5 Additional assessment

Additional investigations or assessment have been carried out during the EIS exhibition period due to project design refinements as outline in Chapter 4 of this report, and in response to submissions received from Government agencies and the community as outlined in Chapter 2 and Chapter 3 of this report respectively.

Table 5-1 provides a summary of the additional assessments carried out including a summary of their scope, the reason the assessment was required and where the additional assessment id provided in this report.

Table 5-1 Summary of additional assessments since exhibition of the EIS

Assessment	Need for further assessment	Where addressed in this report
Noise and vibration	To assess project design refinements associated with minor changes to the vertical and horizontal alignment of the project.	Appendix B Summarised in Section 5.1.2
Biodiversity	To assess project design refinements that resulted in changes to the footprint of the project and in response to submissions.	Appendix C Summarised in Section 5.1.3 and throughout response to submissions
Water quality	To assess project design refinements associated with revised pavement drainage and changes to footprint.	Section 5.2.2
Aboriginal Heritage	Revised desktop assessment to assess project design refinements that resulted in changes to the footprint of the project	Section 5.2.3
Non-Aboriginal Heritage	To assess project design refinements that resulted in changes to the footprint of the project and in response to submissions.	Appendix D Summarised in Section 5.2.4 and throughout response to submissions
Hydrology and flooding	To assess project design refinements associated with revised pavement drainage.	Summarised in Section 5.2.1

The changes to the project as outlined in section 4.2 have been assessed for consistency against the outcomes of the assessments provided in the EIS. Consideration of these refinements against the issues assessed in the EIS is provided below. Where required, additional technical assessment has been provided as appendices to this submissions and preferred infrastructure report.

5.1 Key issues

5.1.1 Traffic and transport

The design refinements outlined in Figure 4-1 have been considered against the outcomes of the traffic and transport assessment carried out for the EIS as outlined in Chapter 7.1 of the EIS. Refinements that could have potential to result in minor changes to the traffic and transport assessment include:

- Changes to staging and delivery
- The provision of split carriageway between Gates Road and Longview Road
- Refinements to medians and kerbs along the main alignment and local roads
- Refinements to intersections
- Assessment of potential construction impacts.

Section 7.1.3 of the EIS provided an assessment of potential construction traffic impacts associated with the project. The design refinements outlined in this report have been reviewed against the outcomes of EIS construction traffic assessment.

Intersection performance

Section 7.1.4. of the EIS provides an analysis of the intersection performance along The Northern Road with the project. The analysis shows that most of the intersections within the study area would operate satisfactorily under the 2021 and 2031 future year scenarios with Level of Service (LoS) C or better. The only exception being the intersection of The Northern Road and Elizabeth Drive which would be operating near capacity in the evening peak hour at LoS D by 2021. This is due to the large volumes of conflicting traffic movements that are forecast to travel through this intersection by 2021.

A review of the design refinements provided in Table 4-1 has the following implications for intersection performance:

- Changes to staging and delivery of the proposed bus lanes is unlikely to affect the performance of intersections. The intersections would be built with the ultimate number of lanes at the stop line and would allow for a „bus jump" (traffic light phasing staged to allow bus priority). Given the very small number of buses using The Northern Road, buses merging back into general traffic lanes would not alter the performance of the intersections
- Refinements to median lengths at signalised intersections would not change accessibility or functionality as long as the median is retained. Overall, this would have negligible impact on traffic arrangements and therefore the operation and Level of Service (Los) of the intersections
- Addition of splitter islands allows for pedestrians crossing side streets to be separated from left turning traffic, removing this conflict and separating left turning vehicles from buses. Due to the low forecast pedestrian volumes along The Northern Road and the relatively low volumes of left turning traffic at most intersections, this would have minimal impact on intersection performance, in most cases a very minor improvement

- Signal phasing changes would allow for shorter minimum phase times for Littlefields Road and Gates Road extension. This would result in a very minor improvement in operation by reducing minimum phase time for side streets in the event of a pedestrian fall across The Northern Road.

Travel times

Section 7.1.4. of the EIS provides a comparison of modelled travel times along the existing The Northern Road corridor with and without the project. The modelled travel times indicate that the project would result in reduction of travel times in both directions along The Northern Road when comparing the project scenario with the „Do Minimum" scenario. In this section, northbound travel times are likely to remain similar to those without the project since the project would introduce delays at five new signalised intersections.

A review of the design refinements provided in Table 4-1 has the following implications for travel times with the introduction of the project:

- Changes to staging and delivery of the proposed bus lanes may result in a very small increase in bus travel time due to the fact that buses would be required to merge in and out of the general traffic lanes at the approached to bus stops (either at intersections or mid-block) rather than utilise a stand-alone bus lane. Changes to travel times for general traffic would be negligible as the number of buses that use The Northern Road is very small
- Provision of a section of split carriage way for a short section between Gates Road and Longview Road would have no impact of the modelled traffic arrangements or travel times
- Changes to the width of the median would not change the functionality of the main alignment and would therefore have no impact of traffic arrangements and not result in changes to travel times.

Impacts on local roads and access

The project would include the provision of a wide central median that would remove existing right turns at some intersections and property accesses. Table 7-13 of the EIS summarised the changes to access as a result of the project and also outlines the maximum additional travel distance and time that would result from changes to access.

A review of the design refinements provided in Table 4-1 has the following implications for local roads and access:

- Changes to staging and delivery of the proposed bus lanes is unlikely to result in additional impacts to local roads or property access during the initial construction of the project. Should provision for continuous lanes be required in the future, as demand requires, construction impacts similar to those described in this report may be experienced although those impacts would be in mid-block areas where the continuous lanes would be connected to the intersection bus lane areas.
- Changes to the width and length of the median would not result in a change of access to and from the main alignment and would therefore have no impact on traffic arrangements or further access issues
- Changes at Elizabeth Drive would result in small increases in travel distance for trips accessing the properties on the cul-de-sac (up to an additional 150 m). Reassignment of this traffic would not substantially affect the operation of the intersection of The Northern Road and Elizabeth Drive.

The potential construction traffic and transport impacts due to the proposed design refinements have also been considered. Overall, potential construction related impacts associated with the refined design for the project are considered consistent with those presented in the EIS. This is

due to the fact that, in general, the design refinements have only marginally altered the design of the road when compared to the EIS design. Additionally, construction plant and equipment, and haulage routes would be the same as outlined in the EIS.

5.1.2 Noise and vibration

As outlined in section 4.2 of this report, there have been a number of design refinements since exhibition of the EIS for the project which have resulted in minor changes to the project‟s horizontal and vertical alignments. These changes have the potential to alter some of the operational noise predictions presented in the EIS, and the associated number of receivers identified as qualifying for consideration of noise mitigation.

An assessment has been carried out to identify additional receivers that would potentially qualify for consideration of noise mitigation as a result of these design refinements (in addition to the 77 mitigation-eligible receivers identified in the EIS). The results of the technical assessment are presented in Appendix B.

In summary, one additional residential receiver (2778-2828 The Northern Rd, Luddenham) was identified as likely to qualify for consideration of noise mitigation, bringing the total to 78 receivers. Roads and Maritime carried out additional consultation with this property owner in December 2017 to inform them of the outcomes of the assessment. As identified in the EIS, further assessment and verification of noise impacts and any additional mitigation measures would be determined post-construction.

The potential construction noise and vibration impacts due to the proposed design refinements have also been considered as part of this assessment. Overall construction related noise and vibration impacts associated with the design refinements for the project are considered consistent with those presented in the EIS. This is due to the fact that, in general, the design refinements have only marginally altered the horizontal alignment when compared to the EIS design. Additionally, construction plant and equipment and haulage routes would be the same as outlined in the EIS. Further information regarding potential worst case noise impacts, out of hours works and the application of standard and additional mitigation measures as outlined in Roads and Maritime‟s CNVG (2016) is presented in Appendix A of this report, to support the response to submissions in section 2.6 of this report.

5.1.3 Biodiversity

As outlined in section 4.2 of this report, there have been a number of design refinements to the project since exhibition of the EIS which have resulted in changes to the project‟s construction footprint. This has affected the calculated direct impacts of the project as assessed within the BAR and corresponding information presented in section 7.3 of the EIS.

A revised assessment of the impacts under the FBA has been carried out including recalculation of landscape values, impacts to native vegetation (including threatened ecological communities), impacts to threatened species, and impacts to MNES, including impacts to the environment of commonwealth land.

The assessment is presented in Appendix C (Technical Memorandum – Biodiversity) and includes both the assessment of project changes as well as response to submissions relevant to biodiversity. A summary of the revised impacts of the project is presented below, with comparison against the results presented in the BAR and section 7.3 of the EIS.

Existing environment

Landscape values

Alteration to the proposed construction footprint has resulted in the need for recalculation of landscape value components including the percent extent of native vegetation cover in the landscape and the area to perimeter ratio. The connectivity value and patch size calculations

remain valid with the design change therefore no recalculation of these values were required. The results are presented ion Appendix C.

Table 5-2 provides a summary of the revised landscape component scores based on the revised construction footprint.

Table 5-2 Summary of the revised landscape component scores for the project

Threatened species	EIS design	Refined design	Change
Score for per cent native vegetation cover	1.25	0	Slight reduction
Score for connectivity value class	2.5	2.5	No change
Area / perimeter ratio score	1	2	Slight increase
Average patch size score	12.5	12.5	No change

The landscape value score as determined by the BioBanking credit calculator is 17, similar to that previously assessed in the BAR in which the landscape value score was calculated as 17.25.

Assessment of potential impacts

Removal of TSC Act listed threatened ecological communities

The potential loss of vegetation and habitat associated with the revised construction footprint for the project has been assessed in Appendix C, and summarised in Table 5-3. In summary, the revised construction footprint would impact on up to about 40.79 ha of native vegetation. This is a decrease of 3.50 ha when compared to the assessment of the EIS design.

Based on the refined design, the overall impact to the critically endangered Cumberland Plain Woodland in the Sydney Basin Bioregion ecological community has reduced by 2.96 ha. The impact to the River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions endangered ecological community has been reduced by 0.43 ha.

Table 5-3 Revised impacts to native vegetation (assessed under the FBA)

Vegetation zone	PCT	Condition	Status (TSC Act)	Impact (ha) - EIS design	Impact (ha) - refined design	Change
1	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	6.67	5.38	1.29 ha reduction
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good	EEC River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	2.53	2.43	0.1 ha reduction

Vegetation zone	PCT	Condition	Status (TSC Act)	Impact (ha) - EIS design	Impact (ha) - refined design	Change
3	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	4.92	4.92	No change
4*	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good_Poor	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	4.68	4.30	0.38 ha reduction
5	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good_Poor	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	3.21	3.11	0.1 ha reduction
6	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good_Poor	EEC River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	1.76	1.43	0.33 ha reduction
7	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good_High	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	1.25	1.37	0.12 ha increase
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good_Derived grassland	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	12.01	10.81	1.2 ha reduction
9	*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	Moderate/ Good_Other	-	6.17	6.05	0.12 ha reduction
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Moderate/ Good_Medium	CEEC Cumberland Plain Woodland in the Sydney Basin Bioregion	1.09	0.98	0.11 ha reduction
Totals				**44.29**	**40.79**	**3.50 ha reduction**

Note: * = The impacts to Vegetation Zone 4 have been included in Table 5-3 to provide an overview and comparison of impacts to native vegetation. Due to the manual override of the „Number of Trees with Hollows' and 'Fallen Logs' for HN528, Vegetation Zone 4 now has a site score of 29.17 and requires an offset to be calculated. A discussion on biodiversity impacts is included below.

Removal of EPBC Act listed threatened ecological communities

The assessment of impacts based on the EIS design identified that the project would result in the direct clearing of about 16.37 ha of the critically endangered Cumberland Plain Shale Woodlands

and Shale-Gravel Transition Forest ecological community. After detailed design, this impact has been reduced by 1.29 ha to 15.08 ha (refer to Table 5-4).

Table 5-4 Summary of impacts to the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community

Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest condition category	EIS design impact (ha)	Refined design impact (ha)	Change
Category A (core)	10.69	9.99	0.70 ha reduction
Category C	1.47	1.50	0.03 ha increase
Category C Derived Native Grassland	4.21	3.59	0.62 ha reduction
Total	16.37	15.08	1.29 ha reduction

Removal of threatened plants

The EIS identified that the project would impact the following threatened plant species and endangered population:

- *Pultenaea parviflora* (Endangered – TSC Act)
- *Marsdenia viridiflora* subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas (Endangered population – TSC Act).

The impact to these plants has been recalculated based on the refined design. The revised calculations also incorporate the results of an additional targeted survey conducted for *Pultenaea parviflora* and *Marsdenia viridiflora* subsp. *viridiflora* and other threatened plants around the Vineyard Road extension on the 7 August 2017. This was to account for the construction footprint changes at this location. Additionally, as stated in the BAR, this area was not able to be accessed during the fieldwork carried out for the original assessment therefore additional survey was required at this location following design refinements. The survey located a further six *Pultenaea parviflora* plants (two of which were in the construction footprint, and four outside of the footprint). No additional *Marsdenia viridiflora* subsp. *viridiflora* were recorded (refer to Figure 5-1).

The EIS construction footprint contained (and therefore would have removed) all known individuals and habitat for the *Marsdenia viridiflora* subsp. *viridiflora* endangered population in the study area. The refined design has resulted in the avoidance of four *Marsdenia viridiflora* subsp. *viridiflora* plants in the area of the DEOH fence between Kings Hill Road and Longview Road (see Figure 5-2). There is no requirement to impact on the location of these plants and exclusion zones would be established around the plants during construction in accordance with standard Roads and Maritime procedure. This reduces the overall impact to 31 individuals.

The EIS construction footprint contained (and therefore would have removed) all four known *Pultenaea parviflora* plants within the EIS design footprint as well as the two additional plants recorded in the Vineyard Road extension during the August 2017 survey (six *Pultenaea parviflora* plants in total). The August 2017 survey of the Vineyard Road extension recorded six additional *Pultenaea parviflora* plants of which four are outside of the construction footprint. The impact assessed in the EIS was to four *Pultenaea parviflora* plants because the extent of habitat along Vineyard Road extension was unable to be surveyed at the time. The overall impact to *Pultenaea parviflora* is now estimated at six plants.

Table 5-5 Summary of threatened plant species impacts from the refined design footprint

Threatened species	Ecosystem or species credit species	Status		EIS impact	Refined design impact	Change
		TSC Act	EPBC Act			
Pultenaea parviflora	Species credit species	Endangered	Vulnerable	4 individuals	6 individuals	2 additional plants to be impacted 4 additional plants avoided
Marsdenia viridiflora subsp. viridiflora – endangered population	Species credit species	Endangered population	Not listed	35 individuals	31 individuals	4 individuals avoided

Removal of threatened fauna species habitat and habitat features

Impacts to threatened fauna species habitat and habitat features have been recalculated based on the refined design as summarised in Table 5-6. Overall, based on the refined design, the project would have less impact on threatened fauna species habitat and habitat features than the design assessed as part of the EIS.

Figure 5-1 | Additional targeted survey for Pultenaea parviflora and Marsdenia viridiflora subsp. viridiflora undertaken in the Vineyard Road extension

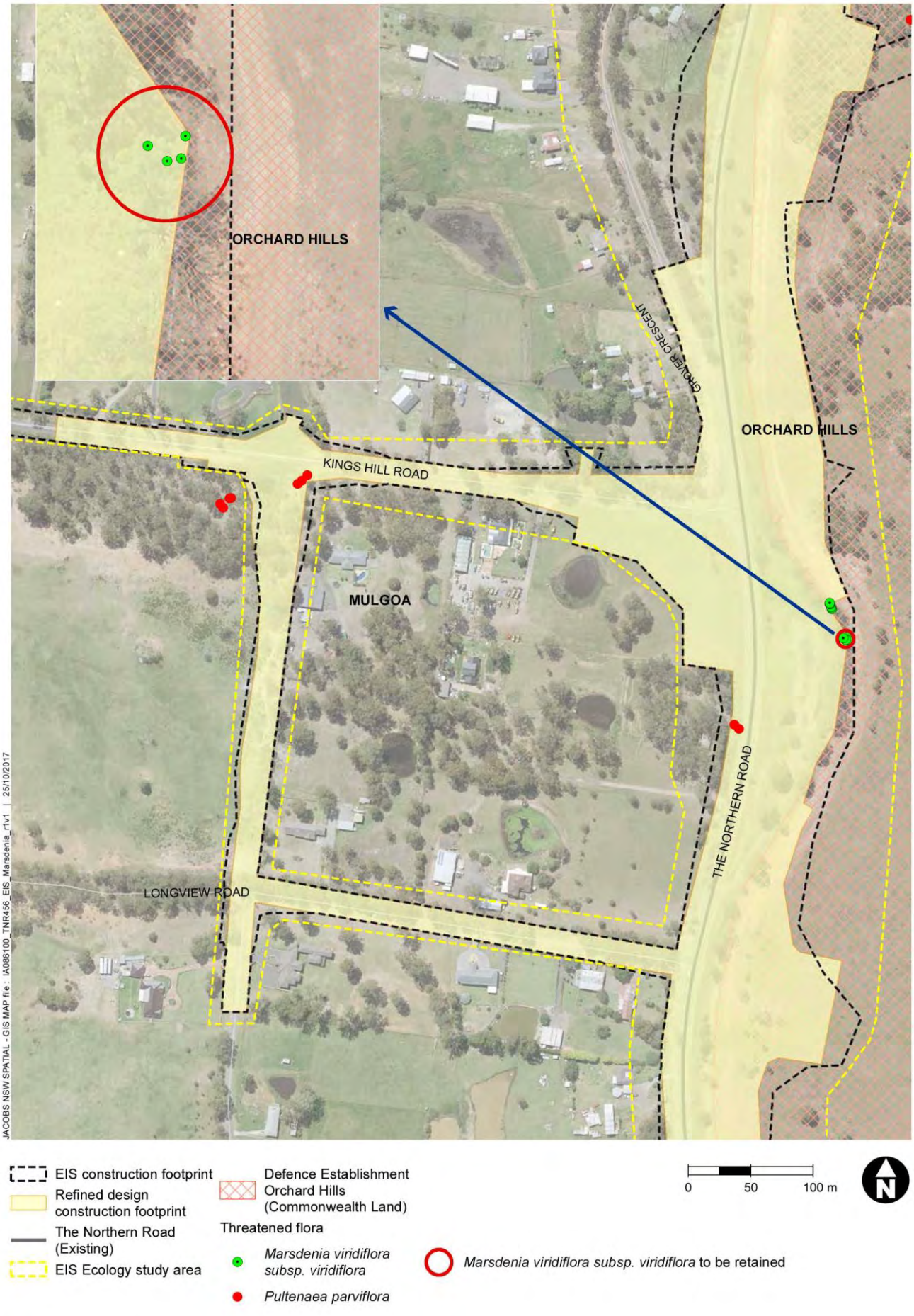

Figure 5-2 | Marsdenia viridiflora subsp. Viridiflora to be retained

Table 5-6 Summary of threatened fauna species impacts from the refined design footprint

Threatened species	Status		EIS design habitat impact (ha)	Refined design habitat impact (ha)	Change
	TSC Act	EPBC Act			
Cumberland Plain Land Snail	Endangered	Not listed	13	12.40	0.60 ha avoided
Grey-headed Flying-fox	Vulnerable	Vulnerable	26.25	24.10	2.15 ha avoided
Regent Honeyeater	Critically endangered	Critically endangered	26.25	24.10	2.15 ha avoided
Swift Parrot	Endangered	Critically endangered	26.25	24.10	2.15 ha avoided
Large-eared Pied Bat	Vulnerable	Vulnerable	26.25	24.10	2.15 ha avoided

Fragmentation of biodiversity links and habitat corridors

As outlined in section 2.7.5 of this report, the EIS acknowledged that the operation of the project would create barrier effects that restrict fauna movement, particularly for fauna groups such as mammals, frogs, and reptiles. Mobile species such as birds and bats may not be affected to the same extent.

The EIS identified that the detailed design of culverts would ensure that barriers to fish are not created and associated long-term impacts to the existing hydrology are minimised. Additionally, in response to submissions, two fauna crossings have been included as part of the refined design of culverts at Badgerys Creek and Surveyors Creek crossings. Further details are provided in section 2.7.5 of this report, including cross sections of the proposed culverts incorporating fauna passage.

Summary of impacts to the environment on Commonwealth

The EIS provided a summary of potential impacts to the environment of Commonwealth land as a result of the project, including biodiversity impacts associated with clearing of vegetation on Commonwealth land. This has been recalculated based on the refined design construction footprint as summarised in Table 5-7. In summary, there would be a decrease in clearing of remnant native vegetation by approximately 0.88 ha. This incorporates a decrease in clearing of the Critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community by 0.8 ha.

Table 5-7 Revised impacts to vegetation on Commonwealth land

Feature	Original impact	Revised impact after design refinements	Change
Remnant native vegetation (excluding man-made dams)	13.34 ha	12.46 ha	0.88 ha decrease
Critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community	10.07 ha	9.27 ha	0.80 ha decrease

Environmental management measures

A number of additional environmental management measures have been identified as a result of the revised assessment of impacts as outlined in this section, as well as in response to community and stakeholder submissions as outlined in Chapter 2 and Chapter 3 of this report.

Additional biodiversity measures for the project been incorporated into the revised environmental management measures outlined in Chapter 6 this report. In summary, the revised management measures relate to:

- The preparation of a Vegetation Management Plan (VMP) in consultation with DPI Water prior to construction
- The reuse of topsoil as part of the Urban Design and Landscape Plan for the project
- Consideration of transplanting native species from areas to be cleared into revegetation areas
- The set-up of exclusion areas in the proximity of *Marsdenia viridiflora* and *Pultenaea parviflora*.

Biodiversity offsets

A summary of the biodiversity offset credits required for the project based on the refined design is presented in Appendix C, including a comparison against the previous calculations prepared as part of the EIS. The revised credit calculations take into account the amendments to the landscape assessment, altered areas of impact, avoidance of some threatened species impacts, amendment of some benchmark data in the BioBanking credit calculator, and reassignment of the Derived Native Grassland to HN 529.

5.1.4 Socio-economic and land use

Property impacts

Section 7.4 of the EIS provides an assessment of the project‟s likely impacts on the socio-economic environment of the project area during both construction and operation of the project. This assessment includes details of temporary and permanent acquisitions required.

Project design refinements have resulted in minor changes to the project construction and operational footprint and therefore the location and type of acquisition has also changed.

The proposed design refinements would generally result in a reduction in property impacts associated with the operation of the project. These properties would include a combination of privately owned land as well as land owned by Roads and Maritime, other NSW Government agencies and the Commonwealth Government. The majority of land to be partially or fully acquired for the project comprises residential uses. Table 5-8 compares the EIS predicted property impacts against the revised property impacts taking into consideration the proposed design refinements.

Table 5-8 Revised property impacts table (EIS vs refined design)

Assessment	Impacted lots	Impacted owners	Impacted houses	Impacted sheds
Predicted property impacts (EIS)	142	83	10	16
Revised property impacts (current refined design)	121	76	8	15

Generally, affected properties would be partially acquired by Road and Maritime where only part of the property would be directly impacted by the project. In some instances, Roads and Maritime would give consideration to total acquisition (dual offer) or acquisition of any residual parcels created by the location and design of the project. This would provide affected property owners with a level of flexibility or choice during the property acquisition process in relation to property decisions. For example, some property owners may want to retain residual parcels for future use. Roads and Maritime would continue to consult with land owners through the detailed design about these land parcels. The acquisition of land required for the operation of the project would be permanent and would result in long-term impacts to property as a result of the project.

Table 5-9 provides a revised summary of property acquisitions required for the project taking into consideration the proposed design refinements.

Table 5-9 Revised summary of property acquisitions

Property ID	Property (lot number)	Existing land use*	Acquisition type	Dwellings affected	Buildings (sheds) affected
1	Lot 1 DP235845	Residential	Partial	-	-
2	Lot 97 DP27550	Residential	Partial	-	-
3	Lot 1 DP250684	Residential	Partial	-	-
4	Lot 96 DP27550	Residential / business	Partial	-	-
5	Lot 95 DP27550	Residential / business	Partial	-	-
6	Lot 94 DP27550	Residential	Partial	-	-
7	Lot 93 DP654182	Residential	Partial	-	-
8	Lot 92 DP27550	Business	Partial	-	-
9	Lot 102 DP812653	Rural / residential	Partial	-	-
10	Lot 1 DP838361	Rural / Western Sydney Airport / Commonwealth land	Partial	-	Yes (2)
11	Lot 11 DP1092165	Rural residential	Partial	-	Yes (2)

Property ID	Property (lot number)	Existing land use*	Acquisition type	Dwellings affected	Buildings (sheds) affected
12	Lot 27 DP259698	Residential	Partial	-	-
13	Lot 28 DP259698	Residential	Partial	-	-
14	Lot 33 DP259698	Rural residential	Partial	-	-
15	Lot 22 DP258581	Rural residential	Partial	-	-
16	Lot 21 DP258581	Residential	partial	Yes (1)	-
17	Lot 20 DP258581	Residential	Partial	-	Yes (1)
18	Lot 2 DP851626	Business	Partial	-	-
19	Lot 1 DP851626	Rural	Partial	-	-
20	Lot 2 DP623457	Business	Partial	-	-
21	Lot 21 DP614481	Residential	Partial	-	-
22	Lot 1 DP250030	Residential	partial	Yes (1)	Yes (1)
23	Lot 1 DP90157	Residential	Partial	-	-
24	Lot 2 DP250030	Residential	Partial	-	-
25	Lot 3 DP250030	Residential	Partial	-	-
26	Lot 2 DP519034	Residential	Partial	-	-
27	Lot 104 DP846962	Residential	Partial	-	-
28	Lot 3 DP827223	Residential	Partial	-	-
29	Lot 103 DP846962	Residential	Partial	-	-
30	Lot 102 DP846962	Residential	Partial	-	-
31	Lot 1 DP232996	Rural residential	Partial	-	-
32	Lot 101 DP846962	Residential	Partial	-	-
33	Lot 100 DP846962	Residential	Partial	-	-
34	Lot 5 DP232324	Crown land (road reserve)	Full	-	-
35	Lot 4 DP232324	Crown land (road reserve)	Full	-	-

Property ID	Property (lot number)	Existing land use*	Acquisition type	Dwellings affected	Buildings (sheds) affected
36	Lot 3 DP911607	Crown land (road reserve)	Full	-	-
37	Lot 1 DP517853	Rural Residential	Partial	Yes (2)	Yes (4)
38	Lot 2 DP517853	Rural residential	Partial	-	-
39	Lot 1 DP1169433	Residential/ business	Partial	-	-
40	Lot 3 DP32026	Residential/ business	Partial	Yes (1)	-
41	Lot 504 DP581138	Residential	Partial	-	-
42	Lot 2 DP32026	Residential/ business	Partial	Yes (1)	Yes (1)
43	Lot DP160890	Residential/ business	Partial	Yes (1)	-
44	Lot 5 DP599382	Residential	Partial	-	-
45	Lot 1 DP200435	Residential/ business	Partial	-	-
46	Lot 501 DP580982	Residential	Partial	-	-
47	Lot 12 DP249113	Residential	Partial	-	-
48	Lot 11 DP249113	Residential	Partial	-	-
49	Lot 10 DP249113	Residential	Partial	-	-
50	Lot 9 DP249113	Residential	Partial	-	-
51	Lot 1 DP109697	Residential	Partial	-	-
52	Lot 8 DP249113	Residential	Partial	-	Yes (1)
53	Lot 7 DP249113	Residential	Partial	-	-
54	Lot 101 DP580082	Business	Partial	-	-
55	Lot 11 DP30775	Residential	Partial	-	-
56	Lot 12 DP30775	Sydney Water pumping station	Partial	-	-
57	Lot 13 DP30775	Residential	Partial	-	Yes (1)

Property ID	Property (lot number)	Existing land use*	Acquisition type	Dwellings affected	Buildings (sheds) affected
58	Lot 14 DP30775	Residential	Partial	-	-
59	Lot 22 DP32053	Rural	Partial	-	-
60	Lot 15 DP30775	Residential	Partial	-	-
61	Lot 23 DP207317	Residential	Partial	-	-
62	Lot 2 DP32053	Residential/ rural	Partial	-	-
63	Lot 1 DP420840	Residential	Partial	-	-
64	Lot 16 DP30775	Residential	Partial	-	Yes (1)
65	Lot A DP341893	Water NSW asset maintenance	Partial	-	-
66	Lot A DP341629	Water NSW asset maintenance	Partial	-	-
67	Lot 1 DP226972	Water NSW asset maintenance	Partial	-	-
68	Lot 22 DP843123	Residential	Partial	-	Yes (1)
69	Lot 68 DP651114	Residential	Partial	-	
70	Lot 71 DP668758	Residential	Partial	-	-
71	Lot 73 DP2120	Residential	Partial	-	-
72	Lot 1 DP1064093	Residential	Partial	-	-
73	Lot 1 DP232322	Crown land (road reserve)	Full	-	-
74	Lot 77 DP659462	Business	Partial	-	-
75	Lot 10 Sec H DP2234	Vacant	Full	-	-
76	Lot 36 DP959167	Vacant	Partial	-	-
77	Lot 101 Sec H DP2234	Vacant	Partial	-	-
78	Lot 100 Sec H DP2234	Vacant	Partial	-	-
79	Lot 99 Sec H DP2234	Vacant	Partial	-	-
80	Lot 98 Sec H DP2234	Vacant	Partial	-	-
81	Lot 97 Sec H DP2234	Vacant	Partial	-	-

Property ID	Property (lot number)	Existing land use*	Acquisition type	Dwellings affected	Buildings (sheds) affected
82	Lot 96 Sec H DP2234	Vacant	Partial	-	-
83	Lot 37 DP959167	Vacant	Partial	-	-
84	Lot 84 Sec H DP2234	Vacant	Partial	-	-
85	Lot 83 Sec H DP2234	Vacant	Partial	-	-
86	Lot 38 DP959167	Residential	Partial	-	-
87	Lot 75 Sec H DP2234	Residential	Partial	-	-
88	Lot 74 Sec H DP2234	Residential	Partial	-	-
89	Lot 73 Sec H DP2234	Residential	Partial	-	-
90	Lot 72 Sec H DP2234	Residential	Partial	-	-
91	Lot 71 Sec H DP2234	Residential	Partial	-	-
92	Lot 70 Sec H DP2234	Residential	Partial	-	-
93	Lot 69 Sec H DP2234	Residential	Partial	-	-
94	Lot 1 DP202647	Business	Partial	-	-
95	Lot 68 Sec H DP2234	Residential	Partial	-	-
96	Lot 67 Sec H DP2234	Residential	Partial	-	-
97	Lot 66 Sec H DP2234	Residential	Partial	-	-
98	Lot 65 Sec H DP2234	Residential	Partial	-	-
99	Lot 64 Sec H DP2234	Residential	Partial	-	-
100	Lot 63 Sec H DP2234	Residential	Partial	-	-
101	Lot 42 DP878814	Residential	Partial	-	-
102	Lot 62 Sec H DP2234	Residential	Full	-	-
103	Lot 23 DP29081	Residential	Partial	-	-
104	Lot 61 Sec H DP2234	Residential	Full	-	-
105	Lot 60 Sec H DP2234	Residential	Partial	-	-
106	Lot 24 DP29081	Residential	Partial	-	-
107	Lot 10 DP29081	Residential	Partial	-	-

Property ID	Property (lot number)	Existing land use*	Acquisition type	Dwellings affected	Buildings (sheds) affected
108	Lot 3 DP238092	Commonwealth Department of Defence uses	Partial	-	-
109	Lot 31 DP244610	Residential	Partial	-	-
110	Lot 32 DP244610	Residential	Partial	-	-
111	Lot 2 DP224861	Rural residential	Partial	-	-
112	Lot 1 DP224861	Residential	Partial	Yes (1)	-
113	Lot 7 DP4832	Residential	Partial	-	-
114	Lot 500 DP1133119	Residential	Partial	-	-
115	Lot 1 DP551558	Residential	Partial	-	-
116	Lot 1 DP238092	Commonwealth Department of Defence uses	Partial	-	-
117	Lot 5 DP26658	Rural residential	Partial	-	-
118	Lot 6 DP26658	Rural residential	Partial	-	-
119	Lot 7 DP26658	Rural residential	Partial	-	-
120	Lot 1 DP711076	Residential	Partial	-	-
121	Lot 2 DP711076	Vacant	Partial	-	-

Notes:
* Information on existing land use is based on a review of aerial photography and visual inspections
** Strip of land located along road reserve

Roads and Maritime would acquire properties for the project in accordance with the provisions of the *NSW Property Acquisition (Just Terms Compensation) Act 1991*. Among other things, the Act provides the basis for assessing compensation.

Access to residual property parcels would be maintained through the current design via either The Northern Road or the local road network, however some permanent changes may be required. Roads and Maritime would continue to consult with property owners to effectively mitigate potential land use and access impacts where possible through detailed design.

Where partial acquisition of rural properties would occur, infrastructure such as fencing, dams, sheds and other structures, within the project construction footprint would be demolished or relocated due to the project. Any relocation of rural infrastructure for the project would be carried out in consultation with the property owner, prior to the removal of the infrastructure.

As outlined in section 3.10.2, there have been a number of design refinements which have resulted in an overall reduction to the construction footprint and associated lease areas, including ancillary facility C17. Additionally, a lease area within WaterNSW land previously proposed for drainage works would no longer be required based on the refined design. Other minor changes to temporary

leases of land may be required to accommodate the design refinements. This would result in limited changes to impacts on farm infrastructure such as dams, irrigation, fencing, shed and storage areas, and other facilities. Where this infrastructure would be demolished and reinstated or relocated as a result of the project, this would be carried out in consultation with the property owner, prior to the removal of the infrastructure.

No additional environmental management measures have been proposed beyond those identified in the EIS.

Land use impacts during operation

The proposed design refinements would result in an overall reduction in the size of the operational footprint of 16.26 ha. As outlined in Table 5-10, the proposed design refinements would result in a net decrease in the land required by the project for all land uses with the exception of land that is currently zoned for infrastructure, mainly transport of other infrastructure corridors; which would experience an increase of 0.05 ha. Where this land lies within the operational footprint of the project design it would remain in use as infrastructure and would be zoned accordingly.

Primary production uses would still comprise the largest area of land directly impacted by the project. As a result of the proposed design refinements, 11.56 ha of land currently used for primary production, and earmarked for rezoning to infrastructure land use within the EIS, would no longer be impacted by the project.

Table 5-10 Revised extent of directly affected land uses within the operational footprint

Land use	Penrith LGA		Liverpool LGA		Total region	
	Land in operational footprint (ha)	Change from EIS (- / + ha)	Land in operational footprint (ha)	Change from EIS (- / + ha)	Land in operational footprint (ha)	Change from EIS (- / + ha)
Environmental uses	1.20	-0.19	6.00	-0.34	7.20	-0.53
Primary production uses	20.19	-8.19	73.97	-3.37	94.17	-11.56
Transport and other corridors	44.88	-0.16	13.22	+0.21	58.10	+0.05
Urban	3.35	-1.23	1.04	-0.31	4.39	-1.54
Special category	20.05	-2.55	2.10	-0.15	22.16	-2.69
Total	**89.67**	**-12.32**	**96.34**	**-3.94**	**186.01**	**-16.26**

The use of land affected by temporary leases during construction would be temporarily disrupted or suspended for the duration of the lease. Any structures, facilities or infrastructure located on the affected lands would likely be demolished and/or relocated, in consultation with the landowner. On completion of construction, any land not required for the project‟s long-term operation would be reinstated to its former use.

No additional environmental management measures have been proposed beyond those identified in the EIS.

Social and economic impacts

The EIS considered a range of potential social and economic impacts associated with project. The design refinements would not result in a significant change to the social and economic impacts outlined in the EIS. No additional environmental management measures have been proposed beyond those identified in the EIS.

Impacts on local businesses

An error was identified in the EIS in relation to Figures 7-13 and 7-14 of the EIS which show the location of directly affected businesses and agricultural businesses respectively. These figures correspond to Table 7-62 of the EIS which summarises the potential impacts to businesses. It has been identified that some of the impacted primary production lots identified in this table of the EIS were not included in the corresponding figures as follows:

- Market Garden and Cattle at 350-370 Willowdene Avenue, Luddenham
- Primary production at 2422-2430 The Northern Road, Luddenham
- Primary production at 28 Eaton Road, Luddenham.

These additional properties are shown in Figure 5-3.

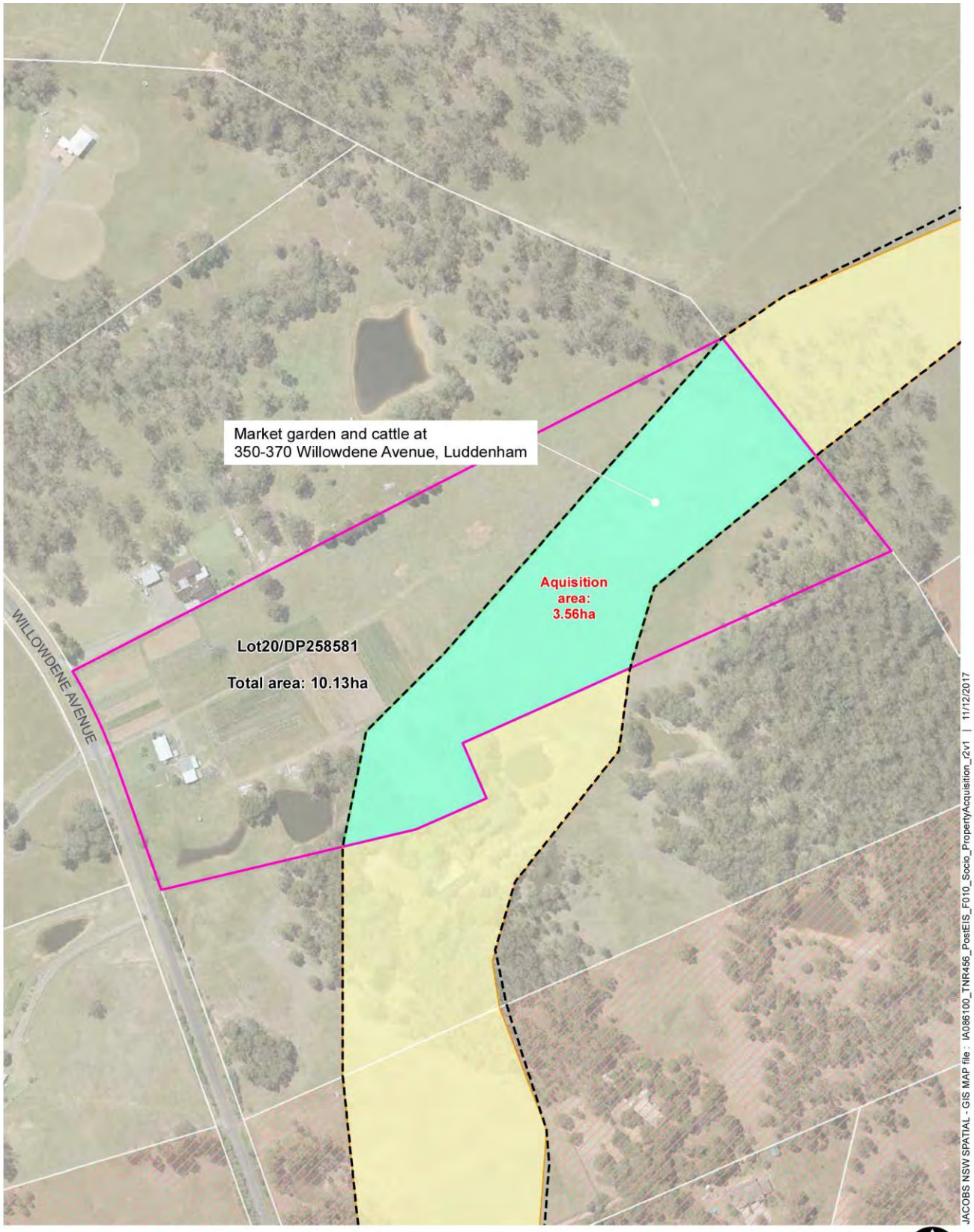

Figure 5.3 | Directly affected businesses not shown in the EIS

Page 1 of 3

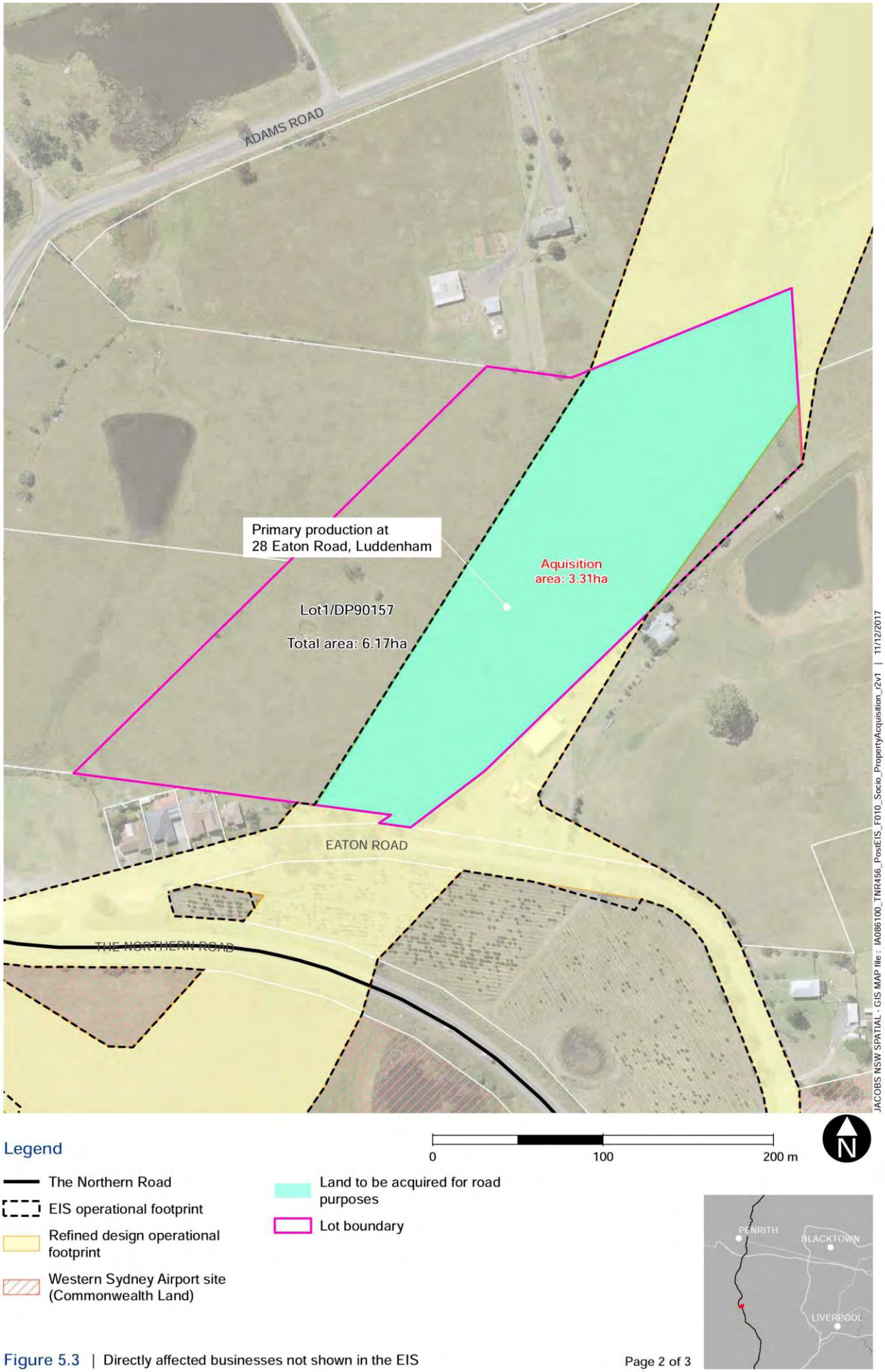

Figure 5.3 | Directly affected businesses not shown in the EIS

Page 2 of 3

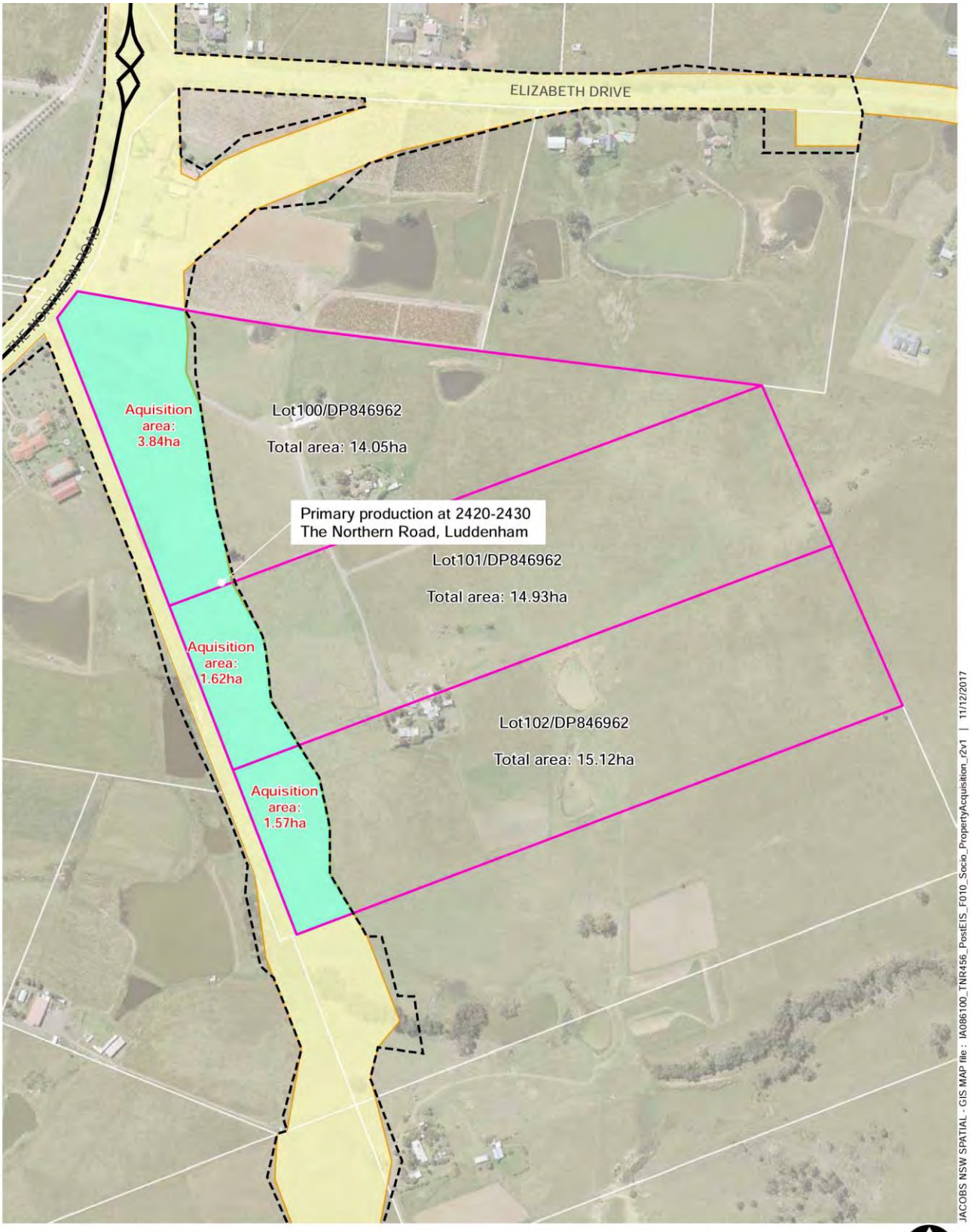

Figure 5.3 | Directly affected businesses not shown in the EIS

Page 3 of 3

5.2 Other issues

5.2.1 Hydrology and flooding

The design refinements outlined in Table 4-1 have been considered against the outcomes of the hydrology and flooding assessment carried out for the EIS as outlined in section 8.1 of the EIS. Refinements that could have potential to result in minor changes to the hydrology and flooding assessment include:

- Refinements to drainage and water quality infrastructure
- Refinements to cuttings, embankments and median along the main alignment
- Geometry and alignment changes along the main alignment and local roads
- Refinements to medians and kerbs along the main alignment and local roads.

Section 8.1.3 of the EIS provided an assessment of potential impact of the project on flooding behaviour during construction of the project. The design refinements outlined in this report have been reviewed against the outcomes of EIS construction flooding and hydrology assessment.

Assessment methodology

Design checks have been carried out to compare and check the consistency of the design exhibited in the EIS and the current project design:

- The transverse drainage was checked by:
  - comparing culvert locations, types and dimensions
  - remapping of the catchments contributing to each structure and comparison of those areas
  - re-run of the TUFLOW model for the section of the main alignment about 600m north of Chain-O-Ponds Road to confirm that flooding conditions were not exacerbated in existing development located downstream of the road corridor
  - re-run of the TUFLOW model for Badgerys Creek where the main alignment has been lowered to confirm that the resulting afflux is comparable to the findings of the sensitivity study that is presented in the EIS.
- The pavement drainage was checked by:
  - comparing outlet locations with those shown in the EIS
  - remapping of the catchments draining to outlets and comparing with the areas shown in the EIS.
  - checked peak flows in drainage line MC DL16 to make sure that the rate of flow had not been increased in private property.
- Catch drain types, lengths and locations were checked against the EIS design
- The lengths of scour protection at the inlets and outlets of transverse drainage structures have been compared against the EIS design.

Assessment of potential operational impacts

The potential impacts of the project on flooding behaviour and the scour potential within receiving drainage lines has been considered during the design phases of the project and is ongoing as the design is finalised. Detailed flood modelling has been carried out to identify the potential residual flooding and drainage related impacts of the project following the incorporation of a preferred set of transverse drainage upgrade and flood mitigation measures into its design.

The design checks outlined above have indicated that the finalised drainage design for the project can be developed to ensure performance is consistent with the commitments made in the EIS.

Assessment of potential construction impacts

The potential construction hydrology and flooding impacts due to the proposed design refinements have also been considered. Overall, potential construction related impacts associated with the refined design for the project are considered consistent with those presented in the EIS. This is due to the fact that, in general, the design refinements have only marginally altered the design of the road when compared to the EIS design. Additionally, construction plant and equipment, construction timings and haulage routes would be the same as outlined in the EIS.

5.2.2 Soils, water and contamination

During the design refinement process, design refinements were made to the proposed road and pavement drainage design.

The refined design proposes 23 operational water quality swales (a reduction from the 24 proposed in the EIS). Pollutant removal is facilitated by the interaction between the flow and the vegetation along the length of the swale. Rock check dams are also proposed to provide additional treatment by slowing down the runoff and allowing it to temporarily pond during storm events. The location and size of each swale has been optimised to maximise filtering out of suspended materials and pollutants, including those proposed upstream of identified sensitive receiving waterways (i.e. Key Fish Habitat).

GPTs and water quality basins have been considered by Roads and Maritime as part of the water quality treatment type selection process. Since the generation of gross pollutant loads from the upgraded road is significantly lower than those generated from an urbanised catchment of residential or commercial landuse, any gross pollutants from the upgraded road would be removed at the swales as part of a road maintenance program.

Space constraints along a narrow road corridor was the main reason for not adopting specific water quality basins. These constraints included private and commonwealth properties, utilities, topographical constraints and clearing of trees and valuable vegetation.

The details of these swales are summarised in Table 5-11 and shown in Figure 5-4.

Table 5-11 Water quality treatment measures – Swales

Stage	Swale name	Swale length (m)	Receiving Creek	Catchment area to swale (ha)
Between Mersey Road, Bringelly and Eaton Road, Luddenham	S1*	257	Badgerys Creek	4.45
	S2*	136	Badgerys Creek	8.63
	S3	111	Duncans Creek	1.88
	S4	62	Duncans Creek	0.75
	S5*	83	Unnamed Creek	3.17
	S6*	38	Unnamed Creek	3.32
	S7*	65	Narro Dam	1.31
	S8*	40	Narro Dam	4.42

Stage	Swale name	Swale length (m)	Receiving Creek	Catchment area to swale (ha)
Between Eaton Road, Luddenham and Littlefields Road, Luddenham	S9	70	Adams Road Culvert	3.18
	S10	160	Adams Road Culvert	3.36
	S11	100	Adams Road Culvert	4.73
	S12*	60	Cosgroves Creek	0.39
	S13*	80	Cosgroves Creek	4.64
	S14	100	Unnamed Creek	0.26
	S15	80	Unnamed Creek	0.26
	S16	70	Unnamed Creek	3.49
	S17	40	Unnamed Creek	3.49
	S18	75	Unnamed Creek	2.53
	S19	80	Unnamed Creek	3.22
	S20	90	Unnamed Creek	0.36
Between Littlefields Road, Luddenham and Glenmore Parkway, Glenmore Park	S21	75	Unnamed Creek	3.40
	S22*	57	Surveyors Creek	1.40
	S23*	85	Surveyors Creek	0.41

*represents sensitive receiving waterway or creek

In addition to the 23 swales outlined above, two detention basins have been proposed to mitigate hydrological and flooding impacts (refer to Table 5-12 and Figure 5-4). The primary purpose of the detention basins is to provide peak flow mitigation for hydrology purposes, however an opportunity was presented to utilise the same area to also provide water quality treatment over the same footprint. This was achieved by creating a wet basin below the normally dry detention space. Therefore, these basins also provide pollution load reductions. No detention basins were originally proposed as part of the EIS.

Table 5-12 Water quality design refinements – Detention basins

Stage	Swale name	Swale length (m)	Receiving Creek	Catchment area to swale (ha)
Between Littlefields Road, Luddenham and Glenmore Parkway, Glenmore Park	P2140R	3775	Unnamed Creek	4.50
	P3650R	1170	Unnamed Creek	3.90

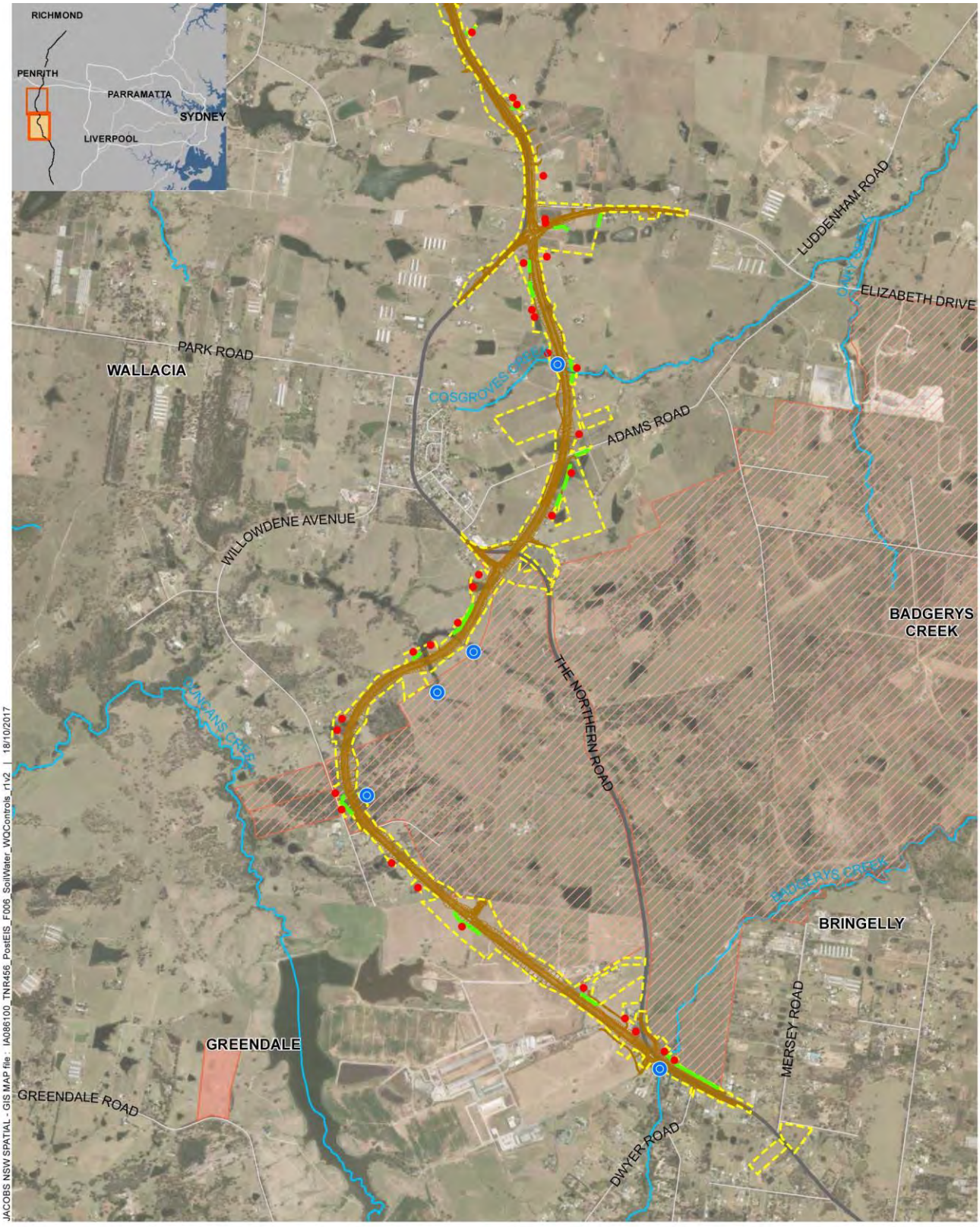

Figure 5-4 | Water quality controls

Page 1 of 2

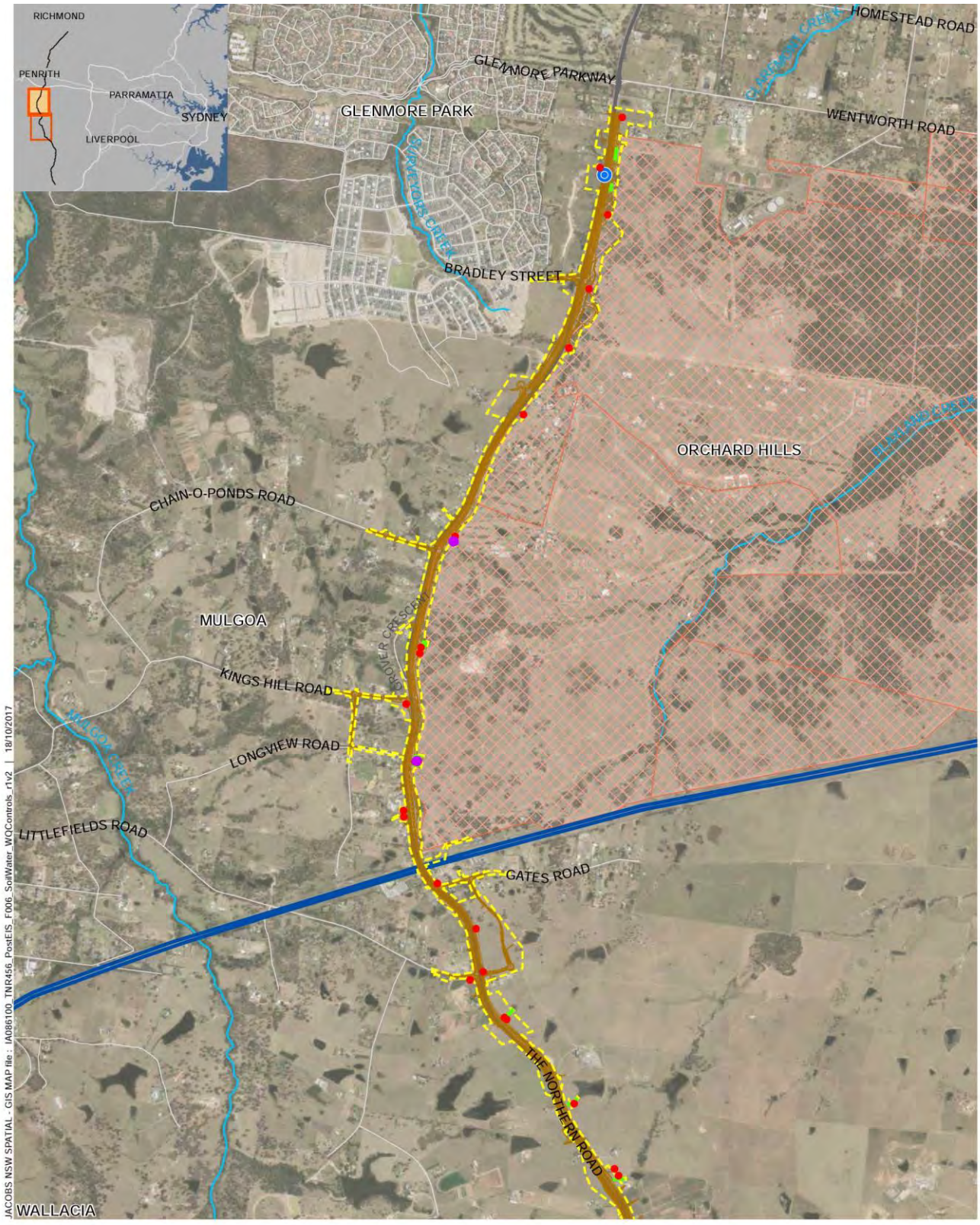

Figure 5-4 | Water quality controls

Page 2 of 2

Assessment methodology

Water quality modelling using the MUSIC - Model for Urban Stormwater Improvement Conceptualisation (MUSIC), was also carried out to identify the pollutant load reductions that can be achieved by permanent water quality swales (with rock check dams) for total suspended solids, total nitrogen and total phosphorus.

The catchment draining to an individual control measure was delineated by considering the formation of the proposed carriageway and the proposed pipe drainage network. The total catchment area was divided into two sub-catchments according to the different land-use characteristics of the „impervious road catchment" area, and the batter slope or „pervious road side" area.

The MUSIC model was set up to represent proposed catchment conditions. Models of the swales were created by adopting the sub-catchment areas estimated in the catchment analysis. Rock check dams were also added to the model as per the design of typical swale details.

The results of the MUSIC model were compared against the result previously achieved for the road and pavement drainage proposed in the EIS.

Construction impacts

The potential impact on receiving waterways during construction would be effectively mitigated through erosion and sediment controls including appropriately sized temporary sediment basins in accordance with the requirements of the Blue Book. The Blue Book criteria of „Minimum 150 m^3 of annual sediment loss would be adopted. Impacts associated with the construction of this infrastructure would generally be consistent with the design proposed in the EIS and would not result in any additional impacts on water quality.

The proposed design refinements would not result in any additional impacts to soils or contamination during construction beyond that which was assessed in the EIS.

Operational impacts

The result of the MUSIC modelling for the 23 swales (S1-S23) (refer to Table 5-13) indicates that pollutant load reductions can be achieved as follows:

- Total suspended solids (ranged from 31 per cent to 93 per cent)
- Total phosphorous ranged from (17.2 per cent to 75 per cent)
- Total nitrogen (range from 5.3 per cent to 49 per cent).

Table 5-13 Annual average pollutant load reduction for the proposed vegetated swales

Swales	Total suspended solids (%)	Total phosphorous (%)	Total nitrogen (%)
S1	82	55	19
S2	70	45	13
S3	87	60	30
S4	74	46	15
S5	86	67	37
S6	92	75	49
S7	88	60	30
S8	56	39	12

Swales	Total suspended solids (%)	Total phosphorous (%)	Total nitrogen (%)
S9	80.1	58.1	17.8
S10	66.1	32.1	23.1
S11	67.1	35.1	11.8
S12	92.9	73.1	48.6
S13	71.3	50.3	12.9
S14	21.8	20.6	31.7
S15	73.6	73.6	48.7
S16	62.3	42.7	9.5
S17	31	17.2	5.3
S18	76.3	54.6	15.7
S19	78.5	56.1	16.7
S20	91.3	67.9	29.5
S21	67	47	14
S22	78	59	21
S23	93	72	42

The results of the MUSIC modelling for the two proposed basins (P2140R and P3650R) are outlined in Table 5-14.

Table 5-14 Annual average pollutant load reduction for the proposed basins

Basin	Total suspended solids (%)	Total phosphorous (%)	Total nitrogen (%)
P2140R	89	76	56
P3650R	77	64	40

The results of the MUSIC modelling, which are measured in annual pollutant load reductions, indicate that the refined road and pavement drainage would generally result in an improvement in water quality compared to that which was previously achieved (and assessed within the EIS).

The Water Management Policy of Liverpool City Council (section 4.1j) refers to pollutant load reductions for suspended solids, total phosphorus and total nitrogen. General policy pollutant load reductions are not available in the latest Council General DCPs, however a previous DCP 2008, Part 1, General Controls for all Development (section 6.4) indicates that post development water quality shall be reduced by 45 per cent for TP and TN and by 80 per cent for TSS.

The Penrith City Council Water Sensitive Urban Design Policy (section 3.2) indicates that pollutant load reductions should be 45 per cent for TN, 65 per cent for TP, 85 per cent for TSS and 90 per cent for gross pollutants.

The percentage reductions that are achieved by the proposed controls indicate that those reductions are not always achieved. This is due to site constraints that do not allow the provision of additional permanent water quality controls.

The proposed design refinements would not result in any additional impacts to soils or contamination during operation beyond that which was assessed in the EIS.

Environmental management measure

The EIS identified environmental management and mitigation measures that Roads and Maritime would adopt with regards to operational water quality; specifically, that 24 water quality swales would be constructed upstream of identified sensitive receiving waterways (refer to section 12 of the EIS). As described above, this would now comprise 23 water quality swales and two basins.

Consistent with the EIS, an Operational Water Quality Management Plan would be established which would outline monitoring and reporting requirements to confirm the effectiveness of these water quality measures, and identify if any additional measures are required.

5.2.3 Aboriginal heritage

As outlined in section 4.2 of this report, there have been a number of design refinements since exhibition of the EIS for the project which have resulted in changes to the construction footprint (ie the area of disturbance). The assessment of these changes in relation to Aboriginal heritage is outlined below.

Kelleher Nightingale Consulting (KNC) carried out the Aboriginal heritage assessment as part of the EIS. For the purpose of this this report, KNC carried out a desktop assessment in September 2017 to assess the potential impact of the proposed design refinements on Aboriginal cultural heritage in comparison to the EIS design. The results of this assessment are outlined below.

Impact assessment

The assessment concluded that the proposed design refinements would not result in any additional impact on Aboriginal cultural heritage and are consistent with the impacts identified in the EIS. That is, a total of 28 Aboriginal archaeological sites would be impacted by the project as identified in the EIS, with 12 sites totally impacted and 16 sites partially impacted by the project.

Environmental management measure

Due to there being no change in impact, the design refinements would not result in any revised or additional environmental management measures for the project. The management measures identified in the EIS for Aboriginal cultural heritage would be implemented for the project.

5.2.4 Non-Aboriginal heritage

As outlined in section 4.2 of this report, there have been a number of design refinements since exhibition of the EIS for the project which have resulted in changes to the construction footprint (ie the area of disturbance). The assessment of these changes in relation to non-Aboriginal heritage is outlined below.

For the purpose of this assessment, a staged desktop assessment was carried out between June and September 2017 to assess the potential impact of the proposed design refinements on non-Aboriginal heritage in comparison to the EIS design. Additionally, a non-Aboriginal heritage technical memorandum was prepared in response to community and agency submissions, which reflected the refined design (refer to Appendix D). The results of this assessment are outlined below.

Existing environment

As outlined in the response to community and agency submissions, further historical research has been carried out and the associated assessments of heritage significance of some items assessed

in the EIS have been updated. Although the statements of heritage significance for some items were updated to reflect increased knowledge of these sites, there was no change to whether or not an item satisfied the criteria for local or State heritage listing, with no items of State heritage significance identified for the project.

Impact assessment

The desktop assessment focused on new areas of the construction (i.e. disturbance) footprint not previously assessed as part of the EIS. The assessment did not identify any new areas that overlap with registered historical heritage items, and did not identify any new impacted areas as having the potential for heritage items. However, the assessment identified a number of revised impacts to heritage items previously identified and assessed as part of the EIS as follows:

- Item 2: Orchard Hills Cumberland Plain Woodland Commonwealth Heritage Place (including the Chaffey Brothers Irrigation Scheme Canal) – new areas of the construction footprint extend further into the DEOH, with increased impacts to the Orchard Hill Cumberland Plain Woodland site in relation to impacts to natural heritage and to historic heritage associated with the Chaffey Brothers Irrigation Scheme Canal located within the site. It is noted that some areas of the footprint have also reduced the impact to this item. An assessment of the area of the heritage features directly impacted by the revised footprint has been carried out and is presented below in comparison to the impact assessed as part of the EIS:
  - About 2.36 per cent of the northern part of the canal would be impacted based on the refined design construction footprint (refer to Figure 5-5), a slight reduction in comparison to the previously identified 2.43 per cent assessed in the EIS
  - About 9.28 ha of native vegetation within the Orchard Hills Cumberland Plain Woodland site would be impacted based on the refined design construction footprint (refer to Figure 5-6), a reduction in comparison to the previously identified 9.68 ha identified in the EIS. The revised footprint would not change the outcome of the EIS, with areas of low to moderate natural heritage significance being impacted, no areas of high significance are impacted as a result of the proposed design refinements. Additionally, there is no change to the tolerance for change of areas proposed to be impacted as a result of the proposed design refinements.
- Item 3: Warragamba Dam to Prospect Reservoir pipeline – an extension of the construction footprint in the location of the WaterNSW pipelines is located adjacent to an area of potential heritage significance not previously identified as part of the EIS. This area includes four concrete building foundations associated with the pipeline depot building (refer to Figure 5-7). The area was previously identified and surveyed by Jacobs in September 2016, however did not overlap with the design at the time and was therefore not further assessed or documented as part of the EIS. The design refinements have resulted in a change to the construction footprint at this location, with impacts to these heritage features avoided. A low risk remains that unknown potential heritage items associated with the pipeline may be located within this new impact area. With the implementation of the revised environmental management measures (see below), no additional heritage impacts are expected.
- Item 9: Miss Lawson"s Guesthouse site – a research design and excavation methodology has been prepared for the site (refer to Appendix D) which has identified further details about the site and associated features (refer to Figure 5-8).
- Item 10: Lawson"s Inn Site – a research design and excavation methodology has been prepared for the site (refer to Appendix D) which has identified through historical photographs and maps that the location of the Inn site is expected to be outside the project footprint. This has further informed the proposed management of the site. Where the EIS predicted about a third of the site would be impacted by the project, it is now expected that the main Inn site can be avoided and about one quarter of the curtilage of

the site is expected to be impacted. This part of the site has been identified as being of low archaeological significance based on further archaeological research (refer to Figure 5-9). If during testing significant archaeological resources are identified within these areas of low archaeological potential to be impacted by the project, then the design would be reviewed and where reasonable and feasible adjusted to avoid where possible or minimise these impacts.

No new potential heritage items were identified as part of this desktop assessment.

Environmental management measure

A research design and excavation methodology has been prepared for item 2 in relation to the canal (refer to Appendix D), with a requirement for archaeological investigation of the canal in the form of test excavation of the portion of the canal to be impacted. This would be implemented in addition to photographic archival recording of the item already proposed as part of the EIS.

An additional environmental management measure is also proposed to avoid potential impacts to the historical building footings identified on WaterNSW land associated with the item 3. This area is to be fenced off as an exclusion zone to avoid potential impacts as a result of the proposed drainage infrastructure works adjacent to this feature.

Additionally, research designs and excavation methodologies have also been prepared for items 9 and 10 as incorporated into Appendix D of this report. Further archaeological investigation would be undertaken in accordance with these requirements, including test excavation and salvage excavation for item 9 and test excavation of a portion of item 10.

As identified above, in relation to item 10: Lawson"s Inn site, if during testing significant archaeological resources are identified within these areas of low archaeological potential to be impacted by the project, then the design would be reviewed and where reasonable and feasible adjusted to avoid where possible or minimise these impacts.

These measures have been incorporated into the revised environmental management measure for the project, as outlined in Chapter 6 of this report.

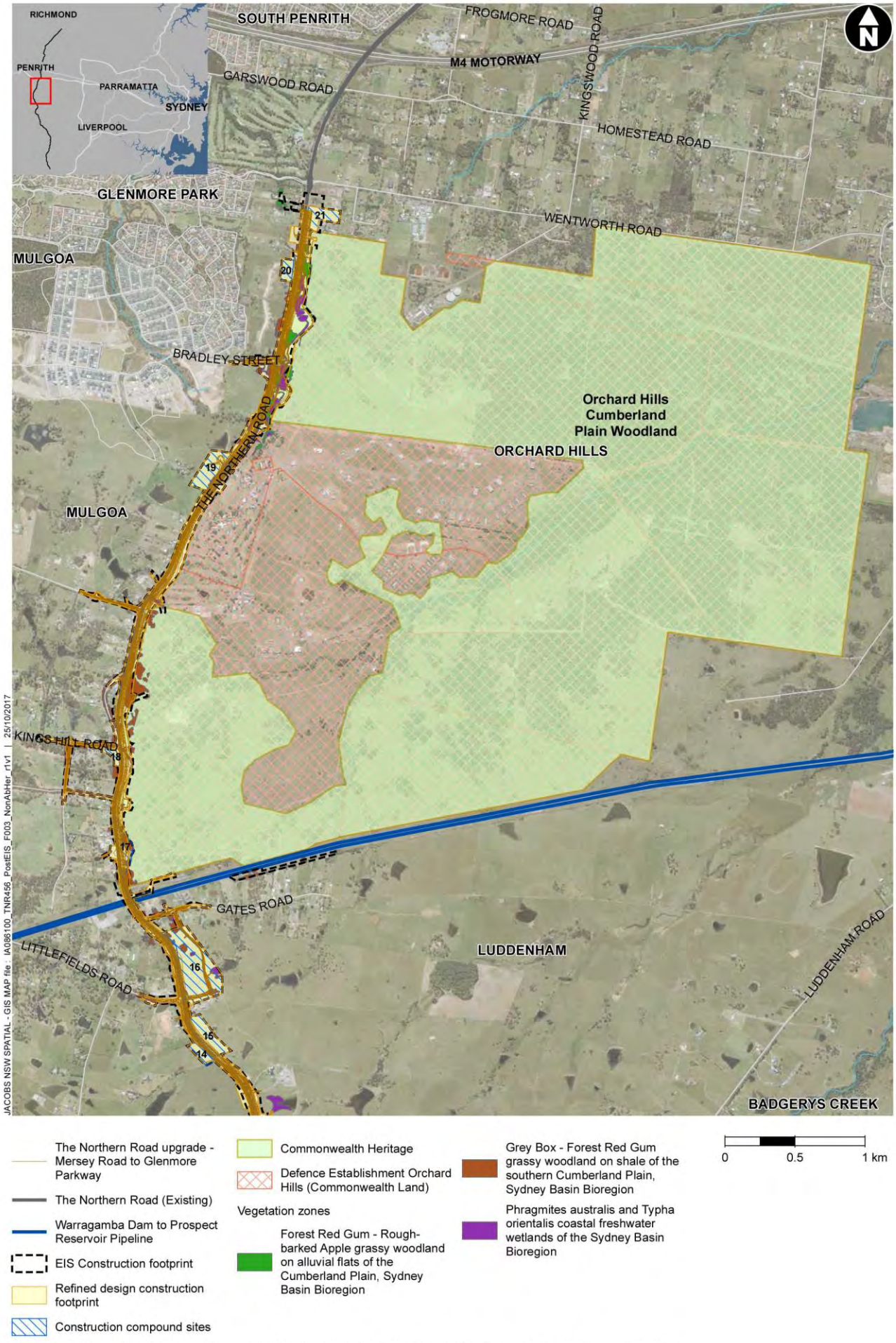

Figure 5-5 | Location of Orchard Hills Cumberland Plain Woodland (Item 2) in relation to proposed works

Figure 5-6 | Location of Orchard Hills Cumberland Plain Woodland showing extent of Chaffey Brothers Irrigation Scheme Canal (item 2) in relation to proposed works

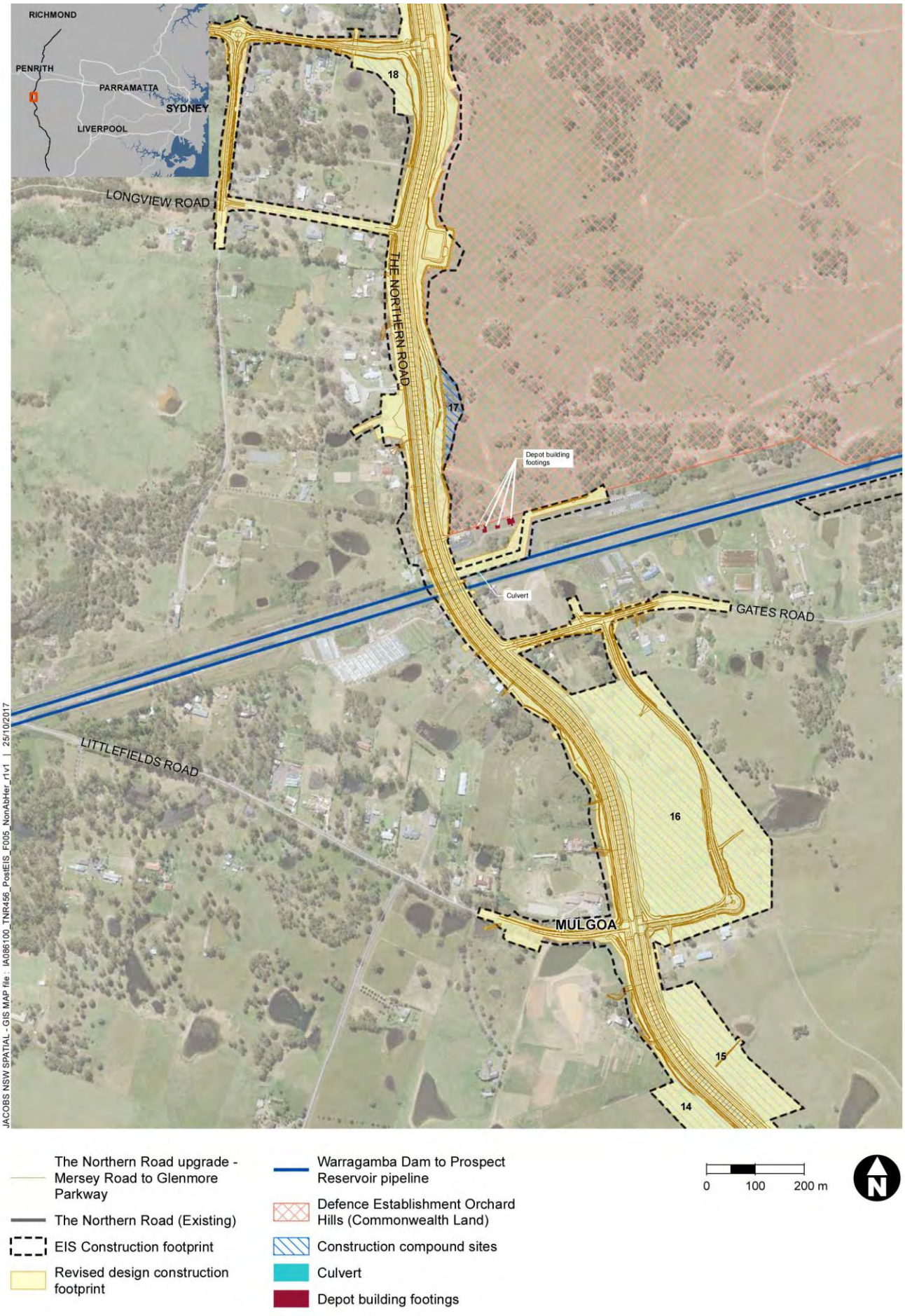

Figure 5-7 | Location of Warragamba Dam to Prospect Reservoir Pipeline (Item 3) in relation to proposed works

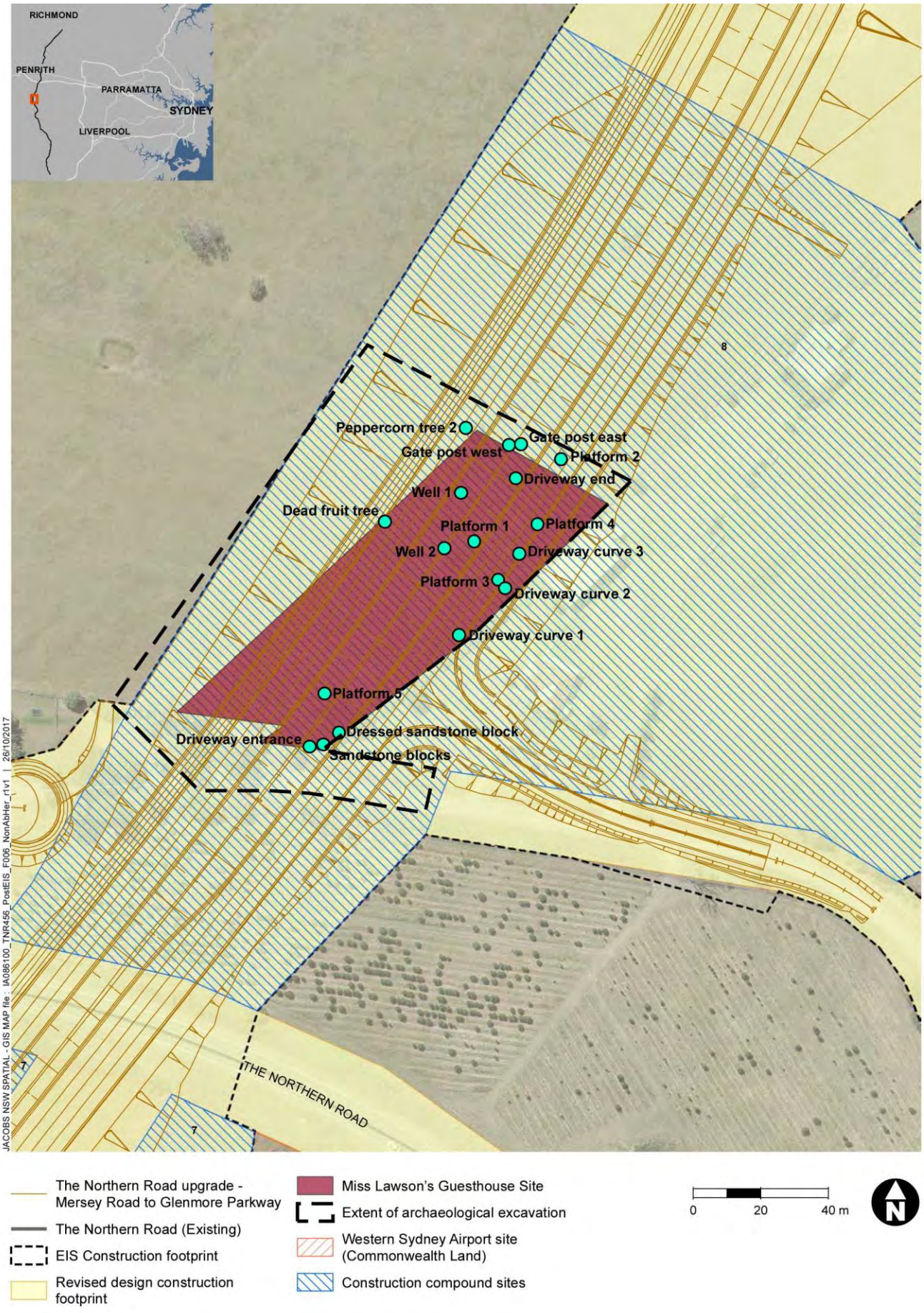

Figure 5-8 | Location of Miss Lawson's Guesthouse Site (Item 9) in relation to proposed works

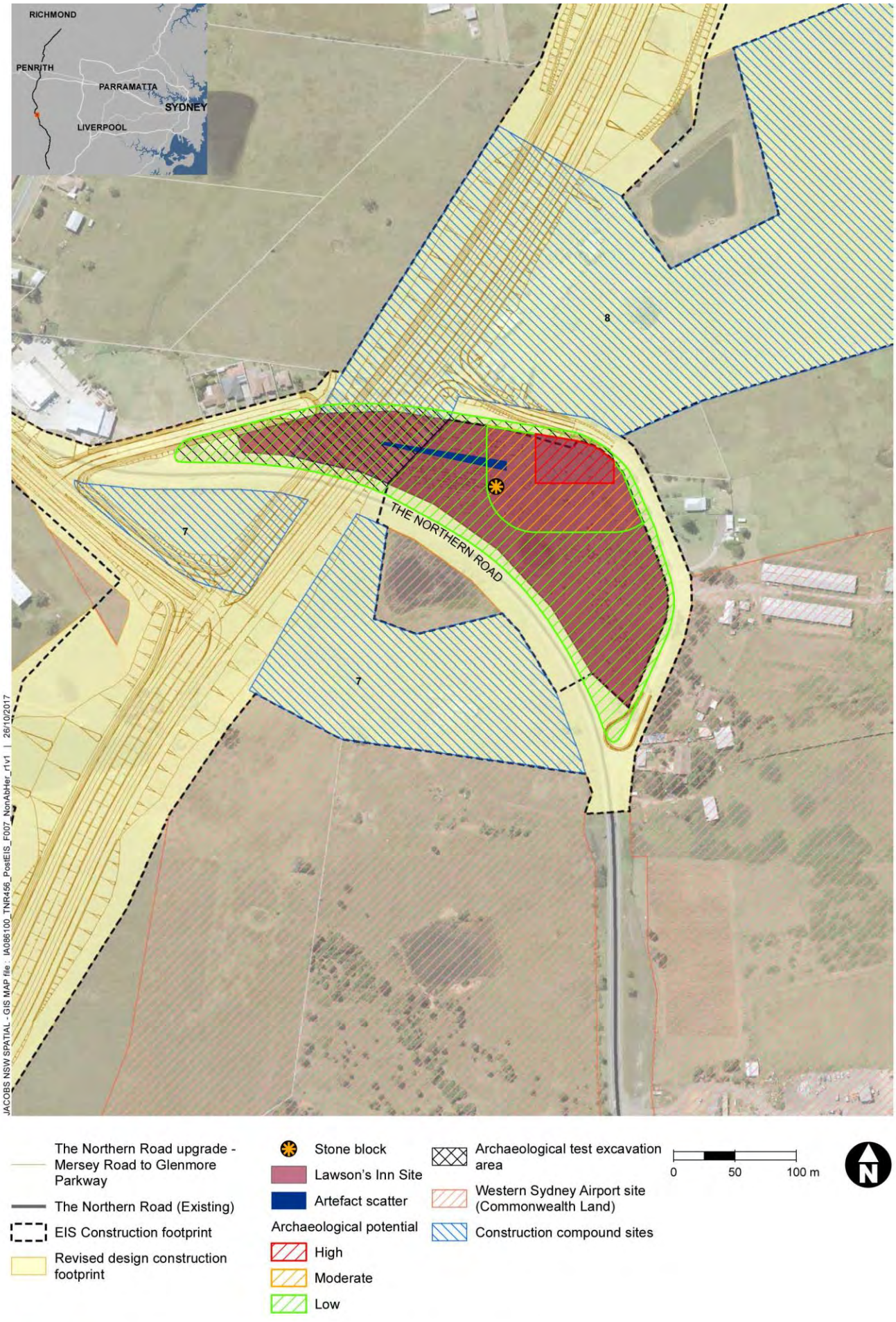

Figure 5-9 | Location of Lawson's Inn Site (Item 10) in relation to proposed works

5.2.5 Urban design and visual impacts

An urban design concept and Landscape Character and Visual Impact Assessment (LCVIA) was presented as Appendix O of the EIS and summarised in section 8.6 of the EIS. The findings of the LCVIA have been reviewed considering the project design refinements presented in Table 5-1.

The design refinements are located entirely within the area assessed during the EIS investigations, and further site investigations were not required. The design refinements have also not resulted in the development of new landscape character zones (LCZs) or viewpoints.

Potential construction impacts

Potential impacts to each of the LCZs as a result of the establishment and use of ancillary facilities during construction is summarised in section 8.5.4 of the EIS. The proposed design refinements would not alter the construction impacts presented in the EIS. Impacts as a result of typical construction activities would generally be temporary short-term, direct and indirect impacts. The removal of vegetation during construction would result in long-term impacts, which would be reduced in some areas during operation of the project as vegetation becomes established.

Landscape character impacts

A qualitative assessment of landscape character impacts across the five identified LCZs for the project is detailed in the Urban Design and Visual Impact Assessment (Appendix O of the EIS). The result of these assessments ranges from moderate to high, and is summarised in Table 8-33 of the EIS.

The five LCZs and the visual environment presented in the EIS remain unchanged. Sensitivity of the zone, and the magnitude of the proposed upgrade in that zone also remain unchanged. The proposed design refinements would not alter the landscape character zone impact ratings presented in the EIS however the following has been considered:

- Geometry and alignment refinements such as changes to batter slopes, vertical alignments and super elevation adjustments would occur within all five LCZs. Changes to intersection configurations would also occur within all five LCZs. Refinements are generally minor and would not impact the existing landscape character impact rating
- Changes to batter slopes would occur within all five LCZs. Steepening of some batters to a maximum of 1:2 slope has occurred to minimise property impacts but could result in minor changes to the existing landscape character impact rating presented in the EIS, however ratings were already assessed as Moderate to High
- The removal of VMS would occur within LCZ 3 (Luddenham Plateau) and LCZ 4 Cosgrove Creek. The removal of VMS is likely to result in less impact to the landscape character in these areas. Despite this, the impact rating for both LCZ remains unchanged
- Removal of the northbound heavy vehicle inspection bays (at Grover Crescent) would occur within LCZ 5 (Mulgoa-Orchard Hills). The removal is likely to result in less impact to the landscape character in these areas. Despite this, the impact rating for both LCZ remains unchanged
- Local road upgrades at Kings Hill Road, Vineyard Road extension and Gates Link Road would all occur within LCZ 5. LCZ 5 is a largely linear zone along the existing road corridor. Due to the variable topography and tree cover, proposed changes would be more easily absorbed and not widely visible beyond the road corridor. The changes to alignments of the local roads in this LCZ are relatively minor and would not impact the existing landscape character impact rating of Moderate.

Visual impacts

The potential visual impact of the project was assessed in relation to a number of key viewpoints and groups of viewpoints in Appendix O of the EIS). Table 8-34 of the EIS provides a summary of the visual impact at each viewpoint and each group of viewpoints.

A total of 19 viewpoints form the basis of the visual impact assessment in the EIS and this has not changed due to design refinements. The viewpoints are generally focused on locations that would be commonly viewed by the local community. The assessment indicates that the proposed upgrade of The Northern Road would have a high visual impact on two thirds of the assessed views.

The installation of VMS contributed to high visual impact ratings at Viewpoints 13, 15 and 18. At these locations it was noted that the VMS would be a large built structure that would be inconsistent with the surrounding rural environment. Removal of VMS is likely to reduce the visual impact at those viewpoints.

Minor refinements such as geometry changes, intersection changes and kerb and median refinements would be unlikely to affect the visual impact assessment provided in the EIS.

Urban Design Concept

An urban design strategy and concept plan is outlined in Appendix O of the EIS. The concept plan was based on the urban design and objectives and principles established for the project.

Roads and Maritime has reviewed design refinements against the urban design principles and advised additional assessment of the refined design by urban design specialist is not required. The urban design concept would be further refined during detailed design in conjunction with the construction contractors for the project and in consultation with relevant stakeholders such as Penrith and Liverpool City Councils.

5.2.6 Air quality

Construction activities have the potential to increase airborne particulate matters and cause nuisance impacts where construction is in proximity to sensitive receivers such as residential dwelling and community areas. Operational air quality impacts are associated with motor vehicle emissions arising from changes in the volumes of motor vehicles, model of travel (such as free flow or congestion) and proximity to sensitive receivers.

The refinements to the proposed design would not substantially alter the distance to sensitive receivers or traffic conditions and would be unlikely to substantially alter the air quality impacts. No additional environmental management measures have been proposed beyond those identified in the EIS.

5.2.7 Resources and waste management

During construction, earthworks would be required across the project area including for road widening, bridge construction and drainage. These works would generate spoil in surplus to that which can be reused on site. The proposed design refinements, including the changes to the batter slopes, would have only a negligible increase in surplus spoil. Surplus spoil that could not be reused on-site would be transported for beneficial reuse off-site in accordance with the relevant EPA resource recovery exemption or disposed at a licensed waste facility.

It is unlikely that the proposed design refinements would result in any other increase in waste generation or resource use during construction or operation. No additional environmental management measures have been proposed beyond those identified in the EIS.

5.2.8 Climate change and greenhouse gas

During construction, the greatest sources of greenhouse gas emissions are associated with the combustion of fuel by plant and equipment, the use of bitumen as part of the asphalting process and the removal of vegetation. The design refinements would not result in any significant changes to these emission generating activities and therefore would be unlikely to result in more than a negligible increase in the greenhouse gas emissions.

During operation, greenhouse gas emissions are generally attributed to the combustion of fuel for road transport. The design refinements would not result in a substantial change in traffic volumes, congestion (level of service), or average speeds and therefore would be unlikely to result in more than a negligible increase in greenhouse gas emissions.

The design refinements would not result in a change to the climate change risks assessment outlined in the EIS. No additional environmental management measures have been proposed beyond those identified in the EIS.

5.2.9 Hazard and risk

The proposed design refinements would not result in any additional hazards or risks during the construction and operation of the project. Further, several of the design refinements were specifically designed to reduce potential safety risks including:

- The removal of the left turn onto The Northern Road from the existing Elizabeth Drive due to safety concerns about the proximity to the signalised intersection.
- The removal of left out Grover Crescent (south) access to increase safety of vehicles entering The Northern Road from Grover Crescent.

No additional environmental management measures have been proposed beyond those identified in the EIS.

5.2.10 Cumulative impacts

The EIS assessed the cumulative impact of potential construction and operational phase interfaces of the project with other projects in the vicinity.

As identified in the EIS, the construction timeframes of the other components of The Northern Road Upgrade would overlap with that proposed for the project and therefore are likely to result in cumulative impacts during those periods. As indicated in section 4.2.3 of this report, the project start and finish date would be delayed from what was assessed in the EIS, however this is not expected to significantly change the outcome of cumulative impacts of the project with this or other projects.

The EIS also identified potential cumulative impacts with other nearby developments that are not related to The Northern Road Upgrade program of work and which are likely to be under construction at a similar time to the project including:

- Western Sydney Airport
- Urban growth areas in western Sydney
- M12 Motorway
- M4 Smart Motorway civil work
- Other State Significant Developments proposed within the Penrith and Liverpool LGAs and in proximity to the project.

With regard to the Western Sydney Airport, the EIS stated that aviation infrastructure works are scheduled to overlap with the project‟s construction schedule by about one year – starting in mid-2019. Site preparation activities associated with the Western Sydney Airport, including substantial

earthworks are scheduled to commence in 2018 ahead of the aviation infrastructure works. The overlap of impacts would be larger than identified in the EIS, about two years rather than one.

Key cumulative impact considerations assessed as part of the EIS in relation to potential cumulative impacts associated with these projects included:

- Traffic and transport
- Noise and vibration
- Biodiversity
- Visual amenity, built form and urban design
- Air quality
- Socio-economic.

The outcomes of the EIS would generally be consistent with the project changes assessed in this report, taking into account taking into account revised impacts of the project as outlined above.

The additional construction timeframes associated with Western Sydney Airport site preparation activities would result in longer-term traffic and transport related impacts along the Northern Road. Construction traffic generated by the site preparation works would impact primarily on the arterial road network, including The Northern Road, with additional trucks travelling along the key arterials through the surrounding area. This would mean that higher than normal car and truck movements would be expected over a longer timeframe compared to that discussed in the EIS.

Construction activities and the additional traffic associated with them are likely to result in lower travel speeds and increased delays at intersections along The Northern Road. Increased heavy vehicle volumes may also result in delays in sections where cars are unable to overtake vehicles along The Northern Road.

The additional timeframes associated with the cumulative impacts of the Western Sydney Airport have not resulted in any additional management measures.

6 Revised environmental management measures

The environmental impact statement (EIS) for the project identified a range of environmental outcomes and management measures that would be required to avoid or reduce the environmental impacts.

After consideration of the issues raised in the public submissions, the environmental management measures for the project have been revised. Should the project be approved, the environmental management measures in Table 6-1 will guide the subsequent phases of project development. Additional and/or modified environmental management measures to those presented in the EIS have been italicised and deleted measures, or parts of measures, have been struck out.

6.1 Construction safeguards and management measures

These safeguards would minimise potential adverse impacts of the project. All safeguards described in this EIS would be incorporated into the contractor"s CEMP. The timing and responsibility for the implementation of the safeguards would also be outlined in the CEMP. Roads and Maritime would retain responsibility for some of the safeguards including those related to detailed design, however the construction contractor would be responsible for implementing the majority of safeguards. The estimated costs of environmental mitigation measures have been captured in project capital costs and, whilst difficult to quantify specifically, would represent less than 10 per cent of project costs.

Table 6-1: Summary of revised environmental management measures

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Construction impacts	T-1	A Construction Traffic Management Plan (CTMP) would be developed, approved, implemented and monitored as part of the project. The TMP would: • Outline the general principles and procedures for the development of specific construction traffic control plan (CTP"s), taking into consideration where possible other construction works utilising similar haulage and access routes • Ensure safe and continuous traffic movement for construction workers and the general public • Maintain the capacity of existing roads where possible • Identify the requirements for temporary speed	Construction contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the CTMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		restrictions where traffic may pose a safety risk to workers • Maintain continuity of access to local roads and properties, particularly along the existing alignment of The Northern Road (may require temporary u-turn facilities). Where access is affected, RMS would consult with residents for alternative access arrangements • Details of access to construction sites including measures to prevent construction vehicles queuing on public roads • Provide temporary traffic control where necessary • Provide appropriate warning and signage for traffic in the vicinity of work areas • Include methods to minimise road user delays such as undertaking works around live traffic including tie-in and bridge work outside of peak periods • Undertake construction activities off-line where possible to minimise the requirement to operate temporary traffic control and reduced speed zones • Develop a communication plan to advise local residents and businesses of any changes to traffic conditions during construction • Consult with bus operators regarding temporary bus stop relocations during construction and proposed bus stops during operation. • *Ensure the use of local roads by heavy vehicles to access temporary ancillary*			

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		facilities would be limited as far as is reasonably practicable.			
Construction staging	T-2	Staging plans to be prepared in consultation with adjoining contractors and for each stage of the upgrade.	Construction contractor	Construction	Proven to be effective. The requirements for staging plans would be outlined within the TMP. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.
Road damage	T-3	Undertake a pre-construction dilapidation survey of local roads used for construction. Defects caused by construction activities would be rectified prior to completion of construction.	Construction contractor	Construction	Proven to be effective.
Property access	T-4	Access to properties along affected roads would be maintained during construction. The need for any alternative and/or temporary access arrangements would be agreed with affected property managers/owners.	Construction contractor	Construction	Proven to be effective. Access arrangements would be outlined in the TMP, the effectiveness of those arrangements and the need for any alternative and/or temporary access arrangements would be agreed with affected property owners.
Local road upgrades	*T-5*	*Roads and Maritime will consult with Councils regarding the requirements for upgrade of local roads.*	*Roads and Maritime*	*Construction*	*Expected to be effective.*
Property access	*T-6*	*Roads and Maritime will consult further with all utility providers on required access and consents for utility corridors prior to construction*	*Roads and Maritime*	*Pre-construction*	*Expected to be effective.*

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Construction noise impacts	NV-1	Construction Noise and Vibration Management Plan (CNVMP) would be prepared during the detailed design stage of the project and applied to all construction processes throughout the project. The CNVMP would be prepared in accordance with the requirements in the ICNG and RMS CNVG. The CNVMP would nominate: • Noise goals at all sensitive receivers • Restrictions on the hours of construction activity including an out-of-hours work procedure • Works programming that has the aim of minimising impacts on sensitive receivers • Noise and vibration mitigation measures consistent with the RMS CNVG • The project's commitments to noise and vibration monitoring and reporting *including:* – *vibration monitoring of work in the vicinity of the Warragamba Dam pipeline* – *safe working distances for vibration intensive plant to be adopted in proximity to the Warragamba Dam pipeline* • Protocols for engaging with and notifying residents of any work processes that may impact them • Describe an out-of-hours work procedure (with proforma) to be applied to all construction assessments, which is consistent with the applicable Environmental Protection Licence (EPL) for the project.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting to confirm effectiveness of measures. Continuous improvement to be achieved through ongoing evaluation of monitoring results.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• A complaints mechanism so that residents may contact the project manager • A protocol to enable the project to respond quickly to non-compliances.			
	NV-2	Viable mitigation measures that would be expected to be deployed by the construction contractor once the final construction sequencing and scheduling is known include: • Restricting works to standard construction hours as far as practicable, considering safety and traffic management requirements • Selecting quieter plant and equipment • Erecting temporary acoustic hoarding to reduce noise form works within a confined area • Deploying mobile hoardings (eg, acoustic screen curtains mounted on a wheeled trailer) to track moving, but tightly-contained processes • Maximising offset distances between receivers and noisy plant or activities • Orientating plant and processes away from residences, where reasonably practicable • Scheduling works for times outside of	Construction contractor	Construction	Expected to be effective. Monitoring and reporting to confirm effectiveness of measures. Continuous improvement to be achieved through ongoing evaluation of monitoring results.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		heightened sensitivity for the impacted receiver, eg, outside of school hours • Scheduling respite periods for noise-intensive processes undertaken near receivers, eg limiting operation of pavement sawing to three hours at a time • Planning any OOHW so that noisier works are carried out in the earlier part of the evening or night-time • Minimising the number of consecutive nights of works adjacent to any particular set of receivers • Restricting heavy vehicle movements, heavy deliveries and loading and unloading processes to daytime periods and to areas well away from receivers • Regularly maintaining and monitoring plant and equipment to ensure that their noise emissions are not excessive • Minimising the annoyance from reversing alarms by either fitting closed circuit monitors or non-tonal reversing alarms ("quackers") on vehicles or deploying „spotters" to oversee reversing movements • Reducing throttle settings and switching off equipment when it is not being used. • *Hoarding (2.4 metres) to be installed at the perimeter of all ancillary facilities except where it can be justified that the acoustic benefit of the hoarding is not warranted* • *Haulage routes will be located as far away as possible from residential receivers, where this*			

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		is reasonable and feasible • *Where it has been identified as necessary (eg in response to community complaints), noise monitoring will be undertaken to check that the noise mitigation measures are effective* • *Static noise sources, such as generators, pumps and lighting towers, will be located as far as possible from sensitive receivers* • *Loading and unloading will be carried out away from sensitive receivers, where practicable* • *Ensure all deliveries occur during standard construction hours where reasonable and feasible.*			
	NV-3	Implement operational noise mitigation early in the construction program, where possible, to minimise construction noise impacts	Roads and Maritime	Construction	Proven to be effective
General construction impacts	B-1	• A Flora and Fauna Management Plan (FFMP) would be developed for the project. The plan would include procedures for pre-clearance surveys that are consistent with the Roads and Maritime Biodiversity Guidelines (RTA, 2011). The FFMP would outline: • Details of pre-construction surveys to verify the construction boundaries/ footprint of the project and to confirm the vegetation to be cleared as part of the project, identify habitat trees to be felled in a staged approach and identification of fauna release areas should fauna be encountered during vegetation removal	Contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Updated sensitive aerial vegetation maps based on clearance surveys and previous survey work • Exclusion zones and fencing or other means to demarcate vegetation to be retained (endangered ecological communities) in close proximity to the works • Clearing of vegetation and removal of bush rock (Guide 7) including implementation of the pre-clearing process (Guide 1) and the associated staged habitat removal process where hollow-bearing trees, habitat trees or bush rock is to be removed • Weed management (see Guide 6) through the use of mechanical weed control methods such as slashing or mowing, as well as a range of herbicides • Pathogen management (see Guide 7) through the implementation of hygiene protocols such as the provision of vehicle and boot wash down facilities and ensuring vehicles and footwear are free of soil before entering or exiting the site, as well as the establishment of exclusion zones and designated access tracks • Mechanism for the monitoring, review and amendment of this sub-plan.			

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Removal of native vegetation, threatened species and threatened species habitat	B-2	Native vegetation removal would be minimised through detailed design.	Roads and Maritime	Detailed design	Expected effective. The design has been optimised throughout design options to minimise impacts to vegetation
	B-3	Pre-clearing surveys would be undertaken in accordance with *Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Identify and locate habitat features on site, and mark those to be protected during clearing • Identify suitable habitat areas for fauna relocation (if encountered during clearing works) • 24 hours prior to clearing, licensed wildlife carers and/or ecologists should capture and/or remove fauna that have the potential to be disturbed as a result of clearing activities and relocate to the pre-determined location (as above) • Carry out staged habitat removal (Guide 4) where fauna habitat features have been identified and marked.	Contractor	Pre-construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	B-4	Vegetation removal would be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Carefully clear vegetation so as not to mix topsoil with debris and to avoid impacts to surrounding native vegetation • Retain stumps in riparian zones and aquatic habitats to reduce the potential for bank erosion • Separate woody vegetation into millable timber, secondary re-use (Guide 5) or exotic (non-native) vegetation • Non-woody vegetation should be incorporated into the stripping of topsoil to retain any organic materials and nutrients • The staged habitat removal process is to be used when identified habitat is to be removed, with a licensed wildlife carer or ecologist on site • Undertake bush rock removal in a way that minimises damage to the bush rock, avoids excessive soil disturbance and avoids climatic seasons when species are utilising this resource	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• The Australian Standard AS 4373 Pruning of amenity trees should be followed for all pruning works.			
	B-5	The unexpected species find procedure is to be followed under Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (NSW Roads and Traffic Authority, 2011) if threatened ecological communities, flora or fauna not assessed in the biodiversity assessment, are identified in the project site. The procedure is as follows: • Threatened flora or fauna species unexpectedly encountered Stop work • Notify the environment manager • Environmental manager would arrange for an ecologist to conduct an assessment of significance of the likely impact, develop management options and notify OEH, DPI and DoEE as appropriate • If a significant impact is not likely to occur, recommence work and maintain regular inspections, • If a significant impact is likely to occur: – Consult with OEH, DPI and DoEE as appropriate, – Obtain approvals, licenses or permits as required, – Recommence works once advice is sought and necessary approvals, licences and permits are obtained,	Contractor	Construction	Proven to be effective. Reporting requirements of the FFMP to be adhered to.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		– Include species in subsequent inductions, toolbox talks and update the CEMP.			
Removal of native vegetation, threatened species and threatened species habitat	B-6	Native vegetation would be re-established in accordance with *Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • *Ecologists and landscape architects will work together on the preparation of revegetation plans and specifications that clearly identify the locations of areas to be revegetated.* • Use experienced and licensed seed collectors to carry out seed collection in accordance with RTA Seed Collection QA Specification R176 and the Florabank Guidelines and Model Code of Practice. • Planting operations should be in accordance with RTA Landscape Planting QA Specification R179. • Collect local native topsoils and leaf litter and store for use in revegetation works. • Ensure areas to be revegetated have an appropriate level of natural drainage, avoid compaction of soils in those areas and ensure suitable moisture requirements are maintained.	Contractor	Post construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Implement planting as per the planting plan for the project, including planting during suitable conditions, spacing and diversity of plants, etc. • Inspection, monitoring and maintenance of revegetated areas should be conducted in accordance with the Landscape Management Plan.			
	B-7	Habitat removal would be minimised through detailed design.	Roads and Maritime	Detailed design	Proven to be effective if done in accordance with the Biodiversity Guidelines.
	B-8	Habitat removal would be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Carefully clear vegetation so as not to mix topsoil with debris and to avoid impacts to surrounding native vegetation. • Retain stumps in riparian zones and aquatic habitats to reduce the potential for bank erosion. • Separate woody vegetation into millable timber, secondary re-use (Guide 5) or exotic (non-native) vegetation.	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Non-woody vegetation should be incorporated into the stripping of topsoil to retain any organic materials and nutrients. • The staged habitat removal process is to be used when identified habitat is to be removed, with a licensed wildlife carer or ecologist on site. • Undertake bush rock removal in a way that minimises damage to the bush rock, avoids excessive soil disturbance and avoids climatic seasons when species are utilising this resource. • The Australian Standard AS 4373 Pruning of amenity trees should be followed for all pruning works.			
	B-9	Habitat would be replaced or re-instated in accordance with Guide 5: Re-use of woody debris and bushrock and *Guide 8: Nest boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Separate weeds from native vegetation. • Carry out removal, stockpiling, transportation and relocation of woody debris and/or bush rock in a manner that minimises disturbance to native vegetation or bush rock. • Engage an ecologist to provide advice on	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		positioning woody debris and bush rock in designated relocation areas. • Keep topsoil disturbance to a minimum.			
Aquatic impacts	B-10	Aquatic habitat would be protected in accordance with *Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011) and section 3.3.2 Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013 (Department of Primary Industries, 2013). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Avoid activities in aquatic habitats and riparian zones as much as practicable • Establish exclusion zones and set up exclusion fencing around sensitive area • Keep vehicles and machinery away from the banks of a waterway where possible • Refuelling of vehicles and plant, and chemical storage and decanting should not take place within 50 m of aquatic habitats • Avoid clearing within the riparian zone during periods when flooding is likely to occur • Retain the roots of trees on the bank of a	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		waterway in order to maintain bank stability • During rehabilitation, stabilise the banks of the waterway through revegetation and/or armouring according to available landscape plans • Remove all temporary works, flow diversion barriers and sediment control barriers within aquatic habitats as soon as practicable and in a manner that does not promote future channel erosion.			
Removal of woody debris	B-11	All large woody debris or snags would be relocated instream (Guide 10).	Contractor	Construction	Expected to be effective.
Changes to hydrology	B-12	Changes to existing surface water flows would be minimised through detailed design.	Roads and Maritime	Detailed design	Expected to be effective. Drainage upgrades for the project have been designed and optimised to minimise changes to existing flows as much as possible.
	B-13	Measures to mitigate potential water quality impacts during construction are outlined in section 8.1 and section 8.2 of the EIS.	Contractor	Construction	N/A

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Fragmentation of identified biodiversity links and habitat corridors	B-14	*Identified* connectivity measures ~~have been considered~~ *at Surveyors Creek and Badgerys Creek to be further considered* during design in accordance with the *Wildlife Connectivity Guidelines for Road Projects* (RMS in prep). In particular, design where connectivity has been considered is to include culvert design, lighting and fencing. *Opportunities for increasing the height of culverts proposed to provide fauna underpass at these locations would be investigated during detailed design of the project where reasonable and feasible.*	Roads and Maritime and Contractor	Detailed design, during construction and post construction	Expected to be effective if done in accordance with the Wildlife Connectivity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.
Edge effects on adjacent native vegetation and habitat	B-15	Exclusion zones would be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Identify exclusion zones on a suitable plan as required to prevent damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease • Mark out exclusion zones on site with temporary markings such as pegs or paint and where possible use a qualified surveyor • Erect signs to inform personnel of the purpose of exclusion zone fencing • Ensure all exclusion zones are regularly	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		inspected and repairs to fencing are made where required • Maintain exclusion fencing until the risk to disturbance within the excluded zone has been eliminated through other means. Removal of fencing should be undertaken in consultation with environmental staff • Communicate the importance of exclusion zones, and any changes to the zones, to all site staff and visitors (eg in toolbox talks and inductions) • *Exclusion zones would be established around Marsdenia viridiflora subsp. viridiflora plants proposed to be retained in the area of the DEOH fence between Kings Hill Road and Longview Road, in accordance with standard Roads and Maritime procedure* • *Exclusion zones would be established around the four Pultenaea parviflora plants to be retained in the area of the Vineyard Road extension in accordance with Roads and Maritime procedure* • *Roads and Maritime will investigate options for salvage of genetic material and/or translocation of Marsdenia viridiflora subsp. viridiflora and Pultenaea parviflora plants that are to be impacted prior to construction.*			

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Injury and mortality of fauna	B-16	Fauna would be managed in accordance with *Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Allow fauna to leave an area without intervention as much as possible. • Use a licensed fauna ecologist or wildlife carer with specific animal handling experience to carry out any fauna handling. • Include the procedures to follow if fauna is found or injured on site in project inductions. • Release fauna into pre-determined habitat identified for fauna release. • Release fauna into similar habitats, as near as possible to their capture location. Release nocturnal fauna at dusk. • Temporary fauna fencing may be required on projects to reduce the chances of road kill/injury from public traffic or construction machinery.	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Invasion and spread of weeds	B-17	Weed species would be managed in accordance with *Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Use an ecologist or person trained in weed management and identification to undertake a site weed assessment to identify and describe or map weed infested areas within the site and adjacent areas. • Develop a Weed Management Plan for the site. • Map and mark areas that are infested with weeds as an exclusion zone with fencing and signage to limit access by personnel and vehicles. • Minimise soil disturbance within weed infested areas. • Use mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance • Mow/slash areas infested with weeds before they seed. This may reduce the propagation of new plants. • Clean machinery, vehicles and footwear before moving to a new location.	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Securely cover loads of weed-contaminated material to prevent weed plant material falling or blowing off vehicles. • Dispose of weed-contaminated soil at an appropriate waste management facility.			
Invasion and spread of pathogens and disease	B-18	Pathogens would be managed in accordance with *Guide 7 – Pathogen Management: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Ensure vehicles and footwear are free of soil before entering or exiting the site (ie directed to wash down area before entering or exiting the site). • Provide vehicle and boot wash down facilities. • Set up exclusion zones with fencing and signage to restrict access into contaminated areas. • Restrict vehicles to designated tracks, trails and parking areas.	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Impacts to riparian corridors	*B-19*	*A Vegetation Management Plan (VMP) would be prepared in consultation with DPI Water prior to construction commencing, including details on:* • *The riparian corridor widths along the watercourses in proximity to the project (so that these areas can be avoided where possible)* • *Riparian areas potentially temporarily or permanently impacted by the project.* • *The rehabilitation of riparian areas temporarily impacted* • *Riparian offsets for the riparian areas permanently impacted* *The VMP would include a scaled map should be provided which identifies:* • *The riparian corridor widths in proximity to the project so that these areas can be avoided where possible* • *Riparian areas potentially temporarily or permanently impacted by the project.* • *Riparian offset areas.*	*Construction contractor*	*Prior to construction*	*Proven to be effective if done in accordance with the Biodiversity Guidelines.* *Monitoring and reporting requirements of the VMP to confirm effectiveness of measures.*
Impacts to riparian corridors	*B-20*	*All works on waterfront land would be carried out in accordance with the DPI Water Guidelines for Controlled Activities on Waterfront Land (2012).*	*Construction contractor*	*Construction*	*Proven to be effective if done in accordance with the Guidelines.*
Revegetation	*B-21*	*Roads and Maritime would consider reuse of topsoil as part of the Urban Design Landscape Plan (UDLP) for the project.*	*Roads and Maritime*	*Prior to construction*	*Proven to be effective if done in accordance with the Biodiversity Guidelines.* *Monitoring and reporting requirements of the UDLP to confirm effectiveness of measures.*

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Revegetation	*B-22*	*Roads and Maritime would consider transplanting native species from areas to be cleared into revegetation areas, depending on the type of species being removed and the likely success of transplanting. Plants to be used in revegetation would be sourced from local provenance seed where appropriate and available, and associated seed collection would be undertaken prior to clearing.*	*Roads and Maritime*	*Prior to construction*	*Proven to be effective if done in accordance with the Biodiversity Guidelines.* *Monitoring and reporting requirements of the UDLP to confirm effectiveness of measures.*
Revegetation	*B-23*	*Rehabilitation of the disturbed areas of the site would be undertaken in accordance with Roads and Maritime Batter Stabilisation Guidelines and Roads and Maritime contractor specifications.*	*Construction contractor*	*Construction*	*Proven to be effective if done in accordance with guidelines*
Biodiversity offsets	*B-24*	*Offsets requirements (including Biobanking credits and additional supplementary measures) would be delivered in accordance with a Biodiversity Offset Strategy and supplementary measures package for the project in consultation with OEH and DOEE.*	*Roads and Maritime*	*Construction*	*Proven to be effective if done in accordance with guidelines*

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
General socio-economic impacts	SE-1	A Draft Community Involvement Plan would be prepared to guide community engagement during construction of the project and would be updated throughout construction. Communication would be with the local community, stakeholders and the wider region. The Draft Community Involvement Plan includes: • Guiding principles overall approach to community and stakeholder involvement • A comprehensive list of identified stakeholders • A register of specific issue communications strategies • Requirements for the project regarding access to information, complaints and inquiries procedures and community consultation • A range of communication tools applicable to the project • Contact names and details • Complaints procedures.	Roads and Maritime	Construction	Proven to be effective. To ensure flexibility in the communications approach to the project, communications and engagement activities would be monitored, assessed and reported regularly.
	SE-2	Areas affected by construction would be reinstated and restored in accordance with the urban design and landscape strategy.	Construction contractor	Construction	See Chapter 8.5 of the EIS
Noise and vibration during construction and operation	SE-3	Mitigation measures specific to construction noise and vibration can be found in section 7.2 of the EIS for this project.	Construction contractor/ Roads and Maritime	Pre-construction and during construction	See Chapter 7.2 of the EIS

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Air quality during construction and operation	SE-4	Mitigation measures specific to construction air quality can be found in section 8.6 of the EIS for this project.	Construction contractor/ Roads and Maritime	Pre-construction and during construction	See Chapter 8.6 of the EIS
Property acquisition	SE-5	Provide appropriate compensation in accordance with the *NSW Land Acquisition (Just Terms Compensation) Act 1991* for properties to be partially or fully acquired for the project.	Roads and Maritime	Pre-construction	N/A
	SE-6	Impact from the acquisition on owners" remaining holdings would be considered in the acquisition process. As required and in consultation with owners, Roads and Maritime would engage the use of appropriately qualified professionals to carry out property assessments and identify alternate opportunities for any remaining land holdings.	Roads and Maritime	Pre-construction	N/A
Property acquisition	SE-7	Undertake property adjustments and relocation of infrastructure (for example, fencing, dams, property access) in consultation with the property owner.	Construction contractor	Construction	Expected to be effective if carried out in accordance with consultation requirements
	SE-8	Undertake any adjustments to the Orchard Hills golf course, in consultation with the managers of the Orchard Hills Golf Club.	Roads and Maritime/ Construction contractor	Construction	Expected to be effective if carried out in accordance with consultation requirements.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Business and economic activity	SE-9	On-going consultation with local business owners, including owners of agricultural businesses, located close to construction works about the timing, duration and likely impact of construction activities on their business operations would be carried out.	Construction contractor/ Roads and Maritime	Construction	Expected to be effective. To ensure flexibility in the communications approach to the project, communications and engagement activities would be monitored, assessed and reported regularly.
	SE-10	Relocate and/or remove farm infrastructure, including farm dams, as required and in consultation with affected land owners.	Construction contractor	Construction	Expected to be effective if carried out in accordance with consultation requirements.
	SE-11	Maintain a business impact risk register to identify and manage the specific impacts associated with construction related works for individual businesses.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting would be required to measure the effectiveness.
	SE-12	Access to existing businesses would be provided on a continuous basis throughout the construction of the project.	Construction contractor	Construction	Proven to be effective. Access arrangements would be outlined in the TMP, the effectiveness of those arrangements and the need for any alternative and/or temporary access arrangements would be agreed with affected property owners.
	SE-13	Roads and Maritime would undertake the project	Roads and	Construction	Expected to be effective.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		in accordance with the *NSW Government Policy on Aboriginal Participation in Construction* (NSW Finance and Services, 2016). *As part of the tender process, the contractor would also be required to prepare a Small to Medium Enterprise (SME) Participation Plan in line with the NSW Government SME Policy Framework to show how their tender will support local industry, including jobs, skills and capability development.*	Maritime / Construction contractor		Contractors for all projects covered by this policy must provide an Aboriginal Participation Plan to the contracting agency within 60 days of the contract being awarded.
Access and connectivity	SE-14	The Traffic Management Plan would include a signage strategy (consistent with Roads and Maritime policy) to provide guidance to passing patrons on access to shops, services and businesses during construction.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.
	SE-15	Access to properties would be provided on a continuous basis throughout the construction of the project Where temporary changes to property access are required, alternate access should be determined in consultation with affected property owners and tenants.	Construction contractor	Construction	Proven to be effective. Access arrangements would be outlined in the TMP, the effectiveness of those arrangements and the need for any alternative and/or temporary access arrangements would be agreed with affected property owners.
	SE-16	Access for pedestrians and cyclists near construction works would be maintained, including consideration of pedestrian access needs for elderly people, children and people with disability.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	SE-17	Mitigation measures specific to Traffic and Transport can be found in section 7.1 of the EIS for this project.	Construction contractor	Construction	See Chapter 7.1 of the EIS
Cumulative impacts	SE-18	Mitigation measures specific to cumulative impacts can be found in Chapter 9.	Refer to Chapter 9	Refer to Chapter 9	See Chapter 9 of the EIS
Impacts to utilities	*SE-19*	*Strategies to address impacts to utilities would be developed in consultation with utility providers during detailed design and during construction of the project.*	*Roads and Maritime*	*Pre-construction Construction*	*Expected to be effective*
Impacts on flood behaviour during construction	FH-1	Temporary works would consider flood impacts during construction. Should construction staging require a temporary departure from the design (eg higher embankments for preloading, temporary diversions or temporary crossings), flood impacts would be assessed before finalising the approach.	Construction contractor	Construction	Expected to be effective Monitoring and reporting requirements of the Soils and Water Management Plan (SWMP) to confirm effectiveness of measures.
	FH-2	Appropriate scour protection measures would be implemented along any temporary drainage lines within the project construction area. Scour protection would be added to the outlets of the upgraded transverse drainage Scour protection measures would also be incorporated on the inlet of the upgraded transverse drainage in order to prevent damage to the structure during major flood events. Scour protection measures would take the form of dumped rock riprap or reno mattress.	Contractor	Pre-construction	Expected to be effective Monitoring and reporting requirements of the SWMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	FH-3	A contingency plan to be prepared to manage a potential flood event during construction that would outline procedures to reduce the likelihood, including removing plant/equipment and stabilising exposed areas. This plan would consider the likelihood of flooding, evacuation routes, warning times, and potential impacts from the site flooding.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the SWMP to confirm effectiveness of measures.
Drainage infrastructure	*FH-4*	*Roads and Maritime will consult further with all utility providers regarding any drainage infrastructure required within their utility corridors prior to construction*	*Roads and Maritime*	*Pre-construction*	*Proven to be effective.*
General construction impacts	SWC-1	A Soil and Water Management Plan (SWMP) would be developed in accordance with the Roads and Maritime specification G38 – Soil and Water Management and the Blue Book – *Soils and Construction – Managing Urban Stormwater Volume 1* (Landcom, 2004) and Volume 2D (DEC, 2008a). The SWMP would include but not be limited to: • An erosion and sedimentation control plan and maintenance schedule for ongoing maintenance of temporary erosion and sediment controls • A Sediment Basin Management Plan to guide appropriate management of runoff during construction and operation • An incident emergency spill plan which would include measures to avoid spillages of fuels, chemicals and fluids onto any surfaces or into any nearby waterways • Preparation of a wet weather rain event which	Construction contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the SWMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		includes a process for monitoring potential wet weather and identification of controls to be implemented in the event of wet weather • Provision of a maintenance schedule for ongoing maintenance of erosion and sedimentation controls • A review process by a soil conservationist and a process for updating the report to address any recommendations • A *stream and* farm dam dewatering plan to be prepared include: – A map showing locations of *streams and* farm dams to be dewatered *and the selected relocation sites* – *fisheries Permit and Animal Care and Ethics requirements* – Methodology for dewatering *streams and* dams with consideration to aquatic ecology *including the capture, storage, relocation, release of fish and other aquatic fauna* – *Euthanisation procedure (as required)* – Location of any offsite discharge points – Requirements to manage encounters of contaminated water.			

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Water quality during construction	SWC-2	A water quality monitoring program would be developed during detailed design which would outline the pre-construction baseline water quality monitoring to be undertaken, as well as the ongoing construction and operational water quality monitoring requirements. The program would be updated once the construction and operational phase water quality monitoring parameters have been determined (based on the results of the baseline water quality monitoring). The program would include specific monitoring locations, frequency, parameters, and relevant procedures to be implemented. This would include a procedure to be followed in the event that monitoring results during construction or operation indicate an exceedance of the specified criteria, including any stop works requirements, relevant non-conformance, corrective and preventative actions, reporting and review procedures. This would include a requirement to review the effectiveness of control measures and identify any potential additional controls or revised work procedures or management measures that may need to be implemented. It is noted that any sample locations or access requirements within the DEOH site would be determined in consultation with Department of Defence (DoD).	Construction contractor / Roads and Maritime	Pre-construction / construction / operation	Proven to be effective.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	SWC-3	The realignment of the tributary of Surveyors Creek would be progressively stabilised to avoid potential scour and sedimentation and permanent stabilisation measures would be implemented as soon as practicable. *The permanent stabilisation measures would consist of soft engineering solutions where reasonable and feasible and the realigned creek would mimic a natural creek system of the local area.* *The riparian corridor along either side of the realigned creek would be rehabilitated in accordance with the Vegetation Management Plan to be developed for the project in accordance with the DPI Water guidelines.*	Construction contractor	Construction	Expected to be effective. Monitoring and reporting to confirm effectiveness of measures. Continuous improvement to be achieved through ongoing evaluation of monitoring results.
	SWC-4	~~50 temporary sediment basins are proposed during construction of the project.~~ *Appropriately sized sediment basins would be designed, implemented and managed during construction in accordance with the requirements of the Blue Book. Temporary sediment basins would be located outside of the riparian corridor where possible.*	Construction contractor	Construction	Proven to be effective Temporary basins have been designed to provide sufficient volume for settling and storage of sediments.
Soil salinity impacts	SWC-5	Durability and aggressivity samples of soil material would be collected and analysed prior to the construction phase, to determine potential impacts of soil salinity on pavement infrastructure.	Contractor	Pre-construction	Proven to be effective.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Sedimentation and Erosion	SWC-6	Erosion and sediment controls would be implemented before construction starts in accordance with Blue Book requirements: • Sediment basins would be regularly serviced and maintained to comply with water quality and capacity requirements • Clearing of vegetation and site stabilisation of disturbed areas would be undertaken progressively to limit the time disturbed areas are exposed to erosion prices • High risk soil and erosion activities such as earthworks would not be undertaken immediately before or during high rainfall or wind events • Stockpiling of topsoil separately for potential reuse in landscaping and rehabilitation works • Permanent catch drains would be installed behind cut faces to act as diversion drains during the construction phase • Erosion and sediment control measures would be maintained until the works are complete and areas are stabilised by revegetation	Construction contractor	Construction	Proven to be effective. Monitoring and reporting built into the SWMP to confirm effectiveness of measures.
Sedimentation and Erosion	SWC-7	A soil conservationist from Roads and Maritime Erosion, Sedimentation and Soil Conservation Consultancy Services would be engaged to review the erosion and sedimentation plans and conduct routine inspections of the construction works.	Roads and Maritime	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the SWMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Impacts to water pollution (surface water and groundwater)	SWC-8	All fuels, chemicals, and liquids would be stored at least 50 m away from the existing stormwater drainage system and would be stored in an impervious bunded area within the compound site. The refuelling of plant and maintenance machinery would be undertaken *at least 50m from waterways with appropriate spill containment mechanisms in place such as impervious bunding and the provision of spill kits nearby*. ~~in impervious bunded areas in the designated compound area.~~ Vehicle wash downs and/or concrete truck washouts would be undertaken within a designated bunded area of an impervious surface or undertaken off-site. Disposal of dam water would be done in accordance *with the stream and* farm dam dewatering plan.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting to confirm effectiveness of measures. Continuous improvement to be achieved through ongoing evaluation of monitoring results.
Impacts to water pollution (surface water and groundwater)	SWC-9	It is not expected that specific controls for groundwater would be required. This is primarily due to the low to very low permeability of Wianamatta Shale and subsequently minor to negligible extent of drawdown and negligible seepage through identified road cuttings. The expected groundwater inflows are anticipated to be in the order of 0.1 L/s/km of cuttings, although probably much less. It is considered prudent that if groundwater is encountered during excavation works the groundwater monitoring plan detailed below should be implemented.	Construction contractor	Construction	N/A

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Disturbance of contaminated or potentially contaminated land	SWC-10	Intrusive investigations should be undertaken in the vicinity of moderate risk areas including service stations (operational and non-operational), stockpiles and market gardens. A Contaminated Land Management Plan would be prepared in accordance with the *Contaminated Land Management Act 1997*, relevant EPA Guidelines and Roads and Maritime Guideline for Management of Contamination (Roads and Maritime,2013) and would include at a minimum: • Contaminated land legislation and guidelines including any relevant licences and approvals to be obtained • Identification of locations of known or potential contamination and preparation of a map showing these locations • Identification of rehabilitation requirements, classification, transport and disposal requirements of any contaminated land within the construction footprint • Measures to manage stockpiled potentially contaminated soil in accordance with the requirements of NSW EPA Waste Guidelines • Contamination management measures including waste classification and reuse procedures and unexpected finds procedures for unanticipated discovery of contaminated material during construction • Asbestos handling and disposal requirements in accordance with NSW EPA guidelines • Excavated material that is not suitable for on-	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CLMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		site reuse or recycling would be transported to a site that may legally accept that material for reuse or disposal.			
Encountering UXO	SWC-11	For UXO"s, an investigation should be undertaken to confirm the likelihood of UXO"s being present within the areas of the project within DEOH. The investigation should be undertaken prior to construction activities by a suitably qualified consultant registered on the Commonwealth Department of Defence UXO Panel (DUXOP) now subsumed into the Defence Environment and Heritage Panel (DEHP).	Construction contractor	Construction	Proven to be effective
Soil stockpiling	*SWC-12*	*There would be no stockpiling of soil or construction materials within utility easement corridors.*	*Construction contractor*	*Construction*	*Proven to be effective*
Aboriginal construction heritage management plan	AH-1	A Construction Cultural Heritage Management Plan (CHMP) would be prepared prior to construction and implemented as part of the CEMP. The CHMP would include details on: • The policy basis for management measures • The erection of any temporary fencing for the protection of heritage sites being partially impacted • Unexpected finds procedures • Responsibilities for heritage management • Salvage excavation methodologies • Consultation requirements	Construction Contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the CHMP to confirm effectiveness of measures. Specific measures carried out in accordance with agreed guidelines and by qualified archaeologists.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Procedures for monitoring and reporting on the effectiveness of measures.			
Archaeological sites partially impacted by the project	AH-2	The location of the portions of these sites to be conserved would be identified in the CHMP, Construction Heritage Sites Map and project inductions to ensure they are not inadvertently damaged as a result of construction works. The portion of the site outside the project boundary would be fenced off prior to the commencement of construction works in accordance with the management procedures outlined in the CHMP. Archaeological salvage excavation would be undertaken for the impacted portion of the following sites in accordance with the salvage excavation methodology detailed in Appendix M: • B6 • TNR AFT 08 • TNR AFT 11 • TNR AFT 12 • TNR AFT 13 • TNR AFT 14 • TNR AFT 20 • TNR AFT 22 • TNR AFT 24 • TNR AFT 26 • TNR AFT 27	Construction contractor	Construction	Expected to be effective. Salvage excavation activities would be carried out in accordance with the methodology outlined in the Cultural Heritage Assessment Report (CHAR) by a qualified team and in consultation with relevant stakeholder groups. The salvage methodology is considered bot efficient and effective.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• TNR AFT 29 • TNR AFT 30 • TNR AFT 31 • TNR AFT 33			
Archaeological sites wholly impacted by the project	AH-3	Archaeological salvage excavation would be undertaken for the following wholly impacted sites in accordance with the management procedures outlined in Appendix M: • TNR AFT 06 • TNR AFT 07 • TNR AFT 16 • TNR AFT 17 • TNR AFT 19 Archaeological salvage excavation must be completed prior to any activities which may harm Aboriginal objects in accordance with the management procedures outlined in Appendix M. No construction activities would occur on lands to be salvaged until the relevant archaeological excavations at the nominated site have been completed.	Roads and Maritime	Pre-Construction	Expected to be effective. Salvage excavation activities would be carried out in accordance with the methodology outlined in the CHAR by a qualified team and in consultation with relevant stakeholder groups.
Unexpected identification of skeletal remains	AH-4	• In the event of the unexpected discovery of suspected archaeological Aboriginal human remains during the proposed works, in addition to the procedures outlined in the Roads and Maritime Unexpected Heritage Items Procedure (2015a), the CHMP would require that Roads and Maritime immediately notify the identified knowledge holders of the	Construction contractor	Construction	Expected to be effective if carried out in accordance with procedures outlined in CHAR.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		discovery. If the material is confirmed to be archaeological Aboriginal human remains that consultation would occur with the identified knowledge holders. Procedures for Handling Human Remains are detailed in Appendix M and summarised below: • As soon as remains are exposed, all work is to halt at that location immediately and the Project environmental manager on site is to be immediately notified to allow assessment and management: – Stop all activities – Secure the site. • Contact police as the discovery of human remains triggers a process which assumes that they are associated with a crime. The NSW Police retain carriage of the process until such time as the remains are confirmed to be Aboriginal or historic • The relevant approval authority(s) will be notified when human remains are found • Once the police process is complete and if remains are not associated with a contemporary crime contact the relevant approval authority(s) who will determine the process in consultation with OEH and/or the Heritage Office as appropriate: • If the remains are identified as Aboriginal, the site is to be secured and the approval authority(s) and all Aboriginal stakeholders are to be notified in writing. The approval authority(s) will act in consultation with OEH as appropriate. OEH will be notified in writing according to the approval authority(s)			

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		instructions or • If the remains are identified as non-Aboriginal (historical) remains, the site is to be secured and the approval authority(s) is to be contacted, who will act in consultation with the Heritage Division as appropriate. The Heritage Division will be notified in writing according to the approval authority(s) instructions • Once the police process is complete and if the remains are identified as not being human work can recommence once the appropriate clearances have been given.			
Unexpected identification of Aboriginal objects	AH-5	Where there is a proposed change to the project (once approved), this change will be considered in the context of potential impact to Aboriginal cultural heritage, whether increased or reduced. Where a proposed change to the approved project occurs outside of the project boundary, further heritage assessment will be required in consultation with the appointed Archaeologist to determine if there would be an impact on Aboriginal cultural heritage. Where the change is considered to have a neutral or lesser significant impact on Aboriginal cultural heritage than that identified for the approved project (as per this assessment), it would be considered a consistent impact. Where the change to the approved project is considered to have a more significant impact on Aboriginal cultural heritage than that identified in the EIS, it would be considered an inconsistent	Construction contractor	Construction	Expected to be effective if carried out in accordance with procedures outlined in CHAR.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		impact. In this case, Roads and Maritime would require a modification to the approved project, and further consultation with Aboriginal stakeholders would be required to be undertaken.			
Consultation	*AH-6*	*Council would be provided copies of heritage reports and photo archival results. Release of sensitive information would be carried out in accordance with the wishes of Aboriginal stakeholders.*	*Roads and Maritime*	*Construction*	*Proven to be effective.*
Construction impacts to non-Aboriginal heritage items and places	NAH-1	A Construction Cultural Heritage Management Plan would be prepared as part of the CEMP prior to construction in consultation with the NSW Heritage Division of OEH. As a minimum, the plan would include the following: • Induction protocols for staff and project personnel to undertake a cultural heritage induction, to assist them in understanding and complying with their legal obligations under the *Heritage Act 1977* • A list, plan and GIS layer showing the location of identified heritage items • A significance assessment and statement of significance for each item • Detail the mitigation measures identified and	Construction contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the CHMP to confirm effectiveness of measures. Specific measures carried out in accordance with agreed guidelines and by qualified archaeologists.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		when the measures are to be implemented • Provide protocols and procedures to be enacted during construction to ensure the protection of items of heritage significance • An unexpected finds procedure in the event that further sites are identified during works • The separate procedure for the discovery of skeletal remains (highly effective).			
Orchard Hills Cumberland Plain Woodland (Chaffey Brothers Irrigation Scheme Canal)	NAH-2	Archival photographic recording in accordance with the Heritage Division of the OEH guidelines. This would include: • Report (paper), thumbnails, CD-R and prints (10.5x14.8cm) to NSW Heritage Office • Report (paper), thumbnails and CD-R to State Library of NSW • Report (paper), thumbnails and CD-R to Owner/client • Report (paper), thumbnails and CD-R to Local Council • Report (paper), thumbnails and CD-R to Local Council Library.	Construction contractor	Construction	Proven to be effective. An archival photographic recording would be made of the extent of the canal, including the section outside the project area, in accordance with the Heritage Division of the OEH guidelines (Heritage Council of NSW 2006) prior to its demolition
	NAH-3	*Archaeological investigation of the portion of the canal to be impacted by the project, including test excavation in accordance with the research design and excavation methodology for the item.*	*Roads and Maritime*	*Pre - construction*	

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Warragamba Dam to Prospect Reservoir pipeline	*NAH-4*	*The construction contractor would identify suitable measures to be incorporated into the CEMP to prevent physical damage to the pipeline in accordance with The Guidelines for development adjacent to the Upper Canal and Warragamba Pipelines (Sydney Catchment Authority 2012). These measures would be developed in consultation with Roads and Maritime and the Sydney Catchment Authority and include measures for the management of potential vibration impacts, erosion and sediment controls and agreed site access protocols.*	*Construction contractor*	*Construction*	*Expected to be effective if carried out in accordance with procedures outlined in CEMP.*
	NAH-5	*An exclusion zone would be established to protect the depot building footings associated with the pipelines (item 3), which are immediately adjacent to the proposed drainage infrastructure works within WaterNSW land.*	*Construction contractor*	*Construction*	*Expected to be effective if carried out in accordance with procedures outlined in CHMP.*
	NAH-6	*Roads and Maritime would consult with WaterNSW with all aspects of construction near the pipeline corridor during detailed design and construction of the project*	*Roads and Maritime Construction contractor*	*Construction*	*Expected to be effective.*

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Miss Lawson"s guesthouse site	~~NAH-3~~ *NAH-7*	~~Detailed salvage archaeological investigation of the site.~~ *Archaeological investigation of the item including test and salvage excavation in accordance with the research design and excavation methodology.*	Roads and Maritime	Pre - construction	Expected to be effective. ~~Salvage~~ Test and salvage excavation would be carried out in accordance with the Heritage Division of OEH guidelines including ~~an appropriate~~ *the* research design and methodology *for the site* in order to best realise the research potential of this area of the site. ~~Salvage~~ *Test and salvage* excavation would be undertaken under the supervision of an appropriately qualified and experienced historical archaeologist in accordance with the Heritage Division of OEH criteria *for sites of local significance*.
Lawson"s Inn site	~~NAH-4~~ *NAH-8*	~~Detailed salvage archaeological investigation of the site~~. *Archaeological investigation of the item including test excavation in accordance with the research design and excavation methodology.* *If during testing significant archaeological resources are identified within areas of low archaeological potential to be impacted by the project, then the design would be reviewed and where reasonable and feasible adjusted to avoid where possible or minimise these impacts.*	Roads and Maritime	Pre - construction	
Unexpected impacts on heritage values	~~NAH-5~~ *NAH-9*	The project"s Construction Environmental Management Plan would include „unexpected finds" procedures to guide the management of any archaeological sites identified during construction. The management response would vary depending on the nature of the find, its significance and likely impacts.	Construction contractor	Construction	Expected to be effective if carried out in accordance with procedures outlined in CHMP.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Urban design	UD-1	The urban design and landscape concept developed for the project would be adopted during detailed design. This would include design treatments for: • Location and identification of existing vegetation and proposed landscaped areas, including species to be used • Built elements including retaining walls and Adams Road Bridge • Design‟ treatments for stormwater quality measures and infrastructure • Pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings • Fixtures such as seating, lighting, fencing and signs • Details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • Procedures for monitoring and maintaining landscaped or rehabilitated areas.	Contractor	Detailed Design / Construction / Operation	Expected to be effective. Urban design outcomes have been incorporated into concept design and would be further refined during detailed design of the project in consultation with a range of stakeholders including State Government agencies, Penrith City Council, Liverpool City Council and the local community.
Lighting impacts	UD-2	The design of temporary lighting must avoid unnecessary light spill on adjacent residents or sensitive receivers and be designed in accordance with AS 1158.1-1986.	Contractor	Detailed Design / Construction	Proven effective if carried out in accordance with AS 1158.1-1986.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Visual impacts from construction sites	UD-3	Consider the provision of barriers to screen views from visually sensitive nearby areas such as rural dwellings, residential and recreational areas.	Contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Visual impacts from construction sites	UD-4	Contain construction activities within the construction works zone boundary and occupy the minimum area practicable for limiting impacts on adjoining areas, including the extent of native vegetation clearing.	Contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Visual impacts as a result of vegetation loss	UD-5	Construction programming must show how progressive rehabilitation of disturbed areas would be undertaken to minimise the duration and extent of temporary visual and landscape character impacts and to minimise soils exposure and the potential for erosion and dust generation.	Contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Visual impacts as a result of vegetation loss	UD-6	Existing trees to be retained within construction areas are to be identified, protected and maintained in accordance with AS4970 Trees on Development Sites, or as otherwise directed by a qualified ecologist or arborist.	Contractor	Construction	Proven effective if carried out in accordance with AS4970 Trees on Development Sites.
Excessive exhaust emissions arising from plant and equipment	AQ-1	Plant and equipment would be operated in a proper and efficient manner by: • Inspecting the plant/equipment prior to commencement of works on site • Conducting routine servicing and maintenance, and subsequent inspections to ensure that equipment continues to operate efficiently.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Dust generation and emissions at compound locations	AQ-2	*Dust and emissions generation at compounds would be managed by:* • Installation of perimeter screening around compound sites • Impose low speeds limits around compound sites to limit the generation of dust from vehicle movements • Apply wheel-wash or rumble grid facilities at access points to limit the tracking of materials beyond the site boundary • Ensure that compound area surfaces are well compacted or sealed to limit the potential for dust generation • Regularly water stockpiles and limit the amount of materials stockpiled around the site • Position stockpiling areas as far as possible from surrounding receivers • Limit stockpiling activities during conditions where winds are blowing strongly in the direction(s) from the stockpiling location to nearby receivers • Consultation would be carried out consistent with the Community Consultation Framework in relation to air quality near ancillary sites and relevant incident management process during construction.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Dust generation and emissions from construction activities and materials haulage	AQ-3	*Dust generation and emissions from construction activities and materials haulage would be managed by:* • Impose low speeds limits across all site haulage routes • Ensure that all loads are covered when materials are being hauled to and from site • Wherever possible, position internal haulage routes away from surrounding receivers • Regular watering of exposed and disturbed areas especially during inclement weather conditions • Wherever possible, minimise the extent of disturbed and exposed surfaces, and restore as soon as possible • Adjust the intensity of activities based on measured dust levels, weather forecasts and the proximity of and direction of the works in relation to the nearest surrounding receivers • Ensure that any material exposed areas are secured during project shutdown periods to prevent any dust emanating over adjacent roads • Install depositional dust gauges to quantify dust levels and determine whether control measures are adequate or whether further actions are required • These gauges should be installed at regular intervals along the project alignment at representative receiver locations. Gauges should also be installed around major construction compound and stockpiling locations.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Windborne dust emanating from non-vegetated surfaces	AQ-4	*Windborne dust emanating from non-vegetated surfaces would be managed by:* • Stage work to ensure that finished areas are revegetated as soon as possible • Regularly maintain and water revegetation areas to aid the establishment of adequate vegetation cover.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Odours arising from uncovered contaminated and/or hazardous materials.	AQ-5	Application of odour supressing agents to materials as necessary to minimise related impacts should any contaminated or hazardous materials be uncovered during the works.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Cumulative dust impacts arising from con-current construction of the proposed upgrade and the Western Sydney Airport	AQ-6	Develop construction program in consultation with the contractor(s) developing the Western Sydney Airport site. Maintain consultation through the course of both projects to plan activities in a manner which limits potential air quality-related impacts. Wherever possible and practical, co-ordinate activities with a high potential to generate dust so that they do not occur at the same time. Stop activities if dust is observed to be emanating from the airport.	Construction contractor	Prior to and during construction	Expected to be effective. Monitoring and reporting requirements of the Operational Environmental Management Plan (OEMP) to confirm effectiveness of measures.
Inappropriate handling and/ or disposal of waste	WR-1	The waste minimisation hierarchy principles of avoid/reduce/reuse/ recycle/dispose would be used	Construction contractor	Construction	Proven to be effective

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	WR-2	A project-specific Construction Waste and Energy Management sub-plan (CWEMP) would be prepared before construction. The plan would adopt the Resources Management Hierarchy principles of the WARR Act and include: • The major construction related waste streams expected to be generated from the project • The major sources of construction related energy consumption (fuel and power) • Classification of waste streams • Waste orders and exemptions • Re-use and recycling practices to be implemented • Measures to be applied where waste is required to be handled and stored onsite prior to onsite reuse or offsite recycling/disposal • Specific measures to manage vegetation waste • Energy conservation best practice and the reduction of greenhouse gases by adopting energy efficient work practices • A resource management strategy detailing beneficial reuse options for surplus and/or unsuitable material • Procedures for the identification, handling and disposal of hazardous materials including potential asbestos waste • Protocols for engaging with and notifying residents of any work processes that may impact them • A complaints mechanism so that residents	Construction contractor	Pre-Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		may contact the project manager • A protocol to enable the project to respond quickly to non-compliances.			
Inappropriate handling and/ or disposal of waste	WR-3	All wastes, including contaminated wastes, would be identified and classified in accordance with the Waste Classification Guidelines: Part 1 Classifying Waste.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-4	Disposal of any non-recyclable waste would be in accordance with the POEO Act and Waste Classification Guidelines: Part 1 Classifying Waste.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-5	Trees and plant material would be mulched or chipped on-site and used in landscaping where practicable to stabilise disturbed soils where possible.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
Inappropriate disposal of excavated material that cannot be reused in the project	WR-6	Where possible and fit for purpose, spoil would be beneficially reused within the project before off-site reuse of disposal options is pursued.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-7	Excavated material that is not suitable for on-site reuse or recycling would be transported to a site that may legally accept that material for reuse or disposal.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	WR-8	Before being transported from construction sites, excavated spoil would be classified in accordance with the Waste Classification Guidelines: Part 1 Classifying Waste (EPA, 2014) to ensure appropriate reuse of disposal.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-9	A Spoil Management Strategy would be developed prior to the commencement of construction and implement during construction. The strategy would identify spoil disposal site(s) and describe the management of spoil on-site and during off-site transport.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
Resource use	WR-10	Wherever feasible and reasonable, construction material would be sourced from within the Sydney region.	Construction Contractor	Construction	Proven to be effective.
Water use	*WR-11*	*Where water is sourced from far dams, it would be done so in consultation with landowners*	*Construction Contractor*	*Construction*	*Proven to be effective.*
Emissions of greenhouse gases during construction	GHGC-1	Identify recycled materials (such as recycled aggregates in road pavement and surfacing; steel with recycled content) for use in construction or operation of the project where they are cost, quality and performance competitive.	Construction contractor	Detailed design	Expected to be effective if carried out in accordance with the project-specific Construction Waste and Energy Management sub-plan (CWEMP)
	GHGC-2	Use of modern diesel engine equipment, to ensure highest fuel efficiency ratings.	Construction contractor	Construction	Proven to be effective.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	GHGC-3	Specification of the use of biofuels, or biofuel blends in construction plant and equipment.	Construction contractor	Pre-construction	Proven to be effective
	GHGC-4	Provision of clear guidance to construction staff on equipment start up and shut down procedures to ensure that they are not left idling when not in use.	Construction contractor	Pre-construction	Proven to be effective. Induction and training requirements of the CEMP to confirm effectiveness of measures.
	GHGC-5	Review of cut and fill balances for earthworks to ensure material is transported the least possible distances.	Construction contractor	Construction	Expected to be effective. To be confirmed during detailed design
	GHGC-6	Review of local options for import and export of fill materials as needed to reduce excess fuel used during transport.	Construction contractor	Construction	Expected to be effective. To be confirmed during detailed design
	GHGC-7	Specification and certification of steel from recycled sources where suitable for offsetting virgin steel	Construction contractor	Construction	Proven to be effective.
Emissions of greenhouse gases during construction	GHGC-8	Specification of materials with low embodied energy / embodied GHG content, such as: Replacement of Portland cement in concrete mixes with low carbon alternatives such as fly-ash Use of warm mix asphalt versus hot mix.	Construction contractor	Detailed design	Proven to be effective.
	GHGC-	A project-specific Construction Waste and	Construction	Pre-	Proven to be effective.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	9	Energy Management sub-plan (CWEMP) would be prepared before construction. The plan would adopt the Resources Management Hierarchy principles of the WARR Act and include: • The major construction related waste streams expected to be generated from the project • The major sources of construction related energy consumption (fuel and power) • Classification of waste streams • Waste orders and exemptions • Re-use and recycling practices to be implemented • Specific measures to manage vegetation waste • Energy conservation best practice and the reduction of greenhouse gases by adopting energy efficient work practices • A resource management strategy detailing beneficial reuse options for surplus and/or unsuitable material • Procedures for the identification, handling and disposal of hazardous materials including potential asbestos waste • Protocols for engaging with and notifying residents of any work processes that may impact them • A complaints mechanism so that residents may contact the project manager • A protocol to enable the project to respond quickly to non-compliances.	contractor	construction	Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
General	HR-1	Hazard and risk management planning would be incorporated throughout the CEMP, which may include items such as: • Details of the hazards and risks associated with construction activities • Risk management measures, including those identified in Chapters 7 and 8 of this EIS • Procedures to comply with all legislative and industry standard requirements • Contingency *and emergency response* plans, as required • Site-specific Work, Health and Safety plans and activity specific Safe Work Method Statements Training for all personnel (including subcontractors) in site inductions, including the recognition and awareness of site hazards and the locations of relevant equipment to protect themselves and manage any spills.	Construction contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.
Storage of dangerous goods and hazardous substances	HR-2	Storage of dangerous goods and hazardous materials would occur in accordance with suppliers" instructions and relevant Australian Standards and may include bulk storage tanks, chemical storage cabinets / containers or impervious bunds.	Construction contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	HR-3	Storage, handling and use of dangerous goods and hazardous substances would be in accordance with the *Work Health and Safety Act 2011* and the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005).	Construction contractor	Construction	Proven to be effective if carried out in accordance with *Work Health and Safety Act 2011* and the Storage and Handling of *Dangerous Goods Code of Practice* (WorkCover NSW, 2005).
Storage of dangerous goods and hazardous substances	HR-4	Secure, bunded areas would be provided around storage areas for oils, fuels and other hazardous liquids.	Construction contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.
	HR-5	Material Safety Data Sheets would be obtained for dangerous goods and hazardous substances stored onsite prior to their arrival.	Construction contractor	Construction	Proven to be effective.
Contamination from transportation of hazardous goods	HR-6	Transport all hazardous substances in accordance with relevant legislation and codes, including the Road and Rail Transport (Dangerous Goods) (Road) Regulation 1998 and the „Australian Code for the *Transport of Dangerous Goods by Road and Rail'* (National Transport Commission, 2008).	Construction Contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Bushfire	HR-7	Measures to mitigate and manage bushfire would be developed and included as part of site-specific hazard and risk management measures within the CEMP *The road is to be designed with consideration to the requirements of the Planning for Bush Fire Protection 2006.*	Construction Contractor	Construction	Proven to be effective.
Warragamba Pipelines	*HR-8*	*Roads and Maritime would notify WaterNSW of any incident such as vehicle accident, discovery of any heritage items, spill or fire that affects or could affect the Warragamba Pipelines including the corridor.*	*Roads and Maritime*	*Construction*	*Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.*
Cumulative impacts	CI-1	Consultation would be undertaken with local communities potentially affected by the impacts of multiple projects in addition to the project.	Roads and Maritime / Construction Contractor	Construction	Expected to be effective. To ensure flexibility in the communications approach to the project, communications and engagement activities would be monitored, assessed and reported regularly.
Cumulative impacts	CI-2	Where relevant, consultation would be undertaken with proponents of other nearby developments to increase the overall awareness of project timeframes and impacts.	Roads and Maritime / Construction Contractor	Construction	Proven to be effective. To ensure flexibility in the communications approach to the project, communications and engagement activities would be monitored, assessed and reported regularly.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	CI-3	Construction traffic management plans for this project should be developed in consultation with plans for ~~these projects so that increased traffic on the local road network would be spread over the road network to ensure that construction traffic is not concentrated on any one particular route if there are alternatives available~~ *other projects to assist in spreading the traffic load over the network and to minimise construction traffic being concentrated on any one particular route.*	Roads and Maritime / Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.

6.2 Operational environmental management

Once construction on the Northern Road upgrade has been completed, the responsibility for ongoing operational management would be handed back to Roads and Maritime from the construction contractor.

The maintenance and management of the Roads and Maritime road asset network in the Sydney region has been vested to private organisations that carry out all operational aspects of the network on behalf of Roads and Maritime in the form of Stewardship Maintenance Contracts. The obligations under the Roads Act 1993, the Environmental Planning and Assessment Act 1979 and the State Infrastructure Planning Policy (Infrastructure) 2007 and all other relevant legislation is the responsibility of the private organisations as an agent of Roads and Maritime. In addition, organisations contracted to provide operational maintenance for Roads and Maritime are bound to address any operational requirements provided by the Minister through the Conditions of Approval for the project.

Roads and Maritime manage their legislative and environmental management obligations through the use of a number of procedures, guidelines, guidance notes, and technical notes to provide guidance and set expectations in environmental planning and management of the road network and assets. Specifications, including, but not limited to Routine Services Specification (M3); General Specification – Environmental Protection (Management Systems) Maintenance (G36M); General Specification – Soil and Water Management (G38) are used to outline the environmental planning and management expectations and requirements of the Stewardship Maintenance Contractors. The Stewardship Maintenance Contractors are also required to operate under an Environmental Management System, have a program Environmental Management Plan and have specific Construction Environmental Management Plans activities that are carried out on the network.

The iterative design and EIS process has enabled Roads and Maritime to avoid and minimise environmental impacts from the project where possible. Where environmental controls have been incorporated into the design there is a program of monitoring and review including independent auditing, to ensure the controls comply with stated objectives (refer Table 6-2).

Specific monitoring that would be considered during operation of the project may include:

- Noise monitoring to compare actual noise performance of the project against predicted noise performance
- Monitoring and maintaining landscaped or rehabilitated areas
- Monitoring of surface water quality in order to:
  - assess and manage impacts on the receiving waters as the site stabilises
  - assist in deciding when the site has stabilised
  - identify water quality conditions after development.

Table 6-2 Summary of operational environmental safeguards and management measures

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Operational noise impacts	NV-4	Where noise barriers and/or low noise pavements are not considered feasible and/or reasonable, noise impacts at affected dwellings would be mitigated by at-property treatments.	Roads and Maritime	Operation	Proven to be effective To be carried out in consultation with affected residents
	NV-5	Within 12 months of the commencement of operation of the project an operational noise review would be undertaken. This would include: • Monitoring to compare actual noise performance of the project against predicted noise performance • An assessment of the performance and effectiveness of applied noise mitigation measures together with a review and if necessary, reassessment of all feasible and reasonable mitigation measures • Identification of any additional feasible and reasonable measures that would be implemented with the objective of meeting the criteria in the *NSW Road Noise Policy* (DECCW, 2011), when these measures would be implemented and how their effectiveness would be measured and reported.	Roads and Maritime	Operation	Proven to be effective

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Noise, light and vibration	B-25	Shading and artificial light impacts would be minimised through detailed design. Measures to mitigate potential noise and vibration impacts are provided in section 7.2 of the EIS.	Roads and Maritime	Detailed design	Expected to be effective.
Operational socio-economic impacts	SE-20	Appropriate road signage would be provided in accordance with the Roads and Maritime Services Guidelines Tourist Signposting (2012) to provide guidance to passing patrons on access to shops and services, including within Luddenham town centre. *Liverpool Council as well as Penrith City Council would be consulted in the preparation of plans to revitalise Luddenham town centre and appropriate gateway signage or other features.*	~~Construction contractor~~ *Roads and Maritime*	Construction	Proven to be effective. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.
Operational socio-economic impacts	SE-21	Roads and Maritime will, in consultation with Liverpool Council *and Penrith City Council,* provide ~~appropriate~~ *monetary* support for preparation of plans to revitalise Luddenham town centre, for the purpose of encouraging motorists to continue to pass through or visit the town. Any streetscape and landscape treatments would be determined after finalisation of any town centre revitalisation plans.	Roads and Maritime	Pre-construction and construction	Expected to be effective. Roads and Maritime have experience with similar by-pass projects in NSW.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Impacts on flood behaviour during operation	FH-5	The transverse drainage and flood mitigation strategy would continue to be refined during detailed design. If the properties are still impacted, and if mitigation is required, this would be investigated in consultation with the landowners. It would include but not be limited to: • Identification of potential flood impacts to the project and adjoining areas, including consideration of local drainage catchment assessments and climate change implications on rainfall, drainage • Design and mitigation measures to protect proposed operations and not worsen existing flooding characteristics during construction and operation, including soil erosion and scouring • Drainage system upgrades and preparation of a Flood and Emergency Management Plan.	Roads and Maritime	Detailed design	Proven to be effective. Further design development would be carried out at detailed design stage to reduce the potential for flood attributable to the project in the affected properties
	FH-6	The 100 year ARI flood level is to be adopted in the assessment of measures which are required to mitigate any adverse impacts attributable to the project. Changes in flood behaviour under PMF conditions would also be assessed in order to identify impacts on critical infrastructure and substantial changes in flood hazards as a result of the project.	Roads and Maritime	Detailed design	Proven to be effective. Further design development would be carried out at detailed design stage to reduce the potential for flood attributable to the project in the affected properties

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
	FH-7	A floor level survey would be undertaken in affected areas to determine whether the project would increase flood damages in adjacent developments (ie in properties where there is a potential for increases in peak flood levels for events up to the 100 year ARI flood).	Roads and Maritime	Detailed design	Proven to be effective. Further design development would be carried out at detailed design stage to reduce the potential for flood attributable to the project in the affected properties
Reductions in water volumes	FH-8	Consultation would be carried out with each affected landholder where reductions in the volume of flow would cause existing dams to fill less frequently, reducing the available yield.	Roads and Maritime	Detailed design	Expected to be effective if carried out in accordance with consultation requirements
Operational water quality	SWC-13	~~24 water quality swales are proposed, including those upstream of identified sensitive receiving waterways.~~ *Water quality swales will be implemented for the proposal, including upstream of identified sensitive receiving waterways.*	Roads and Maritime	Detailed Design Operation	Expected to be effective. The proposed swales have been optimised by increasing their base width to provide additional water quality treatment Monitoring and reporting requirements of the Water Quality Management Plan (WQMP) to confirm effectiveness of measures and if any additional measures are required.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Roadside air quality during operations	AQ-7	• Post-construction traffic measurements should be collected to verify that traffic volumes and characteristics are not materially different from the forecast numbers considered in this assessment. • Where material differences are identified, further assessment should be completed to confirm that the level of impacts remain consistent with the predictions of this study.	Roads and Maritime Services	Operation	Expected to be effective. Monitoring and reporting requirements of the OEMP to confirm effectiveness of measures.
Landscaping	*UD-7*	*Development of the landscaping plan would include consultation with Council regarding its maintenance requirements*	*Construction contractor*	*Operation*	*Expected to be effective.* *Monitoring and reporting requirements of the OEMP to confirm effectiveness of measures.*
Emissions of greenhouse gases during operation	GHGC-10	Opportunities to use renewable energy for road operation would be investigated.	Roads and Maritime	Detailed design	Expected to be effective. To be confirmed during detailed design

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Incident response	HR-9	An Incident Response Management Plan would be developed and implemented. The response to incidents within the motorway would be managed in accordance with the memorandum of understanding between Roads and Maritime and the NSW Police Service, NSW Rural Fire Service, NSW Fire Brigade and other emergency services. An incident response facility has been provided for the project.	Roads and Maritime	Operation	Proven to be effective Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace, and regular testing and monitoring of any fire and life safety systems.

7 References

Artefact Heritage 2015 *The Northern Road. Stage 4, Route Options Assessment. Non-Aboriginal Heritage Constraints Report*. Report to Parsons Brinckerhoff on behalf of Roads and Maritime Services, Rose Bay NSW

Australian Government 2016, *Western Sydney Airport Environmental Impact Statement*, Canberra

Australian Museum Consulting 2014 *Badgerys Creek Initial Environmental Survey: Historic Heritage.* A report to SMEC Australia, Sydney NSW

Australian Standard *AS 1158.1-1986 – The lighting of urban roads and other public thoroughfares, performance and installation design requirements*

Department of Environment and Climate Change 2008, *Managing Urban Stormwater-Volume 2D Main Road Construction, NSW Department of Environment, Climate Change and Water (known as the Blue Book Volume 2)*: Sydney.

Department of Environment and Climate Change and Water (DECCW) 2011, *NSW Road Noise Policy*, Sydney South

Department of Finance & Services 2016, *NSW Government Policy on Aboriginal Participation in Construction. NSW Department of Finance, Services and Innovation*

Department of Primary Industries 2003, *Policy and Guidelines for Fish Friendly Waterway Crossings, Department of Primary Industries*

Department of Primary Industries 2013, *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update)*

Department of Primary Industries 2012, *Water Guidelines for Controlled Activities on Waterfront Land*

Desic, R. and P. Kottaras 2017 *The Northern Road Upgrade: Item 10 - Lawson's Thistle Inn and Store archaeologcial site, Archaeological Assessment and Research Design*. Prepared for Roads and Maritime Services, EMM Consulting, St Leonards

Environment Protection Authority 2014, *Waste Classification Guidelines Part 1: Classifying waste, EPA*, Sydney South

Heritage Office and Department of Urban Affairs & Planning 1996, *NSW Heritage Manual*

Fairfull, S and Witheridge, G 2003, *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*. NSW Fisheries, Cronulla

Godden Mackay Logan 2013 *Defence Establishment Orchard Hills NSW Heritage Management Plan.* A report to Department of Defence

Heritage Council of NSW 2006 *Photographic Recording of Heritage Items Using Film or Digital Capture*. Sydney: NSW Government

Kottaras, P. 2017a *The Northern Road Upgrade: Item 9 - Miss Lawson's Guesthouse Archaeological Site, Reseach Design and Excavation Methods*. Report prepared for Roads and Maritime Services, EMM Consulting, St Leonards.

Kottaras, P. 2017b *The Northern Road Upgrade: Mulgoa Irrigation Canal, Archaeological Research Design and Excavation Methods*. Prepared for Roads and Maritime Services, EMM Consulting, St Leonards.

Landcom 2004, *Managing Urban Stormwater- Soils and Construction, Volume 1, 4th Edition (known as the Blue Book Volume 1),* Sydney.

NSW Rural Fire Service 2016, *Planning for Bush Fire Protection* 2006

Office of Environment and Heritage 2016, *NSW Guide to Surveying Threatened Plants, Office of Environment and Heritage*, Sydney

Roads and Maritime Services 2012, *Tourist Signposting guide*

Roads and Maritime Services 2013, *Guideline for Management of Contamination*

Roads and Maritime Services 2013, *Environmental Impact Assessment Practice Note N04 - Landscape Character and Visual Impact Assessment (EIA-N04)*

Roads and Maritime Services 2014, *Environmental Impact Assessment Practice Note N05 – Socio-economic assessment (EIA-N05)*

Roads and Maritime Services 2016, *Construction Noise and Vibration Guideline*

Roads and Maritime Services 2017, *The Northern Road Upgrade, Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park, NSW Environmental Impact Statement / Commonwealth Draft Environmental Impact Statement. June 2017*, Sydney

Roads and Traffic Authority 2011, *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects, NSW Roads and Traffic Authority*, Sydney

Roads and Traffic Authority 2011, *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects*

Sydney Catchment Authority 2012 *Guidelines for development adjacent to the Upper Canal and Warragamba Pipelines*, Sydney, NSW

WorkCover NSW 2005, *Work Health and Safety Act 2011 and the Storage and Handling of Dangerous Goods Code of Practice.*

rms.nsw.gov.au/autorenew

13 22 13

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

December 2017
RMS 17.629