LEGEND

Development site

Vegetation Community Type

PCT

1590 - Spotted Gum/ Broad-leaved Mahogany/ Red Ironbark shrubby open forest

1600 - Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter

1619 - Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands

Other

Cleared grassland

Exotic trees

Spillway

Urban verges

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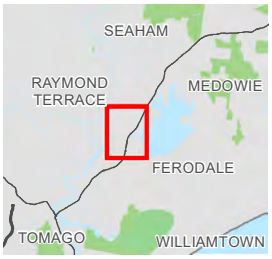

Figure 7-4 Distribution of plant community types and other vegetation

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Created by : AB
QA by : KC

Terrestrial fauna

Terrestrial fauna habitat

The key terrestrial fauna habitat types identified for the Proposal include:

- Woodland – Woodland habitats occur in the road reserve of Rees James Road, Hunter Water land, Kings Hill URA and isolated patches in the southern compounds. These areas typically contain scattered eucalypts with a grassy understorey and low shrub density, though vary in vegetative cover, habitat features and weed incursion/disturbance.
- Cleared grassland, exotic trees and urban verges – occurs in most areas of the proposal site.

Five hollow-bearing trees were identified in the woodland vegetation in the Proposal site and three directly adjacent.

One hollow-bearing tree supporting a medium sized hollow is located on the edge of the Proposal site in urban vegetation. Several other hollow-bearing trees are located in urban vegetation just outside the Proposal site along Rees James Road. These contain small to large hollows providing habitat for arboreal fauna.

Further, several nest boxes have been installed on planted trees in a small strip of the road reserve and adjacent residential land at James Rees Road.

Draft important areas for the Swift Parrot (*Lathamus discolor*) have been mapped by DPIE in Boomerang Park and Newbury Park (supplied from DPIE via email on 3 October 2019). The mapped important areas overlap with the subject land, however in the overlapping areas, there are no eucalypts/potential feed trees. Some eucalypts are nearby though the densities are very low such that they are unlikely to be an important foraging resource for the species.

Threatened fauna species and endangered populations

Field surveys carried out for the Proposal identified seven listed threatened fauna species within or next to the Proposal site (Figure 7-5):

- Little Lorikeet (*Glossopsitta pusilla*)
- Grey-crowned Babbler (*Pomatostomus temporalis temporalis*)
- Eastern Coastal Free-tailed bat (*Micronomus norfolkensis*)
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
- Little Bentwing-Bat (*Miniopterus australis*)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*).

Another 22 listed threatened species were identified as having a moderate or high likelihood of occurrence within the Proposal site or assumed to be present, despite not being identified during field surveys. These species were:

- Magpie Goose (*Anseranas semipalmata*)
- Regent Honeyeater (*Anthochaera phrygia*)
- Dusky Woodswallow (*Artamus cyanopterus cyanopterus*)
- Glossy Black-Cockatoo (*Calyptorhynchus lathami*)
- Spotted Harrier (*Circus assimilis*)
- Brown Treecreeper (*Climacteris picumnus victoriae*)

- Varied Sittella (*Daphoenositta chrysoptera*)
- Black Falcon (*Falco subniger*)
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*)
- Little Eagle (*Hieraaetus morphnoides*)
- Swift Parrot (*Lathamus discolor*)
- Square-tailed Kite (*Lophoictinia isura*)
- Turquoise Parrot (*Neophema pulchella*)
- Powerful Owl (*Ninox strenua*)
- Scarlet Robin (*Petroica boodang*)
- Eastern Grass Owl (*Tyto longimembris*)
- Masked Owl (*Tyto novaehollandiae*)
- Squirrel Glider (*Petaurus norfolcensis*)
- Brush-tailed Phascogale (*Phascogale tapoatafa*)
- Southern Myotis (*Myotis macropus*)
- Koala (*Phascolarctos cinereus*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*)

Migratory bird species

No migratory species listed under the EPBC Act were recorded from the Proposal site during surveys, and none are considered likely to occur.

LEGEND

- Development site

Threatened species

- Grey-headed Flying-fox camp
- Grey-headed Flying-fox
- Grey-crowned Babbler
- Little Lorikeet
- Large Bent-winged Bat, Greater Broad-nosed Bat, Eastern Freetail-bat, Southern Myotis
- Little Bent-winged Bat, Large Bent-winged Bat, Southern Myotis, Greater Broad-nosed Bat, Easter False Pipistrelle

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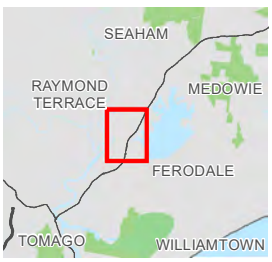

Figure 7-5 Recorded Threatened Species

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Aquatic biodiversity

Aquatic habitat

Aquatic habitats in the Proposal site are limited to mapped second order ephemeral streams. Several minor unmapped ephemeral drainage lines and soaks occur which are unlikely to provide habitat for fish.

The Proposal site crosses three mapped watercourses, two of which have been created by the operating Grahamstown Spillway and the obsolete Irrawang Spillway and are part of the Pennington Drain (Figure 7-6). Pennington Drain is a large open channel, constructed centrally through Irrawang Swamp in the 1970's as a component of the initial Grahamstown Dam construction works to efficiently convey spillway flows through the swamp to the Williams River (Alluvium, 2019). The third watercourse, the Kings Hill URA watercourse, is from the Kings Hill URA area draining from the north (part of the Kings Hill South sub-catchment area). The Irrawang Spillway is a concrete-lined channel conveying flow from a drainage channel on HWC-land from the east of the Pacific Motorway. The Irrawang Spillway is disused and the flow from Grahamstown Dam is directed to the Grahamstown Spillway further south, severing fish habitat connectivity between the channel feeding into the Irrawang Spillway and Grahamstown Dam. Key Fish Habitat has been mapped at the Irrawang Spillway (Figure 7-6). However, it is considered Type 3 – Minimally sensitive key fish habitat and Class 3 – Minimal key fish habitat in accordance with DPI's Policy and guidelines for fish habitat conservation and management (2013 update) (DPI, 2013). A second order channel feeds into Irrawang Spillway near the development site. At this location, the channel is about 13 metres wide with an open pool at the spillway edge and exotic grasses and shrubs occurring on the channel and banks. The channel is considered Type 2 – moderately sensitive key fish habitat and Class 3 – Minimal key fish habitat in accordance with DPI's Policy and guidelines for fish habitat conservation and management (2013 update) (DPI, 2013).

A second order channel flows from Grahamstown Spillway near the Proposal site. At this location, the channel is about 60 metres wide and contains emergent vegetation and scattered casuarinas with open pools at the spillway edge. The banks are steep and graded and covered in large rock. The channel is considered Type 1 – highly sensitive key fish habitat and Class 2 – Moderate key fish habitat in accordance with DPI's Policy and guidelines for fish habitat conservation and management (2013 update) (DPI, 2013).

Threatened ecological communities, species and endangered populations

A search of DPI's Fisheries Spatial Data Portal found none of the waterways in the Proposal site contain mapped habitat for threatened fish listed under the FM Act, based on predicted occupancy extents (DPI, 2019). Further, no threatened fish are predicted to occur in any waterways on or directly downstream of the proposal site. No critical habitat is known to occur in proximity to the proposal site. No named creeks or rivers transect the Proposal site. The second order stream bisecting the Proposal site on the Kings Hill URA provides fish habitat and is considered Type 1 – highly sensitive key fish habitat and Class 2 – Moderate key fish habitat.

Groundwater dependent ecosystems

A search of the National Atlas of Groundwater Dependent Ecosystems (BOM, 2019) identified several groundwater dependent ecosystems (GDEs) with potential reliance on subsurface groundwater within and adjoining the Proposal site, based on regional studies. A total of 1.78 hectares of GDEs were identified in the Proposal site, with

potential reliance on subsurface groundwater ranging from high to moderate (Table 7-5 and Figure 7-7). All areas of mapped GDEs were in the northernmost portions of the Proposal site, north of Irrawang Spillway. Irrawang Swamp, to the west of the Proposal site, is mapped as a high potential GDE. The closest aquatic GDE, Williams River, is mapped about 700 metres west of the Proposal site.

Table 7-5 Groundwater dependent ecosystems mapped by BOM (2019) in the Proposal site

GDE potential	Mapped vegetation types	Area within Proposal site (ha)
High	Smooth-barked Apple/ Red Bloodwood/ Brown Stringybark/ Hairpin Banksia heathy open forest Spotted Gum/ Broad-leaved Mahogany/ Red Ironbark shrubby open forest	0.36
Moderate	Smooth-barked Apple/ Red Bloodwood/ Brown Stringybark/ Hairpin Banksia heathy open forest Spotted Gum/ Broad-leaved Mahogany/ Red Ironbark shrubby open forest	1.42
Total		**1.78**

Wetlands and conservation areas

Part of the Proposal site is within a mapped Coastal Wetland – Irrawang Swamp (ID 36586), listed under the Coastal Management SEPP (Figure 7-7). About 700 metres of the water and wastewater infrastructure alignment transects the north-eastern margin of Irrawang Swamp Coastal Wetland. The Coastal Wetland covers an approximate area of 450 hectares, of which 2.01 hectares (0.45%) is located within the Proposal site.

Mapping of Coastal Wetlands include the following vegetation types (DPE, 2018):

- Mangroves
- Saltmarshes
- Melaleuca forests
- Casuarina forests
- Sedgelands
- Brackish and freshwater swamps
- Wet meadows.

The vegetation in the area within the Proposal site mapped as the Coastal Wetland is almost entirely cleared grassland dominated by exotic grass species such as *Axonopus fissifolius, Paspalum dilatatum* and the cosmopolitan native grass *Cynodon dactylon.* There are two small (0.08 ha) patches of the Plant Community Type (PCT) Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest (PCT 1590) – one in poor condition (0.02 ha) and one planted road batter (0.06 ha) identified in this area.

The vegetation within the section of the Proposal site mapped as Coastal Wetland does not align with the vegetation types that define a Coastal Wetland. These vegetation types lie further to the west of the Proposal site. It is likely that the eastern boundary of the Coastal Wetland is mapped inaccurately to include the Proposal site.

LEGEND

- Development site

NSW Coastal Management SEPP (2018):

- Coastal Wetlands
- Coastal Wetlands Proximity Area
- Key Fish Habitat (DPI 2007)
- Stream buffer
- Local wetland buffer - 20m
- Watercourse

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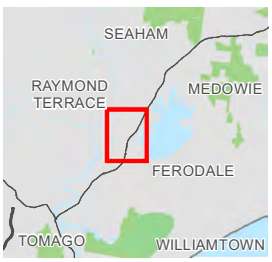

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Figure 7-6 Watercourses and Wetlands

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Created by : AB
QA by : KC

LEGEND

Development site

Terrestrial groundwater dependent ecosystem
- High potential GDE
- Low potential GDE
- Moderate potential GDE

Aquatic groundwater dependent
- High potential GDE

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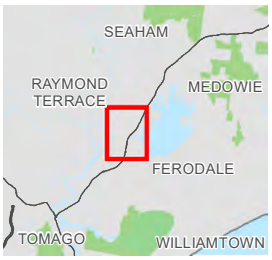

Figure 7-7 Groundwater dependent ecosystems mapped by BOM (2019)

7.3.3 Potential impacts

Construction

Direct impacts on native vegetation and habitat

Removal of native vegetation

The Proposal would result in the removal of about 5.22 hectares of native vegetation from within the Proposal site. The areas of each PCT that would be removed as a result of the Proposal are listed in Table 7-6.

Table 7-6 Direct impacts on native vegetation

PCT	PCT name	Vegetation zone	Area of direct impact (ha)	Vegetation integrity score
North Coast bioregion				
1590	Spotted Gum/ Broad-leaved Mahogany/ Red Ironbark shrubby open forest	1590 – Moderate	0.14	66.6
		1590 – Road batter	0.36	28.3
		1590 – Poor	0.03	11.8
1600	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	1600 – Moderate	1.32	33.3
Sydney basin bioregion				
1590	Spotted Gum/ Broad-leaved Mahogany/ Red Ironbark shrubby open forest	1590 – Poor	0.07	14.6
1619	Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	1619 – Moderate	0.41	45.4
		1619 – Poor	0.66	25.8
		1619 – Planted trees	2.23	14.0
Total			**5.22**	

Removal of threatened species habitat

The clearing of 5.22 hectares of vegetation that meets the definition of a PCT would result in the loss of habitat for threatened fauna species known or considered likely to occur in the Proposal site. This includes the species that were identified as predicted ecosystem species from the BAM Calculator (BAMC) with a moderate to high likelihood of occurrence in the Proposal site.

Clearing of vegetation from the Proposal site would result in the removal of specific fauna habitat components, including live trees, tree hollows, foraging resources, groundlayer habitats such as ground timber and well-developed leaf litter. Clearing of vegetation would result in the loss of up to five hollow-bearing trees that were identified in the Proposal site and potentially additional three trees identified just outside the Proposal site due to encroachment on the tree root zone. The removal of hollow-bearing

trees would impact a range of fauna, largely birds and arboreal mammals, including the threatened Brush-tailed Phascogale and Squirrel Glider.

No threatened species to which species credits would apply were recorded in the Proposal site during targeted seasonal surveys. However, there is potential for four species credit species to be impacted by the Proposal. Habitat impacts in each IBRA bioregion are outlined in Table 7-6.

Table 7-7 Impacts to species credit species per IBRA subregion

Species	Habitat to be impacted Sydney Basin bioregion (ha)	Habitat to be impacted in North Coast bioregion (ha)	Total impact (ha)
Southern Myotis	0.07	0.03	0.1
Squirrel Glider	0.48	1.49	1.97
Brush-tailed Phascogale	0.48	1.49	1.97
Koala	0.34	1.54	1.88

Fauna injury and mortality

Fauna injury or mortality may occur during vegetation clearing activities (particularly during the felling of hollow-bearing trees) or may result from collisions with work vehicles or plant, or accidental entrapment in plant, trenches or other works.

The majority of fauna species recorded within the Proposal site were highly mobile bird and mammal species and these species are likely to be able to move away from vegetation clearing activities quite readily.

Indirect impacts on native vegetation and habitat

Edge effects on native vegetation

The vegetation adjacent to the Proposal site is currently subject to edge effects. The clearing of small areas of vegetation, mostly existing edges, may create some new edges. These new edges could be subject to degradation by the establishment and spread of weeds and enriched runoff from new areas of hardstand.

Trenching may result in impacts to tree roots, and damage to adjacent trees, including heritage trees in Boomerang Park.

Invasion and spread of weeds, pathogens and disease

Seven exotic species recorded in the Proposal site are listed as Priority Weeds in the Hunter region, which includes Port Stephens LGA. Invasive exotic grasses that occur in the Proposal site also represent a threat to native vegetation. An increase in the movement of people, vehicles, machinery, vegetation waste and soil during construction of the Proposal may facilitate the introduction or spread of exotic grasses and other weeds that currently occur within the Proposal site. The areas adjoining the Proposal site are also currently subject to weed invasion, particularly roadside areas and tracks that have substantial cover of exotic grasses. Management measures would be required to minimise the risk of introduction and spread of weeds.

The Proposal has the potential to increase the spread of pathogens that threaten native biodiversity values, such as the soil-borne pathogen Phytophthora (*Phytophthora cinnamomi*). Phytophthora infects roots and is associated with damage and death to native plants. It may be dispersed over large distances in flowing water, such as storm

runoff, or may be spread within a site via mycelial growth from infected roots to roots of healthy plants. Propagules of Phytophthora may also be dispersed by vehicles (e.g. cars and earth moving equipment), animals, walkers and movement of soil. It is listed as a Key Threatening Process (defined as a process which threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community) under BC Act. There may be an increased risk of dispersal of Phytophthora as a result of the construction activities that involve soil disturbance.

Noise, vibration, dust and light spill impacts

The Proposal would be lit during the construction phase if/when nightworks are required. Lighting and other disturbance during nightworks is likely to result in some short-term disruption to the typical behaviour of nocturnal (active) and diurnal (roosting) fauna in the vicinity of the construction. Based on the existing lighting associated with urban areas it is unlikely that this additional temporary lighting would impact the long-term behaviour of nocturnal fauna in these areas. Impacts are more likely in the Kings Hill URA and Hunter Water land, though impacts would be temporary in nature.

Construction activities would generate short-term dust emissions which could impact adjacent vegetation by increasing smothering of leaves and groundcover. Impacts are likely to be minor and localised.

Construction activities would result in localised and temporary noise and vibration impacts, however as most construction areas occur in urbanised areas that are currently subject to ambient noise, this increase in noise and vibration is not expected to have a significant impact on native fauna. Fauna inhabiting native vegetation in Kings Hill URA and Irrawang Swamp, adjacent to the Proposal site, would be most sensitive to impacts.

The impacts of construction noise on the Raymond Terrace Grey-headed Flying-fox camp (the camp) have been considered in further detail.

Grey-headed Flying-foxes would be most sensitive to construction noise during the months of August to February during gestation and creching, and when there is potential for heat stress.

Best practice guidelines for the Grey-headed Flying-fox (DECC, 2008) state that absolutely no work activities should be conducted (loud or quiet) in 'close proximity' to a camp between the months of September to February. The Raymond Terrace Grey-headed Flying-fox Camp Management Plan (Port Stephens Council, 2017) states that any activity likely to disturb flying-foxes should be avoided during the day during August to December and avoided altogether from December to February.

The camp is approximately 50 metres northwest of the Proposal site at its closest point and lies adjacent to Adelaide Street. Existing background noise levels 1.5 kilometres further northeast (adjacent to Adelaide Street) are likely to be similar to those at the camp. Here they range from 33-49 dB(A) at night and 42-59 dB(A) in the day as noted in the NVIA by Resonate (Appendix N). Typical worst-case construction noise levels (LAeq 15 minute) have been modelled at the camp where they range between 70-75 dB(A) (refer to NVIA at Appendix N) about 30 dB(A) above the average day and night noise levels. The majority of works would take place in the day when existing background levels are highest. The species typically exit the camp at dusk to forage through the night and therefore impacts at night are likely to be minor. Reasonable and feasible noise mitigation measures would be implemented when works are occurring in proximity to the Grey-headed Flying-fox camp and are included in Section 7.3.4.

Impacts to MNES

Four EPBC Act listed threatened fauna species are known or considered likely to occur at the Proposal site:

- Regent Honeyeater
- Swift Parrot
- Koala
- Grey-headed Flying-fox.

Significant Impact Assessments using the EPBC Act – Significant Impact Guidelines (DoE 2013) were undertaken for these threatened fauna species. The results of the significant impact criteria assessments determined that the Proposal would not significantly impact on any of the four threatened fauna species assessed. As such the Proposal is not considered likely to require referral to the Australian Government Minister for the Environment for impacts to MNES.

Of note, draft important areas for the Swift Parrot mapped by DPIE would be impacted by the Proposal. The areas to be impacted do not contain eucalypts/foraging habitat and are therefore unlikely to impact the species. Nonetheless, any eucalypts in these areas adjoining the Proposal site would be protected during construction.

Assessment of prescribed biodiversity impacts

Clause 6.1 of the *NSW Biodiversity Conservation Regulation 2017* identifies actions that are prescribed as impacts to be assessed under the Biodiversity Offsets Scheme. Prescribed biodiversity impacts must be assessed in accordance with Section 9.2 of the BAM.

The two prescribed biodiversity impacts in the BAM that are relevant to the Proposal are listed in Table 7-8.

Table 7-8 Prescribed biodiversity impacts specified by the BAM that are relevant to the Proposal

Prescribed biodiversity impact (BAM)	Relevance to current proposal
Impacts of development on the habitat of threatened species or ecological communities associated with human made structures	Several nest boxes are present on Rees James Road in the Proposal site. They may be inhabited by threatened fauna species such as woodland birds. Though they are within the Proposal site, clearing of the trees and nest box removal can be avoided and nest boxes can be relocated if impacted. No other human made structures to be impacted are likely to be inhabited by threatened species or TECs.
Impacts of development on the habitat of threatened species or ecological communities associated with non-native vegetation	Non-native vegetation occurs within and adjacent to the Proposal site. Trees and shrubs associated with non-native vegetation offers foraging, nesting and sheltering habitat to locally occurring threatened birds, arboreal mammals and Grey-headed Flying-fox. The removal of non-native vegetation from the Proposal site may have direct and indirect impacts on these threatened species.

Assessment of serious and irreversible impacts

The OEH (2017) *Guidance to assist a decision-maker to determine a serious and irreversible impact* identifies threatened species and ecological communities most at risk of serious and irreversible impacts. One species identified within the guidance document is known to occur within the Proposal site: the Little Bentwing-bat . However, OEH (2017) specifies that, for this species, only breeding habitat is subject to assessment to determine serious and irreversible impacts. As the Proposal site does

not support breeding habitat for Little Bentwing-bat, no further assessment of serious and irreversible impacts is required for this species.

Vegetation clearing activities

In accordance with the *State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017*, soil and water impacts of native vegetation clearing are required to be considered. Table 7-9 summarises the impacts of each soil and water aspect to be considered as required by the SEPP.

Table 7-9 Soil and water impacts associated with vegetation clearing

Aspect	Impact
Soil erosion	Vegetation clearing activities would result in soil disturbance. In areas that the soil types are prone to erosion, there is a risk of this occurring, though this would be contained to a narrow linear strip along the length of the development site and is likely to be easily managed with the implementation of standard erosion mitigation measures.
Salination	Nil.
Acidification	Acid sulphate soil disturbance from vegetation clearing is a risk in a small part of the development site. Investigations will be undertaken at detailed design to determine potential impacts and an Acid Sulphate Soils Management Plan would be prepared as part of the CEMP (section 7.1 of the EIS) to manage acid sulphate soils if a risk is identified.
Land slip	Land clearing activities are unlikely to result in land slip. Though some of the soil landscapes on the development site have a mass movement hazard, vegetation to be cleared would be contained to a narrow linear strip on relatively flat land and is unlikely to trigger this.
Flooding	Vegetation clearing would result in minimal/negligible changes in local hydrology and are unlikely to affect flooding.
Pollution	Vegetation clearing activities will require use of some machinery and equipment with a risk of chemical or fuel leaks and spills. Offsite water quality pollution could occur in surrounding watercourses. Any impacts are likely to be localised and minor. Spill response management would be implemented as outlined in the mitigation measures in Section 7.2 of the EIS.
Other	Nil.

Assessment of potential impacts to aquatic biodiversity

Construction activities at the Kings Hill URA watercourse would result in soil disturbance over a small area of the channel and potential downstream sedimentation and water quality impacts. Additional potential impacts include spills or leaks including fuels, lubricants and hydraulic oils from construction plant and equipment within the waterway. Impacts would be minimised by the implementation of erosion and sediment controls and spill management. There would be minimal removal of aquatic habitat in the Kings Hill URA watercourse. A small area of aquatic sedges and some instream coarse woody debris may be impacted. Works would be undertaken during periods of no flow so that fish passage would not be impacted. No impacts to threatened fish are anticipated.

Acid sulphate soil disturbance is a risk in a small part of the Proposal site. Investigations will be undertaken at detailed design to determine potential impacts and an ASSMP would be prepared as part of the CEMP (Section 7.1 of the EIS) to manage acid sulphate soils and reduce the risk of water quality impacts if disturbance is likely.

Offsite water quality impacts, including spills and sedimentation could occur in the watercourses of the Irrawang Spillway and Grahamstown spillway during construction in nearby areas. Any impacts are likely to be localised and minor as no works are occurring directly in these watercourses. No impacts to threatened fish are anticipated. No obstruction of fish passage would occur at these waterways.

Impacts to groundwater dependent ecosystems

Potential GDEs with reliance on subsurface groundwater have been mapped within and adjoining the Proposal site in the *Groundwater Dependent Ecosystem Atlas* (BOM, 2019). A total of 1.78 hectares mapped by BOM (2019) as potential GDEs would be removed for the Proposal.

Groundwater may be intercepted during construction. The nature and duration of impacts is unknown and potential GDEs near the Proposal site may be impacted.

Operation

Whilst unlikely, during the operational period there is the risk of the pipelines leaking or spillage during maintenance activities which could potentially impact the downstream water quality of nearby waterways. The extent of water quality impacts would depend on the volume of leakage/spill and spread.

Stormwater runoff volumes and pollutant loads could increase during the operational period at the proposed WWPS. Water quality and flow of nearby receiving waterways could be impacted, though impacts are likely to be minor.

Groundwater may be contaminated from wastewater leakage along the pipeline during operation. The nature and duration of impacts is unknown and potential GDEs near the Proposal site may be impacted.

There is potential for edge effects during maintenance activities through the operational period. Trampling of adjacent native vegetation, rubbish dumping, soil disturbance and weed spread could occur, though this is likely to be minor and localised.

No further impacts on biodiversity are anticipated during operation of the Proposal.

7.3.4 Mitigation measures

Proposal-specific mitigation and management measures to minimise air quality and odour impacts are outlined below.

- A Flora and Fauna Management Plan would be prepared and implemented as part of the CEMP. It will include, but not be limited to:
  - plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas
  - pre-clearing survey requirements
  - procedures for unexpected threatened species finds and fauna handling
  - procedures addressing relevant matters specified in the Policy and guidelines for fish habitat conservation and management (DPI Fisheries, 2013)
  - protocols to manage weeds and pathogens.
- Site inductions for construction staff will include a briefing on the potential presence of threatened species and their habitat adjacent to the Proposal site, their significance and locations and extents of no-go zones
- Clearance of native vegetation would be minimised as far as is practicable
- The limits of vegetation clearing would be marked on plans and on site with signed fencing so that clearing activities are constrained to approved areas only
- Where fauna species are identified in vegetation to be cleared, animals would be removed and relocated to adjacent bushland prior to felling. If this is not possible, the tree would be sectionally dismantled or soft felled under the supervision of an ecologist or wildlife carer, before relocating the animal
- Pre-clearance surveys would be undertaken to identify any breeding or nesting activities by native fauna in hollow-bearing trees and native vegetation. No breeding attempts or active nests should be disrupted, as far as practical
- Prior to clearing, all hollow-bearing trees would be marked by an ecologist so that they are retained and avoided by contractors. Their location would be recorded using a GPS
- Eucalypts in Newbury Park and Boomerang Park adjacent to the subject land would be protected during construction
- A two-stage clearing process for the removal of hollow-bearing trees would occur
- Hollow-bearing tree removal and disturbance of the tree drip line of any hollow-bearing trees would be avoided
- The pipeline trench would be microsited to avoid tree driplines. If tree driplines cannot be avoided, measures would be put in place in accordance with *AS4970-2009 Protection of trees on development sites*
- A pre-start-up check for sheltering native fauna of all infrastructure, plant and equipment and/or during relocation of stored construction materials would be undertaken
- If any pits/trenches are to remain open overnight adjacent to native vegetation, they would be securely covered, if possible. Alternatively, fauna ramps (logs or wooden planks) would be installed to provide an escape for trapped fauna
- Appropriate sediment and erosion controls would be installed prior to the commencement of earthworks and construction, around the impact area, to reduce run-off into adjoining vegetation and downstream to the Coastal Wetland

- Discharge of water into watercourses and overland flow paths that drain to Irrawang Swamp during commissioning of pipes would be avoided. HWC's *Procedure EP0112 – Dechlorination of discharge water* would be followed
- Where possible, earthworks would be undertaken during dry weather conditions. Clearing of vegetation should be avoided during overland flow events
- Soil or mulch stockpiles would be located away from key stormwater flow paths to limit potential transport of these substances into waterways and Irrawang Swamp
- Works at the Kings Hill URA watercourse would be undertaken during periods of no flow so that fish passage is not blocked
- Stabilisation of disturbed areas would be undertaken as soon as practicable after disturbance
- Regular maintenance checks are to occur along the pipelines to prevent leaks
- Construction activities within 250 metres of the Grey-headed Flying-fox Camp as shown in Figure 7-8 (Section 7.3.3 of this EIS) would only occur between March and July
- Reasonable and feasible noise mitigation measures would be implemented when any works occur within 250 metres of the Grey-headed Flying-fox camp (between March and July) and would include the installation of temporary noise barriers where construction activities result in generating noise above average background levels (as outlined in Section 2.4 of the NVIA at Appendix N)
- The Grey-headed Flying-fox camp would be monitored at regular intervals (daily) by a suitably qualified ecologist during any construction activities occurring within 250 metres of the camp (between March and July) to detect any stress response signs. Noise monitoring would occur concurrently. If a stress response is detected, works would cease and mitigation measures would be reviewed/amended. Construction activities within 100 metres of the Grey-headed Flying-fox camp as shown in Figure 7-8 (Section 7.3.3 of this EIS) generating noise above average background levels (as outlined in Section 2.4 of the NVIA at Appendix N) would be limited to a maximum of 2.5 hours in any 12 hour period, preferably at sunrise or sunset or during the night
- Species selection for any revegetation works within the Proposal site would include species commensurate with the mapped PCT
- Equipment used for treating weed infestation would be cleaned prior to undertaking work in the Proposal to minimise the likelihood of transferring any exotic plant material and soil
- Soil stripped and stockpiled from areas containing known weed infestations would be stored separately and is not to be moved to areas free of weeds
- Vehicles, equipment, materials and footwear are to be clean on entry (free of soil, mud and/or seeds) to minimise the introduction or spread of *Phytophthora cinnamomi*.

LEGEND

- Development site
- Grey-headed Flying-fox camp
- Grey-headed Flying-fox camp buffer

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Coordinate System: GDA 1994 MGA Zone 56
Date issued: October 21, 2019
Aerial imagery supplied by NSW LPI

1:5,000 at A4

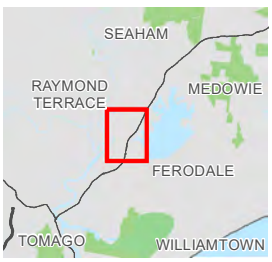


Figure 7-8 Grey-headed Flying-fox camp buffers

Date: 21/10/2019 Path: \\HC-AUS-NS-FS-01\jobs\AA006855\L-GIS\A_Current\B_Maps\Pipeline_EIS\EIS\Biodiversity figures for EIS\KHD_PipelineEIS_017_FlyingFox_A4P_v1.mxd
Created by : AB
QA by : KC

7.3.5 Biodiversity offsets

A number of credits would be required as part of the biodiversity offsets for the Proposal, as outlined below. A Biodiversity Offset Strategy for the Proposal would be prepared prior to construction.

Several areas mapped as PCTs do not require offsets under the BAM as the vegetation integrity scores for these vegetation zones are below the offset threshold of 20 for non-TEC vegetation and also the offset threshold of 17 for threatened species habitat. These areas total 2.33 hectares in area. The 13.07 hectares of non-native vegetation that does not conform to the definition of any PCTs also does not require offset in accordance with Section 10.4 of the BAM.

The required ecosystem credits for the Proposal in relation to native vegetation to be removed is summarised in Table 7-10. Offsets required for the potential threatened species impacted by the project that require species credits are summarised in Table 7-10.

The offsets required for the Proposal site were calculated using the BAMC. A total of 42 ecosystem credits and 110 species credits are required to offset the impacts of the Proposal, summarised in Table 7-10. This calculation would be refined at detailed design.

Table 7-10 Ecosystem and species credits summary

Biodiversity value	Credit requirement
Spotted Gum – Broad-leaved Mahogany – Red Ironbark shrubby open forest (PCT 1590)	7 ecosystem credits
Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter (PCT 1600)	22 ecosystem credits
Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands (PCT 1619)	13 ecosystem credits
Myotis macropus Southern Myotis	1 species credit
Petaurus norfolcensis Squirrel Glider	37 species credits
Phascogale tapoatafa Brush-tailed Phascogale	37 species credits
Phascolarctos cinereus Koala	35 species credits

Delivery of offsets

The available options for delivery of offsets under the Biodiversity Offsets Scheme are as follows:

- An appropriate number and class of like-for-like biodiversity credits may be retired
- If all the required like-for-like biodiversity credits cannot be sourced, an appropriate number and class of variation biodiversity credits may be retired. The use of variation offset rules must be approved by the consent authority. The use of variation offset rules cannot be approved unless an applicant can demonstrate that they have taken reasonable steps to secure like-for-like biodiversity credits

- Alternatively, the Offsets Payment Calculator may be used to determine the cost of all or part of the credit obligations, and a payment may be made to the Biodiversity Conservation Fund.

KHD are currently considering the most suitable strategy for the delivery of these offsets. Confirmation of this strategy would be confirmed as part of detailed design of the Proposal.

7.4 Aboriginal heritage

An ACHAR was prepared in accordance with the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW (OEH, 2010a) and the Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW (OEH, 2010b).

The methodology implemented included:

- A desktop review to determine if Aboriginal sites have been previously identified within the Proposal site. This included a review of the Aboriginal Heritage Information Management System (AHIMS) maintained by OEH
- Consultation with the local Aboriginal community (described below)
- A field survey to identify visible surface evidence of cultural heritage sites and landforms with archaeological sensitivity (described below)
- A significance assessment of the study area including cultural and archaeological values
- A description of statutory requirements for the protection of Aboriginal heritage
- An impact assessment for the recorded Aboriginal sites and areas of archaeological potential
- Provision of recommendations for management and mitigation measures for Aboriginal sites and areas of archaeological potential.

Aboriginal consultation

Aboriginal consultation was undertaken in accordance with the *Aboriginal cultural heritage consultation requirements for proponents* (OEH, 2010c). This included:

- Notification of the Proposal and registration of interest:
  - Advertisement placed in the Port Stephens Examiner on 13 June 2019, with a 14-day period for registration ending 27 June 2019
  - Letters to agencies seeking information on knowledge holders sent on 13 June 2019
  - Letters to identified knowledge holders sent on 2 July 2019, with a 14-day period for registration ending 16 July 2019.
- Participation of Registered Aboriginal Party (RAP) representatives during the field survey undertaken on 30 and 31 July 2019
- A draft copy of the methodology sent to RAPs on 13 August 2019, with a 28-day period for providing comment ending 10 September 2019
- A draft copy of the ACHAR sent to RAPs on 27 September 2019, with a 28-day period for providing comment ending on 25 October 2019
- Three (3) responses from RAPs were received for the draft ACHAR and have been documented in the final ACHAR provided in Appendix F.

Field survey

A field survey was undertaken on 30 and 31 July 2019. The Proposal site was surveyed in five survey units which were bounded by landform, disturbances and streetscape/urbanisation. Areas of ground exposure were inspected for the presence of artefacts or other evidence of Aboriginal occupation. Old growth trees were inspected for possible cultural scars. RAPs were present on both days of surveying to provide appropriate information on the cultural significance of the Proposal site.

7.4.1 Existing environment

Aboriginal context

The Worimi people are the traditional custodians of the Port Stephens area, including the Proposal site. It is generally accepted that the lands of the Worimi were bounded by the Hunter River to the south, the Manning River to the north and the Allyn and Patterson Rivers to the west.

The exact nature of Aboriginal land use patterns in the vicinity of the Proposal site before colonisation is unknown, however it is likely that movement was related to resources and socio-cultural factors such as gatherings and ceremonies. Archaeological studies undertaken in the Lower Hunter have identified a pattern of base camps being located in elevated areas on the margins of swamps and wetlands where food resources are in abundance.

Whilst there are few historic records that directly relate to Aboriginal occupation of the Proposal site, there is a connection between Aboriginal people and the Irrawang Pottery Site[3], which is in the Proposal site. This is depicted in an engraving of the pottery site from the 1830s that shows an Aboriginal family in the foreground (refer to Appendix F for further detail).

Sites identified

Previously recorded Aboriginal sites

No previously recorded sites were identified in the AHIMS search for the proposal site. The closest site is approximately 140 metres to the south-east in Boomerang Park. The most common site type present in the vicinity of the Proposal site is artefacts and open camp site scatters.

Recently recorded Aboriginal sites

Two newly recorded Aboriginal sites were located during the survey for the Proposal and have been registered with the AHIMS, namely: AHIMS ID 38-4-2023 - KHW01 Artefact Scatter and Potential Archaeological Deposit (PAD) and AHIMS ID 38-4-2025 - KHW02 PAD.

RAPs identified potential significance of the southern portion of Newbury Park as it was identified as a modified watercourse and recommended that it be considered for sub-surface testing. However, due to the location and extent of substantial past disturbance in the area from the installation of telecommunications and water infrastructure, archaeological testing has been deemed not to be warranted and the area has not been considered further in this assessment.

No Aboriginal sites or areas of archaeological sensitivity have been identified in the remaining portion of the proposal site.

AHIMS ID 38-4-2023 - KHW01 Artefact Scatter and PAD

AHIMS ID 38-4-2023 - KHW01 is located immediately east of Rees James Road on the end of a gentle ridgeline between a back swamp of the Williams River to the west and what would have been the Campvale/Sandhole Swamp (now the Grahamstown Dam). The site, identified during the field survey in survey unit 3 (SU 3), comprises an artefact scatter and PAD (Figure 7-9). Three artefacts were identified in the scatter 70 metres

[3] The Irrawang Pottery Site is listed as an item of non-Aboriginal heritage significance under the Port Stephens LEP and HWC s170 Register. Further information, including an assessment of potential impacts of the Proposal, is provided in Section 7.5 and Appendix G.

in length and 12 metres wide. The PAD at this site extends 170 metres, is 12 metres wide (limited by the road siding) and is likely 30 centimetres in depth.

AHIMS ID 38-4-2025 - KHW02 PAD

AHIMS ID 38-4-2025 - KHW02 is located north of Rees James Road (Figure 7-10). The area was identified as a PAD during the field survey in survey unit 2 (SU 2) due to its strategic location between the Williams River back swamp and what would have been the Campvale/Sandhole Swamp (now the Grahamstown Dam). The northern portion of this area was occupied by King's Irrawang House, Winery and Barn from 1835 and therefore land surfaces have remained relatively the same (refer to Section 7.5.2 for further information). The area was heavily grassed and thus no surface artefacts were able to be identified. It extends 560 metres and is approximately 100 metres wide. Area A (Figure 7-10) was not surveyed during this assessment, however it is within the Proposal site and there is potential for Aboriginal heritage in this area.

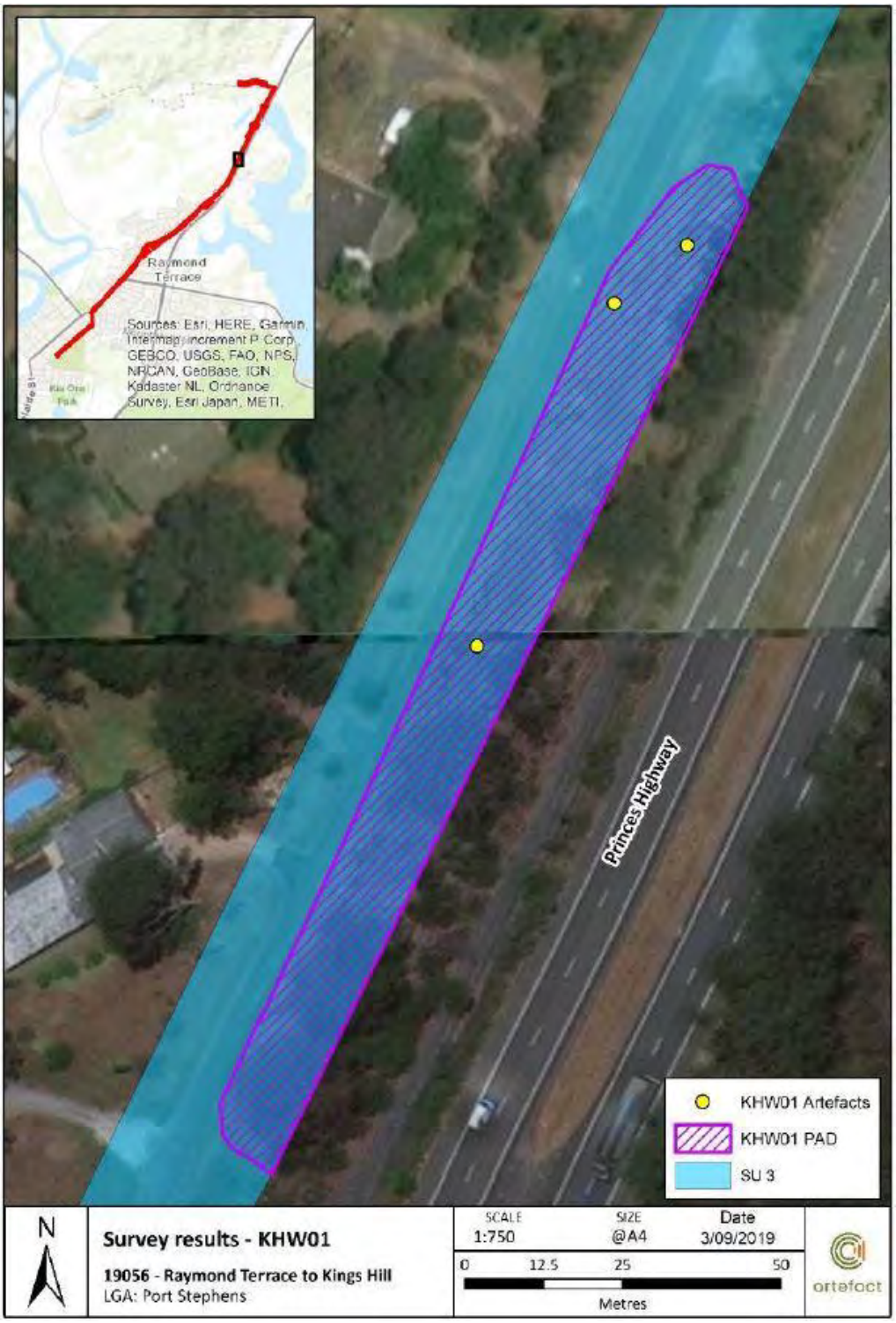


Figure 7-9 AHIMS ID 38-4-2023 - KHW01 (Artefact, 2019)

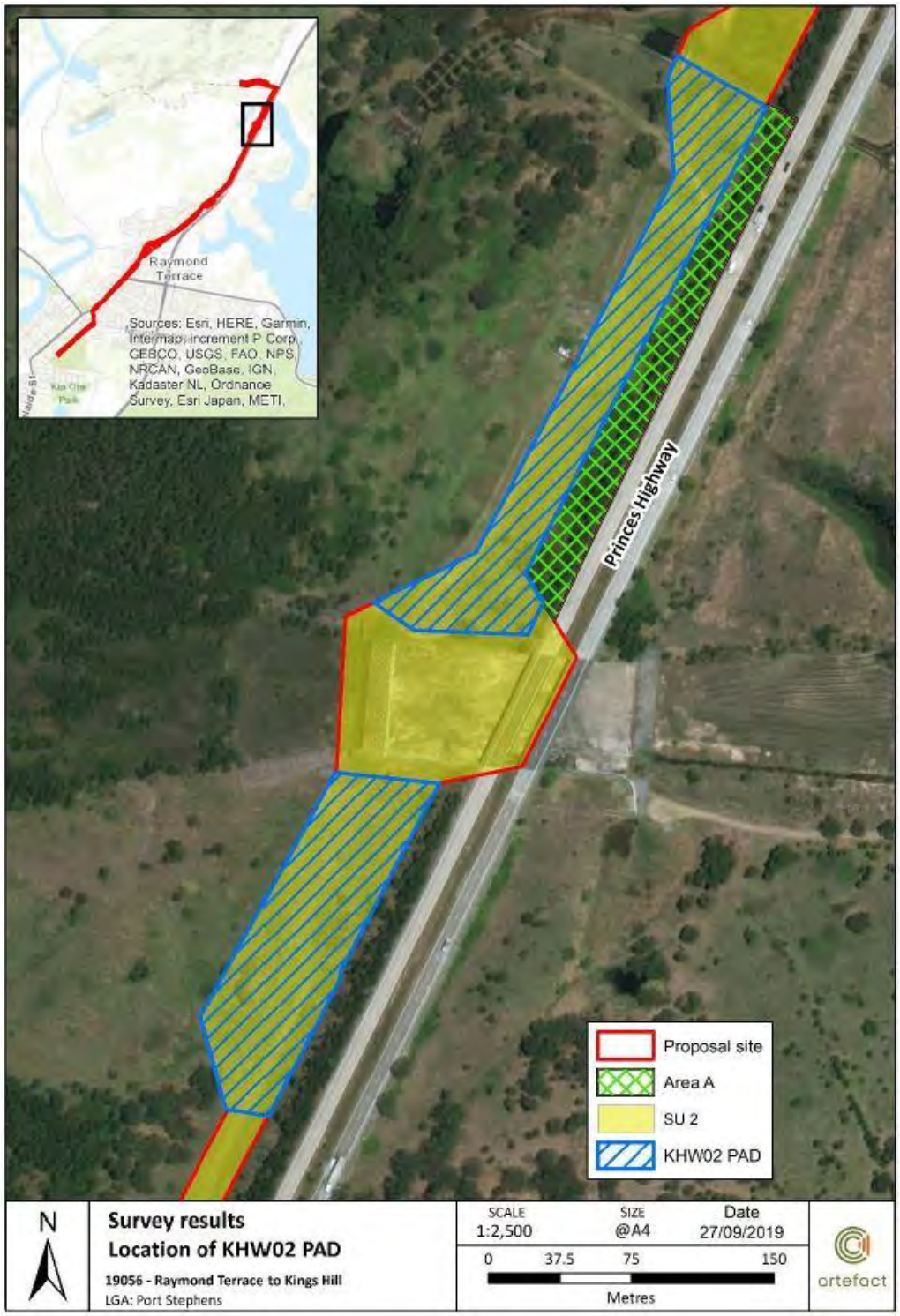


Figure 7-10 AHIMS ID 38-4-2025 - KHW02 PAD (Artefact, 2019)

Significance assessment

Assessing the cultural significance of a place or object means defining why a place or object is culturally important. The Proposal site has been assessed according to the following significance criteria:

- Social/cultural
- Historic
- Scientific/archaeological
- Aesthetic.

Social/cultural values and significance

Social/cultural heritage significance should be addressed by the Aboriginal people who have a connection to, or interest in, the Proposal site. RAPs indicated that the Proposal site is significant as part of a wider cultural landscape that spans the Williams River catchment and Campvale/Sandhole Swamp area, and that it should be regarded as moderate-high in significance.

Historic values and significance

Historic values refer to the association of the place with aspects of Aboriginal history. Historic values are not necessarily reflected in physical objects, but may be intangible and relate to memories, stories or experiences. There are few historic records that directly relate to Aboriginal occupation of the Proposal site, however based the association with the Irrawang Pottery Site, the Proposal site is assessed to have moderate historical significance.

Scientific/archaeological values and significance

Archaeological significance refers to the archaeological or scientific importance of a landscape or area. This is characterised by using archaeological criteria such as archaeological research potential, representativeness and rarity of the archaeological resource and potential for educational values. AHIMS ID 38-4-2023 - KHW01 has been assessed for scientific significance (Table 7-11). Further investigation is required at AHIMS ID 38-4-2025 - KHW02 before its significance can be determined.

Aesthetic values and significance

Aesthetic values refer to the sensory, scenic, architectural and creative aspects of the place. These values may be related to the landscape and are often closely associated with social/cultural values. The southern two-thirds of the Proposal site has been subject to residential development. There is some aesthetic value to the northern portion of the Proposal site which has vistas towards Kings Hill. Overall, the Proposal site has low-moderate aesthetic significance.

Table 7-11 Scientific/archaeological values and significance

Criteria	AHIMS ID 38-4-2023 - KHW01 significance
Research potential	The site has potential for archaeological deposits. The PAD would have originally been larger; however it has been truncated by Rees James Road and the Pacific Highway. The PAD is the only remaining portion of the site in the immediate area and has potential to provide new information of the local area. Local scale: moderate-high significance Regional scale: low significance

Criteria	AHIMS ID 38-4-2023 - KHW01 significance
Representativeness	The site contains stone raw materials and artefacts that are represented and expected in the local area. This is the only site located on a ridge between Kings Hill and Raymond Terrace, and is therefore the only site representing this landform. Local scale: high significance Regional scale: moderate significance
Rarity	The artefacts identified are not rare, however the site is the only one of its kind and the only site on a ridge between Kings Hill and Raymond Terrace. It is also rare as it contains a PAD of which there is only one other in the Raymond Terrace area based on AHIMS results. Local scale: high significance Regional scale: moderate significance
Education potential	Whilst the site demonstrates Aboriginal occupation, it is small in size, located on a road siding and the artefacts are relatively common. Local scale: moderate significance Regional scale: low significance
Overall significance	**Local scale: high significance** **Regional scale: low significance**

7.4.2 Potential impacts

Potential impacts to AHIMS ID 38-4-2023 - KHW01, AHIMS ID 38-4-2025 - KHW02 and the remainder of the Proposal site during construction and operation of the Proposal are considered below.

Construction

There is potential that AHIMS ID 38-4-2023 - KHW01 would be impacted by earthworks and pipe installation. An option would be to contain works to the road verge directly beside the road (i.e. outside of the AHIMS ID 38-4-2023 - KHW01 boundary) to limit vegetation clearance and potential impact to artefacts. Alternatively, during refinement of the alignment at detailed design, it may be determined that AHIMS ID 38-4-2023 - KHW01 cannot be avoided and there would be risk of impact. This would be determined during detailed design.

As the presence of artefacts at AHIMS ID 38-4-2025 - KHW02 is unknown, there is potential risk of impact. Area A identified on Figure 7-10 was not surveyed as part of this assessment, however it within the Proposal site and artefacts may be present. There is potential risk of impact to Area A should the alignment be refined. This would be determined during detailed design.

No Aboriginal sites or areas of archaeological sensitivity have been identified in the remaining portion of the proposal site.

Operation

Operation of the Proposal (i.e. the routine delivery of water, routine pumping of wastewater and inspection and maintenance of infrastructure) would not impact Aboriginal heritage.

Should sub-surface maintenance or repairs of infrastructure be required, potential environmental impacts would be considered as relevant.

7.4.3 Mitigation Measures

- A heritage induction will be provided to all onsite personnel so that they are aware of their obligations under the *National Parks and Wildlife Act 1974* with respect to archaeological artefacts or human remains, including 'stop-work' conditions applicable in the event that any identified or suspected heritage artefacts or human remains are discovered at any time
- In the event identified or suspected historical artefacts or human remains are detected at any time, all disturbance work should immediately cease within 20m of the find and temporary protective fencing erected around this 'no-go zone' pending further management advice from the heritage division of DPIE. If the find consists of or includes human remains, the NSW Police Department and NSW Coroner's office would be contacted
- If works do not impact AHIMS ID 38-4-2023 - KHW01, site boundaries for the scatter and PAD will be delineated by temporary fencing or other visual markers. A heritage consultant is to be on site to determine where the fencing will be installed. Fencing will remain until completion of construction
- A program of test excavation under the *Code of Practice* will be undertaken at AHIMS ID 38-4-2023 - KHW01 (if impacts cannot be avoided), AHIMS ID 38-4-2025 - KHW02 and Area A (adjacent to AHIMS ID 38-4-2025 - KHW02) prior to commencement of earthworks in these areas to determine if there are subsurface artefacts present and to determine their extent. Any newly identified sites will be submitted to AHIMS
- If impact to any artefacts cannot be avoided, an Aboriginal Heritage Impact Permit (AHIP) will be sought from the heritage division of DPIE for surface salvage of artefacts and/or subsurface archaeological excavation. Any AHIP works will be undertaken in accordance with DPIE requirements
- A portion of AHIMS ID 38-4-2025 - KHW02 and Area A is in close proximity to a historic archaeological site. Due to the overlap, the methodology for archaeological test excavation will take into consideration the protection of relics under the *Heritage Act 1977* and the conditions of any s139 exemption and/or s140 permit issues for investigation and/or impact to historic archaeological remains. Non-Aboriginal relics cannot be impacted under an AHIP and historical archaeological investigations cannot impact Aboriginal Objects. Hence, historic heritage and AHIP approvals will need to be held concurrently to allow for the excavation of Aboriginal and non-Aboriginal contexts.

7.5 Non-Aboriginal heritage

The information presented in this section is based on the findings of the Statement of Heritage Impacts (SoHI) undertaken by Artefact (Appendix G).

The SEARs (No. 1291) identified an assessment of impacts to non-Aboriginal heritage is required.

A summary of the relevant SEARs and where they are addressed in this section is provided in Appendix A.

7.5.1 Methodology

A SoHI was prepared using the document *Statements of Heritage Impact* (NSW Heritage Office, 2002) contained within the NSW Heritage Manual as a guideline.

The methodology implemented included:

- Desktop searches of relevant heritage registers
- Review of Proposal drawings and concept design reports
- Background research into the historical development of Raymond Terrace in the vicinity of the Proposal site using the historic plans, historical photographs, newspapers and other primary and secondary historical sources as relevant as referenced
- A site inspection conducted on 30 and 31 July 2019
- Assessment of the Proposal against the heritage significance of the Proposal site. The assessment has been undertaken in light of the conservation processes and principles found in The Burra Charter, *The Australian ICOMOS Charter for Places of Cultural Significance* (2013).

The assessment of potential impacts of the Proposal on non-Aboriginal heritage has considered Clause 5.10 of Port Stephens LEP, which relates to Heritage conservation. The objectives of this clause are as follows:

a) to conserve the environmental heritage of Port Stephens
b) to conserve the heritage significance of heritage items and heritage conservation areas, including associated fabric, settings and views
c) to conserve archaeological sites
d) to conserve Aboriginal objects and Aboriginal places of heritage significance.

7.5.2 Existing environment

Historical Context

First surveyed by Europeans in 1801 (Lt. Colonel Paterson), lands laying at the junction of the Hunter and Williams river systems were made available through grants during the 1820s and would become part of the townships known as Raymond Terrace and Nelson Plains (Ward-Harvey, 2008). The 1830s saw the arrival of steam powered paddle boats along the Hunter and Williams river systems and these encouraged a flourish of local industries utilising the town's shipping facilities to transport goods south to Hexham and Newcastle. Through the 1840s, Raymond Terrace became a significant port for the shipping of New England wool (Ward-Harvey, 2008). As the town grew, some significant construction using local sandstone took place, notably the Catholic and Anglican churches throughout the 1860s (Maitland Mercury and Hunter River General Advertiser, 1861).

Attempts at growing sugar cane and wheat were made during the latter half of the 1800s, however these industries were abandoned in the 1870s (Dungog Chronicle,

1947). Throughout the 1900's, factories were established that contributed to growth in the area, including:

- A butter factory established in 1902, which prospered, and later led to the large OAK factory being established at Hexham
- The Masonite Factory opened in 1939, employing 150 people
- The Courtaulds Factory began making yarns for motor tyres in the 1950's,150 houses were built and British families were brought out to live and help staff the factory
- The French-owned Tomago Aluminium Smelter started up in 1983.

The RAAF Base (established in 1942), and more recently the Newcastle Airport at Williamtown, have contributed greatly to Raymond Terrace's development. Raymond Terrace is today an administrative centre for the popular, extensive, and varied tourist region of Port Stephens.

Summary of heritage listings

There are three heritage items that overlap with the construction footprint, identified in Table 7-12 and described below. There are two items listed on the Hunter Water s170 register: Irrawang Pottery Site (SHI#3630109) and Grahamstown Dam (including the spillways) (SHI# 3630054). The curtilage of the Irrawang Pottery Site is the same as the Port Stephens LEP listing for the same item (ID 127). Four additional heritage items and one conservation area are listed in the Port Stephens LEP located adjacent, however outside of, to the Proposal site (Table 7-13).

No unlisted non-Aboriginal heritage items were identified during the site inspection.

Table 7-12 Heritage items within the construction footprint

Instrument	Listing ID	Name	Address	Lot and DP
LEP s170	A4 ID127	Irrawang Pottery Site	70 Rees James Road	Lot 113 DP 733181
S170	ID60	Grahamstown Dam including Grahamstown and Irrawang Spillways	Grahamstown Moor	Multiple
LEP	I45	"Boomerang Park", including former stone quarry and mature tree planting	17E Irrawang Street	Lot 1, DP 1018979 (Abuts the Proposal site)

Table 7-13 Heritage items adjacent to the construction footprint

Listing Id	Name	Address	Lot and DP
I44	Timber cottage (former mounted police barracks)	11 Irrawang Street	Lot 6, DP 38088
I46	St Brigid's Catholic Church Group—St Brigid's Convent	52 and 54 Irrawang Street	Lots 13 and 14, Section 15, DP 758871
I47	St Brigid's Catholic Church Group—St Brigid's Church Hall	58 Irrawang Street	Lot 16, DP 547042
I81	St Brigid's Catholic Church Group—St Brigid's Church	69 William Street	Lot 12, Section 15, DP 758871

Listing Id	Name	Address	Lot and DP
C2	Raymond Terrace Heritage Conservation Area	Multiple	Multiple

Irrawang Pottery Site, House and Winery

James King was granted a 1920-acre property, named 'Irrawang', approximately 8 kilometres north of Raymond Terrace town centre. While grazing cattle and growing wheat were his primary interests, King began an experimental vineyard and pottery factory in 1831. The first grape vines were planted around 1832, and samples of Irrawang pottery were sent to Sydney as early as 1834.

By this time, Irrawang was substantial in size and several new buildings had been constructed and encompassed the main homestead (Jack & Liston, 1982). The main house itself was 60 by 45 feet with verandahs on each side. A separate kitchen and servants quarters had been constructed close to the house, and the carpenter also had his own separate house and workshop. Additional agricultural outbuildings located close to the house included a granary, storehouse, cornhouse, and several 25 by 14 feet huts, with brick fireplaces and shingled roofs, to house the workmen on site. The homestead also included a 90 ft well and a large ground-level tank for the estate's water supply.

Archaeological work was carried out through the second half of the 20th century that identified that King's pottery manufacturing works comprised two substantial kilns, a horse works, a large workshop and several tanks (Bickford, 1993). These findings exactly align with an illustration of the site made in the mid-1830s (Figure 7-11). The excavations concentrated solely on the Pottery Site, located approximately 400 metres south-east of the Proposal site (Figure 7-12), and did not investigate Irrawang house or winery.

Visible in the 1965 aerial (Figure 7-12), Irrawang house and winery structures, including what appears to be associated fields with substantial enclosures, were still standing until 1969 when they were demolished (Birmingham, 1993). There is reference to King having a stone lined cellar near Irrawang House (Birmingham et al., 1982), but no specific location is identified. King subdivided part of the Irrawang estate in 1842, and the location of farmhouses and outbuildings with these subdivided blocks are unknown (Jack & Liston, 1982).

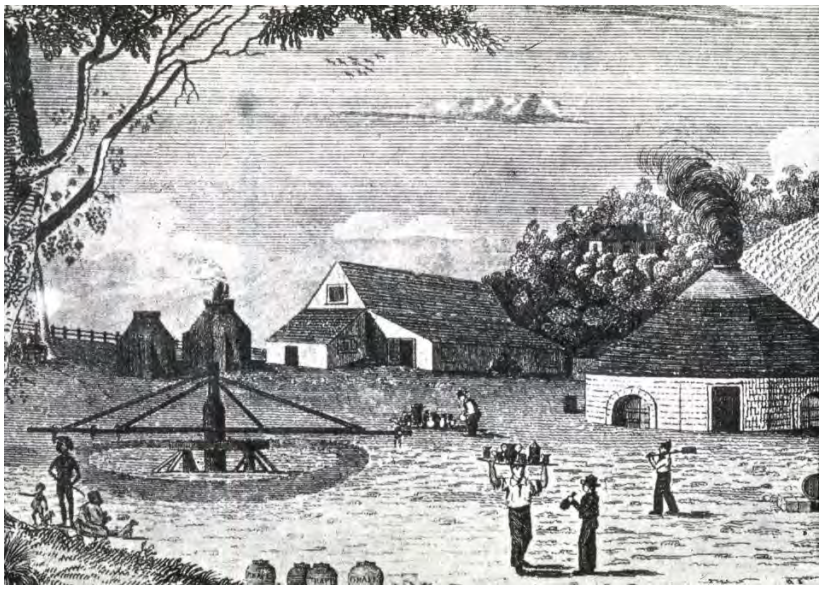


Figure 7-11 Irrawang pottery site c1830s illustration

By 1976, a new residence had been constructed over the old barn, however the installation of the Grahamstown Spillway in the late 1990s/early 2000s cut road access to the residence, and the area had no further residential development.

Bickford (1993) notes that extensive archaeological potential was still present on the site. Possible remnant structures may include the stone lined cellar, the homestead, a well or tank, barns, storehouses and other outbuildings, and the huts or cottages that would have housed King's workmen. Due to the potential inaccuracies of historic plans, the exact location of these structures cannot be pinpointed.

Part of the Proposal site overlaps with the Irrawang house and winey lot.

Grahamstown Dam

In 1953, construction of a dam at the Grahamstown Moors was proposed to meet capacity needed to supply the demand of the Newcastle area. Construction of the Grahamstown Dam commenced in 1957 and was brought into service by the Hunter District Water Supply and Sewerage Board (now HWC) in 1960.

The Irrawang Spillway was constructed to deal with large rainfall events and formed part of the Grahamstown Water Supply Scheme which officially opened 11 July 1964. Capacity of the dam was further upgraded from 1998 into the early 2000s. The Grahamstown Spillway formed part of this upgrade and was completed in 2005.

The Proposal site is traverses both Grahamstown and Irrawang Spillways.

Boomerang Park

Boomerang Park was dedicated as a public reserve in 1837 and subsequently as a recreational reserve in 1892. The park includes a former stone quarry from which stone buildings of Raymond Terrace were built. Mature trees are present throughout the park, including along the Irrawang Street boundary adjacent to the Proposal site.

Potential for archaeological remains

There is potential for archaeological remains associated with King's House and Winery, including field enclosures, stone barn and house remains, outbuildings, cisterns and wells, dumps and evidence of convict occupation to be present within the construction footprint. Although structures identified on the 1965 aerial are likely King's House and Winery, and along the western boundary of the Proposal site, there is moderate potential that these structures were more extensive, and/or extended further into the construction footprint than anticipated. Figure 7-13 identifies areas of moderate and high archaeological potential.

There is no potential for archaeological remains at the Grahamstown and Irrawang Spillways or Boomerang Park where the Proposal site is located.

Significance assessment

Heritage significance is assessed according to criteria established within the significance assessment guidelines provided by the heritage division of DPIE (formerly OEH). Listed heritage items generally have existing assessments and statements of significance. Statements of significance for heritage items within the Proposal site are provided in Table 7-14.

The existing statement of significance for the Irrawang Pottery Site does not make reference to the Kings House and Winery, therefore additional significance assessment has been undertaken for this area (Table 7-15).

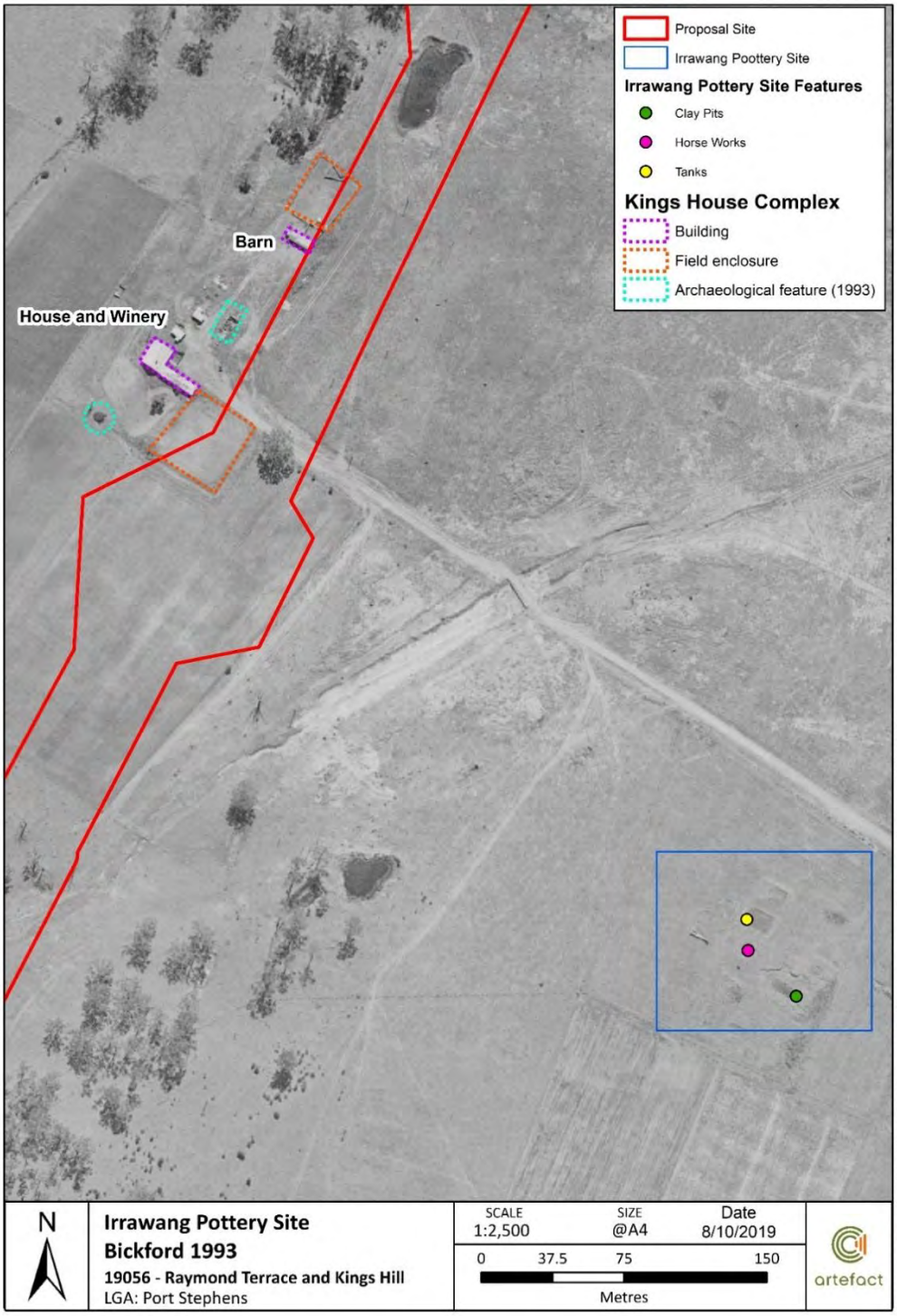


Figure 7-12 Irrawang Pottery Site 1965 aerial

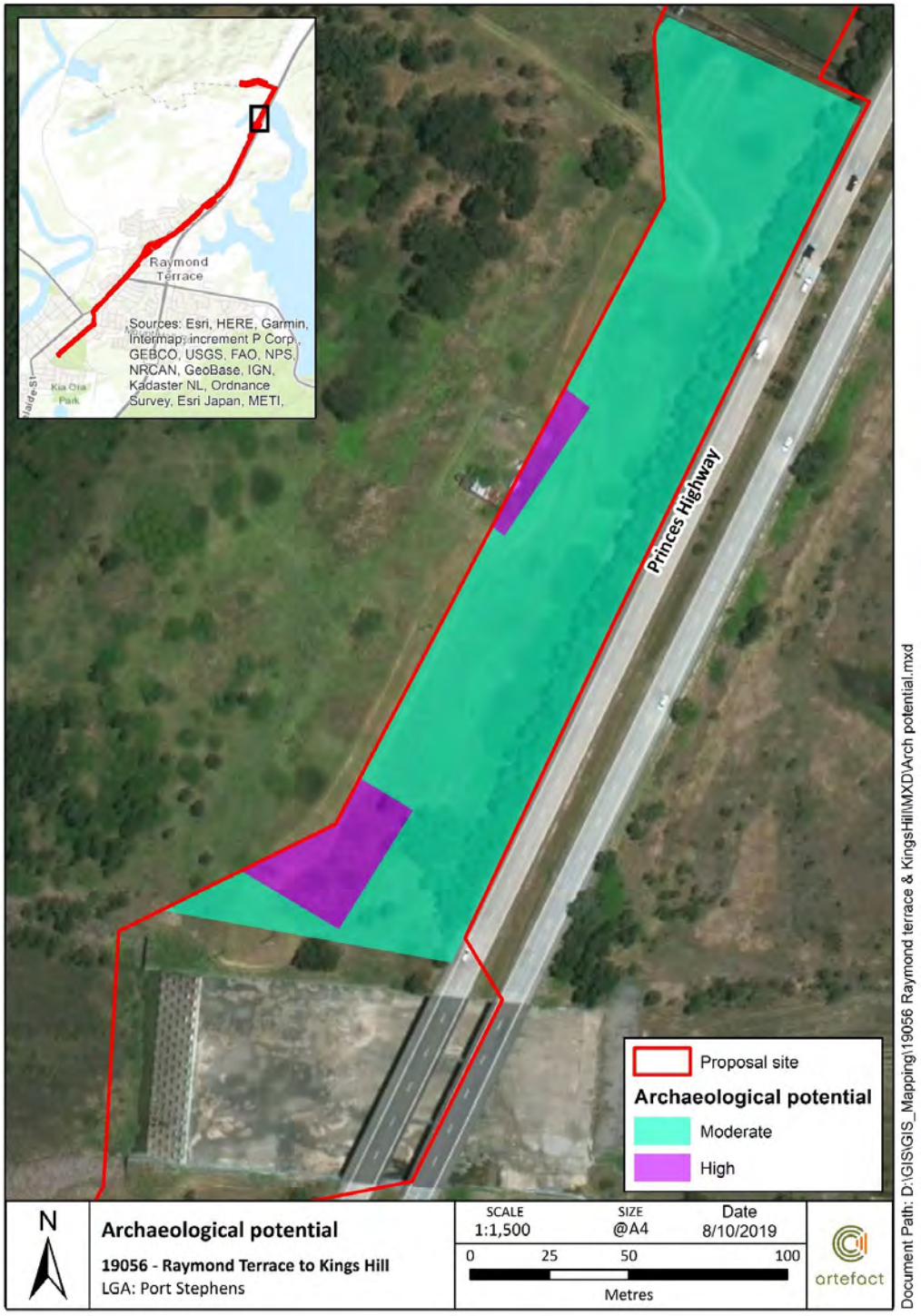


Figure 7-13 Archaeological potential of the Irrawang house and winery area

Table 7-14 Statements of significance (OEH, 2019)

Heritage item	Statement of significance
Irrawang Pottery Site	The Irrawang Pottery Site is the location of the earliest known pottery works in the Hunter Valley, established by colonial entrepreneur James King in 1835. Operating from the 1830s to the 1850s, the pottery works produced domestic pottery and building materials sold throughout the colony. King also established a vineyard on the site. The site has been the subject of some archaeological investigation in the 1960s and 1970s, but further archaeological research to determine the heritage significance would need to be undertaken. Significant collections of Irrawang pottery materials exist in public collections including the Newcastle Regional Museum and the University of Sydney.
Grahamstown Dam	Grahamstown Dam represents the last major expansion of the Newcastle water supply system and was substantially larger than all previous schemes. Unlike many other large-scale metropolitan dams, the Grahamstown Scheme relies on a long, low earth embankment dam which enclosed the Grahamstown Moors and allowed for storage of water from the Williams River. While somewhat altered, the Dam functions much as originally designed and supplies the bulk of the water to the Hunter Water network.
Boomerang Park	Public Reserve provided for when the town of Raymond Terrace was surveyed in 1836. It was dedicated a Recreation Reserve in September 1892 and has been in continuous use since this date.

Table 7-15 Potential significance of archaeological features within the Pottery Site

Archaeological Feature	Description of significance
Field enclosures	These potential remains would provide information on the layout, organisation and construction of the enclosures, as well as potentially providing information on the use of the enclosures. These features would be of local significance and would contribute to the understanding of the site as a whole.
Stone Barn	The stone barn would provide information on early nineteenth century rural construction methods. It may also contain artefactual deposits which reflect the agricultural and winemaking activities which took place on the site. Remains of the stone barn would be of local significance and contribute to the understanding of the site as a whole.
Outbuildings	The outbuildings would contribute information on the layout of the complex as well as use of the site for agriculture and wine making. These features would be of local significance and contribute to the understanding of the site as a whole.
Cisterns and Wells	The cisterns and wells would contribute to the local significance of the Irrawang Pottery Site by providing information on colonial construction methods, water provisioning, as well as domestic, agricultural and wine making activities.
Cesspits	These features have the potential to provide detailed insights into the domestic occupation of the site and thus contribute to the local significance of the site.
Dumps	The potential dump sites may provide detailed insights into the domestic occupation and winemaking activities and thus contribute to the local significance of the site.

Archaeological Feature	Description of significance
Kings House and Winery	These features have the potential to provide detailed insights into the domestic occupation of the site and thus contribute to the local significance of the site.
Convict occupation	Convict settlement in the region beginning in Newcastle in 1801 is amongst the early penal settlements and convict labour contributed to the development of the region. Evidence for convict occupation could have potential to be state significant.

7.5.3 Potential impacts

Construction

Key components of the Proposal that have potential to impact non-Aboriginal heritage are:

- Trenching, underboring, back filling and restoration works
- Vegetation clearance.

The potential impact of these activities on heritage sites within the Proposal site are described below.

Irrawang Pottery Site, House and Winery

Earthworks may impact the remains of King's homestead, field enclosures, outbuildings, cisterns and wells, as well as dumps associated with the Irrawang House, Winery and Barn. Vegetation clearance has the potential to disturb ground surfaces and thus may also impact these archaeological features, as along with the barn remains.

A program of archaeological test excavation would be undertaken during detailed design to identify if relics are present and if present, possibility of avoiding them by refining the pipeline alignment (see Section 7.4.4. for further information).

Grahamstown and Irrawang Spillways

Earthworks and vibration at the Grahamstown and Irrawang Spillways have the potential to impact the fabric and stability of these structures. Vegetation clearance also has the potential to impact the fabric of these structures.

The proposed preferred method for crossing the spillways is underboring. Alternatively, the Proposal would cross over the spillways via the existing Pacific Highway bridge and/or the existing Irrawang Spillway infrastructure. The final chosen method, determined at detailed design, would be undertaken to ensure minimal impact to the stability and fabric of the spillways.

Boomerang Park mature trees

The mature trees in Boomerang Park along the Irrawang Street boundary are within approximately 12 metres of the proposed works. Earthworks in the vicinity of these trees may impact on their root zones, resulting in harm to the trees. Impacts to tree root zones would be avoided where practicable.

Surrounding heritage items

Heritage items adjacent to the Proposal would experience temporary visual impacts during construction. This potential indirect impact would be temporary in nature and areas visually impacted would be reinstated to their pre-construction condition where practicable.

Operation

Non-aboriginal heritage would not be impacted during operation of the Proposal, as the pipeline would be underground, and areas reinstated to their pre-construction condition where practicable.

7.5.4 Mitigation Measures

- A heritage induction will be provided to all onsite personnel so that they are aware of their obligations under the *Heritage Act 1977*
- A stop work procedure for unexpected heritage finds will be included in the CEMP for the Proposal to ensure the appropriate management of historic heritage finds. This involves the obligation to stop ground disturbing works in the area of the find, contacting the project heritage consultant, implementing management strategies as directed by the heritage consultant and/or heritage division of DPIE (formerly OEH) and recommencing works in that area only once clearance has been obtained from the heritage consultant and/or DPIE
- A program of archaeological test excavation will be undertaken either prior to approval or at detailed design to identify if relics are present and if there is a possibility of avoiding them by refining the pipeline alignment. The archaeological test excavation program will be conducted in accordance with a Section 139 (s139) exception issued by NSW Heritage (Department of Premier and Cabinet) under the *Heritage Act 1977*. The application for the s139 exception will be supported by the SoHI (Appendix G) and a standalone excavation methodology (Archaeological Research Design [ARD]). The excavation methodology will include detailed assessment of potential archaeological remains, archaeological potential mapping, and detailed significance assessment
- Based on the results of the s139 archaeological testing, the final pipeline alignment may be refined to avoid as much impact as possible to significant archaeological remains. Depending on the results of the s139 archaeological testing a call-out procedure and/or archaeological monitoring may be required during construction works
- An updated heritage report will be prepared that provides a final assessment of impacts to significant archaeological remains that may result from installation of the pipeline. The updated heritage report will provide recommendations for further approvals and archaeological investigation that may be required
- Where there will be impacts to relics as a result of construction of the Proposal, a Section 140 (s140) permit issued by NSW Heritage under the *Heritage Act 1977* must be in place prior to commencement of works. Archaeological salvage excavation may also be required under the s140 permit prior to commencement of pipeline installation works
- Any archaeological remains identified through background research and the s139 archaeological test excavation program in the immediate vicinity of the works area will be identified and mapped in the CEMP and physically cordoned off during works to prevent any inadvertent impacts
- Vibration impacts to heritage items must not exceed the recommended screening level of 7.5 millimetres per second. Vibration monitoring occurs during works in the vicinity of heritage items is recommended. Vibration monitoring and inspection by a structural engineer who is familiar with heritage structures should be undertaken

(where required) if the predicted ground-borne vibration levels exceed the anticipated rating and/or cause impacts to significant fabric

- A qualified arborist will prepare a report as part of detailed design, post approval and as relevant, to determine whether there will be impacts to the root zones of the heritage listed trees in Boomerang Park. Advised additional mitigation measures from this report are to be implemented as required.

7.6 Waste management

This section provides an assessment of the waste-related impacts of the Proposal during both construction and operation, and presents the management and mitigation measures associated with these impacts.

The key issues which have been raised in the SEARs (No. 1291) under 'waste management' relate to an assessment of the impacts of construction and operation of the Proposal. The SEARs relating to waste management, and a summary of where they are addressed, are presented in Appendix A.

7.6.1 Methodology

Assessment of waste management impacts has been conducted as follows:

- Review of relevant waste strategies and guidelines
- Identification of the predicted waste streams and quantities that would be generated during construction and operation of the Proposal
- Determination of the appropriate disposal of generated waste
- Identification of mitigation measures to implement efficient use of resources.

7.6.2 Existing environment

As stated in Section 2 of this EIS, the site is relatively greenfield at the northern portion of the Proposal site. The southern portion of the Proposal site is located within Raymond Terrace and traverses urban areas characterised by low density residential development. All waste generated by residential developments is collected by Council's (or contractor's) waste management services. Therefore, the site is generally devoid of waste within greenfield and residential areas.

7.6.3 Potential impacts

Compliance with waste strategies and policies

The following section summarises the relevant waste strategies and policies, and outlines how the waste management changes under the Proposal would impact the requirements of these strategies and policies.

Waste Avoidance and Resource Recovery Strategy 2014-2021 (WARR Strategy)

The *NSW Waste Avoidance and Resource Recovery Strategy 2014-2021* (WARR Strategy) sets out a framework for waste management, including long-term directions aligned with the NSW Government waste reforms in *NSW 2021: A plan to make NSW number one*.

The key areas identified in the WARR Strategy aim to support investment in infrastructure, while encouraging innovation and improving recycling behaviour. They also promote developing new markets for recycled materials, as well as reducing litter and illegal dumping.

The WARR Strategy has six key result areas (KRAs) and corresponding targets and approaches to achieve the targets. These include the following:

1. Avoid and reduce waste generation
2. Increase recycling
3. Divert more waste from landfill
4. Manage problems wastes better

5. Reduce litter
6. Reduce illegal dumping

The *Waste Avoidance and Resource Recovery Report 2017-2018* (WARR Report) aims to update the WARR Strategy by establishing new targets for the KRAs that are identified as priorities within the WARR Strategy. The WARR Report contains robust and accurate waste generation and recycling data which is to be used as a benchmark for measuring progress on targets related to waste generation, recycling and diversion.

Some unsuitable material may be generated during the construction of the Proposal. Unsuitable material is surplus material that cannot be used beneficially elsewhere onsite. This material would need to be disposed of offsite. The Proposal would act to achieve WARR Strategy's KRAs Nos. 2 and 3 ('increase recycling' and divert more waste from landfill'). Where feasible and reasonable, the approach to managing surplus material generated during construction would be to re-use or recycle the material on-site. Where there is no capacity to reuse the excess material, or in the event of contamination, it would be disposed offsite at an adequate licensed facility.

Waste Classification Guidelines

The *NSW Waste Classification Guidelines* (EPA, 2014) would help on the assessment, classification, management and disposal for all waste on the proposal. The waste classification process under the guidelines follows the following principles:

- Where practicable, safe and appropriate, it is desirable to separate a mixture containing different classes of wastes before classifying them separately
- Two or more classes of waste must not be mixed in order to reduce the concentration of chemical contaminants. Dilution of contaminants is not an acceptable waste management option. This includes the addition of water to any waste before laboratory analysis for the purpose of waste classification
- When classifying waste using chemical assessment it is not appropriate to exclude sample results. Selectively choosing sample results to classify waste introduces bias and violates fundamental statistical principles. There must be scientifically valid reasons for the exclusion of sample results.

Disposal of surplus material offsite to other public land is permitted or to private land with the permission of the landholder. Before any surplus material is disposed offsite, it would be classified in accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* (EPA, 2014) and the *Protection of the Environment Operations Act 1997* (POEO Act). The volume of surplus material would be calculated during detailed design, and subsequent appropriate management would be prescribed.

Construction

The Proposal would result in waste generation primarily during construction as a result of civil works and vegetation clearing. The construction stage of the Proposal would generate a number of waste streams, including:

- Spoil and excavation waste: The spoil generated from construction is likely to be predominantly spoil with some clay. As stated in Section 4.3 of this EIS, the Proposal would require the excavation of approximately 78,000 cubic metres of excess material and topsoil during trenching and underboring. Where practicable and subject to its suitability, excavated material would be reused on-site for foundation preparation, levelling works, access track maintenance and backfilling of trenches and boring pits at the completion of construction.
- Green waste: This waste stream would be generated from clearing relatively small amounts of vegetation, mainly consisting of existing landscaped areas on the Pacific Highway road reserve. Waste would include tree branches, green waste and weeds. Tree branches and green waste would generally be mulched (where not

contaminated by weeds) and beneficially reused onsite for landscaping as a first preference, or offsite in the local area.

Key additional waste streams that could be generated include:

- Excess building materials (excess PVC, plastics, timber (form formwork) and packaging materials)
- Demolition materials (concrete/asphalt from road and footpath bases)
- Surplus excavated material (natural rock, soil sand and clay)
- Waste produced from the maintenance of various construction plant and equipment including liquid hazardous waste, fuel and oils
- General waste, including food, paper and other waste generated by construction workers
- If encountered, acid sulfate soil and treated acid sulfate soil (refer to Section 11 of this EIS for further discussion)
- Sewerage from ancillary sites.

The specific quantities of these waste streams would be determined during detailed design.

These waste streams could have potential impacts in terms of:

- Excessive volumes of waste generated on-site
- Excessive volumes of waste sent to landfill from the inadequate collection, classification and disposal of waste
- Contamination of soil, surface water and groundwater from inadequate waste handling.

These waste streams would need to be managed appropriately to ensure to minimise waste generation and avoid transportation to the landfill.

Operation

Limited volumes of waste are likely to be generated from the operation of the Proposal. Waste would most likely be derived from the water and wastewater channel and access track maintenance activities. Waste streams and potential waste impacts are likely to include:

- Green waste from maintenance of surrounding vegetation
- Vehicle oils and greases from maintenance vehicles.

Like construction waste, operational waste would need to be disposed appropriately to avoid negative impacts to the environment. Operational waste management and disposal will be undertaken in accordance with the relevant policies and guidelines outlined in Section 7.6.3 above.

7.6.4 Mitigation measures

Proposal-specific management measures to minimise waste impacts are outlined below.

Construction

Measures to mitigate the effect of the construction waste streams would be incorporated into the Proposal's CEMP, including the following information:

- Characterisation of construction waste streams
- Procedures to manage construction waste streams, including handling, storage, classification, reuse and tracking
- Mitigation measures for avoidance and minimisation (including reuse) of waste materials
- Roles and responsibilities for ensuring compliance with the mitigation measures
- Training, monitoring, reporting and reviewing requirements to ensure compliance with the mitigation measures.

Operation

The major sources of waste during operation would be limited to maintenance works. Where feasible and reasonable, waste would be managed, reused and recycled in accordance with the WARR Strategy.

7.7 Air quality and odour

The information presented in this section is based on the findings of the Air Quality Assessment (AQA) undertaken by Northstar Air Quality Pty Ltd (Northstar) (refer to Appendix M).

The key issues which have been raised in the SEARs (No. 1291) identified an assessment of air quality-related issues, including impacts on sensitive receivers surrounding the Proposal site as a result of construction activities and operations. Each of these impacts has been assessed against relevant air quality criteria, detailed in Section 7.3.

A summary of the relevant SEARs and where they are addressed in this section is provided in Appendix A.

7.7.1 Methodology

The methodology implemented in the AQA for the Proposal includes:

- Identification of sensitive receptor areas that may be affected by the Proposal
- Review of meteorological conditions, ambient air quality and climatic features within the Proposal site and surrounds
- Identification of potential sources of air and odour emissions associated with construction and operational activities
- Assessment of potential dust generation associated with construction and operational activities, including potential impacts on sensitive receivers
- Identification of mitigation measures to minimise potential air quality and odour emissions
- The Proposal has been assessed against the following legislation, policies and guidelines:
  - *Protection of Environment Operations Act 1997* (POEO Act)
  - *Port Stephens Local Environmental Plan 2013* (Port Stephens LEP)
  - *Approved Methods for the Modelling and Assessment of Air Quality in* NSW ('the Approved Methods', NSW EPA, 2017)
  - *IAQM Guidance on the Assessment of Dust from Demolition and Construction* (UK Institute of Air Quality Management, 2016)
  - *Technical framework: Assessment and management of odour from stationary sources in NSW* ('Odour Technical Framework', DECC, 2006)
  - *Hunter Water Corporation Guidelines* (HWC, 2008)
- The methodology implemented to determine the risk of impact is outlined below:

Air Quality Standards

The Approved Methods (EPA, 2017) contains air quality guidelines which define the ambient air quality criteria for NSW. The standards associated with pollutants anticipated to be emitted during construction of the Proposal are outlined in Table 7-16.

Table 7-16 EPA's Air Quality Standards

Pollutant	Averaging period	Units	Criterion
Particulates (as PM_{10})	24 hours	$\mu g \cdot m^{-3}$ (a)	50
	1 year	$\mu g \cdot m^{-3}$	25
Particulates (as $PM_{2.5}$)	24 hours	$\mu g \cdot m^{-3}$	25
	1 year	$\mu g \cdot m^{-3}$	8
Particulates (as Total Suspended Particulate [TSP])	1 year	$\mu g \cdot m^{-3}$	90
Deposited dust(d)	1 Year	$g \cdot m^{-2} \cdot month^{-1}$(b)	2
		$g \cdot m^{-2} \cdot month^{-1}$(c)	4

Notes: (a): Micrograms per cubic metre of air
(b): Maximum increase in deposited dust level
(c): Maximum total deposited dust level
(d): Assessed as insoluble solids as defined by AS 3580.10.1

Odour Assessment Criteria

The Odour Technical Framework (DECC, 2006) recommends that no individual should be exposed to ambient odour levels greater than 7 odour units (OU). Table 7-17 shows a summary of odour performance goals for various population densities. Given that residential areas would be in close proximity to the Proposal site (including the WWPS), the population of affected community is considered to be 'high' and therefore, an odour criterion of 2 OU would be applicable for the Proposal.

Table 7-17 Odour Criteria - Odour Technical Framework

Population of Affected Community	Impact Assessment Criteria for Complex Mixture of Odours (OU)
Urban area (≥2000)	2.0
500 – 2000	3.0
125 – 500	4.0
30 – 125	5.0
10 – 30	6.0
Single residence (≤2)	7.0

Impact magnitude

Construction impacts from the Proposal have been analysed using a risk-based assessment procedure in accordance with the IAQM Guideline, as outlined in Table 7-18. Construction activities at the Proposal site include earthworks, transportation of material, and construction of the water/wastewater pipelines and WWPS. For the purpose of this assessment, a screening distance of 350 metres has been applied to the construction activities at the Proposal site. The 350-metre buffer distance has been determined in accordance with the maximum screening distance established in the *IAQM Guidance on the Assessment of Dust from Demolition and Construction* (2016).

Table 7-18 Methodology - Impact Magnitude (Source: Northstar)

Category	Distance from Proposal site	Impact Magnitude
Large	<50 metres Associated with major construction works	• Widespread major short-term exceedance of air quality standards resulting in hospitalisation of members of the public.
Medium	<50 metres All other construction works	• Local minor ongoing exceedance of air quality standards. • Widespread minor short-term exceedance of air quality standard. • Ongoing impacts on wellbeing and air quality complaints.
Small	50-350 metres All other construction works	• Isolated and localised exceedance of air quality standards. • Short-term impacts of wellbeing. • Complaints received about air quality that are resolved within days.
Negligible	>350 metres All other construction works	• Air quality standards met at all times.

Land Use Sensitivity

Locations may be attributed different sensitivities based on the land use, and may be classified as having 'high', 'medium' or 'low' sensitivity relative to dust deposition and human health impacts. This scale is derived directly from the IAQM Guideline and has been applied by the AQA (Appendix M).

Specific to this assessment, each land use within 350 metres of the Proposal site has been given a land use sensitivity as seen in Table 7-19. Equivalent land uses have been amalgamated for ease of reference.

Table 7-19 Land Use Sensitivity surrounding the Proposal Site (Source: Northstar)

Land Use	Value
Residential (General, Low and Medium Density)	High
Public and Private Recreation	Medium
Environmental Conservation	Medium
Neighborhood Centre, Local Centre, Commercial Core, Mixed Use	Medium
Light Industrial	Medium
Rural Landscape	Low
Special Activities and Infrastructure	Low

Land Use Risk

The risk matrix constructed from the impact magnitude and the land use sensitivity is shown in Table 7-20.

Table 7-20 Land Use Risk - Methodology (Source: Northstar)

Category		Impact Magnitude			
		Large	**Medium**	**Small**	**Negligible**
Land Use Sensitivity	**High**	High Risk	Medium Risk	Low Risk	Negligible
	Medium	Medium Risk	Medium Risk	Low Risk	Negligible
	Low	Low Risk	Low Risk	Negligible	Negligible

7.7.2 Existing environment

Sensitive receivers

As outlined above, sensitive receivers for air quality/odour assessment purposes have been identified within 350 metres of the Proposal site. Sensitive receivers surrounding the Proposal site have been identified based on the land use zones in the Port Stephens LEP. These comprise a number of sensitive receptor areas, including residential, commercial and recreational areas, as seen in Figure 7-14. The identification of individual receptor locations is not considered necessary given the linear nature of the Proposal.

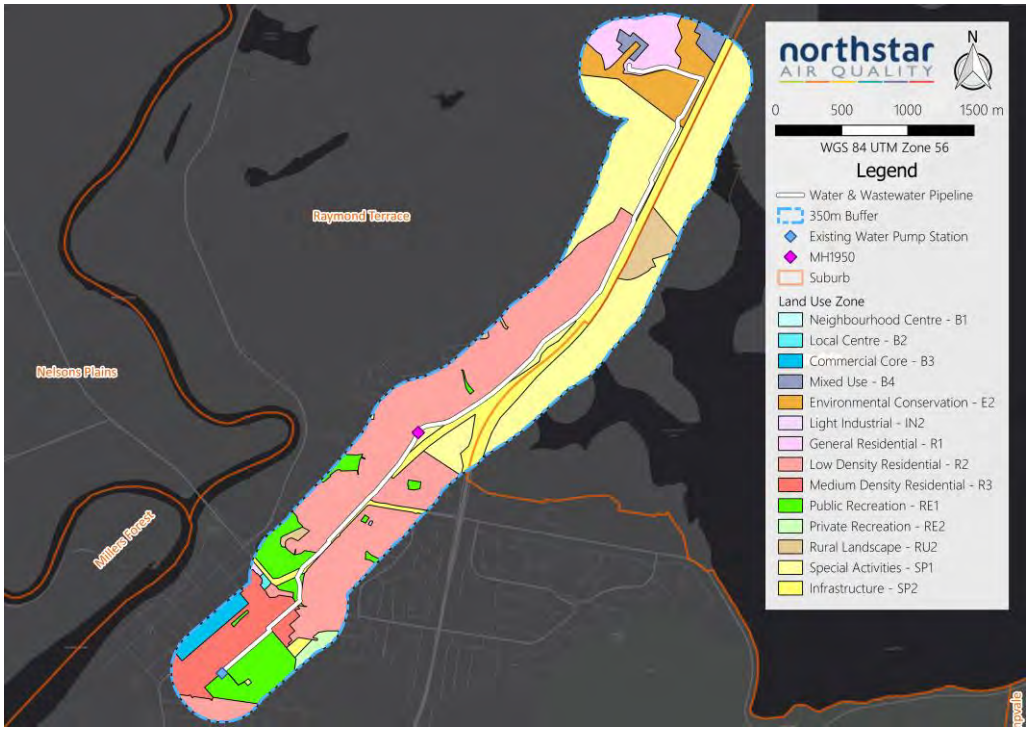


Figure 7-14 Sensitive receivers - land uses surrounding the Proposal site (Source: Northstar)

Topography

As noted in Section 7.2 of this EIS, elevations along the Proposal site range from approximately 33mAHD to 4mAHD. The local topography may alter the path that a pollutant may take between the source of emission and the point of impact. As assessed in the AQA, the more 'complicated' the topography (i.e. the greater the vertical range in height over horizontal distance, such as hills and valleys), the more likely pollutant dispersion could occur by terrain-affected airflow.

The topography between the Proposal site and the location of the nearest sensitive receptors is not considered 'complicated' and therefore, modelling of topographical effects is not considered necessary as part of the AQA for this Proposal.

Meteorological conditions

Meteorological data relevant to the Proposal site has been obtained from the Australian Government Bureau of Meteorology (BoM) for Williamtown RAAF Automatic Weather Station (AWS) (Station ID 061078), located approximately 7 kilometres to the southeast of the Proposal Site.

The majority of wind speeds experienced at Williamtown AWS over a 5-year period (2013 - 2017), are generally in the range of 1.5 metres per second (m·s-1) to 8.0 m·s-1 with the highest wind speeds (greater than 8 m·s 1) occurring from a north-westerly direction. Winds of this speed are not uncommon, occurring during 9.4% of the observed hours over the 5-year period at Williamtown AWS. Calm winds (<0.5 m·s-1) occur during 6.8% of hours on average across the 5-year period.

A windrose outlining the wind speed frequency and direction is shown in Figure 7-15.

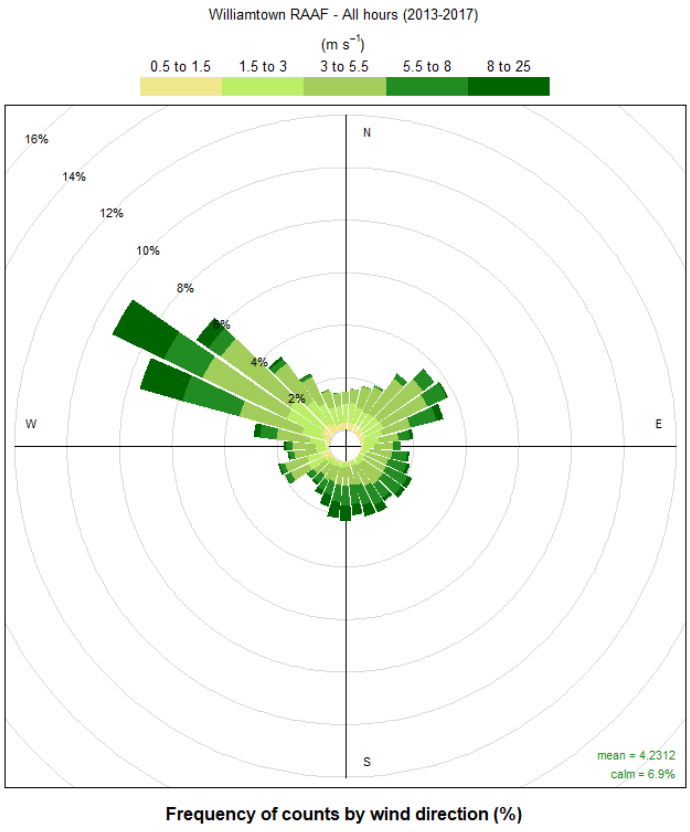


Figure 7-15 Annual windrose for Williamtown RAAF AWS (2013-2017)

Climate

Climate statistics relevant to the Proposal site have been obtained from Williamtown AWS records. Maximum temperatures at Williamtown AWS have been recorded in January, with a mean maximum temperature of 28.2°C between the years 1949 and 2019. Historically, the mean minimum temperature has been recorded in July, as 6.4°C.

The mean rainfall generally peaks in June, with an average precipitation of 125.2 mm. The lowest monthly mean rainfall historically recorded at Williamtown AWS is in September, with 60.4 mm.

Ambient air quality

The Air Quality Monitoring Station (AQMS) at Beresfield is the closest to the Proposal site, located approximately 8.5 kilometres southwest to the Proposal site. Particular matter concentrations measured at Beresfield AQMS provide an appropriate representation of air quality which might be experienced at the Proposal site.

24-hour average PM_{10} and $PM_{2.5}$ concentrations as measured at the Beresfield AQMS are presented in Figure 7-16 and Figure 7-17, respectively. Annual average PM_{10} concentrations measured at Beresfield AQMS in 2018 were 21.6 μg· m-3 (below the criterion of 25 μg· m-3). Additionally, $PM_{2.5}$ concentrations were all below the 24-hour criterion of 25 μg· m-3, with a measured annual average $PM_{2.5}$ concentration of 8.7 μg · m-3. This is above the annual average $PM_{2.5}$ criterion of 8 μg· m-3.

PM_{10} concentrations have been below average due to intense drought conditions and an increase in the frequency of widespread dust storms throughout the year, as has been recorded by OEH (2019). Similarly, $PM_{2.5}$ concentrations are above the national standard, mainly due to an increase in particles due to the intense drought (OEH, 2019). Further detail is provided as part of the AQA.

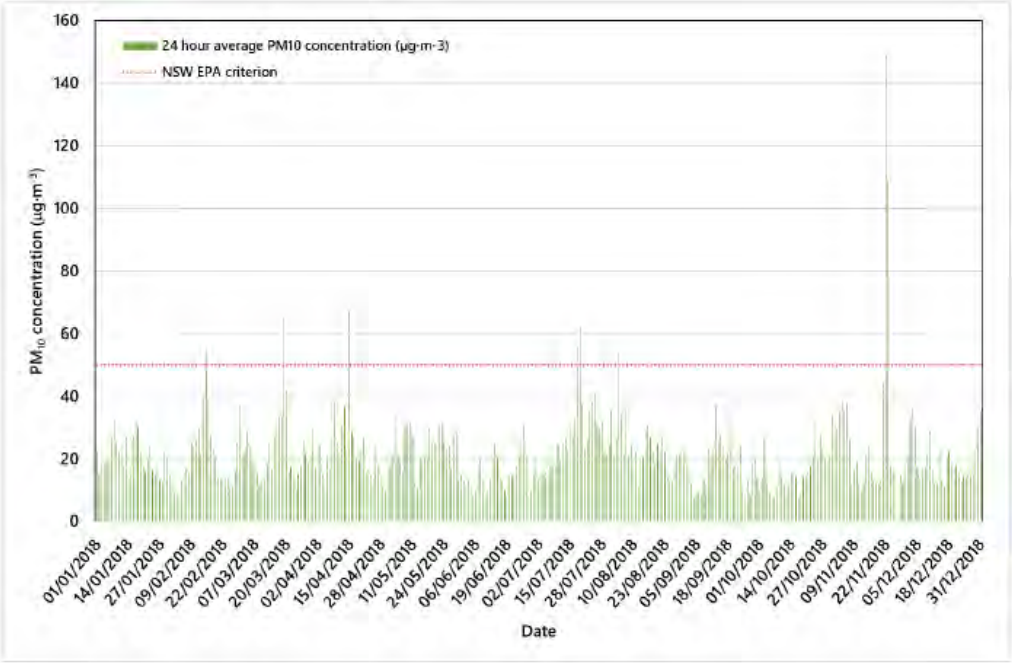


Figure 7-16 Measured PM_{10} concentrations - Beresfield AQMS, 2018 (Source: Northstar)

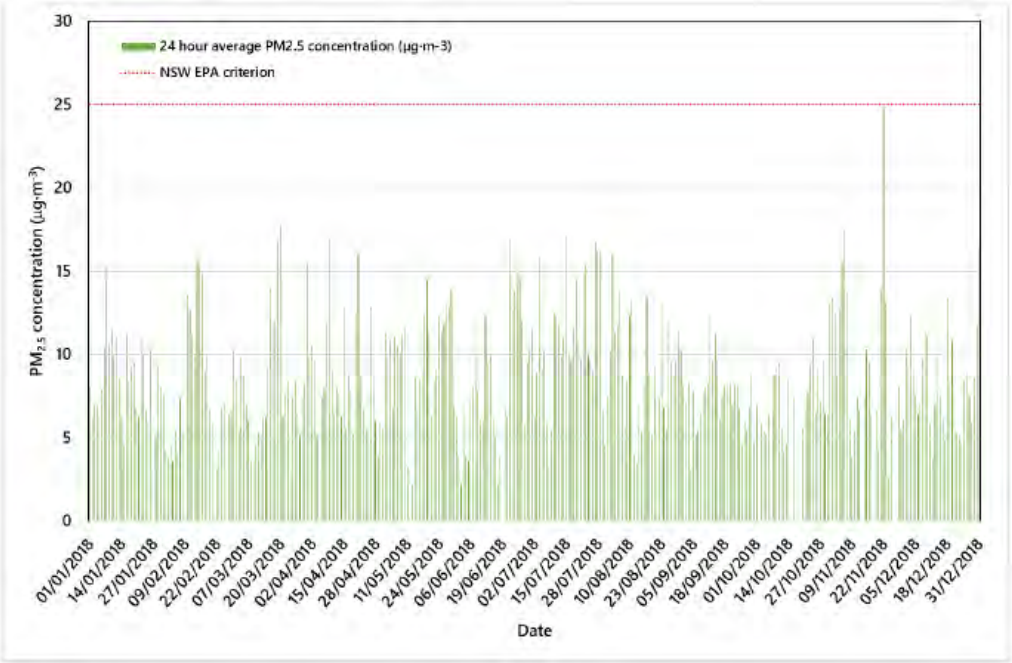


Figure 7-17 Measured PM2.5 concentrations - Beresfield AQMS, 2018 (Source: Northstar)

7.7.3 Impact Assessment

Construction

Potential for Emissions to Air

The majority of the potential impacts as a result of the Proposal would occur during construction phase. Construction activities would generate short-term emissions of particulates (construction dust) and generally, these are related to fugitive emissions that may affect sensitive receives in close proximity to the construction activities. However, construction particulate matter is generally typified by heavier size fractions, which would primarily result in amenity impacts (such as deposition and/or visible dust plumes, rather than health-related impacts). The risk of health-related impacts associated with smaller particles (less than 10 micrometres in diameter) would be negligible.

Pre-Mitigated Risk

No demolition works are required given the nature and layout of the Proposal. However, earthworks would be undertaken at the Proposal site as part of the construction activities. The construction of the WWPS would result in minor impacts which are addressed in the section below.

The resulting risk of air quality impacts (without mitigation) is calculated as outlined in Table 7-20 above and Figure 7-18.

As shown in the figure below, with no mitigation measures in place, there is a 'medium' to 'negligible' risk of human health, and dust soiling impacts associated with construction activities at all directions from the Proposal site. This pre-mitigated risk assessment is used to identify appropriate mitigation measures to be applied to during construction.

Analysis of the alignment shows that the majority of the Proposal would intersect with land uses associated with 'medium' and 'low' risk construction activities. Following a review of the mitigation measures related to 'low' risk construction activities, it is

considered that the application of mitigation measures associated with ‘medium’ risk sites would be equally appropriate.

A range of mitigation and management measures are included in Section 7.7.4, which would result in construction risks to be reduced to ’negligible’.

Note: No colour shading = negligible impact magnitude (>350m).

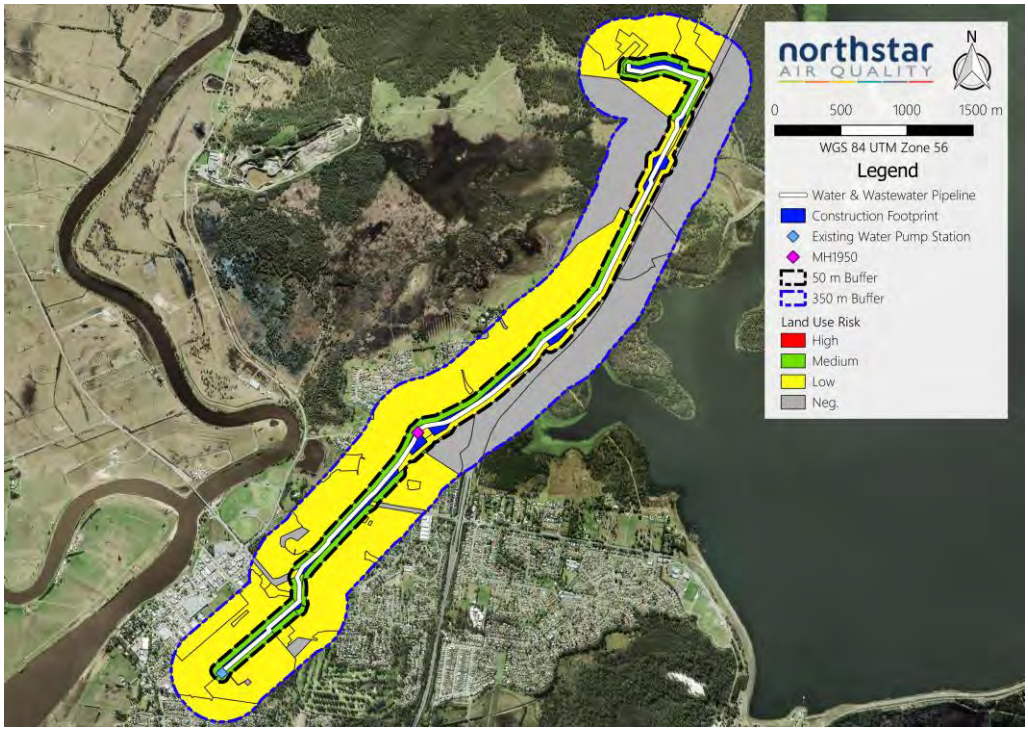


Figure 7-18 Risk of air quality impacts from construction activities (Source: Northstar)

Residual Consequence

During general construction activities, the aim is to prevent significant effects on sensitive receptors through the use of effective mitigation measures that minimise air emissions. Experience have demonstrated that this is achievable in most cases.

Given the extent of the Proposal site, the distance to sensitive receptors and of the construction activities, residual risks associated with fugitive dust emissions from the Proposal post-mitigation are anticipated to be negligible.

Operation

Air emissions from the operation of the Proposal would be negligible. Operational activities that may be required for the Proposal involve routine maintenance of the proposed pipelines and WWPS, which would give raise to short-term and localised dust impacts. Any impacts related to operational activities can effectively be minimised through good practice and adherence to HWC standards.

Other maintenance activities at valve, hydrant and scour locations may generate odour emissions, which would also be short-term in nature. The proposed WWPS would be a potential source of odour. Impacts associated with the WWPS would involve emissions from the pump well, valve pit and any educt ventilation stacks installed within the WWPS location.

HWC standard design for wet well and pit covers is for these to be 'gas tight' (HWC, 2009). Odour emissions from gas tight covers are therefore anticipated to be negligible (zero). With regard to odour control in the WWPS, HWC also provides guidance on odour control systems (HWC, 2008). Any odour emitted through the educt ventilation stack can be appropriately managed to ensure that impacts on the surrounding locality remain below the odour criterion of 2 OU as established in the criterion in Section 7.7.1.

As noted in Section 5.3 of this EIS, the design and operation of the Proposal would be in accordance with the conditions in the current Raymond Terrace WWTW Environmental Protection Licence (No. 217).

The POEO Act emphasises the importance of preventing 'offensive odour' and therefore, the principles contained within the POEO framework are applicable. Any odour emissions would be appropriately managed to ensure that impacts on sensitive receivers would be below the odour criterion established under the POPEO Act. Accordingly, the appropriate mitigation measures have been identified in the following section.

7.7.4 Mitigation measures

Proposal-specific mitigation and management measures to minimise air quality and odour impacts are outlined below.

Construction

The following mitigation measures would be implemented during construction of the Proposal:

- Implementation of dust protection measures during construction activities, such as solid screens or barriers around dust generating activities. Other measures include covering or fencing stockpiles to prevent wind erosion
- Construction vehicles would comply with relevant vehicle emission standards, where applicable. Speed limits would also be established and enforced
- Vehicles entering and leaving the Proposal site are to be covered and secured to prevent escape of materials during transport
- Reinstatement of areas impacted during the construction of the Proposal and rehabilitation works would be undertaken progressively during the construction phase, as soon as practicable
- Dust suppression (water cart), and wheel wash/shakedown will be implemented during construction works. Details on these measures will be included in the CEMP
- Air quality monitoring is not considered necessary for the Proposal. However, it may be undertaken to assure that the impacts are as predicted within the AQA.

Operation

The following mitigation measures would be implemented during the operation of the Proposal:

- Mitigation and management measures identified for construction activities would be impended during operation and maintenance activities, where necessary and applicable
- Maintenance activities would involve the use of cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques, such as water sprays or local extraction, e.g. suitable for local exhaust ventilation systems

- Any potential operational impacts can be managed through good design and adherence to HWC standards, including the use of odour control units which can assist in ensuring that odour emissions are maintained at the minimum during routine operation and maintenance
- Ongoing air quality/odour monitoring is not considered necessary. However, an air quality and odour complaints log should be kept, allowing identification of any issues which may arise and require rectification.

7.8 Noise and vibration

The information presented in this section is based on the findings of the Noise and Vibration Assessment (NVA) undertaken by Resonate Consultants Pty Ltd (Resonate) (refer to Appendix N).

The key issues which have been raised in the SEARs (No. 1291) identified an assessment of noise and vibration-related issues, including impacts on sensitive receivers surrounding the Proposal site as a result of construction and operation. Impacts that have been assessed in this section include construction noise and vibration impacts, operational noise impacts, potential sleep disturbance and road traffic noise. Each of these impacts has been assessed against relevant noise assessment criteria, detailed in Section 7.8.1.

A summary of the relevant SEARs and where they are addressed in this section is provided in Appendix A.

7.8.1 Methodology

The noise monitoring methodology, as well as relevant noise and vibration criteria for both construction and operation activities related to the Proposal are outlined below.

Noise monitoring

Resonate undertook unattended and attended noise monitoring to determine the existing ambient noise levels at the Proposal site and surrounds. The existing ambient acoustic environment is characterised by noise from traffic at Pacific Highway and surrounding local roads, as well as some wildlife sounds (e.g. birds). Noise measurements were taken in general accordance with *Australian Standard AS1055.1 Acoustics–Description and measurement of environmental noise*.

Unattended noise monitoring was conducted at locations labelled L1 – L4 as seen in Figure 7-19 below. Operator attended noise monitoring was conducted at locations labelled A1 – A4 as seen in Figure 7-19. Noise levels results for both unattended and attended noise monitoring are summarised in the following tables.

Table 7-21 Unattended noise measurement results (Source: Resonate)

Noise logger location label	Rating Background Level (RBL), dB(A) L_{90}[1]			Ambient noise level, dB(A) L_{eq}		
	Day 7 am - 6 pm	Evening 6 pm - 10 pm	Night 10 pm - 7 am	Day 7 am - 6 pm	Evening 6 pm - 10 pm	Night 10 pm - 7 am
L1 (Near 3219 Pacific Hwy)	49	49	39	61	59	54
L2 (Near 34 Rees James Rd)	45	43	38	61	58	52
L3 (Near 8 Rees James Rd)	42	41	33	59	59	49
L4 (17F Irrawang St – Raymond Terrace Vacation Care)	45	38	37	58	52	50

(1) The Rating Background Level is a measure of the typical minimum steady background noise level for each time of day.

(2) The measured RBL for the evening period at Location 1 was 51 dB(A). It has been reduced to equal to the daytime RBL in-line with the procedure of the NPI.

Table 7-22 Operator-attended short-term noise monitoring results

Attended measurement location label	Length (min:sec)	Leq dB(A)	LFmax dB(A)	L10 dB(A)	L90 dB(A)
A1 - Daytime	15:00	55	64	57	51
A2 – Daytime	15:00	53	66	56	49
A3 – Daytime	15:00	54	74	52	38
A4 – Daytime	15:00	47	62	51	41

Figure 7-19 Attended and unattended noise monitoring locations (Source: Resonate)

The following observations were noted during the attended noise monitoring described above:

Table 7-23 Observations during attended noise monitoring

Attended measurement location	Observations
A1	The noise levels, measured in the free field, were controlled by distant traffic noise from the Pacific Highway and the local road. There was presence of nature sounds. The maximum sound level was generated by one passing jet fighter.
A2	The noise levels, measured in the free field, were controlled by distant traffic noise from the Pacific Highway. The maximum sound level was generated by a car passby on the nearby local road.
A3	The noise levels, measured in the free field, were controlled by distant traffic noise from the Pacific Highway and Adelaide Street. Sparse traffic on Rees James Road. The maximum sound level was generated by a car passby on the nearby local road.
A4	The noise levels, measured at 1 metre from the façade, were controlled by local traffic noise from Irrawang Street. Sparse traffic on Rees James Road. The maximum sound level was generated by a car passby on the nearby local road.

Noise assessment criteria

Construction Noise Criteria

Construction noise impacts have been assessed against the provisions of the *NSW Interim Construction Noise Guidelines* (ICNG) (DECC, 2009). The ICNG prescribes Noise Management Levels (NMLs) depending on the time that construction work is to be carried out.

Table 7-24 presents the NMLs for residential and aged care receivers for both standard working hours and periods outside of the standard working hours. As outlined in the NVA (Appendix N), the NMLs 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.

Table 7-24 MMLs for residential receivers (Source: Resonate)

Time of day	Noise Management Level (NML), $L_{Aeq(15\text{-}minute)}$	Actions
Standard hours: • 7 am to 6 pm, Monday to Friday • 8 am to 1 pm, Saturday	Noise affected RBL +10 dB(A)	May be some community reaction to noise. Actions: 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. All residents potentially impacted by the works should be informed of the nature of the works, the expected noise levels and

Time of day	Noise Management Level (NML), $L_{Aeq(15\text{-}minute)}$	Actions
		duration, and provided with site contact details.
	Highly noise affected >= 75 dB(A)	May be strong community reaction to noise. Actions: 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. 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.
Out of Hours Works (OoHW)	Noise affected RBL +5 dB(A)	Actions: 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.

Out of hours works (OOHW) may comprise day, evening and night-time periods over the course of a week.

Table 7-25 details the schedules of OOHW for day, evening and night.

Table 7-25 Schedule of construction hours (Source: Resonate)

Standard Hours	Monday to Friday	7am to 6pm
	Saturday	8am to 1pm
OOHW Day	Saturday	7am to 8am & 1pm to 6pm
	Sunday	7am to 6pm
OOHW Evening	Monday to Friday	6pm to 10pm
	Saturday	6pm to 10pm
	Sunday	6pm to 10pm
OOHW Night	Monday to Friday	10pm to 7am
	Saturday	10pm to 7am
	Sunday	10pm to 7am

Proposal specific NMLs for residential and aged care facilities are outlined in Table 7-26 below in accordance with the ICNG noise levels identified in Table 7-24 above.

Table 7-26 Proposal-specific NMLs for residential receivers (Source: Resonate)

Residential	Noise Management Levels, $L_{Aeq(15\text{-}minute)}$ dB			
	Std Hrs Day	OOHW Day	OOHW Evening	OOWH Night
NCA 1	55	50	43	42
NCA 2	52	47	46	38
NCA 3	55	50	48	43
NCA 4	55	50	48	43

In addition to the above, ICNG also establishes NMLs for other sensitive receivers. Table 7-27 outlines those other sensitive receivers identified within the Proposal site.

Table 7-27 NMLs for other sensitive receivers (Source: Resonate)

Land use	Noise Management Level, $L_{Aeq(15\text{-}minute)}$[1]
Classrooms at schools and other educational institutions	Internal noise level – 45 dB(A) (55 dB(A) external)[2]
Places of worship	Internal noise level – 45 dB(A) (55 dB(A) external)[2]
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.

(1) Applies when premises are in use.

(2) A factor of 10 dB attenuation has been applied assuming windows open across the façade. This 10 dB has been included to achieve an external noise level.

Operational Noise Criteria

Operational noise criteria were established with consideration to the *NSW Industrial Noise Policy for Industry* (NPI) (EPA, 2017), which provides guidance on the assessment of operational noise impacts. The NPI guidelines include both intrusive and amenity criteria that are designed to protect receivers from noise significantly louder than the background level and to limit the noise level from all sources near a receiver.

Intrusive noise limits set by the NPI control the relative audibility of operational noise compared to the background level. The amenity criteria limit the total noise level from all industrial sources affecting a receiver.

Proposal specific criteria have been established in accordance with the NPI and are outlined in Table 7-28.

Table 7-28 NPI Project Specific Criteria (Source: Resonate)

Location	Noise Level (dB re 20 µPa) during Period		
NCA 1			
Residential receivers	**NPI Daytime** 07:00 – 18:00	**NPI Evening** 18:00 – 22:00	**NPI Night-time** 22:00 – 07:00
Rating Background Level (RBL) - L1	45	38	37
Intrusive criterion (RBL + 5 dB)	50	43	42
Amenity Criterion (suburban)[1]	55	45	40
NPI Project specific criteria	50	43	40
NCA 2			
Residential receivers	**NPI Daytime** 07:00 – 18:00	**NPI Evening** 18:00 – 22:00	**NPI Night-time** 22:00 – 07:00
Rating Background Level (RBL) - L1	42	41	33
Intrusive criterion (RBL + 5 dB)	47	46	38
Amenity Criterion (suburban)[2]	55	45	40
NPI Project specific criteria	47	45	38
NCA 3			
Residential receivers	**NPI Daytime** 07:00 – 18:00	**NPI Evening** 18:00 – 22:00	**NPI Night-time** 22:00 – 07:00
Rating Background Level (RBL) - L1	45	43	38
Intrusive criterion (RBL + 5 dB)	50	48	43
Amenity Criterion (traffic dominated)	46	43	37
NPI Project specific criteria	46	43	37
NCA 4 (Based on NCA 3 results for the draft report due to noise logger being damaged by wildlife – the survey is being repeated)			
Residential receivers	**NPI Daytime** 07:00 – 18:00	**NPI Evening** 18:00 – 22:00	**NPI Night-time** 22:00 – 07:00
Rating Background Level (RBL) - L1	45	43	38
Intrusive criterion (RBL + 5 dB)	50	48	43

Location	Noise Level (dB re 20 µPa) during Period		
Amenity Criterion (traffic dominated	46	43	37
NPI Project specific criteria	46	43	37

(3) An urban classification has been adopted for this NCA based on the measured RBLs and noted noise sources.

(4) A suburban classification has been adopted for this NCA based on the measured RBLs and noted noise sources.

(5) The project-specific criteria are the lowest of the Intrusive criterion and the Amenity criterion for new sources for each time period.

Sleep disturbance criteria established by ICNG references EPA's sleep disturbance screening level, which is described as a L_{Amax} level that should not exceed the rating background level by more than 15 dB.

The sleep disturbance screening criteria for the Proposal are the following:

- NCA1: 52 dB(A)
- NCA2: 48 dB(A)
- NCA1: 53 dB(A)
- NCA2: 53 dB(A).

These criteria would only apply during night-time out of hours works if conducted.

Construction vibration criteria

Vibration impacts from construction works have been considered in accordance with the EPA's *Assessing Vibration: A Technical Guideline* (the Guideline). Management levels for continuous and intermittent vibration at different land uses have been presented in Table 7-29 below.

The Guideline specifies the management levels as suitable for vibration sources predominantly in the frequency range of 8 - 80 Hz, as would be normally expected for construction vibration. Vibration levels are specified as overall unweighted Root-Mean-Square vibration velocity levels (V_{rms}) as seen below.

Table 7-29 Daytime V_{rms} management levels for continuous and impulsive vibration (Source: Resonate)

Receiver	Continuous vibration V_{rms}, mm/s		Impulsive vibration V_{rms}, 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

Vibration Dose Value (VDV) is used as the metric for assessment of intermittent vibration. It accounts for the duration of the source, which will occur intermittently over the assessment period. The VDV management levels at different land uses for intermittent vibration sources are outlined in Table 7-30.

Table 7-30 VDV management levels for intermittent vibration (Source: Resonate)

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

7.8.2 Existing environment

Section 7.7.2 of this EIS provides information on topography and meteorological conditions at the Proposal site which are also relevant to the acoustic assessment.

Sensitive receivers

Sensitive receivers and other relevant receivers within the vicinity of the Proposal site are identified in Table 7-31 and Figure 7-20.

Four (4) noise catchment areas (NCAs) have been determined in the NVA for the Proposal site. The majority of the sensitive receivers surrounding the Proposal site are generally residential developments integrated with commercial, educational and recreational receiver types as seen below.

Table 7-31 Sensitive receivers for each NCA (Source: Resonate)

Noise Catchment Area	Location	Description of receivers within catchment of the Proposal site
NCA 1	East and west sides of Pacific Highway	• Medium to high density residential • Irrawang Public School • Irrawang High School • Muree Golf Club • Raymond Terrace Public School • Raymond Terrace wastewater treatment works
NCA 2	East and west side of the Pacific Highway extending from south of Richardson Road to the intersection Adelaide Street and Pacific Highway	• Medium density residential • Church for the Nations • Grahamstown Public School • TLC Early Learning Centre • Raymond Terrace Baptist Church • Raymond Terrace Community Church
NCA 3	West of Pacific Highway and north of the intersection between Adelaide Road and Pacific Highway	• Low to medium density residential
NCA 4	Towards the northern extent of the Proposal site	• Low density residential

Noise Catchment Area	Location	Description of receivers within catchment of the Proposal site
		• Riding for the Disabled Australia • Future residential developments

Figure 7-20 Noise Catchment Areas (NCAs) (Source: Resonate)

7.8.3 Potential impacts

Construction

The construction of the Proposal is described in Section 4.3. In summary, construction would last approximately nine (9) months and is likely to occur concurrently in multiple decentralised work zones. Construction works would be divided into seven (7) stages as outlined in Section 4.3.

Construction Traffic

Access to the compound areas and general construction zone would require the use of local roads, which would result in a temporary change in road traffic noise levels at directly affected receivers. Common construction traffic includes light vehicles, such as utes and heavy construction vehicles (e.g. dump trucks and concrete agitators).

As noted in Section 7.9 of this EIS, up to 55 workforce staff would be employed during the construction period, with the potential for up to 35 staff to be on-site (i.e. within the work-zone) at any given time or day throughout the construction period. In addition, trucks bringing materials to the Proposal site are estimated at 25 trucks per day the for the construction period. An increase of 25 vehicles per day would not represent an increase in noise levels exceeding 2 dB. Therefore, further detailed assessment of construction traffic noise is not considered necessary.

The mitigation measures outlined in Section 7.8.4 below would be implemented to minimise the potential noise impacts from construction traffic on local roads.

Predicted Airborne Noise Levels

Potential construction noise emissions arising from the use of plant and equipment have been modelled using SoundPLAN v8.1 acoustic prediction software. The predicted noise levels associated with construction activities within each NCA are presented in Table 7-32.

Table 7-32 Summary of predicted noise levels per NCA (Source: Resonate)

NCA	NML, $L_{eq(15\text{-}minute)}$ dB(A)				Predicted range of noise levels per works grouping, $L_{eq(15\text{-}minute)}$ dB(A)			Min. Dist. (m)
	Day	Day OoHW	Even.	Night	Stages 1 & 4	Stages 2, 3, 5 & 7	Stage 6	
1	55	50	43	42	<45 to >85	<45 to >85	<45 to >85	5
2	52	47	46	38	<45 to >85	<45 to >85	<45 to >85	5
3	55	50	48	43	45 to >85	50 to >85	45 to >85	5
4	55	50	48	43	65 - 75	70 - 80	61 - 71	25

(1) Note: Construction stages with similar sound power levels have been grouped in this table.

The predicted construction noise levels associated with the activities within the compound areas range between 0 dB(A) at remote receivers and 85dB(A) at the nearest noise sensitive receiver locations.

The predicted maximum levels within the compound areas result from general construction, including storage and movement of materials and staff car parking. There would be potential for sleep disturbance if the compound areas were to operate outside of standard construction hours. This is particularly relevant for the compound areas in NCA 1, NCA 2, the southern area in NCA 3 and NCA 4.

Sensitive receivers located in close proximity to the Proposal site (including residential, active recreation areas, educational establishments and places of public worship) are predicted to exceed the NMLs. Those located directly adjacent to the compound areas are likely to be in the highly noise affected category when work is occurring at their location. Construction works would move progressively along the alignment and therefore maximum noise impacts would generally be temporary.

All relevant mitigation measures described in Section 7.8.4 would be implemented in order to minimise the potential noise impacts from construction activities.

Other sensitive receivers

As discussed in Section 7.3, the BDAR prepared by Arcadis (Appendix D) identified a Grey-headed Flying-fox camp in close proximity to the Proposal site. The 'Raymond Terrace Flying-fox Camp' (Camp ID 265) is located within NCA 1 and approximately 50 metres northwest of the Proposal site adjacent to Adelaide Street.

The BDAR recommends that construction within a radius of 250 metres of the camp should be limited to months of March to July to minimise potential impacts to breeding and heat-stressed individuals. Furthermore, the installation of temporary noise barriers (such as a mobile enclosure and demountable noise barriers) have been recommended as part of the NVIA. For further details on potential impacts and mitigation measures related to the Raymond Terrace Flying-fox Camp refer to Section 7.3 and the BDAR.

Vibration

Minimum work distances are established where vibration intensive works are required. Minimum work distances should be complied with at all times and are based on the OEH guidelines for building damage.

For the majority of the construction activities, vibration emissions would be intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods may be allowed.

Table 7-33 outlines the recommended minimum working distances for vibration intensive plant and equipment.

Table 7-33 Recommended minimum vibration work distances from vibration intensive plant and equipment (Source: Resonate)

Plant Item	Rating/Description	Minimum Working Distance – Cosmetic Damage[1] (BS7385)	Minimum Working Distance – Human Response
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m

Plant Item	Rating/Description	Minimum Working Distance – Cosmetic Damage[1] (BS7385)	Minimum Working Distance – Human Response
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	4 m
Jackhammer	Hand held	1 m (nominal)	2 m

Generally, the separation distance from the nearest receivers is sufficient to mitigate the potential vibration impacts. As such, it is considered that structural or cosmetic damage impacts from vibration intensive works are generally unlikely for the adjacent receivers, however some cosmetic damage may be caused by the use of the vibration intensive equipment on the residential boundary when works are located less than 10 metres from the boundary of the construction footprint.

Where work is proposed within the safe working distances, the mitigation measures outlined in Section 7.8.4 below would be implemented to reduce the impacts as far as practicable.

Operation

Potential noise emissions arising from operational activities are associated with the proposed WWPS. The other infrastructure included within the operation of the Proposal is not considered to result in a potential noise impact.

The WWPS would be designed and constructed in accordance with HWC's specifications and the exact location would be determined at detailed design.

As established by the OEH, noise levels related to the WWPS are not to exceed 85dB(A) measured at 1 metre from the source. Noise levels outside the WWPS, measured at the nearest boundary, are not to exceed the level criteria of the as set out in the Noise Guide for Local Government (EPA, 2013).

Table 7-34 outlines the maximum allowable sound power level for the proposed WWPS.

Table 7-34 Maximum total allowable sound power levels from the WWPS (Source: Resonate)

Sensitive Receiver	Minimum Distance (m)	Maximum Total allowable Sound Power Level (dB(A))	Resulting Noise Level dB(A)	Meets Criterion? Yes/No
Kings Hill URA	7	66	41	Yes
RDA	10	69	41	Yes

The above table demonstrates that the Proposal can meet the criterion at the most stringent night time noise level of 41 dB(A) within the tentative location of the WWPS.

Section 5.6.13 of the *Hunter Water Corporation Water and Sewer Design Manual (Water Pumping Stations)* provides design requirements with respect to operational and occupational noise from the WWPS.

The Proposal is anticipated to comply with the established noise criteria through the implementation of the relevant acoustic control measures within HWC guidelines.

7.8.4 Mitigation measures

Construction

During construction works it is recommended that best practice management strategies, where feasible and reasonable, are applied to manage any potential noise impacts. A Construction Noise and Vibration Management Plan (CNVMP) will be developed as part of the CEMP. The CNVMP will contain the following measures:

- Construction activities will be generally undertaken between the nominated construction hours, between 7:00am-6:00pm Monday to Friday, and 8:00am-1:00pm Saturday, with no work on Sundays or public holidays
- If works must occur out of hours for justified reasons (e.g. worker safety or reduction of impact on traffic), preference would be given to day and/or evening time works (i.e. between 7 am and 10 pm). Noise intrusive works would be completed before 10 pm where feasible to do so. Additionally, a site specific out of hours assessment of impacts would be required in order to determine appropriate noise and vibration mitigation measures. Potential noise receivers would be notified within ten (10) days prior any construction activity in accordance with HWC requirements
- Where practicable, particularly noisy construction works will be staged with consideration to the least sensitive time of day for the closest receivers, providing respite periods as necessary – particularly during works adjacent to surrounding receivers
- Where practicable, equipment and work areas will be strategically positioned to reduce the noise emission to noise sensitive receivers.
- Construction machinery will be well maintained and equipment not in use would be shut down
- All plant would be properly maintained and low vibration alternatives for plant would implemented where practicable. Plant that have high and low vibration operating settings should be run on the lowest effective vibration setting
- Where vibration intensive works are required to be undertaken within the specified minimum working distances, vibration monitoring should be undertaken to ensure acceptable levels of vibration are satisfied
- Measures identified in Section 7.3.4 of this EIS would be implemented to mitigate construction noise impacts on the Greay-headed Flying-fox camp
- A noise and vibration complaints log should be kept, allowing identification of any issues which may arise and require rectification.

Operation

- Operational noise from the WWPS would be managed through the use of the design requirements established within Section 5.6.13 of the *Hunter Water Corporation Water and Sewer Design Manual (Water Pumping Stations)*. The Proposal would implement HWC's acoustic control measures to ensure compliance with NPI criteria
- Noise emissions should be a consideration in the final position of the WWPS. Operational noise emissions from all potential sources in the context of the final position of the WWPS would be assessed at detailed design to ensure that compliance with the NPI criteria is achieved.

7.9 Traffic and transport

The information presented in this section is based on the findings of the Transport Impact Assessment (TIA) undertaken by Arcadis (refer to Appendix E).

The key issues which have been raised in the SEARs (No. 1291) identified an assessment of the key traffic and transport-related issues for the Proposal, including construction impacts, vehicle movements, safety and function of the road network.

A summary of the relevant SEARs and where they are addressed in this section is provided in Appendix A.

7.9.1 Methodology

The methodology undertaken for the assessment of potential traffic impacts for the Proposal is as follows:

- Review of existing transport network surrounding the Proposal site, including an assessment of existing traffic volumes and conditions, and its impact assessed with respect to road capacity, public transport facilities, pedestrian and cyclist provisions, parking allocation, existing infrastructure, access and safety
- Review of traffic data from recent studies in the surrounding area and current road network operation to determine the daily and weekly profiles for traffic, forecast volumes and traffic generation assumptions
- Assessment of traffic generation based on the proposed construction activities, vehicle type, program and hours of work, and impacts of additional construction traffic vehicles accessing the proposed compound areas during construction works
- Intersection analysis was conducted using SIDRA Intersection Version 8 Traffic Analysis Software Suite. The analysis was done for the construction year 2020 to determine the operational impacts the envisaged construction traffic volumes would have on existing intersection operations
- Identification of mitigation and management measures that can be implemented to minimise potential impacts, including traffic and transport management controls during construction. These measures have considered pedestrians, cyclists, public transport, accesses and parking along the Proposal site
- To assess the proposed transport impacts and arrangements, the Proposal has been assessed against the following legislation, policies and guidelines:
  - *Transport Administration Act 1988*
  - *Road Transport Act of 2013*
  - *Guide to Traffic Generating Developments* (Roads and Maritime Services [Roads and Maritime, formerly Roads and Traffic Authority], Version 2.2, October 2002)
  - *AS/NZ 2890.1: Off-street car parking*
  - *AS/NZ 2890.2: Off-street commercial vehicle facilities*
  - *Department Transport and Main Roads Road Planning and Design Manual: Chapter 5 Traffic Parameters and Human Factors,* August 2004
  - *Department Transport and Main Roads Road Planning and Design Manual: Chapter 13 Intersections at Grade,* October 2006
  - *Austroads Guide to Road Design Part 4a: Unsignalised and Signalised Intersections* (Austroads, 2009)
  - *Highway Capacity Manual*, 2010 (HCM2010)

- *Guide to Traffic Management Part 3: Traffic Studies and Analysis and Highway Capacity Manual* (Austroads, 2016)

Traffic data collection

- Spot surveys were conducted for 15 minutes on Monday 22 July 2019 at the following intersections, expected to be impacted by construction traffic:
  - I-1: Pacific Highway/ Access road (2.36pm – 2.51pm)
  - I-2: Rees James Road/ Link to Pacific Highway (3.18pm – 3.33pm)
  - I-3: Rees James Road/ Adelaide Street (3.01pm – 3.16pm)
  - I-4: Richardson Road/ Adelaide Street (3.58pm – 4.13pm)
  - I-5: Irrawang Street/ William Street (3.40pm – 3.55pm).
- Review of MetroCount data obtained from Council to estimate peak hourly traffic where the spot survey intersection counts were conducted. Figure 7-21 below shows the locations of the available intersection and midblock survey data within the Proposal site

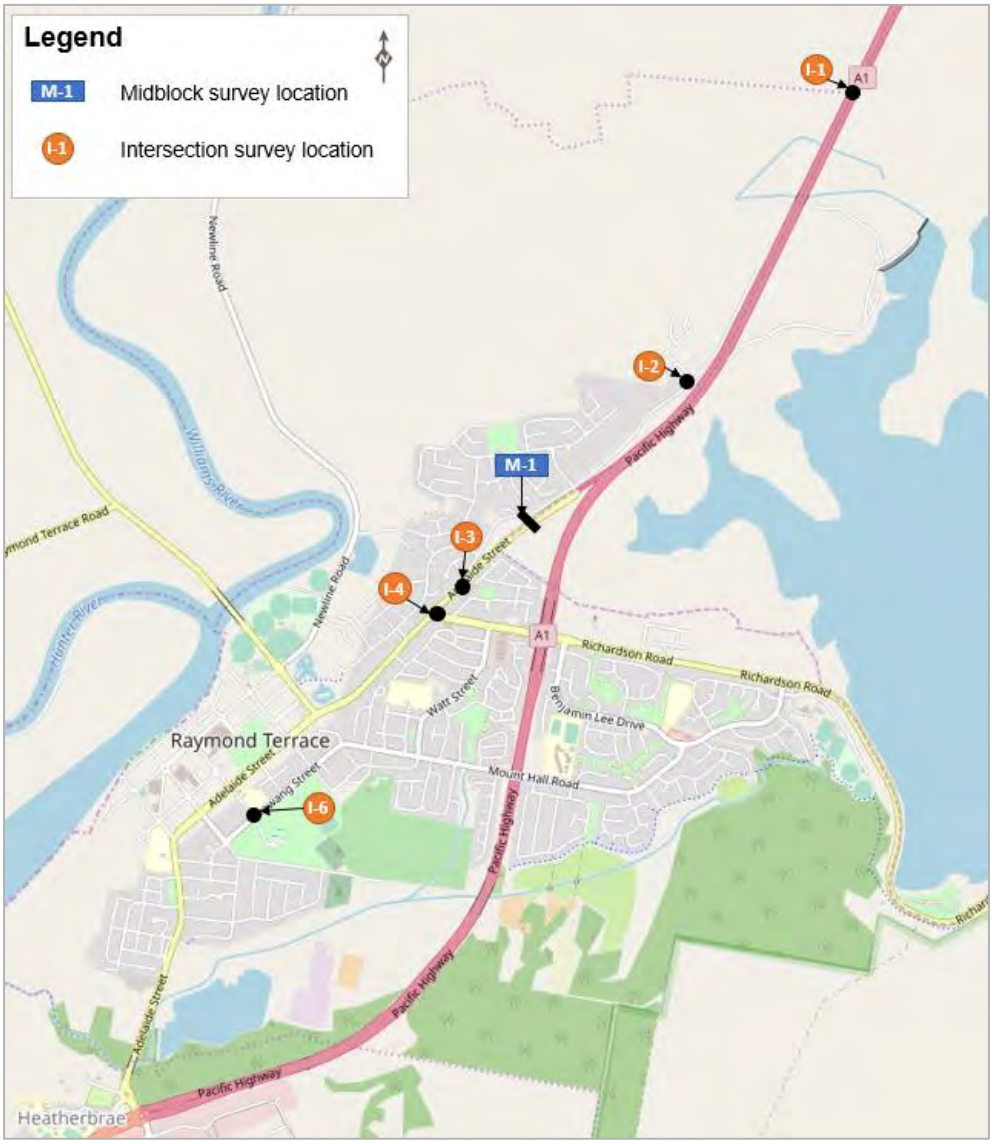


Figure 7-21 Spot survey locations

Construction traffic generation and peak periods

Construction hours and workforce are discussed in Section 4.3 of this EIS. For the purpose of this assessment it is assumed that vehicle trips to and from the construction zone would occur outside of normal commuter peaks. However, to be conservative, it was assumed that these trips will coincide with background peak traffic.

Up to 35 workforce staff would be on site at any given time, as such a daily construction staff generation of 29 vehicle trips (35 divided by an average car occupancy of 1.2 people per vehicle) are assumed. All workforce staff are assumed to be traveling from home to the primary compound area (i.e. the site office) in the morning and then vice versa after the end of each workday.

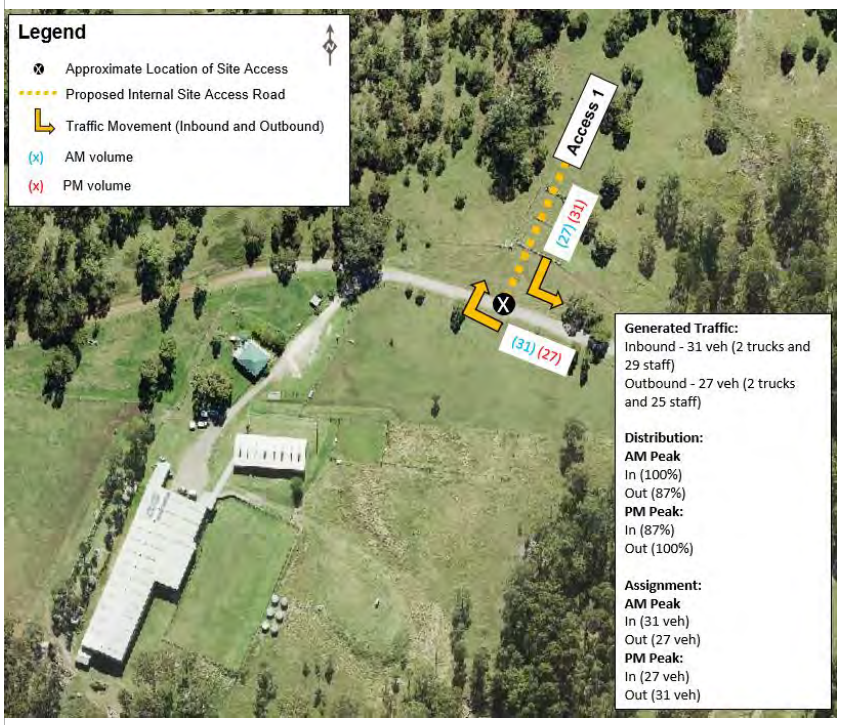
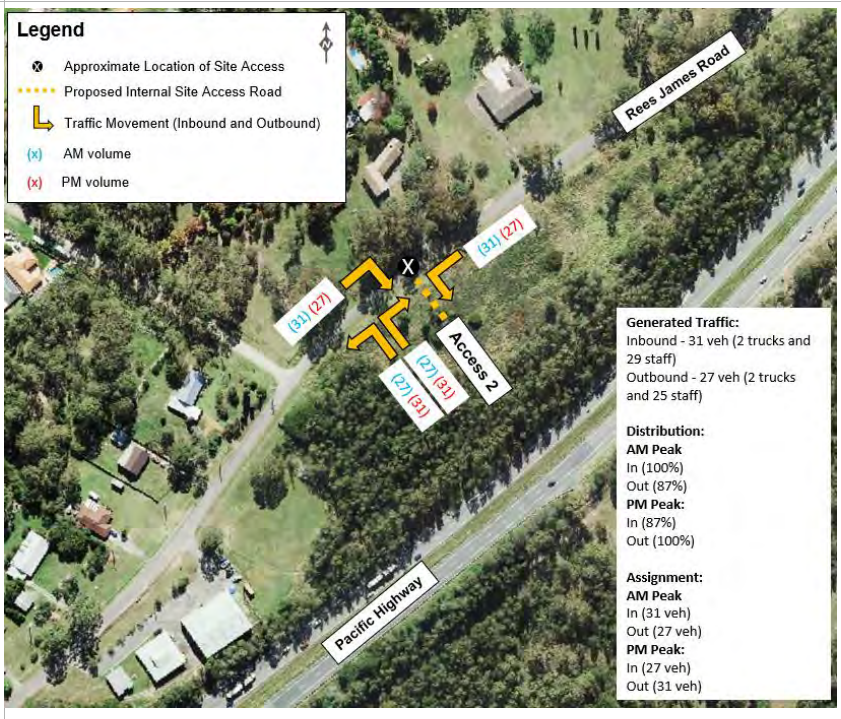
It is also assumed that workforce would arrive to the site office in the morning, travelling to 3 work zones consisting of 10 people per work zone, and then back to the site office at the end of the workday. This would generate about 25 vehicle trips (30 divided by an average car occupancy of 1.2 people per vehicle). The remaining vehicles that arrive in the AM assumes that 5 personnel will remain at the site office.

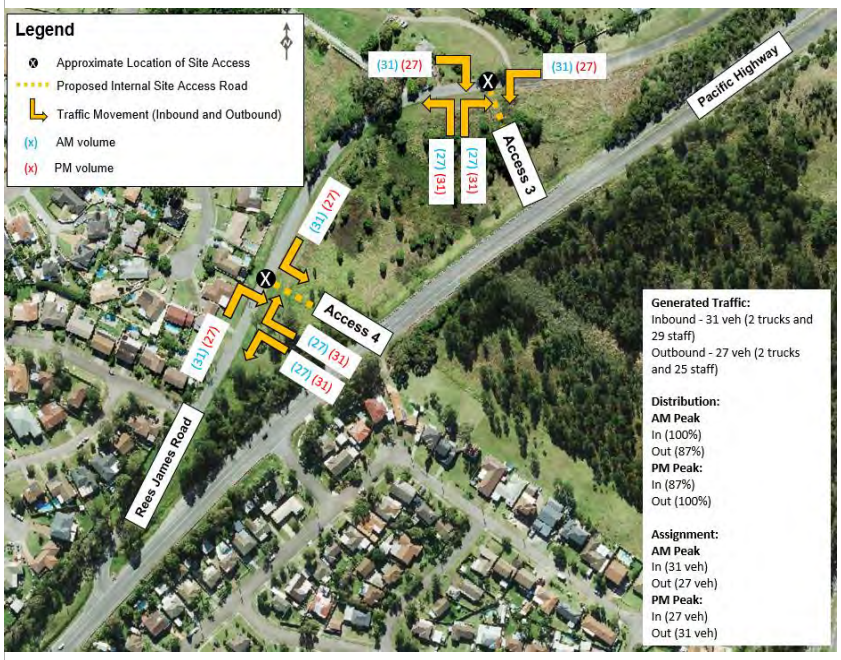
Given the construction work hours (7am to 6pm), it is assumed that these trips would occur outside of normal commuter peaks, however for the purpose of this assessment and to be conservative it was assumed that these trips will coincide with background peak traffic. It should be noted that the trip patterns might change from the assumed, should more detailed construction scheduling information become available closer to construction works.

Due to the preliminary nature of the assessment and the details of construction movements to be confirmed prior to construction, construction traffic could occur at any given location and at any given time throughout the construction period. Therefore, to provide a conservative analysis, it is assumed that all construction generated traffic would impact the site compound and stockpiling accesses, intersections and road links at any given point in time. All peak hour construction traffic is therefore assigned to all movements at the proposed construction access locations as a worst-case scenario. The movement-based trip distribution and assignment for both AM and PM peaks is shown in Table 7-35.

The difference in directional distribution would mainly account for the workforce traffic (4 cars) remaining at the site office. The estimated two peak hour heavy vehicles would travel to and from the compound/stockpiling areas to transport material to and from the Proposal site. No differentiation has been made between material which might be stockpiled along the trench, as it is assumed as worst case that the heavy vehicle generated traffic accounts for all material to be stockpiled at the compound areas. Hence, it is assumed that 100 per cent of construction traffic would be travelling inbound (29 workforce vehicles plus two heavy vehicles) and 87 per cent then back in the outbound direction (25 workforce vehicles plus two heavy vehicles).

Table 7-35 Trip Distribution and Assignment (Worst Case Scenario)

Access	Trip Distribution
1	
2	

Access	Trip Distribution
3	
4	

Vehicle Access

Access to the Proposal site compound areas are to be from the roads as indicated in Table 7-36. Details are also provided regarding the proposed access type, requirements for use and location co-ordinates. The proposed access locations are illustrated in Figure 7-22 below.

Table 7-36 Site Access Details

Access No.	Coordinates	Location	Access Type	Description
1	32°43'29.64"S 151°47'0.24"E	Laydown Access Road, 250m west of the Pacific Highway	Temporary Access	Delivery of construction materials (e.g. pipes, fittings, pre-cast concrete components), Stockpiling of excavated materials and soil, workforce movements
2	32°44'35.16"S 151°46'22.44"E	Rees James Road, about 85m north of Kuranga Avenue		
3	32°44'56.04"S 151°45'48.60"E	Rees James Road, 325m north of Alton Road		
4	32°45'0.36"S 151°45'42.84"E	Rees James Road, 115m north of Alton Road		
5	32°45'55.80"S 151°44'46.32"E	Irrawang Street, 25m south of William Street		

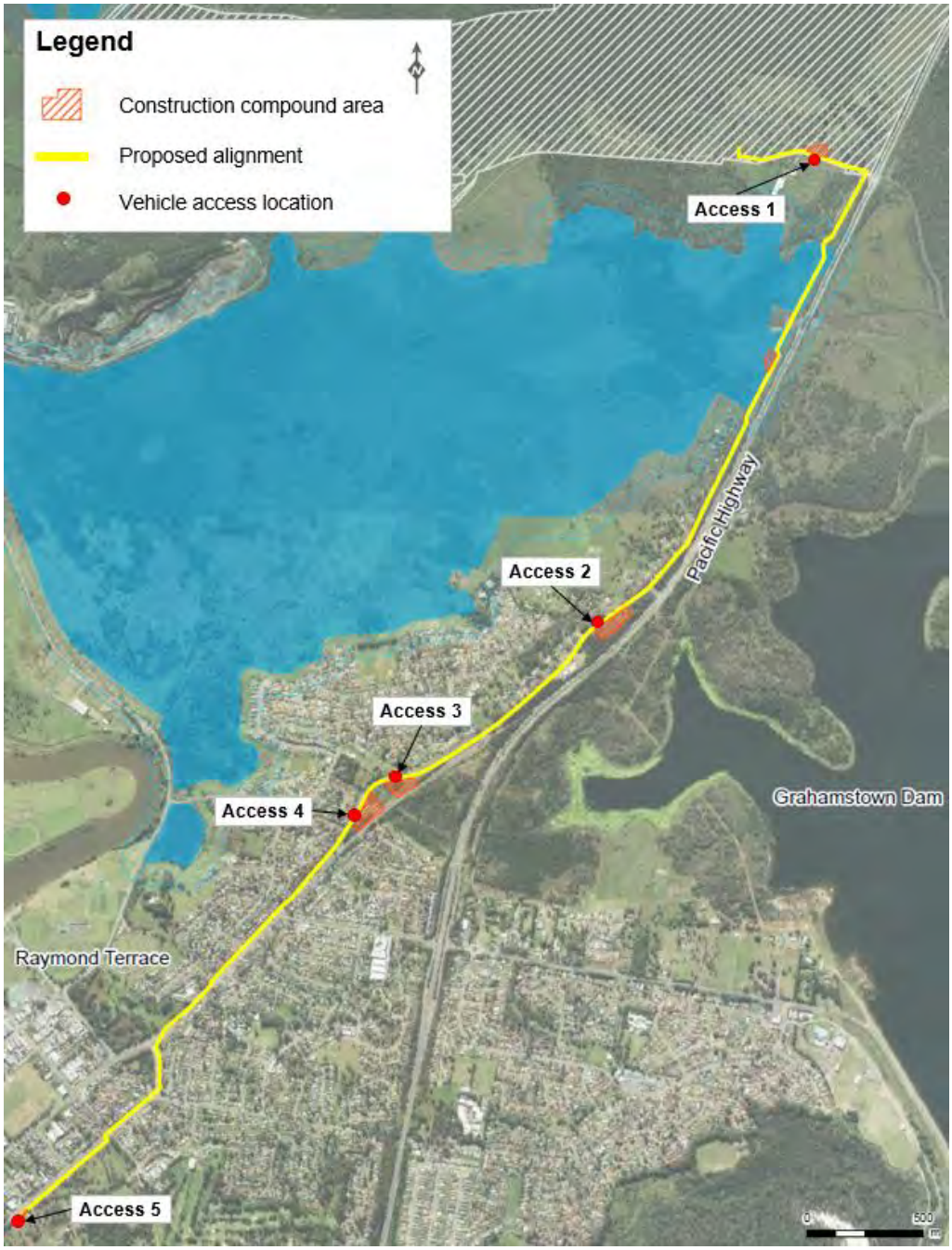


Figure 7-22 Proposed Access Locations

Intersection traffic flows

Peak hour traffic volumes estimated through the peak hour background traffic estimation process are provided in traffic volume stick diagrams in the TIA (Appendix E). Figure 7-22 above shows the proposed locations of proposed construction vehicle accesses. A summary of the existing peak hour traffic volumes is provided below:

- The Laydown Access Road, providing a connection to Access 1, is estimated to service through traffic volumes of about 8 vehicles per hour in the AM peak, and 14 vehicles per hour in the PM peak
- Rees James Road around the proposed Access 2 location services about 21 through vehicles in the AM peak and 55 through vehicles in the PM peak hour
- Rees James Road around the proposed Access 3 and 4 locations service about 67 through vehicles in the AM peak and 120 through vehicles in the PM peak hour
- Irrawang Street around the proposed Access 5 location services about 210 through vehicles in the morning peak and 378 through vehicles in the afternoon peak hour.

Intersection analysis criteria

At unsignalised intersections with minor roads, where there are relatively low volumes of through and turning vehicles, capacity considerations are usually not significant, and detailed analysis of capacity is not warranted.

As a guide, at volumes below the following combinations of maximum hourly volumes at a cross intersection with a two-lane two-way road, capacity analysis is not warranted:

- Major road 400 vehicles per hour, minor road 250 vehicles per hour
- Major road 500 vehicles per hour, minor road 200 vehicles per hour
- Major road 650 vehicles per hour, minor road 100 vehicles per hour.

Comparison between these threshold volumes and the peak hourly volumes on the key roads indicates that the existing traffic volumes on some of the roads are below the threshold volumes above, and as such, there is no capacity concerns regarding the operation of those intersections. However, volumes at some of the intersections exceed the thresholds and were further evaluated through a capacity analysis. These intersections include:

- Intersection 1: Pacific Highway/ Laydown Access Road
- Intersection 4: Adelaide Street/ Richardson Road
- Intersection 5: Irrawang Street/ William Street.

An increase in vehicles through an intersection as a result of the development will likely increase traffic delays.

The following input types were taken into consideration as a basis to evaluate existing intersection performance:

- Existing intersection geometry and lane configuration data
- Existing traffic signal phasing and sequence data where required
- Vehicle movement data
- Peak hour traffic volume data.

A growth rate of two per cent per annum was applied to the spot counts collected in 2019 to forecast background traffic in 2020, selected due to the urban nature of the area.

The delay-based analysis criteria adopted for the purposes of this assessment are provided in Table 7-37, which is in accordance with the accepted Roads and Maritime Services method of delay for intersection operation. The table indicates the level of service (LOS) by intersection control type associated with a respective delay per vehicle measured in seconds. A LOS of D or better is generally considered acceptable operation.

Table 7-37 Intersection analysis criteria

Level of service	Average delay (sec)	Stop, give way or yield signs	Traffic signals and roundabouts
A	<14	Good operation	Good operation
B	15 to 28	Acceptable delays and spare capacity	Good operation with acceptable delays
C	29 to 42	Satisfactory but accident study required	Satisfactory
D	43 to 56	Near capacity, crash study required	Operating near capacity
E	57 to 70	At capacity requires other control mode	At capacity, at signals, incidents will cause excessive delays
F	>70	At capacity with long delays	At capacity with long delays

LOS is defined in terms of service measures such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience. The practical application of LOS to different road environments accounts for factors such as road hierarchy, volume/capacity ratios, terrain types, proportion of heavy vehicles and road gradients. The methodology and LOS criteria were obtained from the *Guide to Traffic Management Part 3: Traffic Studies and Analysis and Highway Capacity Manual 2016*.

7.9.2 Existing environment

Road network

The key roads within the Proposal site are summarised in Table 7-38.

Table 7-38 Key roads within the study area network

Road link name	Number of lanes per direction	Divided (D) / undivided (U)	Posted speed (km/h)
Pacific Highway	2	D	110
Laydown Access Road	1	U	50
Rees James Road	1	U	50
Adelaide Street	1	U	60
Irrawang Street	1	U	50*

*A school zone operates along the road, where the speed limit is reduced to 40 km/h between 8am to 9.30am and 2.30pm to 4pm.

Public transport

Table 7-39 summarises the key bus routes within the Proposal site, including their frequency.

Table 7-39 Public bus frequencies within study area

Bus service	Weekday frequency (per direction)	Relevant roads
Route 136 – Raymond Terrace to Stockton via Medowie	• 2 services/ hour	Irrawang Street
Route 137 – Raymond Terrace to Lemon Tree Passage via Medowie	• 1 service/ hour during the 6am – 10am morning peak • 1 service/ hour during the 2pm – 6pm afternoon peak • 1 service/ 2 hours during the off-peak periods	Irrawang Street
Route 140 – Newcastle to Lakeside Shops via Hexham and Raymond Terrace	• 2 services/ hour during the 6am – 9am morning peak • 2 services/ hour during the 3pm – 6pm afternoon peak • 1 service/ hour during the off-peak periods	Irrawang Street
Route 141 – Raymond Terrace Town Service (loop service)	• 2 services/ hour	Adelaide Street, Rees James Road
Route 145 – Newcastle Airport to Stockland Green Hills via Raymond Terrace	• 1 service/ hour	Irrawang Street

Source: Transport for NSW bus timetables, valid from 22 July 2019, accessed 16 July 2019

Figure 7-23 below shows the public bus routes within the study area.

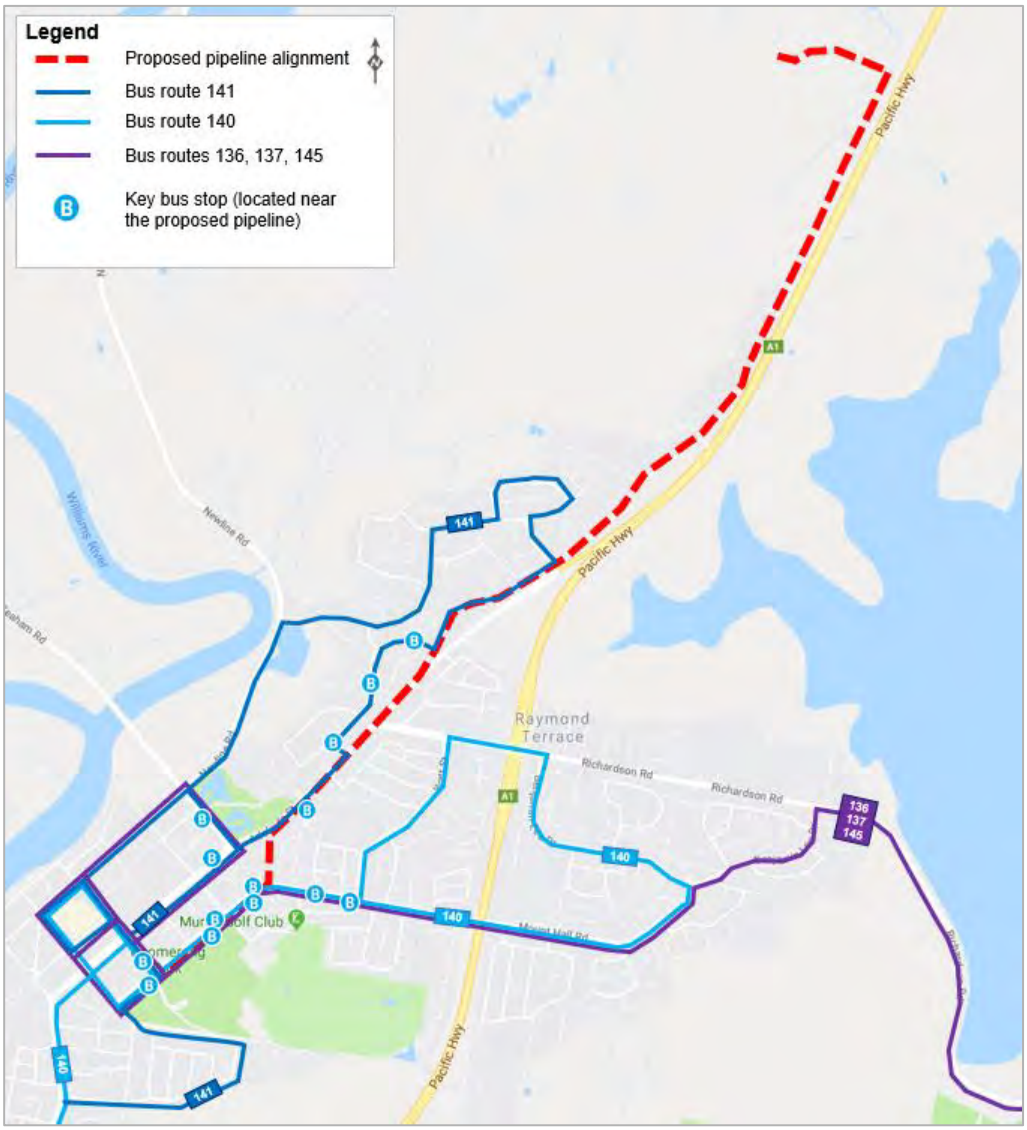


Figure 7-23 Bus routes in the vicinity of the Proposal site

School bus routes

Within Raymond Terrace, Hunter Valley Buses provide school bus services to primary and secondary schools. The following schools within the region are serviced by school buses:

- Irrawang High School
- Irrawang Primary School
- St Brigid's Primary School
- Raymond Terrace Primary School
- Grahamstown Primary School.

The morning and afternoon school bus services are as per each school requires individually. However, due to the location of Irrawang Public School, St Brigid's Primary School and Raymond Terrance Public School, a large proportion of all school buses travel along Rees James Road, Adelaide Street or Irrawang Road to access the schools. While school buses servicing Grahamstown Public School and Irrawang High School are not required to use the key roads, a high proportion of school bus services use a route travelling via residential areas of Raymond Terrace.

Schools within the region of the Proposal site are shown in Figure 7-24.

Figure 7-24 Schools in the region of the Proposal site

Long distance coach services

Existing long-distance coach services in the locality have been identified based on the data provided by Transport for NSW are indicated in Table 7-40.

Table 7-40 Impacted long-distance coach services

Bus service	Weekday frequency (per direction)	Relevant roads
Route 100 – Port Stephens to Sydney Coach	1 service/ day	Adelaide Street
Route 135 – Broadmeadow to Taree Coach	1 service/ day	Adelaide Street

Cycling network

There are cycle paths along Adelaide Street which provide a major north-south connection, and Richardson Road, which provides a major east-west connection across Raymond Terrace for residents.

However, the dedicated cycle path on Adelaide Street stops short of the section of the Proposal site. No dedicated cycle paths are provided at any section along the Proposal site. Figure 7-25 below shows the cycle network within the region of the Proposal site.

Figure 7-25 Cycle network surrounding the Proposal site

Pedestrian infrastructure

The following pedestrian amenities are provided on key roads within the Proposal site:

- No formal pedestrian footpaths are provided on Rees James Road, which runs parallel to the Pacific Highway, and provides access to low density residential dwellings. However, Rees James Road is not expected to service significant volumes of pedestrian traffic as its main use would be to provide a vehicular connection to roads that lead directly into the residential neighbourhood to the west. Pedestrian access is not suitable on Pacific Highway

- Adelaide Street is generally well serviced by pedestrian footpaths on both sides of the road south of Kangaroo Street, and on the eastern side of the road north of Kangaroo Street. It provides pedestrian access to residential neighbourhoods in Raymond Terrace, as well as access to the retail and dining areas within the town centre. High volumes of pedestrian traffic are not expected along Adelaide Street north of William Bailey Street, due to the section servicing primarily low density residential dwellings
- Irrawang Street runs between Boomerang Park, St Brigid's Primary School and Catholic Church, and is affected by a school zone around William Street. A marked foot crossing is provided across Irrawang Street, north of William Street, and a pedestrian footpath is provided along the northern edge (opposite Boomerang Park).
- Generally, the main generators of pedestrian traffic such as the retail and dining areas within the town centre are located outside of the Proposal site. However, some pedestrian traffic can be expected across Irrawang Street due to its proximity to Boomerang Park.

Heavy vehicle routes

Pacific Highway, Richardson Road, and Adelaide Street (south of Richardson Road) are designated heavy vehicle routes for trucks up to 26 metres long. Pacific Highway, Richardson Road (west of the Pacific Highway) and Adelaide Street (south of Richardson Road) are designated routes for vehicles up to 4.6 metres high. Figure 7-26 shows the restricted vehicle map in the context of the Proposal site.

Figure 7-26 Restricted access vehicle map

7.9.3 Potential impacts

Construction

Intersection Impact Assessment

The intersection analysis has been conducted for the following scenarios:

- Scenario 1: Existing conditions (geometry and control) – Future base year 2020 intersection analysis results, AM peak hour without construction traffic
- Scenario 2: Existing conditions (geometry and control) – Future base year 2020 intersection analysis results, PM peak hour without construction traffic
- Scenario 3: Existing conditions (geometry and control) – Future base year 2020 intersection analysis results, AM peak hour with construction traffic
- Scenario 4: Existing conditions (geometry and control) – Future base year 2020 intersection analysis results, PM peak hour with construction traffic.

Intersection analysis was conducted using SIDRA Intersection Version 8 traffic analysis software suite. The analysis was done for the construction year 2020 to determine the operational impacts the envisaged construction traffic volumes would have on existing intersection operations. The future base year 2020 analysis results representing existing conditions 'without' construction traffic for the AM peak hour and PM peak hour are provided in Table 7-41 and Table 7-42 respectively.

Table 7-41 Scenario 1: Existing conditions (geometry and control) – Future base year 2020 intersection analysis results, AM peak hour without construction traffic

Intersection	Existing conditions			
	Queue length (m)	Average delay (s)	Degree of saturation	Level of service (1)
Intersection 1: Pacific Highway/ Laydown Access Road	0	16	0.156	B
Intersection 4: Adelaide Street/ Richardson Road	27	9	0.479	A
Intersection 5: Irrawang Street/ William Street	1	5	0.059	A

Note (1): The level of service is based on the worst movement of the intersection.

It is evident from the analysis results in Table 7-41 that even for the worst movements, the intersections operate within acceptable levels of delay during forecast AM peak base conditions without the addition of construction traffic volumes.

Table 7-42 Scenario 2: Existing conditions (geometry and control) – Future base year 2020 intersection analysis results, PM peak hour without construction traffic

Intersection	Existing conditions			
	Queue length (m)	Average delay (s)	Degree of saturation	Level of service (1)
Intersection 1: Pacific Highway/ Laydown Access Road	2	58	0.282	E
Intersection 4: Adelaide Street/ Richardson Road	164	12	0.887	A
Intersection 5: Irrawang Street/ William Street	3	6	0.107	A

Note (1): The level of service is based on the worst movement of the intersection.

Results from Table 7-42 indicate that Intersection 1 (Pacific Highway/Laydown Access Road) is estimated to experience delays of 58 seconds and subsequent LOS E for the worst movement, which is attributed to the right turn movement from the Laydown Access Road to the Pacific Highway during the PM peak. It is considered that these delays are manageable.

The future base year 2020 analysis results based on existing conditions 'with' construction traffic for the AM peak hour and PM peak hour are provided in Tables 7-43 and 7-44 below.

Table 7-43 Scenario 3: Existing conditions (geometry and control) – Future base year 2020 intersection analysis results, AM peak hour with construction traffic

Intersection	Proposed conditions			
	Queue length (m)	Average delay (s)	Degree of saturation	Level of service (1)
Intersection 1: Pacific Highway/ Laydown Access Road	3	19	0.156	B
Intersection 4: Adelaide Street/ Richardson Road	28	9	0.494	A
Intersection 5: Irrawang Street/ William Street	2	5	0.073	A

Note (1): The level of service is based on the worst movement of the intersection.

It is evident from the analysis results in Table 7-43 that even for the worst movements, the intersections operate within acceptable levels of delay during existing conditions without the addition of construction traffic volumes.

Table 7-44 Scenario 4: Existing conditions (geometry and control) – Future base year 2020 intersection analysis results, PM peak hour with construction traffic

Intersection	Proposed conditions			
	Queue length (m)	Average delay (s)	Degree of saturation	Level of service (1)
Intersection 1: Pacific Highway/ Laydown Access Road	16	114	0.652	F
Intersection 4: Adelaide Street/ Richardson Road	171	12	0.923	A
Intersection 5: Irrawang Street/ William Street	3	7	0.107	A

Note (1): The level of service is based on the worst movement of the intersection.

Results from Table 7-44 indicate that Intersection 1 (Pacific Highway/Laydown Access Road) is estimated to experience delays of around 114 seconds and subsequently operate at LOS F for the worst movement, which is the right turn movement from the Laydown Access Road to the Pacific Highway when construction traffic is introduced during the PM peak. It is considered that these delays are manageable. However, drivers experiencing long delays could potentially become impatient and turn within insufficient gaps which may have an increased safety risk.

The remainder of the intersections would operate within acceptable levels of delay even for the worst movement when construction traffic is introduced during the PM peak.

The key findings of the construction phase intersection impact assessment are:

- The Adelaide Street/Richardson Road and Irrawang Street/William Street intersections would operate within acceptable LOS and delay during both AM and PM peak periods with the introduction of construction traffic
- The Pacific Highway/Laydown Access Road intersection would operate at LOS E (delays of 58 seconds) during the PM peak without construction traffic, and LOS F (delays of 114 seconds) during the PM peak with the added construction traffic