Transport
for NSW

Heathcote Road Bridge

Addendum Review of Environmental Factors

April 2022

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Appendix A

Design drawings

Appendix B

Consideration of Section 171 factors and matters of National Environmental Significance and Commonwealth land

Section 171 Checklist

In addition to the requirements of the Is an EIS required? (1995/1996) guideline and the Roads and Related Facilities EIS Guideline (DUAP, 1996) as detailed in the addendum REF, the following factors, listed in Section 171 of the Environmental Planning and Assessment Regulation 2021, have also been considered to assess the likely impacts of the proposed modification on the natural and built environment.

Factor	Impact
a) Any environmental impact on a community? The proposed modification would result in the following environmental impacts on the community: • improved road safety and network reliability during operation • traffic delays and increased travel time during the proposed full road closure and detour route for construction of the proposal • potential noise and vibration impacts to surrounding sensitive receivers during construction of the proposal • decreased duration of construction traffic impacts due to a reduced duration required of the full continuous road closure compared to the approved project	Long-term moderate positive impact Short-term moderate negative impacts
b) Any transformation of a locality? The proposed modification is unlikely to result in any transformation of a locality as it would not change the current land use within the proposal footprint	Nil
c) Any environmental impact on the ecosystems of the locality? The proposed modification would involve removal of additional vegetation at the north-west cut, and may avoid impact to 0.05 hectares consistent with an EEC listed under the BC Act. The refined clearing extent would be up to 1.2 hectares of vegetation. Safeguards and mitigation measures have been proposed in Section 6.3.4, to manage and minimise these impacts where possible.	Long-term minor negative impact
d) Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? The proposed modification may result in a temporary reduction in the aesthetic and recreational quality of the area during the construction phase in the form of noise and visual impacts. The proposal may also result in temporary reduction of environmental quality due to water quality and hydrological impacts during construction. Safeguards and mitigation measures have been proposed to manage and minimise these impacts where possible.	Short-term minor negative impact
e) Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural,	

Factor	Impact
historical, scientific or social significance or other special value for present or future generations? The proposed modification would have a lesser impact on non-Aboriginal heritage values of the existing bridge compared to the approved project. The new bridge would be visually separate to the existing bridge that is listed on the Roads and Maritime Services Section 170 Heritage and Conservation Register. The revised design has been able to mitigate these minor impacts further as not to diminish the item's heritage significance to the extent that the works are unacceptable from a heritage perspective or to preclude it from the ability to be formally state heritage listed in future. The proposed modification area would cover a larger portion of the listed Cubbitch Barta National Estate heritage place. Natural landscapes which are tied to the cultural values of the site would be partially impacted by the proposal (through activities such as rock excavation and construction of the temporary access track).	Long-term minor negative impact Short-term minor negative impact
f) Any impact on the habitat of protected fauna (within the meaning of the Biodiversity Conservation Act 2016)? The proposed modification would involve removal of up to 1.2 hectares of vegetation. Safeguards and mitigation measures have been proposed in Section 6.3.4, to manage and minimise these impacts where possible.	Long-term minor negative impact
g) Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? The proposed modification may result in a potential for wildlife injury or mortality throughout the construction phase due to vehicle and equipment movements within the proposal area. However, this is not anticipated to endanger any species.	Short-term minor negative impact
h) Any long-term effects on the environment? The proposed modification would result in loss of vegetation due to the works, however this would not result in a significant impact to the environment.	Long-term minor negative impact
i) Any degradation of the quality of the environment? Providing the mitigation measures outlined in this REF are implemented (refer to Section 7.2), the proposed modification is not expected to result in noticeable degradation of the quality of the environment.	Nil
j) Any risk to the safety of the environment? The proposed modification would result in increased safety for road users of the Heathcote Road bridge and approaches through the separation of the two lanes of traffic and provision of increased lane and shoulder widths.	Long-term major positive impact

Factor	Impact
k) Any reduction in the range of beneficial uses of the environment? The proposed modification would not result in a reduction in the range of beneficial uses of the environment.	Nil
l) Any pollution of the environment? Providing the mitigation measures outlined in this REF are implemented (refer to Section 7.2), the proposed modification is not expected to result in any pollution of the environment.	Nil
m) Any environmental problems associated with the disposal of waste? The proposed modification is not likely to cause environmental problems associated with the disposal of waste. Standard mitigation measures have been proposed in Section 6.11.2.	Nil
n) Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply? The proposed modification is not likely to result in increased demands on resources which are or are likely to become in short supply.	Nil
o) Any cumulative environmental effect with other existing or likely future activities? The proposed modification may result in cumulative traffic impacts with other nearby future activities during construction, including the Linden Street upgrade. However, the proposed modification and the upgrade of Linden Street are being constructed by the same construction contractor. This would allow for scheduling of construction activities to be aligned to minimise cumulative impacts during construction of the two projects. Due to the reduced duration of the full continuous road closure, the proposed modification would also minimise any traffic delays and travel time increases caused by the detour when compared with the approved project. Mitigation measures have been proposed in Section 6.12.5, to avoid or minimise impacts, where possible. During operation, the proposed modification would result in cumulative positive traffic impacts with other future upgrades proposed to improve the reliability, safety and efficiency of the A6 road corridor such as the Heathcote Road intersection improvements project and Linden Street upgrade.	Short-term minor negative impact Long-term minor positive impact
p) Any impact on coastal processes and coastal hazards, including those under projected climate change conditions? The proposed modification would not impact on coastal processes or hazards, including those under projected climate change conditions.	Nil

Factor	Impact
q) Any applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1? The Sutherland Shire Council Local Strategic Planning Statement has been addressed in Section 2.1.3 Local policy context of the project REF. The proposed modification positively aligns with two priorities outlined in the planning statement. These are Planning Priority 2: Managing Traffic Congestion and Parking, and Planning Priority 14: ANSTO Innovation Precinct.	Long-term moderate positive impact
r) Any other relevant environmental factors? The proposed modification would have reduced traffic impacts during construction compared to the approved project. There would be decreased traffic delays and travel time due to the reduced duration of full, continuous road closure. During construction, the proposed modification would result in greenhouse gas emissions through use of materials as well as use of construction equipment, as well as increased vehicle kilometres travelled for haulage.	Short-term minor positive impact Short-term minor negative impact

Matters of National Environmental Significance and Commonwealth land

Under the environmental assessment provisions of the EPBC Act, the following matters of national environmental significance and impacts on Commonwealth land are required to be considered to assist in determining whether the proposed modification should be referred to the Australian Government Department of Water, Agriculture and the Environment.

Under the EPBC Act strategic assessment approval a referral is not required for proposed road actions that may affect nationally listed threatened species, populations, endangered ecological communities and migratory species. Impacts on these matters are assessed in detail as part of this addendum REF in accordance with Australian Government significant impact criteria and taking into account relevant guidelines and policies.

Factor	Impact
a) Any impact on a World Heritage property? There are no World Heritage properties within or near the proposed modification area.	Nil
b) Any impact on a National Heritage place? The proposed modification would involve a minor impact to a small portion of the Cubbitch Barta National Estate Area (Aboriginal and Non-Aboriginal heritage significance), which is a Commonwealth Heritage Place. This area would be slightly larger than that of the approved project area. The modified proposal is considered to	Minor direct impact on Cubbitch Barta National Estate Area

Factor	Impact
represent a more positive heritage outcome than the approved project. The closest National Heritage place is the Royal National Park, which is located about 100 metres north-east of the Heathcote compound. However, no direct or indirect impacts are expected on the Royal National Park.	
c) Any impact on a wetland of international importance? There are no wetlands of international importance within or near the proposed modification area.	Nil

d) Any impact on a listed threatened species or communities?
 	
Assessments of significance for threatened species listed under the EPBC Act were carried out as part of the project REF or this addendum REF for:
 	
• flora species:
  – Thick-leaf Star-hair *Astrotricha crassifolia* (Vulnerable)
  – Small-flower *Grevillea Grevillea parviflora subsp. parviflora* (Vulnerable)
  – Woronora Beard-heath *Leucopogon exolasius* (Vulnerable)
  – Deane's Paperbark *Melaleuca deanei* (Vulnerable)
 	
• fauna species:
  – Broad-headed Snake *Hoplocephalus bungaroides* (Vulnerable)
  – Large-eared Pied Bat *Chalinolobus dwyeri* (Vulnerable)
  – Grey-headed Flying-fox *Pteropus poliocephalus* (Vulnerable)
  – Koala *Phascolarctos cinereus* (combined populations of Qld, NSW and the ACT) (Vulnerable)
  – Australian Bittern *Botaurus poiciloptilus* (Endangered)
 	
• Yellow-bellied Glider (south-eastern) *Petaurus australis* (Vulnerable).
 	
These assessments are provided in Appendix D of the *Biodiversity Assessment Report* provided in Appendix D of the project REF and Appendix D to this addendum. Overall, the assessments of significance concluded that a significant impact on threatened species is not considered to be likely providing safeguards and management measures are implemented (refer to Section 6.3.4).
	Minor direct and indirect impacts may occur for listed threatened species.
	
	No significant impact on threatened species would occur as a result of the proposal, provided appropriate safeguards and management measures are implemented.

e) Any impacts on listed migratory species? The biodiversity assessment for the project REF concluded two of the listed migratory species may occur within the study area on	Minor direct and indirect impacts may

Factor	Impact
occasion: Black-faced Monarch *Monarcha melanopsis* and Rufous Fantail *Rhipidura rufifrons.* The proposed modification would involve the removal of up to 1.2 hectares of vegetation, which is considered a small amount compared to other potentially suitable habitat surrounding the proposal. Overall, a significant impact is considered unlikely on these species as no important habitat will be substantially modified, destroyed, or isolated, the risk of invasive species establishment can be mitigated, and no serious disruptions to the lifecycle of these migratory species is anticipated.	occur for listed migratory species.
f) Any impact on a Commonwealth marine area? There are no Commonwealth marine areas within or near the modified project boundary.	Nil
g) Does the proposal involve a nuclear action (including uranium mining)? The proposed modification would not involve any nuclear action.	Nil
h) Additionally, any impact (direct or indirect) on the environment of Commonwealth land? The proposed modification is located near Commonwealth Land associated with the Holsworthy Military Barracks and the Australian Nuclear Science & Technology Organisation. The proposed modification has been designed to avoid additional impacts to Commonwealth land beyond those assessed as being within the approved project boundary in the project REF. However, the proposed modification may involve short-term indirect impacts on Commonwealth Land associated with noise and vibration during construction, however these impacts would be minor and minimised through safeguards and management measures.	Minor indirect impacts on Commonwealth land

Appendix C

Noise and Vibration

Friday, 8 April 2022

Project number: S210732
Reference: S210732LT1D

Sam Leigh
Fulton Hogan
Level 3, 90 Bourke Road
Alexandria NSW 2015

Dear Sam,

Heathcote Road Bridge
Addendum to Review of Environmental Factors

1 Introduction

The REF noise and vibration impact assessment report evaluated the potential impacts from the construction and operation of a design that included widening of both sides of the existing bridge. This option would have required closure of Heathcote Road for a period of approximately six months, necessitating an extensive amount of out of hours works that would have occurred 24 hours per day, 7 days per week in order to minimise the duration of construction and of the road closure.

An alternative option has ultimately been selected to proceed to detailed design and construction. The alternative option incorporates a new additional bridge to be constructed directly adjacent to the western side of the existing bridge.

Whilst the overall construction methodology remains generally consistent with the REF a few key changes would be introduced by constructing a new bridge compared to widening the existing bridge. These include:

- The road alignment would shift slightly to the west resulting in:
  - There no longer being a need to excavate the rock face on the southern approach to the bridge.
  - Piling being required to construct the new bridge piers.
  - Increased rock cutting works on the northern rock face.
- Construction of a new bridge would reduce the extent of extended road closures on Heathcote Road thereby reducing the likely extent of out of hours works required to complete the works.

This Addendum to the Review of Environmental Factors (REF) provides a review of the changes to the construction methodology and the potential effects on noise and vibration generated from the proposal.

This addendum report should be read alongside the Heathcote Road Bridge REF noise and vibration impact assessment report (Aurecon, November 2020).

2 Construction Noise

2.1 Construction noise criteria

The REF noise and vibration impact assessment report provides a detailed description of Construction Noise Management Levels (NMLs) for the proposal. The NMLs were set on the basis of minimum assumed Rating Background Noise Levels (RBLs) for the land use surrounding the proposal alignment and are therefore likely to be conservative particularly for standard hours works.

In this instance a minimum RBL of 30 dB(A) was used resulting in NMLs as follows:

- Standard hours: RBL + 10 dB(A) or 40 dB(A)
- Out of hours: RBL + 5 dB(A) or 35 dB(A)

A set of noise measurements could be conducted at representative sensitive receiver locations prior to construction commencing and during a full road closure (in the absence of construction noise) to confirm actual background noise levels. This would potentially allow for the adoption of NMLs which better reflect the noise environment with normal road traffic conditions. The results of these noise measurements could be incorporated into the Construction Noise and Vibration Management Plan (CNVMP) and future associated noise assessments.

2.2 Construction methodology and predicted noise levels

2.2.1 Construction scenarios

The REF noise and vibration impact assessment report (Annexure A) described the plant and associated noise source levels for five construction scenarios including:

- Bulk Earthworks
- Bridge Works
- Drainage Works
- Retaining Walls
- Compound Activities.

The proposed construction scenarios remain applicable for the revised design incorporating a new bridge on the western side of the existing bridge. The exception being the requirement to construct piers for the new bridge. Pier construction would require installation of driven tubular piles which would then be bored and set with cast in situ concrete. Furthermore, additional detail relating to construction plant and equipment proposed for access track and rock cutting construction works bas become available. Additional plant and equipment are proposed for these activities relative to what was proposed in the REF for Bulk Earthworks.

This has necessitated three additional construction scenarios to what was presented in the REF noise and vibration impact assessment report to capture noise emissions associated with the driven piles, rock cutting and access track works.

It should be noted that the driven piling works would only occur for a short duration which is estimated to be approximately two weeks and would only occur during standard construction hours.

The plant and equipment associated with the driven piling scenario are presented in Table 1. It should be noted that the plant and equipment presented in Table 1 are consistent with those presented in the REF noise and vibration impact assessment report other than a bored piling rig being substituted for a driven piling rig.

Table 1 Plant and equipment noise source levels

Construction scenario	Equipment	Number of equipment	SWL dB(A) $L_{Aeq, 15\ mins}$
Scenario 2B: Bridge works – Driven piles	Franna Crane (20t)	1	98
	Piling rig – driven	1	116
	Power generator	1	100
	Concrete pump	1	102
	Concrete Truck	4 per hour	109
	Compressor	1	109
Scenario 1A: Access track works	Excavator with hammer	3	122
	Dump truck	3	110
	Chainsaw petrol (4-5 hp)	2	114
	Hand tools	1	94
	Chipper/mulcher	1	116
	Line drill	1	94
	Lighting tower	3	98
Scenario 1B: Rock cutting works	Excavator with hammer	4	122
	Excavator	2	110
	Dump truck	6	110
	Lighting tower	3	98
	Hand tools	1	94
	Franna crane	1	98
	Street sweeper	1	108

- The overall scenario sound power level for driven piling scenario is 3 dB higher than the bored piling scenario.
- The overall scenario sound power level for the access track scenario is 4 dB higher than the bulk earthworks scenario.
- The overall scenario sound power level for the rock cutting scenario is 5 dB higher than the bulk earthworks scenario.

The noise levels at nearby noise sensitive receivers have been predicted utilising the TfNSW Noise Estimator Tool (NET) consistent with the approach implemented within the REF noise and vibration impact assessment report.

The modelling approach conservatively assumed that all plant would be operating simultaneously and the source to receiver distance was relative to the construction footprint boundary. In practice not all plant and equipment would be operating simultaneously, and the location of individual plant items would move around the construction site. For example, piling works would occur at the bridge pier locations and not at the construction footprint boundary. Furthermore, the Noise Estimator Tool does not factor in the complexity of the local landscape including the steep rock escarpments and dense bushland therefore in reality it is likely that these results represent a conservative assessment.

2.2.2 Predicted noise levels and additional mitigation measures

The proposed driven piling scenario would only occur during standard construction hours and therefore the predicted noise levels at the nearest most potentially affected receivers have been assessed against the standard hours NML of 40 dB(A) as presented in Table 2. The proposed access track and rock cutting scenarios would occur during standard and out of normal construction hours periods, therefore a comparison is made against the standard daytime NML and night-time out of hours NML.

Additional noise mitigation measures required in accordance with the TfNSW Construction Noise and Vibration Guideline are also provided.

Table 2 Summary of predicted construction noise levels for the driven piling scenario

Noise Catchment Area	Noise Catchment Distances[3] (m)	NML[4] dB(A)	Predicted noise levels dB(A)	Recommended additional mitigation measures
Construction Scenario 2B: Bridge works – Driven piles				
NCA3 (shielded)	≤440	40 (Daytime)	53	Notification[1], Verification monitoring[2]
NCA2	≤685			Notification, Verification monitoring
NCA3	<1000		43	-
NCA4 (shielded)	440 – 685			-
Construction Scenario 1A: Access track works				
NCA1	≤370	40 (Daytime) 35 (Night-time)	64	Daytime: Notification[1], Verification monitoring[2] Night-time: Notification[1], Verification monitoring[2], Individual Briefings, Phone Calls, Respite Period 2, Duration Respite, Alternative Accommodation
NCA2 (shielded)	≤575		54	Daytime: Notification[1], Verification monitoring[2] Night-time: Notification[1], Verification monitoring[2], Individual Briefings, Phone Calls, Respite Period 2, Duration Respite
NCA2	370 – 880			
NCA3	880 – 1000		44	Daytime: N/A Night-time: Notification[1], Verification monitoring[2], Respite Period 2, Duration Respite
NCA3 (shielded)	575 – 1000			

Noise Catchment Area	Noise Catchment Distances[3] (m)	NML[4] dB(A)	Predicted noise levels dB(A)	Recommended additional mitigation measures
Construction Scenario 1B: Rock cutting works				
NCA1	≤370	40 (Daytime) 35 (Night-time)	65	Daytime: Notification[1], Verification monitoring[2] Night-time: Notification[1], Verification monitoring[2], Individual Briefings, Phone Calls, Respite Period 2, Duration Respite, Alternative Accommodation
NCA2 (shielded)	≤575		55	Daytime: Notification[1], Verification monitoring[2] Night-time: Notification[1], Verification monitoring[2], Individual Briefings, Phone Calls, Respite Period 2, Duration Respite
NCA2	370 – 880			
NCA3	880 – 1000		45	Daytime: N/A Night-time: Notification[1], Verification monitoring[2], Respite Period 2, Duration Respite
NCA3 (shielded)	575 – 1000			

Notes:

1. Notification via letterbox drops to potentially affected noise sensitive receivers.
2. Verification Monitoring at representative noise sensitive receiver locations to confirm predicted noise levels.
3. Post these distances, it is likely that the RBL/NML will change due to proximity to other major roads or significant shielding from the site is applicable, reducing noise impacts greater than predicted levels. The NCA zones are described in the REF Noise and Vibration Impact Assessment Report.
4. The NMLs assume minimum background noise levels.

The construction noise risks associated with all other construction scenarios remain consistent with the evaluation of the REF noise and vibration impact assessment report and the noise mitigation measures as described in the REF are to remain applicable.

However, it is noted that significant trimming of the rock face adjacent to the south-eastern approach to the bridge would no longer be required.

A detailed noise contour map for the rock cutting scenario is provided in Appendix A. Additional noise contour maps for all works would be provided in the approved Construction Noise and Vibration Management Plan.

2.2.3 Project program and respite periods

Overall program and out of hours works duration

The change in the construction methodology has resulted in a reduction of customer interruptions and a six-month closure of Heathcote Road is no longer required.

The project will require weekend shutdowns to allow for works that would have been done during the six-month closure of Heathcote Road.

The project requires up to 12 weekend shutdowns to enable specific works to occur and includes drainage works, earthworks and the placing of beams on the new bridge and laying of pavements. Each weekend shutdowns would generally commence at 9 pm on Friday and continue through to 5am on Monday. A respite from audible night-time construction works would then be provided until the following Friday.

A comparison of the road closures and out of hours periods anticipated by the REF and Addendum REF is provided in Table 3.

Table 3 Comparison of road closure periods / out of hours period between the REF and Addendum REF

Construction Periods	REF	Addendum REF
Prolonged Road Closure	6 Months	No prolonged road closures
Weeknights	Construction works occurring 24 hours per day, 7 days per week for entire 6-month closure	67
Weekend Closures		12

The revised construction programming proposed by the Addendum REF would realise an approximate 50% reduction in out of hours works compared to the approved REF.

Other construction related noise and vibration mitigation measures will be implemented as required by the TfNSW Construction Noise and Vibration Guideline (CNVG) will be applied.

Changes to Rock Cutting and Access Track Construction Duration

The proposed shift of the road alignment to the west would result in additional rock cutting requirements on the north western rock face. This may result in an extension of duration for these activities due to the increased volume of cut material to be removed from the site.

3 Construction vibration

3.1 Construction vibration criteria

Construction vibration criteria are described in Section 5.2 of the REF noise and vibration impact assessment report. Vibration criteria utilised for this addendum report remain consistent with the criteria presented in the REF.

3.1.1 Predicted vibration levels and additional mitigation measures

An additional construction scenario would be required on the basis of the revised design as described in Section 2.2.1. The additional scenario would involve the use of a driven piling rig which would be a vibration intensive activity requiring assessment.

Peak Particle Velocity (PPV) vibration levels have been predicted at the nearest most potentially affected receivers. The vibration levels were predicted in line with the methodology described in in *BS 5228-2:2009 Code of practice for noise and vibration control on construction and open sies – Part 2: Vibration*. Predicted vibration levels are presented alongside the corresponding controlling criterion for each receiver in Table 4 for the case where the pile is not yet driven to refusal and for the case where the pile is driven to refusal. The calculations assume a nominal hammer energy of 85 kJ and a pile diameter of 1500 mm.

Table 4 Predicted vibration levels due to impact piling at sensitive receiver locations

Sensitive receiver	Distance to Receiver (m)	Exposure Duration	Pile Not Yet Driven to Refusal PPV (mm/s)	Pile Driven to Refusal PPV (mm/s)	Criteria PPV (mm/s)	Criterion Category
Aboriginal Cultural Heritage site	150	Continuous	1.3	2.2	2.5	Heritage (damage)
ANSTO	1,100	Continuous	0.1	**0.17**	0.14	Critical Working Areas (preferred)
ANSTO	1,100	Continuous	0.1	0.17	0.28	Critical Working Areas (maximum)
Woronora-Penshurst Pipeline	200	Continuous	0.9	1.5	2.5	Heritage (damage)
Residential Receivers	390	Continuous	0.4	**0.6**	0.56	Human Comfort Continuous Vibration (Day, maximum)
Additional eVDV assessment for human comfort at residential receivers (eVDV $m/s^{1.75}$)						
Residential Receivers	390	9 hours out of standard 11-hour daytime construction period	0.27	0.4	0.4	Human Comfort eVDV (Day, maximum)

Assessment of the predicted vibration levels indicate the following:

- Compliance with the established criteria is predicted at the Aboriginal Heritage Site and at the Woronora – Penshurst Pipeline.
- A marginal exceedance of the preferred criterion adopted for the ANSTO site is predicted when the piles are being driven at refusal but less than the maximum criterion for all scenarios. The modelling is based on a conservative offset distance from the proposal construction footprint boundary to the nearest ANSTO property boundary.
- A marginal exceedance of the maximum continuous vibration criterion at the nearest residential receiver when piles are driven at refusal. In line with REF noise and vibration impact assessment report a further assessment of potential human comfort was conducted by calculating an Estimated Vibration Dose Value (eVDV).

- The eVDV considers the absolute vibration level of the activity as well as the duration of exposure during the respective assessment period (in this case the 11-hour standard daytime construction hours). The eVDV calculation (as shown in Table 4) shows that impact piling could occur for up to 9 hours out of the standard 11-hour construction day and remain less than or equal to the maximum daytime VDV target of 0.4 $m/s^{1.75}$ which is considered a worst-case scenario.

On the basis that the predictions indicate the potential for minor criteria exceedances at the ANSTO site and at the nearest residential receivers for continuous piling durations exceeding approximately 9 hours out of the standard daytime construction period, the following additional mitigation measures are recommended:

- Selection of the smallest plant item that can reasonably complete the required works.
- It is recommended that ANSTO is consulted with in order to confirm potential sensitivities which is an existing requirement from the REF.
- Notification via letterbox drop to other potentially affected receivers.
- It is recommended that vibration levels be measured at the nearest potentially affected receiver locations, including the existing bridge, upon commencement of activities requiring high vibration intensity plant items to confirm vibration predictions and appropriateness of mitigation measures.
- The vibration risks associated with all other construction scenarios remain consistent with the evaluation of the REF noise and vibration impact assessment report and the vibration mitigation measures as described in the REF are to remain applicable.

4 Operational Noise and Vibration

The proposal is for the purpose of safety rather than increased road traffic capacity and the alignment change relative to the REF noise and vibration impact assessment report is minor, with the road alignment shifting slightly to the west away from the nearest residential receivers. Therefore, a negligible change in operational noise levels relative to the REF is anticipated.

Please let me know if you have any queries or wish to discuss the above.

Yours sincerely,

Andrew Parker
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Appendix A Noise Contour Map

Heathcote Road Bridge Upgrade

Predicted Construction Noise Levels
Scenario 1B: Rock cutting works

PROJECT NUMBER	S210732
DRAWN BY	RS
DATE ISSUED	31 March 2022
CLIENT	Fulton Hogan

Legend

- Buildings

Construction Noise Contours Leq dB(A)

- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- > 70

N

0 100 200 300 400 500 m

Datum GDA 94, Projection MGA ZONE 56

Resonate

Appendix D

Heathcote Road Bridge Upgrade Technical Memorandum – Biodiversity

Heathcote Road Bridge Widening Early Works Pre-clearance Survey Report

Lodge Environmental
ABN: 85 631 988 148
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Sam Leigh
NSW Environmental Manager
Fulton Hogan
1914 Illawarra Highway,
Albion Park Rail NSW 2527
e: Sam.Leigh@fultonhogan.com.au

8th April 2022

Project: LE1420

Subject: Heathcote Road Bridge Upgrade Technical Memo

Dear Sam,

Lodge Environmental Pty Ltd were engaged to undertake ecological services associated with the Heathcote Road Bridge Upgrade (HRBU). This technical memo specifically addresses biodiversity impacts that were raised in the Review of Environmental Factors (REF) and provides an updated assessment of impacts under the modified proposal HRBU layout. The main purpose of the assessment is to provide a consistency review of the original Biodiversity Assessment Report (NGH 2020) and a supplementary assessment of new or modified biodiversity impacts. This Technical Memo should be read in conjunction with the BAR.

Biodiversity impacts during construction are summarised in Table 6-11 of the REF. These summaries were used alongside modified scope and construction methodologies, as supplied by Fulton Hogan and Transport for NSW, to guide this report. Biodiversity impacts during operation of the proposal have also been considered and addressed.

Table 1 provides detail on impacts to biodiversity raised in the REF, alongside revised impacts that are expected to eventuate under the current layout. Assessments of impacts, as well as brief details on mitigation measures or relevant reports are also provided. Relevant figures are provided to complement information contained in **Table 1**.

Should the reader have any further questions regarding the content of this report, please do not hesitate to contact the author for further information or assistance.

Yours sincerely,

Max de Beer

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| Lodge Environmental
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Table 1: Assessment of biodiversity impacts associated with the Heathcote Road Bridge Upgrade

Initial impacts outlined in REF	Revised impacts that are considered to eventuate	Assessment of impact
Hibbertia woronorana is a recently described, locally endemic flora species. The primary population has been recorded approximately 50m west of the Proposal Area. There is the potential for vegetation clearance associated with HRBU to impact this species.	A targeted survey for this species was conducted on 15th December 2021, during the known flowering period. *Hibbertia woronorana* was not recorded. A similar species was located during the targeted survey and was sampled for later identification. This plant was confirmed as *Hibbertia fasciculata*. **Figure 2** provides the location of *Hibbertia fasciculata* in relation to the initial design layout. Further details of survey methodology and general considerations are provided in the **Heathcote Road Bridge Widening Early Works Pre-clearance Report**.	*Hibbertia woronorana* was not located within the Proposal Area. Limited potential habitat is present within the Proposal Area. As such, no impacts to *Hibbertia woronorana* are expected to eventuate from HRBU.
Removal of threatened fauna habitat.	Vegetation and bush rock removal will be undertaken in accordance with Guide 4: Clearing of vegetation and removal of bush rock of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA 2011).*	No threatened flora was recorded within the impact area during multiple field surveys. Two *Corymbia gummifera* (Red Bloodwood) trees were noted as having incisions characteristic of Yellow-bellied Gliders (listed as Vulnerable under BC Act and EPBC Act), indicating present feeding activity within the Proposal Area. One of these feed trees is required to be removed. *Corymbia gummifera* occur directly adjacent to the clearing footprint and are a diagnostic species of PCT 1250. The removal of one Yellow-bellied Glider feed tree is not considered to impose a significant impact on this species. Bush rock will be required to be removed in areas above the northwest cut. No evidence of vertebrate fauna occupation was present in and around bush rock to be removed. Such evidence includes scats, tracks and nests. Reptile scats and a nest (likely Rockwarbler – *Origma solitaria*) were recorded in less disturbed bush rock beyond the impact area. Suitable Broad-headed Snake habitat is present above the northwest cut and in areas directly adjacent. The original AoS for this species suitably

Initial impacts outlined in REF	Revised impacts that are considered to eventuate	Assessment of impact
		considers the presence of suitable habitat, as well as numerous records surrounding the proposal area.
The proposal would require removal of up to 3.12ha of vegetation, including up to 3.08ha of native vegetation.	Final impact footprints confirm that no more than 1.2ha of vegetation will be removed. This includes the removal of native vegetation, as well as the removal of invasive species including *Lantana camara* (Lantana), *Senna pendula* (Cassia) and *Salix* sp. (Willow).	The REF Main Report assumed broad vegetation clearance within the Proposal Area. Vegetation is only required to be removed within the impact footprint, with adjacent native vegetation and other habitat features to be retained. **Figure 1** shows the final area of vegetation clearance associated with HBRU. The clearing footprint is conservative with numerous HBTs to be retained (**Table 2**). A detailed breakdown of vegetation clearance is provided in **Table 3.** Key points surrounding changes to vegetation impacts are summarised below: • New design alignment requires the additional clearance of approximately 1800m^2 of native vegetation above the northwest cut. This vegetation is characteristic of PCT 1250 (Coastal Sandstone Gully Forest) and is not associated with a Threatened Ecological Community. Native vegetation above the northwest cut was cleared prior to construction of the original Heathcote Road Bridge. As a result, native vegetation within the clearing footprint is considered to provide lower habitat potential than native vegetation directly adjacent to the impact area (Heathcote National Park and Holsworthy Military Reserve). • New design alignment removes the need for a retaining wall on the northeast extent of the project (reduced clearing of 533m^2). • New temporary works design has reduced the need for clearing downstream of the existing bridge, thereby

Initial impacts outlined in REF	Revised impacts that are considered to eventuate	Assessment of impact
		retaining PCT 781 (Coastal Freshwater Wetland) vegetation, which can be associated with an Endangered Ecological Community (reduced clearing of 200m^2). • New design alignment has reduced the need for vegetation clearance above the southeast cut. Vegetation above the southeast cut is considered to be of at least comparable, if not better condition than vegetation above the northwest cut (reduced clearing of 780m^2).
Assessments of Significance (AoS) for threatened species considered likely to be impacted by the proposal were conducted in original BAR.	The AoS conducted in the BAR were reviewed alongside current vegetation clearance footprints and other impacts considered likely to eventuate.	All original AoS remain relevant under the final design alignment, subject to comments below: • The Koala AoS was updated to reflect the presence of *Eucalyptus punctata*, which is known to be a key feed tree species for local Koalas. One additional Assessment of Significance was conducted for Yellow-bellied Glider (*Petaurus australis*). Diagnostic incisions left as a result of feeding were recorded in *Corymbia gummifera* trees within the proposal area and in areas directly adjacent. This species is listed as Vulnerable under the BC Act. The AoS concluded that the proposal is not considered likely to impose a significant impact on a local viable population of this species (**Appendix A**). The south-eastern subspecies of Yellow-bellied Glider (*Petaurus australis australis*) is the locally occurring subspecies and is listed as Vulnerable under the EPBC Act. As such, a Significant Impact Criteria (SIC) assessment was conducted (**Appendix B**). No significant impact on a local, viable population is expected to eventuate. No AoS is required for Spotted-tailed Quoll. Few contemporary records exist

Initial impacts outlined in REF	Revised impacts that are considered to eventuate	Assessment of impact
		within 10km of the proposal area. No viable population is likely to exist within Heathcote National Park or areas of bushland surrounding the proposal area.
Initial Biodiversity Offset Calculations include purchase of Species Credits for: • *Cercartetus nanus* (Eastern Pygmy-possum) • *Chalinolobus dwyeri* (Large-eared Pied Bat) • *Heleioporus australiacus* (Giant Burrowing Frog) • *Pseudophryne australis* (Red-crowned Toadlet) • *Allocasuarina diminuta subsp. mimica – endangered population* • *Astrotricha crassifolia* (Thick-leaf Star-hair) • *Grevillea parviflora subsp. supplicans* • *Leucopogon exolasius* (Woronora Beard-heath) • *Hibbertia stricta subsp. furcatula* • *Melaleuca deanei* (Deane' s Paperbark)	Final design alignment requires less native vegetation clearance. No changes to offset obligations are required.	A revised Biodiversity Assessment Report would conclude less offsets would be required compared to the original impact footprint. Accordingly, the original offset calculations are sufficient to cover all impacts under the final design alignment.
PCT 781 which is associated with Sydney Freshwater Wetland EEC (0.06ha within Study Area).	Clearance of this vegetation is not required. **LE1420 HBRW Aquatic Survey Report** assessed potential impacts to aquatic vegetation. New design alignment has reduced the need for clearing downstream of the current bridge, thereby retaining all EEC vegetation. Though direct impact through clearing is avoided, potential indirect impacts remain such as from the scope of adjacent bridge repair/maintenance works and upstream works in waterway (such as spills or siltation).	Potential impacts to vegetation associated with PCT 781 were assessed as minor. This vegetation is sited directly adjacent to the HRBU impact area with no clearance required. It is noted that the condition and species composition of aquatic vegetation below Heathcote Road Bridge has changed since the initial biodiversity reporting was conducted. High weed incursion and significant alteration from frequent flooding was noted during field surveys in December 2021 through March 2022. Suitable mitigation measures such as a sediment and erosion control will be implemented to reduce risks of indirect impacts.

Initial impacts outlined in REF	Revised impacts that are considered to eventuate	Assessment of impact
The clearance of 3.12ha of vegetation would result in up to 16 Habitat Bearing Trees being removed.	17 Habitat Bearing Trees and/or Yellow-bellied Glider feed trees were recorded within or directly adjacent to the impact area. Of these 17 trees, seven (7) are required to be removed from above the northwest cut, with two (2) required to be removed on the southwest abutment. All other HBTs and Yellow-bellied Glider feed trees are sited in areas suitable for retention. Some trees are located within a couple of metres of the impact area boundary. Any additional trees should be retained and any impact would be subject to separate assessment and approval. **Table 2** provides detail on each HBT and those at risk of direct impacts (removal) from either the construction footprint or final design. **Figure 3** shows the location of HBTs. Numerous *Eucalyptus punctata* are present within the clearing footprint. Previous clearing impacts associated with construction of the original Heathcote Road Bridge has resulted in few HBTs or suitably sized Koala feed trees being present within the clearing footprint. Surrounding vegetation contains many large feed trees and HBTs which will not be impacted by the proposal.	Best practice felling must be implemented. At a minimum, this includes pre-clearance survey and knocking of HBTs 24 hours prior to felling. All HBTs must be felled under the supervision of an onsite ecologist. No Koala scratch marks, or scats were noted around *Eucalyptus punctata* trees within the clearing footprint. Hollows must be retained once felled. Where practical, these hollows should be reinstated in a similar position and height in surrounding trees. Where hollows cannot be practically reinstated, they must be retained and placed beyond the impact area to provide habitat for terrestrial fauna.
Removal of scuppers within the bridge structure, which constitute known habitat for threatened microbats including Southern Myotis (*Mytois macropus*) which has been recorded roosting in scuppers.	Under the current layout, the pre-existing Heathcote Road Bridge will not be removed. The conversion of the existing bridge to a single lane bridge includes resurfacing and changing the cross-fall to direct all drainage flow to one side. This means that scuppers along one side of the bridge will be permanently blocked. It is proposed to cap these scuppers (rather than fill with grout) so that they can continue to function as potential habitat. Some indirect impacts, including noise and vibration disturbance, will be imposed on roosting bats during construction. Suitable roosting features will remain post-construction, however may be subject to some disturbance during the construction phase.	**LE1420 Heathcote Road Bridge Upgrade Microbat Management Plan** (in development) details impacts and mitigation measures related to microbats. The Microbat Management Plan considers seasonal requirements, with relevant mitigation measures outlined. These can be summarised as: Impacts • Temporary loss of access to roost sites, including scuppers in the current bridge. • Potential abandonment of roost sites. • Injury or death if potential roost sites are not thoroughly inspected prior to removal or other works taking place.

Initial impacts outlined in REF	Revised impacts that are considered to eventuate	Assessment of impact
		• Disturbance from increased noise and vibration association with construction. Mitigation measures • Installation of microbat boxes to compensate for the loss of potentially suitable habitat features which are required to be cleared. • Pre-clearance survey of any potential roosting site, both natural and artificial (including bridge scuppers). • No demolition of habitat features to occur while microbats are present. • Where microbats have been recorded as roosting, exclusion devices would be installed once roosting bats have exited for the night.
Disturbance of aquatic habitat through impacts on water quality such as sedimentation, erosion and localised contamination. Sources of sedimentation and/or contamination include the installation of a temporary river crossing and stockpiling of mulch.	Potential impacts on aquatic ecology were addressed in **LE1420 HBRW Aquatic Survey Report**. The design of the temporary river crossing ensures that there is no disruption to water flow.	Potential impacts on aquatic ecology were addressed in **LE1420 HBRW Aquatic Survey Report**. Existing AoS for Macquarie Perch, Australian Grayling and Sydney Hawk Dragonfly remain relevant. Final impact areas are expected to be less than originally accounted for and design of the temporary river crossing will continue to allow for water flow and fish passage, and no new key threatening processes to be introduced. Appropriate sediment control barriers and other measures to reduce sediment flow and run off are to be incorporated throughout construction. Furthermore, it has been concluded that minor increases in sediment flow or minor alterations to water flow are potentially negligible when compared to the impacts of water releases from the upstream Woronora Dam. Increased volumes of water are currently being released due to maximum dam capacity. Flooding and temporary submersion of riparian vegetation is expected, with an increased amount of sediment likely to be deposited downstream.

Initial impacts outlined in REF	Revised impacts that are considered to eventuate	Assessment of impact
Fauna injury or death during construction caused by construction equipment and vehicles, as well as the removal of vegetation and other habitat features within the Study Area.	The revised impact footprint still imposes a risk to wildlife residing in vegetation or other habitat features within areas to be cleared. A procedure should be developed which provides advice on what to do should wildlife, particularly injured wildlife, be located during construction. The procedure can be informed by Transport Guidelines for protecting and managing biodiversity on projects, which the CEMP is required to comply with.	At a minimum, an ecologist should be contacted if injured wildlife is located. Contact details for the nearest vet or WIRES representative should be made available to personnel on site. Transport *Guidelines for protecting and managing biodiversity on projects* provides guidance on these requirements.
Impacts associated with noise and vibration and altered light conditions during night work from construction activities.	Noise, vibration and altered light conditions will remain. Wildlife in areas directly adjacent to the Study Area are likely to relocate to other areas within Heathcote National Park or Holsworthy Military Reserve. Where feasible and reasonable, attempts must be made to limit excess artificial light entering areas beyond the construction zone.	No adverse effects from increased noise and light are expected. Minor disturbances are expected, however can be mitigated by ensuring excess light does not enter surrounding bushland.
Invasion and spread of pests, weeds, pathogens and disease from construction equipment, vehicles and personnel.	Construction equipment and vehicles still pose a risk for the introduction of weed propagules, seeds and fungal spores that do not currently occur within the Study Area. The introduction or spread of pests is not considered likely.	Construction vehicles and equipment should be thoroughly inspected by a qualified weed hygienist to reduce the risk of site contamination. A Weed Management Plan should be developed and adhered to for weed removal beyond the scope of previous reports. The introduction and inadvertent spread of *Phytothphora* remains a risk. Excess mud should be removed from vehicles and equipment prior to construction.
Changes to hydrology and effects on fish passage from the temporary waterway crossing.	Impacts from the installation of a temporary crossing were discussed in **LE1420 HBRW Aquatic Survey Report**.	The temporary river crossing has been designed in such a way that there will minimal disruption to waterflow and no impact to fish passage. Impacts to water flow and fish passage were assessed as minor.
Operation of the proposal has the potential to result in direct impacts on biodiversity along Heathcote Road leading to fauna injury or death. Two Koala roadkill records highlight the potential risk to this species.	Risks to Koalas and other fauna will remain, however can be mitigated. **LE1420 HRBW Koala Report** provides further detail on Koala movement corridors and potential mitigation measures including: • Installation of exclusion fencing to prevent wildlife from accessing Heathcote Road • Enhancement of wildlife corridors by installing Koala furniture on both sides of the Woronora River,	Proposed fauna connectivity features will assist in reducing the risk of fauna entering the road corridor, as well as encouraging movement beneath the bridge.

Initial impacts outlined in REF	Revised impacts that are considered to eventuate	Assessment of impact
	ensuring that a dry route is available at all times.	
An access track to provide access to areas below Heathcote Road Bridge will be widened to 6m, utilising a historic access route.	Under the current HRBU layout, a modified access track will be required. This includes a 6m extension of impacts over the top of the northwest cut. All impacts will be contained within the REF boundary and are included in the impact footprint that is outlined in **Figure 1**.	Previous field surveys assessed all vegetation and habitat features within the REF boundary, with a targeted survey for *Hibbertia woronorana* conducted within the northwest section of the impact area. As all impacts are contained within the REF boundary, no significant changes to biodiversity impacts are considered to eventuate under the current HBRU layout.

Table 2: HBTs within the impact area (bold denotes removal required)

HBT Number	Habitat Feature(s)	Tree Fate
1	Fissured Trunk	Retained
2	Stag – medium hollow and multiple fissures	Retained
3	**One medium hollow**	**Removed**
4	Active Yellow-bellied Glider feed tree	Retained
5	Fissured Trunk	Retained
6	Fissured Trunk	Retained
7	**Active Yellow-bellied Glider feed tree**	**Removed**
8	**Fissured Trunk**	**Removed**
9	**Two medium hollows**	**Removed**
10	**Fissured Branch**	**Removed**
11	**One small hollow**	**Removed**
12	**Two medium hollows**	**Removed**
13	Two small hollows	Retained
14	1 large hollow	Retained
15	Three small and one medium hollow	Retained
16	**Two medium hollows**	**Removed**
17	**One large hollow**	**Removed**

Table 3: Vegetation clearance within each vegetation type

PCT	Condition	Patch size	TEC Association	Extent in Proposal Area	Impact area outlined in REF	Maximum area to be impacted under current design layout
PCT 1292 – Water Gum-Coachwood Riparian Scrub Along Sandstone Streams, Sydney Basin (referred to as Coastal Sandstone Gully Forest)	Moderate	>100ha	No	2.36ha	0.50ha	0.22ha
PCT 1250 – Sydney Peppermint-Smooth-barked Apple-Red Bloodwood Shrubby Open Forest on Slopes of Moist Sandstone Gullies, Eastern Sydney Basin (referred to as Coastal Sandstone Riparian Scrub)	Moderate	>100ha	No	8.35ha	2.53ha	0.92ha
PCT 781 – Coastal Freshwater Lagoons of the Sydney Basin and South East Corner	Moderate	>5ha	Yes – Sydney Freshwater Wetland – listed as an Endangered Ecological Community under the BC Act.	0.06ha	0.05ha	0ha – the final design alignment avoids the need for clearance of PCT 781.
Exotic vegetation	N/A	N/A	N/A	0.04ha	0.04ha	0.04ha
Total Vegetation Impacted	-	-	-	**10.81ha**	**3.12ha**	**1.18ha**

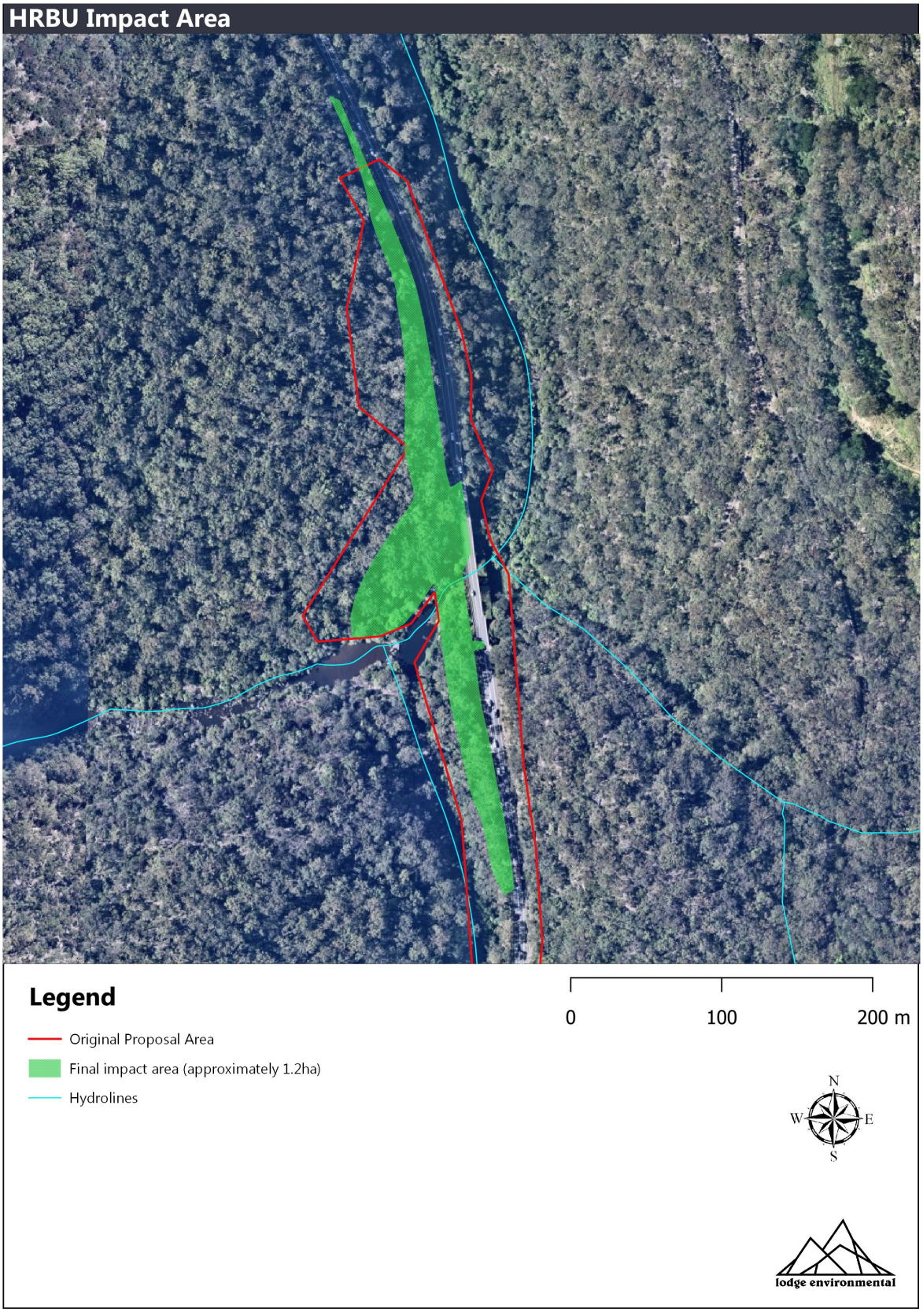

Figure 1: Heathcote Road Bridge Upgrade impact area

Figure 2: *Hibbertia fasciculata* location in relation to initial design layout

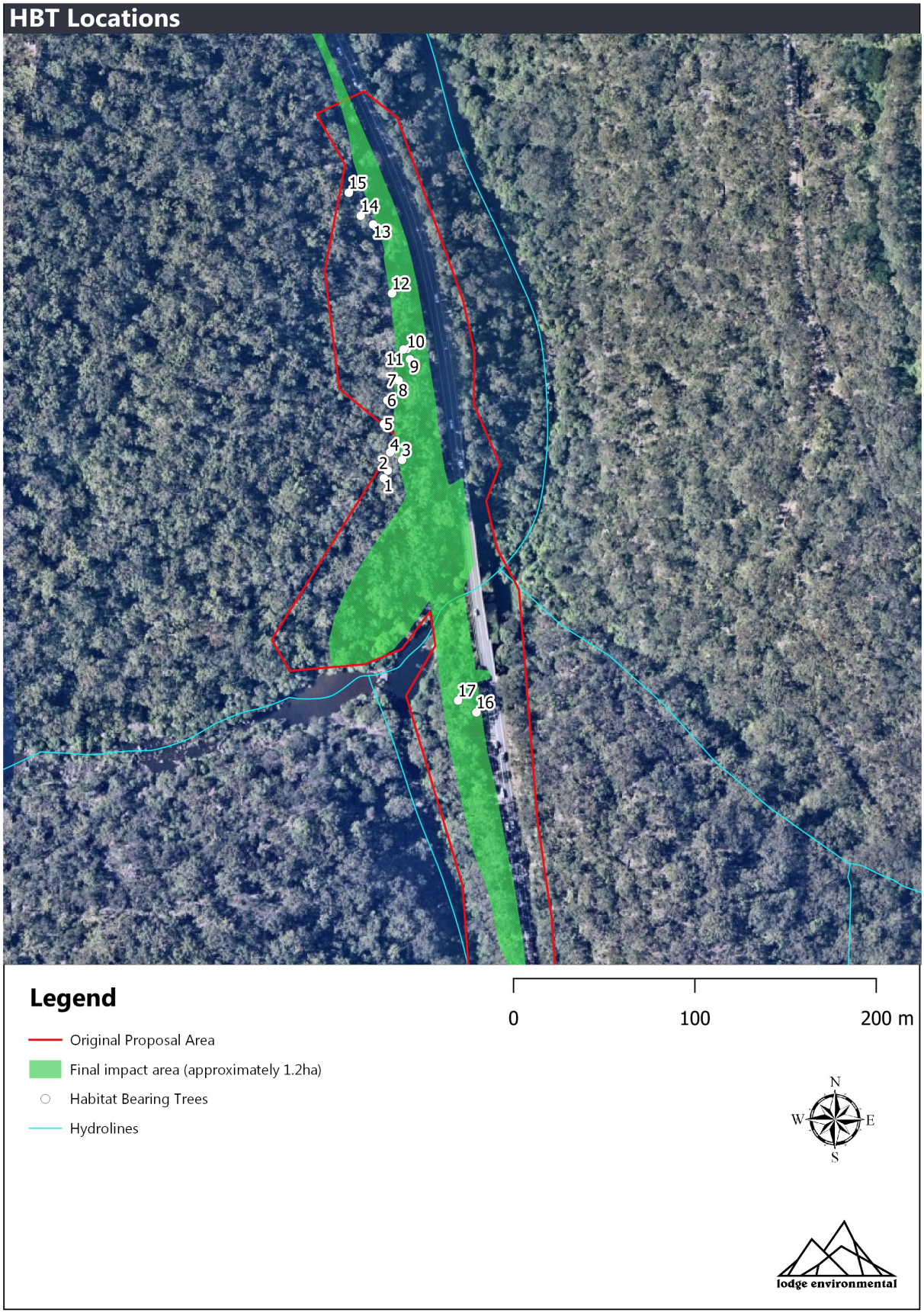

Figure 3: HBT locations

Conclusion

Biodiversity impacts raised in the REF have been weighed against the current Heathcote Road Bridge Upgrade layout and impact footprint. Field surveys and subsequent reports prepared by Lodge Environmental were referenced when assessing the likely impacts on biodiversity.

Vegetation clearance is lower under the final design alignment than was originally considered in the REF. No more than 1.2ha of native vegetation is to be impacted. Vegetation above the southeast cut is no longer impacted, however an extended area of clearance is required above the northwest cut. Both areas of vegetation are in a similar condition and are characteristic of PCT 1250, which is not associated with a Threatened Ecological Community. The final design alignment avoids downstream clearance of PCT 781 which can be associated with an Endangered Ecological Community.

Seventeen HBTs are present within the Proposal Area. Nine of these trees are located within the final impact area and are required to be removed. Where practical, felled hollows should be reinstated at a similar height and in a similar position in surrounding trees. Hollows that cannot be practically reinstated must be retained and positioned beyond the impact area, where they will continue to provide habitat for terrestrial fauna.

Previously conducted Assessments of Significance (AoS) were reviewed with the final design alignment considered. Outcomes of the original AoS are considered to remain applicable, with no significant impacts reported. Furthermore, vegetation clearance under the current design alignment is considerably lower than originally calculated.

One additional Assessment of Significance and an assessment of Significant Impact Criteria were conducted for Yellow-bellied Glider (*Petaurus australis*). The AoS and SIC concluded that no significant impact is likely to eventuate due to vegetation clearance required for the proposal.

Hibbertia woronorana is known to occur less than 50m west of the Proposal Area in Heathcote National Park. Targeted surveys did not record this species within the impact area and no suitable habitat is considered present within the impact area.

Eucalyptus punctata is recognised as being a key feed species for the local Koala population. No Koala scratch marks or scats were noted on *E. punctata* trees within the impact area. Due to difficulty in accessing vegetation above the northwest cut, it is considered unlikely that Koalas would utilise this area for feeding. Suitable feeding areas are present beyond the impact area. The Woronora River, including areas below the Heathcote Road Bridge are a known movement corridor for Koalas.

The original Biodiversity Offset calculations considered a larger area of native vegetation clearance. Under the final design alignment, native vegetation clearance is reduced. As such, the original offset obligations are considered sufficient to cover native vegetation clearance associated with the Heathcote Road Bridge Upgrade.

Appendix A: Assessment of Significance

Yellow-bellied Glider (*Petaurus australis*) – Vulnerable (BC Act)

In NSW, Yellow-bellied Gliders occur in a variety of forests from the coastal fringe to the western slopes, living in social groups. They favour tall, mature eucalypt forest, however, are known to utilise forest edges for foraging. Within the Sydney Basin and along areas of the NSW south coast, *Corymbia gummifera* (Red Bloodwood) is a key feed tree for this species, with Yellow-bellied Gliders drinking the sap. Diagnostic incisions left in the upper branches of small (typically less than 30cm DBH) trees are a useful field sign for inferring the presence of Yellow-bellied Glider in the Sydney Basin. This species are known to use individual feed trees for up to 10 years.

Within the proposal area, evidence of recent Yellow-bellied Glider feeding was noted in two *Corymbia gummifera* trees. One feed tree is required to be removed. Evidence of feeding was also noted adjacent to the proposal area, suggesting a local, active population. Yellow-bellied Gliders roost in large tree hollows, usually with an entrance diameter of at least 30cm. No suitable hollows were recorded within the impact area. The proposal is to remove no more than 1.2ha of native vegetation, with a single active feed tree to be removed.

a. in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The removal of one feed tree is not considered likely to affect the life cycle of this species such that a local, viable population will be placed at risk of extinction. Proximity of the proposal area to Heathcote National Park and Holsworthy Military Reserve ensures that surrounding vegetation will not be impacted in the future.

No other direct or indirect impacts are expected to be imposed on this species. The relative impact of the proposal is expected to be negligible.

b. in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable – not an ecological community.

c. In relation to the habitat of a threatened species or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposal will require the removal of no more than 1.2ha of native vegetation. Of the area to be cleared, one active feed tree is to be removed. Multiple other active feed trees were recorded directly adjacent to the proposal area. The extent of suitable habitat that is to be impacted is considered minimal, with large areas of habitat in Heathcote National Park and Holsworthy Military Reserve being retained.

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

Vegetation that is to be removed for the proposal has a history of disturbance and represents edge habitat. As such, no further fragmentation will occur as all vegetation removal is parallel to a pre-existing road.

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality

No more than 1.2ha of native vegetation is to be impacted. This vegetation is considered to provide marginal habitat for Yellow-bellied Glider, due to the absence of suitable breeding hollows. One feed tree is to be removed, however numerous other feed trees will be retained directly adjacent to the impact area. Extensive areas of suitable habitat exist in Holsworthy Military Reserve and Heathcote National Park.

d. Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding value (either directly or indirectly)

There are no areas of outstanding biodiversity value in the Study Area.

e. Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatened process.

There is one key threatening process, as listed in Schedule 4 of the BC Act, of relevance to the proposed vegetation clearance:

- Clearing of native vegetation (as defined and described in the final determination of the Scientific Committee to list the key threatening process)

1.2ha of native vegetation is to be cleared for the proposal. This vegetation is considered to provide marginal habitat, with a single feed tree to be removed. The proposal area is bordered by Heathcote National Park and Holsworthy Military Reserve, with limited future land clearing possible. As such, the proposal is not considered likely to increase the impact of vegetation clearance.

Conclusion

The proposal will impact 1.2ha of native vegetation in total. One active feed tree will be removed, with numerous other active feed trees to be retained in native vegetation directly adjacent to the proposal area. No suitably sized breeding hollows are to be removed by the proposal. With the above factors considered, it is unlikely that any direct or indirect impact associated with the proposal will put a local viable population at risk of extinction.

In summary:

- 1.2ha of native vegetation clearance in total.
- One active feed tree (*Corymbia gummifera*) to be removed; numerous feed trees retained directly adjacent.
- No breeding habitat to be impacted.
- This species is highly mobile and will not be significantly impacted by the proposal.
- Extensive areas of suitable habitat exist in Heathcote National Park and Holsworthy Military Reserve, which border the proposal area.

A Species Impact Statement or BDAR is not recommended with respect to Yellow-bellied Glider.

Koala (*Phascolarctos cinereus*) – Vulnerable, BC Act

A significant population of Koala is known to occur in Heathcote National Park and bushland to the east of Heathcote Road. Koalas move between these two areas via the riparian corridor below Heathcote Road Bridge. Accessibility features will be retained and enhanced, ensuring continued safe passage for Koalas. A key feed tree species (*Eucalyptus punctata*) is present within the impact area, however, due to the inaccessibility of these trees, they are not considered to be utilised by Koalas.

a. in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Numerous *Eucalyptus punctata* trees are to be removed. This species is considered the key feed tree species for the local Koala population. All *Eucalyptus punctata* trees to be removed are small (less than 15cm DBH) and are not considered to be actively utilised by Koalas due to their relatively inaccessible position within the proposal area. Koalas are known to utilise areas of native vegetation in Heathcote National Park for feeding. As such, the removal of immature *Eucalyptus punctata* trees within the proposal area is not considered to have an adverse effect on the life cycle of this species.

b. in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable – not an ecological community.

c. In relation to the habitat of a threatened species or ecological community:

I. The extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposal will require the removal of 1.2ha of native vegetation. Of the area to be cleared, no signs of recent Koala activity (scats and scratch marks) were noted. The extent of suitable habitat that is to be impacted is considered minimal, with large areas of habitat in Heathcote National Park and Holsworthy Military Reserve being retained; areas where Koalas are frequently recorded.

II. Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

Vegetation that is to be removed for the proposal has a history of disturbance and represents edge habitat. As such, no further fragmentation will occur as all vegetation removal is parallel to a pre-existing road. Connectivity features below Heathcote Road Bridge will be retained and enhanced, allowing for continued safe passage of Koalas.

III. The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality1.2ha of native vegetation is to be impacted. This vegetation is not considered to be currently utilised by Koalas, primarily due to difficulty in accessing the steep cliff-side areas. Extensive areas of suitable habitat are present beyond the proposal area and will not be impacted.

d. Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding value (either directly or indirectly)

There are no areas of outstanding biodiversity value in the Study Area.

e. Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatened process.

There is one key threatening process, as listed in Schedule 4 of the BC Act, of relevance to the proposed vegetation clearance:

- Clearing of native vegetation (as defined and described in the final determination of the Scientific Committee to list the key threatening process)

1.2ha of native vegetation is to be cleared for the proposal. This vegetation is not considered to be utilised by Koalas, due to inaccessible cliffs and other steep slopes. The proposal area is bordered by Heathcote National

Park and Holsworthy Military Reserve, with limited future land clearing possible. As such, the proposal is not considered likely to increase the impact of vegetation clearance.

Conclusion

The proposal will impact 1.2ha of native vegetation in total. One active feed tree will be removed, with numerous other active feed trees to be retained in native vegetation directly adjacent to the proposal area. No suitably sized breeding hollows are to be removed by the proposal. With the above factors considered, it is unlikely that any direct or indirect impact associated with the proposal will put a local viable population at risk of extinction.

In summary:

- 1.2ha of native vegetation clearance in total.
- *Eucalyptus punctata*, the key feed tree species for local Koalas, is present within the impact area.
- Feed trees are not accessible by Koalas due to surrounding cliffs. As such, the area to be impacted is not considered to be utilised by the local Koala population.
- Accessibility features below Heathcote Road will be retained, ensuring continued safe passage.
- Extensive areas of suitable habitat exist in Heathcote National Park and Holsworthy Military Reserve, which border the proposal area.

A Species Impact Statement or BDAR is not recommended with respect to Koala.

Appendix B: Significant Impact Criteria

Yellow-bellied Glider (south-eastern subspecies) (*Petaurus australis australis)* – Vulnerable, EPBC Act

In NSW, Yellow-bellied Gliders occur in a variety of forests from the coastal fringe to the western slopes, living in social groups. They favour tall, mature eucalypt forest, however, are known to utilise forest edges for foraging. Within the Sydney Basin and along areas of the NSW south coast, *Corymbia gummifera* (Red Bloodwood) is a key feed tree for this species, with Yellow-bellied Gliders drinking the sap. Diagnostic incisions left in the upper branches of small (typically less than 30cm DBH) trees are a useful field sign for inferring the presence of Yellow-bellied Glider in the Sydney Basin. This species are known to use individual feed trees for up to 10 years.

1.2ha of native vegetation is required to be removed, with a single active feed tree also required to be removed. Numerous active feed trees were recorded in areas adjacent to the proposal area. Hollows with an entrance diameter of at least 30cm are required for breeding and roosting. No suitably sized hollows are to be impacted by the proposal. Extensive areas of suitable habitat exist in Heathcote National Park and Holsworthy Military Reserve.

As such, native vegetation clearance associated with the proposal is considered unlikely to have a significant impact on the life cycle of this species such that a viable local population would be placed at risk of extinction.

Criterion a: lead to a long-term decrease in the size of an important population of a species

The proposal area does not support an important population of this species.

Criterion b: reduce the area of occupancy of an important population

The proposal area does not support an important population of this species.

Criterion c: fragment an existing important population into two or more populations

The proposal area does not support an important population of either species.

Criterion d: adversely affect habitat critical to the survival of a species

The proposal area is considered to provide marginal habitat to Yellow-bellied Glider due to the lack of suitable hollows. Foraging resources are present in the form of *Corymbia gummifera*, however, this species is abundant in areas directly adjacent to the proposal area. Numerous active feed trees were noted beyond the impact area. Therefore, the proposal will not adversely affect habitat critical to the survival of Yellow-bellied Glider.

Criterion e: disrupt the breeding cycle of an important population

The proposal area does not support an important population of either species. Furthermore, no suitably sized hollows are to be impacted by the proposal. A single feed tree will be removed. This impact is not considered likely to disrupt the breeding cycle of the species.

Criterion f: Adversely affect habitat critical to the survival of a species; modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The proposal area is considered to provide marginal habitat for Yellow-bellied Glider. A single feed tree will be removed, however numerous active feed trees will be retained in areas adjacent to the proposal area. Extensive areas of suitable habitat in Heathcote National Park and Holsworthy Military Reserve will continue to provide favourable conditions for this species. As such, the proposal will not impact habitat critical to the survival of this species.

Criterion g: Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

The project will not result in the establishment of an invasive species that is harmful to Yellow-bellied Glider.

Criterion h: Introduce disease that may cause the species to decline;

The project will not result in the introduction of a disease that is harmful to Yellow-bellied Glider.

Criterion i: Interfere substantially with the recovery of the species;

There is no recovery plan currently in place for Yellow-bellied Glider. As such, the proposal will not interfere with recovery of this species.

Conclusion

The proposed action is not considered to constitute a significant impact on Yellow-bellied Glider (south-eastern subspecies); therefore, a referral to the Commonwealth is not recommended.

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11 February 2022

Project: LE1420

Subject: Heathcote Road Bridge Widening Aquatic Survey Report

Dear Jacob,

Lodge Environmental Pty Ltd were engaged to undertake ecological services associated with the Heathcote Road Bridge Widening (HRBW). This report provides evidence that an aquatic survey was undertaken to assess potential impacts that may arise as the result of the construction of a temporary river crossing and rock platform. One field survey was conducted, with survey methodology and results included below. It is assumed that information contained in all briefing documents, Technical Notes and other information provided is accurate.

Aquatic Survey

An aquatic field survey was conducted on 8th February 2022 by Lodge Environmental Ecologists Max de Beer and Erin Leslie.

The aim of this survey was to identify any potential risks to water quality and flow, as well as long-term impacts to the Woronora River that may result from any construction associated with the HRBW, with a focus on the installation of a temporary river crossing and associated vegetation clearance. Design and construction methodology were reviewed and have been taken into consideration when determining potential aquatic impacts.

It is understood that two impact areas will be established, where riparian vegetation clearance will occur to allow for the passage of a piling rig and associated equipment.

For the purpose of this report, aquatic vegetation is defined as any vegetation that grows in water and relies on water as a primary support structure. Riparian vegetation is defined as any vegetation that grows along the banks of waterways or in areas of occasional submersion.

Methodology

Impact areas on both the northern and southern banks of the Woronora River, as well as the temporary water crossing footprint, were surveyed (**Figure 1**). Riparian and aquatic vegetation was recorded and identified in the field. Reference photographs were taken of the area. Water flow, density of aquatic vegetation and presence of any aquatic fauna was also noted.

Results

Aquatic vegetation was limited to a patch of invasive *Saggitaria platyphylla* (**Figure 2**) growing beyond any areas to be impacted. Riparian vegetation was notably different between the northern and southern banks of the

Woronora River. The northern bank is dominated by native flora (**Figure 3**), with minimal weed incursion, while vegetation on the southern bank was dominated by exotic flora (**Figure 4**).

Water flow and river depth appear to be variable, with upstream releases from the Woronora Dam a primary driver behind this variability. Evidence of recent flooding along the southern bank was evident in the form of deposited rubbish and disturbance to vegetation.

The northern bank appears to be a static system, with established trees and dense vegetation. The southern bank is a dynamic sand island prone to frequent submersion and is covered in dense shrubs and grasses, with no established trees.

A list of flora species recorded in both impact areas is provided in **Appendix A**.

No aquatic fauna was recorded during the field survey.

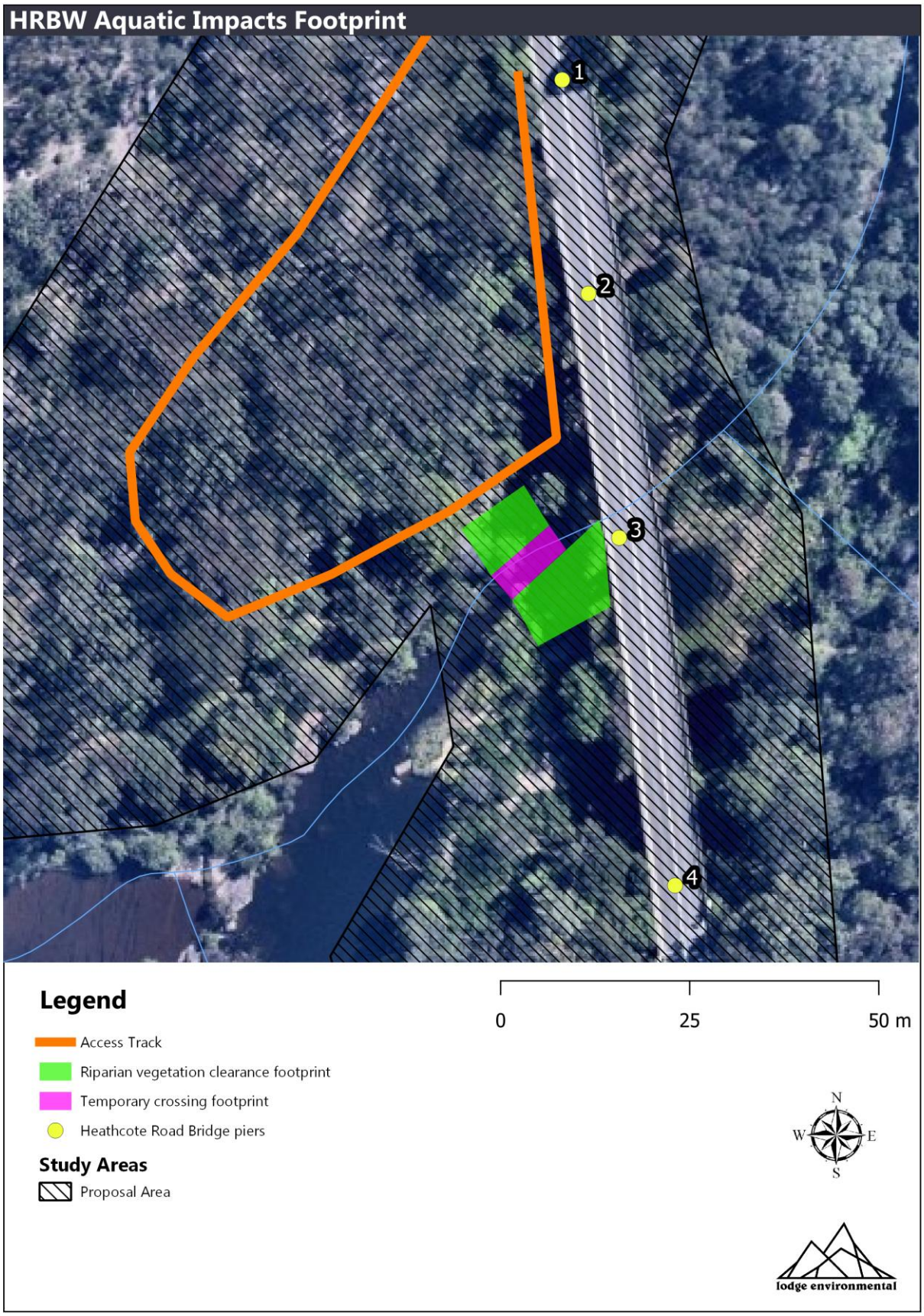

Figure 1: Aquatic impact areas

Figure 2: *Saggitaria platyphylla* growing adjacent to the southern bank

Figure 3: Native vegetation growing along the northern bank

Figure 4: High density exotic vegetation and minimal native vegetation was recorded along the southern bank

Figure 5: Approximate location of temporary river crossing

Summary

- Water flow and depth through the impact area is highly variable, in large part due to frequent releases of water from the upstream Woronora Dam. As such, any minor change to water flow that may arise through the installation of a temporary river crossing is considered a negligible impact when weighed against flow alterations from upstream water releases.
- The design and construction of the temporary river crossing will continue to allow for fish passage, with no disruption to be imposed on aquatic fauna.
- The presence of a downstream Endangered Ecological Community has been taken into consideration. No significant changes to sediment flow are expected through the installation of a temporary river crossing. Intermittent peaks in sediment flow are likely an established pattern, occurring whenever the southern bank is partially or completely submerged. No additional impacts to this EEC are expected to occur as a result of the installation of the temporary river crossing.
- Weed removal and disposal must be conducted in line with the Weed Management Plan provided in LE1420 Heathcote Road Bridge Widening Early Works Pre-clearance Report v1. Inappropriate removal and disposal of weeds and weed propagules could result in downstream contamination if any weed material is to enter the Woronora River.

Conclusion

The installation of a temporary river crossing is a necessary component of the Heathcote Road Bridge Widening. The design of the temporary crossing allows for normal water flow and will not alter fish passage along the Woronora River. Upstream water releases from the Woronora Dam set a precedent of variable water flow, resulting in intermittent peaks in sediment flow to areas downstream. A conservative approach was taken when assessing any potential aquatic impacts and it was determined that even minor changes to water flow or minor sediment flow would be considered negligible when weighed against flow alterations and associated sediment from upstream water releases.

All weed removal and disposal must be conducted in line with the Weed Management Plan provided for HRBW Early Works. This plan will ensure that weed material and propagules do not enter the Woronora River and contaminate downstream vegetation.

Should the reader have any further questions regarding the content of this report, please do not hesitate to contact the author for further information or assistance.

Yours sincerely,

Max de Beer

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Appendix A: Flora species lists

Table 1: Flora recorded along the northern bank of the Woronora River

Scientific Name	Common Name	Native	Exotic
Ageratina adenophora	Crofton Weed		X
Commelina cyanea	Scurvy Weed	X	
Dodonaea triquetra	Common Hop Bush	X	
Entolasia stricta	Wiry Panic	X	
Exocarpus cupressiformus	Cherry Ballart	X	
Ficus coronata	Sandpaper Fig	X	
Gleichenia dicarpa	Pouched Coral Fern	X	
Hakea salicifolia	Willow-leaved Hakea	X	
Juncus planifolius	Broad Rush	X	
Kunzea ambigua	-	X	
Lantana camara	Lantana		X
Lepidosperma laterale	Variable Sword-sedge	X	
Lepidosperma urophorum	-	X	
Leptospermum polyanthum	Slender Tea-tree	X	
Leptospermum polygalifolium	Lemon-scented Tea-tree	X	
Ligustrum sinense	Small-leaved Privet		X
Lomandra longifolia	Basket Grass	X	
Persoonia pinifolia	Pin-leaved Geebung	X	
Pittosporum undulatum	Sweet Pittosporum	X	
Rytidosperma sp.	Wallaby Grass	X	
Tristaniopsis laurina	Water Gum	X	
Westringia longifolia	Long-leaved Westringia	X	

Table 2: Flora recorded along the southern bank of the Woronora River

Scientific Name	Common Name	Native	Exotic
Ageratina adenophora	Crofton Weed		X
Cyperus sanguinolentus		X	
Ficus coronata	Sandpaper Fig	X	
Hakea salicifolia	Willow-leaved Hakea	X	
Hydrocotyle bonariensis	Large-leaved Pennywort		X
Juncus planifolius	Broad Rush	X	
Lantana camara	Lantana		X
Leptospermum polygalifolium	Lemon-scented Tea-tree	X	
Ligustrum sinense	Small-leaved Privet		X
Lomandra fluviatilis		X	
Lomandra longifolia	Basket Grass	X	
Omalnathus populifolius	Bleeding Heart	X	
Paspalum urvillei	Vasey Grass		X
Persicaria elatior	Tall Knotweed	X	
Pittosporum undulatum	Sweet Pittosporum	X	
Saggitaria platyphylla	Saggitaria		X
Salix sp.	Willow		X
Senna pendula	Cassia		X
Verbena bonariensis	Purple Top		X
Westringia longifolia	Long-leaved Westringia	X	

Appendix E

Technical Memorandum: Surface Water

Appendix E – Technical Memorandum: Surface Water

HEATHCOTE ROAD BRIDGE WIDENING

Doc ID: HRB-SMC-DR-01-RPT-0001[1] Revision No: 1 Published: 23/02/2022

ACKNOWLEDGMENT OF COUNTRY

The Alliance team acknowledges the Tharawal People as the Traditional Owners of the land we are working on, and pay our respect to their Elders past, present and emerging.

We recognise their deep connection to Country and value the contribution to caring for, and managing the land and water.

We are committed to pursuing genuine and lasting partnerships with Traditional Owners to understand their culture and connections to Country in the way we plan for and carry out the delivery of the Works.

Artwork by Luke Penrith, from Fulton Hogan's Reconciliation Action Plan.

Luke Penrith is a modern contemporary Aboriginal Artist living in Brungle NSW, Wiradjuri Country. His ancestry is connected through the Wiradjuri, Wotjobaluk, the Yuin and the Gumbaynggirr Nation.

Document control

This is an e-copy of the Plan and it interfaces with the other associated plans, which together describe the proposed overall project management system for the project.

The latest revision of this plan is available on the Alliance server. If any unsigned hard copies of this document are printed, they are valid only on the day of printing.

The revision number is included at the bottom of each page. When revisions occur, the entire document will be issued with the revision number updated accordingly for each owner of a controlled copy.

Attachments/Appendices to this plan are revised independently of this plan.

Revision History

REV	DATE	AUTHOR / REVISED BY	ENDORSED BY	BRIEF DESCRIPTION OF CHANGE
1	23/02/2021	Madeline Harty	Robert Hunter	Issued for review.
2	24/03/2022	Sam Leigh	David Hicks	Updated to included Erosion and Sediment control information

Appendix XX – Technical Memorandum: Surface Water

Contents

Tables

Figures

1. Introduction

1.1. Purpose

The purpose of this Technical Memorandum is to summarise the outcomes of flooding modelling and hydraulic assessment completed for the Heathcote Road bridge Upgrade detailed design. This Technical Memorandum will be used to inform the Addendum REF being prepared for the modified design.

1.2. Definitions and Acronyms

The following TfNSW, abbreviations and definitions are used in this plan.

► Table 1: TfNSW, abbreviations and definitions used in this plan (sample TfNSW)

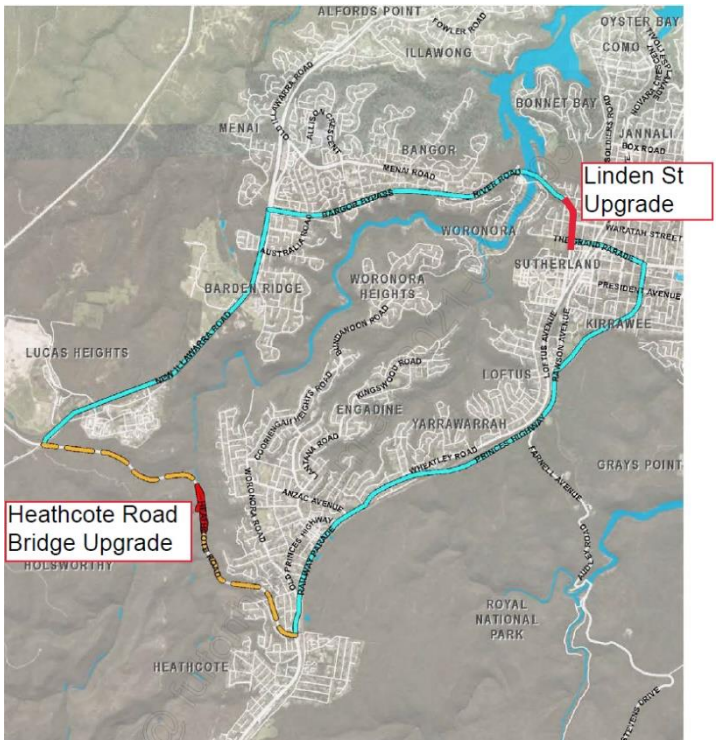
TERM	EXPLANATION
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ALT	Alliance Leadership Team
AMT	Alliance Management Team
AR&R	Australian Rainfall and Runoff
BoM	Bureau of Meteorology
CL	Continuing Loss
DEM	Digital Elevation Model
EIA	Effective Impervious Area
FHWA	Federal Highway Administration
GIS	Geographic Information System
GSDM	Generalised Short Duration Method
HEC	Hydraulic Engineering Circular
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HRB	Heathcote Road Bridge, the Project
IFD	Intensity-Frequency-Duration
IL	Initial Loss
LiDAR	Light Detection and Ranging
LSU	Linden Street upgrade

MCOS	Minimum Conditions of Satisfaction
NCHRP	National Cooperative Highway Research Program
NOP	Non-Owner Participant
NSW	New South Wales
PA	Pervious Area
PAA	Project Alliance Agreement
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RCP	Reinforced Concrete Pipe
REF	Review of Environmental Factors
RFI	Request for Information
SLS	Serviceability Limit State (1% AEP for this project)
SSC	Sutherland Shire Council
TfNSW	Transport for NSW, the Principal
ULS	Ultimate Limit State (0.05% AEP for this project)
WDD	Works Delivery Documents

2. Design Overview

2.1. Site Location

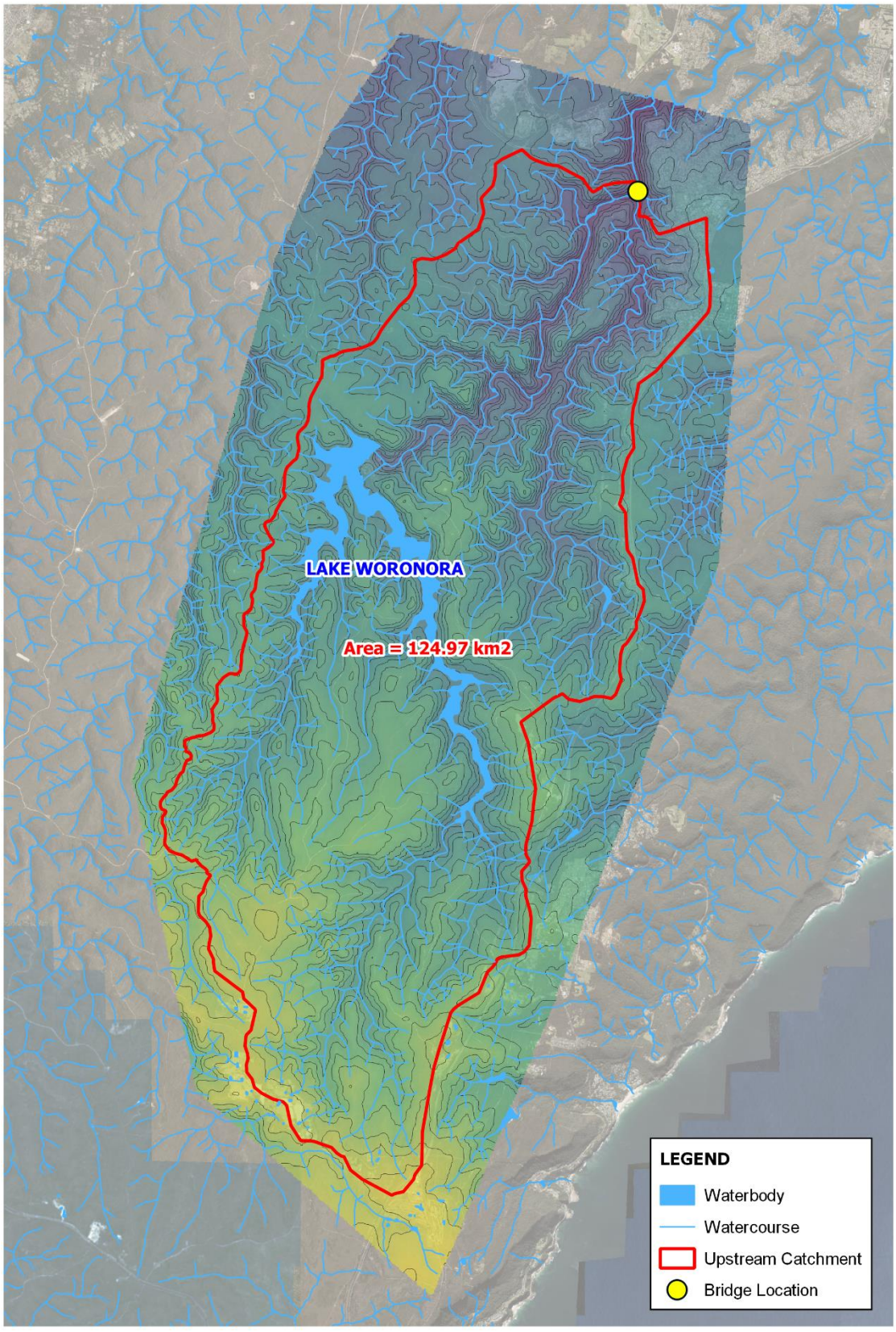
The bridge site is located within Heathcote and Royal National Park spanning over the Woronora River. The site is approximately 14 km from the coast and the ground elevations range from about RL 16 to RL 28. Refer Figure 1 for locality sketch.



- Figure 1: Locality sketch

2.2. Catchment Description

The catchment upstream of Heathcote Road bridge has an area of 124.97 km^2 and includes Department of Defence land, the Woronora Dam catchment owned by WaterNSW, and Heathcote National Park. The catchment comprises of extensive native bushland. Woronora Dam, completed in 1941 prior to construction of the existing Heathcote Road Bridge, provides flood attenuation and supplies drinking water to Sydney's southern suburbs and northern Illawarra region. A catchment plan has been provided in Figure 2.



- Figure 2: Catchment plan.

2.3. Design Changes Since Original REF

The changes from the original REF flooding and drainage design are summarised in Table 2 below.

► Table 2: Flooding and drainage design changes from original REF to addendum REF

DESIGN ELEMENT	ORIGINAL REF	ADDENDUM REF
Peak Flow Estimation Method for flood assessment	Regional Flood Frequency Estimation (RFFE) Refer Section 3.1.1.	Flood Frequency Analysis (FFA) Refer Section 3.1.2 for description of approach. Comparison of peak flows to original REF is provided in Section 3.1.3. The resultant change in flood levels and velocities is discussed in Section 3.2.7.
Bridge Piers in the Waterway	Widening of existing bridge. Retention of existing bridge substructure (i.e. no change to number of piers in the waterway from existing).	New bridge constructed alongside existing bridge. Additional four bridge piers in-line with and upstream of the existing bridge piers. The new piers have the same effective width as the existing piers, minimising the impact on the hydrologic regime. Details of the bridge substructure are provided in Section 2.4.1.1.
Temporary Working Platform Design	▪ Overtopping level = 18.64 m AHD = 50% AEP flood level in permanent design case. The temporary working platform would overtop in frequent rainfall events where the capacity of the low flow pipes is exceeded ▪ 4 x 750 mm diameter low flow pipes (the maximum number and size of pipes that can fit in the river channel, which is about four-metres wide and one metre deep, to allow for the flow of water through the structure) ▪ Maximum low flow pipe velocity = 4.34 m/s ▪ Inlet/outlet scour protection provided for low flow pipes ▪ Scour protection provided on the downstream batter and toe. ▪ Designed to collapse in large flood events.	▪ Overtopping level = 17.5 m AHD (lower than original REF). The lower overtopping level was adopted to minimise temporary works flood impacts and reduce the area of waterway obstructed by the temporary working platform. Consistent with the original REF, the temporary working platform would overtop in frequent rainfall events where the capacity of the low flow pipes is exceeded. ▪ 4 x 600 mm diameter low flow pipes or 3 x 900mm pipes. While these have smaller cross-sectional area than the original REF pipes, they still have adequate capacity to convey environmental low flows. ▪ Maximum low flow pipe velocity = 2.1 m/s (lower than original REF due to lower overtopping level of working platform driving less head through the pipes) ▪ Inlet/outlet scour protection provided for low flow pipes (consistent with original REF) ▪ Scour protection provided over the full face of the platform for the 5% AEP flood event (improvement over original REF and reduced likelihood of the working platform material washing into the waterway).

		Temporary working platform design is described in Section 2.5.1.
Flood Impacts in the waterway	Temporary works flood impact of 30 mm reported for the 1% AEP flood event. No permanent works flood impacts due to retention of existing bridge substructure.	Temporary works flood impact of 70 mm reported for the 1% AEP flood event. Permanent works flood impact of 30 mm reported for the 1% AEP flood event due to additional piers in the waterway. The flood impacts are confined to the Woronora River floodway and will not have a material impact on the hydrologic regime. Refer Section 2.5.2 for further details.
Bridge Drainage	Free-draining scuppers for widened bridge deck. No scour protection proposed in waterway below.	Free-draining scuppers for existing and new bridge decks. No scour protection proposed in waterway below (consistent with original REF). Refer Section 2.4.3 for description of bridge drainage strategy.
Road Drainage	▪ Retention of all but two existing cross-drainage structures ▪ Replacing two cross drainage structures with new culverts of the same diameter ▪ Pavement drainage incorporating pits, pipes, grated box drains at bridge approaches and headwall outlets on both sides of the road with outlet scour protection.	▪ Retention of all cross-drainage structures ▪ Pavement drainage confined to SO kerb along base of rock cutting. One pavement drainage headwall outlet adjacent to each bridge abutment with outlet scour protection ▪ Consistent with original REF intent to minimise footprint of drainage infrastructure and protect drainage outlets from scouring. Refer Section 2.4.2 for description of road drainage strategy.
Bridge Scour Protection	Proposed at bridge abutments.	Model changes since original REF (refer Section 2.4.1.4) have shown that the bridge abutments are not susceptible to scour in events up to the 1% AEP. As such, scour protection not proposed at bridge abutments. This has minimised the disturbance of the new construction bridge within the waterway compared to the original REF.
Water Quality	No water quality treatment measures incorporated into the design other than use of good WSUD practices.	Consistent with original REF. It is noted that there is an increase in hardstand area associated with the new bridge and its widened road approaches. However, as shown in Figure 2, this increase in hardstand area is insignificant in the context of the total catchment size draining to the bridge (124.97 km^2). Therefore, there would be no material

		impact to water quality compared to the original REF. Discussed in further detail in Section 2.4.4.
Spill Containment	No risk assessment for spill containment had been undertaken.	The risk of spills was deemed to be “Medium” based on traffic volume and distance to receiving water (refer Section 2.4.5 for risk assessment). Therefore, since the risk is not “High” or “Extreme”, spill containment does not need to be constructed (consistent with original REF). Complete separation of traffic lanes on each bridge afforded by the central median barrier and wider shoulders has reduced the spill risk compared to the widened bridge design documented in the original REF.
Erosion and Sediment Control	Refer Appendix F	Refer Appendix B of this document
Temporary Drainage	-	Will be updated and shown on progressive erosion and sediment control plans
Utility Relocations	Relocation of AARnet fibre optic required due to road widening works.	Relocation of AARnet no longer required. Improvement from the original REF.

The subsequent report sections describe the flooding and drainage design for the Addendum REF.

2.4. Operational Impacts

The modified design was assessed using a HEC-RAS flood model. The flood modelling outcomes are consistent with the original REF.

The project involves construction of a new bridge over the Woronora River alongside the existing bridge. The additional bridge piers to be constructed in the waterway will be aligned with the existing bridge piers in the direction of flow with the same effective width. As a result, the reduction in waterway area associated with the construction of the new bridge upstream of the existing bridge is negligible. This in turn shall result in negligible impacts to the Woronora River hydrologic regime once the new bridge is in operation.

Once the new bridge is in operation, the flood afflux upstream of the bridge (caused by energy losses of flow obstructed by the new bridge piers) is expected to be no more than 30 mm in the 1% AEP flood event. The upstream flood afflux will not increase flood risk to any private properties, pedestrians, infrastructure, or occupants of vehicles as it is confined to the Woronora River floodway.

The existing bridge piers have been in place for 80 years and the material around them is stable with no signs of scour. There are also no signs of scour protection at the existing bridge piers.

The scour analysis for the new bridge shows that live-bed conditions are present (meaning that any scour holes which form at the bridge piers during a flood event are refilled by upstream bedload (alluvial material) as the flood recedes). Therefore, it is not expected that there will be any long-term effects of the new bridge construction on scour in the waterway.

Drainage on the existing bridge would be slightly modified to change the pavement crossfall. Scuppers along the outside barrier would be permanently blocked due to the placement of a new barrier in front of the existing barrier,

however new free-draining scuppers are proposed to remedy this. The existing scuppers along the inside barrier will no longer be required, since the existing barrier will be removed and there will be a 50 mm gap between the two bridge decks to allow bridge deck runoff to freely flow through the 50 mm gap.

The reduced length of road widening works on the bridge approaches has also removed the need for extension and/or replacement of cross culvert drainage pipes and their corresponding scour protection works.

The modification requires additional longitudinal drainage works on the northern approach (western side). The drainage discharge points would be near the abutments, consistent with the original design.

2.4.1. Flooding

2.4.1.1. Bridge Characteristics

► Table 3: Existing and new bridge characteristics

BRIDGE CHARACTERISTIC	EXISTING BRIDGE	NEW BRIDGE
Relative Position	**Downstream**	**Upstream**
Effective obstructed waterway area below 1% AEP flood level (m^2)	**350.9**	**350.9**
Bridge Soffit Level (m AHD)	**28.24**	**27.218**
Pier Skew to Flow Direction	**0 degrees**	**0 degrees**
Bridge Pier Arrangement	**Twin octagonal reinforced concrete columns (approx. 1500 mm wide at the base, 1300 mm wide at the top)**	**Single 1540 mm wide octagonal reinforced concrete column**

2.4.1.2. Flows, Levels and Velocities

Table 4 documents the flood levels at the upstream face of the new bridge and average velocity results through the new bridge. The construction of the new bridge does not increase flows or velocities through the existing bridge.

► Table 4: Comparison of FFA design discharge to methods adopted in previous studies.

AEP (%)	DESIGN FLOW (M^3/S)[1]	FLOOD LEVEL AT UPSTREAM FACE OF NEW BRIDGE (M AHD)	AVERAGE FLOOD VELOCITY THROUGH NEW BRIDGE (M/S)
20	229.2	19.81	1.2
5	402.6	20.98	1.5
2	499.9	21.58	1.6
1	564.3	21.95	1.7
0.05	764	23.03	1.8

2.4.1.3. Upstream Afflux

The original REF did not report bridge afflux in the operational scenario since the existing bridge substructure was being retained. However, for the Addendum REF, the new bridge construction has placed additional piers in the waterway. This has marginally increased the energy losses for the structure and in turn has caused a small amount of afflux.

[1] Adopted for design

Upstream afflux in the operational scenario has been provided in Table 5. There are no private properties situated in the 1% AEP flood extent in the vicinity of the bridge that will experience adverse flood impacts during construction and operation.

► Table 5: Upstream afflux – operational scenario.

DESIGN FLOOD EVENT AEP (%)	PERMANENT WORKS SCENARIO
	Upstream Afflux (mm)
20	20
5	20
2	30
1	30

2.4.1.4. Permanent Scour Protection

Scour protection must be provided in all areas susceptible to scouring, including, as a minimum, at upstream and downstream ends of drainage structures.

Abutment scour protection will not be provided at either abutment.

The base of the northern abutment (Abutment B) and southern abutment (Abutment A) is above the 1% AEP flood level. Therefore, neither bridge abutment is susceptible to scour. Photographs of the base of the existing bridge abutment walls do not show any evidence of abutment scour in previous flood events.

It is noted that the FFA estimate is biased towards more frequent flows since the gauge is downstream of the dam. It is also noted that for rarer flood events such as the 1% AEP and 0.05% AEP, the storage and attenuation of the upstream dam would diminish. A sensitivity check was carried out using the RFFE 1% AEP concept design flow and the flood level was still found to be below the base RL of the abutments.

The existing bridge piers have been in place for 80 years and the material around them is stable with no signs of scour. There are also no signs of scour protection at the existing bridge piers.

The scour analysis for the new bridge shows that live-bed conditions are present (meaning that any scour holes which form at the bridge piers during a flood event are refilled by upstream bedload as the flood recedes). Live-bed conditions remove the need to perform maintenance to manually fill in the scour hole and reinstate displaced scour protection after major flood events. All four bridge piers are situated in the main channel and there is a large amount of alluvial material present. There is a high likelihood that any rip rap scour protection placed around the new bridge piers would easily get washed away in a large flood event.

Compared to the original REF, the reduction in scour protection required has minimised the disturbance within the waterway, improving environmental outcomes.

2.4.2. Road Drainage

The key drainage objective for the project is to minimise scope while maintaining or improving drainage outcomes compared to the existing case. This has been achieved by:

- Retaining existing cross-drainage structures. This eliminates the need for trenching across the road and minimising the total footprint of the works compared to the original REF, which proposed to replace two existing cross-drainage structures with new structures of the same diameter. In addition, since the existing culvert capacity will be maintained, scour protection shall not be required at the cross-drainage outlets, enabling retention of the heritage sandstone block work;
- Cleaning out the existing catch drain at the top of the rock cutting to capture surface water run-off. The presence of this extensive catch drain network along the crest of the rock cutting has been confirmed during site visits and the topographic survey. The catch drains terminate above each cross-drainage inlet and runoff gets directs down

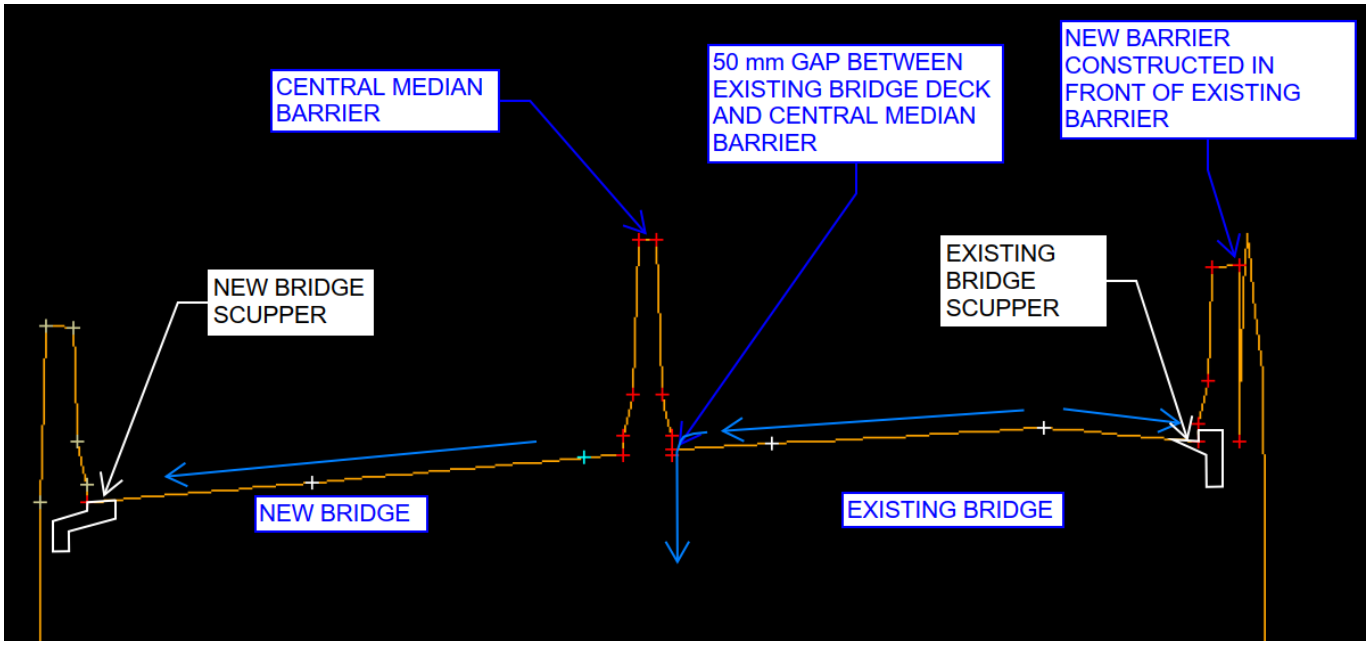
the rock cutting and into the cross-drainage inlets. The external catchment runoff from the catch drains was accounted for in the proposed drainage design; and

- Constructing new pavement drainage along the SO gutter at the base of the rock cutting to manage flow width in the traffic lane and collect pavement runoff before it flows onto the bridge deck, consistent with the original REF and concept design. Slotted drains have been adopted along the SO gutter to reduce the number of inlet pits required and reduce the volume of excavation required into rock compared to the original REF.

2.4.3. Bridge Drainage

The original REF design utilised free-draining scuppers however did not include an assessment to determine suitable dimensions and spacing for the scuppers. For the Addendum REF, this strategy has been developed in further detail.

Free-draining scuppers have been proposed to collect bridge deck runoff, consistent with the existing bridge drainage strategy (refer Figure 3).



- Figure 3: Existing and new bridge deck drainage strategy.

Since the longitudinal grade of the bridge is 0% on both the existing and new bridge, the edge of the outer bridge barrier where bridge deck runoff accumulates will also have a flat longitudinal grade. A scupper spacing of 4 m shall be proposed on both bridges to improve drainage outcomes for the bridge. Due to the wide shoulder on the new bridge, this bridge drainage strategy would allow water to pond up to a high enough depth within the shoulder to still get pushed through the scuppers. However, the flat grade along the base the barrier would lead to the water ponding against the barrier having a very low velocity. Sediments suspended in the bridge deck runoff would likely build up against the barrier over time, requiring regular pressure cleaning.

This drainage strategy is consistent with that on the existing bridge. The build-up of sediment at the drainage slots on the existing bridge have been confirmed during site inspections.

- Scupper spacing (centre to centre) = 4 m
- Scupper dimensions = 200 mm wide x 200 mm long
- Flow width achieved = 0.7 m (up to 3.65 m is permitted)
- Downpipe stub = 100 mm diameter

37 scuppers in total have been provided to drain the bridge surface runoff on each bridge. The 4 m scupper spacing is considered sufficient to also capture the small amount of catchment runoff entering the bridge deck from the approaches.

2.4.4. Stormwater Quality

The Alliance have proposed an operational stormwater quality strategy consistent with the original REF, which seeks to minimise stormwater quality impacts by providing scour protection at pipe outlets in the form of either rock riprap (in flatter areas) or rock-lined mattress chutes (where pipes outlet onto steep embankments) to limit potential scouring and erosion and dissipate energy. Rock protection would blend in well with the surrounding environment, satisfying urban design objectives.

2.4.5. Spill Containment

The original REF did not make an allowance for spill containment; however, it highlighted the need for a spill-containment risk assessment to be carried out.

For the Addendum REF, the risk assessment for each catchment included:

- The characteristics of the catchment such as traffic volume and catchment area; and
- The relative consequences of a spill.

To assess the relative consequences of a spill, the following factors were considered:

- The proximity of discharge to natural waterways/ public areas/ properties and the time available to respond; and
- The sensitivity of the receiving environment (i.e. proximity to a natural waterway or habitat downstream).

The general framework for assigning spill risk is presented in Table 6 below.

► Table 6: Spill Risk Assessment Matrix

			CONSEQUENCE (Discharge Proximity to a Waterway)			
LIKELIHOOD of spill	**CRITERIA***	**RATING**	**MINOR** (Remote, 1km+)	**MODERATE** [Intermediate, (200m-1km)]	**MAJOR** (<200m)	**EXTREME** (Discharging into an environmentally sensitive habitat/ waterway)
	• Traffic Volume (AADT): 60,000+	**Extreme**				
	• Traffic Volume (AADT): 30,000-60,000 • Adjacent to a significant car park, industrial/ commercial area • Catchment >2ha	**High**				

	• Traffic Volume (AADT): 5,000- 30,000 • Adjacent to a public area • Catchment >1ha & ≤2ha • Intersection/ Lights	**Med**				
	• Traffic Volume (AADT): 1,000- 5,000 Catchment ≤1ha	**Low**				

Legend

E	Extreme
H	High
M	Medium
L	Low

The following mitigations are required for each risk rating:

- Road catchments associated with 'High' to 'Extreme' risk ratings would require dedicated spill capture;
- Road catchments associated with 'Low' risk ratings are less critical and where practical may incorporate spill capture aids such as extended flow paths or valves allowing spill containment in the longitudinal pipe network; and
- Road catchments associated with a 'Medium' risk rating will be assessed on a case-by-case basis to determine the most appropriate and feasible type of treatment.

For this project:

- AADT = 21,196 and;
- Waterway < 200 m away.

The spill containment risk has been determined as "medium" for this project. It is noted that:

- The existing drainage infrastructure does not contain provision for spill containment, and;
- Free-draining scuppers are permitted on the bridge. If spill containment were to be provided for pollutants on the bridge, downpipes would be required on the bridge scuppers to transport the runoff into a bunded swale or similar to capture the pollutants. This is impractical and would involve constructing a bunded swale in the river below with standing water present.

As such, no provision for spill capture has been provided, consistent with the original REF. Spill risk has been reduced in the Addendum REF design compared to the original REF by providing median separation between both carriageways on the bridge. If a spill occurs on one carriageway, it will not affect the other.

2.5. Construction Impacts

The modified design will require construction of additional four bridge piers on the upstream side of the existing bridge. The piers will be aligned with the skew of the existing bridge piers. Scour risk modelling demonstrated that the piers would not require scour protection therefore minimising the disturbance area within the waterway for new pier construction. Sleeved piling method, is proposed for pier construction to contain disturbance impacts within the waterway.

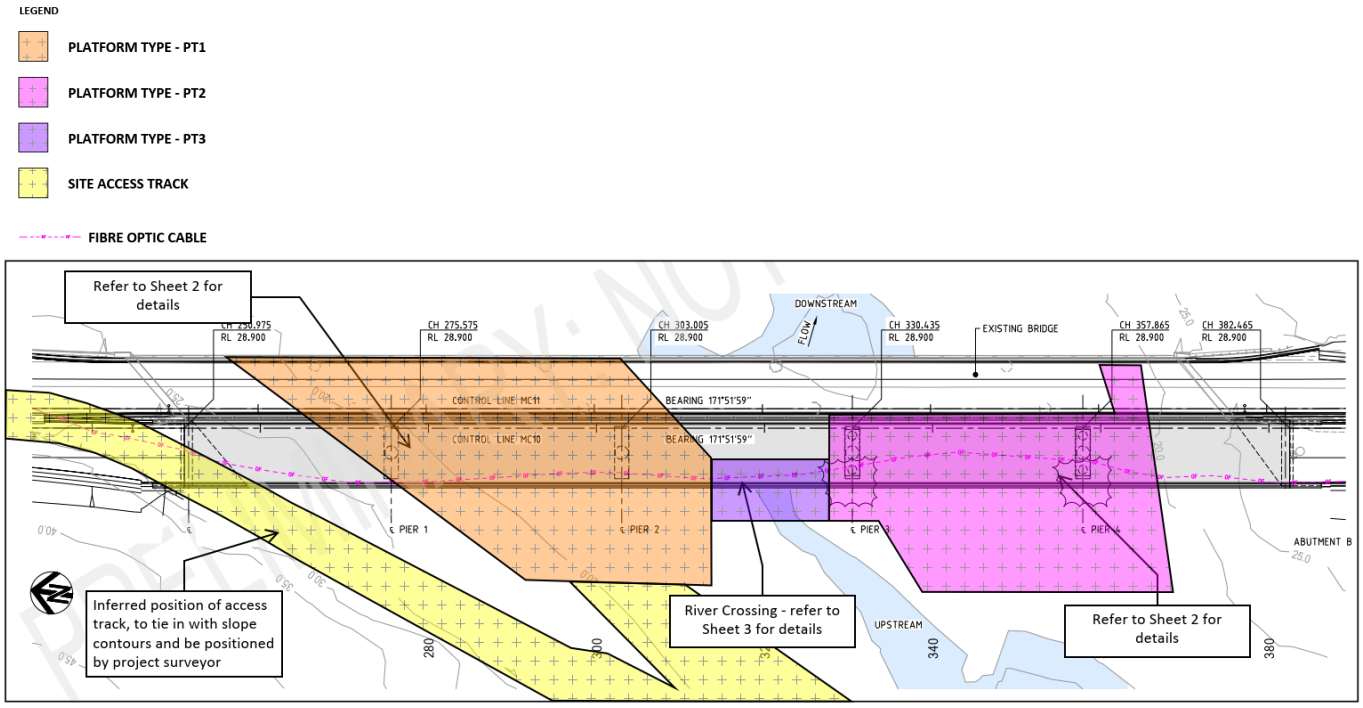
The temporary working platform is still required, consistent with the original REF. The bridge construction will require creation of a piling platform area consistent with the temporary working platform that would otherwise have been required in the original design. Fisheries were consulted in the development of the working platform design. A concise summary of the changes in the temporary working platform design from the original to the Addendum REF and the associated environmental impacts is provided in Table 2.

As per the original design, emergency preparedness plans would be required to de-mobilise construction setups ahead of risk rainfall events or flow releases from Woronora Dam.

2.5.1. Temporary Working Platform Design

For the Addendum REF, a temporary working platform shall be placed across the waterway upstream of the bridge to enable piling.

A plan of the temporary working platform is shown below in Figure 4. The overtopping level of the temporary working platform was reduced as much as practicable to reduce temporary impacts to the flow regime (for upstream flood levels and inundation times).



- Figure 4: Temporary rock platform sketch

The flooding inputs to the temporary working platform provided to the geotechnical team to date have been provided below.

2.5.1.1. Overtopping Level of Working Platform

The minimum height of each section of the temporary working platform above natural surface is as follows:

- PT1: 300 mm
- PT2: 850 mm
- PT3: 1750 mm

This equates to an overtopping level of 17.5 m AHD.

Since the working platform will be overtopped over its full length in the 5% AEP flood event, protection from scour is required over the full surface of the working platform (including the top, side slopes and downstream toe). Details about the scour protection requirements for the working platform are given below in Table 7.

► Table 7: Scour protection details for temporary working platform.

5% AEP Flow Over Working Platform	406.9 m^3/s
5% AEP maximum velocity over working platform (critical case when initial overtopping occurs, irrespective of design AEP)	2.3 m/s
Minimum rock riprap D_{50}	225 mm (Austroads Part 5B Figure 2.22)
Minimum rock riprap thickness	450 mm (2 x D_{50})

A geotextile layer is required under the rock riprap on the surface of the working platform to prevent fines from the underlying fill being washed out through the rock voids.

At the downstream toe of the pad where overtopping flows will generate turbulence, the rock riprap must be extended 2 m beyond the toe on the downstream side of the temporary working platform and “keyed in”.

Table 8 presents the material properties for rock fill as specified in TfNSW QA Specification R44.

► Table 8: R44 rock fill material properties

PROPERTY	REQUIREMENT
Maximum particle dimension	300 mm
Percentage passing:	
100 mm AS sieve	0 – 20%
19.0 mm AS sieve	0 – 10%
1.18 mm AS sieve	0 –5%
Percentage of +100 mm fraction with $I_{S(50)}$ < 1 MPa (Annexure R44/A2.2)	10% (max)
Wet/Dry Strength Variation	35% (Annexure R44/A2.2)

2.5.1.2. Low Flow Pipes

Vinidix StormPro pipes or approved equivalent shall be provided under the working platform to convey low flows and facilitate fish passage, two pipe arrangements have been reviewed

- 4 x 600mm Vinidix StormPro pipes
- 3x900mm Vinidix StormPro pipes

The pipe arrangements have capacity to convey up to 3.3 m^3/s and 5.5m^3/s under the working platform. Accounting for partial sedimentation/debris blockage both piping arrangements would have adequate capacity to convey daily mean flows most days of the year (baseflow in Woronora River is typically less than 1 m^3/s).

Water NSW have been consulted on the flows in the Woronara River following the March 2022 floods. Advice from Water NSW is that increased environmental flows will occur for several days following a rainfall event from the Woronora Dam. Those flows in March for example were 200 mega litres a day which is 2.3m^3 per second. The original design for the temporary crossing pipes of 4 x 600mm pipes have a flow capacity of 3.3m^3.

A secondary option for temporary pipes was investigated by the project, the revised design of 3 x 900m allows for a maximum flow of 5.5m^3 per second or 475 mega litres per day.

Less than 3.6% of days in a 12-month period of record available for the Woronora River @ "The Needles" (North Engadine) stream gauge (213211) (1992 – current) experienced a daily mean flow greater than 3.3 m^3/s. This is not necessarily indicative of the frequency of overtopping events the working platform will experience during construction (as construction may coincide with a wetter or dryer period). However, it gives an indication of how frequently plant equipment may need to be moved to higher ground in a rainfall event.

The low flow pipes must be placed in standing water such that at least half of the pipe diameter is fully submerged at all times to facilitate fish passage. Pipes cannot be elevated above natural surface. NSW Fisheries consultation has been managed by the environment team so that approval can be obtained to construct the temporary piling pad in February 2022.

The inlet and outlet temporary scour protection requirements for the low flow pipes is outlined below in Table 9.

► Table 9: Inlet and outlet scour protection requirements for temporary low flow pipes.

Maximum pipe velocity (critical case prior to overtopping, irrespective of design AEP)	2.1 m/s
Minimum rock riprap D_{50}	350 mm
Minimum rock riprap thickness	700 mm (2 x D_{50})
Width of rock apron	7660 mm
Length of rock apron	4800 mm

A geotextile layer is required under the rock riprap to prevent fines from the underlying fill being washed out through the rock voids.

2.5.2. Upstream Afflux

Compared to the original REF, the afflux in the waterway during the construction stage has marginally increased. Whilst the overtopping level and obstruction area of the temporary working platform has reduced since original REF, wholesale changes to the peak flow estimation approach were also made since original REF (not related to the impact of the temporary working platform construction) which has led to a marginal increase in afflux.

As per the operational scenario, there are no private properties situated in the 1% AEP flood extent in the vicinity of the bridge that will experience adverse flood impacts during construction and operation. It is also noted that the temporary working platform shall only be in place for 6 months during construction.

► Table 10: Upstream afflux for construction flood impacts

DESIGN FLOOD EVENT AEP (%)	TEMPORARY WORKS SCENARIO

	Upstream Afflux (mm)
20	140
5	80
2	70
1	70

2.5.3. Repair and Maintenance Work on Existing Bridge

Repair and maintenance works on the existing bridge are still proposed and may require suspended scaffolding, consistent with the determined REF. Detailed design is investigating any potential contamination risks from these activities including:

- Testing to confirm any contamination risk from bridge wastewater (including cadmium/chromium risk or pH issues) such as from bridge washing and
- Assess feasibility of wastewater recapture methods
- Containment requirements for scaffolding (and any risk from flood events)

Extra safeguards will be applied

2.5.4. Erosion and Sediment Control

An assessment of erosion and sediment control risk has been updated and is included in in appendix B of this document.

The project will implement progressive erosion and sediment controls throughout construction. Planned controls will be shown on progressive erosion and sediment control plans. A suite of mitigation measures SW1,2,3,4,12 and14 are included in the REF, these mitigation measures are designed to reduce potential impacts during construction

- SW1: Soil Water Management Plan
- SW2: EWMS for high risk activities
- SW3: Erosion and Sediment Controls Plan
- SW4: Site Stabilisation Plan
- SW12: Mulch, tannin management
- SW14: Erosion and sediment control impacts

2.5.5. Temporary Drainage

Temporary drainage controls will be detailed on the site specific erosion and sediment control plans.

3. Design Methodology

3.1. Hydrologic Modelling Methodology

The hydrologic modelling methodology is based on Australian Rainfall and Runoff 2019 guidelines (AR&R 2019).

3.1.1. Peak Flow Estimation - Original REF

TfNSW conducted preliminary hydrologic and hydraulic modelling to inform the original REF. This flood investigation was provided to the Alliance to form the basis of any flood modelling undertaken during detailed design.

Peak flows through the bridge were estimated using Regional Flood Frequency Estimation (RFFE) for a range of flood frequencies between the 50% Annual Exceedance Probability (AEP) (1 in 2 year) event up to the 1% AEP (1 in 100 year) flood event. This assessment was based on an estimated catchment size of 124.97 km^2. Review of elevation data for the catchment has confirmed the catchment size estimate is reasonable.

The RFFE method is a regional approach which uses data from nearby gauged catchments of similar area and shape to give a high-level estimate of flows for a catchment of interest. However, AR&R 2019 Book 3 Chapter 3 states that:

- RFFE is only suitable for ungauged catchments that have little or no recorded streamflow data (not applicable for this catchment; and
- RFFE is not suitable for catchments containing dams and other artificial storage, such as Woronora Dam, due to significant attenuation effect on flood discharges.

As such, the RFFE method for peak flow estimation could not be relied upon for this catchment.

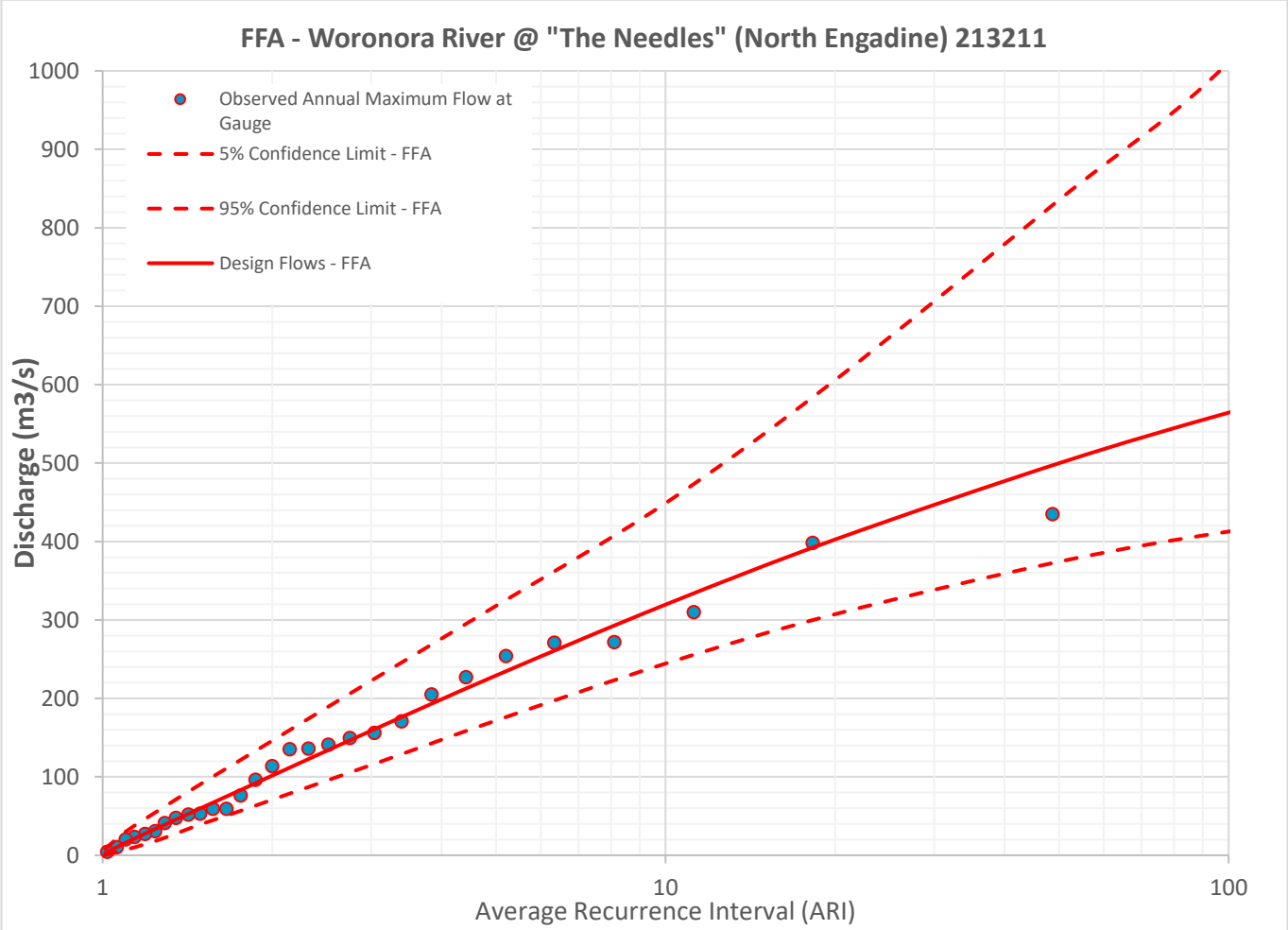
3.1.2. Peak Flow Estimation – Addendum REF

AR&R 2019 states that the peak flow estimation method should utilise observed flood data from the region of interest, if available.

The Alliance obtained 30 years' worth of stream gauge data from the Woronora River @ "The Needles" (North Engadine) stream gauge (213211) and performed an At-Site Flood Frequency Analysis (FFA) for "The Needles" causeway using the TUFLOW FLIKE software. The flood frequency curve is used to relate flood discharge values to return periods to provide an estimate of the intensity of a flood event. The FFA:

- Accounts for effect of dam storage which is particularly important to consider for more frequent flood events; and
- Fits a curve to observed annual maximum flows recorded at the gauge.

Figure 5 shows the FFA flow estimates, 5% and 95% confidence intervals.



- Figure 5: Flood Frequency Analysis for Woronora River @ “The Needles” (North Engadine) 213211.

3.1.3. Changes to peak flows since Original REF

A comparison of FFA design discharge to RFFE adopted in the original REF has been provided in Table 11 below.

► Table 11: Comparison of FFA design discharge to RFFE adopted in original REF.

AEP (%)	RFFE DESIGN FLOW (ORIGINAL REF) (M3/S)	FFA DESIGN FLOW (“THE NEEDLES” (ADDENDUM REF) (M3/S)[2]
50	67.2	**101.6**
20	151	**229.2**
10	232	**319.6**
5	332	**402.6**
2	501	**499.9**
1	661	**564.3**
0.05	-	**764**

[2] Adopted for design

3.2. Hydraulic Modelling Methodology

3.2.1. Software

A one-dimensional steady state hydraulic model was developed using the HEC-RAS software, consistent with the REF.

3.2.2. Model Extent

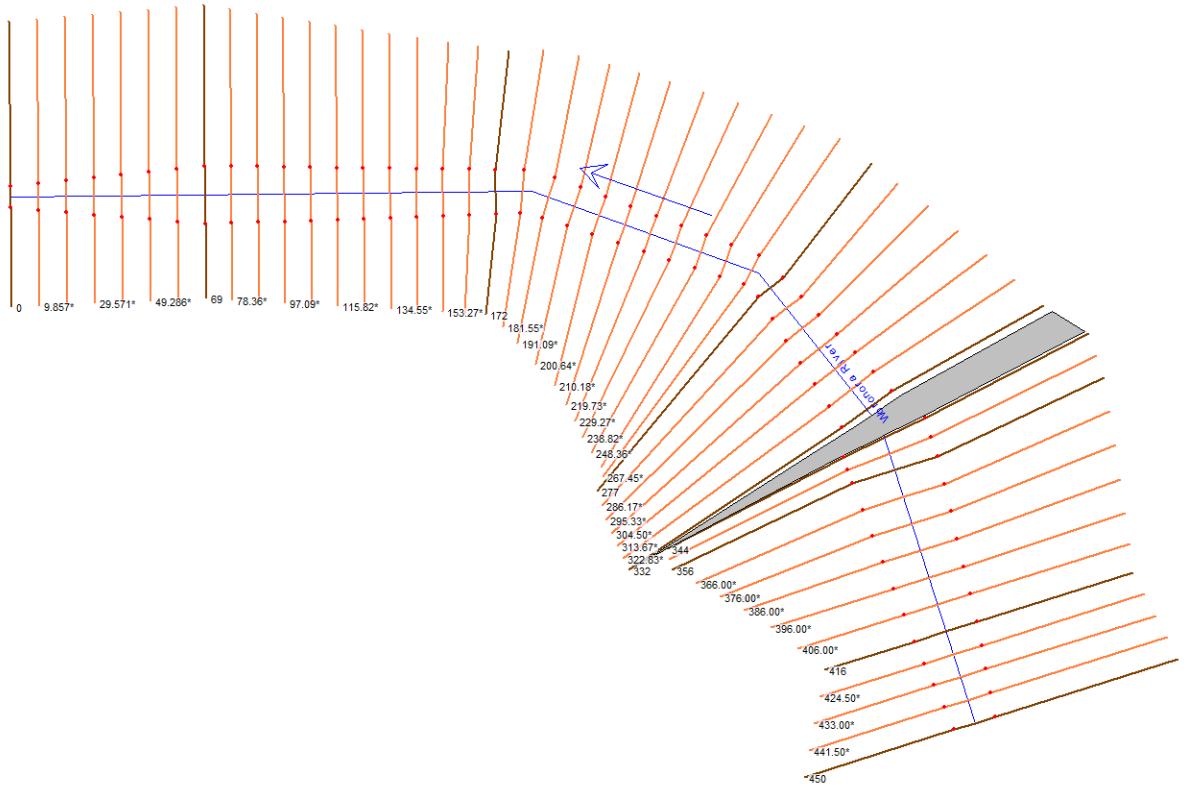
The model extends 120 m upstream of the bridge and 332 m downstream of the bridge, consistent with the REF.

3.2.3. Model Geometry

The Woronora River cross-sections from the original REF were used as the basis of the model geometry. The placement and interval of cross-sections were reviewed for the Addendum REF to ensure their suitability, as the flood level and velocity results are very sensitive to cross-section placement.

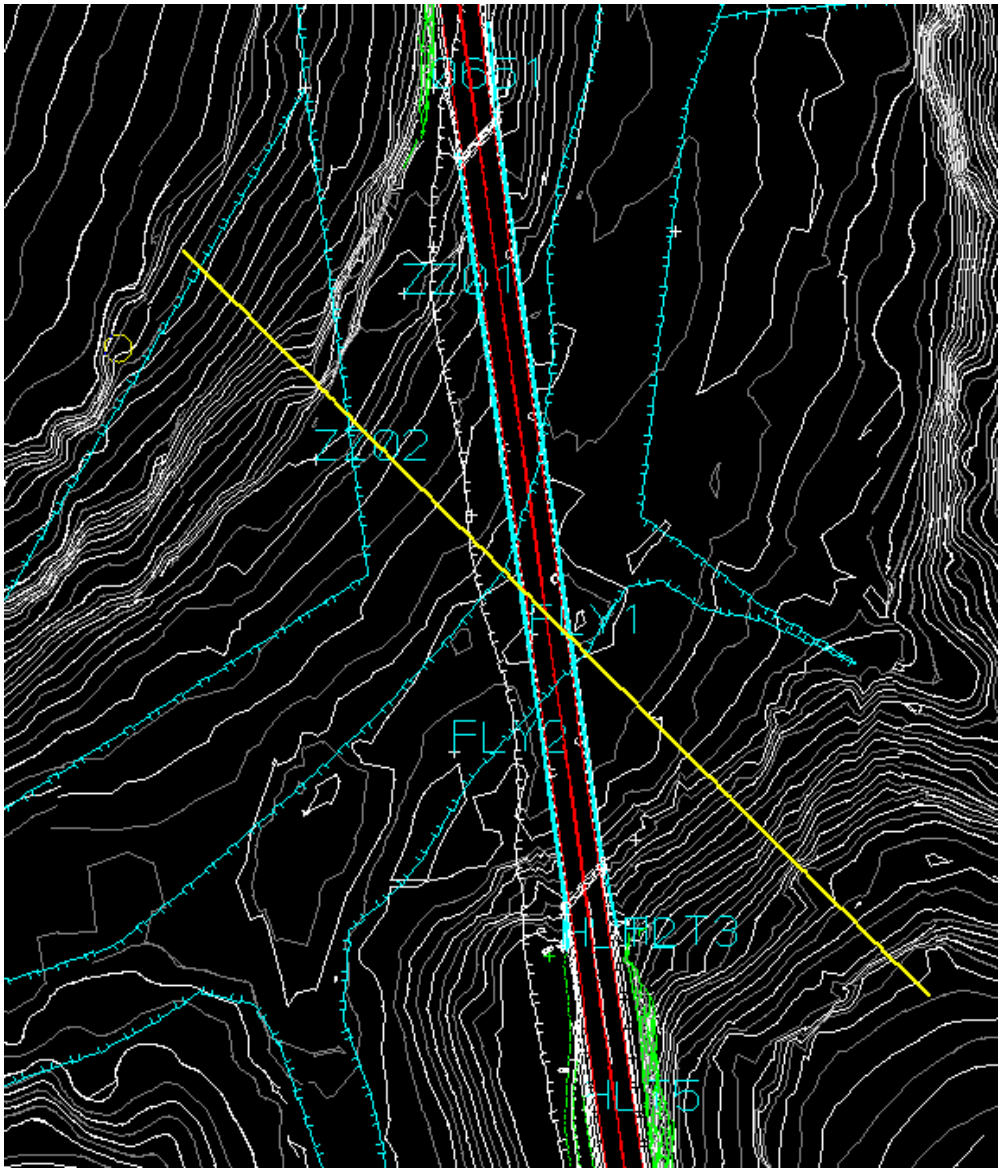
Cross-sections in the original REF HEC-RAS model provided by TfNSW were based on old LIDAR data. Cross-sections 416, 356, 344 and 332 were updated to match the detailed survey and more recent LIDAR surfaces, which include better definition of the low-flow channel in the Woronora River. Two interpolated cross-sections in the vicinity of the bridge were also created to allow for a smoother transition in geometry between subsequent cross-sections. Four cross-sections upstream of the bridge and six downstream of the bridge was considered a suitable number.

The HEC-RAS model cross-section placement is shown below in Figure 6.



- Figure 6: HEC-RAS model cross-section placement.

Since cross-sections are required to be perpendicular to the direction of flow, the cross-sections in the vicinity of the existing and new bridge were skewed at about 40 degrees to the bridge deck (refer Figure 7).



- Figure 7: Skew of bridge cross-section to bridge deck.

3.2.4. Surface Material

In the original REF HEC-RAS model, a Manning's n roughness value of 0.15 was adopted to represent the material roughness of the thick vegetation in the main channel and riverbanks. However, a Manning's n roughness is 0.15 is too high to be justified by literature, especially for smoother in-bank areas.

Suitable Manning's n values were applied as per Open Channel Hydraulics (Chow, 1959):

- 0.07 for in-bank areas (sluggish reaches with weedy, deep pools)
- 0.12 for riverbanks (heavy stand of timber, few down trees, little undergrowth, flood stage reaching branches)

3.2.5. Boundary Conditions

In the Addendum REF flood model, steady state inflows derived using FFA were applied at the upstream extent of the model. The FFA flows are documented in Table 11.

Normal flow conditions for a bed slope of 0.4% were assumed for the downstream boundary condition.

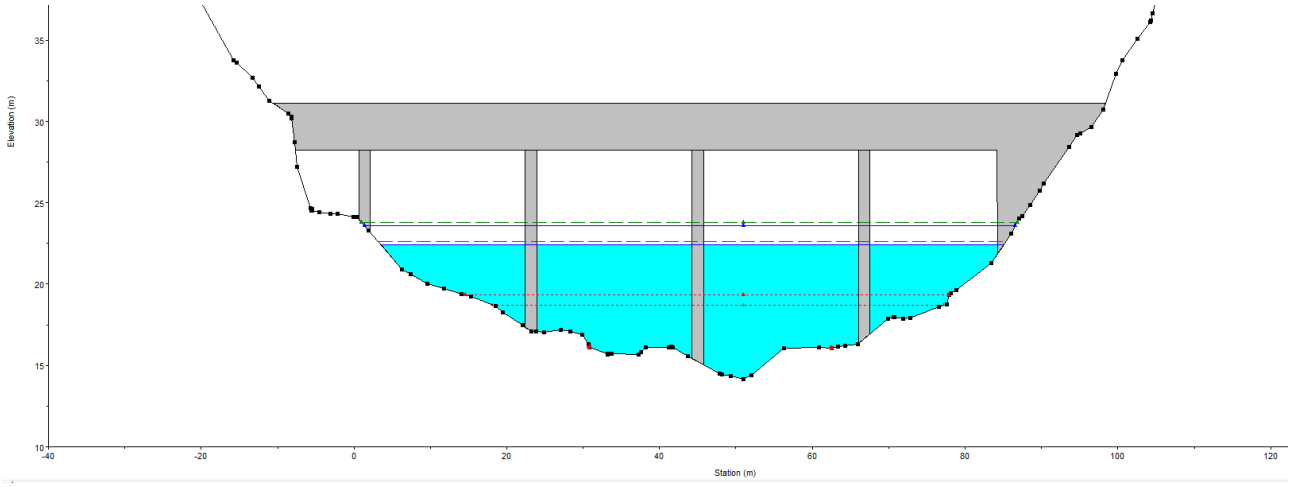
Adjusting the slope of the upstream and downstream boundary conditions did not influence the computed flood level and velocity at the bridge, therefore the positioning and schematisation of the boundary conditions were found to be suitable.

3.2.6. Bridge Structure

3.2.6.1. Waterway Opening

The existing bridge structure was modelled as per the Bridge WAE.

The waterway cross-section through the existing bridge with the 1% AEP and 0.05% AEP flood levels is shown in the figure below. Upstream of the northern abutment, the terrain obscures the northern abutment (Abutment B) from view when facing downstream through the bridge. In addition, HEC-RAS shows that the southern abutment (Abutment A) is inundated in the 1% AEP flood event. However, the terrain shown in the cross-section at Abutment A is downstream of the bridge due to the 40-degree skew of the cross-section. Detailed site survey indicates the bottom of the southern abutment is situated on higher ground, above the 1% AEP flood level. Given the limitations of the 1D HEC-RAS model, these issues are unable to be reconciled. Nonetheless, effort was made to best represent the effective waterway area through the bridge opening.



- Figure 8: Existing bridge waterway opening – HEC-RAS

3.2.6.2. Energy Losses

Three different methods were compared to compute low flow energy losses through the bridge:

- - Energy Equation (standard step method);
- - Momentum Balance with a pier drag coefficient C_d of 1.2 for a circular pier shape; and
- - Yarnell Equation with a pier coefficient K of:
  - 1.05 for the existing bridge (twin-cylinder piers with connecting diaphragm) and;
  - 0.9 for the new bridge (semi-circular nose and tail)

The Energy Equation method was adopted for design purposes as it computes the highest energy losses of the three methods.

3.2.7. Changes to Baseline Modelling Behaviour from Original REF

Several necessary changes were made to the original REF flood model to ensure it was fit-for-purpose for use in detailed design and for the Addendum REF. The changes to the modelling methodology are described and justification has been provided in Section 3.1 and 3.2. This has resulted in changes to the baseline flooding behaviour documented in the original REF.

The effects of the baseline modelling updates on flooding behaviour on flood levels and velocities at the bridge are summarised in Table 12 and Table 13, respectively.

► Table 12: Changes to baseline flooding behaviour from original REF – flood levels

AEP (%)	ORIGINAL REF FLOOD LEVEL AT UPSTREAM FACE OF EXISTING BRIDGE (M AHD)	ADDENDUM REF FLOOD LEVEL AT UPSTREAM FACE OF EXISTING BRIDGE (M AHD)	FLOOD LEVEL DIFFERENCE (M)
50	18.64	18.65	0.01
20	19.76	19.77	0.01
10	20.62	20.41	-0.21
5	21.51	20.94	-0.57
2	22.8	21.52	-1.28
1	24.02	21.90	-2.12

► Table 13: Changes to baseline flooding behaviour from original REF – flood velocities

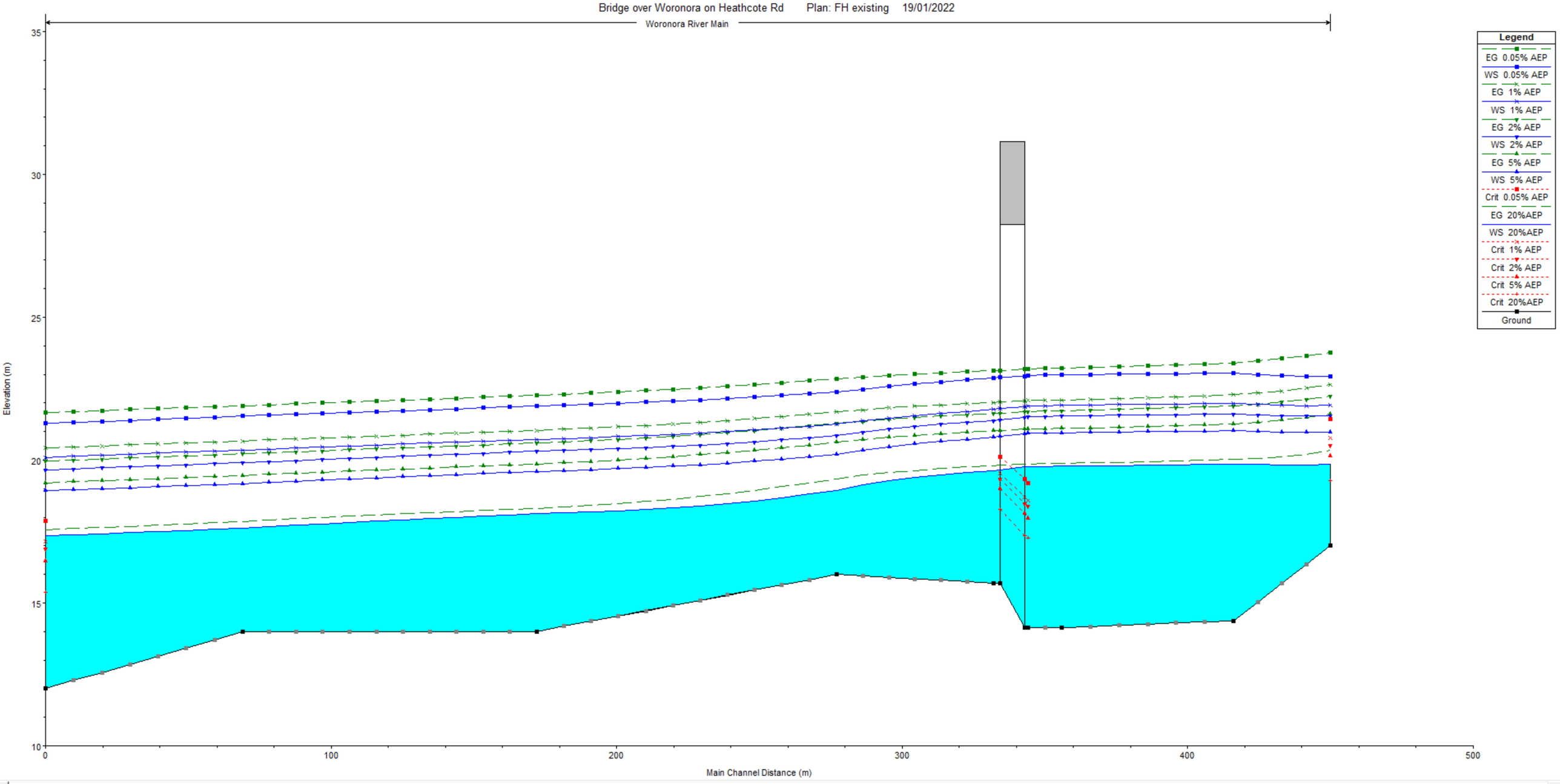
AEP (%)	ORIGINAL REF FLOOD VELOCITY THROUGH EXISTING BRIDGE (M/S)	ADDENDUM REF FLOOD VELOCITY THROUGH EXISTING BRIDGE (M/S)	FLOOD VELOCITY DIFFERENCE (M/S)
50	0.8	1.2	0.4
20	1.1	1.5	0.4
10	1.2	1.7	0.5
5	1.4	1.7	0.3
2	1.5	1.8	0.3
1	1.6	1.8	0.2

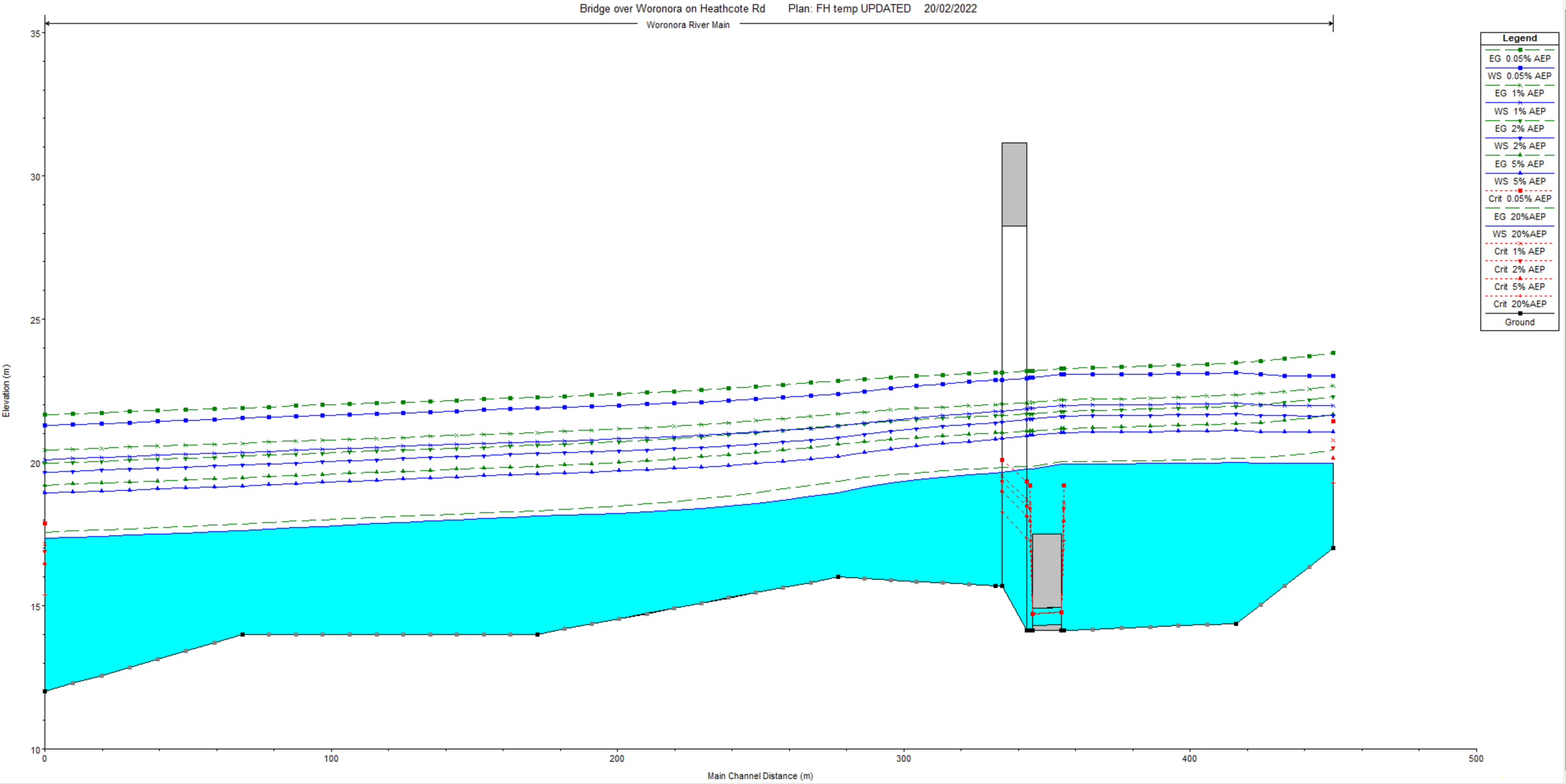
The flood level differences between the original and Addendum REF for flood events up to the 5% AEP and velocity differences for all flood events are not significant. The 1% AEP flood level dropped by over 2 m when the FFA flows were adopted and the Manning's n roughness values reviewed for the Addendum REF. However, it is important to acknowledge that the difference in flood levels and velocities is a function of the changes to the flow estimation approach and hydraulic modelling updates, rather than being related to the impact of constructing the new bridge.

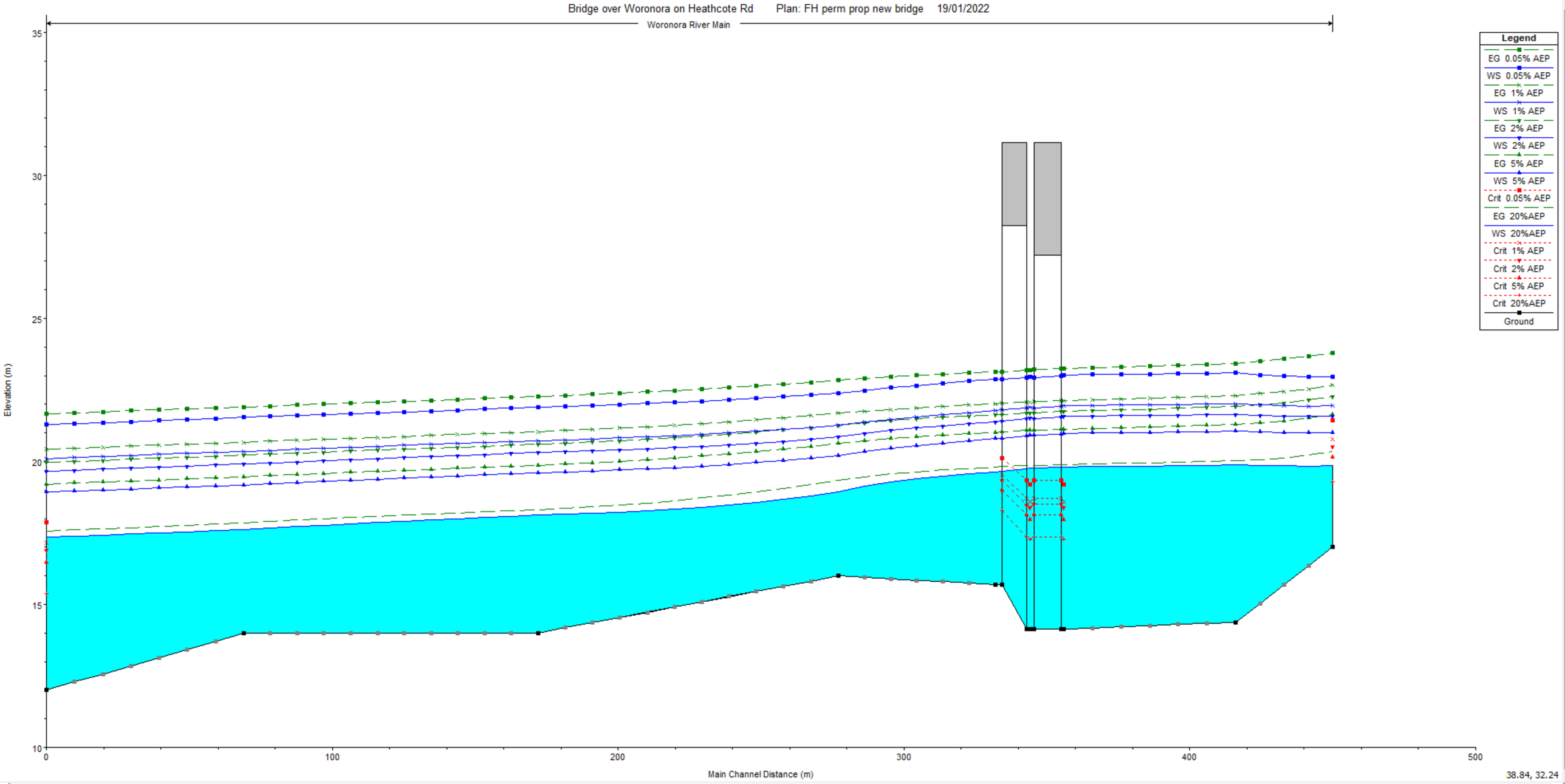
4. Appendices

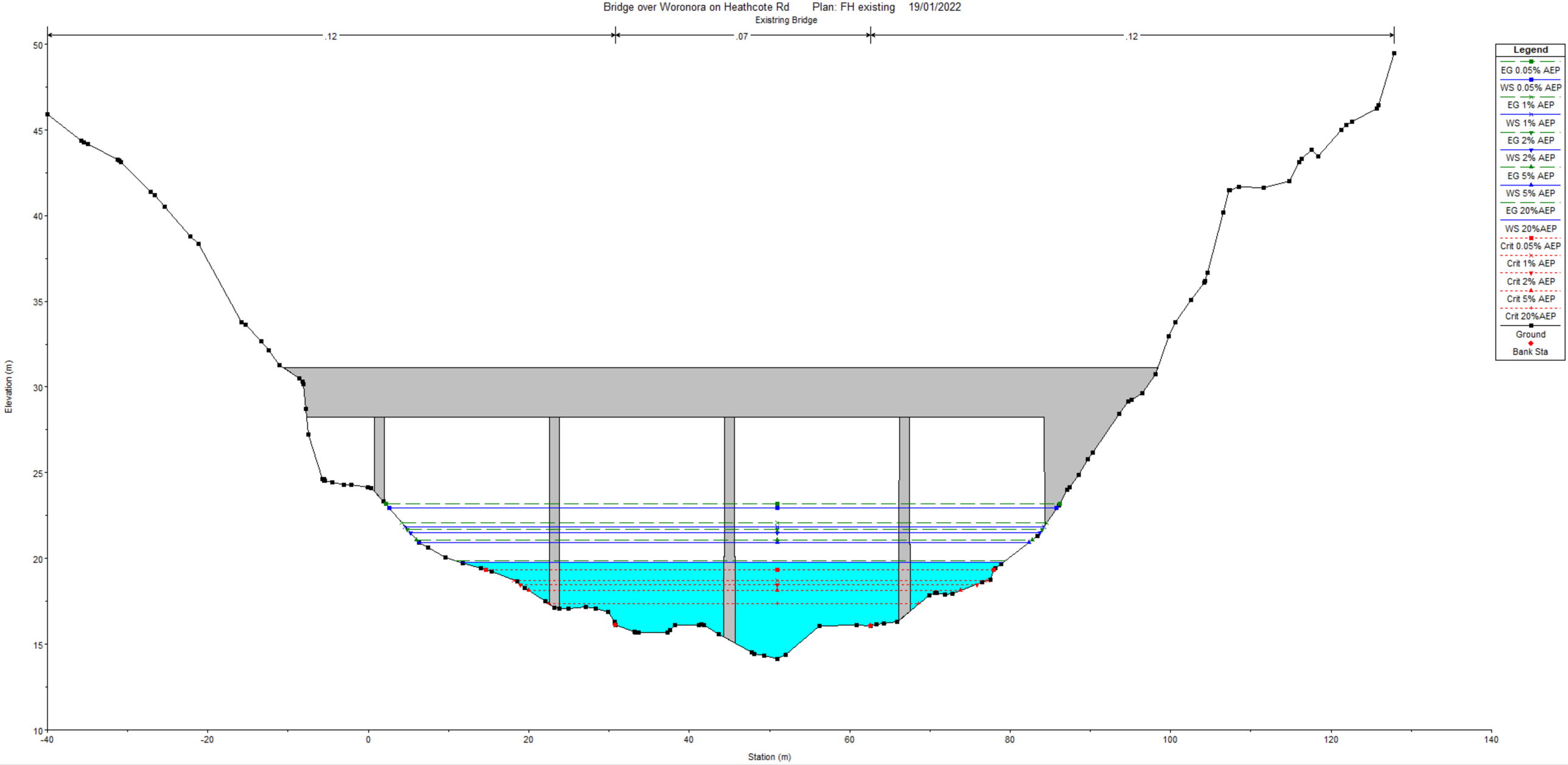
Appendix A: HEC-RAS Model Results

Appendix A: HEC-RAS model results


Bridge over Woronora on Heathcote Rd Plan: FH existing 19/01/2022
Woronora River Main
Legend
EG 0.05% AEP
WS 0.05% AEP
EG 1% AEP
WS 1% AEP
EG 2% AEP
WS 2% AEP
EG 5% AEP
WS 5% AEP
Crit 0.05% AEP
EG 20%AEP
WS 20%AEP
Crit 1% AEP
Crit 2% AEP
Crit 5% AEP
Crit 20%AEP
Ground
Elevation (m)
35
30
25
20
15
10
0
100
200
300
400
500
Main Channel Distance (m)


Bridge over Woronora on Heathcote Rd Plan: FH temp UPDATED 20/02/2022
Woronora River Main
Legend
EG 0.05% AEP
WS 0.05% AEP
EG 1% AEP
WS 1% AEP
EG 2% AEP
WS 2% AEP
EG 5% AEP
WS 5% AEP
Crit 0.05% AEP
EG 20%AEP
WS 20%AEP
Crit 1% AEP
Crit 2% AEP
Crit 5% AEP
Crit 20%AEP
Ground
Elevation (m)
35
30
25
20
15
10
0
100
200
300
400
500
Main Channel Distance (m)


Bridge over Woronora on Heathcote Rd Plan: FH perm prop new bridge 19/01/2022
Woronora River Main
Legend
EG 0.05% AEP
WS 0.05% AEP
EG 1% AEP
WS 1% AEP
EG 2% AEP
WS 2% AEP
EG 5% AEP
WS 5% AEP
Crit 0.05% AEP
EG 20%AEP
WS 20%AEP
Crit 1% AEP
Crit 2% AEP
Crit 5% AEP
Crit 20%AEP
Ground
Elevation (m)
35
30
25
20
15
10
0
100
200
300
400
500
Main Channel Distance (m)
38.84, 32.24


Bridge over Woronora on Heathcote Rd Plan: FH existing 19/01/2022
Existring Bridge
.12
.07
.12
Legend
EG 0.05% AEP
WS 0.05% AEP
EG 1% AEP
WS 1% AEP
EG 2% AEP
WS 2% AEP
EG 5% AEP
WS 5% AEP
EG 20%AEP
WS 20%AEP
Crit 0.05% AEP
Crit 1% AEP
Crit 2% AEP
Crit 5% AEP
Crit 20%AEP
Ground
Bank Sta
Elevation (m)
Station (m)
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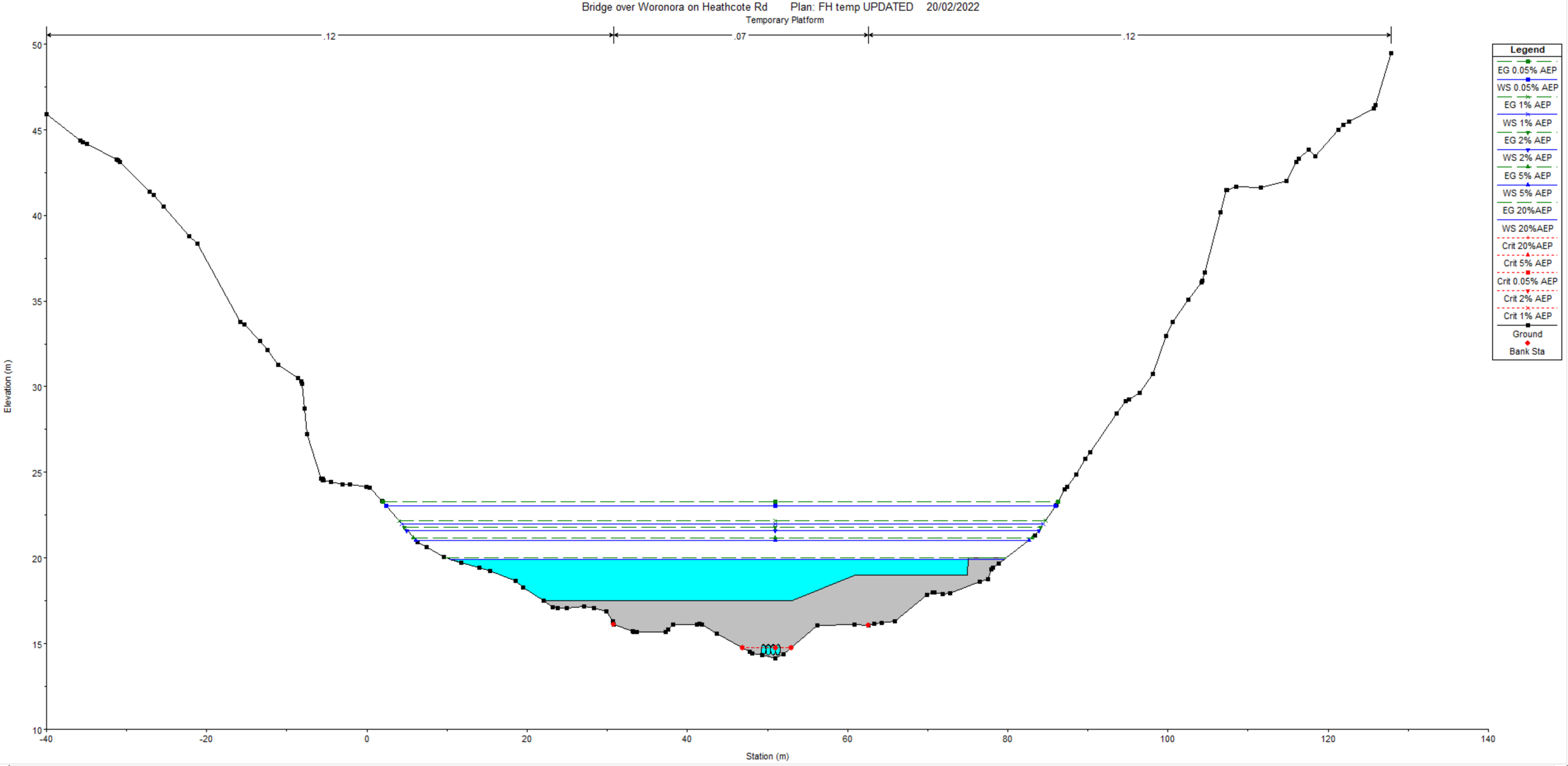
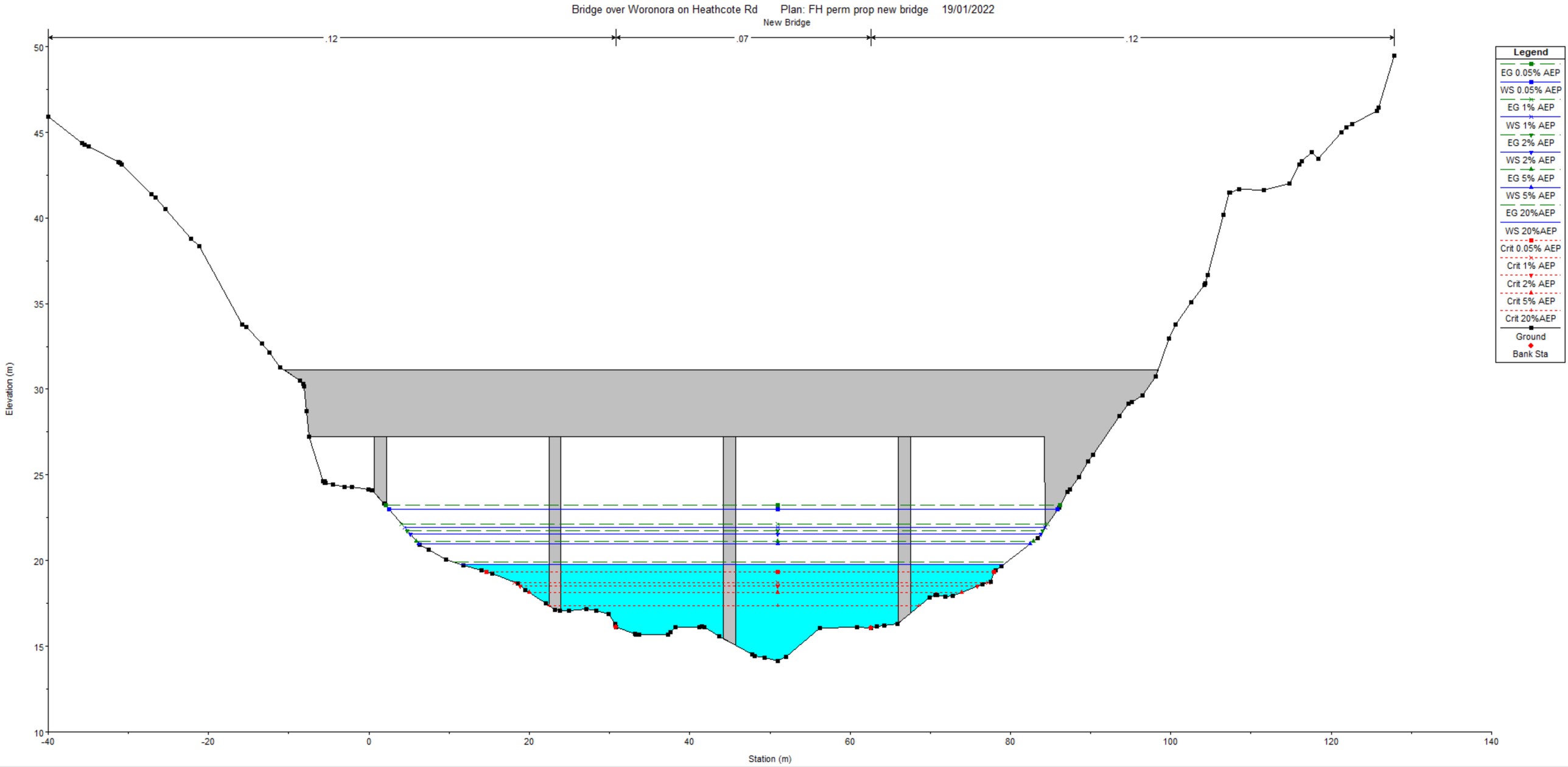
40
35
30
25
20
15
10
-40
-20
0
20
40
60
80
100
120
140


Bridge over Woronora on Heathcote Rd Plan: FH temp UPDATED 20/02/2022
Temporary Platform
.12
.07
.12
Legend
EG 0.05% AEP
WS 0.05% AEP
EG 1% AEP
WS 1% AEP
EG 2% AEP
WS 2% AEP
EG 5% AEP
WS 5% AEP
EG 20%AEP
WS 20%AEP
Crit 20%AEP
Crit 5% AEP
Crit 0.05% AEP
Crit 2% AEP
Crit 1% AEP
Ground
Bank Sta
Elevation (m)
Station (m)
50
45
40
35
30
25
20
15
10
-40
-20
0
20
40
60
80
100
120
140


Bridge over Woronora on Heathcote Rd Plan: FH perm prop new bridge 19/01/2022
New Bridge
.12
.07
.12
Legend
EG 0.05% AEP
WS 0.05% AEP
EG 1% AEP
WS 1% AEP
EG 2% AEP
WS 2% AEP
EG 5% AEP
WS 5% AEP
EG 20%AEP
WS 20%AEP
Crit 0.05% AEP
Crit 1% AEP
Crit 2% AEP
Crit 5% AEP
Crit 20%AEP
Ground
Bank Sta
Elevation (m)
Station (m)
50
45
40
35
30
25
20
15
10
-40
-20
0
20
40
60
80
100
120
140

Existing Bridge - 1% AEP and 0.05% AEP results

Plan: FH existing Woronora River Main RS: 335 Profile: 1% AEP				
E.G. US. (m)	22.08	Element	Inside BR US	Inside BR DS
W.S. US. (m)	21.9	E.G. Elev (m)	22.08	22.04
Q Total (m3/s)	564.3	W.S. Elev (m)	21.86	21.8
Q Bridge (m3/s)	564.3	Crit W.S. (m)	18.71	19.53
Q Weir (m3/s)		Max Chl Dpth (m)	7.72	6.11
Weir Sta Lft (m)		Vel Total (m/s)	1.67	1.82
Weir Sta Rgt (m)		Flow Area (m2)	337.09	309.48
Weir Submerg		Froude # Chl	0.29	0.37
Weir Max Depth (m)		Specif Force (m3)	1011.67	814.49
Min El Weir Flow (m)	31.14	Hydr Depth (m)	4.45	3.85
Min El Prs (m)	28.24	W.P. Total (m)	111.51	111.53
Delta EG (m)	0.06	Conv. Total (m3/s)	9326.8	6844.4
Delta WS (m)	0.12	Top Width (m)	75.71	80.33
BR Open Area (m2)	864.91	Frctn Loss (m)	0.04	0.01
BR Open Vel (m/s)	1.82	C & E Loss (m)	0	0
BR Sluice Coef		Shear Total (N/m2)	108.52	184.98
BR Sel Method	Energy only	Power Total (N/m s)	181.67	337.28

Plan: FH existing Woronora River Main RS: 335 Profile: 0.05% AEP				
E.G. US. (m)	23.2	Element	Inside BR US	Inside BR DS
W.S. US. (m)	22.97	E.G. Elev (m)	23.19	23.15
Q Total (m3/s)	764	W.S. Elev (m)	22.93	22.89
Q Bridge (m3/s)	764	Crit W.S. (m)	19.34	20.11
Q Weir (m3/s)		Max Chl Dpth (m)	8.79	7.2
Weir Sta Lft (m)		Vel Total (m/s)	1.82	1.92
Weir Sta Rgt (m)		Flow Area (m2)	419.25	398.12
Weir Submerg		Froude # Chl	0.24	0.36
Weir Max Depth (m)		Specif Force (m3)	1469.34	1248.61
Min El Weir Flow (m)	31.14	Hydr Depth (m)	5.38	4.85
Min El Prs (m)	28.24	W.P. Total (m)	121.34	123.19
Delta EG (m)	0.06	Conv. Total (m3/s)	12249.4	9504.8
Delta WS (m)	0.1	Top Width (m)	77.88	82.02
BR Open Area (m2)	864.91	Frctn Loss (m)	0.04	0.01
BR Open Vel (m/s)	1.92	C & E Loss (m)	0	0
BR Sluice Coef		Shear Total (N/m2)	131.81	204.75
BR Sel Method	Energy only	Power Total (N/m s)	240.2	392.93

New Bridge - 1% AEP and 0.05% AEP results

Plan: perm prop Woronora River Main RS: 350 Profile: 1% AEP				
E.G. US. (m)	22.13	Element	Inside BR US	Inside BR DS
W.S. US. (m)	21.95	E.G. Elev (m)	22.13	22.09

Q Total (m3/s)	564.3	W.S. Elev (m)	21.91	21.87
Q Bridge (m3/s)	564.3	Crit W.S. (m)	18.72	18.72
Q Weir (m3/s)		Max Chl Dpth (m)	7.77	7.73
Weir Sta Lft (m)		Vel Total (m/s)	1.67	1.68
Weir Sta Rgt (m)		Flow Area (m2)	338.72	335.85
Weir Submerg		Froude # Chl	0.29	0.24
Weir Max Depth (m)		Specif Force (m3)	1023.53	1011.93
Min El Weir Flow (m)	31.14	Hydr Depth (m)	4.5	4.49
Min El Prs (m)	27.22	W.P. Total (m)	111.33	110.57
Delta EG (m)	0.05	Conv. Total (m3/s)	9410.1	9359.7
Delta WS (m)	0.06	Top Width (m)	75.2	74.75
BR Open Area (m2)	750.33	Frctn Loss (m)		
BR Open Vel (m/s)	1.68	C & E Loss (m)		
BR Sluice Coef		Shear Total (N/m2)	107.29	108.27
BR Sel Method	Momentum	Power Total (N/m s)	178.75	181.92

Plan: perm prop Woronora River Main RS: 350 Profile: 0.05% AEP				
E.G. US. (m)	23.25	Element	Inside BR US	Inside BR DS
W.S. US. (m)	23.03	E.G. Elev (m)	23.24	23.21
Q Total (m3/s)	764	W.S. Elev (m)	22.99	22.95
Q Bridge (m3/s)	764	Crit W.S. (m)	19.35	19.35
Q Weir (m3/s)		Max Chl Dpth (m)	8.85	8.8
Weir Sta Lft (m)		Vel Total (m/s)	1.82	1.83
Weir Sta Rgt (m)		Flow Area (m2)	420.55	416.71
Weir Submerg		Froude # Chl	0.24	0.24
Weir Max Depth (m)		Specif Force (m3)	1484.43	1469.18
Min El Weir Flow (m)	31.14	Hydr Depth (m)	5.44	5.47
Min El Prs (m)	27.22	W.P. Total (m)	121.14	119.97
Delta EG (m)	0.06	Conv. Total (m3/s)	12328.5	12265.8
Delta WS (m)	0.06	Top Width (m)	77.24	76.23
BR Open Area (m2)	750.33	Frctn Loss (m)	0.04	0
BR Open Vel (m/s)	1.83	C & E Loss (m)	0	0.01
BR Sluice Coef		Shear Total (N/m2)	130.74	132.15
BR Sel Method	Energy only	Power Total (N/m s)	237.51	242.3

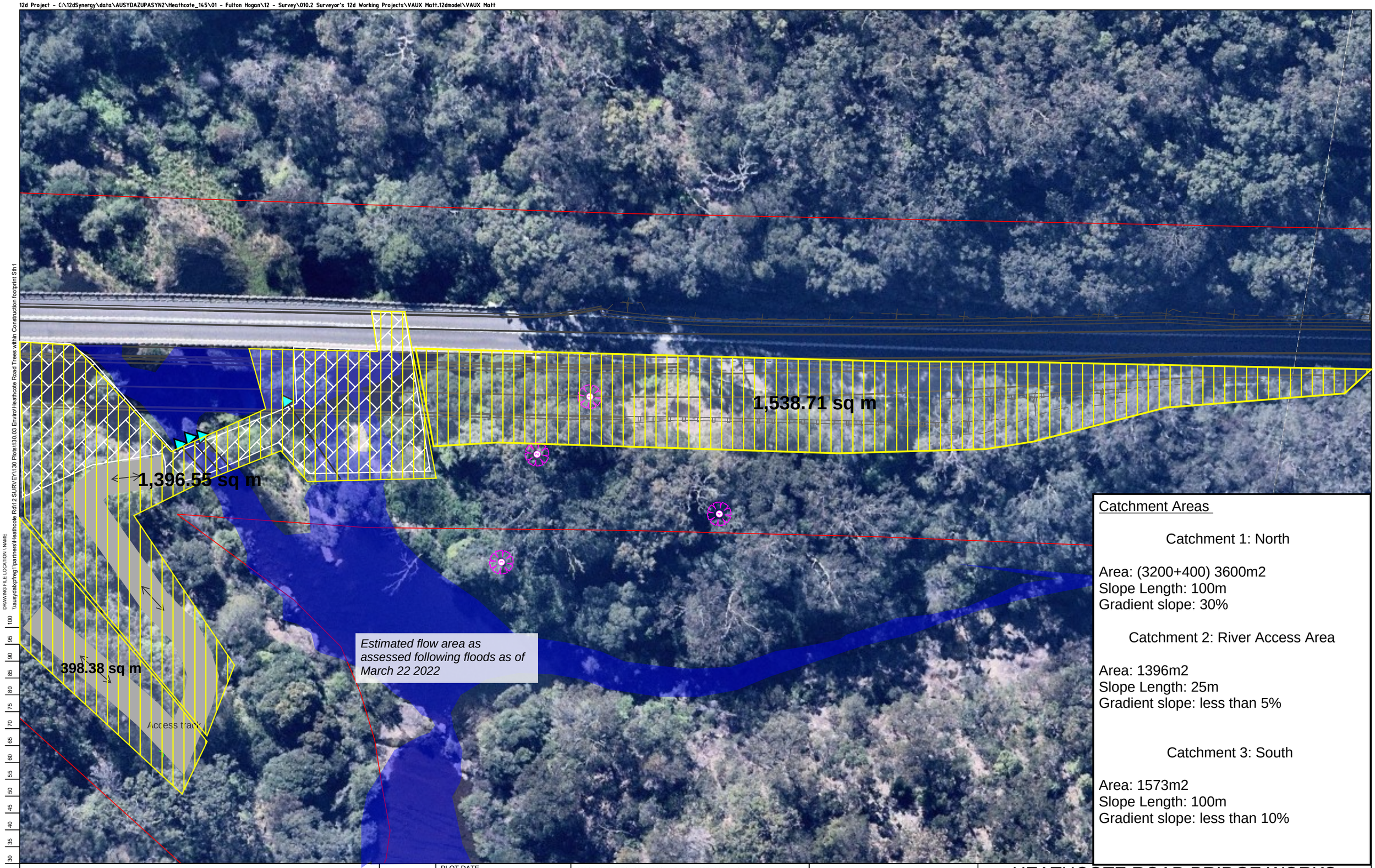
Temporary Crane Pad - 5% AEP results

Plan: FH temp U Woronora River Main RS: 345 Culv Group: Culvert #1 Profile: 5% AEP			
Q Culv Group (m3/s)	3.71	Culv Full Len (m)	10
# Barrels	2	Culv Vel US (m/s)	1.64
Q Barrel (m3/s)	1.86	Culv Vel DS (m/s)	1.64
E.G. US. (m)	21.17	Culv Inv El Up (m)	14.34
W.S. US. (m)	21.03	Culv Inv El Dn (m)	14.3
E.G. DS (m)	21.09	Culv Frctn Ls (m)	0.02
W.S. DS (m)	20.94	Culv Exit Loss (m)	0

Delta EG (m)	0.09	Culv Entr Loss (m)	0.07
Delta WS (m)	0.09	Q Weir (m3/s)	404.3
E.G. IC (m)	15.49	Weir Sta Lft (m)	5.83
E.G. OC (m)	21.17	Weir Sta Rgt (m)	83.07
Culvert Control	Outlet	Weir Submerg	0.94
Culv WS Inlet (m)	15.54	Weir Max Depth (m)	3.67
Culv WS Outlet (m)	15.5	Weir Avg Depth (m)	2.76
Culv Nml Depth (m)		Weir Flow Area (m2)	213.47
Culv Crt Depth (m)	0.75	Min El Weir Flow (m)	17.5

Appendix B: Construction Erosion and Sediment Control Assessment

12d Project - C:\12dSynergy\data\AUSYDAZUPASYN2\Heathcote_145\01 - Fulton Hogan\12 - Survey\010.2 Surveyor's 12d Working Projects\VAUX Matt.12dmodel\VAUX Matt



Catchment Areas

Catchment 1: North

Area: (3200+400) 3600m2
Slope Length: 100m
Gradient slope: 30%

Catchment 2: River Access Area

Area: 1396m2
Slope Length: 25m
Gradient slope: less than 5%

Catchment 3: South

Area: 1573m2
Slope Length: 100m
Gradient slope: less than 10%

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED
DRAWING FILE LOCATION \\ausydalxpfreg1\partners\Heathcote Rd\12 SURVEY\1130 Plots\130.03 Enviro\Heathcote Road Trees within Construction footprint Sth1
A3 ORIGINAL 100 mm ON ORIGINAL
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

REV	DATE	NOTES	WVR No	APPROVAL

PLOT DATE
Tue Mar 15 08:34:40 2022

TITLE	NAME
DRAFTER	vauxm
DRAFTING CHECK	
DESIGNER	
DESIGN CHECK	
DESIGN MANAGER	
PROJECT MANAGER	

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

CLIENT: NSW Government Transport Roads & Maritime Services
CONTRACTOR: Fulton Hogan

SCALE at A3 1:500

CO-ORDINATE SYSTEM: MGA2020 ZONE 56 | HEIGHT DATUM: A.H.D.

HEATHCOTE ROAD BRIDGE WORKS

HEATHCOTE ROAD & LINDEN STREET

PLOT DATE = Tue Mar 15 08:34:40 2022

CLIENT PROJECT / DRAWING No	ISSUE STATUS	FH PROJECT / DRAWING No	ISSUE

12d Project - C:\12dSynergy\data\AUSYDAZUPASYN2\Heathcote_145\01 - Fulton Hogan\12 - Survey\010.2 Surveyor's 12d Working Projects\VAUX Matt.12dmodel\VAUX Matt

THIS SHEET MAY BE PREPARED USING COLOUR AND MAY BE INCOMPLETE IF COPIED

DRAWING FILE LOCATION \ NAME
\\ausydakpfreg1\partners\Heathcote Rd\12 SURVEY\1130 Plots\1130.03 Enviro\Heathcote Road Trees within Construction footprint1

100 mm ON ORIGINAL
A3 ORIGINAL

PLOT DATE
Tue Mar 15 08:27:51 2022

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

SCALE at A3 1:500

HEATHCOTE ROAD BRIDGE WORKS

HEATHCOTE ROAD & LINDEN STREET

REV	DATE	NOTES	WVR No	APPROVAL

TITLE	NAME
DRAFTER	vauxm
DRAFTING CHECK	
DESIGNER	
DESIGN CHECK	
DESIGN MANAGER	
PROJECT MANAGER	

CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

CONTRACTOR: Fulton Hogan

CO-ORDINATE SYSTEM: MGA2020 ZONE 56 | HEIGHT DATUM: A.H.D.

PLOT DATE - Tue Mar 15 08:27:51 2022

CLIENT PROJECT / DRAWING No	ISSUE STATUS	FH PROJECT / DRAWING No	ISSUE

Addendum REF RUSLE Calculations

The Project REF undertook a preliminary review to assess the erosion risk within the proposal area, this assessment focused on the ' access track between Heathcote and the Woronora River from the northern bridge approach.

This revised assessment compliments the preliminary RUSLE calculations, however in this revised assessment the working catchments have been individually reviewed.

Background, factors affecting soil erosion by water include:

- Rain droplet and rainfall intensity
- Soil characterisations (erodibility)
- Topographic characteristics
- Soil conservation practises
- Ground cover, vegetation, rock

The calculated soil loss and erosion hazard is calculated using the 'Revised Universal Soil Loss Equation' RUSLE

Rainfall Erosivity Factor (R-Factor): Measure of rainfall erosivity based on intensity, duration, droplet size from annual average rainfall data (considers 2yr and 6yr event intensity)

Soil Erodibility (K-Factor): Measure of soil erodibility determined soil properties including soil texture, organic matter content, soil structure, soil permeability

Slope Length (LS Factor): Slope and gradient used to determine the topographic risk of the site

Soil Conservation Practice (P-Factor): Based on surface condition of soils

Ground Cover Factor (C-Factor): A measure of the effectiveness of ground cover

RUSLE equation is used to evaluate erosion risk from a catchment area and is not intended to be used to assess channelised flows.

The REF preliminary RUSLE calculations used base value inputs which have been kept the same for this assessment except for the slope gradients in catchments 2 & 3 which are observed to have less slope.

Addendum REF RUSLE Calculations

Soil Loss Assessment consistent with REF

Catchment 1: 1408 (t/ha/yr)
Catchment 2: 62 (t/ha/yr)
Catchment 3: 332 (t/ha/yr)

Soil Loss Assessment Considering Ground Cover

The Heathcote Road construction site is an environment with a low level of topsoil. The main earthworks area is rock face and all working platforms and access tracks will be covered in clean crushed rock.

The existing rock across the site can be considered as providing ground cover, this is consistent with the requirements of the NSW Erosion and Sediment control guideline 'Bluebook'.

The soil loss assessment including a consideration as rock as a cover factor has revised the input numbers as below.

R Factor: 2370
K Factor: 0.033
LS Factor: Catchment 1: 13.82 Catchment 2: 0.61 Catchment 3: 3.27
P -Factor: 1.3
C Factor: 0.5

Catchment 1: 704 (t/ha/yr)
Catchment 2: 31 (t/ha/yr)
Catchment 3:166 (t/ha/yr)

Sediment Basins

The Heathcote Road project is set in a highly constrained environment, the new road alignment is between rock face, existing traffic lanes, national parks boundaries and the Woronora River. There is no space to be able to build sediment basins on the site

Erosion and Sediment control management

Management measures to be employed at the site include
- divert clean waters around the site and away from the construction site
- use clean rock in the river access and crossing points
- break catchments into smaller sections, using slope breaks and check dams
- advanced sediment control devices such as decanting earth bunds
- progressive stabilisation of the catchment

Appendix F

Aboriginal Heritage consistency assessment

Kelleher
Nightingale Consulting Pty Ltd
ABN 26 120 187 671 ACN 120 187 671

Level 10
25 Bligh St
Sydney NSW 2000
p 02 9232 5373

22 March 2022

Sam Leigh
Eastern Region Environment Manager
Fulton Hogan
Level 3, 90 Bourke Road
Alexandria NSW 2015

Dear Sam,

RE. Heathcote Road Bridge over Woronora River
Consistency Assessment – Design Adjustments
Aboriginal Heritage

Kelleher Nightingale Consulting (KNC) has reviewed the proposed design adjustments for the Heathcote Road Bridge over Woronora River project, beyond the previous Review of Environmental Factors (REF) detailed design assessed in the *Heathcote Road Bridge over Woronora River, Safety Improvement Works – Aboriginal Archaeological Survey Report Stage 2 PACHCI* (KNC October 2020).

Assessment
Proposed design adjustments for the project include undertaking bridge replication as opposed to bridge widening, with a new bridge to be built in parallel to the existing bridge structure. As a result, adjustments are required in order for a drill rig to safely access and work above a cut into the rock face on the north western side of the proposed new bridge, necessitating modifications to the proposed access track. The pertinent design adjustments and access track are shown in Figure 1.

The proposed design adjustments area was assessed as part of an Aboriginal archaeological survey assessment completed in accordance with the *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI Stage 2) for the Heathcote Road Bridge over Woronora River project.

The Cubbitch Barta National Estate Area heritage place (Place ID. 105405) identified within the existing Aboriginal archaeological survey assessment will be impacted by the proposed design adjustments. The survey assessment previously identified impacts to the Cubbitch Barta National Estate Area heritage place based upon the design of the proposal. The portion of the Cubbitch Barta National Estate Area impacted by the proposed design adjustments does not contain Aboriginal objects and some disturbance exists within the general landscape. For these reasons the proposed impact to the Cubbitch Barta National Estate Area has been assessed as minor. No further heritage assessment is warranted, however if the Cubbitch Barta National Estate Area cannot be avoided, consultation with the Tharawal Local Aboriginal Land Council should be undertaken.

No additional impacts to Aboriginal heritage were identified as part of this consistency assessment. Impacts to Aboriginal heritage are consistent with the existing impacts identified in the Transport for NSW Heathcote Road bridge widening: Review of Environmental Factors (December 2020) and the *Heathcote Road Bridge over Woronora River, Safety Improvement Works – Aboriginal Archaeological Survey Report Stage 2 PACHCI (KNC October 2020 Final Draft).*

Result
Impacts from the proposed design adjustments are consistent with the findings of the Heathcote Road Bridge over Woronora River project assessment report and REF.

No further Aboriginal archaeological assessment is warranted for the proposed design adjustments. Aboriginal heritage for the project should be managed in accordance with the existing recommendations in the Heathcote Road Bridge over Woronora River Aboriginal archaeological survey report.

If you have any questions, please do not hesitate to contact me on 02 9232 5373.

Yours sincerely

Dr Matthew Kelleher
Director/Archaeologist

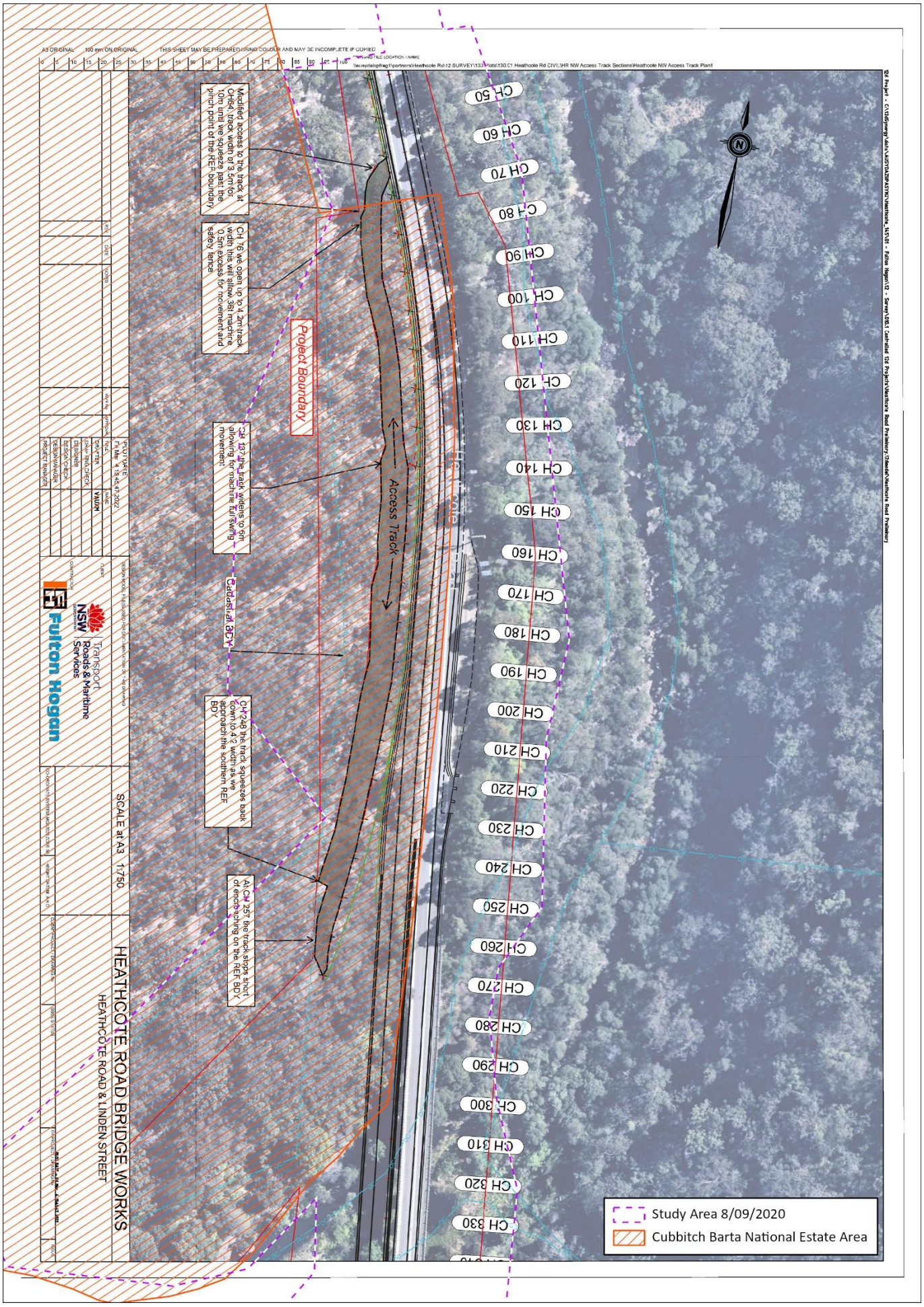


Figure 1. Heathcote Road Bridge over Woronora River – Consistency Assessment Design Adjustments review

From:	LEIGH, Samuel
To:	Katie Schultz; Lachlan Mitchell
Subject:	FW: Heathcote Road Bridge - PACHCI update
Date:	Thursday, 7 April 2022 8:07:41 AM
Attachments:	image001.png was removed from this message.msg image002.png was removed from this message.msg image003.png was removed from this message.msg image006.png image009.png image010.png 20220401_124352.jpg was removed from this message.msg

FYI

From: Matthew Kelleher <matthew.kelleher@knconsult.com.au>
Sent: Friday, 1 April 2022 4:16 PM
To: LEIGH, Samuel <Sam.Leigh@fultonhogan.com.au>
Subject: RE: Heathcote Road Bridge - PACHCI update

Hi Sam,

Kelleher Nightingale Consulting undertook an inspection of the north western extent of the works and the potential scarred tree identified near point 7 in your email (image attached).

The tree scar is not diagnostically cultural with evidence of (branch) tearing along the top and insect damage at the base. No specific cultural markers were visible within or around the scar.

The tree does not pose a constraint for heritage reason.

Please contact me if you have any questions.

All the best,
Matthew

Dr Matthew Kelleher
Director / Archaeologist
Kelleher Nightingale Consulting Pty Ltd
Level 10, 25 Bligh Street, Sydney NSW 2000
p 02 9232 5373 f 02 9223 0680 m 0400 821 264

Site photo: Heathcote Road bridge, vegetation above north-west cutting

Appendix G

Addendum Statement of Heritage Impact

Heathcote Road Bridge

Non-Aboriginal (Historical) Statement of Heritage Impact

Report to Tract on behalf of Transport for NSW

April 2022

artefact

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Australia

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Document history and status

Revision	Date issued	Author	Reviewed by	Date approved	Revision type
1	16/02/2022	SS	SM	16/02/2022	Preliminary Draft
2	28/02/2022	SS	HD		TfNSW review
3	23/03/2022	SS	SM	23/03/2022	Final Draft
4	12/04/2022	SS	SM	08/04/2022	Revised Final

Project number & name:	21172 Heathcote Road Bridge SoHI
Authors:	Sammuel Sammut
Project manager:	Scott MacArthur
Name of organisation:	Artefact Heritage
Document version:	Final

EXECUTIVE SUMMARY

Overview

This Statement of Heritage Impact (SoHI) has been prepared by Artefact Heritage Services (Artefact Heritage) for Tract on behalf of Transport for NSW (the client) to assess the impact of the proposed bridge upgrade on Heathcote Road over Woronora River. In May 2021, Transport for NSW approved a project to widen the existing bridge to improve safety on the bridge and approaches. Since this time, the design has been modified to improve safety and constructability outcomes. Instead of widening the existing bridge, it is proposed to construct an additional single lane bridge on the upstream side of the existing bridge.

The purpose of this SoHI is to assess the potential heritage impacts of the updated preferred design to inform an Addendum review of environmental factors (REF)[1]. This SoHI is supplementary to, and should be read in conjunction with the original SoHI completed for the REF. The original SoHI includes detail on the historical background of the region and provides assessments of heritage significance and archaeological potential of the study area.

The scope of this SoHI includes:

- identification and updated assessment of new or modified features of the proposal compared to the original scope
- review of any changes to statutory advice
- review whether original safeguards can still be satisfied, and,
- identification of any additional management measures required

Conclusions

This report concludes the following:

- Several listed heritage items have been identified within the study area. The impact of the proposed works on these items is summarised below:

Heritage listed item	Direct Impact	Indirect Impact
Woronora River Bridge	**Negligible**	**Minor**
Cubbitch Barta National Estate Area	**Minor**	**Minor**
Kolora Weir	**Nil**	**Negligible**
Woronora-Penshurst pipeline	**Nil**	**Negligible**

[1] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW', 2020.

Heritage listed item	Direct Impact	Indirect Impact
Royal National Park and Garawarra State Conservation Area	**Nil**	**Negligible**

- The construction footprint and work compounds are considered to be areas of low archaeological potential, which is consistent with the previous SoHI.
- On balance, the modified proposal provides a solution which achieves overall positive heritage outcomes. Some minor direct impacts will occur to the Cubbitch Barta National Estate Area, although the impacted area represents a small portion of the heritage item. The proposed bridge duplication represents the design option with the most positive public safety and heritage outcomes.
- No new permits and/or approvals are triggered by the modification.

Recommendations

The following management guidelines have been adapted from the recommendation outlined in the previous SoHI for this project. The recommendations informed the design changes for the current scheme and all recommendations are still applicable. These guidelines should be followed for all aspects of the proposed works:

- In order to ensure the protection of heritage values throughout the detailed design process, it is recommended that heritage reviews take place at the following stages of design process: 30%, 80% and 100% design stage.
- As the Woronora River Bridge meets the criteria for State heritage significance for its technical and aesthetic values, as well as being the sole TfNSW-owned concrete bridge in NSW to exceed 80m in length, a Conservation Management Plan (CMP) is required to outline how the heritage fabric of the item should be managed on an ongoing basis. This is in line with the NSW *Heritage Manual* and its associated guidelines, including the *Statement of Heritage Impact*. This CMP would also investigate the establishment of an extended heritage precinct for Woronora River Bridge, Kolora Weir and former recreation area, and the extant remains of the Heathcote Bridge as an area of local and State heritage significance.
- A Photographic Archival Recording (PAR) of the Woronora River Bridge and any associated heritage items to be impacted (particularly Cross Drain Exist-01) should be undertaken prior to works commencing. This would create a record of the item's appearance prior to construction works and document the views to and from the item which will be affected by the proposed works. A PAR would help to mitigate the indirect impacts cause by the new bridge. To ensure total impacts are catalogued, an archival recording at the completion of works is also recommended.
- To reduce direct and indirect impacts to the Woronora River Bridge, the following should be undertaken as part of the detailed design and planning stages:

  - Retain as much of the original fabric of the Woronora River Bridge as possible
  - Apply the sympathetic bridge design and sandstone capping plan outlined in the proposed works section of this assessment (Section 1.3)
  - Undertake colour and material matching for necessary repair and maintenance works
  - An appropriately qualified structural engineer to undertake an assessment of structural integrity for each element to be removed and/or replaced prior to removal as part of repair and maintenance works. Only replace elements which are at risk of falling. When the scope of maintenance works has been decided upon a conservation architect should be consulted in order to confirm that they are appropriate and will not cause significant heritage impacts to the item
  - Use discrete fencing with hoarding or fabric for Woronora River Bridge during works
- To reduce direct and indirect impacts to other heritage items during works, the following should be implemented:
  - Regularly monitor vibrations levels during works
  - Erect an exclusion zone around the survey marker tree (if located during works) until an archival recording and salvage of the item is conducted. The survey marker to be used as part of an interpretive display
- An Unexpected Finds Procedure should be implemented should any archaeological resources or previously unknown heritage items be identified during the course of the proposed works.
- All contractors on the project should receive a site-specific heritage induction outlining the significance of the area and the Unexpected Finds Procedure.

CONTENTS

FIGURES

TABLES

1.0 INTRODUCTION

1.1 Project background

This Statement of Heritage Impact (SoHI) has been prepared by Artefact Heritage Services (Artefact Heritage) for Tract on behalf of Transport for NSW (the client) to assess the impact of the proposed bridge upgrade on Heathcote Road over Woronora River. In May 2021, Transport for NSW approved a project to widen the existing bridge to improve safety on the bridge and approaches. Since this time, the design has been modified to improve safety and constructability outcomes. Instead of widening the existing bridge, it is proposed to construct an additional single lane bridge on the upstream side of the existing bridge (the proposal).

The purpose of this SoHI is to assess the potential heritage impacts of the updated preferred design to inform an Addendum review of environmental factors (REF). This SoHI is supplementary to, and should be read in conjunction with the original SoHI completed for the REF[2]. The original SoHI includes detail on the relevant historical background of the region, and provides assessments of heritage significance and archaeological potential of the study area.

Consistent with the REF assessment the study area is the location shown as 'construction footprint' and 'work compounds' on figure 1.

The scope of this SoHI includes:

- identification and updated assessment of new or modified features of the proposal compared to the original scope
- review of any changes to statutory advice
- review whether original safeguards can still be satisfied, and,
- identification of any additional management measures required.

1.2 Location

The site of this proposal (the study area) is located within the Sutherland Shire Local Government Area (LGA), and spans the suburbs of Engadine, Heathcote, Holsworthy and Lucas Heights (Figure 1). The study area for the proposed bridge upgrade is consistent with the area assessed for the original REF.

[2] Biosis.

Figure 1: Study area.

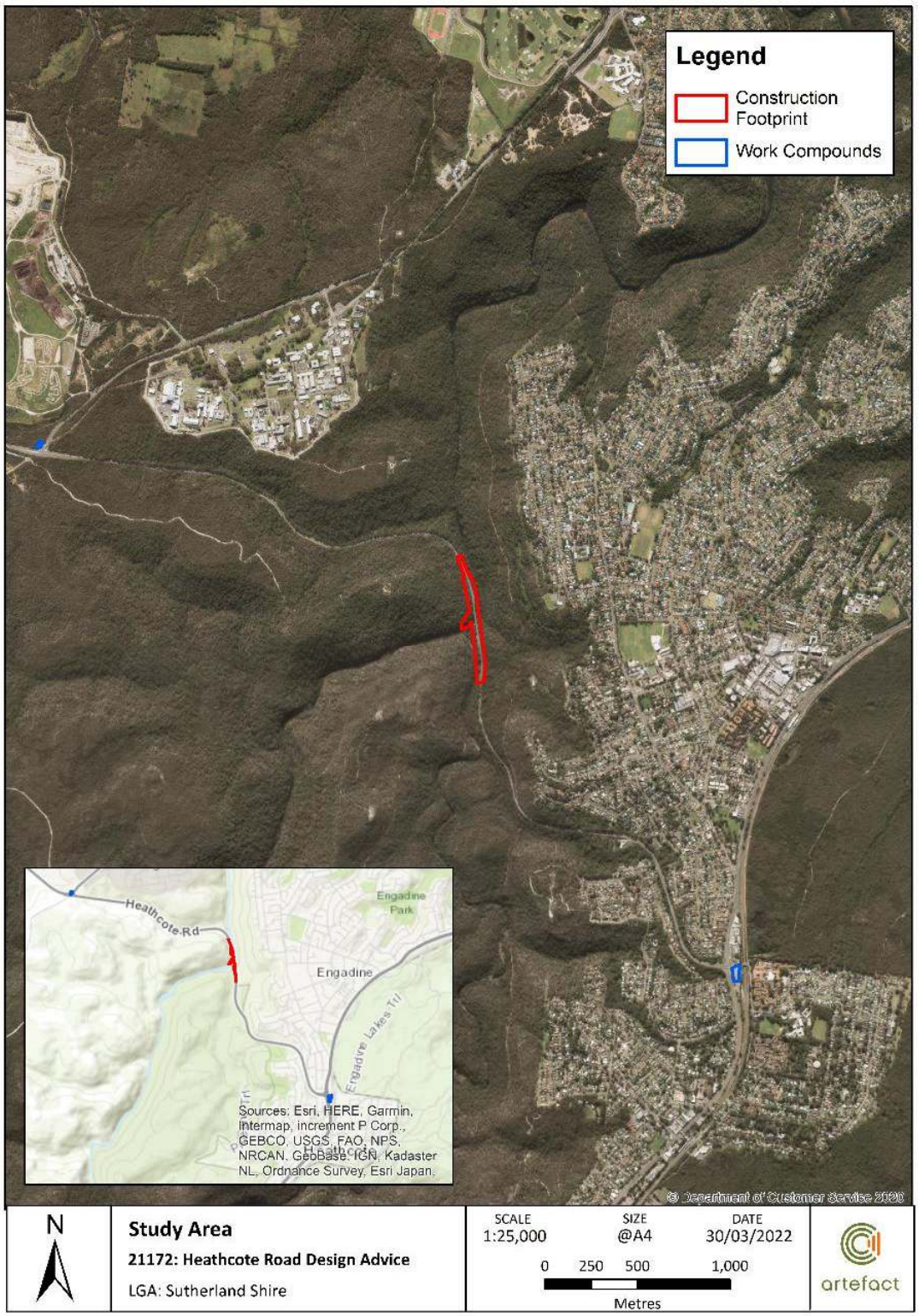


Figure 2: Construction footprint for proposed bridge and associated roadworks.

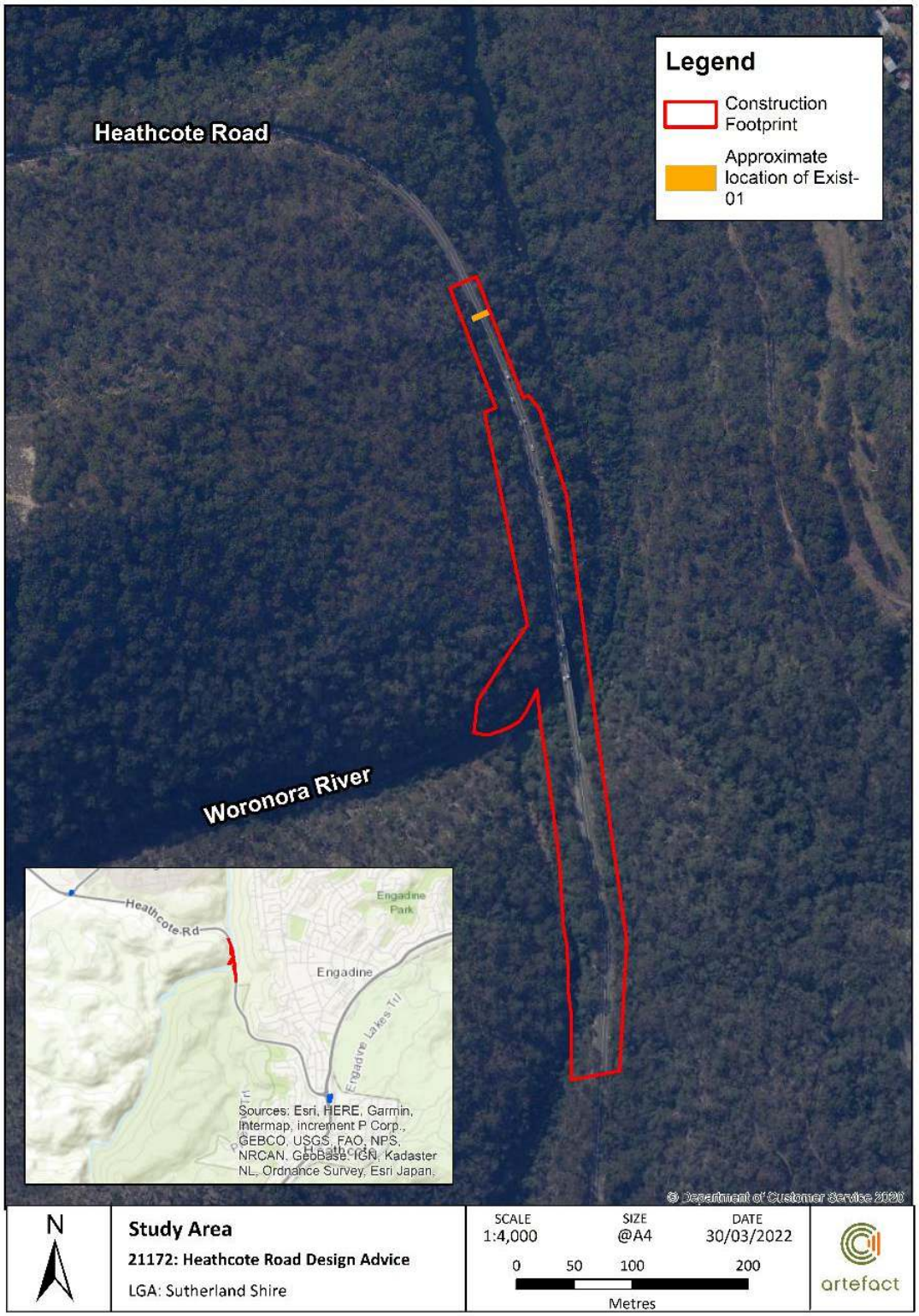


Figure 3: Compound 1.

Figure 4: Compound 2.

1.3 Proposed works

1.3.1 Key features

A summary table of key features of the proposal and comparison to the original project scope is provided in Table 1. Those features which are modified or additional to the original scope are further assessed within this supplementary SoHI assessment. Other common scope features are captured within the original SoHI.

Table 1: Key features of the proposal and comparison to the original scope.

Original REF Scope – Bridge upgrade by widening	Proposed works – Duplicate single-lane bridge
Widening of the bridge by about 1.4 metres on each side to provide one wide 3.5 metre lane in each direction with 1.2 metre shoulders	Widening the existing bridge structure is no longer proposed. The updated scope proposes to construct a new bridge on the upstream side, parallel to the existing bridge. Refer to Section 1.3.2 of this assessment for bridge design details. Abutments would also be modified to include the new bridge footprint. The approved project design planned to remove sandstone at the abutments and re-use it by incorporating it elsewhere in the design however further investigation has since found the stone to be a capping layer only. It is now proposed to cover the stone facing to preserve it and construct over it to expand the abutment to accommodate both bridges
Widening and adjustments to the northern and southern bridge approaches about 250 metres either side of the bridge to improve the road alignment, increase lane and shoulder widths and reinstate the existing breakdown bays either side of the bridge	Widening of the bridge approaches is still required through the length of work is reduced and widening is slightly greater on the western side, and slightly less on the eastern side. The proposed modification would result in the removal of the northbound breakdown bay, however the proposed wide shoulders on the new bridge maintain the ability for a vehicle to pull over into the shoulder and allow traffic to pass.
New bored-pile retaining walls to support the slope along both bridge approaches, which would be up to two metres high and range in length up to 100 metres	The retaining wall on the northern approach (eastern side) is no longer required due to the alignment shifting slightly west. The retaining wall on the southern approach (western side) is substantially reduced in length.
Slope stabilisation measures including rock scaling, shotcreting, rock bolting, rock netting, and vegetation removal	Slope stabilisation works are still required. Due to the alignment shifting slightly west, the modified design requires slightly greater rock cutting works on the northern approach (western side) (Figure 37 and 38). On the southern approach, the scope of slope stabilisation works is slightly reduced.

Original REF Scope – Bridge upgrade by widening	Proposed works – Duplicate single-lane bridge
New and modified drainage infrastructure including replacement and extension of existing cross culvert pipes on the approaches for the widened road pavement, improved drainage gutter along the base of the rock cuttings, new longitudinal drainage outlet at each abutment and scour protection at all discharge points	Some drainage upgrades are still required Additionally, an access track (with variable width between 3.5 and 6 metres) would also be required at the top of the north-west cutting to safely excavate the new rock cut face. This access track would remain in place as a bench in the cutting which would assist with future maintenance access There would be additional drainage works required on the northern approach about 30 metres north of the approved project boundary. At this location, a cross drainage line would be upgraded to divert drainage away from the proposed modification. These works are needed to prevent flows overtopping the upstream drainage network resulting in sheet flows into the project area. Modified design for longitudinal drainage outlets at batters with scour protection chutes down the batter face.
Adjustments to optical fibre conduits for the length of the proposal area	Fibre optical conduits will be avoided for the piling, no change to the existing infrastructure
Repair and maintenance work to the existing bridge structure including: • repairs to cracks • replacement of all bearings • joint replacement • application of an anti-carbonation coating on the bridge structure including piers • installation of new steel maintenance staircase for side access to the bridge for bridge inspections	Repair and maintenance works are still required, consistent with original scope. This includes upgrades to the edge safety barriers. The change in scope will also require the existing bridge deck to be converted to a single lane with wide shoulders. This conversion will include resurfacing and line-marking works.
Other ancillary work required to support construction of the proposal including two off site construction compounds and establishment of a temporary access track, waterway crossing and crane pads	Construction compound locations are considered consistent with the original REF and SoHI. Any change to the proposed compound locations would be addressed in separate assessment and approval. Temporary works have been modified to allow for the construction of the new bridge and road works. The waterway access is required to be slightly larger, and a new access track is required on the edge of the NW cut

The existing bridge is listed on the TfNSW s170 heritage register; however, is not formally listed on the State Heritage Register. The existing bridge is recognised to have State-level heritage significance, for aesthetic, historic, and technical criteria. This SoHI was therefore developed in

collaboration with the Urban Design specialist assessment (Tract 2020) to ensure a holistic consideration of bridge design on the aesthetic significance.

1.3.2 Duplicate bridge design

The superstructure of the bridge is a 6.9m width bridge (excluding edge barriers) with super-T girders and a composite cast in-site deck slab (Figure 5 and Figure 6). The proposed bridge is comprised of five spans and will measure approximately 130m in length and match the height of the existing bridge. The proposal will introduce a physical barrier between the opposing traffic lanes and provide for a 3.5 metre traffic lane and wide shoulder in each direction across the bridge. The bridge will be constructed primarily out of concrete, with steel elements for the barriers and asphalt for the road surface.

The substructure consists of four new piers, which align with the existing piers (Figure 7 and Figure 8). These features have been designed to match the skew and width of the existing piers, as well as featuring an octagonal form to further complement the existing bridge piers.

The proposed bridge will also be coloured in a manner that is intended to complement the existing structure. The new bridge will feature a colour scheme that is broadly similar to the present Woronora River Bridge, but one that is still able to be distinguished from the heritage item. This is intended to support the relationship between the two structures in a respectful and complementary manner. This visual design is in line with the TfNSW Bridge Aesthetics Guide, which does not require the proposed bridge to match the existing bridge's colour.

The proposed works will also involve modification to the existing bridge's abutments (Figure 9). The original SoHI assessed construction plans which involved the removal of the sandstone and its reuse elsewhere in the design; however, subsequent investigation revealed that the sandstone elements are cladding. The new design proposes to cap the sandstone cladding in order to protect and conserve it. This would involve placing a protective geofabric separation layer between the sandstone cladding and a new concrete abutment return wall. In this way, the new abutment will clearly delineate itself from the original form, minimise disturbance at the connection point, and allow the new abutment wall to align with the existing wall.

1.3.3 Enhancing drainage inlet capacity

The design team responsible for the project identified a flow width issue within 100m of the northern tie-in. Spread of flow was observed encroaching on the northbound traffic lane, caused by a large amount of runoff in the informal drain at the base of the rock cutting entering the northern extent of the project boundary. Several existing cross drains on the approach to the northern tie-in have been identified which capture runoff from the large external catchments upstream of the works area.

Several design options were presented to rectify this safety concern; however, the preferred option involves enhancing the inlet capacity of the cross drain closest to the construction footprint's northern boundary, which is referred to in design documents as Cross Drain Exist-01 (Figure 10). This would involve decommissioning the existing culvert inlet pipe and installing four double SO grated inlets in new SO kerb. The 675mm diameter culvert has sufficient capacity to manage the additionally flow due to its size and grade (3.8%). Cross Drain Exist-01, which is shown as measuring 750mm in survey plans, has been relined recently to a 675mm diameter and has been found to be in better condition than other nearby culverts. Moreover, the outlet of Cross Drain Exist-01 flows on to an existing sandstone chute that will mostly contain the flows in the 2% AEP event in the enhanced inlet scenario.

Figure 5: Overview of proposed works and key features (Provided by Fulton Hogan).

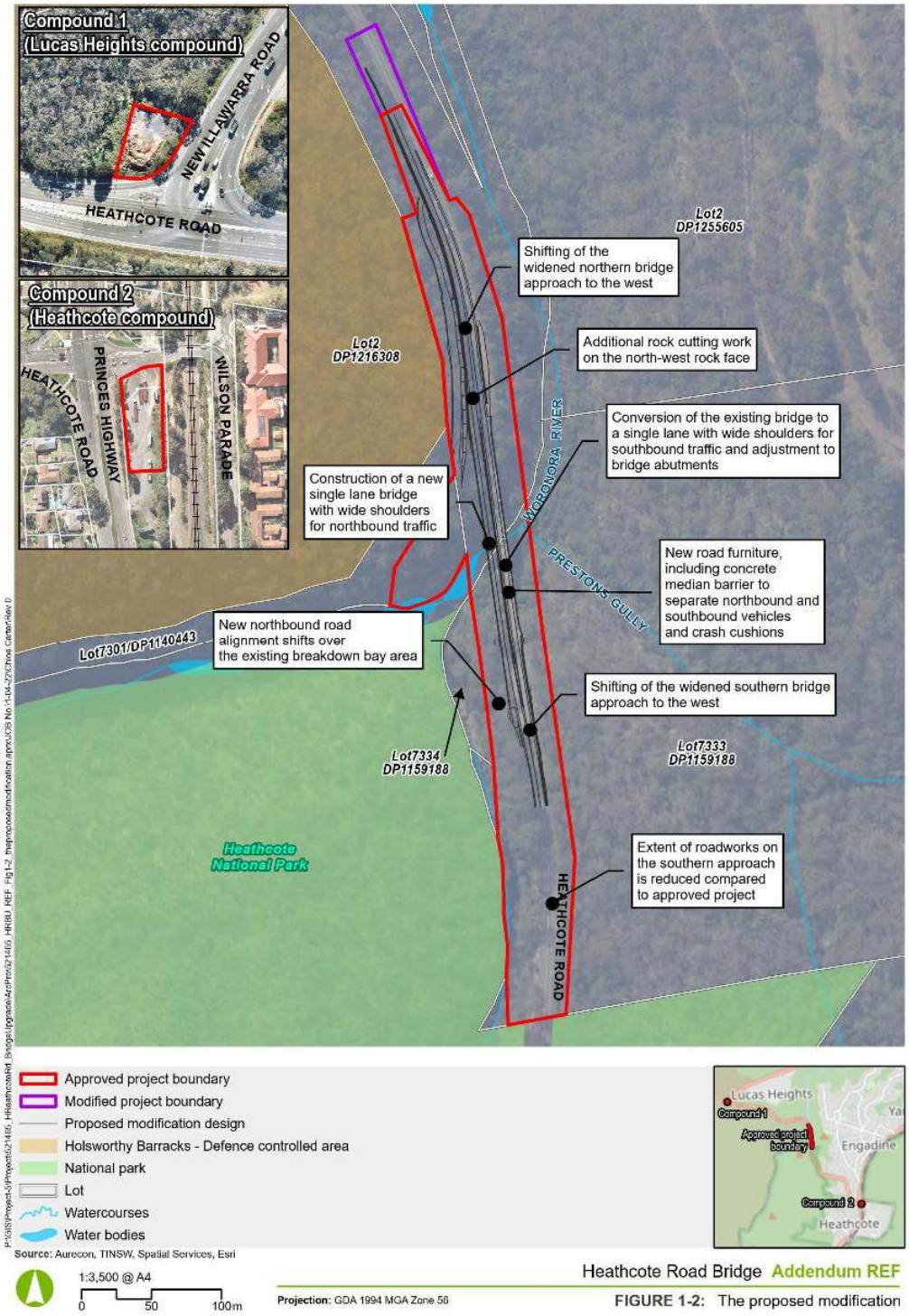


Figure 6: Cross section sketches of the proposed bridge duplication. The new bridge structure is shown on the right (Source – Urban Design Report, Tract 2022).

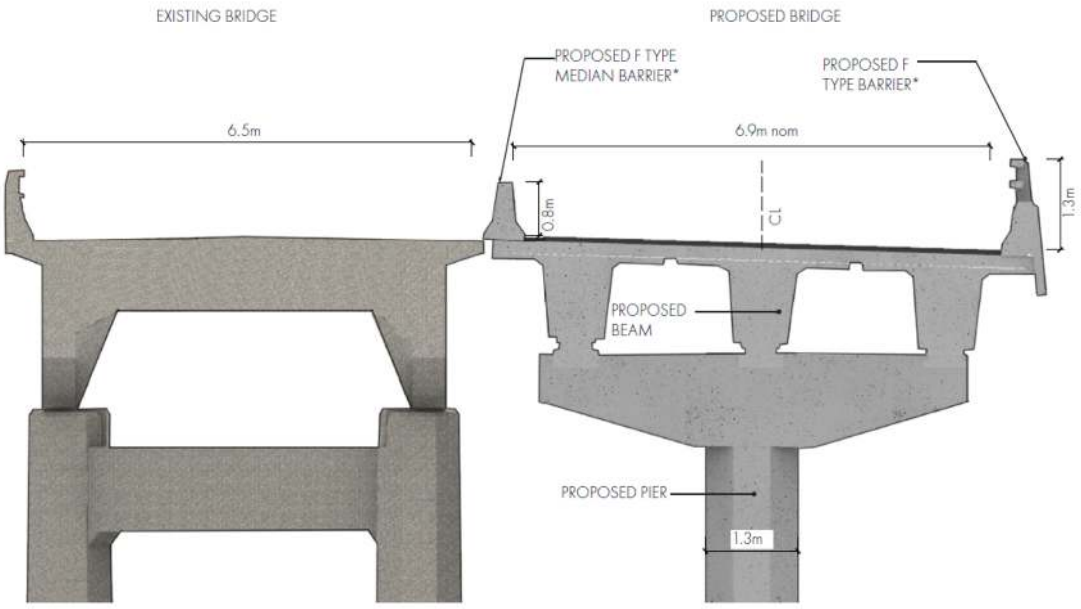


Figure 7: Comparison view showing the change with the addition of the duplicate upstream bridge (Source – Urban Design Report, Tract 2022)..

Elevation view of the existing bridge.

Elevation view with the additional upstream bridge.

Figure 8: Photo montage comparison of the current and previous proposals compared to existing structure (Source – Urban Design Report, Tract 2022).

Existing bridge.

Proposed design.

Previous design.

Figure 9: Abutment treatment (Source – Urban Design Report, Tract 2022).

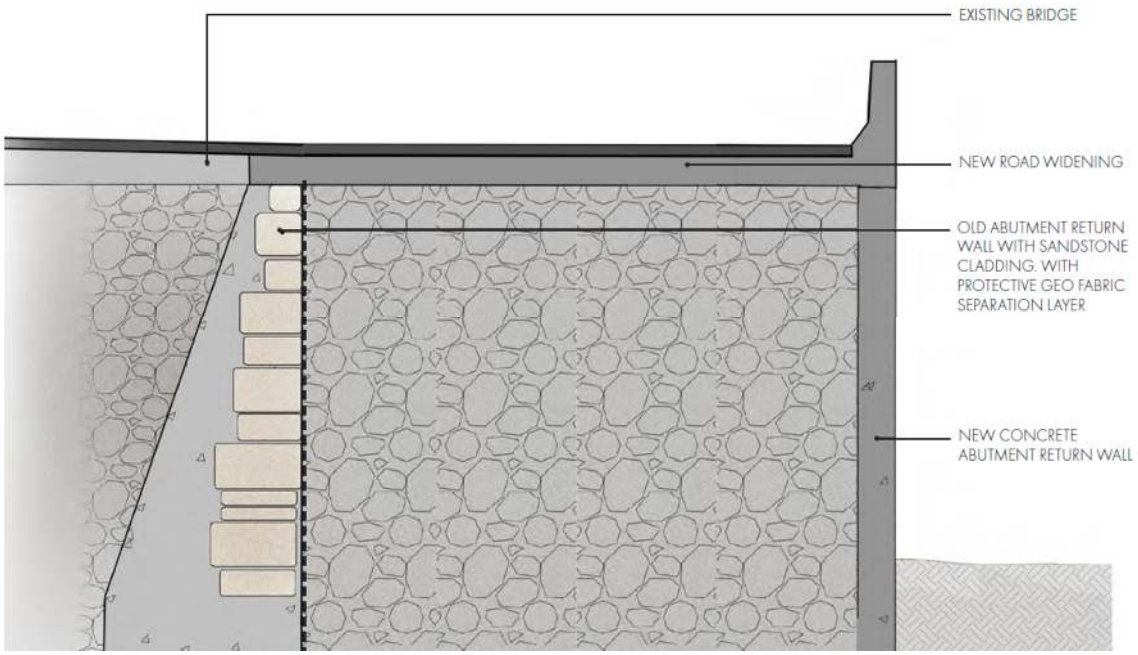
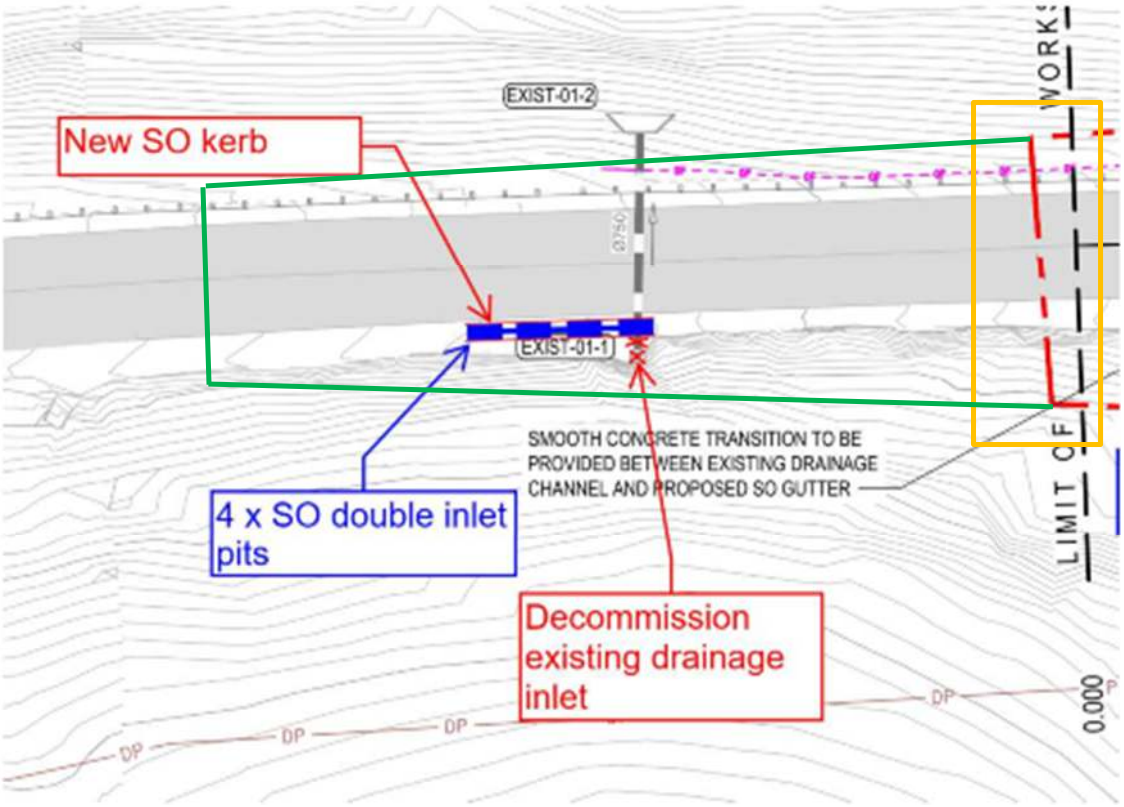


Figure 10: Plan of proposed inlet capacity enhancement for Cross Drain Exist-01 (Plan provided by Fulton Hogan). Previous project boundary outlined in orange and approximate location of new project boundary marked by green line.



1.4 Report limitations

Background research prepared for this assessment does not involve the review of primary historical sources and is derived from existing secondary historical sources. Likewise, the assessments of significance are derived from existing heritage listing information. Furthermore, this report does not include an assessment of Aboriginal archaeology and cultural heritage.

1.5 Authorship

This report was prepared by Sammuel Sammut (Heritage Consultant) and Scott MacArthur (Senior Associate). Management input and review was provided by Dr. Sandra Wallace (Managing Director).

2.0 LEGISLATIVE CONTEXT

2.1 Overview

This section discusses the heritage management framework, notably legislative and policy context, applicable to the study area.

2.2 Identification of heritage listed items

There are several items of legislation relevant to the proposed works locations. The following state and federal statutory heritage registers were searched to identify whether the works locations were listed on them:

- World Heritage List (WHL)
- Commonwealth Heritage List (CHL)
- National Heritage List (NHL)
- State Heritage Register (SHR)
- Sutherland Shire Local Environmental Plan (LEP) 2015
- Section 170 Heritage and Conservation Registers.

Non-Statutory registers were also searched, including:

- Register of the National Estate (RNE)
- The National Trust Register

Items listed on these registers have been previously assessed against the NSW *Archaeological Assessment Guidelines*.[3] Statements of heritage significance, based on the NSW Heritage Assessment guidelines, as they appear in relevant heritage inventory sheets and documents, are provided in this assessment.

2.3 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) provides a legislative framework for the protection and management of matters of national environmental significance, that is, flora, fauna, ecological communities and heritage places of national and international importance. Heritage items are protected through their inscription on the World Heritage List, Commonwealth Heritage List or the National Heritage List. The EPBC Act stipulates that a person who has proposed an action that will, or is likely to, have a significant impact on a World, National or Commonwealth Heritage site must refer the action to the Minister for Sustainability, Environment, Water, Population and Communities (hereafter Minister). The Minister will then determine if the action requires approval under the EPBC Act. If approval is required, an environmental assessment would need to be prepared. The Minister would approve or decline the action based on this assessment. A significant impact is defined as “an impact which is important, notable, or of consequence, having regarded to its context or intensity.” The significance of the action is based on the sensitivity, value and quality of the environment that is to be impacted, and the

[3] NSW Heritage Office, 1996. *NSW Heritage Manual, the Archaeological Assessment Guidelines*; NSW Heritage Office, 2009. *Assessing Significance for Historical Archaeological Sites and ‘Relics’*; NSW Heritage Office, 2009. *Guidelines for the Preparation of Archaeological Management Plans*.

duration, magnitude, and geographic extent of the impact. If the action is to be undertaken in accordance with an accredited management plan, approval is not needed and the matter does not need to be referred to the Minister.

2.3.1 Commonwealth Heritage List

The Commonwealth Heritage List has been established to list places of outstanding heritage significance to Australia. It includes natural, historic and Indigenous places that are of outstanding national heritage value to the Australian nation.

There is **one** item listed on the Commonwealth Heritage List within the construction footprint:

- Cubbitch Barta National Estate Area – 105405 (SHI 1970121)

There is **one** listed item within 200m of works compound 1:

- Cubbitch Barta National Estate Area – 105405 (SHI 1970121)

2.3.2 National Heritage List

The National Heritage List has been established to list places of outstanding heritage significance to Australia. It includes natural, historic and Indigenous places that are of outstanding national heritage value to the Australian nation.

There are **no** items on the National Heritage List within the construction footprint or works compounds.

There is **one** listed item within 200m of works compound 2:

- Royal National Park and Garawarra State Conservation Area – 105893

2.4 Heritage Act 1977

The NSW *Heritage Act 1977* is the primary item of State legislation affording protection to items of environmental heritage in NSW. The Heritage Act is designed to protect both listed heritage items, such as standing structures, and potential archaeological remains or relics.

Under the Heritage Act, 'items of environmental heritage' include places, buildings, works, relics, moveable objects and precincts identified as significant based on historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic values. State significant items are listed on the NSW State Heritage Register (SHR) and are given automatic protection under the Heritage Act against any activities that may damage or affect its heritage significance.

2.4.1 State Heritage Register (SHR)

The SHR was established under Section 22 of the Heritage Act and is a list of places and objects of particular importance to the people of NSW, including archaeological sites. The SHR is administered by Heritage NSW and includes a diverse range of over 1,500 items, in both private and public ownership. To be listed, an item must be deemed to be of heritage significance for the whole of NSW.

To carry out activities within the curtilage of an item listed on the SHR, approval must be gained from the Heritage Council by securing a Section 60 permit. In some circumstances, under Section 57(2) of

the Heritage Act, a Section 60 permit may not be required if works are undertaken in accordance with the NSW Heritage branch document *Standard Exemptions Guidance Document*.

There are **no** items listed on the SHR within the construction footprint or works compounds

There are **no** listed items within 200m of the construction footprint or works compounds.

2.4.2 Section 170 registers

Under the Heritage Act all government agencies are required to identify, conserve and manage heritage items in their ownership or control. Section 170 requires all government agencies to maintain a Heritage and Conservation Register that lists all heritage assets and an assessment of the significance of each asset. They must ensure that all items inscribed on its list are maintained with due diligence in accordance with State Owned Heritage Management Principles approved by the Government on advice of the NSW Heritage Council. These principles serve to protect and conserve the heritage significance of items and are based on NSW heritage legislation and guidelines.

There is **one** item listed on the Roads and Maritime Services Section 170 Heritage and Conservation Register within the construction footprint:

- Woronora River Bridge – RTA Bridge No. 152 (SHI 4309580).

There is **one** item listed on the Sydney Water Section 170 Heritage and Conservation Register within 200m of the construction footprint:

- Woronora-Penshurst Pipeline (SHI 4570509)

2.5 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) establishes the framework for cultural heritage values to be formally assessed in the land use planning and development consent process. The EP&A Act requires that environmental impacts are considered prior to land development; this includes impacts on cultural heritage items and places as well as archaeological sites and deposits. The EP&A Act requires that Local Governments prepare planning instruments (such as Local Environmental Plans [LEPs] and Development Control Plans [DCPs]) in accordance with the Act, to provide guidance on the level of environmental assessment required.

2.5.1 Sutherland Shire Local Environmental Plan 2015

Local Environmental Plans (LEPs) are prepared by councils in accordance with the EP&A Act to guide planning divisions for LGAs. The aim of LEPs in relation to heritage is to conserve the heritage significance listed within this schedule.

The study area falls within the boundary of the Sutherland Shire LGA, which falls under the Sutherland Shire LEP 2015.

There are **no** items listed on the Sutherland Shire LEP 2015 within the construction footprint or work compounds.

There are **two** listed items within 200m of the construction footprint:

- Kolora Weir – A1801 (SHI 2440843)
- Woronora-Penshurst Pipeline – A4302 (SHI 2440830)

2.5.2 State Environmental Planning Policy (Transport and Infrastructure) 2021

With the March 2022 updates to the SEPPs, the former Greater Metropolitan Regional Environmental Plan No 2 – Georges River Catchment was incorporated into the State Environmental Planning Policy (Biodiversity and Conservation) 2021.

The Infrastructure SEPP assists local government, the NSW Government and the communities they support, by simplifying the process for providing essential infrastructure in areas such as education, hospitals, roads and railways, emergency services, water supply and electricity delivery.

The Infrastructure SEPP outlines the planning rules for these works and facilities, including:

- The Infrastructure SEPP outlines the planning rules for these works and facilities, including:
- Where such development can be undertaken;
- What type of infrastructure development can be approved by a public authority under Part 5 of the Environmental Planning and Assessment Act (EP&A Act) following an environmental assessment (REF) (known as 'development without consent');
- What type of development can be approved by the relevant local council, Minister for Planning or Department of Planning under Part 4 of the EP&A Act (known as 'development with consent');
- What type of development is exempt or complying development;
- The relationship of other statutory planning instruments to the Infrastructure SEPP.

This SoHI will form part of the REF submission to Transport for NSW for assessment under Part 5 of the EP&A Act.

2.6 Non-statutory consideration

2.6.1 Register of the National Estate

The Register of the National Estate (RNE) lists historic, Aboriginal and natural heritage places throughout Australia. Originally established under the *Australian Heritage Commission Act 1975,* the RNE entered more than 13 000 places into the register, The RNE was frozen on 19 February 2007 following amendments to the *Australian Heritage Council Act 2003.* It ceased to be a statutory register in February 2012. The RNE is now maintained on a non-statutory basis as an archive and educational resource.

There are **no** items listed on the Register of the National Estate within the construction footprint or work compounds.

There are **no** listed items within 200m of the construction footprint or work compounds.

2.6.2 National Trust of Australia (NSW)

Listing on the National Trust Heritage Register does not impose statutory obligations and is more an indication of the heritage significance held by the community.

There are **no** items listed on the National Trust Heritage Register within the construction footprint or work compounds.

There are **no** listed items within 200m of the construction footprint or work compounds.

2.7 Summary of Heritage Listings

The search of heritage registers has identified several listings within the vicinity of the proposed works locations (Figure 11-Figure 14), which are listed below:

Table 2: Heritage listings for the proposed works locations.

Item name	Heritage Listings	SHI Number	Distance from investigation area
Woronora River Bridge	RMS s170 Heritage and Conservation Register	4309580	Within construction footprint
Cubbitch Barta National Estate Area	Commonwealth Heritage List	1970121	Within proposal area 50m from compound 1
Kolora Weir	Sutherland Shire LEP 2015	2440843	80m from construction footprint
Woronora-Penshurst Pipeline	Sutherland Shire LEP 2015 Sydney Water s170 Heritage and Conservation Register	2440830	180m from construction footprint
Royal National Park and Garawarra State Conservation Area	National Heritage Register		80m from compound 2

Figure 11: Heritage items within the study area.

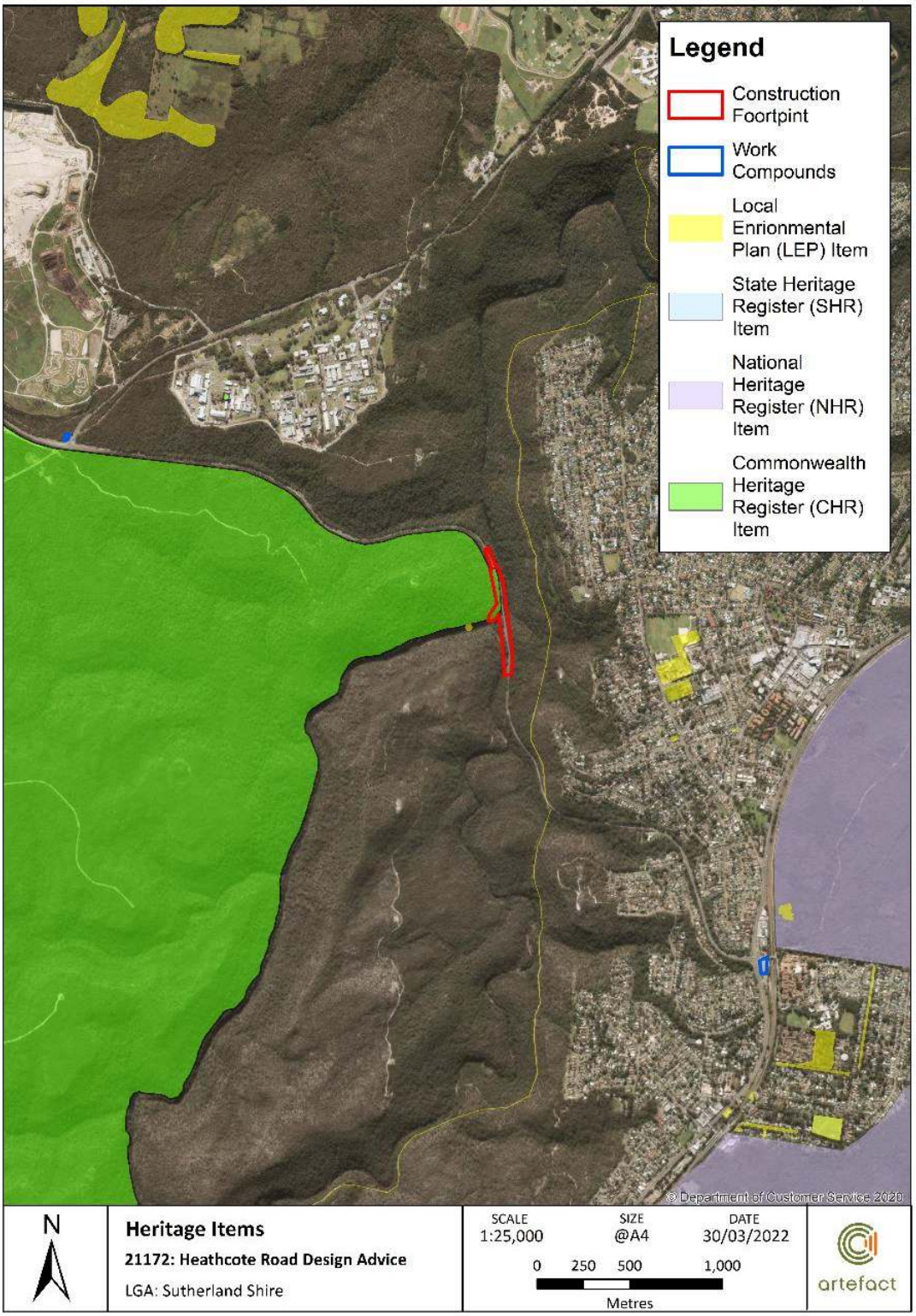


Figure 12: Heritage items in the vicinity of the construction footprint.

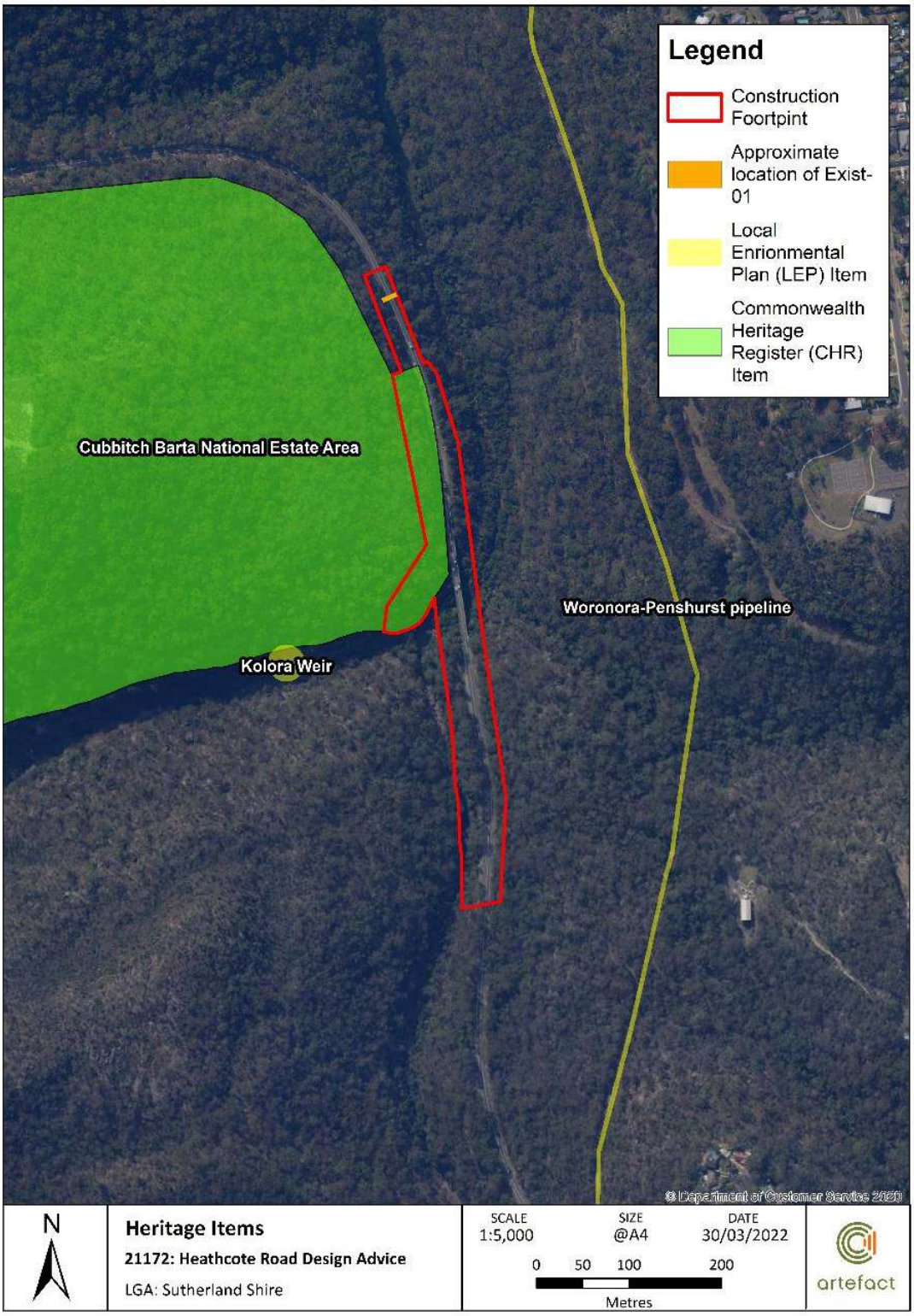


Figure 13: Heritage items in the vicinity of compound 1.

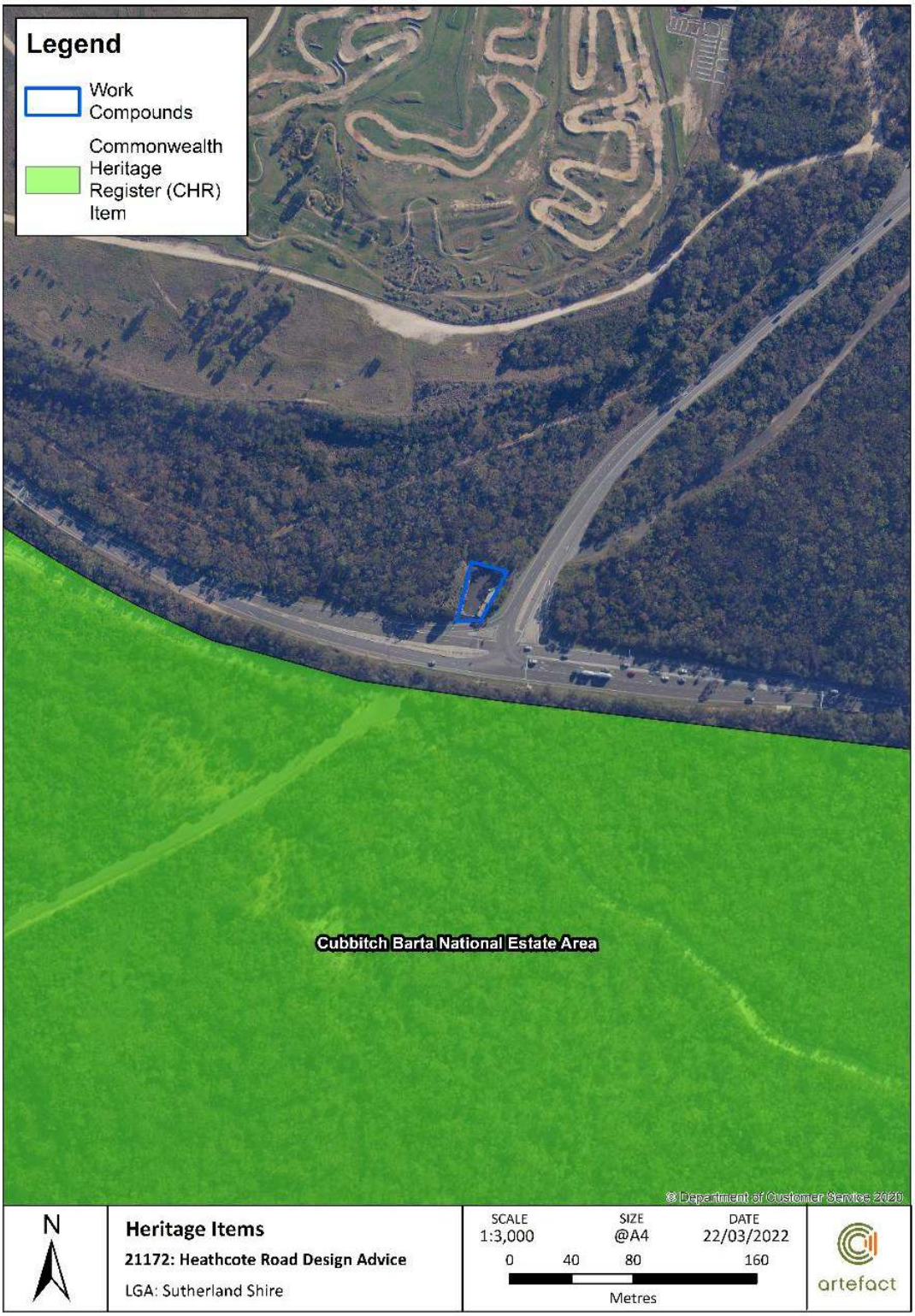


Figure 14: Heritage items in the vicinity of compound 2.

3.0 HISTORICAL CONTEXT

3.1 Aboriginal history of the Sutherland Shire

Aboriginal people have inhabited Australia for more than 60,000 years. Although there is debate about the specific territory, range and nature of Aboriginal language groups within the Sydney region prior to British colonisation, it is generally acknowledged that the Sutherland Shire was occupied by the Dharawal and Gandangara peoples. The land of the Dharawal extended from Kurnell in the north to Nowra in the south, and as far west as the Camden area. The Dharawal were divided into clans, with the Royal National Park occupied by the Tagary[4]. The Gandangara occupied the lands around the George's River, to the west of the study area. The close proximity and permeable borders of the two groups' undoubtedly mean there was frequent contact between the Dharawal and the Gandangara.

These groups occupation of the Sutherland Shire area is certainly linked to the abundant resources that were found in the region. The abundant aquatic and terrestrial resources found in the area would have supplied the Dharawal and Gandangarra peoples with plentiful dietary and material resources[5]. Consequently, many Aboriginal sites and have been identified in the Sutherland Shire, evidencing the widespread and longstanding occupation of this region prior to and during British colonisation.

The arrival of the British colonists in Port Jackson proved devastating to both the Dharawal and Gandangarra clans, as well as to Aboriginal people as a whole. By settling in the territory, the British displaced these Aboriginal people from their traditional lands and ultimately forced them into other areas. The British colonists also introduced Aboriginal people to diseases like smallpox, which proved devastating to Australia's Aboriginal population.

3.2 Development of the Woronora River region

3.2.1 Exploration of the Woronora River (1789 – 1835)

Shortly after their arrival, British colonists set about exploring the Sydney region in search of territory to settle on and resources to acquire. Bass and Flinders obtained permission to explore the region south of Botany Bay in 1796. Through their exploration, they came across the region today known as Port Hacking which contained the mouth of the Woronora River[6]. In the following decades, land around the present Sutherland Shire was granted by Governor Hunter. James Birnie, a mercantile trader, was granted 700 acres in Kurnell in 1815 and by 1821, John Connell, a businessman, had purchased several large tracts of land within the Sutherland and Holsworthy parishes[7]. However, development further south along the Woronora River occurred far more slowly, with few land grants and Crown land sales occurring before 1856[8]. The few grants that were bestowed during this period were intended to encourage farming within the region.

Given the underpopulated nature of the region at this time, references to the Woronora River area appear limited and occurred most frequently in reference to the construction of the Illawarra railway line[9]. Yet, after the Parish of Heathcote was gazetted in 1835, the southern portion of the Woronora

[4] Mary Dallas Consulting Archaeologists, 'Sutherland Shire Council Aboriginal Cultural Heritage Study, Georges and Woronora Rivers' (Report to Sutherlannd Shire Council, 2004).
[5] Bill Gammage, *The Biggest Estate on Earth: How Aborigines Made Australia* (North Sydney: Allen & Unwin, 2012).
[6] M.H. Neve, 'A Brief History of Sutherland Shire', Sutherland Shire Studies, n.d.
[7] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.
[8] Neve, 'A Brief History of Sutherland Shire'.
[9] Business Intelligence Team, 'Origin of Suburbs: Sutherland', 2018.

River began to gradually be developed. This resulted in the development of the suburbs of Heathcote, Lucas Heights, Menai, Bangor and Engadine throughout the remainder of the 19th century.

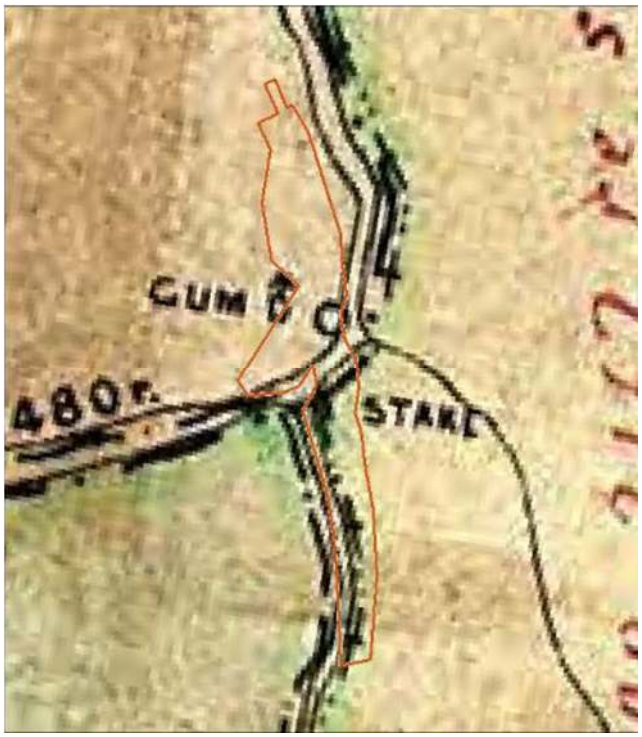
3.2.2 Development of towns around the southern Woronora River (1835 – 1920)

The southern Woronora River region was first mapped in 1843 as the original southern route of the Illawarra route was plotted[10]. The first village in the region was initially called Bottle Forest, although it was later renamed Heathcote for the Parish it was situated in[11]. Though the early town was small and featured small allotments, they housed large, wealthy manors like the now heritage listed Heathcote Hall[12]. A newspaper article from 1886 described the considerations surrounding building a railway station at Bottle Forest as 'extensive…not to be entered upon without due consideration', which further emphasise the small nature of the early town[13]. By 1879, approximately 7,000 hectares of Crown land was set aside as National Park under the Crown Land Alienation Act of 1861[14]. This action would lead to the subsequent establishment of the Heathcote and Royal National Parks, which border the modern suburb of Heathcote. The abundance of trees within the National Park area meant that the Heathcote area acted as an important source for timber supplies to support the developing region around it[15]. Parish maps from 1903 show that the Heathcote National Park area had been reserved from development for this purpose, and the tree used as the survey marker for the map is recorded at the bend in the Woronora River; the tree is noted as a gum tree with a broad arrow and a 'D' as the survey mark (Figure 15 and Figure 16).

Figure 15: 1903 parish map, construction footprint in orange (Source: NSW HLRV).

[10] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.
[11] Biosis.
[12] 'Historic Heathcote Hall', *The Daily Telegraph*, 5 May 1927.
[13] 'Historic Heathcote Hall'.
[14] 'National Park', *New South Wales Government Gazette*, 1879.
[15] NSW National Parks and Wildlife Service, 'Royal National Park, Heathcote National Park and Garawarra Stare Recreation Area Plan of Management', 2000.

Figure 16: Detail from 1903 parish map (Source: NSW HLRV).



As was the case in many towns in NSW at this time, Heathcote's urban development was spurred on by the installation of railway infrastructure in 1886[16]. Newspaper reports from this year detail how the construction of the railway at Heathcote would allow access to extensive coal beds, dramatically increasing growth in the region[17]. Furthermore, it was anticipated that the ensuing growth in commercial activity would be able to pay for the line's construction[18]. Mining permits and mineral leases were consequently granted in the area surrounding Heathcote to further capitalise on the area's newly found economic potential[19].

The towns surrounding Heathcote developed at a much slower pace. The Holsworthy area was declared a permanent army encampment in 1910 by Lord Kitchener[20]. Formalised by the government in 1913, the Holsworthy military area encompassed some 6826 hectares of land and incorporated the modern town of Lucas Heights as well as the study area this report focuses on[21]. At this time, the Holsworthy base was connected to the north by the Old Illawarra Road, which was the only contemporaneous route between Sydney and Wollongong. Engadine, which is to the northeast of the study area, originated as a small parcel of privately-owned land, purchased by Charles McAlister in 1887 during a Crown land auction[22]. It also developed slowly, up until the construction of a school in 1910 and the connection to the Illawarra railway line in 1920.

[16] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.
[17] 'Trial Survey from Bottle Forest to Moss Vale', *Bowral Free Press and Berriman District Intelligencer*, 1886.
[18] 'Trial Survey from Bottle Forest to Moss Vale'.
[19] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.
[20] Biosis.
[21] Business Intelligence Team, 'Origin of Suburbs: Sutherland'.
[22] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.

3.2.3 Early infrastructure projects in the Woronora River region (1920 to 1941)

The 1920s saw the beginning of several infrastructure projects that were intended to support the growth of the Sutherland Shire region. The Kolora Weir, which is located approximately 350m west of the study area, was one of the earliest infrastructure projects built for this purpose. The Woronora Dam was designed as a meant to stop the recurring water shortages that affected the Sutherland Shire in the early 20th century[23]. While works on the dam commenced in 1926, they were stopped shortly after due to the economic hardship created by the Great Depression. As it became apparent that Woronora Dam's completion would be delayed indefinitely, the Water Board constructed the Kolora Weir in the early 1930s as a stopgap measure until the dam could be completed[24]. The Kolora Weir (which consisted of two separate weirs that formed a body of water referred to as Lake Kolora) was utilised for water supply up until 1938, due to the resumption of Woronora Dam's construction and its progress. After this, the Water Board allowed the Weir to be used as a public swimming hole, and eventually transferred ownership of the item and its ancillary resources (which included a pump house and an amenities block) to the local council sometime prior to 1958[25]. The Weir was described as[26]:

> *'…a first class swimming pool under ideal river conditions, and within easy walking distance [from surrounding towns]'*

The Woronora Dam was eventually completed in 1941 and continues to supply water to the Sutherland Shire presently.

Figure 17: Kolora Weir's construction, 1931 (Source: 'Site of Weir on Woronora River', Construction and Real Estate Journal, 11 March 1931).

[23] G. Duncan, 'Kolara/Kolora Weir and Recreational Reserve', *Sutherland Shire Historical Society Bulletin* 7, no. 1 (2004): 11–17.
[24] Duncan.
[25] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'; Duncan, 'Kolara/Kolora Weir and Recreational Reserve'.
[26] Duncan, 'Kolara/Kolora Weir and Recreational Reserve'.

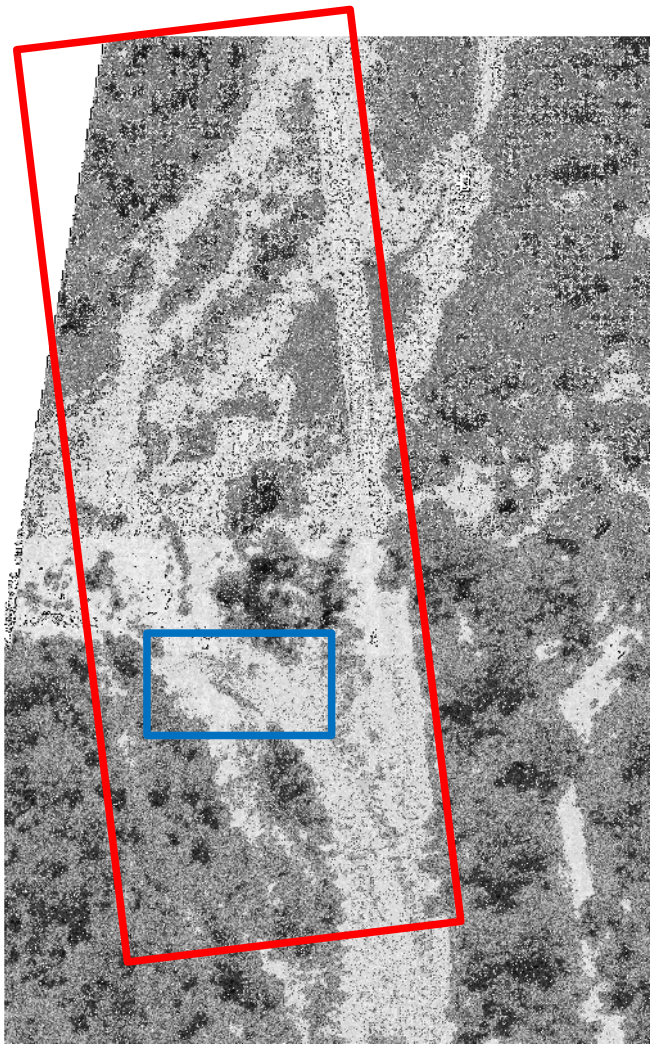
3.2.4 World War II and later infrastructure projects (1941 – Present)

The Second World War led to renewed concerns about infrastructure within Australia, with approximately £1,650,000 given to the county's roads departments by state and federal governments; much of this sum was spent on road construction[27]. Sydney's waterside position was viewed as detrimental for defensive purposes as the limited number of bridges and roads into the region's military and industrial zones would cause major issues should they be destroyed or blocked off. This significant vulnerability necessitated the expansion of military road networks within NSW[28]. Heathcote Road was constructed in 1941 to allow more access to and from the Holsworthy military area (Figure 18)[29]. The route connected Holsworthy to both Liverpool and the Princes Highway through a 20km stretch of road \running through the hills and valleys of the Woronora Plateau[30]. Its construction necessitated the removal of large trees within the road corridor and the construction of the Woronora River Bridge, the focal point of this assessment. Heathcote Road represented a crucial roadway connecting Holsworthy with the surrounding region, and the Woronora River Bridge was a crucial element in this connection, allowing access across over the Woronora River and over the valley this section of the river is located in. The bridge itself is a two lane, reinforced concrete bridge, made up of 5 spans and measuring approximately 130m in length, with concrete abutments that are faced with sandstone[31]. Aerial photography from 1943 also demonstrates that an access track from Heathcote Road down to the river was extant as well as a bridge crossing Heathcote Creek. Although their exact purpose is unclear it can be assumed they were put in place to support the construction of Heathcote Road and the Woronora River Bridge (Figure 19)[32].

Figure 18: Construction of Heathcote Road, 1941 (Source: Department of Main Roads, NSW, 2000).

[27] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.
[28] Biosis.
[29] Department of Main Roads, New South Wales, *The Roadmakers: A History of Main Roads in New South Wales* (Department of Main Roads NSW, 2000).
[30] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.
[31] Biosis.
[32] Biosis.

Figure 19: 1943 aerial photograph of Heathcote Road and Woronora River Bridge (Source: SIXMaps). Access track highlighted in red, and Heathcote Creek Bridge highlighted in blue.



The completion of Heathcote Road coincided with the completion of Woronora Dam. Upon the end of the dam's construction, attention then turned to supplying water from the dam to nearby towns. The Woronora-Penshurst Pipeline, which was completed in 1942 and still utilised today, was one such measure. The pipeline measures 27.1km long and is used to transport water from Woronora Dam to Penshurst Reservoir, and then on to the surrounding suburbs. During its construction, steel was in short supply due to the requirements of the war effort. Therefore, a unique method that utilised mild steel spirally welded pipes was used to construct the pipeline.

The establishment of Heathcote Road had a positive impact on the Sutherland Shire and Holsworthy but would ultimately prove to have a negative impact on the Kolora Weir. The Weir became an increasingly popular recreation spot during the latter half of the 20th century, one which attracted visitors from further afield than previously. These bathers would travel to the Weir by car and park at the closest spots available, which were along Heathcote Road. The parked vehicles further narrowed the two-lane road and led to traffic accidents and frustration for regular users of the roadway[33]. These issues were further compounded by a number of drownings which occurred in the Weir[34]. As a direct

[33] Duncan, 'Kolara/Kolora Weir and Recreational Reserve'.
[34] Duncan.

result of these issues, the Sutherland Shire Council ordered the demolition of the Weir in 1984, which was carried out by the Australian Army's 17th Construction Squad, who were based out of Holsworthy[35]. While much of the Weir and its associated structures were removed, some physical remnants of the structure do remain, and it is possible that other archaeological evidence for the Weir may still be present.

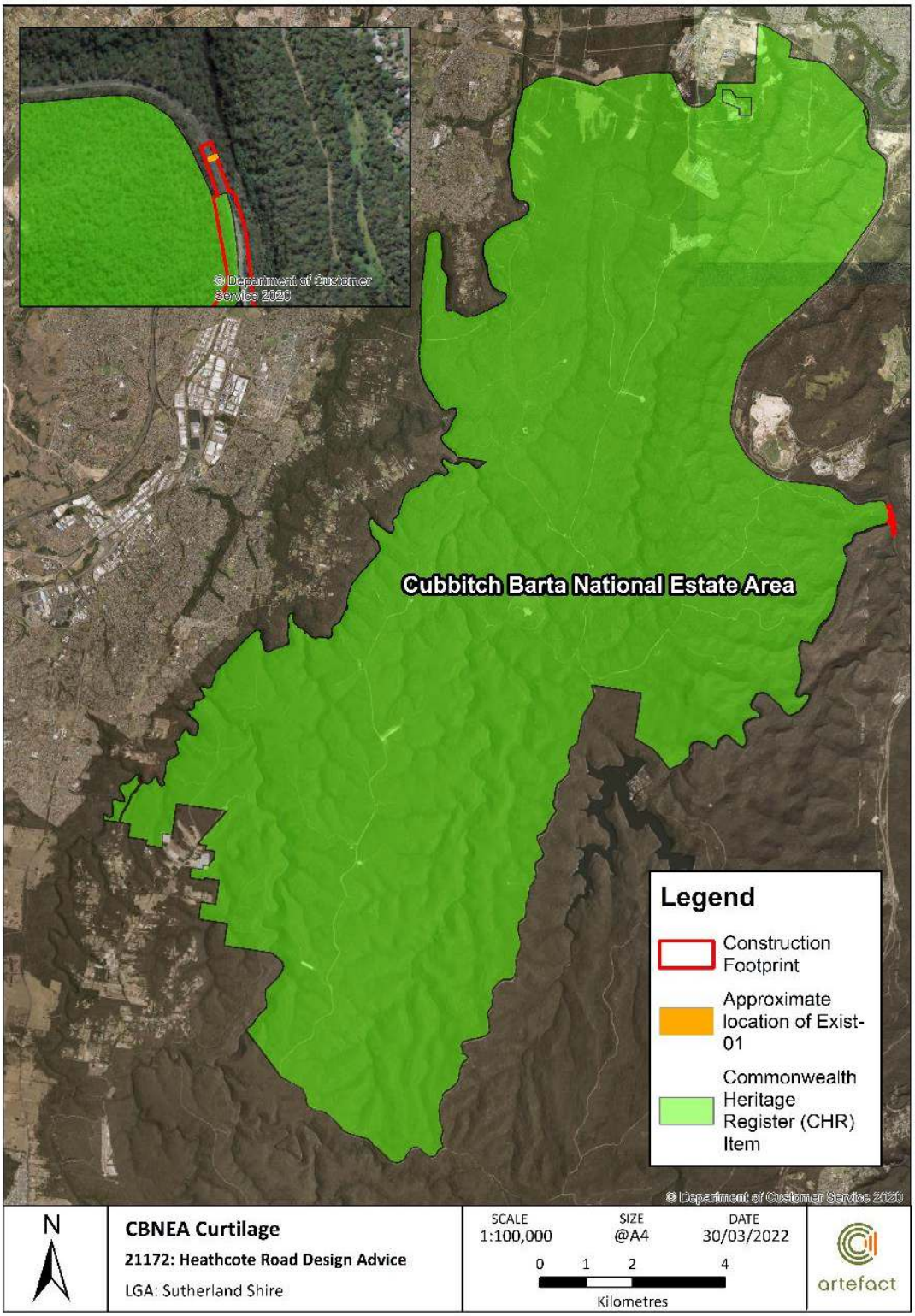
Heathcote Road continued to be more heavily trafficked as the decades went on and the number of motorists in NSW increased. The narrowness and winding nature of the road have always made it a precarious route however, and numerous traffic incidents have consequently occurred on the route[36]. As part of safety upgrades, modifications were made to the Woronora River Bridge in 1990. These included new jersey kerbing and rectangular steel railings, superseding the original bridge railing system, as well as Armco guard railing to protect the bridge's approaches[37].

3.2.5 Cubbitch Barta Estate (2004 – Present)

The Cubbitch Barta National Estate Area was gazetted in 2004 and granted Commonwealth heritage significance. The area contained within the Estate has a longstanding history of Aboriginal occupation prior to European colonisation and contains over 500 Aboriginal sites[38]. This site, which measures approximately 18,000 hectares, is composed of large areas of bushland that are located within the Holsworthy base and the Liverpool region (Figure 20). While it is of exceptional significance to Aboriginal heritage, the Estate is also considered to be of historic heritage significance due to its connections to the development of the Sutherland Shire and Liverpool regions as well its role in Australian military history through its use as a training area for the Holsworthy base. Due to the combination of all these factors, the Estate is considered to possess 'outstanding cultural and natural values' and is an essential component 'in defining the character of the broader Sydney region'[39].

[35] Duncan.
[36] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.
[37] Roads and Traffic Authority, 'Bridge over Woronora River on Heathcote Road, Engadine - Parapet Additions, Schedule of Drawings', 1990.
[38] Heritage NSW, 'Cubbitch Barta National Estate Area', State Heritage Inventory, accessed 14 February 2022, https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=1970121.
[39] Heritage NSW.

Figure 20: Cubbitch Barta National Estate Area.



4.0 PHYSICAL EVIDENCE

4.1 Site Inspection

Two separate inspections of the Woronora River Bridge and its surrounds have been conducted. The first inspection was carried out 11 August 2020 by Biosis, while the second inspection was conducted by Darrienne Wyndham (Senior Heritage Consultant, Artefact Heritage) on 28 January 2022. While both inspections aimed to identify any potential impacts to surrounding heritage items that may occur as a result of the proposed development, the initial inspection carried out by Biosis was guided by the previous bridge widening design. Artefact's inspection of the site occurred after the design change for the proposed works and therefore focused on different elements of the site. Particular focus was given to the refined project boundary, including the additional area for the northwest cut. Both site inspections proved useful in providing an understanding of the impacts of the development and the heritage items within the vicinity of the proposed works. As such, this report will incorporate information about the initial site inspection taken from Biosis' SoHI for the project[40].

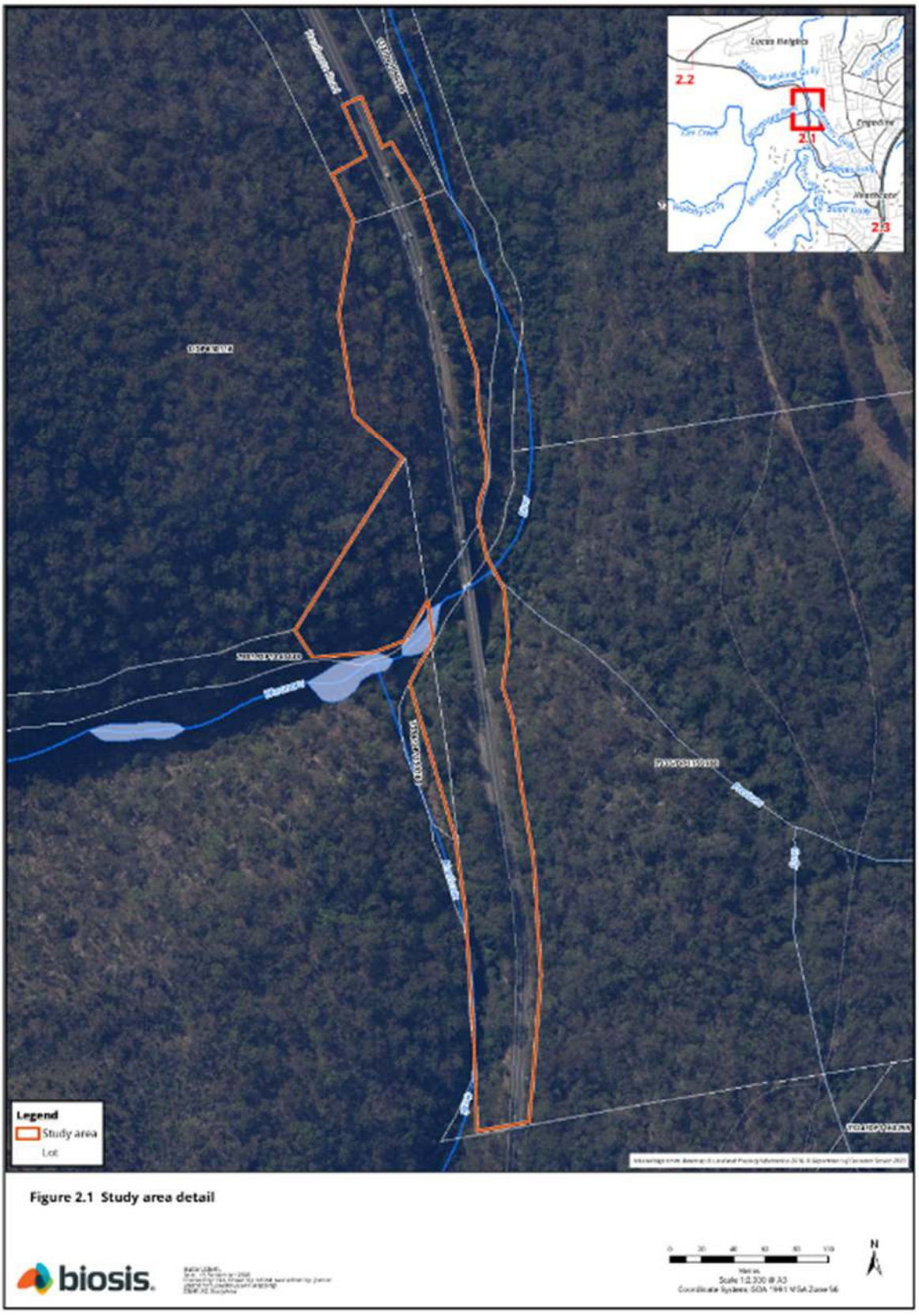
As stated within the Biosis report[41]:

> *The study area is bounded by the Cubbitch Barta National Estate Area to the north-west of the study area, natural landscape to the south and north and the Woronora River to the east along the northern approach.*
>
> *The majority of the study area is comprised of roadways and associated infrastructure, in addition to the Woronora River Bridge and natural landscape. Throughout the southern approach of the study area, a number of culverts, retaining walls, an access track and concrete piers crossing Heathcote Creek on the southern side of Woronora River are present…The northern approach contains the remnants of an access track, in addition to structural foundations associated with the Kolara Weir and culverts. The study area traverses a steep slope on either side of the road corridor, which follows the alignment of Heathcote Creek until it crosses the Woronora River, where the landscape evens out to a more moderate slope.*

The study area for that report is shown in Figure 21.

[40] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.
[41] Biosis.

Figure 21: Study area in Biosis report (Source: Biosis, 2020).



The study area inspected by Biosis was found to contain the following built fabric:

- Road surfaces, rock cuttings and guardrails throughout the central portion of the study area
- Culvert headwalls and inlets along the north-eastern and south-western portions of the study area, within the Heathcote Road corridor (Figure 22)
- Retaining walls along the extent of the south-western portion of the study area (Figure 23)
- Access tracks leading to Kolora Weir from the northern and southern approaches, traversing down to the Woronora River and Heathcote Creek
- Within the northern approach of the study area (Lot 7301 DP 1140443), structural remains of concrete foundations are present, most likely associated with the Kolora Weir (Figure 24)
- Concrete piers across the extent of Heathcote Creek, associated with the access track (Figure 25)
- Large concrete material possibly associated with the weir in the north-western portion of the study area (Figure 26)
- Sandstone abutment possibly associated with the former crossing over Heathcote Creek and the Kolora Weir (Figure 27)
- Small sandstone wall located adjacent to Woronora River, most likely associated with the weir (Figure 28)
- Woronora River Bridge (RTA Bridge no. 152) located through the centre of the study area, extending across Woronora River and forming part of Heathcote Road, including 1990 additions comprising jersey kerb and rectangular steel rails (Figure 29)

Figure 22: Example of sandstone culvert headwall with reinforced concrete pipe (culvert no. 475320) along south-western road alignment, facing north (Source: Biosis, 2020).

Figure 23: Sandstone retaining wall section within the south-western portion of the study area, adjacent to road corridor, facing east (Source: Biosis, 2020).

Figure 24: Concrete foundations located in the north-western portion of the study area, most likely associated with the Kolora Weir and the amenities block (Source: Biosis, 2020).

Figure 25: Concrete piers across the extent of Heathcote Creek, associated with the access track and former bridge (Source: Biosis, 2020).

Figure 26: Large concrete material associated with the Weir in the north-western portion of the study area (Source: Biosis, 2020).

Figure 27: Sandstone abutment possibly associated with the former crossing over Heathcote Creek and the Kolora Weir (Source: Biosis, 2020).

Figure 28: Small sandstone wall located adjacent to Heathcote Creek, most likely associated with the Weir (Biosis, 2020).

Figure 29: View of 1990 additions to Woronora River Bridge comprising jersey kerb and rectangular steel rails on the southern approach (Biosis, 2020).

As the initial site inspection investigated the study area and the surrounding heritage items thoroughly, the inspection conducted by Artefact focused on the areas surrounding the Woronora Bridge that would be more directly impacted through the new bridge design. This included areas of

land to the west of the current Woronora River Bridge, within the construction footprint of the proposed works. On the southwest side of the bridge, the landscape was densely vegetated, with trees and shrubbery taking up the majority of this portion of the study area. Northwest of the bridge was featured similarly dense vegetation (Figure 30 and Figure 31). However, much of this area is significantly elevated above Heathcote Road, located on a sandstone outcropping that was partially cut through in order to construct the road (Figure 32 and Figure 33). This section of the study area was unable to be accessed during Biosis' initial site inspection, however no previously unknown items of heritage significance were identified during Artefact's inspection. Neither the Biosis or Artefact inspections located the survey marker tree used in the 1903 parish map (Figure 15 and Figure 16).

Figure 30: Northern approach of Woronora River Bridge.

Figure 31: Dense vegetation northwest of bridge.

Figure 32: Sandstone outcrop northwest of bridge, located within Cubbitch Barta National Estate Area.

Figure 33: Current bridge viewed from top of sandstone outcrop. Proposed bridge to be constructed parallel to current structure.

The issues surrounding flow width in proximity to the study area were identified after the site inspection was conducted, and, as such, Cross Drain Exist-01 and its immediate surrounds were not inspected. While images of the outlet of the culvert and the sandstone drainage chute were provided by Fulton Hogan (Figure 34 AND Figure 35), no images of the inlet were provided.

Figure 34: Outlet for Cross Drain Exist-01, provided by Fulton Hogan.

Figure 35: Sandstone chute which drains flow from outlet, provided by Fulton Hogan.

5.0 ASSESSMENT OF HERITAGE SIGNIFICANCE

5.1 Definition and approach

Heritage items and a potential archaeological resource should be managed in terms of significance. Determining heritage and archaeological significance is undertaken by utilising a system of assessment centred on the *Burra Charter* (Australia ICOMOS 2013). The principles of the charter are relevant to the assessment, conservation and management of sites and relics. The assessment of heritage significance is outlined through legislation in the *Heritage Act 1977* and implemented through the *NSW Heritage Manual, the Archaeological Assessment Guidelines* (1996)[42] and *Assessing Significance for Historical Archaeological Sites and 'Relics'* (2009).[43]

Section 4(1) of the *Heritage Act 1977* (as amended 2009) defines 'relic' as follows:

> *relic means any deposit, artefact, object or material evidence that:*
>
> *(a) relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and*
>
> *(b) is of State or local heritage significance.*

If an item meets one of the seven heritage criteria, and retains the integrity of its key attributes, it can be considered to have heritage significance (Table 3). The significance of an item or potential archaeological site can then be assessed as being of local or State significance. The following definitions have been provided by the NSW Heritage Office: [44]

'*State heritage significance'* – in relation to a place, building, work, relic, moveable object or precinct, means significance to the State in relation to the historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value of the item.

'*Local heritage significance'* – in relation to a place, building, work, relic, moveable objector precinct, means significance to an area in relation to the historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value of the item.

If a potential archaeological resource does not reach the local or State significance threshold, then it is not classified as a 'relic' under the Heritage Act.

Archaeological research potential is distinct from archaeological potential. Consideration of archaeological research potential is also required when undertaking a significance assessment of an historical archaeological site. In *Assessing the Research Significance of Historic Sites* (1984), Bickford and Sullivan developed three questions to gage significance:[45]

- Can the site contribute knowledge that no other site can?
- Can the site contribute knowledge that no other resource can?

[42] NSW Heritage Office, 1996. *NSW Heritage Manual, the Archaeological Assessment Guidelines,* 25-27.
[43] NSW Heritage Office, 2009. *Assessing Significance for Historical Archaeological Sites and 'Relics'.*
[44] NSW Heritage Office, 2009. *Assessing Significance for Historical Archaeological Sites and 'Relics'*, p. 6.
[45] Bickford, A. & S. Sullivan, 1984. Assessing the Research Significance of Historic Sites. In: Sullivan S. & S. Bowdler (eds.) *Site Surveys and Significance Assessment in Australian Archaeology* (Proceedings of the 1981 Springwood Conference on Australian Prehistory), Department of Prehistory, Research School of Pacific Studies, The Australian National University, Canberra, p. 23–24.

- Is this knowledge relevant to general questions about human history or other substantive questions relating to Australian history, or does it contribute to other major research questions?

The more recent NSW Heritage guidelines mentioned above, *Assessing Significance for Historical Archaeological Sites and 'Relics'*[46], call for broader consideration of multiple values of archaeological sites beyond their research potential. This report implements both above approaches.

Table 3. NSW Heritage Assessment Criteria

Criteria	Description
A – Historical Significance	An item is important in the course or pattern of the local area's cultural or natural history.
B – Associative Significance	An item has strong or special associations with the life or works of a person, or group of persons, of importance in the local area's cultural or natural history.
C – Aesthetic or Technical Significance	An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in the local area.
D – Social Significance	An item has strong or special association with a particular community or cultural group in the local area for social, cultural or spiritual reasons.
E – Research Potential	An item has potential to yield information that will contribute to an understanding of the local area's cultural or natural history.
F – Rarity	An item possesses uncommon, rare or endangered aspects of the local area's cultural or natural history.
G – Representativeness	An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places of cultural or natural environments (or the cultural or natural history of the local area).

5.2 Woronora River Bridge (SHI 4309580)

5.2.1 Description

The description of the item found in its State Heritage Inventory (SHI) listing is as follows[47]:

> *This five span two lane heavily skewed (35 degree) reinforced concrete bridge crosses a significant sandstone gorge in steep coastal forested country. Main spans are 27.43m and the two approach spans 21.94m. The deck is a continuous reinforced concrete structure with two longitudinal beams which curve down at the piers for increased strength. There are cross beams connecting the longitudinal beams, both intermediate and at the piers. Being square to the longitudinal beams, at each pier there are two cross beams, one at each pierhead. The deck is supported on steel rocker bearings at the abutments and approach piers. The piers have two octagonal columns each, connected by a rectangular headstock. The*

[46] NSW Heritage Office, 2009. *Assessing Significance for Historical Archaeological Sites and 'Relics'*.
[47] Heritage NSW, 'Woronora River Bridge', State Heritage Inventory, accessed 10 February 2022, https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=4309580.

taller piers step out to larger size over their lower sections. At the centre span, the skew of the bridge aligns with the river orientation.

Abutments are wall type with square return walls in faced sandstone. Topping the abutment corners are concrete endposts. These provide an interface between guardrailing of the approaches and a retrofitted New Jersey kerb and steel rail system on the bridge. The monumental style endposts, which have strong vertical post art deco design details, have suffered from a variety of impacts, including damage to the outstands holding the bridge plaques.

Each end of the bridge has an expansion joint system, with an elaborate array of hold-downs retrofitted beneath to secure them.

From above the northwestern abutment, an old track allows pedestrian access to the river. This may have been used for access to construct the piers, and possibly for site camp and storage.

5.2.2 Fulfilment of the NSW Heritage Assessment criteria

The heritage item has been assessed in terms of heritage value as presented in Table 3.

Table 4. Significance assessment of the heritage item[48]

Criteria	Description
A – Historical Significance	The Woronora River Bridge is strongly associated with the State theme of Defence, the bridge being constructed as an essential component of the Heathcote Road built during WWII to facilitate the movement of troops and supplies associated with the Army installations in the southern Sydney area and the Illawarra and also to provide part of a strategic cross country connection between the Great Western and Princes Highways. Since WWII, the Woronora River Bridge, as part of Heathcote Road, has provided the third way of reaching the Sutherland Shire, and the only direct connection between Sutherland and western Sydney. The bridge also formed a landmark in the post-war landscape of leisure for swimmers and picnickers from adjacent areas to the northwest and south east, and as part of a landscape no longer used for leisure, can help to demonstrate the way leisure activities have evolved to the present.
C – Aesthetic or Technical Significance	Woronora River Bridge is a large and impressive structure for its type, having five spans and a total length of over 125 metres. The clean modern lines of its design, featuring curved beam profiles and octagonal piers, are attractive and sit well within the rugged sandstone woodland landscape. The bridge forms a landmark on the Heathcote Road, which winds down through impressive sandstone cuttings to reach the bridge. As a large structure it is reasonably sophisticated technically, featuring a heavy skew and rocker bearings to allow thermal movements. Its construction in rugged terrain and at a high level above permanent water constitutes a technical achievement.

[48] Heritage NSW.

Criteria	Description
G – Representativeness	The Woronora River Bridge is the longest continuous concrete beam bridge in the study group of RTA controlled beam bridges constructed prior to 1948, at 125 metres in length being the only structure to exceed eighty metres in length, apart from the redecked bridge crossing the Hawkesbury River at Windsor, which is a series of simply supported spans. The Woronora River Bridge is capable of demonstrating the key characteristics of the class of larger concrete beam bridges of the period 1925-1948.

5.2.3 Statement of significance

As recorded in the SHI statement of significance for this item[49]:

> *Woronora River Bridge has historic, aesthetic and technical significance, and is an outstanding representative example of its class in NSW. Chiefly, the bridge has historic significance due to its strong association with strategic defence planning in World War Two in the south-eastern quarter of the wider Sydney area. The bridge also has significance because of its association with the history of transport to the Sutherland area, and with post war leisure activities in southern Sydney. The bridge is a large and impressive structure in a spectacular sandstone woodland landscape, and forms a landmark on Heathcote Road. The bridge has a high level of representative significance due to its size, as the only reinforced concrete beam bridge currently controlled by the Roads and Traffic Authority and constructed in the period 1925-1948 to exceed eighty metres in length.*

5.3 Cubbitch Barta National Estate Area (SHI 1970121)

5.3.1 Description

As listed in this item's SHI description[50]:

> *The Cubbitch Barta National Estate Area which is within the Holsworthy Military Grounds, commonly known as the Holsworthy Military Training Area. Cubbitch Barta means 'people of the river' in the Aboriginal Gurgur language and was chosen as the name for this National Estate place by the nominator. Holsworthy has been a military training area since the late nineteenth century. It has since become known as the Holsworthy Military Training Area, the Holsworthy Field Firing Range, the Holsworthy Range, or simply The Range. The Cubbitch Barta National Estate Area is a large tract of bushland covering plateaux, ridges and rocky creek valleys immediately adjacent to the dense urban development of Sydney's south-west. The bushland has been largely protected from development and public use, due to the area being set aside as a Commonwealth military training area in 1913. The bushland contains hundreds and possibly well over a thousand Aboriginal sites, which reflect a substantial history of Aboriginal occupation. This represents an extensive landscape where Aboriginal life in this region prior to 1788 is recorded without large scale impact of European settlement.*

[49] Heritage NSW.
[50] Heritage NSW, 'Cubbitch Barta National Estate Area'.

A number of European nineteenth century sites in the area are associated with the history of European settlement and the development of agriculture in the Liverpool region. The Holsworthy area was used as a training area for Australian Defence personnel in the late nineteenth century and throughout the twentieth century. The Range comprises the southern area of the National Estate area and is an extensive tract of open countryside, in parts very undulating and not fully accessible to the public, dominated by a thickly wooded incised plateau. Due to the area being used as a firing range by the army, Defence personnel were settled in the area known as the Old Army Internment Camp, on the northern part of the Range. During World War One, there was an internment camp for migrants and prisoners of war here. The Old Army Internment Camp Group is entered in the Interim list for the Register of the National Estate as a place of individual significance (refer to file RR 014223).

The landscape: The Cubbitch Barta National Estate Area occupies 18, 000ha of the Woronora Plateau, approximately 30km south-west of inner Sydney. It adjoins Heathcote National Park to the south-east and Dharawal State Recreation Area to the south, forming part of an extensive tract of bushland stretching southwards from the Sydney metropolitan area. It also contains part of the Woronora and O'Hare's Creek catchments. The area has soils derived from the interbedded shale and fine to medium grained quartz sandstone of the Mittagong Formation. The landscape is one of crests, ridges, valleys and plateau remnants. The original plateau surface has been eroded by creeks including Harris, Williams and Deadman's Creeks, flowing northwards to join the Georges River, which discharges into Botany Bay. In the southern part, two further creeks, Punchbowl and O'Hares, join the Georges River. The creeks have formed deeply dissected valleys where the underlying Hawkesbury sandstone is revealed and where there are scenic waterfalls and waterholes surrounded by she oaks and tall eucalypts. In other valleys, clear water seeps from wet heaths and collects in the pools on flat sandstone platforms. On these flat rocks are occasionally found Aboriginal engravings. On the sides of many valleys are sandstone overhangs and rock shelters which provide cool, sheltered sites for banks of ferns, mosses and lichens. Aboriginal art such as hand stencils, charcoal sketches and ochre paintings are located in these overhangs. Remnant ridges capped with laterite occur in the area, important as most other laterite caps in the region have been extensively disturbed by mining or suburban development. These elevated areas provide views across the Sydney basin and toward the distant Sydney city skyline. The area contains a wide range of vegetation, varying from dry woodland/heath complex, to plateau forest and woodland, gully forest, riparian forest, sedgeland, heath/swamp complex and melaleuca thickets. The major vegetation types are dry woodland (approximately 50% of the vegetation cover) and gully forest. The southern ridge tops support a dry open woodland similar to that found in nearby Royal National Park, Heathcote National Park and the O'Hares Creek catchment area, with the most common tree species being red bloodwood (E GUMMIFERA), yertchuk (E CONSIDENIANA) and narrow leaved stringybark (E OBLONGA). The ridge tops towards the north of the area consist of sandstone or laterite over sandstone and support woodland dominated by Sydney red gum (ANGOPHORA COSTATA), scribbly gum (E HAEMASTOMA/E RACEMOSA) and red blood wood (E GUMMIFERA). Plateau forest and woodland fall into two main subgroups: tertiary alluvium dominated by ironbarks (E CREBRA and E FIBROSA); and shale dominated by Sydney red gum (ANGOPHORA COSTATA, E PUNCTATA, E SPARSIFOLIA and E GUMMIFERA). Both subgroups have a grassy understorey

with THEMEDA AUSTRALIS, ENTOLASIA STRICTA and LOMANDRA sp among the common plant species encountered. A substantial remnant (approximately 1,650ha) of Cumberland Plain woodland, consisting mainly of grey box (E MOLUCCANA) and forest red gum (E TERETICORNIS), is located between the Georges River and Harris Creek in the north-west. Only 6% of the original area of this woodland is thought to survive in the Sydney Basin and it is listed as an endangered community under NSW Threatened Species Conservation Act. Gully forest covers about 40% of the area, with dominant trees including Sydney red gum (ANGOPHORA COSTATA), Sydney peppermint (E PIPERITA), red blood wood (E GUMMIFERA) and blackbutt (E PILULARIS). The shrub layer includes saw tooth banksia (BANKSIA SERRATA) and Christmas bush (CERATOPETALUM GUMMIFERUM). The spectacular gymea lily (DORANTHES EXCELSA) nears its southern limit here. Small sections of river fringing forest in the area are dominated by coach wood (CERATOPETALUM APETALUM) and river gum (TRISTANIOPSIS LAURINA). Patches of sedgeland and wet heaths are restricted mainly to the southern part around perched swamps on the Woronora Plateau. The sedgelands differ from the heath/swamp complex in lacking a shrub layer. Common species are LEPTOCARPUS TENAX, SCHOENUS BREVIFOLIUS and SPRENGELIA INCARNATA. In the heath/swamp complex, dominant shrubs are fern leaved banksia (BANKSIA OBLONGIFOLIA), heath leaved banksia (B ERICIFOLIA) and dagger bush (HAKEA TERETIFOLIA). Ground cover plants include PTILOTHRIX DEUSTA, LEPYRODIA SCARIOSA, LEPTOCARPUS TENAX and CYATHOCHAETA DIANDRA. Very small areas of melaleuca thickets occur in the north and are dominated by snow in summer (MELALEUCA LINARIFOLIA), together with bangalay (E BOTRYOIDES) and Sydney blue gum (E SALIGNA). Many of the vegetation types within the area contain rare plant species. Cubbitch Barta National Estate Area contains a population of spotted tailed quolls (DASYURUS MACULATUS), a cat sized carnivorous marsupial considered uncommon to rare on mainland Australia and which has declined dramatically this century. It has significant populations of koalas (PHASCOLARCTOS CINEREUS) and is considered prime koala habitat. Evidence suggests that the area provides a connecting corridor between the Campbelltown area and Heathcote and Royal National Parks, along which koalas may have been moving for thousands of years. More than ninety bird species have been recorded here, including some usually found much further west. Species recorded include the turquoise parrot NEOPHEMA PULCHELLA and the powerful owl NINOX STRENUA. Common reptiles include the bearded dragon (POGONA BARBATA), blind snake (RAMPHOTYPHLOPS NIGRESCENS), Lesueur's velvet gecko (OEDURA LESUEURII) and yellow faced whip snake (DEMANSIA PSAMMOPHIS). Thirty-six reptiles and amphibians are known to occur here. Freycinet's frog (LITORIA FREYCINETI), the giant burrowing frog (HELEIOPORUS AUSTRALIACUS) and Haswell's frog (PARACRINIA HASWELLI), are some of the amphibians noted from the area.

The Aboriginal landscape: The Cubbitch Barta National Estate Area contains more than 530 Aboriginal sites spread throughout the plateaux and Rocky Creek valley terrain. These include rock shelters with painted and drawn art, engravings on open rock platforms, camping places, grinding grooves and scarred trees on the older trees of the forests and woodlands. The area contains an important collection of sites which are relatively undisturbed in their landscape setting. While many Aboriginal sites have been recorded within the area, only a portion of the area has been systematically surveyed and there are likely to be many hundreds more sites

to be recognised and documented. According to most sources, the area falls mostly or wholly within the boundaries of the Dharawal people. The Dharawal's boundary with their northern neighbours is generally considered to be the Georges River and in the north-west they shared a boundary with the Dharug which may have taken in a small part of the western side of the National Estate area. In the nineteenth century, Aboriginal sites were first noted within the boundaries of this area by R Etheridge. Etheridge's informant stated that his father visited rock art sites around Harris Creek with Aboriginal people around 1838. Many of the sites within the area were recorded during the 1970s, through the activity of the Sydney Prehistory Group. Additional sites were recorded by Corporal Robert Thompson in the 1980s. These recordings were reassessed in 1995 within the Holsworthy Training Area Environmental Audit. Up to this point, 295 sites had been recorded in the area, with recordings heavily biased toward sites containing rock art (235) and grinding grooves (sixty-nine). In late 1996, a systematic archaeological survey of parts of the area was conducted as part of an Environmental Impact Statement (EIS) for two options proposed for the Second Sydney Airport. This survey recorded a further 240 sites and revealed a broader range of sites than previously known. These included: 128 rockshelters with drawn or painted rock art, sixteen sites with engraved art, sixty-four sites with grinding grooves, forty-seven scarred trees, thirty-seven isolated finds and eighteen open scatters of artefacts. Currently more than 530 sites are recorded within the area. This includes over 300 rock art sites. The EIS study also documented 509 potential archaeological deposits. These are places (usually rockshelters) where it is highly likely that archaeological material will be found under the surface. No archaeological excavations have taken place within the area and the length of association of Aboriginal people and the Cubbitch Barta National Estate area is unknown. The recent survey work indicates considerable potential for future archaeological investigations. The rock art found within the area represents a significant collection of Aboriginal imagery, created using a diverse range of techniques (engravings, pigment applied wet, pigment applied dry) and reflecting a wide variety of subject matter. This collection of art is distinct in its combination of features from other bodies of rock art in the Sydney basin. Dominant motifs in the painted and drawn area include macropods, hand stencils, fish and eels, with emus, wombats, echidnas and koalas. The colour most frequently used is black (charcoal) with red and white also common. A combination of colours was used in a small proportion of sites. Many sites contain ten figures or less and the largest site has more than sixty figures. Fewer engraving sites exist within the area compared with other areas in the Sydney Basin and the number of figures per site is generally small (not more than six). They do however contain different motifs and appear to form compositions. Engraved motifs include large footprints, emu tracks, eels, fish, macropods, koalas, human like figures and one engraving apparently of a pregnant female. This last motif appears to be unique in this area. Small engraved channels have also been found on flat rocks within creeks and in association with engraving sites. These grooves may have been used to channel water from the surrounding spongy heath into deeper rock pools. Archaeological work in the Sydney basin has confirmed north-south differences in the art of the basin, with the Georges River most often identified as the boundary between the two regions. Differences between these regions have been established by complex analyses of the art (both pigment and engraving sites). Fewer engraving sites exist south of the Georges River and there are also a number of differences in the way motifs are depicted. This large body of sites has been generally protected from the impact of the surrounding urban development and remains in excellent condition. It represents a large and important sample of

Aboriginal sites in the southern Sydney basin. In many comparable areas, sites have been flooded behind dams, such as the adjacent Woronora dam and the Cataract, Cordeaux and Avon catchments further to the south. Similarly, as coal mining has not occurred under the area, the rockshelters here have not been affected by subsidence which has been documented affecting sites in catchments to the south. The area has also not been commercially logged since the turn of the century, an important factor in the survival of a significant number of scarred trees. The nineteenth century European settlement sites in the area illustrate the story of settlement in the Liverpool region and the way it affected Aboriginal people. Early colonial farms were established to the north and west of the area from 1800-20 and some of the conflicts that occurred within the first half of the nineteenth century, most notably Governor Macquarie's proclaimed war on Aborigines in 1816, were played out in and around the area. The Aboriginal landscape of this historic period is well represented by the landscapes of the area, containing isolated homesteads, roads, farms and a small town settlement. Etheridge's account indicates that Aboriginal people were still visiting sites within the area in the 1830s. One of the earliest Aboriginal reserves in the Sydney area is thought to have been located immediately adjacent to the area in the north east, around Sandy Point on the Georges River. This reserve was occupied at a time in the late nineteenth century when the settlement of Eckersley was established within the area, along with a number of farms and vineyards. While the relationship between Aboriginal people on the reserve and the area is not currently known, they may have visited the area to obtain bush foods or to maintain other social or spiritual connections. Since the establishment of the military facility in 1913, Aboriginal people have had only limited access to the area. Connections have been maintained, to some extent, through Aboriginal people in the Army. More recently, the Tharawal Local Aboriginal Land Council has assumed a custodial role for the Training Area and in 1993, negotiated with the Army to look after the area's cultural heritage sites. In late 1996, Tharawal representatives visited many of the sites in the area as part of their role in the cultural heritage surveys associated with the Sydney second airport environmental impact statement. The Australian Army has been cooperating with the Tharawal Local Aboriginal Land Council to protect Aboriginal sites in the area by providing access for Aboriginal people, assisting in documenting places and taking steps to avoid sites during military activities.

European settlement and agriculture: From 1798 to 1805 the NSW Colonial Government issued land grants to early settlers in the Liverpool region including Thomas Moore, Captain Thomas Rowley and Thomas Laycock. The first land grants for European settlement were made in the Holsworthy area from 1805-13. In 1835, the rugged sandstone gorges of the area were surveyed and proclaimed as the Parish of Eckersley. The Old Coach Road, Old Illawarra Road and New Illawarra Road provided transport routes for settlers in the Liverpool, Holsworthy and Campbelltown regions. Evidence suggests that the Old Illawarra Road and the Old Coach Road were constructed earlier than attributed and this warrants further investigation. During the 1880s the land south of the Georges River in Eckersley was opened to farmers. Many European vignerons grew olives, almonds and grapes and experimented with wine production in the sandy soils. The first settlers to take up an official selection with the parish were Frank and Harry Etchells in 1889. They built a stone cottage, grew fruit and vegetables, raised poultry and bees and distilled rum inside the rock ledges at waterfalls along the river. They transported their rum by pack horse to Bulli and sold it to miners. Other settlers included Nathanial George Bull, a one time Mayor of Liverpool, who also built a

dwelling. The Freres brothers established a vineyard in the area in association with Charles Kelso. By 1891, the Eckersley area supported over thirty small farms and a post office was built providing a mail service to Liverpool twice a week. Isaac Himmelhoch established the substantial Grodno vineyard with the intention of producing high quality wines. By 1901 the 640 acre selection grew Hermitage and Malbec grapes. By 1911 Eckersley had declined after settlers encountered difficulties growing vines in the sandy soil. Most of the vines were affected by phylloxera. The selections were abandoned to make way for the proposed military reserve and the Grodno vineyard was destroyed following the Army's arrival.

Military history: In the late 1880s the NSW Volunteer Soldiers conducted training exercises and manoeuvres between the Royal National Park and the Georges River at Liverpool. The Army held manoeuvres in the Holsworthy Range in 1906, 1907 and 1910. As part of the new Commonwealth Government's major program of defence construction, it acquired 833 acres to establish a remount depot and veterinary hospital in 1912 and in 1913 a further 16,868 acres at the site now known as Old Army Camp. Eighty thousand acres of land were finally acquired for a military barracks, a training area and an artillery range. At the time of acquisition, the land contained both large and small holdings, many of which were still undeveloped. The site chosen for the barracks was a large orchard surrounded by thick bush and scrub. The remount depot located here was used to prepare 47,000 horses for overseas service in World War One and various Light Horse Divisions trained here before embarking for Gallipoli and other theatres of war. During World War One, Holsworthy Barracks was used as an Internment Camp. Those interned included German, Austrian, Hungarian, Croatian, Czech, Bulgarian and Turkish people from Australia, as well as internees from the South Pacific and Asia. The main compound housed German and Australian civilians. However, there were some prisoners of war including survivors of the German cruiser Emden which was beached at Cocos on 9 November, 1914. A further three compounds held other prisoners. This was the largest internment camp in Australia during World War One, holding over 6 000 internees. At its peak there were more than 210 buildings on site. The German section was closed in mid-1919 with the last man leaving on 5 May, 1920. It appears that almost all of the buildings associated with the World War One internees were razed when hostilities ceased. The only evidence of the camp exists in the three stone buildings (sergeants' mess/corporals' club, burnt-out recreation hall and jail/powder magazine) in the former guards' camp, north of Artillery Road, in the railway siding and its associated permanent way and in some of the road and kerbing surrounding the former parade ground, a flat grassed area. All other existing fabric on the site dates from the period after 1930. After World War One, the former internment camp was used for militia camps and a new ordnance depot was built. The stone buildings erected by the internees were used for permanent army units. (For more information about the internment camp area, see related file: Old Army Internment Camp Group, Holsworthy, RR 014223). In 1938 a further 33,860 acres were added to the Holsworthy Range. From 1939 a prisoner of war camp was established and 6,780 Australians, mostly of Italian origin, were interned. It is unknown if any structures remain from this phase. In 1942 an armoured fighting vehicle school replaced the remount depot. In 1950 the remount site was taken over for National Service personnel. In 1958 the Holsworthy Range became the home of the 1st Infantry Brigade Group. The Range has been used extensively for training soldiers in the use of small firearms, tanks and artillery. Although the Range has been used for military training, the natural features of the landscape

remain relatively undisturbed. With the exception of the Holsworthy Barracks, the airfield and small weapons ranges, there have been a limited number of other developments over the area, mainly the small network of roads, demolition areas and vehicle staging areas. After World War Two, the consolidation of military bases increased the demand for housing to accommodate its personnel. Holsworthy Village, established in 1952, exemplifies this process. The village featured rows of modest fibro-cement cottages of similar architectural form set in wide, tree lined streets. The houses have recently been comprehensively refurbished with modern cladding and aluminium windows, effectively destroying their significance as a post war housing group.

The Cubbitch Barta National Estate Area comprises the following historic elements which are significant in the Liverpool region and are important elements in the cultural landscape : old Illawarra Road, c 1850s. This gravel road linked Liverpool to Darkes Forest; old Coach Road, c 1880s. This gravel road links with the old Illawarra Road near Darkes Forest and features stone culverts; new Illawarra Road, c 1870s. This is a gravel road linking the Liverpool/old Illawarra Road at Eckersley; Grodno settlement site, c 1890s. This includes cleared former vineyard grounds, cellar remains, wells, irrigation channels, stone culverts and a long dry stone wall of stones; Eckersley Post Office site, c 1890s. This site includes the remains of structures covered by overgrowth; Eckersley House site, c 1890s. This includes the remains of a stone and mud dwelling, with cellar; other homestead remains, c 1890s. The site features several other unidentified homestead remains, some with wells and some with chimneys, which are likely to relate to the Grodno and Eckersley settlements.

The recent past and area today: The area continues to be used as a Military Training Area for small arms training, navigation, unit manoeuvres and demolition training. Training has taken place here for both National Service and regular units which have seen active service in Korea, Malaya and Vietnam. Units which continue to have a strong presence at Holsworthy include military engineers and Battalions of the Royal Australian Regiment.

There is increasingly widespread community recognition of the existence of a diverse range of heritage values within the area, encompassing natural, indigenous and historic values. In March 1997, the Liverpool Regional Museum put together an exhibition of the Aboriginal, European, military and environmental heritage of Holsworthy area. In 1997 the community has shown considerable interest in the heritage of the area, largely as a response to suggestions the area could be used as a location for the second Sydney Airport.

5.3.2 Fulfilment of the Commonwealth Heritage List criteria

The Commonwealth Heritage criteria against which the heritage values of a place are tested include[51]:

1. The place has significant heritage value because of the place's importance in the course, or pattern, of Australia's natural or cultural history

[51] 'Commonwealth Heritage List Criteria - DAWE', accessed 14 February 2022, https://www.awe.gov.au/parks-heritage/heritage/about/commonwealth-heritage/commonwealth-heritage-list-criteria.

2. The place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history
3. The place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history
4. The place has significant heritage value because of the place's importance in demonstrating the principal characteristics of:
   a. a class of Australia's natural or cultural places; or
   b. a class of Australia's natural or cultural environments
5. The place has significant heritage values because of the place's importance in exhibiting particular aesthetic characteristics values by a community or cultural group
6. The place has significant heritage value because of the place's importance in demonstrating ahigh degree of creative or technical achievement at a particular period
7. The place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons
8. The place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history
9. The place has significant heritage value because of the place's importance as part of Indigenous tradition.

Table 5: Significance assessment of the heritage item as recorded in CHL listing[52]

Criteria	Description
Criterion A: Processes	The Holsworthy National Estate Area contains a diversity of natural landscapes and vegetation types in a relatively unmodified condition, in an area otherwise greatly altered by urban development. As such it forms an important remnant of the original land system of the Sydney region, where geological and biological processes can continue within a reasonably large and relatively natural area. In particular, the laterite ridgetops within the place demonstrate the formation of laterite caps and the evolution of biological communities adapted to them. The koala *Phascolarctos cinereus* population, located within the place, is the largest in the Sydney metropolitan area and one of the few remaining viable natural populations in southern NSW (L. Gibson pers. comm. 1996). The place is a component of major importance in an identified network of koala habitat in the region (Phillips & Callaghan 1996). The New Holland mouse *Pseudomys novaehollandiae* , considered to regionally rare, occurs in the heath/swamp complex.

[52] Department of Agriculture, Water and the Envrionment, 'Cubbitch Barta National Estate Area, Old Illawarra Rd, Holsworthy, NSW, Australia', Australian Heritage Datatbase, accessed 14 February 2022, https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=state%3DNSW%3Blist_code%3DCHL%3Blegal_status%3D35%3Bkeyword_PD%3D0%3Bkeyword_SS%3D0%3Bkeyword_PH%3D0;place_id=105405.

Criteria	Description
	Its population here, together with wallaroo *Macropus robustus* and grey kangaroo *Macropus giganteus* populations found in plateau forest within the place, are significant as few populations of these animals survive in the region (AXIS Environmental/AMBS Consulting 1995). Because it represents a relatively large remnant of Sydney's original land system and reflects its biophysical diversity, the place contains a correspondingly diverse range of vegetation communities. These include plateau forest, gully forest, woodlands/heath complex, riparian forest, sedgeland, heath/swamp complex and *Melaleuca* thicket. These communities support a high diversity of plant species with over 400 plant species recorded in the area (Benson & Howell 1990, AXIS Environmental/ AMBS Consulting 1995).
Criterion B: Rarity	The turquoise parrot *Neophema pulchella* was recorded here in the 1960s (AXIS Environmental/AMBS Consulting 1995). Regionally significant plants include *Eucalyptus squamosa, Grevillea diffusa* and *Zornia dyctiocarpa* (AXIS Environmental/AMBS Consulting 1995). *Leucopogon exolasius* (2VC-_ found within the place is listed as vulnerable on the Commonwealth Endangered Species Protection Act 1992. A further eight plant species are considered nationally rare including *Darwinia diminuta* (3RCi), *Darwinia grandiflora* (2RCi), *Eucalyptus leumanniana* (2RCa), *Grevillia longifolia* (2RC-), *Hibbertia nitida* (2RC-), *Lomandra fluviatilis* (3RCa), *Melaleuca deanei* (3RC-) and *Tetratheca neglecta* (3RC-) (AXIS Environmental/AMBS Consulting 1995) The rare and undescribed orchid, *Pterostylis* sp. 'E' is recorded from Holsworthy (M. Petersen pers. comm. 1997). The plateau forest and woodland communities on tertiary alluvium/shale have largely been cleared from surrounding lands and many of the last remnants of the shale flora are being destroyed with the expansion of Campbelltown (Benson & Howell 1990). The place includes a significant proportion of the remainder. Plateau forest communities are estimated to cover 9.5% of the Holsworthy Training Area (Axis Environmental/AMBS Consulting 1995). Virtually none of the plateau forest on shale, referred to by Benson & Howell (1990) as 'Cumberland Plain woodlands', is protected in conservation reserves (Benson & Howell 1990, Benson 1992). The melaleuca thicket community is confined to this place (R. Lembit pers. comm. 1996). The broad=headed snake *Hoplocephalus bungaroides* listed as endangered on the Commonwealth Endangered Species Protection Act 1992, occurs here. Other fauna found within the place listed as vulnerable on the NSW Threatened Species Conservation Act include the giant burrowing frog *Heleioporus australiacus*, red-crowned toadlet *Pseudophryne australis*, powerful owl *Ninox strenua*, greater

Criteria	Description
	broad-nosed bat *Scoteanax rueppellii*, koala *Phascolarctos cinereus* and spotted-tailed quoll *Dasyurus maculatus* (AXIS Enrionmental/AMBS Consulting 1995).
Criterion C: Research	The laterite ridgetops within the place are almost entirely intact and are significant reference sites demonstrating the formation of laterite caps and the vegetations communities occupying them (pers. comm. Adam 1996). These laterite caps were once extensive in the Sydney region, but as most have been utilised for suburban developments or distributed by quarrying, the remnants here are particularly important in contributing to understanding the regional land system and the processes leading to it being as it was when European settlement began.
Criterion E: Aesthetic Characteristics	The Holsworthy area has significant aesthetic values for the present community. These relate particularly to the dramatic views of bushland, the Sydney Basin and the Sydney city skyline which can be obtained from the ridgetops. There are also excellent views of rugged creek gorges, rockpools and fringing forest from locations such as Engineers' Bridge.

5.3.1 Statement of significance

As recorded in the SHI listing for this item:

> *Cubbitch Barta National Estate Area is a large area with outstanding cultural and natural values. It is very significant as a cultural and natural landscape which demonstrates relationships between the environment and human occupation through time. Its significance is emphasised by its proximity to Sydney, the Nation's largest metropolitan centre. Cubbitch Barta National Estate Area is an integral component of the Woronora Ramp area, stretching south-west from Sydney, together with Royal National Park, Heathcote National Park, the Woronora catchment and O'Hare's Creek Catchment. Major parts of the Woronora Ramp region are included in the Register of the National Estate. This region, together with the other tracts of undeveloped areas to the west and north of the metropolitan area, are essential in defining the character of the broader Sydney region. In the network of gullies which criss-cross the area, many of the natural values remain undisturbed and the Indigenous heritage is impressively retained. Over 500 Aboriginal sites provide a glimpse of the relationship between people and the land prior to 1788. The sites and the area's long term and more recent connections with Aboriginal people, combine to form a landscape of great significance for its Indigenous heritage. The landscape also provides important illustrations of European settlement, agriculture and Australia's military history. It is unusual to find landscapes in this region so intact. This provides a rare opportunity to understand both the natural and cultural history of the region. It is remarkable that this landscape has survived on the margins of the Nation's earliest and largest urban centre.*
>
> *Indigenous values: The Cubbitch Barta National Estate Area is highly valued by members of the Tharawal Local Aboriginal Land Council and the Dharawal people for its symbolic, cultural, educational and social associations. The Aboriginal cultural landscape of the area reflects the past lifestyle of Aboriginal people in this*

region and its preservation enables Aboriginal people to maintain cultural links to the area. These connections with the past are particularly important, because Aboriginal people in this part of Australia were among the earliest impacted by European settlement of this continent and their culture has since been disrupted by war, disease and urban development. Throughout the environments of the area the Dharawal see evidence of the relationship between their people and the land. The Tharawal Local Aboriginal Land Council is also concerned about maintaining the area's natural environment. The area contains a large and diverse collection of Aboriginal sites, which represent a complex Aboriginal cultural landscape. Over 530 sites are known from the area and a further 509 potential archaeological sites have been documented. It is highly likely that the area contains many hundreds more sites. Sites include rock paintings and drawings, engravings, open scatters of artefacts, grinding grooves and scarred trees. The survival of a significant number of scarred trees within the area is important as this is a rare type of site within the Sydney Basin. While rock art sites are well represented in the Sydney Basin, other types of sites are less so. The preservation within the area of scarred trees, open artefact scatters and archaeological sites in particular, offer considerable potential for further developing a picture of day to day activities of Aboriginal people in the Sydney Basin prior to 1788. This large number of sites and the stories they may tell form a landscape in which Aboriginal life prior to 1788 is recorded without the large scale impact of European settlement. There is also a high density of sites in the area. This is particularly important because sites are found in groups or clusters with their relationship to one another largely intact. By examining where they are located in the landscape and their relationship to other types of sites, a more complete picture of the lifestyle of Aboriginal people could be established. The Georges River, which bounds the National Estate area on the west and is close to the north, has been identified as an important north-south Aboriginal cultural boundary within the Sydney Basin. The cultural landscape of the National Estate area is representative of the southern social unit of the Sydney Basin. This unit has been characterised by the presence of a number of distinctive traits within the art and by complex analyses which show that the art sites of this region are significantly different from those north of the Georges River. The large number of sites, the relatively high site density, the condition of sites and the preservation of the landscape as a whole makes the area important in terms of the further definition of this southern unit. The area also offers considerable research potential in terms of the analysis and interpretation of small scale groups. There is evidence to suggest that this area formed the cultural landscape of a single residence group whose territory extended over the Georges River and Williams/Mill Creek drainage basins. In this region, it is uncommon to have such a landscape preserved in this way and particularly important, as knowledge of local groups from ethnohistory is often incomplete and problematic. The rich collection of more than 300 rock art sites within the area is regionally significant as a group in the Sydney Basin and representative of rock art south of the Georges River. The rock art sites are diverse in terms of technique (paintings, drawings and engravings) and motifs depicted. The art in the area contains a number of motifs which are rare within the Sydney region, such as the engraving of a pregnant woman. The site where this occurs is considered important, as female motifs and gender specific evidence of this kind are relatively rare. The long history of recording the rock art sites by voluntary groups and individuals indicates that they are aesthetically important to groups within the broader community. The aesthetic value of these sites is enhanced by their excellent condition and lack of graffiti. The Cubbitch Barta National Estate Area is important as an illustration of a landscape in which

changes in the relationship between Aboriginal people and early settlers took place. This is a phase in the cultural history of Australia for which traditional documentation is often poor. The area is associated with Governor Macquarie's war against the Aboriginal people of the Liverpool, Campbelltown and Appin areas from April to November 1816. Despite efforts to move Indigenous people away from this country, documentation indicates Aboriginal people were still visiting sites within the area in the 1830s. Within the area, it is the evidence of the strong Aboriginal presence combined with the nineteenth century history and land use without much twentieth century development, which makes this area unusual for the way it can illustrate this period of history. Potential exists for further research to shed light on this era through research relating to exploration, settlements within the area and information about the adjacent Aboriginal reserve.

Natural values: This area contains a diversity of natural landscapes and vegetation types in a relatively unmodified condition, in an area otherwise greatly altered by urban development. Vegetation communities include plateau forest (covering forest and woodland on both tertiary alluvium soils and on shale), gully forest, woodland/heath complex, riparian forest, sedgeland, heath/swamp complex and melaleuca thickets. The laterite ridgetops are almost entirely intact and are significant reference sites which demonstrate the formation of laterite caps and the occupying vegetation communities. Diversity of plant species is high, with more than 400 species recorded in the area. At least seven different plant communities have been distinguished in the area, indicating high community diversity. At least eight plant species considered rare nationally occur here: Darwinia Diminuta, D GRANDIFLORA, EUCALYPTUS LUEHMANNIANA, GREVILLEA LONGIFOLIA, HIBBERTIA NITIDA, LOMANDRA FLUVIATILIS, MELALEUCA DEANEI and TETRATHECA NEGLECTA. A rare and undescribed species of greenhood orchid (PTEROSTYLIS sp E) has also been recorded here. The area contains a substantial remnant of Cumberland Plain woodlands, a vegetation type growing mainly on Wianamatta shale. Only 6% of the original area of Cumberland Plain woodlands remains. This community has been listed as an endangered ecological community under the NSW Threatened Species Conservation Act 1995. LEUCOPOGON EXOLASIUS, found here, is listed as vulnerable under the Commonwealth Endangered Species Protection Act 1992. Regionally significant plants include E SQUAMOSA, GREVILLEA DIFFUSA and ZORNIA DYCTIOCARPA. The broad headed snake (HOPLOCEPHALUS BUNGAROIDES), found in this area, is listed under the Commonwealth Endangered Species Protection Act 1992. The koala (PHASCOLARCTOS CINEREUS) population found locally is considered one of the few remaining viable populations in southern NSW. The area also contains a significant population of the spotted tailed quoll (DASYURUS MACULATUS). Both the koala and quoll are listed as vulnerable under the NSW Threatened Species Conservation Act, together with the giant burrowing frog (HELEIOPORUS AUSTRALIACUS), red crowned toadlet (PSEUDOPHRYNE AUSTRALIS), powerful owl (NINOX STRENUA) and greater broad nosed bat (SCOTEANAX RUEPPELLII), all of which are recorded in the area. The New Holland mouse (PSEUDOMYS NOVAEHOLLANDIAE), considered to be regionally rare, is also found here together with a number of other fauna species of regional or State conservation significance. The area has areas of significant aesthetic values, particularly the forested creek gorges.

Historic values: The settlement sites and transport routes in the area are associated with the history of nineteenth century European settlement and the development of agriculture in the Liverpool region, including the wine industry and subsistence farming in a bushland setting. The Grodno Settlement site is associated with the activities of migrants in the Liverpool region. The Cubbitch Barta National Estate Area also provides evidence of transport routes for settlers in the Liverpool, Holsworthy and Campbelltown areas. These demonstrate the transport linkages that connected the nineteenth century settlements, industry and farms to more established regions of Sydney. Holsworthy is also significant for its military associations. It was a training site for Australian troops and horses engaged in World War One battles, including Gallipoli. The Holsworthy Military Training Area is also significant for the training activities of the Australian Army after World War Two. The Old Army Internment Camp Group was used to inter Germans and other Europeans, from 1914-19. The internment of migrants in Australia followed Britain's foreign nationals policy during World War One and this site reflects Australia's strong defence links with Britain. It also demonstrates Australia's fear of European immigrants during World War One and reflects concerns that Australia's war effort and National security were threatened by spies and invasion. The Old Army Internment Camp Group also indicates the impact of World War One on Australia's home front when men were interned and their families left to fend for themselves. The Old Army Internment Camp Group is associated with the history of Federation. The acquisition of its remaining buildings in 1913 was part of the Commonwealth Government's major program of defence construction for Australia. The Old Army Internment Camp Group survives as evidence of the largest internment camp in Australia during World War One. The guard buildings and structures are rare in demonstrating the guards' section of a World War One internment camp in Australia and are also significant because they were constructed by German and other European internees. This Group has important associations for those who trained there during World War Two and who more recently undertook National Service Training or permanent Army service there during its use as a military camp. It has similar associations for members of the World War One Light Horse Regiments and their families and descendants. It has strong associations for former internees. It also has important associations for Australians as a reminder of a period of conflict and troubled National identity, involving a deep suspicion of non-British immigrants at that time.

5.4 Kolora Weir (SHI 2440843)

5.4.1 Description

No description for this item is given in its SHI listing[53].

5.4.2 Fulfilment of the NSW Heritage Assessment criteria

The SHI listing for this item does not contain a record of its fulfilment of the NSW Heritage Assessment criteria.

[53] Heritage NSW, 'Kolora Weir', State Heritage Inventory, accessed 11 February 2022, https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=2440843.

5.4.3 Statement of Significance

No statement of significance is recorded in this item's SHI listing. However, both the previous and current SoHI for this project have assessed that the item has the potential to be of local significance.

5.5 Woronora-Penshurst pipeline

5.5.1 Description

Currently, no description of the item is contained within its SHI listing[54]. However, a previous version of this item's SHI listing was recorded in the previous SoHI and so a description can be adapted from there[55]:

Woronora Dam is the only one of Sydney's major water supply storage dams which is not primarily part of the Upper Nepean/Warragamba/Shoalhaven interconnected system. It has the smallest catchment area, 85 sq km, of any of the water supply dams. The Dam is located on the Woronora River, just downstream of it's confluence with the Waratah Rivulet, about 6km northwest of the township of Waterfall.

Water is discharged from the lake via two 3 feet (0.9m) diameter pipes in the base of the dam, these lead to a valve house located at the bottom of the downstream face of the wall. The water then flows along a 16.1 mile (27 km) pipeline, consisting of 42 inch (1.07m) mild steel spirally welded pipes lined internally with 1 3/8 inch (34mm) cement mortar. The pipeline crosses the Georges River on the old railway bridge at Como and discharges into the two elevated Penshurst reservoirs.

The 27 km length of pipeline main was constructed in four sections. The first section commences at the outlet of the Woronora Dam and then follows the left bank of the Woronora River. It crosses the river on a concrete causeway and continues along the right bank to No. 1 tunnel, approximately 400 m in length, some 3.2 km from the dam. The line then follows Heathcote Creek to near it's junction with the Woronora River.

The second section follows the right bank of the Woronora River as far as No. 2 tunnel, 13.5 km from the dam, where it continues on to cross Forbes Creek. The tunnel is approximately 244m long and had to be lined with concrete because of the poor strata encountered. The main crosses the Forbes Creek on a specially designed structure. A pressure valve is located at Forbes Creek to reduce the pressure on the main downstream. The section ends at Grand Parade, Sutherland, where 20 inch (508mm) and 18 inch (457mm) branches feed the Sutherland Reservoir.

In the third section from Grand Parade to Como the main is laid partly above ground and partly in trench and crosses under the railway line near Jannali in a concrete culvert. At the southern end of the railway bridge over the Georges River, the 48 inch (1.22m) main bifurcates into two 24 inch (0.61m) mains which are

[54] Heritage NSW, 'Woronora-Penshurst Pipeline', State Heritage Inventory, accessed 21 March 2022, https://www.hms.heritage.nsw.gov.au/App/Item/ViewItem?itemId=2440830.
[55] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.

carried across the river on brackets welded to the lower chord on each side of the bridge.

After passing over the Georges River the fourth section of the main reverts to 48 inch (1.22m) diameter and follows the eastern side of the railway line to Oatley. At this point it deviates and proceeds principally underground along streets to the intersection of Hillcrest Avenue and Laycock Road, Penshurst, whereby a 36 inch (0.91 m) branch runs to the Penshurst Reservoirs.

5.5.2 Fulfilment of the NSW Heritage Assessment criteria

The following has been extracted from the SHI listing contained within the previous SoHI for this project:

Table 6: Significance assessment of the heritage item as recorded in SHI listing within previous SoHI.

Criteria	Description
A – Historical Significance	The Woronora-Penshurst Pipeline is historically significant because of its relationship with the Woronora Dam, the fifth of the water supply dams built as part of Sydney's water supply. Woronora Dam was completed in 1942 and is the only one of Sydney's water supply dams which is not part of the Upper Nepean/Warragamba/Shoalhaven interconnected system. The dam was built with the objective of supplementing Sydney's water supply whilst the much larger Warragamba Dam was being constructed. The pipelines were constructed with the purpose of transferring water from the dam site on Woronora River, near Waterfall, to the Penshurst Reservoirs, whence the Cronulla/Sutherland area could be supplied with gravitational water.
C – Aesthetic or Technical Significance	The pipeline was originally camouflaged during the second world war. It was repainted silver after the war period. Around 1980 environmental measures resulted in the pipes being repainted green to blend in with the natural bushland. The pipeline also passes through an area which is now the Heathcote National Park.

D – Social Significance	The Woronora - Penshurst pipeline is socially significant as it supplies water from Woronora Dam to the areas of Sutherland, Cronulla, Engadine, Heathcote, Helensburgh, Stanwell Park and the areas just north of Georges River and as such is likely to be held in high regard by the broad community for the function it serves. The completion of the Woronora Dam was a significant step in the continuing process of providing reliable water supply to Sydney and surrounding areas. It further served the purpose of providing an interim measure, when it was realised that the growth of Sydney would require a water supply augmentation of a magnitude which could only be met by the construction of a major dam on the Warragmba River. The construction of the pipeline allowed for the career of Sir William Hudson to advance. He was the resident engineer on the Woronora Dam/Pipeline project and went on to be the Engineer-in-Chief of the Water Board and the first Commissioner of the Snowy Mountains Scheme. The Woronora Dam and Pipeline also strengthened Sydney's defences During WW2 by supplying an independent and alternate supply to the Upper Nepean Scheme in case of emergency.
E – Research Potential	The pipeline is 27.1 km long consisting of 42 inch (1.07m) mild steel spirally welded pipes. A corkscrew technique was used in order to obtain a large diameter pipeline, as only small width sheet steel was available at the time of construction. A lack of expansion joints has resulted in minor leakages along the length of the pipeline. The pipeline did not have adequate expansion joints when built. This caused some leakage of joints at later stages. The pipeline has numerous river and creek crossings along it's route. At Woronora River and Forbes Creek the pipeline crosses the water via single pipe aqueducts. At Georges River the pipeline bifurcates and crosses the water via the former Como Railway Bridge. This bridge is significant as it is a Whitton's Lattice Girder Bridge and was built in 1885. The pipeline bifurcates when it crosses the bridge in order to equalise the load on the structure. The bridge is no longer used by the railway and is now owned by Sydney Water. It is presently used only for pedestrian and bicycle access. The pipeline also passes through a rock tunnel known as Dingo Tunnel.
F – Rarity	One of a number of water supply pipelines in Sydney.
G – Representativeness	Representative of water supply pipelines and of infrastructure associated with the Woronora Dam which is the only one of Sydney's water supply dams that is not part of the Upper Nepean/Warragamba/Shoalhaven interconnected system.

5.5.3 Statement of Significance

As recorded in the original SoHI:

> *The Woronora-Penshurst Pipeline is significant because of its relationship with the Woronora Dam, the fifth of the water supply dams built as part of Sydney's water supply. Woronora Dam was completed in 1942 and is the only one of Sydney's water supply dams which is not part of the Upper Nepean/Warragamba/ Shoalhaven interconnected system. The dam and pipeline were built with the objective of supplementing Sydney's water supply whilst the much larger Warragamba Dam was being constructed.*
>
> *The Woronora - Penshurst pipeline is culturally significant as it supplies water from Woronora Dam to the areas of Sutherland, Cronulla, Engadine, Heathcote, Helensburgh, Stanwell Parkland the areas just north of Georges River.*
>
> *The pipeline has technical significance because of its corkscrew construction method. At the time of construction only small width steel sheets were available and in order to obtain a large diameter pipeline these were welded together in a spiral technique.*

5.6 Royal National Park and Garawarra State Conservation Area

5.6.1 Description

The following description is contained within the item's Australian Heritage Database entry[56]:

> *Royal NP is a large, mainly natural area managed for both recreation and nature conservation. The Park features a diverse range of natural environments and is a popular recreation destination. Most of the originally gazetted area (1879) of the Park remains within the current Royal NP boundary. At establishment, 7,200 hectares (18,000 acres) were reserved as National Park. Today, with various additions of land, the Royal NP is 15,068 hectares in size.*
>
> *Garawarra SCA covers 900 hectares and adjoins the south-western corner of Royal NP. It protects rainforest in the upper catchment of the Hacking River, and also links the rainforests of Royal NP to those of the Illawarra Escarpment directly to the south. Both reserves are contiguous with a larger area of natural vegetation further to the west and south-west, which includes the Holsworthy defence training area, and various reserves including Dharawal SCA, and Sydney Water catchment areas.*
>
> *As part of the Woronora Plateau, Royal NP and Garawarra SCA are deeply dissected in the west by the Hacking River system where the sandstone has been eroded into deep gorges, with a landscape of low plateaus, steep valleys, ridges and rocky outcrops. High cliffs are a feature of the coast, especially between*

[56] 'Royal National Park and Garawarra State Conservation Area, Sir Bertam Stevens Dr, Audley, NSW, Australia', Australian Heritage Datatbase, 2006, https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;place_id=105893.

Curracurrong and Garie. The place is part of the much larger Sydney-Bowen Basin and of Permian and Triassic age (270-180 million years ago). The Hawkesbury sandstones formed 190 to 225 million years ago, when Australia was part of Gondwana and the Sydney region was a large deltaic system comprised of freshwater rivers and lakes. The lakes were gradually filled by sand, silt and pebble-sized sediments, over millions of years compressed into sandstone, mudstone and shale rock formations. The Hacking River system drains northwards into Port Hacking exposing the Narrabeen shales in the sheltered, coastal valleys in the southern part of the park, which weather into richer soils that support areas of rainforest and moist eucalypt forest. Elsewhere, Wianamatta shales occur as lenses within the sandstone.

*Well over 1000 plant species are known from Royal NP and Garawarra SCA. The two reserves contain areas of subtropical, warm temperate rainforest that are mainly restricted to sheltered places in the upper catchment of the Hacking River valley. The park also contains a wider range of eucalypt forests including shale forests, which are significant as remnants of a community that once stretched from Sutherland to Cronulla. Shale forests occur on outcrops along the western edge of the Royal NP, near Loftus and Helensburgh. Much of the sandstone plateau supports a eucalypt woodland community which in western Royal NP grades into sandstone gully forest dominated by smooth-barked apple (*Angophora costata*). The region's rainforest and wet eucalypt forests were logged for red cedar (*Toona ciliate*) and other valuable timbers in the past, and it is estimated that some 75 per cent of the rainforest of the Illawarra has been cleared since settlement. As a result, regional reserves such as Royal NP and Garawarra SCA are especially important for conservation purposes.*

Prominent along the eastern side of Royal NP, on the sandstone plateau, are species-rich heathlands, which contain over 500 species of flowering plants. Many of the park's heathland wildflowers are in bloom from July to November. The relict cliff top dunes to the east and south of Bundeena support an assemblage of large shrub species which once covered the eastern suburbs peninsula of Sydney. This habitat is now restricted in the Sydney region.

Freshwater lagoons occur in the park in the coastal sand sheets at Jibbon and Marley. These lagoons are of potential value for research into management of the vegetation in Royal NP. Fossil pollen recorded in these lagoons and in the upland swamps could give clues to the relationships between fire regimes and vegetation dynamics over the last 10,000 years (NPWS, 2000).

Royal NP and Garawarra SCA are recognised as supporting a rich native vertebrate fauna, a reflection of the diversity of vegetation communities and habitats present, and the park's location on the junction of the northern warm-temperate and the southern cool-temperate zones. The place is especially rich in birds with 231 species. Garawarra SCA is particularly noted for the diversity and abundance of rainforest birds. The herpetofauna (reptiles and frogs) of Royal NP and Garawarra SCA is abundant and diverse with 40 species of reptiles and 30 species of amphibians recorded. This is richer than in any other studied part of coastal park in New South Wales. There are at least 43 species of mammals recorded in the reserves of which 16 are bats. The tall, moist eucalypt forests and rainforests of the Hacking River catchment support the greatest diversity of birds and also the majority of the mammals known in the two reserve areas (26 out of 43

species).

Royal NP has one of the richest native insect faunas of any studied area in NSW and is the type locality for hundreds of species. It also has a diverse terrestrial mollusc fauna. The rainforests along the Hacking River are rich areas for molluscs as also are the littoral rainforest patches.

Royal NP is one of only, four coastal nation parks in NSW that protect land below high water mark and associated estuarine habitats. The submerged and intertidal lands of South West Arm and Cabbage Tree Basin, both in Port Hacking, are part of Royal NP. Both areas are sheltered bodies of water which support nursery grounds for juvenile fish and invertebrates, seagrass beds and diverse benthic fauna. Cabbage Tree Basin also supports a mangrove community and is an area frequented by migratory birds (NPWS 2000).

Royal NP and Garawarra SCA were occupied by the Dharawal people whose territory extended southward from Port Hacking to around Jervis Bay. As a result Royal NP and Garawarra SCA contain an important suite of comparatively undisturbed Aboriginal sites, including rock engravings, middens, art sites, occupation sites, axe-grinding grooves, and sacred sites. Two Aboriginal Places, protected under the National Parks and Wildlife Act 1979*, have recently been declared within Royal NP at North Era Beach and Costens Point. These places are used as resting places for the remains of Dharawal people repatriated from Australian and overseas museums (Koori Mail, 5/10/2005). Royal NP also contains one place listed on the Register of the National Estate for its Aboriginal heritage values.*

Evidence of Aboriginal occupation is closely correlated with environmental land units. Shell midden deposits, some with burials, have been recorded along the shores of Port Hacking, in sand dunes behind the ocean beaches in Royal NP and in rock shelters along the coast. Engraving sites have been recorded on sandstone outcrops along the coast around Port Hacking and on the sides and tops of ridges throughout Royal NP. Shelters with pigment art have been recorded mainly along ridges in the park. Grinding grooves are common within the parks, sometimes in association with engravings, though more often these are found in creek lines and near waterholes.

Archaeological investigations were conducted during the 1960s into Aboriginal occupation sites at Audley, Wattamolla and Curracurrang within Royal NP. Radiocarbon dates from these sites suggest occupation from about 7000 years ago (during the Holocene) to about 1000 years. The commencement of occupation broadly corresponds with the stabilisation of sea levels about 6500 years ago (Attenbrow, 2002: 18-19; 38-39).

The stone tool technologies identified at these sites conform with the established late Pleistocene/Holocene sequence in the broader Sydney region: Capertian, Early Bondaian, Middle Bondaian and Late Bondaian. Capertian assemblages are well represented at Curracurrang 1, while Bondaian assemblages (particularly middle to late) are represented at both Curracurrang and Wattamolla (Megaw, 1974). Other remains from these sites include animal, bird and fish bone, shell and shell fish hooks, suggesting the exploitation of a range of resources (refer Megaw, 1974).

Rock rt sites in Royal NP and Garawarra SCA occur within a distinct stylistic variant of the broader Sydney Basin rock art style. Research has identified a stylistic boundary occurring south of the Georges River, based on the presence and proportions of different motifs and on overriding schematic differences (McDonald, 1994). Art sites in these parks include engravings of whales, anthropomorphic figures, marine and terrestrial animals and a few tracks, together with pigment art, commonly charcoal drawings of anthropomorphic figures, marine and terrestrial animals, with a smaller proportion of stencils of hands and material culture objects.

Aboriginal sites and cultural places in the park are of importance to the Aboriginal community today for cultural revival, educational and historical reasons (Bean 2002; DEC, 2005d).

Royal NP contains many features which reflect the early management (1879-1914) of the Park. Audley in particular reflects the early period of Park management. The area was principally developed for recreation and some acclimatisation projects were also carried out in this area. The use of the area for boating (1883-), the picnic lawns (1890-), the causeway (1883-), Lady Carrington Drive (1886-) are all features that reflect the early use and management of the Park.

Other features within Royal NP reflect the early management of the Park. These include for example the exotic plantings, some walking tracks and roads, the National Park Railway Station (1886-), the remnant military encampment area at Loftus Heights (188601901), the remnant evidence of early acclimatisation experiments and the evidence in the landscape of early charcoal manufacturing, mining and forestry.

5.6.2 Fulfillment of National Heritage List criteria

The National Heritage criteria against which the heritage values of a place are assessed are[57]:

a. the place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history
b. the place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history
c. the place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history
d. the place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:
    i. a class of Australia's natural or cultural places; or
    ii. a class of Australia's natural or cultural environments;
e. the place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group

[57] Department of Agriculture, Water and the Envrionment, 'National Heritage List Criteria', National Heritage, 2021, https://www.awe.gov.au/parks-heritage/heritage/about/national/national-heritage-list-criteria.

f. the place has outstanding heritage value to the nation because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period
g. the place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons
h. the place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history
i. the place has outstanding heritage value to the nation because of the place's importance as part of Indigenous tradition.

Table 7: Significance assessment of the heritage item as recorded in NHL listing.

Criteria	Description
Criterion A Events, Processes	Royal National Park and Garawarra State Conservation Area constitute a major centre of plant species richness, having one of the richest concentrations of plant species in temperate Australia with more than 1000 species. The place is important for its richness in a wide array of species including heaths (Epacridaceae), peas and wattles (Mimosaceae and Fabaceae), orchids (Orchidaceae), grevilleas and banksias (Proteaceae) and members of the eucalypt family (Myrtacea). The place can be regarded as exemplifying the biodiverse Hawkesbury Sandstone environment (Braby 2000; DEH 2004; DEH 2006; NSW NPWS 2000). Royal National Park was the first National Park to be established in Australia in 1879 and this event is seen as the beginning of the Australian conservation movement (Heathcote 1988). The permanent reservation of a large natural area for the purpose of public recreation marked the start of the development of Australia's National Park system of protected areas (Worboys et al 2005).

5.6.3 Statement of Significance

The following statement of significance is recorded within this item's Australian Heritage Database entry:

> *Royal National Park (Royal NP) and Garawarra State Conservation Area (Garawarra SCA) constitute a major centre of temperate plant species richness, having one of the richest concentrations of plant species in temperate Australia with more than 1000 species. The place is also extremely rich in perching birds, reptiles and butterflies and can be regarded as exemplifying the biodiverse Hawkesbury Sandstone environment.*

Royal NP was the second National Park to be established in the world after Yellowstone and the first in Australia. Its declaration in 1879 marked the beginning of the development of Australia's National Park system of protected areas. Establishment of the park as a recreation area for the then residents of Sydney also marks a time when public attitudes towards the Australian natural environment were becoming more appreciative. With greater access to and use of natural areas for recreation, the public's concern for the natural environment grew and this, in part, influenced the evolution of a broader conservation movement. The establishment of Royal NP is considered to be the beginning of the Australian conservation movement.

6.0 HERITAGE IMPACT ASSESSMENT

6.1 Overview

This section assesses the heritage impact of the proposed works at the study area on heritage values within the study area. Justifications are also provided for the proposed works.

Within this approach, the objective of a heritage impact assessment is to evaluate and explain how the proposed works, rehabilitation or land use change will affect the heritage value of the study area and/or place. A heritage impact assessment should also address how the heritage value of the site/place can be conserved or maintained, or preferably enhanced by the proposed works.

In order to consistently identify the impact of the proposed works, the terminology contained in the following table has been references throughout this document. This terminology and corresponding definitions are based on those contained within the guidelines produced by ICOMOS (2011), as seen in Table 8 below.

Table 8: Terminology for assessing the magnitude of heritage impact

Grading	Definition
Major	Actions that would have a long-term and substantial impact on the significance of a heritage item. Actions that would remove key historic building elements, key historic landscape features, or significant archaeological materials, thereby resulting in a change of historic character, or altering of a historical resource. These actions cannot be fully mitigated.
Moderate	This would include actions involving the modification of a heritage item, including altering the setting of a heritage item or landscape, partially removing archaeological resources, or the alteration of significant elements of fabric from historic structures. The impacts arising from such actions may be able to be partially mitigated.
Minor	Actions that would result in the slight alteration of heritage buildings, archaeological resources, or the setting of an historical item. The impacts arising from such actions can usually be mitigated.
Negligible	Actions that would result in very minor changes to heritage items.
Nil / Neutral	Actions that would have no heritage impact.

6.2 Assessment of heritage impact

This section assesses the potential direct (physical) and indirect (visual) impacts of the proposed development on nearby heritage items as listed below with a summary provided in Table 9:

6.2.1 Impacts to listed heritage items

6.2.1.1 Direct impacts

Woronora River Bridge

The existing bridge is to be modified from a two lane bridge to a single lane unidirectional bridge. This includes changes to the pavement and line marking. These are considered negligible changes that would alone constitute exempt minor or maintenance works. Barrier replacement on the bridge is still required, as was also required for the original REF. The modified proposal would change the western barrier to an upgraded barrier which would form a dividing barrier between the opposing carriageways. The original assessment found that the edge barriers were not original fabric as they had been replaced in the 1990s and therefore proposed changes to the barriers did not detract from the heritage significance criteria.

Repair and maintenance works are still required consistent with the original REF and were found to add value as they would prolong the design life of the bridge. Additionally, the proposed conversion of the bridge to single lane reduces the weight load on the bridge which is considered to also extend its design life.

The proposed modifications to the abutments differ from the original proposal which planned to remove the sandstone and re-use it by incorporating it elsewhere in the design. Further investigation however revealed that the sandstone was capping only. Consequently, it is now proposed to cap the sandstone facing (Figure 9) to protect it and expand the total abutment area on the northern and southern sides to capture both the old and new bridge structures.

The client has stated that in October 2021, TfNSW gave a briefing presentation to Heritage NSW to discuss the modified proposal and seek feedback. During the meeting, Heritage NSW provided in principle support for the modification with comment that it has “better heritage outcomes, is much less intrusive and less fabric impact”.

The proposed works will have **negligible** direct impacts to the Woronora River Bridge. The bridge design is considered to adequately mitigate these impacts through its simplistic and sympathetic design which follows the design principles of the TfNSW Bridge Aesthetics guide. Overall, this design option is considered to result in far less of a heritage impact than the original design, which would have caused moderate direct impacts to the Woronora River Bridge. As such, the item still retains its State heritage significance.

Cubbitch Barta National Estate Area

The necessary roadworks to and realignment of Heathcote Road will involve works within the curtilage of the Cubbitch Barta National Estate Area. Specifically, it will involve rock cutting to enable shifting the alignment of the northern bridge approach. This action will result in a direct physical alteration to a portion of the Cubbitch Barta National Estate Area by removing elements oof the landscape and vegetation within the area.

However, neither this assessment or the previous version identified any items of heritage significance within the area to be impacted. Furthermore, both assessments have deemed that the overlapping area possesses low archaeological potential. It is also important to clarify that the section of the National Estate Area to be impacted represents less than 1ha of the 18,000ha are overall (see Figure 20 for reference), and already contains a section of Heathcote Road within it. The proposed works would be enabling the continued function of this portion of the Cubbitch Barta National Estate Area in a manner that results in improved safety outcomes for the high volume of motorists who use this route. So, although the proposed works would involve the physical alteration of a portion of the Cubbitch Barta National Estate Area, given the findings of this assessment and the physical context of the works location, the proposed works would have **minor** direct impacts to the item.

As part of this project, surveying of the area was carried out to determine the overlap between the construction footprint and the Cubbitch Barta National Estate Area curtilage and Commonwealth Defence Land cadastral boundary (Figure 36 - Figure 37). While it was demonstrated that the previous cadastral boundary of the Defence land was incorrectly applied in the past due to surveying issues, the curtilage of the Cubbitch Barta National Estate Area has still been maintained, as it is not guided by the extents of the Defence land. There is no encroachment by the road corridor on the Commonwealth Defence land cadastral boundary. Although cadastral lots and heritage curtilages may often prove to be the same boundary, they are in fact independent of one another, and this is the case with the Cubbitch Barta National Estate Area.

Figure 36: Encroachment of the road corridor into the CBNEA curtilage (Source: TfNSW).

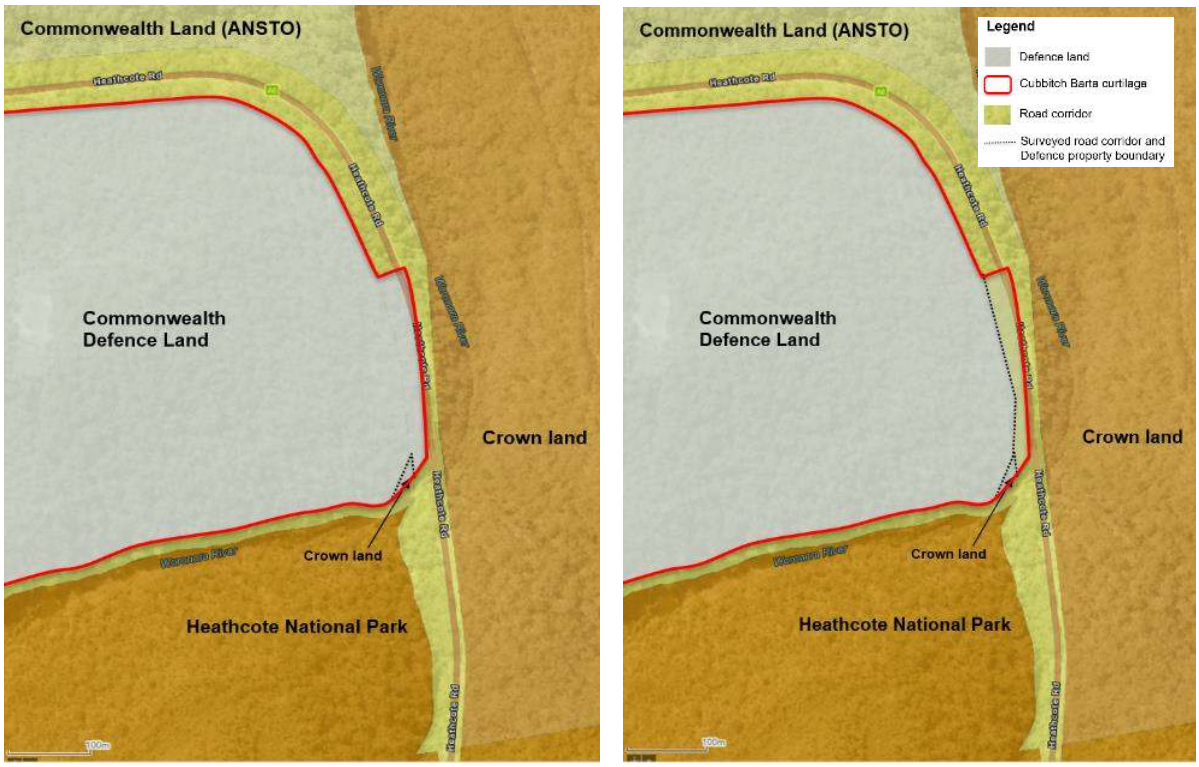


Figure 37: Construction footprint in relation to cadastral boundaries of surrounding lots (Provided by Fulton Hogan).

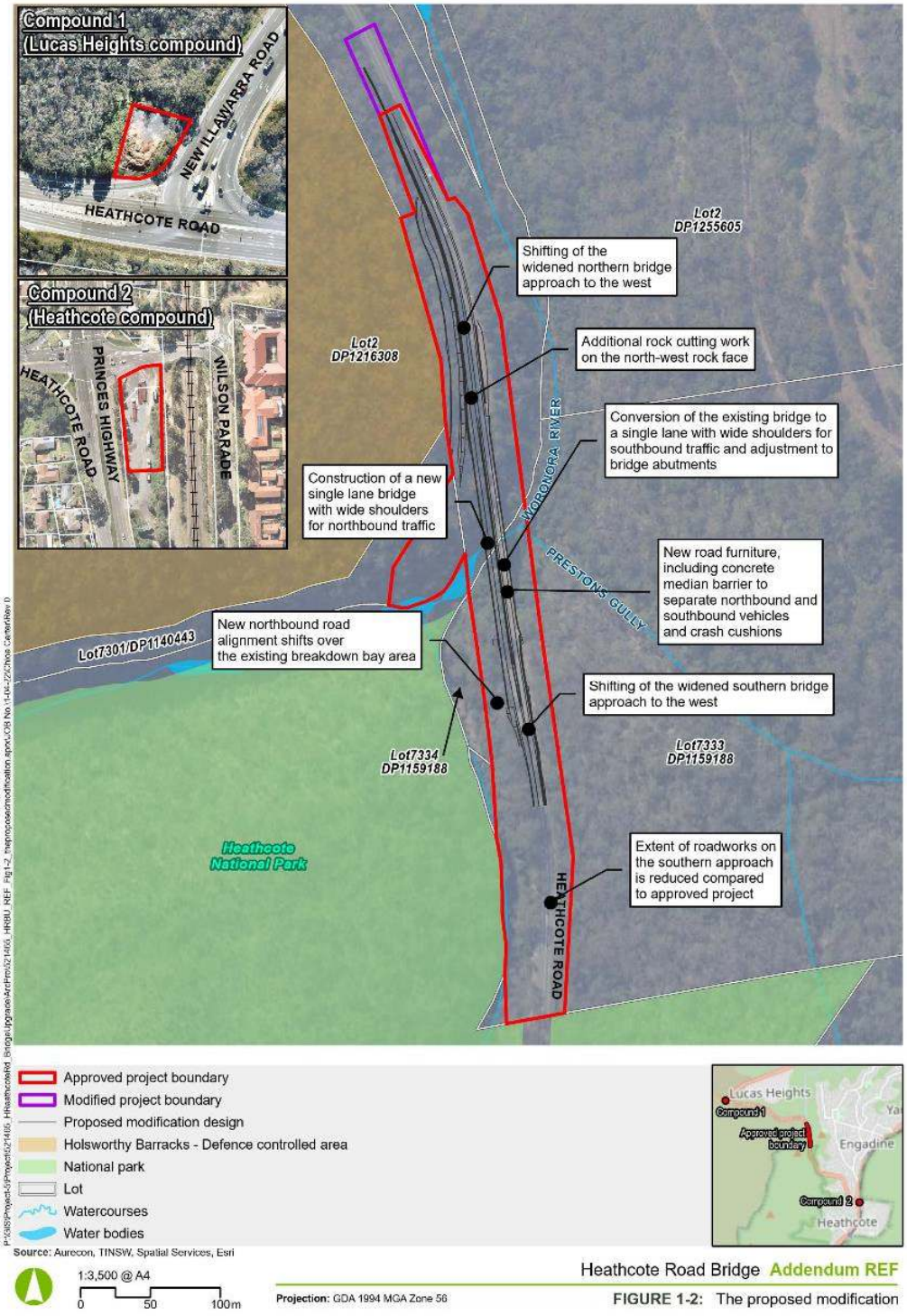
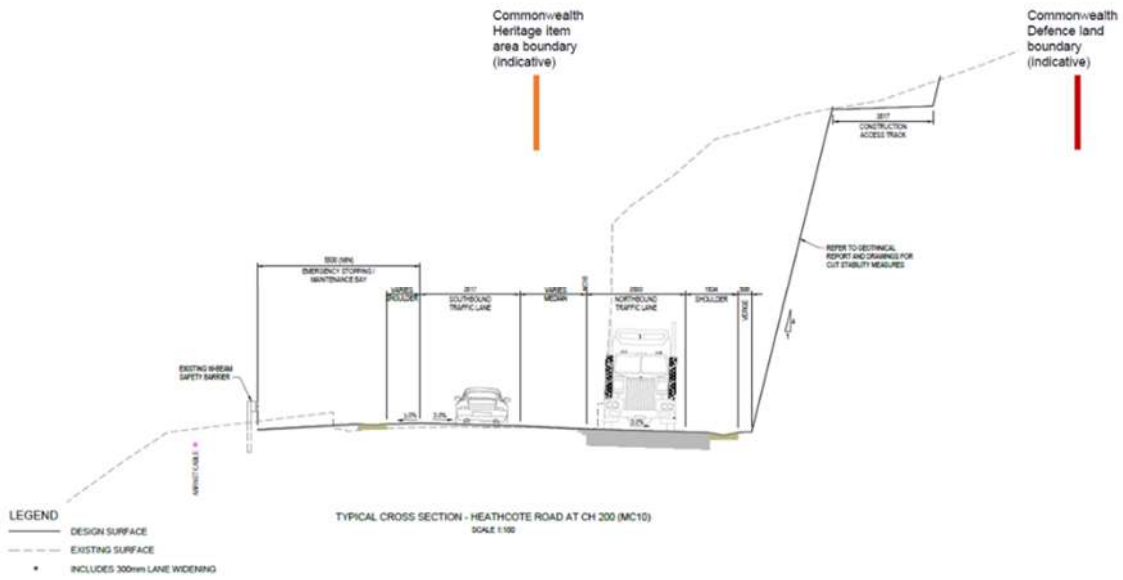


Figure 38: Cross-section showing relationship of existing and proposed roadway and cuttings with the Commonwealth Heritage List item and Commonwealth Defence land boundaries (Source: Aurecon, 2022).



Surrounding heritage items

Several heritage items were identified within the vicinity of the construction footprint and the work compounds. These items include the Kolara Weir, Woronora-Penshurst pipeline, and the Royal National Park and Garawarra State Conservation Area. Given the defined location of the proposed works and the distance between these items and the construction footprint and work compounds, the proposed works will have **nil** direct impact to these surrounding heritage items.

Unlisted heritage

Unlisted heritage features have been considered as they contribute to the local features of a Conservation Management Plan for the bridge and ultimately a potential future curtilage for formal nomination for State Heritage Listing. The reduced length of roadworks on the approaches has avoided impact to some of the cross culverts which required extension in the original design. This avoids impact to some of the heritage stone features observed at the culvert outlets (Figure 22).

The enhancement of Cross Drain Exist-01 would involve works to the inlet of the existing culvert, although the proposed plans would retain its outlet and sandstone drainage chute. The heritage value of the culverts surrounding the Woronora River Bridge largely stems from the sandstone construction of their outlets and their aesthetics. As the proposed works would retain the outlet of Cross Drain Exist-01, the enhancement of the cross culvert would have a **negligible** impact. To mitigate this impact, the inlet and outlets of the culverts as well as present drainage chutes should be captured in the scope of pre-works archival recording.

Construction works on the southern approach in the original scope had the potential to directly (through earthworks) or indirectly (i.e. through vibration) impact the unlisted retaining wall features at the existing bridge edges both east and west of the existing north and south abutments (Figure 23). In the revised project, the southwest sandstone wall will potentially be impacted. The impacted wall would be captured in the scope of pre-works archival recording and encapsulation under geo-technical fabric, consistent with original safeguards outlined in the original SoHI and REF. Relocation of the sandstone blocks would destabilise the adjacent ground and not be feasible.

Unexpected heritage

The potential to impact unexpected heritage is considered low risk consistent with the original REF because the proposal area is consistent with the original REF boundary.

6.2.1.2 Indirect impacts

Woronora River Bridge

The construction of a new bridge in close proximity to the current Woronora River Bridge will result in indirect impacts to the heritage item. As noted previously in this assessment, the aesthetics of the present bridge are an important element in its heritage significance. The location of the proposed bridge directly to the west of the heritage item will obstruct views towards the bridge and reduce the ability to appreciate its aesthetic appeal, although it is necessary to note that the environment surrounding the item does already restrict visuals of the bridge and public access to those viewpoints (Commonwealth Defence land, ANSTO land, steep terrain rock escarpments and fringe of Heathcote National Park) which reduces the magnitude of the adverse indirect impact.

However, the design of the proposed bridge does contain sympathetic elements including concrete construction, similar colouring and matching pile shapes, which are intended to mitigate the indirect impacts incurred through its construction in accordance with the *TfNSW Bridge Aesthetics Guide*. The design of the new bridge as well as its visuals are intended to complement the Woronora River Bridge without attempting to produce an identical replicate. In this way, the proposed bridge will allow the

design of the heritage item to still be appreciated whilst also exhibiting a sympathetic visual appearance that will allow the original bridge to be clearly identified. The SoHI for the previous scheme found that the proposed bridge widening works would involve the construction of a number of large additions which would visually dominate the heritage item. The current proposal will therefore result in less harmful indirect impacts compared to the previous bridge widening proposal, which would have involved the construction of a number of large additions which would have visually dominated the heritage item. ~~design plans~~. The proposed works would have a **minor** indirect impact on the Woronora River Bridge.

As the proposed bridge would be constructed independent of the present bridge there would also be no risk of operational vibration impacts.

Cubbitch Barta National Estate Area

The proposal would impact a greater depth of rock cutting impacted on the northern approach (western side) with associated vegetation impacts along the crest of the cutting (Figure 37). However, the cross-sectional area of the rock cutting face would remain largely consistent with the original scope and is still proposed to be a near vertical cut (with no benching within the height of the existing cutting). Additionally, the proposed slope face treatments are considered largely consistent with the approved scope including potential shotcrete treatments. As such, upon completion of the works, the affected area will appear similar to its current state. It is also important to affirm that the works will not affect specific significant elements of the Cubbitch Barta National Estate Area (which are discussed in-depth in Section 5.3.1 of this assessment), and that the area to be impacted represents a small portion of the item overall.

Therefore, the proposed works will result in **minor** indirect impacts to this item. TfNSW has also advised that options to mitigate the impacts of the proposed works are being explored, such as Erkat header slope face treatment which has an appearance similar to hand pick marks. Such options, along with natural rock weathering and the regrowth of vegetation, will assist in reducing the indirect impacts of the proposed works over time.

Surrounding heritage items

While the proposed works will have minor indirect impacts to the heritage items outlined above, the items that are outside of the construction footprint and work compounds will be markedly less impacted. Views of the Kolora Weir and Woronora-Penshurst pipeline will potentially be affected by the works occurring within the construction footprint, although these will occur only temporarily while the works are ongoing. Upon the completion of the proposed works, there will be no significant indirect impacts to the items, although it is possible that views to the Kolora Weir from the Woronora River Bridge may be partially obstructed. As such, the proposed works will have **negligible** indirect impacts to the Kolora Weir and the Woronora-Penshurst pipeline.

The work compounds are also within the vicinity of the Cubbitch Barta National Estate Area and the Royal National Park and Garawarra State Conservation Area. Despite this, the small scale and temporary nature of the work compounds means that they will both result in **negligible** indirect impacts to these items.

Unlisted heritage

The unlisted items of potential heritage significance associated with the Woronora River Bridge are presently obscured from public view by the bridge itself. As such, the proposed works would have **negligible** indirect impact on these items.

Table 9: Summary of heritage impacts.

Heritage listed item	Direct Impact	Indirect Impact
Woronora River Bridge	**Negligible**	**Minor**
Cubbitch Barta National Estate Area	**Minor**	**Minor**
Kolora Weir	**Nil**	**Negligible**
Woronora-Penshurst pipeline	**Nil**	**Negligible**
Royal National Park and Garawarra State Conservation Area	**Nil**	**Negligible**

6.3 Commonwealth heritage impacts

The northwest portion of the construction footprint is located within the curtilage of the Cubbitch Barta National Estate Area, a CHL Place. Therefore, it is necessary to employ the self-assessment process outlined in *Significant Impact Guideline 1.2* of the EPBC Act to assess the impacts of the proposed works on the heritage value of the item. The self-assessment process examines the environmental context of the Place, the proposed impact and avoidance or mitigation strategies to determine if a significant impact will occur.

The self-assessment contained within this report only takes into consideration the historical values of the CHL Place as TfNSW has engaged another consultancy to prepare the Indigenous and natural values assessments for the study area. This assessment should only be accepted when viewed in conjunction with the results of the Aboriginal values self-assessment for the CHL Place. Furthermore, a self-assessment was conducted as part of the previous SoHI for this project. Although the project design has been altered from the previous version, elements of the initial self-assessment conducted by Biosis are still applicable to the current assessment; therefore, where appropriate, elements will be adapted from the original SoHI. The responses to the questions posed by the Significant Impact Guideline 1.2 are contained within Table 10 below:

Table 10: Significant Impact Guideline 1.2 responses for historical heritage values (EPBC Act 1999).

Question	Response
Step 1 – Environmental context	

Question	Response
What are the components or features of the environment in the area where the action will take place?	The proposed actions are to take place within the CHL Place Cubbitch Barta National Estate Area (CHL no. 105405). This area comprises of approximately 18,000 hectares of the Woronora Plateau, approximately 30 kilometres south-west of inner Sydney. It adjoins Heathcote National Park to the south-east and Dharawal State Recreation Area to the south, forming part of an extensive tract of bushland stretching southwards from the Sydney metropolitan area. It encompasses important Indigenous, natural and historical values for the region and was used as a military training ground during WWII. Specifically the proposed works would affect less than 1ha of the 18,000ha CHL Place. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
Which components of features of the environment are likely to be impacted?	The proposed works would not impact on any previously identified built fabric as part of the CHL Place. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
Is the environment which is likely to be impacted, or are elements of it, sensitive or vulnerable to impacts?	Historical values relating to the CHL Place present within the northern portion of the study area are vulnerable to impacts, due to the type of proposed works specified in Section 1.3. However, mitigation and management recommendations would greatly reduce the risk of inappropriate impacts to the majority of these elements. The proposed works would necessitate rock cutting, therefore causing irreversible impacts to a small portion of the Estate. Historical remnants of the Kolora Weir were identified during the field investigation, located within the boundary of the CHL Place. It is anticipated that the historical elements found throughout the north-western section of the study area would not be adversely affected once mitigation measures have been implemented. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
What is the history, current use and condition of the environment which is likely to be impacted?	The land present within the current study area, which is a part of the CHL Place, was originally used for the construction and operation of Kolora Weir, and subsequently public recreation purposes until the Weir was decommissioned in 1985. However, it has also been used as a road corridor connecting the Holsworthy Army base to surrounding areas since the mid-20th century. The road, which was cut into the existing landscape, continues to be used as a vital route between Liverpool and the Sutherland Shire today. Biosis conducted a physical inspection of the area as part of this initial assessment for this project, with the portion of the CHL Place remaining largely untouched since the Weir was decommissioned and in good condition. An inspection was also carried out by Artefact, which supported the assessment of the area's condition made by Biosis. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
Step 2 – Proposed impacts	

Question	Response
What are the components of the Action?	Many of the current proposed works are consistent with the original SoHI and REF for this project and involve using an old access track from Heathcote Road to Kolora Weir (which is approximately 80m for the LEP boundary of the Kolora Weir) for machinery and vehicle access, and the potential installation of a water crossing and crane platforms in the central portion of the study area. However, the current proposed design also involves a greater amount of rock cutting, additional vegetation removal, modified drainage, and a shift in the present alignment of Heathcote Road. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
What are the predicted adverse impacts associated with the action including indirect consequences?	Predicted adverse impacts associated with the action include minor direct and indirect impacts to the CHL Place stemming from rock cutting and vegetation removal. However, these elements are required to ensure the continued safety of drivers using the roadway and bridge. Currently, the roadway does not conform to current road design guidelines, with crash history statistics for the bridge including a record of both fatalities and serious injuries. Road safety concerns are a key issue for motorists and the local community. Predicted population and traffic growth for the area is also anticipated to place increased pressure on the road corridor, potentially increasing the risk of the number and severity of incidents. Increased incidents would potentially lead to an increase in unplanned road closures, and a reduction in travel time reliability. Overall, the majority of works will result in a minor heritage impact to the Place. Heritage controls would be required to ensure that as much of the significance of the heritage item is maintained as possible. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
How severe are the potential impacts?	The proposed actions to the western boundary of the CHL Place have been assessed against the Significant Impact Guidelines 1.2 of the EPBC Act and are considered to be small scale, low intensity and localised to the area, thus the overall impact to the Place is considered to be minor. Although these impacts will not be reversible, they are not large enough to adversely impact the entirety of the CHL Place. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
What is the extent of uncertainty about potential impacts?	Comprehensive investigations have been undertaken for historical heritage values for the Cubbitch Barta National Estate Area. As such, these heritage values and their relationship with the study area are well understood. The potential impacts associated with the proposed works are well understood and have been modified to minimise potential impacts to heritage fabric. Heritage controls within this assessment would also minimise impacts. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
Step 3 – Impact avoidance and mitigation	

Question	Response
Will any measures to avoid or mitigate impacts ensure, with a high degree of certainty that impacts are not significant?	The proposed actions to the western boundary of the CHL Place have been assessed as having a small scale, low intensity and localised impact on the wider CHL Place. In order to successfully widen Heathcote Road, impacts to the rock face is required, with the removal of vegetation on the face of the cutting and crest of the slope, scaling of the rock face, shotcreting, possible rock bolting, maintenance access points, and reconstruction of the drainage gutter at the base of the slope proposed on the northern and southern road approaches (see Table 18 for further details). As the proposed works are required to ensure the continued health and safety of road users travelling along Heathcote Road and across the Woronora River Bridge, TfNSW have tried to ensure as much of the impacts (direct and indirect) are able to be reversible to the natural heritage values within the study area (such as the regrowth of vegetation over time), however this is not possible with the rock face. The remainder of the impacts appear to be reversible and/or temporary, therefore mitigating any loss of natural or historic values in this area of the CHL Place. Based on overall impacts and mitigation measures in place, these necessary impacts would not detract or contain any adverse effects on the CHL Place as a whole. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
Step 4 – Are the impacts significant? Is there a chance or possibility the action will:	
Permanently destroy, remove or alter the fabric of a heritage place?	Yes, the works would result in impacts to heritage fabric within the study area in the form of roadworks within the road corridor (i.e. rock cutting, vegetation removal, road realignment). Whilst these impacts are required for Heathcote Road and Woronora River Bridge to continue to function safely, there would be a nominal loss of significance to the overall CHL Place. These impacts would not adversely affect the fabric of the heritage place or diminish the overall heritage significance. The proposed works would not impact on the heritage significance of the National Estate Area as a whole. Furthermore, the works will allow the area to continue in its current function in a much safer capacity for motorists. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
Involve extension, renovation, or substantial alteration of a heritage place in a manner which is inconsistent with the heritage values of the place?	No. Whilst the proposed works would result in either an impact or temporary alteration to some heritage fabric within the study area, the works are required to assist in priority safety improvement works to Heathcote Road and Woronora River Bridge. As a result, existing access tracks and clearings have been used where possible to minimise the overall disturbances that would occur as a result of the proposed works, and the impacts to the rock face on the northern approach would only be completed where necessary to ensure they are not inconsistent with the heritage values of the area. TfNSW have also attempted to reduce the indirect impacts of slope treatments by adopting Transport Urban Design Guidelines into the design. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.

Question	Response
Involve the erection of buildings or other structures adjacent to, or within important site lines of a heritage place which are inconsistent with the heritage values of the place?	Yes, the proposed actions would require the erection of crane platforms throughout the clearing at the base of the access track, located in the north-western portion of the study area. It would also involve the temporary construction of a waterway crossing for vehicles. However, these platforms and waterways would be removed at the completion of the proposed works, therefore no long term structures will remain within the CHL Place. There are no other structures or buildings that would impact on significant heritage views, proposed to be erected within the CHL Place bounds. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
Substantially diminish the heritage value of a heritage place for a community or group for which it is significant?	No, the works would not substantially diminish the heritage values of places in the study area. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.
Substantially alter the setting of a heritage place in a manner which is inconsistent with the heritage values of the place?	No, the works would not substantially alter the settings of heritage values of places in the study area. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report..
Substantially restrict or inhibit the existing use of a heritage place as a cultural or ceremonial site?	No, the works would not restrict or inhibit access. Aboriginal cultural heritage values and natural heritage values were not assessed as part of this report.

The proposed actions on the historical heritage values of the place are not considered to be significant as defined by the Significant Impact Guidelines 1.2.[58]

6.4 Assessment of archaeological potential

Archaeological assessments refer to the predicated level of preservation of archaeological resources within a study area as the archaeological potential of the resources. This potential is impacted by the geographical and topographical context of a site, the amount of previous ground disturbance, and factors that affect the preservation of archaeological resources such as soil types and environmental influences. The grades of archaeological potential are outlined in Table 11:

[58] Department of Sustainability, Environment, Water, Population and Communities 2013 Department of Sustainability, Environment, Water, Population and Communities 2013

Table 11: Grades of archaeological potential

Grading	Justification
Nil	No evidence of historical development or use, or where previous impacts such as deep basement structures would have removed all archaeological potential.
Low	Little or low intensity historical development, or where there have been substantial previous impacts, disturbance and truncation in locations where some archaeological remains such as deep subsurface features (privies, cesspits or wells) may survive.
Moderate	Known historical development and some previous impacts, but it is likely that archaeological remains survive with some localised truncation and disturbance.
High	Evidence of multiple phases of historical development and structures with minimal or localised later development impacts, and it is likely the archaeological resource would be largely intact.

As part of the previous SoHI, Biosis performed an assessment of archaeological potential for resources within the study area[59]. Although their assessment was based on a different design, it remains valid to the current proposal. This assessment is presented below in Table 12:

Table 12: Assessment of archaeological potential as per Biosis, 2020.

Archaeological Resource	Predicted features	Construction Date	Archaeological potential
Heathcote Road	Compacted layers of stone, gravels and soils, postholes	1941	Low
Bridge over Woronora River	Footings and/or foundations	1941	Low
Vehicular track and bridge over Heathcote Creek	Levelling deposits, road base, footing and foundations	Pre-1943	Low
Bridge over Heathcote Creek	Footings and foundations	Pre-1943	Low
Amenities block	Footings and foundations, floor surfaces, underfloor deposits, postholes, levelling deposits	1970	Low

[59] Biosis, 'Bridge over Woronora River, Near Heathcote Historical Heritage Assessment. Report for Transport for NSW'.

Archaeological Resource	Predicted features	Construction Date	Archaeological potential
Infrastructure associated with Heathcote Road and Woronora River Bridge	Culverts, retaining walls, cut and fill, sandstone materials	1941	Low
Infrastructure associated with Kolara Weir	Weir abutments, cut and fill, footings, construction materials	Post-1920	Low
Landscape features associated with the public recreation	Postholes, fencing, walls, footings, access tracks, recreational material	1960-1985	Low

Due to accessibility issues, Biosis was only able to perform a desktop assessment of the portion of the study area that encroaches upon the Cubbitch Barta National Estate Area (the north-west portion of the study area). However, Artefact was able to access this section during the site inspection conducted for this assessment. Based on observations made during the site inspection, the conclusions reached by Biosis through their desktop assessment are retained. This portion of the study area does not appear to contain any apparent archaeological resources and is therefore considered to be of **low** archaeological potential.

The north-east portion of the study area was considered inaccessible by Biosis due to the steep topography in that area, and this was found to be the case during Artefact's site inspection also. As such, the original assessment for this area was also desktop-based. While Biosis stated that there is potential for sections of the retaining wall and culverts to be present in this area, its archaeological potential is overall low. Based on their findings as well as examination of the available historical evidence, this report retains Biosis' original conclusion and the archaeological potential for the north-east of the study area is also considered to be **low**.

The proposed compound locations were unsurveyed in both the original SoHI and this current report as desktop assessments were deemed sufficient for these areas. As the new proposed works have not altered the location, size or function of the works compounds, the original assessment of archaeological potential assessment for these items is retained. Due to an absence of evidence for structures in these two areas and historical photographs demonstrating extensive ground disturbance in these locations, the archaeological potential for the compound sites is considered to be **low**.

It is necessary to note that this assessment of the Cubbitch Barta National Estate Area applies only to non-Aboriginal archaeological potential. Further assessment may necessary to determine whether the proposed works will have any impacts to the Aboriginal heritage values of the area.

6.5 Heritage Impact Assessment

Table 13. Heritage Impact Assessment

Impact	Discussion
What aspects of the proposal respect or enhance the heritage significance of the study area?	The proposed works would retain more of the heritage fabric of the existing bridge and its original design integrity, and the client has stated that they have received in principle support from Heritage NSW. The scope still requires modifications to the existing bridge though these changes are largely repair and maintenance works which extend its design life. It would still continue to function as its original intended use, and the upgrade would contribute to improved road safety outcomes. The design of the new bridge design has applied the TfNSW Bridge Aesthetics guide to mitigate impact of the new structure adjacent to an existing heritage bridge. The features of the new bridge including height, angle, pier number and form have all been designed to be sympathetic to the existing bridge structure. Consequently, the new proposed design proves to be less impactful to the heritage significance of the Woronora River Bridge and results in the item retaining many of the aspects which make it significant. The altered design proves to be more respectful of the heritage item and allows it to remain eligible for a future listing on the SHR. The enhancement of Cross Drain Exist-01 also represent the least impactful design option to mitigate the identified flow issues. The proposal would retain the elements of the culvert which possess heritage value and therefore respect the significant aspect of this feature.
What aspects of the proposal could have a detrimental impact on the heritage significance of the study area?	The proposed works would involve rock cutting and roadworks within the curtilage of the Cubbitch Barta National Estate Area. While no specific aspects of the Estate's heritage significance will be impacted and the archaeological potential of the overlapping area is considered low, the works do represent an alteration to the heritage item. The installation of the new bridge will also result in minor indirect impacts to the Woronora River Bridge, as views towards the item from the west will be obstructed.
Have more sympathetic options been considered and discounted?	The proposed construction of a new bridge represents the most sympathetic design choice available. The previous option, to widen the current Woronora River Bridge, would have resulted in direct and indirect impacts to the item. The choice to place a new bridge next to the current one represents the most considered and sensitive design option. While minor indirect impacts will occur, this option reduces the direct impacts that would have resulted from the previous proposal. However, these indirect impacts are minimised by the implementation of sympathetic design features such as the octagonal piers which mirror the design of the original. This proposed development offers a considered approach that respects the heritage significance of the Woronora River Bridge whilst improving safety for vehicles travelling Heathcote Road. The proposed works would also involve direct impacts to the Cubbitch Barta National Estate Area. However, these have been designed to be as minimally invasive as possible, and the area that would be impacted represents an extremely small portion of the land within the heritage listed area with no known heritage significance. The proposed plan to enhance Cross Drain Exist-01 is the most sympathetic design option to mitigate the flow issues identified during the design process.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This report concludes the following:

- Several listed heritage items have been identified within the study area. The impact of the proposed works on these items is summarised below:

Heritage listed item	Direct Impact	Indirect Impact
Woronora River Bridge	**Negligible**	**Minor**
Cubbitch Barta National Estate Area	**Minor**	**Minor**
Kolora Weir	**Nil**	**Negligible**
Woronora-Penshurst pipeline	**Nil**	**Negligible**
Royal National Park and Garawarra State Conservation Area	**Nil**	**Negligible**

- The construction footprint and work compounds are considered to be areas of low archaeological potential., which is consistent with the previous SoHI.
- On balance, the modified proposal provides a solution which achieves overall positive heritage outcomes. Some minor direct impacts will occur to the Cubbitch Barta National Estate Area, although the impacted area represents a small portion of the heritage item. The proposed bridge duplication represents the design option with the most positive public safety and heritage outcomes.

Recommendations

The following management guidelines have been adapted from the recommendation outlined in the previous SoHI for this project. The recommendations informed the design changes for the current scheme and all recommendations are still applicable. These guidelines should be followed for all aspects of the proposed works:

- In order to ensure the protection of heritage values throughout the detailed design process, it is recommended that heritage reviews take place at the following stages of design process: 30%, 80% and 100% design stage.
- As the Woronora River Bridge meets the criteria for State heritage significance for its technical and aesthetic values, as well as being the sole TfNSW-owned concrete bridge in NSW to exceed 80m in length, a Conservation Management Plan (CMP) is required to outline how the

heritage fabric of the item should be managed on an ongoing basis. This is in line with the NSW *Heritage Manual* and its associated guidelines, including the *Statement of Heritage Impact*. This CMP would also investigate the establishment of an extended heritage precinct for Woronora River Bridge, Kolora Weir and former recreation area, and the extant remains of the Heathcote Bridge as an area of local and State heritage significance.

- A Photographic Archival Recording (PAR) of the Woronora River Bridge and any associated heritage items to be impacted (particularly Cross Drain Exist-01) should be undertaken prior to works commencing. This would create a record of the item's appearance prior to construction works and document the views to and from the item which will be affected by the proposed works. A PAR would help to mitigate the indirect impacts cause by the new bridge. To ensure total impacts are catalogued, an archival recording at the completion of works is also recommended.
- To reduce direct and indirect impacts to the Woronora River Bridge, the following should be undertaken as part of the detailed design and planning stages:
    - Retain as much of the original fabric of the Woronora River Bridge as possible
    - Apply the sympathetic bridge design and sandstone capping plan outlined in the proposed works section of this assessment (Section 1.3)
    - Undertake colour and material matching for necessary repair and maintenance works
    - An appropriately qualified structural engineer to undertake an assessment of structural integrity for each element to be removed and/or replaced prior to removal as part of repair and maintenance works. Only replace elements which are at risk of falling. When the scope of maintenance works has been decided upon a conservation architect should be consulted in order to confirm that they are appropriate and will not cause significant heritage impacts to the item
    - Use discrete fencing with hoarding or fabric for Woronora River Bridge during works
- To reduce direct and indirect impacts to other heritage items during works, the following should be implemented:
    - Regularly monitor vibrations levels during works
    - Erect an exclusion zone around the survey marker tree (if located during works) until an archival recording and salvage of the item is conducted. The survey marker to be used as part of an interpretive display
- An Unexpected Finds Procedure should be implemented should any archaeological resources or previously unknown heritage items be identified during the course of the proposed works.
- All contractors on the project should receive a site-specific heritage induction outlining the significance of the area and the Unexpected Finds Procedure.

8.0 REFERENCES

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Appendix H

Addendum urban design concept report

Heathcote Road Bridge over Woronora River

Addendum to TfNSW Appendix I: HEATHCOTE ROAD BRIDGE URBAN DESIGN CONCEPT

Prepared for HRB Alliance

Tract

Level 8, 80 Mount Street,
Sydney 2060 NSW

02 9954 3733

Issued
12 April 2022

Quality Assurance

Heathcote Roa
Heathcote Road bridge over Woronora River
Addendum to TfNSW Appendix I

Prepared for HRB Alliance

Project Number
[22-0045-02-L-RP01

Revision (see below)
06

Prepared By
Mathew Nenadic

Reviewed By
Anne Lucas

Project Principal
Matthew Easton

Issued
12 April 2022

Document control

This is an e-copy of the Plan and it interfaces with the other associated plans, which together describe the proposed overall project management system for the project.

The latest revision of this plan is available on the Alliance server. If any unsigned hard copies of this document are printed, they are valid only on the day of printing.

The revision number is included at the bottom of each page. When revisions occur, the entire document will be issued with the revision number updated accordingly for each owner of a controlled copy.

Attachments/Appendices to this plan are revised independently of this plan

Revisions

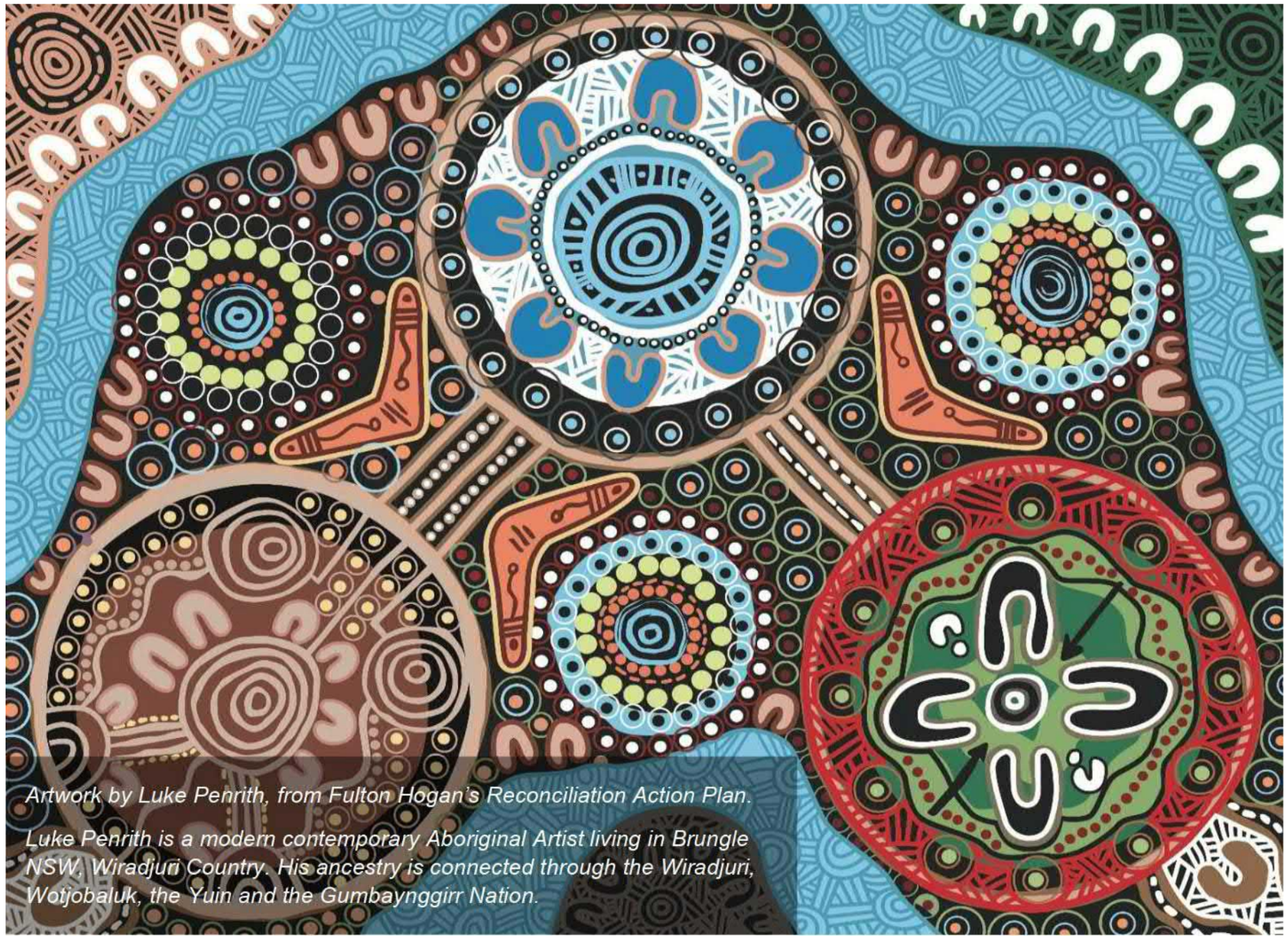
Rev	Issued	Details	Prepared By	Reviewed By	Project Principal
01	10 February 2022	Draft Issue for Review	AR	AL	ME
02	15 March 2022	Revised Draft for Coordination	MN	AL	ME
03	17 March 2022	Revised Draft for Coordination - Note: In this issue red text is added in response to TfNSW review dated 28.02.2022	MN	AL	ME
04	01 April 2022	Revised Draft for Coordination - Note: In this issue red text is added in response to TfNSW review dated 28.02.2022	MN	AL	ME
05	08 April 2022	Updated Issue post coordination	MN	AL	ME
06	12 April 2022	Updated with TfNSW review comments	MN	AL	MF

ACKNOWLEDGMENT OF COUNTRY

The Alliance team acknowledges the Tharawal People as the Traditional Owners of the land we are working on, and pay our respect to their Elders past, present and emerging.

We recognise their deep connection to Country and value the contribution to caring for, and managing the land and water.

We are committed to pursuing genuine and lasting partnerships with Traditional Owners to understand their culture and connections to Country in the way we plan for and carry out the delivery of the Works.



Artwork by Luke Penrith, from Fulton Hogan's Reconciliation Action Plan.

Luke Penrith is a modern contemporary Aboriginal Artist living in Brungle NSW, Wiradjuri Country. His ancestry is connected through the Wiradjuri, Wotjobaluk, the Yuin and the Gumbaynggirr Nation.

Contents

Figures

1 Introduction

1.1 Background

The Heathcote Road Bridge Upgrade (further referred to as the Project) involves making improvements to the narrow Heathcote Road Bridge over Woronora River built by the military in 1943.

The bridge spans over the Woronora River located within Heathcote National Park. The road and bridge was originally constructed during the second World War as a military route which used the ridge lines and a causeway crossing of the Woronora River. The bridge was built in 1942 as a concrete structure with twin girders and cross beams.

Transport for NSW (TfNSW) identified the need to make improvements to the bridge due to its limited width and crash history.

A range of options to widen the existing bridge were considered during the Tender Design stage before arriving at the preferred solution of duplication with a new bridge adjacent and independent of the existing bridge.

The modified design will include the construction of a second bridge structure alongside the existing bridge and associated adjustments to the widen approach roads in both directions.

Construction of a new bridge structure and widening the approaches to the bridge will enhance safety for road users, allow for revitalisation of the existing bridge structure and enhance the connectivity between Heathcote and areas further south with Liverpool and other areas to the north west.

The Project is delivered as an Alliance comprised of TfNSW, Fulton Hogan (FH) and SMEC Australia Pty Ltd (SMEC) Heathcote Road is a major arterial road in the south of Sydney, from Newbridge Road in Liverpool to the Princes Highway in Heathcote.

1.2 Purpose of this report

This report is to provide an addendum to Appendix I Urban Design Concept Report: Heathcote Road Bridge Urban Design Concept Report by KIA STUDIO 24.11.2020, prepared for TfNSW.

This report will describe the changes to the design, demonstrating acknowledgment of, and responding to, design principles and objectives set out in Appendix I .

1.3 Summary of design changes

The initial design process included an REF with an approved scope. As the design has progressed some features are inconsistent with the REF scope. Overall, the design changes to this project are considered to be improvements for user safety, constructability, future maintenance and impact on bridge structure which has heritage value.

These changes include;

- Construction of a second bridge over the Woronora River of 6.9m width between traffic barriers and immediately to the west of the existing Heathcote Road Bridge;
- Reconfiguration of the existing Heathcote Road Bridge to allow for single lane unidirectional traffic flow;
- Road alignment is adjusted to accommodate the new bridge providing an appropriate transition which has some minor amendments to the impacts on the immediate road corridor environment.

Though bridge widening is no longer proposed, modifications to the existing bridge are still required as part of the duplication project. These are largely consistent with the original scope and include;

- Repair and maintenance works
- Upgrade of eastern edge barriers, removal of western barrier.
- New maintenance stairs

Assessment of these features is covered by the original REF and Appendix I - UD report.

Variations from the original design include;

- New single lane northbound bridge parallel to the existing including new abutments;
- Greater degree of slope cutting work on the north west cut with an access track along the crest;
- Change in location of the proposed maintenance stairs;
- Convert the existing bridge to a one way single lane configuration and resurfacing to change the crossfall in response to this; and
- The protection in place of sandstone covering/ cladding at the abutments after further investigation confirmed they were not solid blocks of sandstone.

1.4 Addendum content

This addendum should be read in conjunction with the original Urban Design assessment (REF Appendix I). It expands on the original assessment and considers only the new or modified design elements.

A summary of amendments to each chapter is provided here.

Appendix I Urban Design Concept Report: Heathcote Road Bridge Urban Design Concept Report.	Addendum to: Appendix I Urban Design Concept Report
Chapter 1 Introduction Project background, purpose, report structure and reference documents	Chapter 1 Introduction This chapter outlines the purpose of the addendum, summary of design changes, additional reference documents and clarification of addendum content
Chapter 2 Contextual Analysis Summary of investigations to demonstrate an understanding of project context. Description of regional context, understanding the study area, description of the existing bridge, existing vegetation, wildlife, non-Aboriginal cultural heritage, Aboriginal cultural heritage and an understanding of existing landscape character	No change, chapter not included in this addendum
Chapter 3 Urban Design Objectives & Principles Outline of Urban Design Objectives and Principles with comment on Landscape Design, Built Form and Cultural Interpretation	Chapter not included in this addendum - All Urban Design Principles are carried forward, except: deletion of 3.2.2 Built Form Principles which are addressed in Chapter 2.
Chapter 4 Landscape Concept Design Assessment of the existing site conditions, appropriate landscape design responses to site, approach to vegetation design principals and species selections.	No change, chapter not included in this addendum
Chapter 5 Bridge Widening Concept Design Outlines proposals to widen the existing bridge to create an additional traffic lane with an adaptation to the existing headstock to support widening the carriageway to both sides	Chapter 2 Bridge Widening Concept Design Updated to reflect design of new bridge structure to along the south side of existing bridge and subsequent adjusted road alignment
Chapter 6 Landscape Character and Visual Impact Assessment The assessment of the bridge widening proposals on the landscape character and visual impact of the proposals	Chapter 3 Landscape Character and Visual Impact Assessment A review of the new bridge structure and adjusted road alignment on the landscape character and visual impact of the proposals This updated assessment relates only to Operational phase impacts. Construction phase LCVIA impacts are considered to be addressed by the original assessment as the construction footprint and methods are largely consistent and no new receivers affected.
Chapter 7 Conclusion Conclusion statement regarding approach to design, landscape assessment and visual impact assessment.	Chapter 4 Conclusion Conclusion statement updated to refer to design changes as described in this addendum

Figure 1. Comparison Table for inclusions to the Addendum report

1.5 Additional Reference Document

This addendum acknowledges an additional reference document being : Appendix I: Urban Design Concept Report - Heathcote Road Bridge Widening

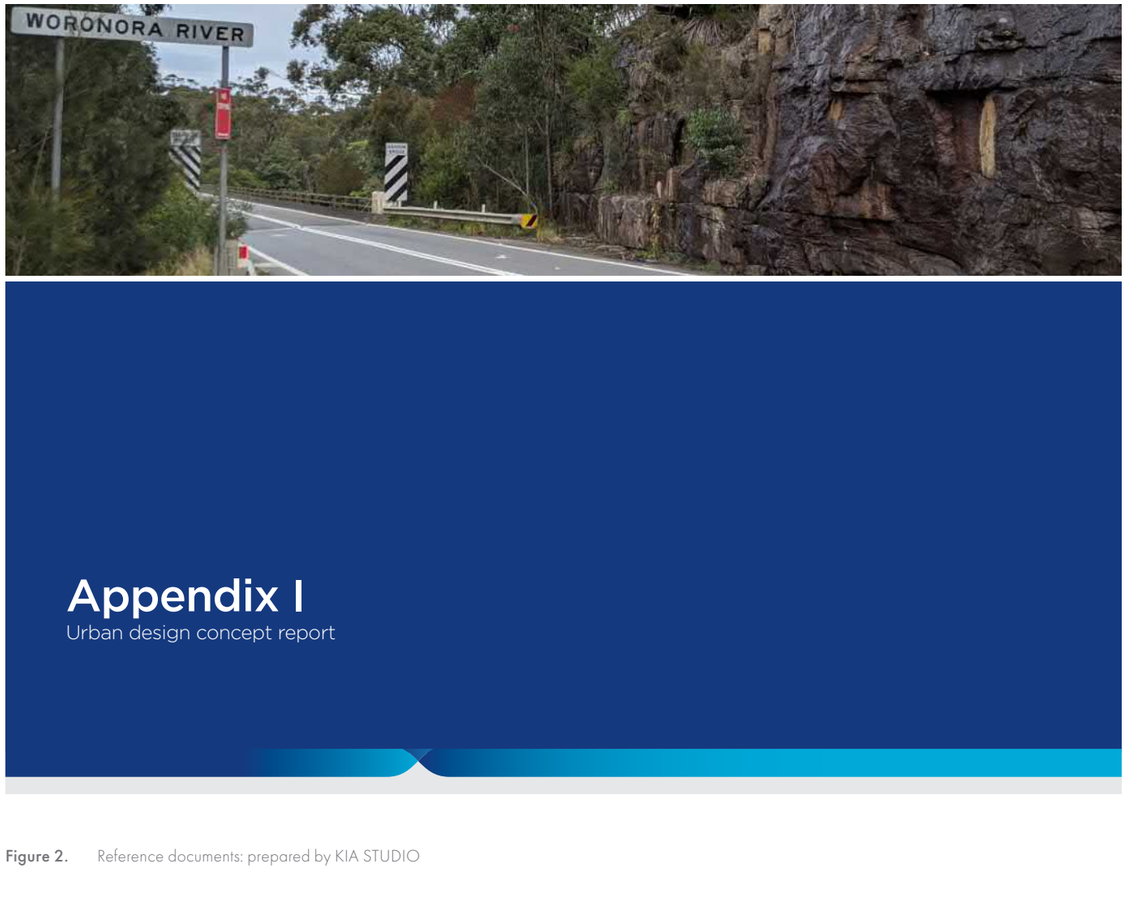


Figure 2. Reference documents: prepared by KIA STUDIO

2.1 Design Approach

The proposed design solution is to duplicate the existing road bridge with a new bridge, adjacent and independent of the existing bridge on the upstream side.

This has the benefit of minimising the physical impact to the existing structure as the construction of the bridge is a free standing independent element.

The heritage impacts of the proximity of the new bridge have been reviewed with input sourced from heritage consultant Artefact who have confirmed that no significant heritage issues are identified with this approach.

The new bridge:

- Takes its aesthetic cue from the existing bridge being a expression of engineering and construction of its time. This clarity of form and function gives an architectural simplicity as a result;
- Is designed holistically, as a bridge with considered proportions of elements, elevational and sectional design as well as appropriate response within the landscape setting;
- Will be distinctly separate from the existing bridge, having a physical gap and a different concrete colour; and
- Is designed with a relationship to the existing bridge, a respectful and complementary response to the heritage aspects and the aesthetic approach.

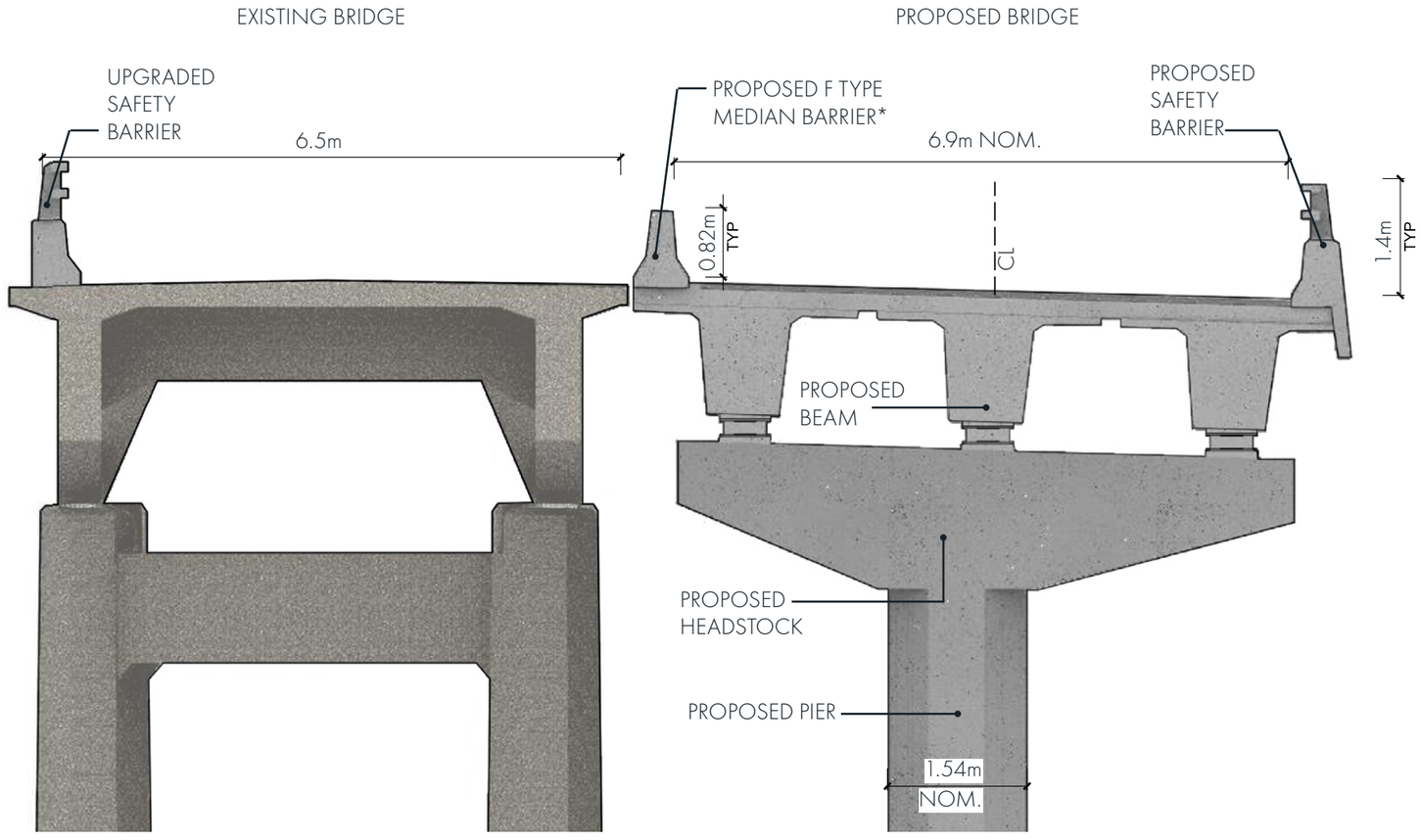


Figure 3. Detail of proposed bridge structure and its relationship to existing bridge
*Detail under condsieration at time of writing

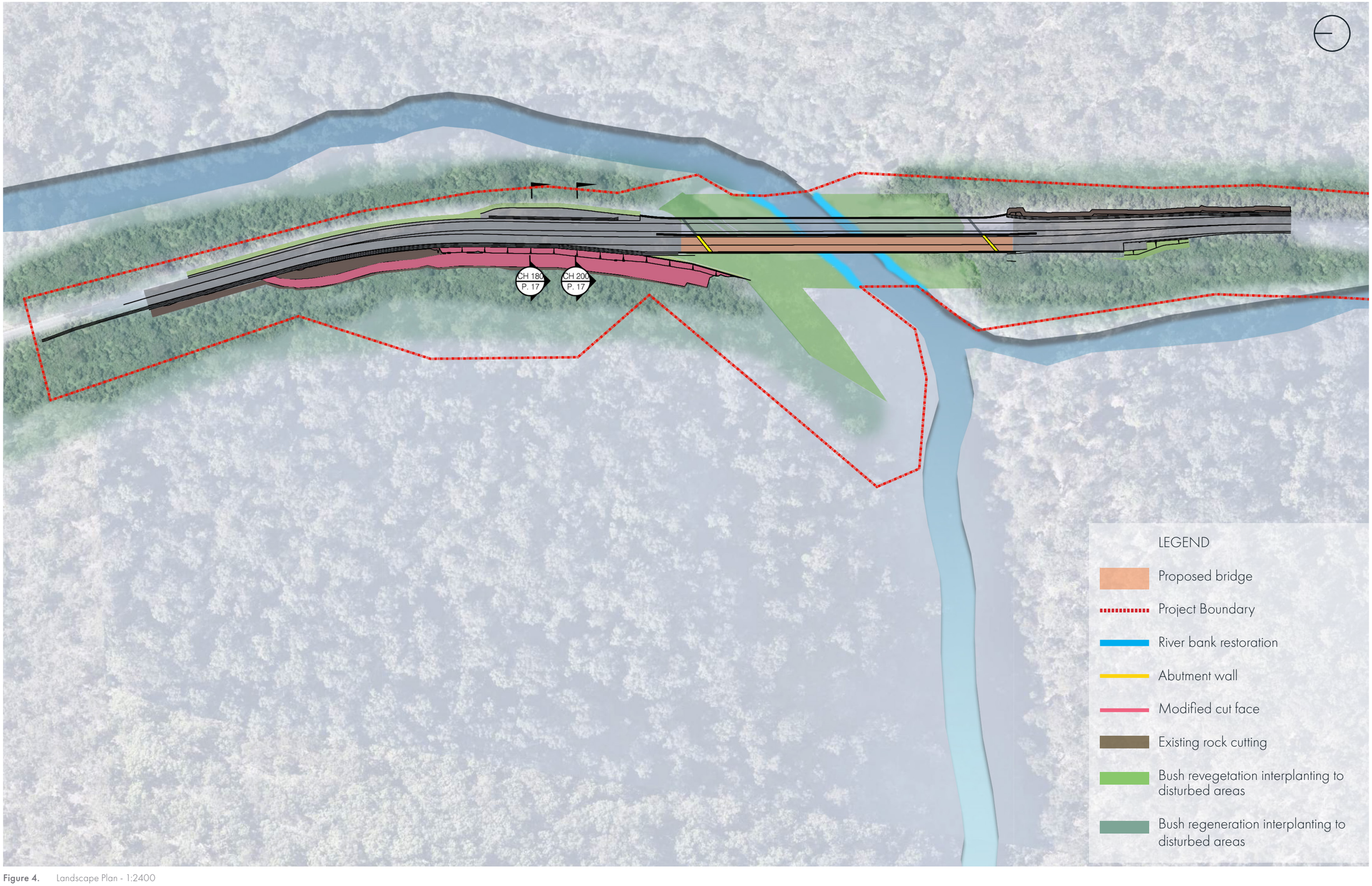


Figure 4. Landscape Plan - 1:2400

2.2 Substructure - Headstock and Pier

Substructure includes the pier and headstock of the bridge the design considerations for these elements are integrated, the focus for design resolution being:

- In response to the form, proportions and character of the existing bridge;
- Holistic design of all elements; and
- Minimising the visual impacts of the new bridge within the landscape setting.

Pier form:

- The pier has adopted an octagonal form, the proportions of which echo and complement the shape of the existing piers.
- The spacing of each pier is arranged to match the existing piers.
- The alignment of each pier relates to the skewed alignment of the existing bridge piers.
- The pier is offset from the centre line of the bridge to minimise impact on existing underground fibre optic cable

Headstock:

- The headstock is a traditional headstock arrangement supporting the super-T girders.
- The sectional form tapers from the junction at the pier, narrowing towards the outer edges to minimise its mass and bulk when viewed in elevation.
- The proportions of the tapered shaped being considered in relation to the existing bridge. The taper is asymmetrical in response to the pier locations.

While the elevational views of the bridge are limited given the limited access to the bridge surroundings, it is considered appropriate to ensure the shape and form of the headstock has a relationship with the existing bridge.

2.3 Superstructure - Girder and Parapet

The girder is a Super-T form, design considerations being:

- A simple and functional engineering approach to create the bridge deck;
- Using this form accommodates a longer span allowing the new piers to align with the existing piers; and
- Allows for a cleanly expressed relationship with the supporting headstock element.

Parapet

- The parapet design echoes the reference design:
- Being parallel to road surface;
- Has minimum depth, which contributes to the minimal impact on visual aspect of the elevation; and
- Extends below deck element providing a shadow line.

2.4 Bridge Furniture

Barriers and Central Median

The proposed design uses safety barriers to match existing furniture on road approaches to protect edges where necessary. The barrier along the east of existing bridge is being upgraded to meet current safety requirements and will match the barriers on the west of new bridge. The upgraded barriers have a slightly higher concrete base and as a result will have a slightly increased presence in the bridge corridor experience and if viewed from the landscape setting.

The design of a central median barrier detail is under consideration. The current design under review is a split F-type concrete barrier. Where adapted for use as a central barrier, this is a physical and visual element separating the two lanes of traffic and from a drivers perspective, the only visual indication of the duplicated bridge.

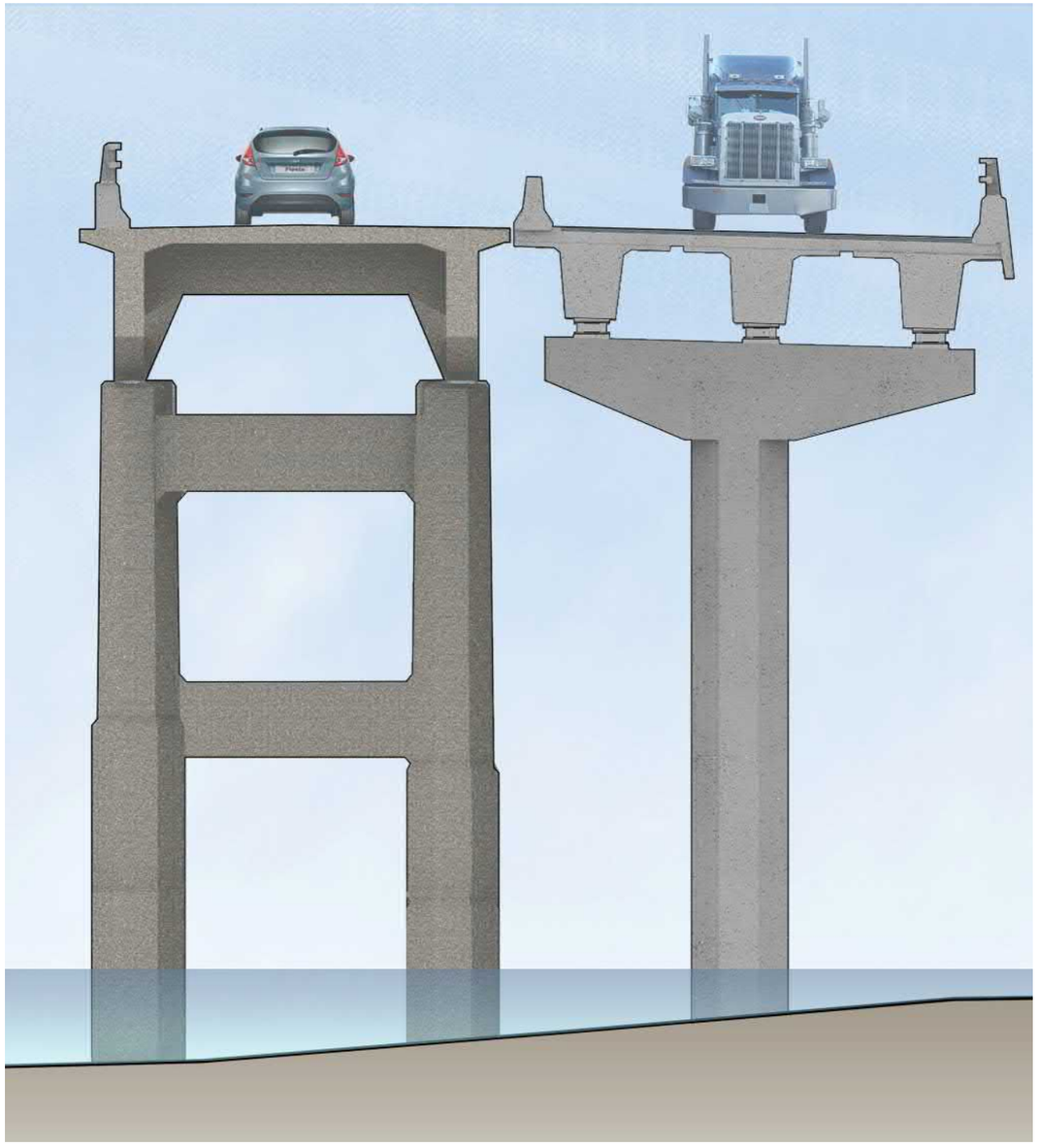


Figure 5. Cross section to demonstrate the relatioship between the new bridge alongside the existing bridge

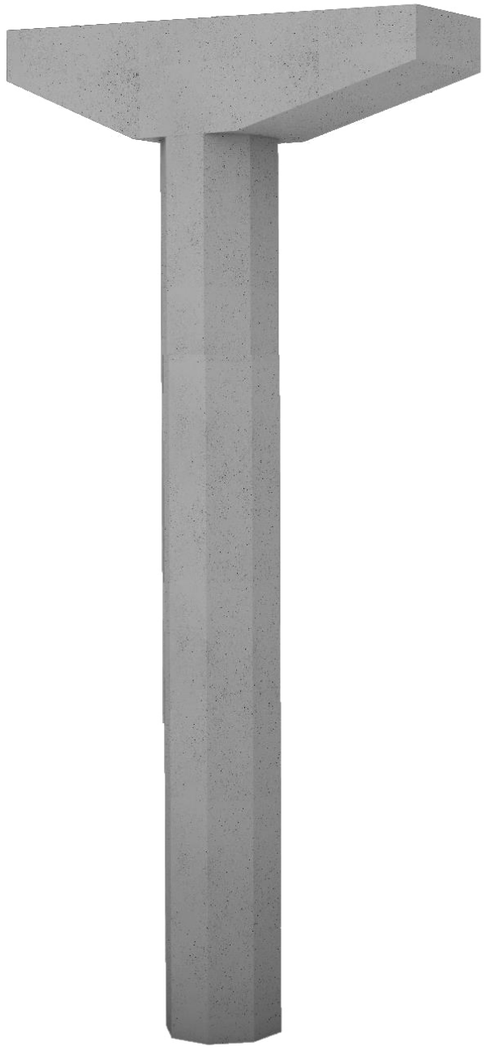


Figure 8. Indicative 3D study of proposed pier

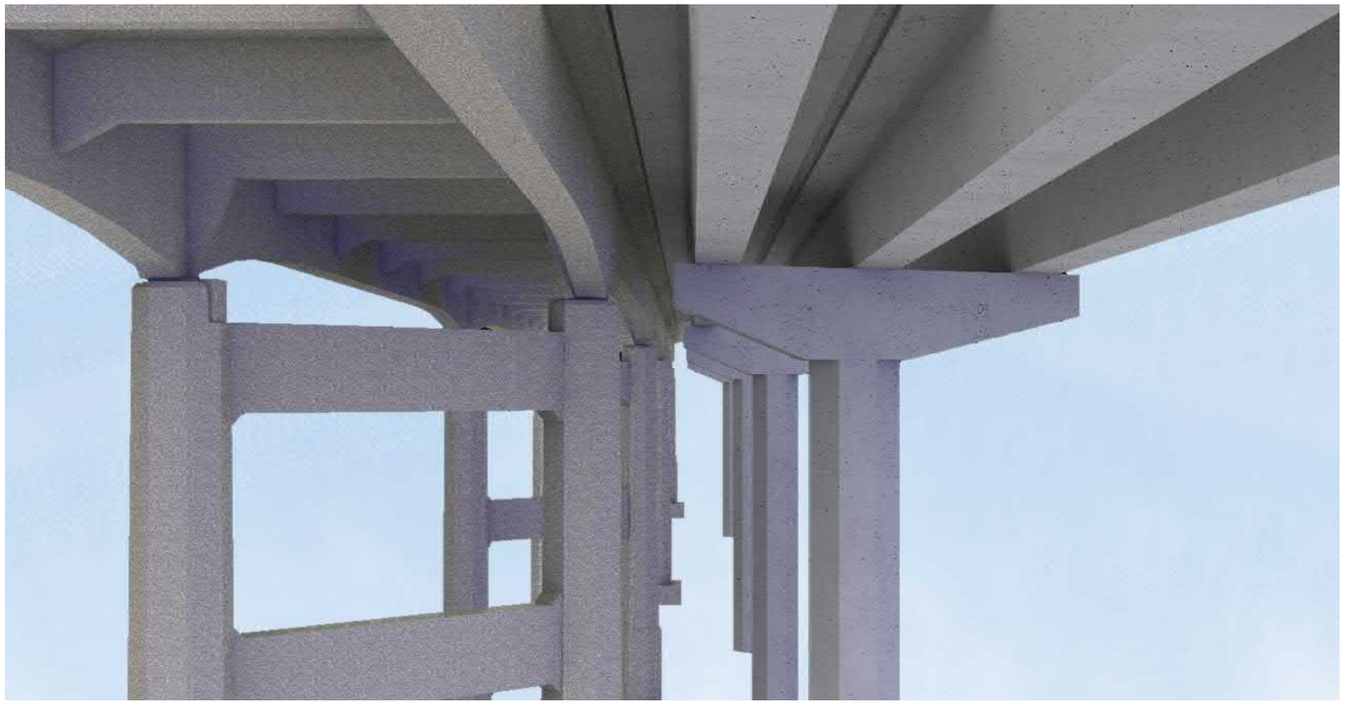


Figure 6. Indicative 3D study of underside of proposed and existing bridges

Figure 7. Indicative 3D study of underside of proposed and existing bridges

Figure 9. Visualisation of existing bridge view, looking south

Figure 10. Visualisation of proposed bridge view showing central barrier under consideration

2.5 Abutment treatment

The design of the abutments for the new bridge integrates new into into the existing abutments and protects the sandstone cladding in place as a heritage priority:

- Clearly delineate itself from the original form;
- Minimise disturbance at point of connection; and
- The orientation of the new abutment wall aligns with the existing.

The material of the abutment is suggested to be a dark recessive colour utilising either the addition of pigments or pigments and aggregates, with simple rebates to break-up the mass of the wall and reduce its susceptibility to vandalism.

Figure 11. Abutment treatment example

Maintenance access to the abutment will be provided in the form of stairs with handrails.

- Handrail should be simple off-shelf profile similar to Monowills and painted in a charcoal or black colour to recede into landscape setting.
- Consider opportunity to separate the stair element from the heritage abutment wall.
- Stair material to be dark and recessive being either masonry or steel.

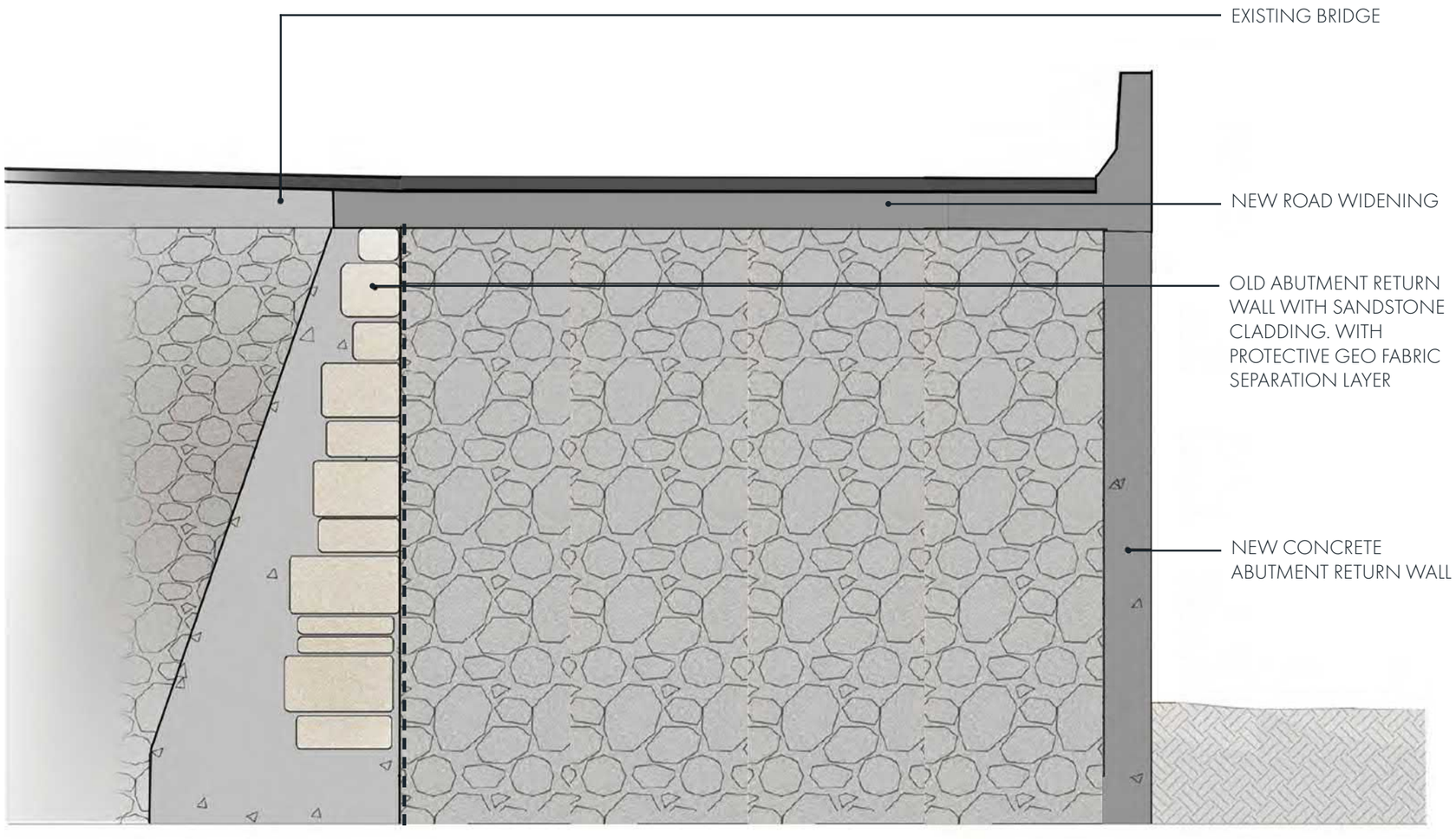


Figure 12. Abutment treatment

Figure 13. Elevation of existing bridge

Figure 14. Elevation of new bridge in relation to existing bridge

Figure 15. View of existing bridge looking east

Figure 16. Indicative photomontage of the new bridge with the existing bridge

2.6 Rock cuttings

The approach roads will be widened to accommodate the realignment of lanes to meet the new bridge and the creation of a construction access track.

The increased width requires some modifications to the existing rock cuttings, the extent as outlined on the landscape plan and on these cross sections.

The existing rock cuttings are a notable aspect of this road corridor and part of the landscape character and experience here.

The new rock cuttings, having increased in height and length, will be noticeable, however are considered to be a continuation of the existing road corridor experience. The management of the bench however will need to be carefully considered as it introduces a new element into the rock cutting profile

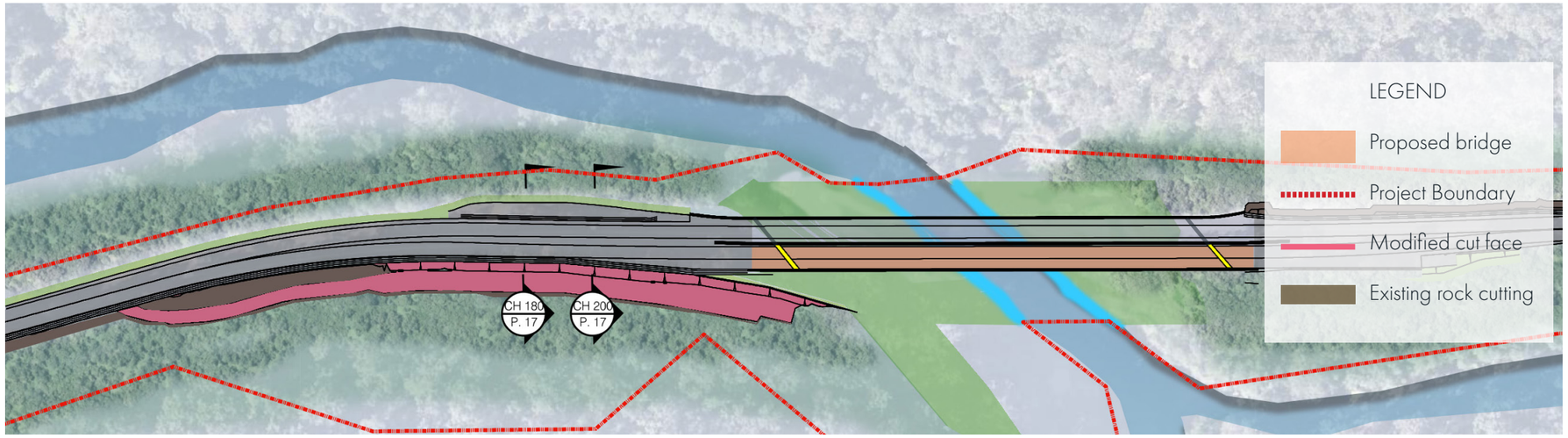


Figure 17. Plan: location of descriptive cross sections

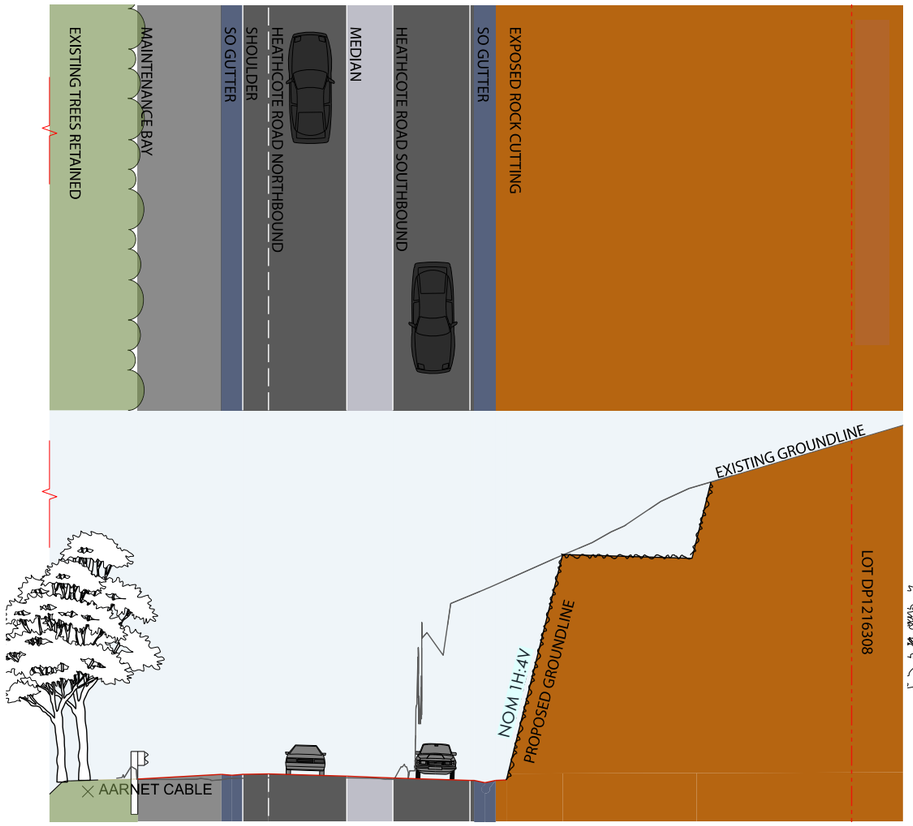


Figure 18. Descriptive cross section: Chainage 180

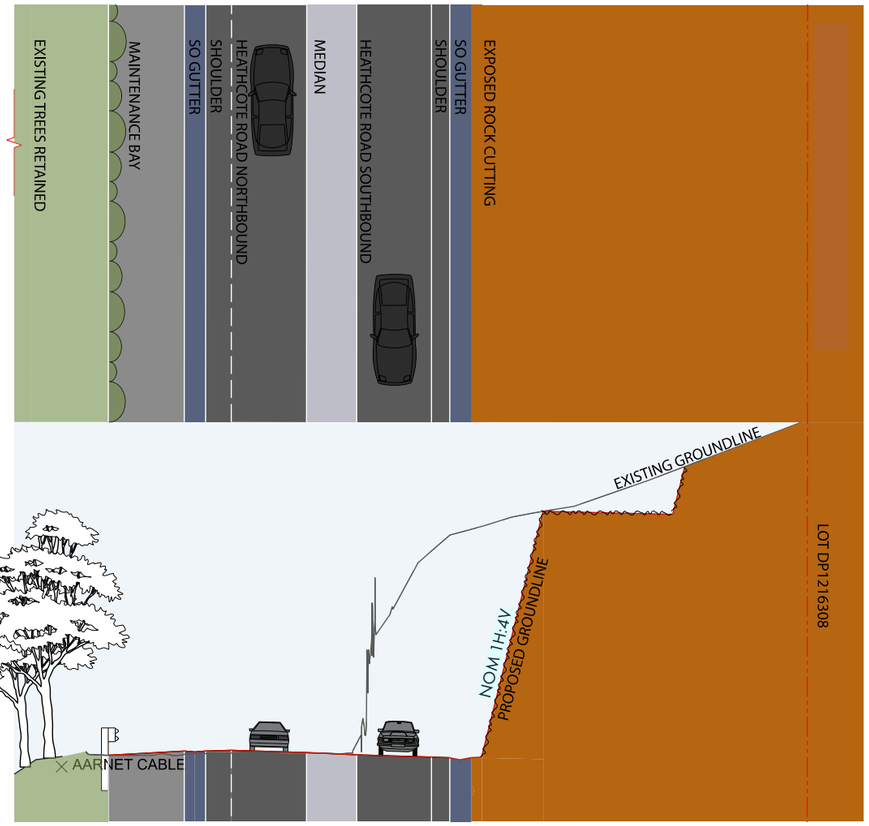


Figure 19. Descriptive cross section: Chainage 200

2.7 Rock cuttings - surface finishes

Profile and cutting surface:

The proposed nature and appearance of the modified rock cutting will be in character with the existing rock cuttings found in the vicinity of the project site. The existing rock cutting profile is near vertical and it is considered that it is possible to achieve a similar sub-vertical profile for the new rock cutting face. This will be subject to continual geotechnical assessments as excavation is carried out and the new rock cutting face is exposed.

Line Drilling

The existing cuttings for much of Heathcote Road have been line drilled and split, reflecting the ability to access the corridor during the initial construction of the alignment. The proposed works could continue this treatment, retaining the character of the cuts with vertical drill marks and coarsely textured face. Issues associated with this method would be: gaining access to the top of the cut for the entire length and its impact on clearing extents, as a result of a need for construction tracks suitable for drilling rigs and a suitable working platform; and the ability to manage the removed face adjacent to live traffic. The latter issue is common to whatever method is used although the level of difficulty in managing this may vary.

Leading Edge Treatment:

The treatment of the top of the cut plays an important role in the overall appearance of the cut, particularly where the cutting has been cut near vertical. This edge is influenced by its interface with residual soil profiles and whether it is stable without treatment. The design of this edge needs to consider the stability of this element and how this is handled.

Rock Stabilisation:

If geotechnical constraints dictate that shotcrete, rock mesh or rock bolts are warranted, these would be designed in consultation with TfNSW, Urban Designer and in accordance with relevant TfNSW guidelines.

Particularly with regard use of shotcrete, guidelines ask for a precision application, neatly masked at edges and to have a relationship with surrounding rock. Guidelines also ask for colour matching to the seam or erodible bed, which is being covered, or the adjacent rock. Care needs to be taken to select a colour which compliments the rock present in the cutting face. This decision needs to consider that both shotcrete and rock will weather and that this weathering may not be consistent.

Continual geological mapping of the cut face is required to assess whether any potential areas of instability are present and which (if any) stabilisation treatments are required to provide support to these areas. Finalisation of slope stabilisation treatments in the design phase is not possible and can only be reached once the new face is exposed and the risk has been assessed

2.8 Aboriginal Cultural Recognition

The Project design team are currently seeking assistance from Tharawal Aboriginal Land Council and representatives with regard the following initiatives for the new bridge and landscape design of the road corridor.

- Signage, Name of River, recognition of Country:

There is an opportunity to celebrate language and acknowledge Country with new signage celebrating traditional name for this place and/ or river.

- Plant species and vegetation:

There is opportunity to collaborate on planting design with culturally appropriate plant species and rehabilitation of vegetation communities.

Investigate appropriate locations to highlight and showcase particular species which are culturally significant.

Figure 20. Example of Linedrilling rock face

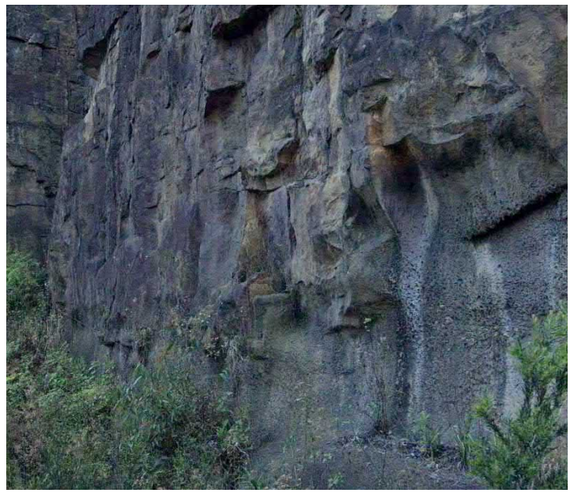


Figure 21. Shotcrete finish Heathcote Road

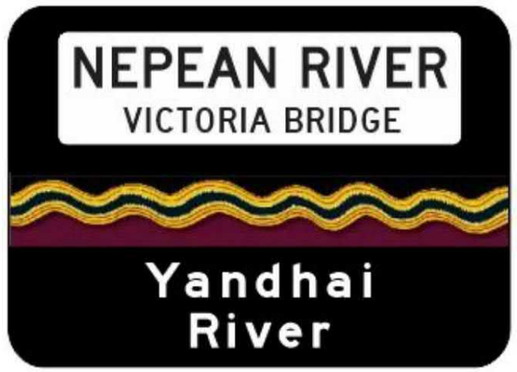


Figure 22. RMS - Technical Manual - Signposting Country

2.9 Landscape Character Impact Assessment

The impact of the new bridge is assessed using the established TfNSW protocol and as outlined in Appendix I being:

- Landscape character impact based on the aggregate of an area's built, natural and cultural character and sense of place.
- Impact is measured by the combination of the area's sensitivity and the magnitude (scale, character and distance).

2.10 Summary of Landscape Impacts

It is considered that the design changes to the project have no further changes to the landscape impacts as outlined in Appendix I:

- The landscape character zones remain as established in Appendix I.
- The extents of the project remain unchanged.
- The nature of the bridge design is in keeping with Appendix I design objectives.

2.11 Visual Envelope

In order to assess the visual impact of the design changes, the Visual Envelope Map of the project's visual catchment from the surrounding area has been reviewed.

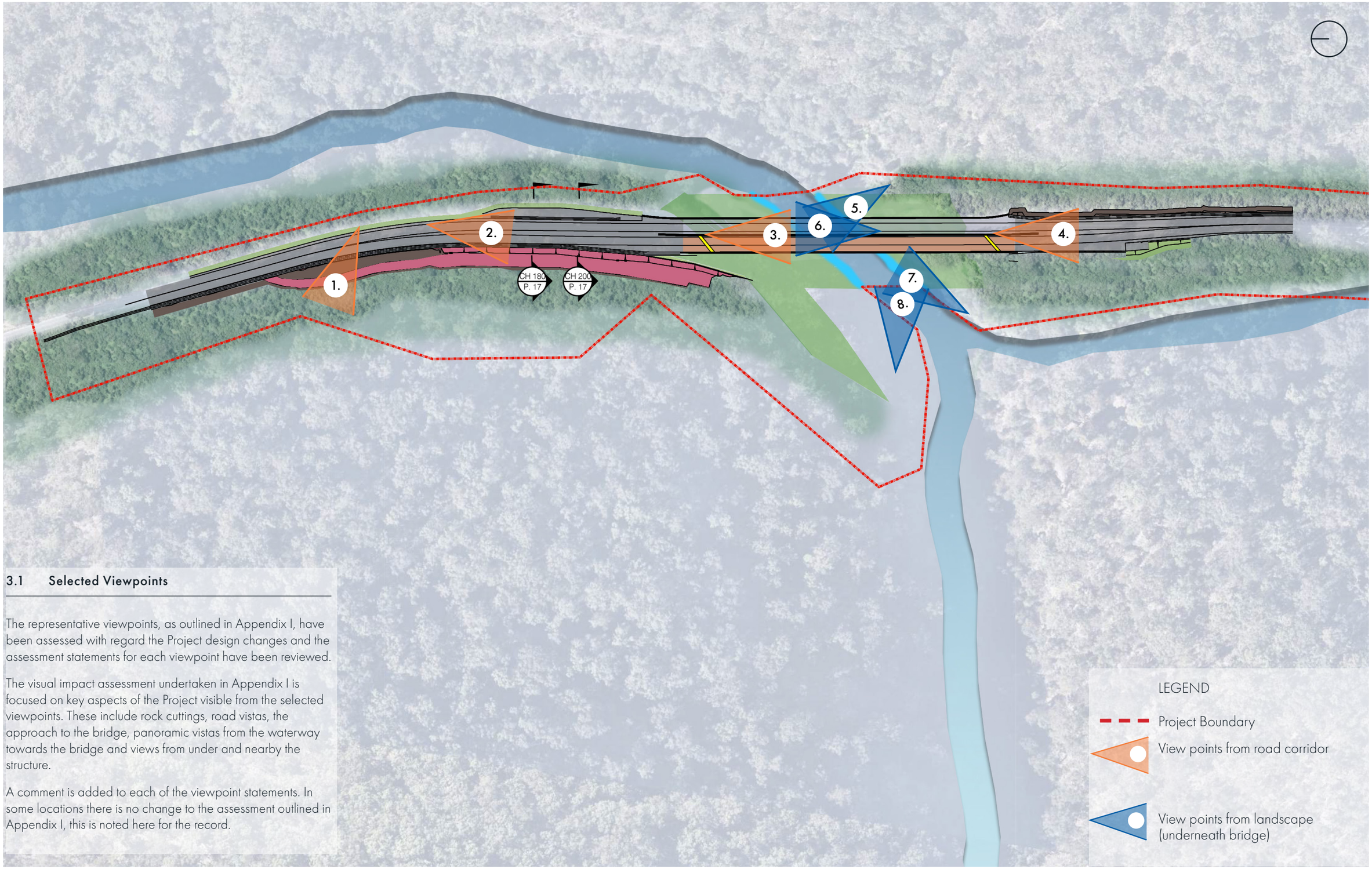
This review confirms that there are no changes to the visual catchment as a result of the design changes, being:

- Within the established Project boundaries;
- The location of the Project works is the same as that described in Appendix I; and
- The nature of the design changes do not change the physical height or extents to a degree that the visual catchment of the Project are extended or reduced.

LEGEND

Project Boundary

Figure 23. Visual impact assessment of new bridge



3.1 Selected Viewpoints

The representative viewpoints, as outlined in Appendix I, have been assessed with regard the Project design changes and the assessment statements for each viewpoint have been reviewed.

The visual impact assessment undertaken in Appendix I is focused on key aspects of the Project visible from the selected viewpoints. These include rock cuttings, road vistas, the approach to the bridge, panoramic vistas from the waterway towards the bridge and views from under and nearby the structure.

A comment is added to each of the viewpoint statements. In some locations there is no change to the assessment outlined in Appendix I, this is noted here for the record.

Figure 24. Plan illustrating view points selected for visual impact assessment.

3.2 Assessment of Sensitivity of View - Viewpoints 1-4

View 01 *View looking north near the northern approach to the bridge.*

View 02 *View looking south from the northern approach to the bridge. To the right side of the picture, sandstone cuttings expose the geology of the area.*

View 03 *Crossing over the Woronora River with panoramic vistas of the pristine bushland.*

View 04 *Sandstone cutting at the southern approach creates a visually dramatic setting and displays the rugged topography.*

View	Description of setting	Sensitivity of view		Addendum commentary
V01	Existing sandstone cutting along the northern approach to the bridge, travelling north. The cutting exposes the geology of the area and contributes to the identity of the roadway.	M	Moderate, although the road is of a high scenic quality, the transient nature of the viewer limits the sensitivity compared to other viewpoints assessed.	assessment remains
V02	Northern approach to the bridge travelling south. Highly scenic setting with dense bushland within a rugged terrain.	M	Moderate, although the road is of a high scenic quality, the transient nature of the viewer limits the sensitivity.	assessment remains
V03	Bridge over the Woronora River, travelling south. Open panoramic vistas towards the adjacent bushland with vistas towards a deep gully, exposing sandstone cliffs.	H	High, the bridge crossing visually accentuates the scenic character of the area, providing elevated panoramic views to the adjacent landscape. The crossing is a key visual marker along the journey experience and the scenic setting contributes to the higher rating to an otherwise transient viewpoint.	assessment remains
V04	View of the southern approach looking south towards a dramatic sandstone cutting.	M	Moderate; similar to V01 and V02, the transient nature of the viewer limits the overall sensitivity of the viewpoint.	assessment remains

3.3 Assessment of Magnitude and Impact - Viewpoints 1-4

View	Element of project visible	Magnitude of change		Nature of impact
V01	Addendum CHANGED DESIGN Exposed rock cuttings and new verge treatment.	M	Addendum NO CHANGE magnitude Magnitude of change remains moderate: Modified rock cuttings new verge treatment would contrast with the current situation, although would become less over time as rock weathers.	Adverse
V02	Widened road with shoulder and paved break-down bay. Minor changes to verge treatments. Addendum comment - NO CHANGE	H	The formalisation of the break-down bay and the widened road contribute to the road being more dominant within the setting. The presence of rock mesh, rock bolts and shotcrete would contrast with the current situation. Also the removal of vegetation would contribute to this effect, all contributing to a high rating.	Adverse
V03	Widened bridge with new barriers overlooking the Woronora River. Addendum comment - NO CHANGE	M	The widened bridge with the additional shoulders would make the structure visually more dominant. The enhanced sense of safety through the road widening would contribute to a better visual experience.	Adverse
V04	Addendum CHANGED DESIGN View of widened road. Some vegetation cleared and embankment to support widened approaches introduced.	M	Addendum No CHANGE Magnitude of change remains moderate: New verge treatment would contrast with the current situation, although would become less over time as vegetation establishes.	Adverse

View	Sensitivity	Magnitude	Visual impact	Comments	Addendum commentary
V01	Moderate	Moderate	A moderate visual impact is assessed based on the relative minor interventions to the existing rock cutting and widened road formation.	It is important to ensure any shotcrete works are minimised. If larger areas are required, a set of aesthetic guidelines needs to be considered in the next phases of the design. The use of rock mesh and bolts should be minimised to retain the existing natural character. The overall driving experience would be slightly enhanced by introducing better sight lines.	Addendum NO CHANGE visual impact Design has changed because the amount of rock cutting is slightly greater on the north west side, however Magnitude and Visual Impact assessment remains
V02	Moderate	High	The more formal road and break-down bay contributes to a moderate to high visual impact, increasing the presence of the roadway. The intervention of sandstone cutting stabilisation works would reinforce the new roadworks.	Consideration of verge treatments such as barrier typologies is important to retain vistas to the bushland setting. Double rail barriers or tri-beams are preferred over solid type F barriers. It is important to ensure any shotcrete works are minimised. If larger areas are required, a set of aesthetic guidelines needs to be considered in the next phases of the design. The use of rock mesh and bolts should be minimised to retain the existing natural character.	Addendum NO CHANGE visual impact
V03	High	Moderate	Although the visual impact is moderate to high, the rating is a result of both a higher visual presence of the bridge but also an improved visual experience.	The enhanced perception of safety through the wider bridge also improves the opportunity to visually absorb the scenery.	Addendum NO CHANGE visual impact
V04	Moderate	Moderate	A moderate visual impact is assessed based on the relative minor interventions to the existing rock cutting and widened road formation.	It is important to ensure any shotcrete works are minimised. If larger areas are required, a set of aesthetic guidelines needs to be considered in the next phases of the design. The use of rock mesh and bolts should be minimised to retain the existing natural character. The overall driving experience would be slightly enhanced by introducing better sight lines.	Addendum NO CHANGE visual impact Design has changed however, Magnitude and Visual Impact assessment remains

3.4 Assessment of Sensitivity of View - Viewpoints 5-8

View 05 *View looking north from the river foreshore with the structure clearly visible.*

View 06 *View looking north from beneath the structure. .*

View 07 *Close up view of the structure looking from the southern foreshore to the northeast. Note the structure being in the shade (dark grey) helping it to visually blend with the backdrop.*

View 08 *Distant view from the northern foreshore looking east. The bushland backdrop helps settle the structure in its setting.*

View	Description of setting	Sensitivity of view		Addendum commentary
V05	River foreshore in a pristine bushland setting with wetland grasses, rock shelves and sand banks. Road bridge clearly visible that is a dominant feature.	M	Moderate, the viewpoint's scenic quality is detracted by the bridge in close proximity, resulting in a moderate rating.	assessment remains
V06	View from under the bridge looking towards the northern abutment. Bushland setting with riverscape in the foreground	L	Low, the dominance of the structure deters the quality of the viewscape, limiting its sensitivity. This viewpoint is considered of a transient nature, contributing to the low rating.	assessment remains
V07	River foreshore looking towards road bridge overhead.	M	Moderate, although the bridge crossing is a dominant feature, the scenic quality of the setting makes this viewpoint more sensitive compared to Viewpoint 06.	assessment remains
V08	Riverscape with rock shelves and dense bushland. Road bridge in the mid-ground.	H	High; the highly scenic setting and the limited dominance of the bridge makes this viewpoint more sensitive.	assessment remains

3.5 Assessment of Magnitude and Impact - Viewpoints 5-8

View	Element of project visible	Magnitude of change		Nature of impact
V05	Addendum CHANGED DESIGN New bridge structure, piers and girders will be clearly visible behind the existing bridge, northern abutment wall may be visible	L	Addendum NO CHANGE magnitude Magnitude of change remains Low. The existing bridge remains a dominant element in the view, new bridge is sheltered behind existing bridge in this view.	Adverse
V06	Addendum CHANGED DESIGN New bridge structure, piers and girders will be clearly visible behind the existing bridge, northern abutment wall may be visible, some loss of vegetation.	H	Addendum NO CHANGE magnitude Magnitude of change remains High. The new bridge will be clearly in the view.	Adverse
V07	Addendum CHANGED DESIGN New bridge structure, piers and girders will be clearly visible to the front of the existing bridge`	L	Addendum NO CHANGE magnitude Magnitude of change remains Low. The new bridge will be clearly in the view however considerations of aligned piers and elevational design contributes to a low magnitude of change.	Adverse
V08	Addendum CHANGED DESIGN New bridge structure, piers and girders will be clearly visible to the front of the existing bridge	M	Addendum CHANGED magnitude to Moderate Magnitude of change is Moderate. The new bridge will be clearly in the view, with considerations of aligned piers, elevational design and matching colours contributes to a moderate magnitude of change.	Adverse

Table 6.8 Magnitude rating for viewpoints 5 to 8

View	Sensitivity	Magnitude	Visual impact	Comments	Addendum commentary
V05	Moderate	Low	A low to moderate visual impact is assessed based on the relative minor interventions to the overall setting. The long term visual impact is considered negligible once the riverscape vegetation recovers post construction.	Rock shelves mould likely be exposed but not necessarily be out of character with the setting.	Addendum NO CHANGE visual impact Design has changed, however Magnitude and Visual Impact assessment remains
V06	Low	High	The higher magnitude of impact combined with the lower visual sensitivity result in a moderate visual impact. This is partially a result due to the proximity of the proposal.	Impacts to existing vegetation for the construction access track are considered of a long term duration until the vegetation is fully re-established.	Addendum NO CHANGE visual impact Design has changed, however Magnitude and Visual Impact assessment remains
V07	Moderate	Low	The visual impact is low to moderate, the viewscape would not dramatically change. It should be noted, that the impact is higher after construction due to impacts to the foreshore setting.	The long term visual contrast is considered limited and the re-establishment of foreshore vegetation is considered of a temporary nature, resulting in the low to moderate rating.	Addendum NO CHANGE visual impact Design has changed, however Magnitude and Visual Impact assessment remains
V08	High	Moderate	Visual impact is moderate - high the proposal is evident in the view and partially obstructs the existing structure.	Construction Operations Comment: It should be noted that this rating is based on the temporary nature of the impacts to the foreshore setting as part of hardstand areas for construction.	Addendum has CHANGED magnitude to moderate. Introduction of a new structure has changed the Magnitude to be considered Moderate and consequently Visual Impact assessment changed to moderate. Given the limited access of the viewpoint for potential viewers, the visual impact is considered to be acceptable.

Table 6.9 Overall risk rating (sensitivity x magnitude) for viewpoints 5 to 8

4 Conclusion

The Project design changes summarised in this addendum follow the Urban Design Principles and Objectives as set out in Appendix I, the development of which are a considered and appropriate response to the landscape setting.

The design changes to the Project follow and respect these key design drivers as set out in the conclusions of Appendix I:

- Development of a built form that is sympathetic to the existing structure;
- Expressing new bridge components to differentiate them from the old structure;
- Limiting the physical intervention on site and reducing the construction footprint;
- Sensitively integrating rock/slope stabilisation works and limiting their extent;
- Landscape design measures that re-establish the endemic species of the area and provide slope stabilisation and water sensitive design "soft engineering" approaches; and
- Establishing a heritage curtilage that protects the various historic river crossing intervention as a unique ensemble

The commentary outlined in the final concluding statement remains supported by the Project with the design changes summarised in this Addendum further emphasising their intent.

"The proposal has a limited visual exposure and the highest visual impact assessed is along the road itself. The identified moderate to high rating is project specific and driven by the visual contrast of the proposed slope stabilisation (rock cutting) works and the wider bridge which is considered a positive development that enhances the journey's visual experience and functioning of the bridge.

In regards to landscape character impacts, the design has focused in minimising impacts to the most sensitive zones and affects the zone most disturbed in the past.

It should be noted that from a landscape character point of view, the proposal provides a positive contribution to the functioning of Heathcote Road; Zone 4, by creating a safer road and a more enjoyable experience to travellers.

The proposal also safeguards the continuing use of the existing heritage bridge, ensuring its heritage value is conserved into the future."

Ref Appendix I Urban Design Concept Report: Heathcote Road Bridge Urban Design Concept Report by KIA STUDIO 24.11.2020, prepared for TfNSW.

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