iron sulphate minerals such as pyrite to oxygen. ASS occurs predominantly on coastal lowlands, with elevations generally below five metres.

The study area is not mapped as having a risk of ASS occurrence. An extremely low probability is mapped northeast of the intersection between Garfield Road East and Hamilton Street and McCulloch Street.

Hydrology and hydrogeology

The hydrology and hydrogeology of the proposal are described in Sections 6.3 and 6.10 of this REF.

History of the study area and surrounds

Based on a review of aerial photography; ongoing development has occurred within the study area, particularly to the southwest of First Ponds Creek, since pre-1955. The study area as a whole has also seen development throughout history, numerous areas of unknown agricultural practices, areas with a history of commercial/ industrial use including service stations, tyre mechanics, lawnmower sales and service, farm infrastructure, a school, a hospital, vehicle repair shops and general industry. There is also the potential for fill of unknown composition to be present throughout the study area due to redevelopment over time.

The type of development that has occurred outside of the study area is similar to that within, with mostly residential or farm related buildings being present. There are, however, a number of possible commercial and/or industrial properties surrounding the study area with full histories unknown include:

- Automotive businesses, motor wreckers, brake and clutch specialists, service specialists, tyre dealers and vulcanisers
- Panel beaters and spray painters
- Scrap metal merchants and steel fabricators
- Engineering works
- Firework manufacturers and/ or wholesalers
- Farm equipment and agricultural machinery suppliers
- The stockpiling of unknown materials, and possible storage of hazardous materials and substances.

NSW EPA public records

A search of the NSW EPA Contaminated Land records on 24 February 2020 showed there were three notified sites or management notices within the vicinity of the study area.

The notified sites are identified below:

- 7-Eleven Riverstone, 55 Garfield Road East, Riverstone - is shown to be located within the study area at the western most end of Garfield Road East. The service station is currently on the EPA list; however, regulation under Contaminated Land Management Act 1997 (CLM Act) is not required
- Vacant commercial land, 88-94 Junction Road, Riverstone - is located approximately 348 metres north of the study area. The site is listed as unclassified and is currently on the EPA list; however, regulation under the CLM Act is not required
- Former waste management facility, 25 Terry Road, Box Hill - is located approximately 542 metres northeast of the study area. The site is listed as a landfill on the EPA list; however, regulation under the CLM Act is not required.

POEO database

A search of the NSW EPA POEO EPL registers was carried out on 24 February 2020. Table 6.50 identifies the licences for sites within one kilometre of the study area.

Table 6.50: POEO EPLs within one kilometres of the study are

Licence no.	Name	Location	Type	Status	Activity
1100	A J Bush & Sons (Manufacturers) Pty Ltd	Windsor Road, Riverstone (within the study area)	POEO licence	Issued	Rendering or fat extraction.
12208	Sydney Trains	203m southwest.	POEO licence	Issued	Railway systems activities
4653	Luhrmann Environment Management Pty Ltd	Waterways throughout NSW (within the study area)	POEO licence	Surrendered	Other activities/ non-scheduled activity – application of herbicides
4838	Robert Orchard	Various waterways throughout NSW (within the study area)	POEO licence	Surrendered	Other activities/ non-scheduled activity – application of herbicides
6630	Sydney Weed & Pest Management Pty Ltd	Waterways throughout NSW (within the study area)	POEO licence	Surrendered	Other activities/ non-scheduled activity – application of herbicides
1664	Blacktown City Council	Garfield Road East, Riverstone (within the study area)	POEO licence	Surrendered	Miscellaneous licenced discharge to waters
3054	Howard & Sons Pyrotechnics (manufacturing) Pty Ltd	Windsor Road, Box Hill (163m northeast)	POEO licence	Surrendered	Explosives production
5625	Roadmaster Haulage Pty Ltd	81 Riverstone Parade, Riverstone (241m southwest)	POEO licence	Surrendered	Crushing, grinding or separating

Areas of environmental concern

Based on the history and observations of the study area, six Areas of Environmental Concern (AECs) and potential contamination sources were identified throughout the construction footprint including:

- AEC 1 - Area near current service stations from storage and use of fuels, oils and lubricants, including underground storage tanks (UST's) and associated pipework, and mechanical repairs. Also includes lawnmower sales/service and tyre repair workshop.
- AEC 2 - Areas near former building structures/ sheds from weathering and / or ineffective demolition of hazardous building materials.
- AEC 3 - Fill materials of unknown composition
- AEC 4 - Areas of former possible crop/ agricultural use (including immediately outside of the study areas)
- AEC5 - Commercial/ industrial land use areas from unknown activities including material/ chemical storage, accidental spillage, disposal of residues etc.
- AEC 6 - An area which is part of meat by-product processing, from potential wastewater discharges to land.

The ACEs are described in Table 6.51.

Table 6.51: ACEs relevant to the study area

No.	AEC	Likelihood of contamination	Media potentially affected
AEC1	Area near current service stations 7-Eleven and Riverstone Petroleum from storage and use of fuels, oils and lubricants, including UST's and associated pipework and mechanical repairs. Also includes lawnmower sales/service and tyre repair workshop.	High	Soil Groundwater Vapour
AEC2	Areas near former building structures/sheds from weathering and/or ineffective demolition of hazardous building materials and possible application of pesticides.	Moderate to High	Soil
AEC3	Areas of potential fill of unknown origin and quality.	Low	Soil
AEC4	Areas of former possible crop/agricultural use, including outside the study area and within study area dams.	Low	(potentially groundwater)
AEC5	Commercial/industrial land use areas from unknown activities including material/chemical storage, accidental spillage, disposal of residues etc.	Moderate	Soil
AEC6	An area which is part of meat by-product processing, from potential wastewater discharges to land.	Moderate	Soil

6.12.3 Potential impacts

A conceptual site model was developed which indicates potential contaminants of concern associated with these AECs could impact on environmental media such as soil and a range of receptors within and surrounding the study area could be impacted by contamination if it were present, including human receptors and ecological receptors. Some data gaps were noted relating to limitations on the searches performed for a study area of this size and access constraints for during the initial walkover.

6.12.4 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Contaminated land	<p>A Contaminated Land Management Plan will be prepared in accordance with the <i>Guideline for the Management of Contamination</i> (Transport for NSW, 2013) and implemented as part of the CEMP. The plan will include, but not be limited to:</p> <ul style="list-style-type: none"> • Capture and management of any surface runoff contaminated by exposure to the contaminated land • Further investigations required to determine the extent, concentration and type of contamination, as identified in the detailed site investigation (Stage 2) • Management of the remediation and subsequent validation of the contaminated land, including any certification required • Measures to ensure the safety of site personnel and local communities during construction. 	Contractor	Detailed design / Pre-construction	Standard safeguard CL1 Section 4.2 of QA G36 <i>Environment Protection</i>
Contaminated land	If contaminated areas are encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. All other works that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed and any necessary site-specific controls or further actions identified in consultation with the Transport for NSW Environment Manager and/or EPA.	Contractor	Construction	Standard safeguard CL2 Section 4.2 of QA G36 <i>Environment Protection</i>

Impact	Environmental safeguards	Responsibility	Timing	Reference
Accidental spill	A site specific emergency spill plan will be developed, and include spill management measures in accordance with the Transport for NSW <i>Code of Practice for Water Management</i> (RTA, 1999) and relevant EPA guidelines. The plan will address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including Transport for NSW and EPA officers).	Contractor	Construction	Standard safeguard CL3 Section 4.3 of QA G36 <i>Environment Protection</i>
Contamination	A Detailed Site Investigation should be conducted within identified AECs. The assessment should comprise additional study area observations once access is available, selected additional history searches of the study area, sampling and analysis of relevant media to further assess the study area with respect to contamination.	TfNSW	Detailed design/pre-construction	Additional safeguard CL4
Unexpected finds	Whilst further assessment is recommended to reduce the likelihood of unexpected finds during construction, some AECs may be able to be managed through an unexpected finds procedure prepared as part of the CEMP.	Contractor	Pre-construction	Additional safeguard CL5
Hazardous materials	Hazardous materials assessments should be conducted on all structures proposed for demolition as part of the proposal. These assessments will help define the nature and extent of hazardous materials, including asbestos, lead paints, synthetic mineral fibre, Polychlorinated Biphenyls (PCBs) etc., within the structures and define appropriate management measures prior to demolition.	TfNSW	Detailed design/pre-construction	Additional safeguard CL6

Other safeguards and management measures that would address contamination impacts are identified in section 6.10.4 and section 6.13.3.

6.13 Waste and resource management

6.13.1 Policy setting

The Protection of the Environment Operations Act 1997 (POEO Act) covers the requirements for waste generators in terms of storage and correct disposal of waste and their responsibility for the correct management of waste and these have been considered in the assessment of waste generated by the proposal, including the development of environmental management measures.

The Waste Avoidance and Resource Recovery Act 2001 (WARR Act) promotes waste avoidance and resource recovery by developing waste avoidance and resource recovery strategies and programs. TfNSW endeavours to manage waste in order to conserve resources and reduce the impact associated with waste disposal. The waste management hierarchy is a guide for prioritising waste management practices to achieve these outcomes. This hierarchy was established under the WARR Act. It sets out the preferred order of waste management practices from the most preferred to least preferred as follows:

- Waste Avoidance - Take action to avoid the generation of waste and to be more efficient in its use of resources. If unable to avoid generating waste, then reduce the amount of waste generated and reduce the toxicity or potential harm associated with its generation and management
- Resource Recovery - Maximise the reuse, reprocessing, recycling and recovery of energy from materials
- Disposal - Disposal is the least desirable option and must be carefully handled to minimise negative environmental outcomes.

In addition to managing waste in accordance with the relevant legislation, TfNSW manages waste according to the NSW Waste Avoidance and Resources Recovery Strategy 2014-21 (EPA, 2015) and the NSW Waste Classification Guidelines (EPA, 2014).

6.13.2 Potential impacts

Construction

Waste generated during construction would primarily be from work associated with site preparation, relocation of utilities, and construction of road infrastructure and landscaping. Major waste-generating activities would include vegetation clearance, generating green waste such as logs and mulched material, construction of temporary construction ancillary facilities and demolition of dwellings and structures on land being wholly or partially acquired.

Additionally, construction including earthworks, placement of pavement layers, drainage, concrete pour, utilities placement and protection, installation of road furniture also has the potential to generate waste streams.

Waste streams are likely to include the following:

- Surplus spoil (excavated soil, sediment, rock) from bulk earthworks or left-over imported fill which is unable to be reused within backfilling or restoration
- Concrete, pavement, steel, and other materials from demolition of kerbs, fencing, pavements
- Packaging materials from items delivered to site, such as pallets, crates, cartons, plastics, and wrapping materials
- Vegetative waste from clearing and grubbing Plant and vehicle maintenance waste, such as oil containers and paint and chemical residue from bridge preparation

- General office waste generated by onsite personnel, such as paper, cardboard, beverage containers, and food wastes
- Sewage waste generated through the use of personnel facilities.

The inappropriate handling or disposal of waste could result in a potential impact to the local environment, including soils, waterways and fauna. Given that all waste would be managed in accordance with TfNSW guidelines and disposed of by a licensed contractor to an appropriately licensed facility, the potential for a significant impact related to waste management is considered unlikely.

Fill would be required for the proposal, such as for construction of embankments. Imported fill would either be virgin excavated natural material (VENM) or would comply with the conditions for reuse attached to a relevant resource recovery exemption.

Surplus or unsuitable material that cannot be used on-site would be classified in accordance with the Waste Classification Guidelines (NSW EPA, 2014) and disposed of at an approved materials recycling or waste disposal facility.

The road pavement materials would be sourced from appropriately licensed facilities such as quarries. The demand for resources would be separated into the various stages of construction work.

The amount of water that would be required during construction is unknown at this stage. The amount would depend on material sources and methodologies applied by the contractor. It is proposed that water would be obtained from the local water supply network.

Operation

Waste generated by the operation of the proposal would be limited. The main waste streams would include any oils, liquids and chemicals used for maintenance of plant and equipment used in road maintenance activities and general litter along the road corridor.

Operational waste, including general litter clean up, would be managed in accordance with existing operational maintenance requirements for the proposal and the impact is expected to be minimal.

6.13.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Waste	<p>A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to:</p> <ul style="list-style-type: none"> • Measures to avoid and minimise • Waste associated with the proposal • Classification of wastes and management options (re-use, recycle, stockpile, disposal) • Statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • Procedures for storage, transport and disposal 	Contractor	Pre-construction	Standard safeguard WR1 Section 4.2 of QA G36 <i>Environment Protection</i>

Impact	Environmental safeguards	Responsibility	Timing	Reference
	<ul style="list-style-type: none"> Monitoring, record keeping and reporting. <p>The WMP will be prepared taking into account the Environmental Procedure - Management of Wastes on Roads and Maritime Services Land (Roads and Maritime, 2014) and relevant TfNSW Waste Fact Sheets.</p>			
Waste	Waste material, other than vegetation and tree mulch, is not to be left on site once the work has been completed	Contractor	Construction	Standard safeguard WR2 Section 4.2 of QA G36 <i>Environment Protection</i>

Other safeguards and management measures that would address waste and resource management impacts are identified in section 6.10.4 and section 6.12.4.

6.14 Greenhouse gas and climate change

6.14.1 Existing environment

Greenhouse gases include carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, hydrofluorocarbons and perfluorocarbons. These gases absorb heat that is reflected from the earth, which results in warming of the air. This effect is known as the greenhouse effect. The primary human produced greenhouse gas is carbon dioxide.

Human activities such as the combustion of carbon-based fuels increase the amount of greenhouse gases in the atmosphere. This leads to an increase in atmospheric temperatures and is known as the enhanced greenhouse effect.

Climate change projections detailed in this assessment have utilised publicly available information. Table 6.52 provides information on climate change forecasts for the Sydney Metropolitan and Sydney/Central Coast regions of NSW. The table provides details of the climatic change projections for the area surrounding the proposal to the year 2070, adapted from the NSW Climate Impact Profile (DECCW 2010) and the Metropolitan Sydney Climate Change Snapshot (OEH 2014).

Table 6.52: Projected climatic change predictions for the Sydney/Central Coast region, NSW

Season	Seasonal rainfall (% increase)	Temperature		Evaporation (% increase)
		Minimum (°C)	Maximum (°C)	
Spring	10-20	2.0-3.0	2.0-3.0	10-20
Summer	20-50	1.5-3.0	1.5-2.0	10-20
Autumn	No significant change	1.5-3.0	1.5-3.0	No clear pattern
Winter	10-20	1.5-3.0	2.0-3.0	No clear pattern

Source: Adapted from the results for 'far future' (2060-2075) climate change in the Metropolitan Sydney Climate Change Snapshot (OEH 2014) and the NSW Climate Impact Profile (DECCW 2010)

Expected regional climatic changes for the Sydney/ Central Coast region of NSW as defined in DECCW (2010) are as follows:

- Increase in average daily minimum and maximum temperatures.
- Shifts in current patterns of climate variability, including increased rainfall in summer and decreased rainfall in winter.
- Increased intensity of extreme events such as droughts, floods, severe storm events.
- Changes in seasonality and amount of precipitation (the direction and magnitude of changes will vary between geographic locations).

By 2070, the Sydney Metropolitan region of NSW is expected to experience a hotter climate, with temperatures projected to increase by between 1.25°C to 3°C throughout the year. Rainfall is projected to increase in spring, summer and autumn, and a decrease in winter. Evaporation in spring and summer will increase, with no clear change in evaporation patterns in autumn and winter.

6.14.2 Potential impacts

Construction

Greenhouse gas emissions

Construction of the proposal is anticipated to be completed within about 30 months. During this time, greenhouse gas emissions would be produced, including:

- Carbon dioxide, methane and nitrous oxide generated from liquid fuel use in plant and vehicles such as diesel and petrol
- Embedded emissions associated with the manufacture and delivery of construction materials
- Methane generated from land filling any carbon based waste.

The volume of greenhouse gas emissions that would be generated during the construction of the proposal would be dependent on the quantity of construction materials used and the types of plant and equipment used during building the proposal.

Given the nature of the proposal, it would not be possible to completely avoid the generation of greenhouse gas emissions during construction (due to the need to consume energy and resources). The volume of greenhouse emissions produced as a result of the proposal would be minimised through the application of standard mitigation measures, as outlined in Section 6.14.3. Overall, construction related greenhouse gas emissions associated with the proposal would be relatively minor and comparable with similar road upgrade projects.

Climate change risks

Climate change risks during the construction of the proposal would primarily be associated with the occurrence of severe weather events; for example, the increased frequency and severity of rainfall events placing increased pressure on erosion and sediment control measures and/or flooding of the work site.

During construction, climate change risks are generally considered to be minor and would be readily manageable through the application of standard mitigation measures that have been adequately designed to respond to the potential occurrence of the increased frequency and severity of rainfall events.

Operation

Greenhouse gas emissions

Greenhouse gas emissions during the operation of the proposal would primarily be associated the operation of private motor vehicles on the road network and during road maintenance activities. The volume of greenhouse gas emissions generated during operation of the proposal would depend on the frequency and intensity of maintenance activities and the volume of vehicles using the road network.

Emissions are anticipated to be comparable with those emissions already occurring within the area and would not be expected to significantly change because of the proposal. Traffic volumes and/or maintenance frequencies would not be anticipated to change as a direct result of the proposal.

Climate change risks

Climate change risks during the operation of the proposal would primarily be associated with:

- Increases in average temperatures and heatwaves which may affect the integrity of pavement and other construction materials. Direct impacts could include more rapid deterioration of infrastructure, which may result in higher operational and maintenance costs. Indirectly, evaporative changes can result in changes to soil moisture content and soil instability, which may impact foundations of structures, cause cracking and/or softening of pavements and road rutting

- The increased frequency and severity of rainfall events placing increased pressure on drainage infrastructure and/or resulting in flooding of the study area.

The proposal it is not likely to be any more susceptible to climate change risks than that of the existing road network. The minor contribution to greenhouse gas emissions are not considered to be significant. Further consideration of the climate change impact would be carried out during detailed design.

6.14.3 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Construction greenhouse	Plant and equipment would be switched off when not in use. Vehicles, plant and construction equipment would be appropriately sized for the task and properly maintained so as to achieve optimum fuel efficiency. Materials would be delivered with full loads and would come from local suppliers, where possible. The energy efficiency and related carbon emissions would be considered in the selection of vehicle and plant equipment.	Contractor	Construction	Additional Safeguard GGCC1

6.15 Other impacts

6.15.1 Existing environment and potential impacts

Environmental factor	Existing environment	Potential impacts
Hazard and risk	Hazardous materials and dangerous goods storage or handling of such materials does not currently occur within the study area. Fuel and oil spills may occur as a result from vehicle passing through the study area.	<p>Small quantities and inventories of hazardous materials and dangerous goods would be required during construction. As a result, the transportation, use and storage of these materials would occur. A potential impact to soil and water quality and workforce safety may result from spills or inappropriate and inadequate handling and storage of material.</p> <p>The potential impact is not considered to be significant given the implantation of relevant legislation to manage such risks. Relevant legislation includes the National Codes of Practice and Australian Standards for the storage and handling of dangerous goods and materials. Such guidelines in conjunction with the recommended safeguards described in section 6.15.2 would potentially reduce the occurrence of an incident on the site.</p>

6.15.2 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Hazards and risk management	<p>A Hazard and Risk Management Plan (HRMP) will be prepared and implemented as part of the CEMP. The HRMP will include, but not be limited to:</p> <ul style="list-style-type: none"> • Details of hazards and risks associated with the activity • Measures to be implemented during construction to minimise these risks • Record keeping arrangements, including information on the materials present on the site, material safety data sheets, and personnel trained and authorised to use such materials • A monitoring program to assess performance in managing the identified risks • Contingency measures to be implemented in the event of unexpected hazards or risks arising, including emergency situations. <p>The HRMP will be prepared in accordance with relevant guidelines and standards, including relevant Safe Work Australia Codes of Practice, and EPA or Office of Environment and Heritage publications.</p>	Contactors	Detailed design / Pre-construction	Additional safeguard HRM1

6.16 Cumulative impacts

The interaction of individual elements of the proposal and the additive effects of the proposal with other concurrent and future projects have the potential to give rise to cumulative impact. This impact is addressed in this section.

6.16.1 Study area

The proposal is located within the NWGA and most of the surrounding land is under Biodiversity Certification. Land adjacent to the eastern half of Garfield Road East in the Riverstone and Riverstone East Planning Stage 2 precinct is planned to accommodate housing subdivisions, some of which are currently under construction.

The NSW Government has proposed a road network to support the forecast growth in the NWGA. The area surrounding Riverstone is an integral part of the NWGA and the expected increase in population and development will mean significantly more traffic in the area.

6.16.2 Broader program of work

In 2014, the NSW Government published the road network strategy to support the forecast growth in the NWGA. Over the next ten years, 33,000 homes will be provided in the area and once fully developed, the area will be home to around 250,000 people. The proposal and Garfield Road West are two of a number of proposals in planning as part of the North West Growth Centre Road Network Strategy.

The DPIE has granted SIC funding for TfNSW to undertake the planning of the proposal and Garfield Road West. This will support planning for the release of the Marsden Park North, West Schofields and Riverstone East Precincts. The overall Garfield Road corridor is 7.2 kilometres and has been split into three sections: Garfield Road East (the proposal), Garfield Road Central and Garfield Road West. TfNSW is planning for the future upgrade of Garfield Road East and Garfield Road West corridors to facilitate development of land surrounding the corridor

The Garfield Road program of work is shown in Figure 6-40 and includes:

- Garfield Road West corridor extending 3.2 kilometres between Richmond Road, Marsden Park and Denmark Road, Riverstone, including:
 - Providing a new bridge over Eastern Creek
 - Traffic light-controlled intersections at Denmark Road, Carnarvon Road/Cemetery Road and Roberts Street

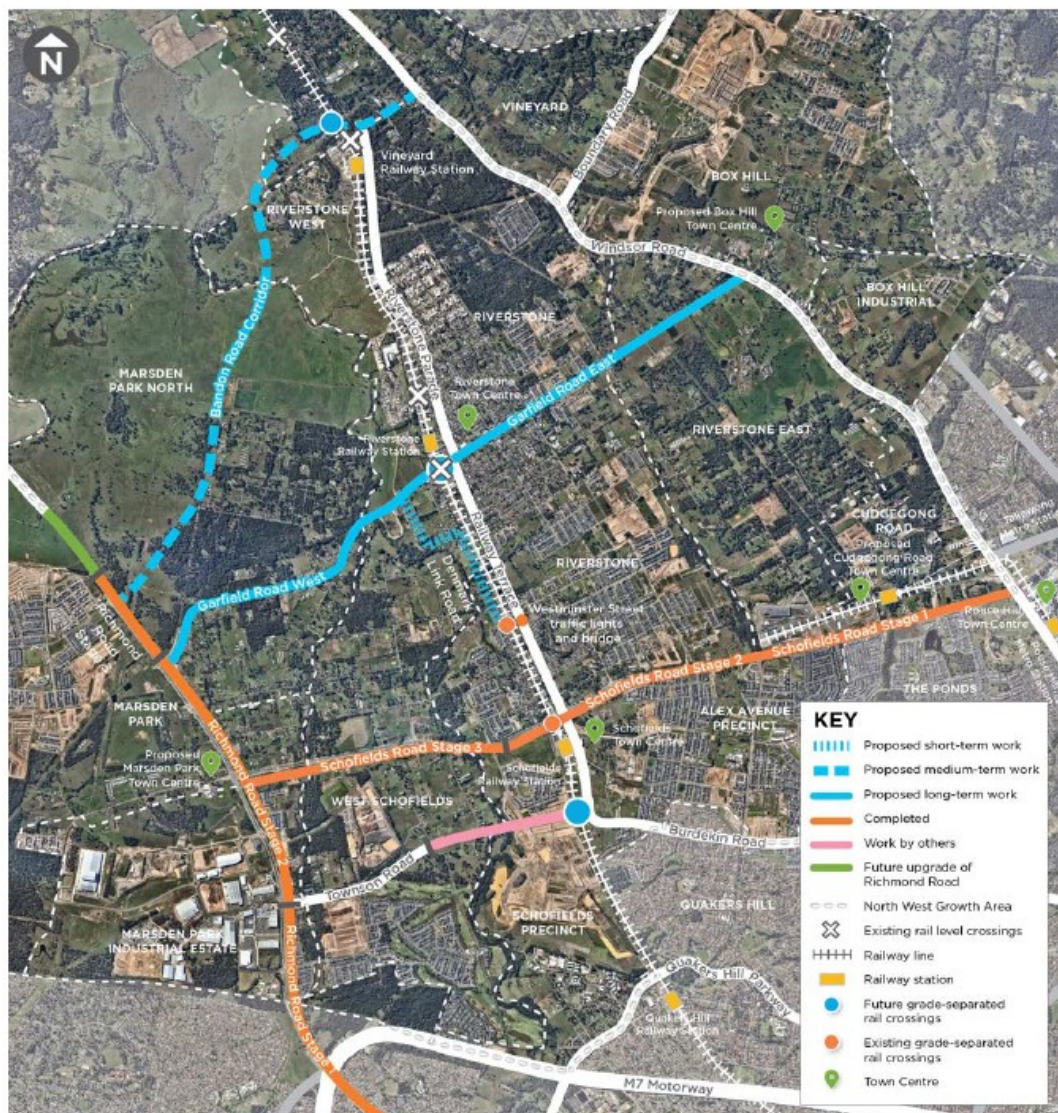


Figure 6-40: North West Growth Centre Road Network Strategy (source: Roads and Maritime, 2019)

6.16.3 Other projects and developments

Projects and developments occurring in the vicinity of the proposal are described in Table 6.53.

Table 6.53: Past, present and future projects

Project	Construction impacts	Operational impacts
<p>Vineyard – Rouse Hill Transmission Line:</p> <p>The Vineyard to Rouse Hill electricity upgrade would involve the reconstruction of an 8.5 kilometres section of an existing, overhead 132 kilovolt transmission line. The upgrades extend between Vineyard bulk power supply point and the site of Integral Energy's future Rouse Hill switching station.</p>	<p>Noise and vibration</p> <p>Construction traffic</p> <p>Clearing of vegetation</p> <p>Temporary closures of public roads</p>	<p>Visual impacts of overhead wire structures</p> <p>Potential impacts of property values</p> <p>Existing and future land use planning</p>

Project	Construction impacts	Operational impacts
<p>Sikh Grammar School Rouse Hill: The proposed Sikh Grammar School, Rouse Hill will provide for students from years K to 12 in an integrated education campus of 1,260 students along with an 86-child Early Learning Centre and student boarding for 112 students. At the time of the preparation of this REF, submissions to the EIS were being collated for review and response.</p>	<p>Construction noise and vibration Air quality and dust generation from construction activities Removal of vegetation Potential impacts to surface water quality including erosion and sedimentation Disturbance of hazardous materials in existing structures to be demolished</p>	<p>Development within a bushfire Assets Protection Zone Changes to existing traffic conditions, particularly during peak pick up and drop off periods</p>
<p>Schofields Public School Redevelopment: The upgraded facilities will accommodate up to 600 students. The upgrades would also involve:</p> <ul style="list-style-type: none"> • 27 new flexible learning spaces. • A new staff/administration area. • A new library. • Upgraded amenities. • A new covered outdoor learning area <p>Construction of the project commenced in May 2018 and is ongoing</p>	<p>Construction noise and vibration Impacts to existing school operational hours and access due to construction activities Pop-up school established during construction Dust generation and air quality impacts from earth works</p>	<p>Development within a bushfire Assets Protection Zone Changes to existing traffic conditions, particularly during peak pick up and drop off periods Increased amenity and positive impact on visual amenity of the area</p>
<p>North West Growth Area Implementation Plan – Riverstone and Riverstone East: The new community in Riverstone East, Stages 1 and 2, will benefit from up to 3,500 new homes and the delivery of local amenities close to transport options, including:</p> <ul style="list-style-type: none"> • A proposed primary school on Riverstone Road • A new community facility adjacent to the village centre on Guntawong Road • Higher residential densities in proximity to the Tallawong Station on the Sydney Metro North West • Access to essential infrastructure including water, sewer and electricity which is being progressively delivered. 	<p>Rezoning of land to accommodate the objectives of the plan Partial and full property acquisitions Development of transport links to service the Sydney Metro North West Line Upgrades to major roads, including Schofields Road Traffic and transport changes due to road works and other upgrades to existing transport infrastructure including rail and bus services Reduced amenity for local residents and the traveling public due to construction activities Construction-generation noise and vibration Clearing of vegetation</p>	<p>Rezoning of land to accommodate the objectives of the plan Upgrades to major roads, including Schofields Road Increased access to transport services Increased socio-economic connectivity Provision of improved pedestrian and cycle facilities throughout the precinct Provision of new homes, primary school and community facilities</p>

6.16.4 Potential impacts

Environmental factor	Construction	Operation
Noise	Construction of the proposal and Garfield Road West would likely occur with some overlap. Over the three years for construction, about [awaiting noise assessment] residences may regularly experience noise levels exceeding the relevant noise criteria.	There may be an operational increase in noise within the study area and surrounds due to the proposal, and in consideration of the broader program of works to upgrade Garfield Road West These noise impacts would be largely associated with increased traffic flows along Garfield Road. Noise mitigation measures would be implemented to manage these impacts. In terms of the cumulative impacts of operational noise with the proposals described above, it is unlikely the proposal would negatively enhance the operational noise impacts of the proposals operational noise
Socio economic	The projects occurring in the western Sydney region relevant to the proposal are likely centred around infrastructure; social, community and transport. During construction, the proposal and other projects would likely involve changes to access to schools as well as the amenity for students and teachers at the schools during construction.	The net outcome of the proposal and other projects in the area would result in increased social connectivity, improved safety for road users and residents and the provision of more social infrastructure. The proposal as well as the other projects considered in these cumulative impacts would improve connectivity and support the ongoing socio-economic development of the Riverstone precinct and the wider western Sydney region.
Traffic and transport	As the proposal is concerned with upgrades to the existing Garfield Road East, it is anticipated there will be road closures. Alternative routes would need to be developed and utilised during these times.	The proposed road upgrades would improve road safety and provide shared path facilities for pedestrians and cyclists along Garfield Road which are currently void of these pieces of road infrastructure. There would be benefits such as improved travel time across the surrounding road network.

6.16.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing	Reference
Cumulative construction impacts	The Consultation Plan will include consultation with proponents of the Garfield Road West, and North West Growth Area Implementation Plan - Riverstone and Riverstone East, Sikh Grammar School Rouse Hill and	Contractor	Pre-construction	Standard safeguard C11

Impact	Environmental safeguards	Responsibility	Timing	Reference
	<p>Schofield's Public School Redevelopment projects to:</p> <ul style="list-style-type: none"> • Increase awareness of construction timeframes and impacts • Coordinate impact mitigation and management such as respite periods. 			

7. Environmental management

This chapter describes how the proposal will be managed to reduce potential environmental impacts throughout detailed design, construction and operation. A framework for managing the potential impacts is provided. A summary of site-specific environmental safeguards is provided and the licence and/or approval requirements required prior to construction are also listed.

7.1 Environmental management plans (or system)

A number of safeguards and management measures have been identified in the REF in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the proposal. Should the proposal proceed, these safeguards and management measures would be incorporated into the detailed design and applied during the construction and operation of the proposal.

A CEMP would be prepared to describe the safeguards and management measures identified. The CEMP would provide a framework for establishing how these measures would be implemented and who would be responsible for their implementation.

The CEMP would be prepared prior to construction of the proposal and must be reviewed and certified by the TfNSW Environment Officer, Sydney Region prior to the commencement of any on-site work. The CEMP will be a working document, subject to ongoing change and updated as necessary to respond to specific requirements.

A CEMP would be developed in accordance with the specifications set out in the: *QA Specification G36 - Environmental Protection (Management System)*, *QA Specification G38 - Soil and Water Management (Soil and Water Plan)*, *QA Specification G40 - Clearing and Grubbing*, *QA Specification G10 - Traffic Management*.

7.2 Summary of safeguards and management measures

Environmental safeguards and management measures outlined in this REF will be incorporated into the detailed design phase of the proposal and during construction and operation of the proposal, should it proceed. These safeguards and management measures will minimise any potential adverse impacts arising from the proposed works on the surrounding environment. The safeguards and management measures are summarised in Table 7.1.

Table 7.1: Summary of safeguards and management measures

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
GEN1	General - minimise environmental impacts during construction	<p>A CEMP will be prepared and submitted for review and endorsement of the Transport for NSW Environment Manager prior to commencement of the activity.</p> <p>As a minimum, the CEMP will address the following:</p> <ul style="list-style-type: none"> Any requirements associated with statutory approvals Details of how the project will implement the identified safeguards outlined in the REF Issue-specific environmental management plans Roles and responsibilities Communication requirements Induction and training requirements Procedures for monitoring and evaluating environmental performance, and for corrective action Reporting requirements and record-keeping Procedures for emergency and incident management Procedures for audit and review. <p>The endorsed CEMP will be implemented during the undertaking of the activity.</p>	Contractor / TfNSW	Detailed design / Pre-construction	Standard safeguard GEN1
GEN2	General - notification	All businesses, residential properties and other key stakeholders (eg schools, local councils) affected by the activity will be notified at least five days prior to commencement of the activity.	Contractor / TfNSW	Pre-construction	Standard safeguard GEN2

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
GEN3	General – environmental awareness	<p>All personnel working on site will receive training to ensure awareness of environment protection requirements to be implemented during the project. This will include up-front site induction and regular "toolbox" style briefings.</p> <p>Site-specific training will be provided to personnel engaged in activities or areas of higher risk. These include:</p> <ul style="list-style-type: none"> • Areas of Aboriginal heritage sensitivity • Threatened species habitat • Adjoining residential areas requiring particular noise management measures 	Contractor / TfNSW	Detailed design / Pre-construction	Standard safeguard GEN3
TT1	Traffic and transport	<p>A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Transport for NSW <i>Traffic Control at Work Sites Manual</i> (RTA, 2010) and <i>QA Specification G10 Control of Traffic</i> (Transport for NSW, 2008). The TMP will include:</p> <ul style="list-style-type: none"> • Confirmation of haulage routes • Measures to maintain access to local roads and properties • Site specific traffic control measures (including signage) to manage and regulate traffic movement • Measures to maintain pedestrian and cyclist access • Requirements and methods to consult and inform the local community of impacts on the local road network • Access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads. • A response plan for any construction traffic incident • Consideration of other developments that may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic • Monitoring, review and amendment mechanisms. 	Contractor	Detailed design / Pre-construction	Standard safeguard TT1 Section 4.8 of QA G36 <i>Environment Protection</i>

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
NV1	Noise and vibration	<p>A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the Interim <i>Construction Noise Guideline</i> (ICNG) (DECC, 2009) and identify:</p> <ul style="list-style-type: none"> • All potential significant noise and vibration generating activities associated with the activity • Feasible and reasonable mitigation measures to be implemented, taking into account <i>Beyond the Pavement: urban design policy, process and principles</i> (Transport for NSW, 2014). • A monitoring program to assess performance against relevant noise and vibration criteria • Arrangements for consultation with affected property owners and sensitive receivers, including notification and complaint handling procedures <p>contingency measures to be implemented in the event of non-compliance with noise and vibration criteria.</p>	Contactor	Detailed design / Pre-construction	Standard safeguard NV1 Section 4.6 of QA G36 <i>Environment Protection</i>
NV2	Noise and vibration	<p>All sensitive receivers such as schools and local residents likely to be affected will be notified at least seven days prior to commencement of any works associated with the activity that may have an adverse noise or vibration impact. The notification will provide details of:</p> <ul style="list-style-type: none"> • The project • The construction period and construction hours • Contact information for project management staff • Complaint and incident reporting <p>how to obtain further information.</p>	Contactor	Detailed design / Pre-construction	Standard safeguard NV2
NV3	Construction noise	<ul style="list-style-type: none"> • Work will be undertaken in accordance with the <i>Construction Noise and Vibration Guideline</i> (Roads and Maritime, 2016a) • Stationary and directional noise sources will be orientated away from sensitive receivers 	Contractor	Construction	Additional Safeguard NV3

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		<ul style="list-style-type: none"> Vehicles, obstacles and stockpiles will be utilised on site to provide shielding to receivers, especially for static noise sources Equipment that has noise levels equal to or less than the sound power levels will be used The simultaneous use of high noise generating equipment will be limited. The use will also be limited to standard hours where possible Plant will be switched off when not in use <p>Plant, tools and equipment will be used such that noise is reduced to the minimum required.</p>			
NV4	Construction traffic noise	<p>The NVMP would include provisions to reduce the potential impact of construction traffic noise including:</p> <ul style="list-style-type: none"> Restricting travel routes to and from the project site to using the main roads and to avoid local roads and roads where residential receivers are potentially impacted Prohibiting the use of engine/compression brakes in or near residential areas Promoting driving behaviour that reduces potential noise impacts Prohibiting idling of plant and equipment engines near residential receivers when not in use Strategic positioning of site accesses to minimise the chance of trucks passing by residential receivers, especially at night. 	Contractor	Construction	Additional Safeguard NV4
NV5	Construction vibration	<ul style="list-style-type: none"> Lower powered equipment will be used when working in close proximity to vibration sensitive receivers where possible 	Contractor	Construction	Additional Safeguard NV5

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		<ul style="list-style-type: none"> Building condition /dilapidation surveys will be completed both before and after the work and attended vibration monitoring undertaken when work is proposed within the specified safe working distances Where work is required within the nominated safe working distance, additional vibration mitigation measures will be considered to avoid impact to buildings and/or human comfort. 			
NV6	Noise and vibration complaints	Attended noise and/or vibration monitoring will be undertaken following a complaint. Report the monitoring results as soon as possible. In the case that exceedances of the management levels are recorded, review the situation and identify means to reduce the impacts to noise and vibration sensitive receivers. This is to include revision to the CNVMP where required.	Contractor	Construction	Additional Safeguard NV6
NV7	Operational noise	<p>Mitigation measures to minimise operational noise will be investigated, including:</p> <ul style="list-style-type: none"> Quieter pavement surfaces and suitability of such pavement types for through lanes and areas of acceleration, deceleration and turning movements Noise barriers Property treatments for residually affected receivers where feasible and reasonable. 	TfNSW	Detailed design	Additional Safeguard NV7
NV8	Property treatments	Where at property treatments are identified, consider implementing these at the commencement of construction. These treatments would alleviate any noise concerns/ complaints during the construction period.	TfNSW	Construction	Additional Safeguard NV8
HF1	Hydrology and Flooding	<p>A contingency and evacuation plan will be prepared for a potential flood event while the proposal is being built. The plan will:</p> <ul style="list-style-type: none"> Evaluate what flood event would trigger the plan 	Contractor	Pre-construction/ Construction	Additional safeguard: HF1

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		<ul style="list-style-type: none"> • Include evacuation procedures • Include a map indicating the area that is flood prone and the locations of where to evacuate. 			
HF2	Hydrology and Flooding	The layout and detail of the drainage system including water quality treatments, discharge points, swale design and scour protection will be refined during detailed design in consultation with the TfNSW Environment Branch	TfNSW	Detailed design	Additional safeguard: HF2
HF3	Hydrology and Flooding	Floor level survey should be conducted to properties experiencing adverse flood level impacts to determine the risks to above flood inundation.	TfNSW	Detailed design	Additional safeguard: HF3
HF4	Hydrology and Flooding	Changes to existing surface water flows will be minimised through detailed design.	TfNSW	Detailed design	Additional safeguard: HF4
AH1	Aboriginal heritage	An Aboriginal Heritage Management Plan (AHMP) will be prepared in accordance with the <i>Procedure for Aboriginal cultural heritage consultation and investigation</i> (Transport for NSW, 2012) and <i>Standard Management Procedure - Unexpected Heritage Items</i> (Transport for NSW, 2015) and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented for managing impacts on Aboriginal heritage. The AHMP will be prepared in consultation with all relevant Aboriginal groups.	TfNSW	Detailed design / Pre-construction	Standard safeguard AH1 Section 4.9 of QA G36 <i>Environment Protection</i>
AH2	Aboriginal heritage	<ul style="list-style-type: none"> • <i>The Standard Management Procedure - Unexpected Heritage Items</i> (Transport for NSW, 2015) will be followed in the event that an unknown or potential Aboriginal object/s, including skeletal remains, is found during construction. This applies where Transport for NSW does not have approval to disturb the object/s or where a specific safeguard for managing the disturbance (apart from the Procedure) is not in place. 	Contactor	Detailed design / Pre-construction	Standard safeguard AH2 Section 4.9 of QA G36 <i>Environment Protection</i>

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		Work will only re-commence once the requirements of that Procedure have been satisfied.			
AH3	Aboriginal heritage	Additional survey on the private land identified as containing areas with moderate to high archaeological potential should be undertaken.	TfNSW	Detailed design / Pre-construction	Additional safeguard AH3
AH4	Aboriginal heritage	To ensure known sites not directly impacted from the proposal a 10 metre exclusion zone must be established around this site during construction works. This must be a hard barrier to ensure personnel or equipment does not impact on this site during project works.	Contractor	Pre-construction / Construction	Additional safeguard AH4
AH5	Aboriginal heritage	All contractors undertaking earthworks in the study area should be briefed on the protection of Aboriginal heritage objects under the NPW Act and the penalties for damage to these items and should undergo an induction on identifying Aboriginal heritage objects. Any unexpected finds should be handled in accordance with the TfNSW Standard Management Procedure for Unexpected Heritage Items (Roads and Maritime, 2015).	Contractor	Pre-construction / Construction	Additional safeguard AH5
AH6	Aboriginal heritage	If there are any changes to the proposal, then a re-analysis of Aboriginal heritage constraints should be undertaken by a qualified archaeological consultant.	TfNSW	Detailed design	Additional safeguard AH6
AH7	Aboriginal stakeholder comment	The DLALC agrees with further testing around Eastern Creek and First Ponds Creek, and recommends further investigation is undertaken before any development of Garfield Road East in the future	TfNSW	Detailed design / Pre-construction	Additional safeguard AH7
NAH1	Non-Aboriginal heritage	A Non-Aboriginal Heritage Management Plan (NAHMP) will be prepared and implemented as part of the CEMP. It will provide specific guidance on measures and controls to be implemented to avoid and mitigate impacts to Non-Aboriginal heritage. [The NAHMP will be prepared in consultation with the Office of Environment and Heritage] <i>[delete if consultation not required]</i> .	Contractor	Detailed design / Pre-construction	Standard safeguard NAH1 Section 4.10 of QA G36 <i>Environment Protection</i>

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
NAH2	Non-Aboriginal heritage	<ul style="list-style-type: none"> <i>The Standard Management Procedure - Unexpected Heritage Items</i> (Transport for NSW, 2015) will be followed in the event that any unexpected heritage items, archaeological remains or potential relics of Non-Aboriginal origin are encountered. <p>Work will only re-commence once the requirements of that Procedure have been satisfied.</p>	Contactor	Detailed design / Pre-construction	Standard safeguard NAH2 Section 4.10 of QA G36 <i>Environment Protection</i>
NAH3	Non-Aboriginal heritage	An application for an Excavation Exception under s139 of the Heritage Act will be required for groundworks at Riverstone Public School (former) corner of Garfield Road and Piccadilly Street; the weatherboard house site at 169 Garfield Road East.	TfNSW	Detailed design / Pre-construction	Additional safeguard NAH3
NAH4	Non-Aboriginal heritage	All items identified as being negatively impacted should undergo photographic archival recording, prior to the commencement of works.	Contractor	Detailed design / Pre-construction	Additional safeguard NAH4
NAH5	Non-Aboriginal heritage	A Statement of Heritage Impact (SoHI) will be required to undertake an assessment of any impacts arising from the detailed design.	TfNSW	Detailed design / Pre-construction	Additional safeguard NAH5
NAH6	Archaeological potential	Depending on the precise location and extent of the proposal, a structure at the Riverstone Public School (former) corner of Garfield Road East and Piccadilly Street; and the weatherboard house site at 169 Garfield Road East should be the subject of archaeological investigations prior to ground disturbance works commencing. Archaeological investigations may include test excavation and/or archaeological salvage excavation depending on the full extent of development impacts.	TfNSW	Detailed design / Pre-construction	Additional safeguard NAH6
SE1	Socio-economic	A Communication Plan (CP) will be prepared and implemented as part of the CEMP to help provide timely and accurate information to the community during construction. The CP will include (as a minimum):	Contactor / TfNSW	Detailed design / Pre-construction	Standard safeguard SE1

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		<ul style="list-style-type: none"> • Mechanisms to provide details and timing of proposed activities to affected residents, including changed traffic and access conditions • Contact name and number for complaints. <p>The CP will be prepared in accordance with the <i>Community Involvement and Communications Resource Manual</i> (RTA, 2008).</p>			
SE2	Property acquisition	TfNSW will continue to consult directly with affected property owners throughout the detailed design phase	TfNSW	Detailed design	Additional Safeguard SE2
SE3	Property acquisition	All property acquisition will be carried out in accordance with the Land Acquisition Information Guide (Roads and Maritime, 2014b), the Land Acquisition (Just Terms Compensation) Act 1991 and the NSW Government Land Acquisition Reform 2016	TfNSW	Detailed design	Additional Safeguard SE3
SE4	Property acquisition	TfNSW will examine the opportunities for reuse of parcels of residual land in more detail during detailed design	TfNSW	Detailed design	Additional Safeguard SE4
SE5	Ancillary sites	All ancillary sites will be restored to pre-existing conditions or to a condition agreed with the land owner	Contractor	Pre-construction	Additional Safeguard SE5
SE6	Council infrastructure	TfNSW will continue to consult with Council regarding impacts to council infrastructure	TfNSW	Pre-construction / Construction	Additional Safeguard SE6
SE7	Parking	Consultation would be carried out with Council to identify alternative parking arrangements to replace car parking lost during construction	TfNSW	Pre-construction / Construction	Additional Safeguard SE7
SE8	Parking	The construction contractor will provide suitable off-street parking to accommodate workers that does not impact on local businesses, Council parking or visitor centre and entertainment centre parking. The Construction TMP will include appropriate measures to prevent construction staff from utilising these public parking areas	Contractor	Pre-construction / Construction	Additional Safeguard SE8

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
SE9	Public transport	Temporary bus stops would be relocated to safe and accessible areas during the construction phase of the work. New locations would be communicated to the public and bus service providers	Contractor	Pre-construction / Construction	Additional Safeguard SE9
LCVI1	Landscape character and visual impact	<p>An Urban Design Plan will be prepared to support the final detailed project design and implemented as part of the CEMP.</p> <p>The Urban Design Plan will present an integrated urban design for the project, providing practical detail on the application of design principles and objectives identified in the environmental assessment. The Plan will include design treatments for:</p> <ul style="list-style-type: none"> • Location and identification of existing vegetation and proposed landscaped areas, including species to be used [cross-reference any relevant specified biodiversity safeguards] • Built elements including retaining walls, bridges and noise walls • Pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings • Fixtures such as seating, lighting, fencing and signs • Details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • Procedures for monitoring and maintaining landscaped or rehabilitated areas. <p>The Urban Design Plan will be prepared in accordance with relevant guidelines, including:</p> <ul style="list-style-type: none"> • Beyond the Pavement urban design policy, process and principles (Transport for NSW, 2014) • Landscape Guideline (RTA, 2008) • <i>Bridge Aesthetics</i> (Transport for NSW 2012) 	Contractor	Detailed design / Pre-construction	Standard safeguard LCVI1

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		<ul style="list-style-type: none"> Noise Wall Design Guidelines (RTA, 2006) Shotcrete Design Guideline (RTA, 2005).			
LCVI2	Landscape character and visual impact	Detail design and documentation drawings would define the extent of all construction activity including temporary works in order to protect the area during construction	TfNSW	Pre-construction	Additional safeguard LCVI2
LCVI3	Landscape character and visual impact	Construction facilities should be contained within the construction footprint and occupy the minimum area practicable for their intended use	Contractor	Construction	Additional safeguard LCVI3
LCVI4	Landscape character and visual impact	Provide suitable barriers to screen views from adjacent areas during construction	Contractor	Construction	Additional safeguard LCVI4
LCVI5	Landscape character and visual impact	Once construction is complete, or progressively throughout the works where possible, return these sites to at least their pre-construction state	Contractor	Construction / Post-construction	Additional safeguard LCVI5
LCVI6	Air pollution	Keep pollution and dust emissions to a minimum and monitor throughout the project construction period	Contractor	Construction	Additional safeguard LCVI6
LCVI7	Pedestrian access	Divert or re-route footpaths affected by construction activities	Contractor	Construction	Additional safeguard LCVI7
LCVI8	Tree protection	Existing trees to be retained within construction facilities areas will be identified, protected and maintained	Contractor	Construction	Additional safeguard LCVI8
LCVI19	Light spill	Temporary lighting should be screened or diverted to reduce unnecessary light spill	Contractor	Construction	Additional Safeguard LCVI9

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
LCVI10	Waste	Material used for temporary land reclamation will be removed once the works are complete.	Contractor	Post-construction	Additional Safeguard LCVI10
BAR1	Biodiversity	<p>A Flora and Fauna Management Plan will be prepared in accordance with Transport for NSW's <i>Biodiversity Guidelines: Protecting and Managing Biodiversity on Projects</i> (RMS, 2011) and implemented as part of the CEMP. It will include, but not be limited to:</p> <ul style="list-style-type: none"> Plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas Requirements set out in the <i>Landscape Guideline</i> (RMS, 2008) Pre-clearing survey requirements Procedures for unexpected threatened species finds and fauna handling Procedures addressing relevant matters specified in the <i>Policy and guidelines for fish habitat conservation and management</i> (DPI Fisheries, 2013) <p>Protocols to manage weeds and pathogens.</p>	Contractor	Detailed design / Pre-construction	Standard safeguard BAR1 Section 4.8 of QA G36 <i>Environment Protection</i>
BAR2	Biodiversity	Measures to further avoid and minimise the construction footprint and native vegetation or habitat removal will be investigated during detailed design and implemented where practicable and feasible.	Contractor	Detailed design / Pre-construction	Standard safeguard BAR2
BAR3	Biodiversity	Native vegetation will be re-established in accordance with <i>Guide 3: Re-establishment of native vegetation</i> of the <i>Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects</i> (RTA 2011).	Contractor	Pre-construction	Additional safeguard BAR3
BAR4	Biodiversity	Habitat removal will be minimised through detailed design.	TfNSW	Detailed design	Additional safeguard BAR4

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
BAR5	Biodiversity	Habitat will be replaced or re-instated in accordance with Guide 5: Re-use of woody debris and bushrock and Guide 8: Nest boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011). This will include installation of nest boxes to replace lost hollows and salvage and re-use/installation of hollows from hollow-bearing trees that are removed.	TfNSW	Detailed design	Additional safeguard BAR5
BAR6	Biodiversity	Clearing limits and exclusion zones clearly identified prior to work within the vicinity of the population of <i>Pimelea spicata</i> to ensure no impacts to the population.	Contractor	Construction	Additional safeguard: BAR6
BAR7	Injury and mortality of fauna	Implementation of two stage clearing process to allow fauna to disperse from habitat voluntarily; inspection of hollows by experienced ecologist/fauna spotter/catcher prior to and after clearing of hollow-bearing trees/stags to safely remove and relocate any injured /displaced fauna.	Contractor	Construction	Additional safeguard: BAR7
BAR8	Noise, light and vibration	Shading and artificial light impacts will be minimised through detailed design.	TfNSW	Detailed design / Pre-construction	Additional safeguard: BAR8
SW1	Soil and water	A Soil and Water Management Plan (SWMP) will be prepared and implemented as part of the CEMP. The SWMP will identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks will be addressed during construction.	Contractor	Detailed design / Pre-construction	Standard safeguard SW1 Section 2.1 of QA G38 <i>Soil and Water Management</i>
SW2	Soil and water	A site specific Erosion and Sediment Control Plan/s will be prepared and implemented as part of the Soil and Water Management Plan <i>[delete reference to SWMP if one is not being prepared - and replace with reference to CEMP]</i> .	Contractor	Detailed design / Pre-construction	Standard safeguard SW2 Section 2.2 of QA G38 <i>Soil and</i>

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		The Plan will include arrangements for managing wet weather events, including monitoring of potential high risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather.			<i>Water Management</i>
SW3	Stockpiles	Stockpiles of raw materials or spoil would be located as close as practical to the work area where they are proposed to be used and to permit any drainage off site so that there would not be any impact to water quality. Stockpile sites would also include environmental protection measures which may include sediment basins to minimise impacts on receiving waters from erosion and sedimentation. Stockpiles sites would be established and managed in accordance with Environmental Procedure Management of Wastes on TfNSW Land (Roads and Maritime, 2014).	Contractor	Detailed design / Pre-construction	Standard safeguard SW3 Section 2.1 of QA G38 Soil and Water Management
SW4	Surface water	<p>Prior to construction, baseline water quality monitoring would be undertaken to identify parameters for monitoring during construction and to determine indicative existing water quality. Sampling locations and monitoring methodology would be determined during the detailed design stage. In accordance with the Guideline for Construction Water Quality Monitoring (RTA 2003) the following parameters are recommended to be monitored:</p> <ul style="list-style-type: none"> • pH, electrical conductivity, dissolved oxygen, turbidity and temperature • Total suspended solids • Hydrocarbons (oil and grease) <p>Data collected during the preconstruction monitoring would be used to develop site specific trigger values so that monitoring undertaken during the construction phase can be compared to these values. This would identify if any changes in water quality are a result of construction activities and demonstrate compliance with any monitoring requirements or targets (RTA 2003).</p>	TfNSW	Pre-construction	Additional safeguard SW4

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
SW5	Groundwater	At a minimum, groundwater quality is to be monitored over three sampling rounds at minoring locations identified to provide baseline groundwater quality data for the proposal. The three sampling rounds should be undertaken at approximately quarterly intervals before construction works commence and analytes should comprise dissolved heavy metals, pH, electrical conductivity, total dissolved solids and major ions. It is recommended additional monitoring bores be installed along the 3.4 kilometre alignment, to adequately characterise the groundwater throughout the extent of the proposal.	Contractor	Construction	Additional safeguard SW5
SW6	Water quality controls	Operational phase monitoring would be undertaken in order to: <ul style="list-style-type: none"> Assess and manage impacts on the receiving waters as the site stabilises Assist in deciding when the site has stabilised Identify water quality conditions after development. Monitoring would be undertaken in line with the TfNSW Guidelines for Construction Water Quality Monitoring (RTA 2003).	TfNSW	Post-construction	Additional safeguard SW6
SW7	Surface water quality	Post- construction groundwater samples may be taken from any groundwater monitoring locations and analysed for the same analytes as tested for the baseline data (plus contaminant analytes where required), with results then compared to baseline data.	TfNSW	Post-Construction	Additional safeguard SW7
SW8	Dewatering	Dam dewatering process will be prepared and implemented as part of the CEMP in accordance with the Technical Guideline Environmental Management of Construction Site Dewatering (RTA, 2011)	Contractor	Pre-construction / Construction	Additional safeguard SW8
GS1	Erosion and sedimentation	Wet weather plans for a rain event would be included in the ESCPs outlining the controls to be implemented in preparation for a rain event	Contractor	Construction	Additional safeguard: GS1
GS2	Erosion and sedimentation	Any material transported onto road surfaces would be swept and removed at the end of each working day and before rainfall	Contractor	Construction	Additional safeguard: GS2

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
GS3	Erosion and sedimentation	Topsoil would be stockpiled separately for possible reuse in landscaping and rehabilitation	Contractor	Construction	Additional safeguard: GS3
GS4	Erosion and sedimentation	Control measures will be implemented at egress points to minimise dirt and mud tracking	Contractor	Construction	Additional safeguard: GS4
GS5	Sediment basins	With the catchments and the disturbed areas proposed there may be a triggered requirement for temporary construction phase basins, as per the Blue Book.	Contractor	Construction	Additional safeguard: GS5
AQ1	Air quality	<p>An Air Quality Management Plan (AQMP) will be prepared and implemented as part of the CEMP. The AQMP will include, but not be limited to:</p> <ul style="list-style-type: none"> • Potential sources of air pollution • Air quality management objectives consistent with any relevant published EPA and/or OEH guidelines • Mitigation and suppression measures to be implemented • Compliance with Stockpile Site Management Guidelines (Roads and Maritime, 2015) • Methods to manage work during strong winds or other adverse weather conditions <p>A progressive rehabilitation strategy for exposed surfaces</p>	Contractor	Detailed design	Standard safeguard AQ1 Section 4.4 of QA G36 <i>Environment Protection</i>
CL1	Contaminated land	<p>A Contaminated Land Management Plan will be prepared in accordance with the <i>Guideline for the Management of Contamination</i> (Transport for NSW, 2013) and implemented as part of the CEMP. The plan will include, but not be limited to:</p> <ul style="list-style-type: none"> • Capture and management of any surface runoff contaminated by exposure to the contaminated land • Further investigations required to determine the extent, concentration and type of contamination, as identified in the detailed site investigation (Stage 2) 	Contractor	Detailed design / Pre-construction	Standard safeguard CL1 Section 4.2 of QA G36 <i>Environment Protection</i>

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		<ul style="list-style-type: none"> Management of the remediation and subsequent validation of the contaminated land, including any certification required measures to ensure the safety of site personnel and local communities during construction. 			
CL2	Contaminated land	If contaminated areas are encountered during construction, appropriate control measures will be implemented to manage the immediate risks of contamination. All other works that may impact on the contaminated area will cease until the nature and extent of the contamination has been confirmed and any necessary site-specific controls or further actions identified in consultation with the Transport for NSW Environment Manager and/or EPA.	Contractor	Detailed design / Pre-construction	Standard safeguard CL2 Section 4.2 of QA G36 <i>Environment Protection</i>
CL3	Accidental spill	A site specific emergency spill plan will be developed, and include spill management measures in accordance with the Transport for NSW <i>Code of Practice for Water Management</i> (RTA, 1999) and relevant EPA guidelines. The plan will address measures to be implemented in the event of a spill, including initial response and containment, notification of emergency services and relevant authorities (including Transport for NSW and EPA officers).	Contractor	Detailed design / Pre-construction	Standard safeguard CL3 Section 4.3 of QA G36 <i>Environment Protection</i>
CL4	Contamination	A Detailed Site Investigation should be conducted within identified AECs. The assessment should comprise additional study area observations once access is available, selected additional history searches of the study area, sampling and analysis of relevant media to further assess the study area with respect to contamination.	TfNSW	Detailed design / Pre-construction	Additional safeguard CL4
CL5	Unexpected finds	Whilst further assessment is recommended to reduce the likelihood of unexpected finds during construction, some AECs may be able to be managed through an unexpected finds procedure prepared as part of the CEMP.	Contractor	Pre-construction	Additional safeguard CL5
CL6	Hazardous materials	Hazardous materials assessments should be conducted on all structures proposed for demolition as part of the proposal. These assessments will help define the nature and extent of hazardous materials, including asbestos, lead paints, synthetic mineral fibre,	TfNSW	Detailed design / Pre-construction	Additional safeguard CL6

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		Polychlorinated Biphenyls (PCBs) etc., within the structures and define appropriate management measures prior to demolition.			
WR1	Waste	<p>A Waste Management Plan (WMP) will be prepared and implemented as part of the CEMP. The WMP will include but not be limited to:</p> <ul style="list-style-type: none"> • Measures to avoid and minimise • Waste associated with the proposal • Classification of wastes and management options (re-use, recycle, stockpile, disposal) • Statutory approvals required for managing both on and off-site waste, or application of any relevant resource recovery exemptions • Procedures for storage, transport and disposal • Monitoring, record keeping and reporting. <p>The WMP will be prepared taking into account the Environmental Procedure - Management of Wastes on Roads and Maritime Services Land (Roads and Maritime, 2014) and relevant TfNSW Waste Fact Sheets.</p>	Contractor	Pre-construction	Standard safeguard WR1 Section 4.2 of QA G36 <i>Environment Protection</i>
GGCC1	Construction greenhouse	<p>Plant and equipment would be switched off when not in use. Vehicles, plant and construction equipment would be appropriately sized for the task and properly maintained so as to achieve optimum fuel efficiency.</p> <p>Materials would be delivered with full loads and would come from local suppliers, where possible. The energy efficiency and related carbon emissions would be considered in the selection of vehicle and plant equipment.</p>	Contractor	Construction	Additional Safeguard GGCC1
HRM1	Hazards and risk management	<p>A Hazard and Risk Management Plan (HRMP) will be prepared and implemented as part of the CEMP. The HRMP will include, but not be limited to:</p> <ul style="list-style-type: none"> • Details of hazards and risks associated with the activity 	Contractor	Detailed design / Pre-construction	Additional safeguard HRM1

No.	Impact	Environmental safeguards	Responsibility	Timing	Reference
		<ul style="list-style-type: none"> Measures to be implemented during construction to minimise these risks Record keeping arrangements, including information on the materials present on the site, material safety data sheets, and personnel trained and authorised to use such materials A monitoring program to assess performance in managing the identified risks Contingency measures to be implemented in the event of unexpected hazards or risks arising, including emergency situations. <p>The HRMP will be prepared in accordance with relevant guidelines and standards, including relevant Safe Work Australia Codes of Practice, and EPA or Office of Environment and Heritage publications.</p>			
CI1	Cumulative construction impacts	<p>The Consultation Plan will include consultation with proponents of the Garfield Road West, and North West Growth Area Implementation Plan - Riverstone and Riverstone East, Sikh Grammar School Rouse Hill and Schofields Public School Redevelopment projects to:</p> <ul style="list-style-type: none"> Increase awareness of construction timeframes and impacts <p>Coordinate impact mitigation and management such as: respite periods.]</p>	Contractor	Pre-construction	Standard safeguard CI1

7.3 Licensing and approvals

Table 7.2: Summary of licensing and approvals required

Instrument	Requirement	Timing
<i>Protection of the Environment Operations Act 1997</i> (s43)	Environment protection licence (EPL) for scheduled activities such as road construction from the EPA.	Prior to start of the activity.
<i>Protection of the Environment Operations Act 1997</i> (s43)	Environment protection licence (EPL) for non-scheduled activities for the purposes of regulating water pollution.	Prior to start of the activity.
<i>Heritage Act 1977</i> (s60)	Permit to carry out activities to an item listed on the State Heritage Register or to which an interim heritage order applies from the Heritage Council of NSW.	Prior to start of the activity.
<i>Heritage Act 1977</i> (s139)	Excavation permit from the Heritage Council of NSW / the Minister.	Prior to start of the activity.
<i>National Parks and Wildlife Act 1974</i> (s90)	Aboriginal Heritage Impact Permit from the Chief Executive of OEH.	Prior to start of the activity.
<i>Water Management Act 2000</i> (s91C)	Drainage work approval from DPI (Water).	Prior to start of the activity.
<i>Water Management Act 2000</i> (s91D)	Flood work approval from DPI (Water).	Prior to start of the activity.
<i>Crown Land Management Act 2016</i> (Division 3.4, 5.5 and 5.6)	Lease or licence to occupy areas of Crown land.	Prior to start of the activity
<i>Roads Act 1993</i> (s138)	Road occupancy licence to dig up, erect a structure or carry out work in, on or over a road	Prior to start of the activity
<i>Biodiversity Conservation Act 2016</i>	Licence to harm or pick threatened species, populations or ecological communities or damage habitat.	Prior to start of the activity

8. Conclusion

This chapter provides the justification for the proposal taking into account its biophysical, social and economic impacts, the suitability of the site and whether or not the proposal is in the public interest. The proposal is also considered in the context of the objectives of the EP&A Act, including the principles of ecologically sustainable development as defined in Schedule 2 of the Environmental Planning and Assessment Regulation 2000.

8.1.1 Justification

While there would be some environmental impacts as a consequence of the proposal including impacts to non-Aboriginal heritage, temporary traffic delays, temporary alternate routes, biodiversity impacts, noise impacts, and socio-economic impacts, they have been avoided or minimised wherever possible through design and site-specific mitigation measures and safeguards.

Compared with the 'do nothing' option, the beneficial effects of traffic safety and efficiency improvements to Garfield Road East are considered to outweigh the adverse impacts and risks associated with the proposal.

8.1.2 Social factors

As documented in Section 6.6 of this REF, there could be some short-term negative social impacts as a result of the proposal. The combined effect of construction noise, traffic delays and alternate routes, temporary changes to access to schools and community facilities as well as general disturbance caused by construction activity, and associated construction traffic would result in a general temporary loss of amenity for residents, road users and others who live near the study area. The partial and full property acquisitions would also result in negative social impacts.

Speed restrictions, traffic delays and traffic alternate routes have the potential to increase travel time for roads users of Garfield Road East. Impacts during construction to business, industry, social facilities and places of worship would be limited to impacts from changes to traffic conditions.

Compared with the 'do nothing' option where Garfield Road East is not upgraded; the long-term effect would be an overall social benefit from the proposal.

8.1.3 Biophysical factors

The proposal would remove about 5.67 hectares of communities listed under either the BC Act and EPBC Act. Of the above 5.67 hectares, 0.47 hectares of BC Act listed vegetation would be removed from non-biocertified land. Several trees would be removed during construction, which potentially support roosting and nesting for breeding birds, microbats and arboreal mammals.

The proposal is not likely to significantly impact threatened species or ecological communities or their habitats, within the meaning of the BC Act or FM Act and therefore a SIS or BDAR is not required.

The proposal is not likely to significantly impact threatened species, ecological communities or migratory species, within the meaning of the EPBC Act.

8.1.4 Economic factors

The proposal would result in changes to parking, road, public transport and active transport travel routes. Resident and employee journeys may be delayed or extended using detour routes, changed bus stop locations and adjusted footpaths during partial closure of Garfield Road East and adjoining roads.

Residents, businesses and social infrastructure may also suffer from amenity loss during construction of the proposal due to associated noise, traffic movements, work activities, and dust generation.

The proposal would involve 14 full acquisitions of developed properties and several partial acquisitions. There is the potential for families to find alternative housing resulting in changes in school catchments and access to local recreational facilities.

Businesses may have positive effects from increased business and patronage from the construction work. However, access restrictions and increased travel times during construction may decrease patronage from the public.

8.1.5 Public interest

The proposal would improve road user safety with improved geometry, bus bays and a separated shared path on the southern side of Garfield Road East. In addition, the proposal would support connectivity and provide necessary infrastructure to drive further developments in the retail sector.

The proposal would improve access to community and recreational facilities and further work to build community values, as well as improved facilities for cyclists and pedestrians and bus amenities with formalised bus stops and bus priority lane facilities.

As a result, the proposal is considered to be in the public interest as the upgrades to road infrastructure fulfil the needs of the majority. The proposal represents a cost-efficient investment in public infrastructure to maximise the long-term social and economic benefits, while minimising the long-term negative impacts on communities and the environment. During the construction phase, the proposal would result in some short-term impacts on visual amenity, traffic and noise.

Compared with the 'do nothing' option, these impacts would be outweighed by the long-term benefits of the proposal. The overall result would be improved safety and traffic efficiency outcomes once the proposal is operational.

8.2 Objects of the EP&A Act

Table 8.1: Objects of the EP&A Act

Object	Comment
1.3(a) To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources.	The proposal would improve the transport network while minimising impacts on the natural and built environment. It is therefore consistent with the objective of promoting the social and economic welfare of the community and a better environment.
1.3(b) To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment.	Ecologically sustainable development is considered in Section 8.2.1 of this REF
1.3(c) To promote the orderly and economic use and development of land.	The proposal supports the objectives of the NWGA and Riverstone precinct development through providing critical transport infrastructure to these key developmental areas of western Sydney.
1.3(d) To promote the delivery and maintenance of affordable housing.	Not relevant to the proposal

Object	Comment
1.3(e) To protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats.	The proposal would have some impact on the natural environment. Measures have been proposed to mitigate the impact. Refer Section 6.8 of this REF
1.3(f) To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage).	The proposal has considered impacts to Aboriginal and non-Aboriginal heritage, refer to Sections 6.4 and 6.5, respectively of this REF. The proposal would not significantly impact cultural or built heritage
1.3(g) To promote good design and amenity of the built environment.	The proposal has been developed with reference to the Urban Design objectives outlined in section 2.3.3.
1.3(h) To promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants.	Not applicable to the proposal
1.3(i) To promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State.	Not relevant to the proposal
1.3(j) To provide increased opportunity for community participation in environmental planning and assessment.	Community involvement has occurred during the proposal's development. Refer to Chapter 5 of this REF.

8.2.1 Ecologically sustainable development

Ecologically sustainable development (ESD) is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. The principles of ESD have been an integral consideration throughout the development of the project.

ESD requires the effective integration of economic and environmental considerations in decision-making processes. The four main principles supporting the achievement of ESD are discussed below.

The precautionary principle

The precautionary principle deals with reconciling scientific uncertainty about environmental impacts with certainty in decision-making. Where there is a threat of serious or irreversible environmental damage, the absence of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation.

This principle was considered during route options development, refer to Chapter 2. The precautionary principle has guided the assessment of the environmental impact for this REF and the development of mitigation measures.

As part of the assessment process, options were considered and assessed with the purpose of reducing the risk of serious and permanent impacts on the environment. Specialist studies were undertaken for the following issues to provide accurate and impartial information for the evaluation of options and development of the proposal:

- Traffic and transport
- Noise and vibration

- Hydrology and flooding
- Aboriginal heritage
- Non-Aboriginal heritage
- Socio-economic
- Landscape character and visual impact
- Biodiversity
- Surface water and groundwater
- Contamination.

In developing the proposal, the best available technical information, environmental standards and measures have been used to minimise environmental risks. The preferred option minimises vegetation clearance, with particular consideration of sensitive areas. The preferred option minimises potential impacts on existing residential properties and other existing land uses, while also taking into consideration potential impacts on proposed future land use. In addition, the option that best minimises or avoids potential damage to known items or areas of cultural significance was selected.

Intergenerational equity

Social equity is concerned with the distribution of economic, social and environmental costs and benefits. Inter-generational equity introduces a temporal element with a focus on minimising the distribution of costs to future generations.

As part of the assessment process, a preferred option was chosen to:

- Minimise the environmental impact such as vegetation clearance
- Improve flood immunity to allow the road to be serviceable for future generations
- Provide for the future predicted traffic increases associated with residential and commercial development in the NWGA
- Improve road safety.

Issues with potential long-term implications were minimised or avoided, for example consumption of non-renewable resources, waste disposal, greenhouse emissions, removal of vegetation and impacts on water quality, through route/concept selection and application of management measures.

The proposal provides benefits to current and future generations of local communities and the surrounding region. The proposal would maintain or enhance the health, diversity and productivity of the environment.

Conservation of biological diversity and ecological integrity

This principle reinforces the previous two principles in requiring the diversity of genes, species and communities, as well as the ecosystems and habitats to which they belong, be maintained and improved to ensure their survival.

As part of the assessment process, a comprehensive assessment of the existing local environment has been carried out to recognise and manage any potential impacts of the proposal on local biodiversity. The proposal would not significantly impact biological diversity or ecological integrity. An ecological assessment and appropriate site-specific safeguards are provided in Section 6.8 and Appendix L of this REF.

Improved valuation, pricing and incentive mechanisms

The principle of internalising environmental costs into decision making requires consideration of all environmental resources which may be affected by the carrying out of a proposal, including air, water, land and living things.

This REF has examined the environmental consequences of the proposal and identified mitigation measures for areas that may possibly experience adverse impacts. Implementation of these mitigation measures would increase both the capital and operating costs of the proposal. This shows environmental resources were valued in economic terms during concept design.

In addition, the concept design was developed with an objective of minimising potential impacts on the surrounding environment, thereby minimising costs to the environment.

In summary, the proposal is generally in accord with the principles of ESD. The proposal would improve traffic movement and would provide a sustainable balance between environmental and economic objectives. It would also provide better facilities for pedestrians, cyclists and buses.

8.3 Conclusion

The proposal is subject to assessment under Division 5.1 of the EP&A Act. The REF has examined and taken into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the proposed activity.

This has included consideration, as relevant, of conservation agreements and plans of management under the NPW Act, biodiversity stewardship sites under the BC Act, wilderness areas, areas of outstanding value, impacts on threatened species and ecological communities and their habitats and other protected fauna and native plants. It has also considered potential impacts to matters of national environmental significance listed under the EPBC Act.

A number of potential environmental impacts from the proposal have been avoided or reduced during the concept design development and options assessment. The proposal as described in the REF best meets the proposal objectives but would still result in some impacts on property, biodiversity, construction traffic and noise. Safeguards and management measures as detailed in this REF would ameliorate or minimise these expected impacts. The proposal would also have a range of benefits including improved road safety; traffic flow; bus, cyclist and pedestrian facilities; access to and from local roads; drainage and flood immunity. On balance the proposal is considered justified and the following conclusions are made.

Significance of impact under NSW legislation

The proposal would be unlikely to cause a significant impact on the environment. Therefore, it is not necessary for an EIS to be prepared and approval to be sought from the Minister for Planning under Division 5.2 of the EP&A Act. A BDAR or SIS is not required. The proposal is subject to assessment under Division 5.1 of the EP&A Act. Consent from Council is not required.

Significance of impact under Australian legislation

The proposal is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the EPBC Act. A referral to the Department of the Agriculture, Water and the Environment is not required.

9. Certification

This review of environmental factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposal.



Greg Tallentire

Principal Environmental Planner

SMEC

Date: 29 October 2020

I have examined this review of environmental factors and accept it on behalf of Transport for NSW.



Matty Mathivanar

Project Manager

Transport for NSW

Date: 29 October 2020

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Blacktown City Council Local Strategic Planning Statement 2019

Terms and acronyms used in this REF

Term / Acronym	Description
AEP	Annual exceedance probability
AASR	Aboriginal Archaeological Survey Report
AEC	Areas of environmental concern
AEP	Annual exceedance probability
AGRD	Austroads Guide to Road Design
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
Alignment	The vertical and horizontal location of the road
ALR Act	Aboriginal Land Rights Act 1983
BAR	Biodiversity Assessment Report
BC Act	<i>Biodiversity Conservation Act 2016 (NSW).</i>
BDAR	Biodiversity Development Assessment Report
BOS	Biodiversity Offset Strategy under the <i>Biodiversity Conservation Act 2016 (NSW).</i>
Capacity	Maximum number of vehicles which has a reasonable expectation of passing over a given section of a lane or a road in one direction during a given time period under prevailing road and traffic conditions.
CEMP	Construction environmental management plan
CLM Act	<i>Contaminated Lands Management Act 1997 (NSW)</i>
CM SEPP	State Environmental Planning Policy (Coastal Management) 2018
Clearway	A kerbside lane in which vehicles may only stop at certain times of the day.
Construction footprint	Construction impact area
DPIE	NSW Department of Planning, Industry and Environment
DPI	NSW Department of Primary Industries
DEES	NSW Department of Environment Energy and Science (formally Office of Environment & Heritage)
EIA	Environmental impact assessment
EIS	Environmental impact statement
EPA	NSW Environmental Protection Authority
EP&A Act	<i>Environmental Planning and Assessment Act 1979 (NSW).</i> Provides the legislative framework for land use planning and development assessment in NSW
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth).</i> Provides for the protection of the environment, especially

Term / Acronym	Description
	matters of national environmental significance, and provides a national assessment and approvals process.
EPL	Environmental protection license
ESD	Ecologically sustainable development. Development which uses, conserves and enhances the resources of the community so that ecological processes on which life depends, are maintained and the total quality of life, now and in the future, can be increased
FM Act	<i>Fisheries Management Act 1994 (NSW)</i>
GDE	Groundwater depended ecosystem
GFR	Geotechnical Factual Report
Growth Centres SEPP	State Environmental Planning Policy (Sydney Region Growth Centres) 2006
Heritage Act	<i>Heritage Act 1977 (NSW)</i>
HAIS	Historical archaeological impact statement
HV	High voltage
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
LALC	Local Aboriginal Land Council
LCVIA	Landscape character and visual impact assessment
LCZ	Landscape character zone
LEP	Local Environmental Plan. A type of planning instrument made under Part 3 of the EP&A Act.
LGA	Local Government Area
LoS	Level of Service. A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers.
MNES	Matters of national environmental significance under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.
NPW Act	<i>National Parks and Wildlife Act 1974 (NSW)</i>
NSW	New South Wales
NWGA	North West Growth Area
OEH	NEW Office of Environment & Heritage
PACHCI	Roads and Maritime Procedure for Aboriginal Cultural Heritage Consultation and Investigation
PAD	Potential archaeological deposit
PCT	Plant Community Type
Phase 1	Phase 1 contamination assessment
POEO Act	<i>Protection of the Environment Operations Act 1997 (NSW)</i>

Term / Acronym	Description
The proposal	The design/operational footprint
PVC	Poly Vinyl Chloride
QA Specifications	Specifications developed by Transport for NSW for use with road work and bridge work contracts let by Transport for NSW.
Roads and Maritime	NSW Roads and Maritime Services (now TfNSW)
ROL	Road Occupancy License
REF	Review of environmental factors
SEIA	Socioeconomic impact assessment
SEPP	State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&A Act.
SHR	NSW State Heritage Register
SIC	Special infrastructure Contribution
SIS	Species Impact Statement
SMEC	SMEC Australia Pty Ltd
The Strategy	North West Growth Centre Road Network Strategy
Study area	The area being considered as part of a specialist study
SSI	State significant infrastructure
PACHCI	Roads and Maritime Procedure for Aboriginal Cultural Heritage Consultation and Investigation
PAD	Potential archaeological deposit
PCT	Plant Community Type
Phase 1	Phase 1 contamination assessment
POEO Act	Protection of the Environment Operations Act 1997 (NSW)
The proposal	The design/operational footprint
PVC	Poly Vinyl Chloride
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Roads and Maritime	NSW Roads and Maritime Services (now TfNSW)
ROL	Road Occupancy License
REF	Review of environmental factors
SEIA	Socioeconomic impact assessment
SEPP	State Environmental Planning Policy. A type of planning instrument made under Part 3 of the EP&A Act.
SHR	NSW State Heritage Register

Term / Acronym	Description
SIC	Special infrastructure Contribution
SIS	Species Impact Statement
SMEC	SMEC Australia Pty Ltd
The Strategy	North West Growth Centre Road Network Strategy
Study area	The area being considered as part of a specialist study
SSI	State significant infrastructure
SWMP	Soil and water management plan
TEC	Threatened ecological community
TfNSW	Transport for New South Wales
TMP	Traffic Management Plan
UMP	Utilities management plan
UST	Underground storage tanks
VMS	Variable message signs
VP	Viewpoints
WM Act	Water Management Act 2000 (NSW)

Appendix A

Consideration of clause 228(2) factors and matters of national environmental significance and Commonwealth land

Clause 228(2) Checklist

In addition to the requirements of the *Is an EIS required?* guideline (DUAP 1995/1996) and the *Roads and Related Facilities EIS Guideline* (DUAP 1996) as detailed in the REF, the following factors, listed in clause 228(2) of the Environmental Planning and Assessment Regulation 2000, have also been considered to assess the likely impacts of the proposal on the natural and built environment.

Factor	Impact
<p>a) Any environmental impact on a community?</p> <p>During construction, it is anticipated that there will be short-term impacts relating to noise, vibration and, to a lesser degree, traffic and access. Impacts would be managed and mitigated through safeguards listed in Chapter 7 of this REF.</p> <p>The long-term benefit of the proposal would result in an upgraded road and improved safety for the community.</p>	<p>Short-term negative (minor), temporary</p> <p>Long term positive (moderate)</p>
<p>b) Any transformation of a locality?</p> <p>Construction of the proposal would temporarily transform the existing locality, predominantly through a negative visual amenity impact, associated with the removal of vegetation and road construction activities. Impacts would be managed and mitigated through safeguards listed in Chapter 7 of this REF.</p> <p>In the longer term, the proposal would positively transport the road corridor. The widening of the existing alignment would result in the removal of some native vegetation. However, through the implementation of the Urban Design Strategy (refer Appendix K of this REF), the overlook landscape character and visual amenity of the proposal would be improved.</p>	<p>Short-term negative (minor), temporary</p> <p>Long term positive (moderate)</p>
<p>c) Any environmental impact on the ecosystems of the locality?</p> <p>Overall, the potential impacts of the proposed works on biodiversity are not considered to be significant. The proposal would remove up to 5.72 hectares of native vegetation/PCTs. The clearing of vegetation would primarily be associated with the widening of the road, the addition of entrances to adjacent roads, and the construction of road-safety infrastructure. The proposal would also require the removal of 7.82 hectares of the Exotic grassland with or without regrowth community, and 0.47 hectares of the Mixed planted exotics and native vegetation community. Neither community supports any TECs.</p> <p>Clearing of the native forest and woodland (PCTs 849, 835, 724 and 1800) would result in the removal of foraging/hunting habitat for microchiropteran bats (such as the Little Bent-wing Bat), larger predatory birds (such as the Powerful Owl), the Cumberland Plain Land Snail and the Grey-headed Flying-fox.</p> <p>However, there would be no significant impact threatened species or ecological communities or their habitats, within the meaning of the BC Act or FM Act and therefore the preparation of an SIS or BDAR is not required. The proposal is not likely to significantly impact threatened species, ecological communities or migratory species, within the meaning of the EPBA Act.</p> <p>Safeguards and management measures are provided in Section 6.8.4 of this REF</p>	<p>Short-term negative (minor), temporary</p>
<p>d) Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?</p> <p>There would be a minor reduction in the aesthetic quality of the locality due to the removal of vegetation, increase in road width and changes to intersections and</p>	<p>Long-term negligible negative impacts</p>

Factor	Impact
<p>property boundaries. The existing aesthetic environment would be temporarily impacted by the presence of construction plant, equipment and staff. Access to First Ponds Creek would also be temporarily obstructed during construction.</p> <p>Mitigation measures would be implemented to reduce impacts and detailed design would be undertaken in line with the urban design objectives of the proposal. These include revegetation and landscaping of the road corridor and retention of vegetation where possible (refer Section 6.7.4 of this REF).</p>	
<p>e) Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations?</p> <p>There would be no impacts on any locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations</p>	Nil
<p>f) Any impact on the habitat of protected fauna (within the meaning of the <i>National Parks and Wildlife Act 1974</i>)?</p> <p>No, the proposed works would not impact on protected fauna as listed under the Act.</p>	Nil
<p>g) Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?</p> <p>The proposal is unlikely to have significant impact on any threatened species, population or community listed under the BC Act or EPBC Act.</p> <p>The proposal will result in the removal of vegetation conforming to four PCTs which are listed under the BC Act, and one TEC listed under the EPBC Act. Tests of significance under the BC Act for each of the recorded TECs found that the proposal would likely have a significant impact on one of the TECs – Shale Gravel Transition Forest in the Sydney Basin Bioregion (Shale Gravel Transition Forest). Assessments of significance conducted under the EPBC Act were not found to be significant.</p>	Nil
<p>h) Any long-term effects on the environment?</p> <p>It is unlikely that the proposal would have any long-term effects on the environment</p>	Nil
<p>i) Any degradation of the quality of the environment?</p> <p>The proposal has the potential to degrade the quality of the environment through noise, visual, water, air, erosion and sedimentation pollution as well as accidental spills during construction. The potential impacts would be managed using a suite of safeguards and mitigation measures, which are outlined in Section 7 of this REF.</p> <p>The construction footprint would be reduced as far as practicable and rehabilitated as work progresses to minimise impacts. Removal of native vegetation would be kept to a minimum and appropriate mitigation incorporated to manage impacts to native flora and fauna.</p> <p>Long-term, the proposal would provide a range of benefits including improved traffic conditions, bus, cyclists and pedestrian facilities as well as drainage and flood immunity.</p>	<p>Short-term negative</p> <p>Long term positive</p>
<p>j) Any risk to the safety of the environment?</p> <p>The proposal is likely to reduce safety along the existing corridor during construction. This would be managed through appropriate signage and a TMP.</p>	<p>Short-term negative</p> <p>Long term positive</p>

Factor	Impact
The proposal would provide shared pedestrian and bicycle paths and signalised intersections. This would improve road user safety.	
<p>k) Any reduction in the range of beneficial uses of the environment?</p> <p>The proposal would result in traffic impacts during construction. Construction traffic impacts would involve an increase in the volume of heavy vehicles, interruption of traffic flow and speeds and temporary obstructions to access to social infrastructure. These traffic impacts would reduce the beneficial use of Garfield Road East during the construction phase.</p> <p>In the long term, the proposal would be consistent with future uses and there would be no reduction in the range of beneficial uses of the environment.</p>	<p>Short-term negative</p> <p>Long-term nil</p>
<p>l) Any pollution of the environment?</p> <p>There would be some potential noise, visual, air, water, erosion and sedimentation impacts associated with the construction of the proposal. Construction activities would be carefully managed with numerous safeguards and mitigation measures (refer Section 7 of this REF). The environmental safeguards and mitigation measures would be incorporated into the project-specific CEMP.</p>	Short-term negative
<p>m) Any environmental problems associated with the disposal of waste?</p> <p>Waste would be generated across a number of waste streams during construction. These streams would be managed in accordance with the <i>Waste Avoidance and Resource Recovery Act 2001</i> and recycled where possible. Any waste generated during the proposed works would be contained and removed for disposal to approved facilities or to licensed landfill. Impacts would be managed and mitigated through safeguards listed in Chapter 7 of this REF.</p>	Nil
<p>n) Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply?</p> <p>The proposal would require resources such as concrete and pre-cast box culverts, road furniture and steel for signalisation and signage. These are common construction materials and readily available. The proposal would not create any increased demand on these resources.</p>	Nil
<p>o) Any cumulative environmental effect with other existing or likely future activities?</p> <p>There is the potential for the proposal to have a cumulative environmental effect with other existing or likely future activities. The key cumulative impacts associated with construction include traffic congestion and delays, visual amenity and the removal of native vegetation.</p> <p>Impacts would be managed and mitigated through safeguards listed in Chapter 7 of this REF.</p> <p>The proposal would have a long-term positive cumulative impact on road safety and visual amenity.</p>	<p>Short-term negative</p> <p>Long term positive</p>
<p>p) Any impact on coastal processes and coastal hazards, including those under projected climate change conditions?</p> <p>The proposal is not located within a coastal area and would not result in any impact on coastal processes and coastal hazards.</p>	Nil

Matters of National Environmental Significance and Commonwealth land

Under the environmental assessment provisions of the EPBC Act 1999, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposal should be referred to the Australian Government Department of Agriculture, Water and the Environment.

A referral is not required for proposed actions that may affect nationally listed threatened species, endangered ecological communities and migratory species. Impacts on these matters are still assessed as part of the REF in accordance with Australian Government significant impact criteria and taking into account relevant guidelines and policies.

Factor	Impact
a) Any impact on a World Heritage property?	Nil
b) Any impact on a National Heritage place?	Nil
c) Any impact on a wetland of international importance?	Nil
d) Any impact on a listed threatened species or communities?	Nil
e) Any impacts on listed migratory species?	Nil
f) Any impact on a Commonwealth marine area?	Nil
g) Does the proposal involve a nuclear action (including uranium mining)?	Nil
h) Additionally, any impact (direct or indirect) on the environment of Commonwealth land?	Nil

Appendix B

Statutory consultation checklists

Infrastructure SEPP

Council related infrastructure or services

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Stormwater	Are the works likely to have a <i>substantial</i> impact on the stormwater management services which are provided by council?	No	NA	ISEPP cl.13(1)(a)
Traffic	Are the works likely to generate traffic to an extent that will <i>strain</i> the capacity of the existing road system in a local government area?	No	NA	ISEPP cl.13(1)(b)
Sewerage system	Will the works involve connection to a council owned sewerage system? If so, will this connection have a <i>substantial</i> impact on the capacity of any part of the system?	No	NA	ISEPP cl.13(1)(c)
Water usage	Will the works involve connection to a council owned water supply system? If so, will this require the use of a <i>substantial</i> volume of water?	No	NA	ISEPP cl.13(1)(d)
Temporary structures	Will the works involve the installation of a temporary structure on, or the enclosing of, a public place which is under local council management or control? If so, will this cause more than a <i>minor</i> or <i>inconsequential</i> disruption to pedestrian or vehicular flow?	No	NA	ISEPP cl.13(1)(e)
Road & footpath excavation	Will the works involve more than <i>minor</i> or <i>inconsequential</i> excavation of a road or adjacent footpath for which council is the roads authority and responsible for maintenance?	No	Blacktown City Council The Hills Shire Council	ISEPP cl.13(1)(f)

Local heritage items

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Local heritage	Is there is a local heritage item (that is not also a State heritage item) or a heritage conservation area in the study area for the works? If yes, does a heritage assessment indicate that the potential impacts to the heritage significance of the item/area are more than <i>minor</i> or <i>inconsequential</i> ?	Yes	Blacktown City Council Refer to section 6.5 and Appendix I for more detail	ISEPP cl.14

Flood liable land

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Flood liable land	Are the works located on flood liable land? If so, will the works change flood patterns to more than a <i>minor</i> extent?	Yes	Blacktown City Council	ISEPP cl.15
Flood liable land	Are the works located on flood liable land? (to any extent). If so, do the works comprise more than minor alterations or additions to, or the demolition of, a building, emergency works or routine maintenance	Yes	State Emergency Services Email: erm@ses.nsw.gov.au	ISEPP cl.15AA

Note: Flood liable land means land that is susceptible to flooding by the probable maximum flood event, identified in accordance with the principles set out in the manual entitled *Floodplain Development Manual: the management of flood liable land* published by the New South Wales Government.

Public authorities other than councils

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
National parks and reserves	Are the works adjacent to a national park or nature reserve, or other area reserved under the <i>National Parks and Wildlife Act 1974</i> , or on land acquired under that Act?	No	Office of Environment and Heritage	ISEPP cl.16(2)(a)
National parks and reserves	Are the works on land in Zone E1 National Parks and Nature Reserves or in a land use zone equivalent to that zone?	No	Office of Environment and Heritage	ISEPP cl. 16(2)(b)
Aquatic reserves	Are the works adjacent to an aquatic reserve or a marine park declared under the <i>Marine Estate Management Act 2014</i> ?	No	Department of Industry	ISEPP cl.16(2)(c)
Sydney Harbour foreshore	Are the works in the Sydney Harbour Foreshore Area as defined by the <i>Sydney Harbour Foreshore Authority Act 1998</i> ?	No	Property NSW	ISEPP cl.16(2)(d)
Bush fire prone land	Are the works for the purpose of residential development, an educational establishment, a health services facility, a correctional centre or group home in bush fire prone land?	No	Rural Fire Service	ISEPP cl.16(2)(f)
Artificial light	Would the works increase the amount of artificial light in the night sky and that is on land within the dark sky region as identified on the dark sky region map? (Note: the dark sky region is within 200	No	Director of the Siding Spring Observatory	ISEPP cl.16(2)(g)

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
	kilometres of the Siding Spring Observatory)			
Defence communications buffer land	Are the works on buffer land around the defence communications facility near Morundah? (Note: refer to Defence Communications Facility Buffer Map referred to in clause 5.15 of Lockhardt LEP 2012, Narrandera LEP 2013 and Urana LEP 2011.	No	Secretary of the Commonwealth Department of Defence	ISEPP cl. 16(2)(h)
Mine subsidence land	Are the works on land in a mine subsidence district within the meaning of the <i>Mine Subsidence Compensation Act 1961</i> ?	No	Mine Subsidence Board	ISEPP cl. 16(2)(i)

Growth Centres SEPP

Issue	Potential impact	Yes / No	If 'yes' consult with	ISEPP clause
Clearing native vegetation	Do the works involve clearing native vegetation (as defined in the <i>Local Land Services Act 2013</i>) on land that is not subject land (as defined in cl 17 of schedule 7 of the <i>Threatened Species Conservation Act 1995</i>)?	Yes	Department of Planning, Industry and Environment	SEPP 18A

Appendix C

Neutral or beneficial effect on water quality assessment

Neutral or Beneficial Effect Assessment

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 relates to the use of land within the Sydney drinking water catchment. In accordance with Clause 12 of the SEPP, Roads and Maritime is required to consider whether or not an activity to which Division 5.1 of the EP&A Act applies will have a neutral or beneficial effect on water quality before carrying out the activity.

Factor	Impact
1. Are there any identifiable potential impacts on water quality? What pollutants are likely? During construction and/or post construction?	There are no identifiable potential impacts on water quality
2. For each pollutant, list the safeguards needed to prevent or mitigate potential impacts on water quality (these may be Water NSW endorsed current recommended practices and/or equally effective other practices)	NA
3. Will the safeguards be adequate for the time required? How will they need to be maintained?	NA
4. Will all impacts on water quality be effectively contained on the site by the identified safeguards (above) and not reach any watercourse, waterbody or drainage depression? Or will impacts on water quality be transferred outside the site for treatment? How? Why?	NA
5. Is it likely that a neutral or beneficial effect on water quality will occur? Why?	Once the activity has been completed, the level of pollutants be the same as they were before work commenced

Appendix D

Concept design drawings

Appendix E

Traffic and transport assessment

Appendix F

Noise and vibration assessment

Appendix G

Hydrology and flooding assessment

Appendix H

PACHI stage 2 assessment

Appendix I

Non-Aboriginal assessment

Appendix J

Socio-economic assessment

Appendix K

Landscape character and visual impact assessment

Appendix L

Biodiversity assessment

Appendix M

Surface water and groundwater

Appendix N

TRAQ air quality model results

Appendix O

Phase I contamination assessment

