Agenda and Business Paper

Floodplain Risk Management Advisory Committee

To be held on
Tuesday 27 February 2024
at 11.00am

Civic Centre cnr Baylis and Morrow Streets,
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City of
Wagga Wagga

FLOODPLAIN RISK MANAGEMENT ADVISORY COMMITTEE AGENDA AND BUSINESS PAPER

TUESDAY 27 FEBRUARY 2024

ORDER OF BUSINESS:

ACKNOWLEDGEMENT OF COUNTRY

Wagga Wagga City Council acknowledges the traditional custodians of the land, the Wiradjuri people, and pays respect to Elders past, present and future and extends our respect to all First Nations Peoples in Wagga Wagga.

We recognise and respect their cultural heritage, beliefs and continuing connection with the land and rivers. We also recognise the resilience, strength and pride of the Wiradjuri and First Nations communities

APOLOGIES

DECLARATIONS OF INTEREST

REPORTS FROM STAFF

RP-1 2018-19-FM-0071 - NORTH WAGGA FLOOD MITIGATION OPTIONS

Author: Andrew Mason
Executive: Phil McMurray

Summary: The project is nearing completion, and the consultant is presenting the draft final report for adoption.

Recommendation

That the Floodplain Risk Management Advisory Committee receive and note the draft report and recommends to the Council that it receive the report and places it on Public Exhibition.

Report

As per the scope and brief of this study the consultant CIE, Woolcott, WMAwater and NGH have completed the four key areas of analysis:

- Economic
- Environmental
- Social
- Cultural

and in discussion with the committee, the final draft report has been developed to reflect the findings of this analysis.

This final draft report is being presented to the committee for acceptance and the committee is required to recommend to Council that it receive the report and that it be placed on Public Exhibition

The timetable for the project has these proposed key dates moving forward:

- An Extra-Ordinary Meeting of FRMAC will be held on 27 February 2024 to consider the final Draft Report. The Committee will be asked to consider making a recommendation, likely “That Council receive the Draft Report place it on Public Exhibition”.
- The Recommendation from FRMAC will be considered by Council at its Meeting on 11 March 2024.
- Public Exhibition will run for five weeks, likely ending 19 April 2024.
- Feedback from the Public Exhibition will be considered by FRMAC, the consultants and Council. Following a Final Report will be prepared by the consultant.
- A detailed report, including the Final Report, will then be presented for consideration at the Council meeting on 13 May 2024. That report will seek Council to adopt the North Wagga Flood Mitigation Option.

Financial Implications

N/A

Policy and Legislation

N/A

Link to Strategic Plan

Safe and Healthy Community

Objective: Our community feel safe

Be responsive to emergencies

Risk Management Issues for Council

N/A

Internal / External Consultation

The Committee are advised that the consultants will attending this meeting remotely and presenting via zoom.

Attachments

1⇩. Draft Final Report (CIE)

2⇩. Community Consultation final anaylsis - Wollcott

3⇩. Environmental Constraints Analysis (NGH)

4⇩. Flood Impact Analysis - WMA

COMMERCIAL IN CONFIDENCE

FINAL REPORT

Flood Mitigation Options for Wagga Wagga

Evaluation of options

Prepared for
Wagga Wagga City Council

23 February 2024

THE CENTRE FOR INTERNATIONAL ECONOMICS
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While the CIE endeavours to provide reliable analysis and believes the material it presents is accurate, it will not be liable for any party acting on such information.

Contents

BOXES, CHARTS AND TABLES

Glossary

AAD	Annual Average Damage - the expected yearly damage cost arising from all occurrences of a given hazard.
AEP	Annual Exceedance Probability
ARI	Annual Recurrence Interval
CBA	Cost Benefit Analysis
Net Benefit	Present Value of Benefits less Present Value of Costs presented in the Economic Analysis
PMF	Probable Maximum Flood
VHP	Voluntary House Purchase
VHR	Voluntary House Raising
Risk	Risk refers to a situation where the occurrence of a future event is not known, but its probability of occurring is known or can be estimated
WWCC	Wagga Wagga City Council

Summary

The CIE has been engaged by Wagga Wagga City Council (the Council) to undertake an evaluation of three alternative flood mitigation options to manage flood risks in the region, with a particular focus on North Wagga Wagga. The options include:

- **PR1: Voluntary House Raising** (VHR) and **Voluntary House Purchase** (VHP) for eligible properties on the floodplain (e.g. North Wagga, Oura and Gumly Gumly).
- **L4B: North Wagga Levee System Upgrade** to withstand a 5% AEP (1 in 20 chance) flood event combined with an increase in some road heights and bridges to provide a safe evacuation route for residents from North Wagga. This would also include conveyance improvements through Wilks Park. The North Wagga Levee system would be upgraded first (Stage 1 or option L4A) and, at a later stage, the surrounding works would be constructed (Stage 1).
- A **combined approach** that is staged and includes
  a) Upgrading the existing North Wagga Levee system (**option L4A**)[1] and offering VHR and VHP to those outside the levees, only where it is cost effective to do so.
  b) Increasing the road heights and bridges along Hampden Ave to provide a safe evacuation route (**Stage 2 of option L4B**).
  c) **VHP and VHR** for those inside the North Wagga Levee system, only where it is cost effective to do so.

This report presents the findings of our analysis of the merits of the options. The analysis utilises the flood modelling conducted by WMA Water for the region, the latest data from the Australian Bureau of Statistics, as well as land value and property sales data captured by the NSW Land Valuer General. The analysis also adopts the August 2023 *Flood Damage and Cost Benefit Assessment Tool* which was developed by the NSW Government to assess flood risk mitigation measures consistent with Flood Risk Management Measures Guide MM01.[2]

This tool accounts for both the flood frequency and severity. The tool provides specific guidance on parameter values to use for the calculation of damages including structural/internal damage to buildings, intangibles (e.g. injury/mortality, mental health costs) and external damage (including to roads and utility services). The tool utilises updated information from more recent flood events throughout NSW.

This evaluation does not provide guidance on how any chosen option should be funded (by government or the community). It also does not place greater weight on any particular part of the community and, therefore, does not provide a judgement on any equity issues.

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1 This includes the "temporary" embankments along Hampden Ave that were added in 2012.

2 https://www.environment.nsw.gov.au/topics/water/floodplains/floodplain-guidelines

Key findings

The key findings from our analysis include:

- **The VHR scheme in North Wagga Wagga results in *net benefits* to the community of around $9.6m in present value terms over a 30 year period. The cost of around $120,000/property is relatively low and significantly reduces the Annual Average Damage (AAD) for the property. We have assumed that the floor level of the property is raised 3m above ground level which substantially reduces the AAD of properties. Based on a visual survey, there are around 165 properties in North Wagga Wagga that could potentially be raised, resulting in a cost of $19.8m and delivering benefits (i.e. risk reduction) equivalent to $29.4m in present value over 30 years. This results in a *net benefit* of $9.6m.**
  - **The VHR scheme, however, may prove challenging for certain members of the community that may find the access to be more challenging. Depending on the additional costs of improving access this could impact on the scheme. If, for example, the cost (including improved access) increases to $200,000/property this switches the net benefit to a *net cost* of $3.6m.**
  - **Benefits would be greater if every property were raised, but a subset of houses have either been raised already or cannot be raised at all. In North Wagga Wagga 44 properties were identified as being already raised, and an additional 59 cannot be raised.**
- **The VHP scheme in North Wagga Wagga performs much worse than VHR, resulting in a *net cost* of $55.9m (in present value terms) to the community. The purchase cost of around $400,000/property significantly outweighs the AAD for most properties.**
  - **The policy could be refined to only target the highest risk properties where the current risks exceed $400,000.**
  - **Further, rather than pre-emptively purchasing the properties the VHP scheme could be applied *after* a flood event has damaged a property. This could be in, for example, 10 years' time. This would also require pre-planning and providing a place for residents to move immediately.**
- **The L4B option (both levee and associated works) does substantially reduce the flood risks in some areas. However, the overall cost of option L4B is around $86m (excluding any biodiversity offset purchases) is substantial.**
  - **The reduction in risk can vary, depending on the assumptions adopted. For the central case, we assume that for residential properties the largest building is the main residence and incurs the main structural/contents damage. Other buildings on the property (e.g. shed/garages) are subject to a lower "external damages" cost estimate. For commercial/industrial properties we assume that all buildings on the lot will be subject to the (higher) structural damage/contents estimates. Under these assumptions, the *costs of L4B exceed the benefits* by around $66.5m (in present value terms over 30 years).**

- L4A removes the surrounding works but maintains the levee upgrade which results in maintaining a large portion of the benefits of L4B but at a fraction of the cost, giving an overall ***net benefit*** **of $16.1m**. The total cost of L4A is $10.3m, which achieves a benefit of $26.4m.
- Combining the L4B option with VHR and VHP applied to properties outside North Wagga Wagga does result in slightly improved results compared to the L4B option on its own, however, it still results in ***net costs*** **of $46.3m**. This assumes that the VHR and VHP options are only applied to 'high risk' properties.
- Similarly, combining L4A with VHR and VHP applied to high risk properties outside North Wagga Wagga results in a moderate improvement over L4A on its own. The ***net benefit of this approach is $21.3m***.
- Combining just the VHR and VHP, targeting the highest risk properties within and outside North Wagga results in ***net benefits of $17.7m***. This highlights the value of adopting a more strategic approach which targets the highest risk properties where there is greatest benefit from the risk reduction.

Conclusions

Based on the analysis conducted, the conclusions are:

- Of the different options that could be adopted:
  - the combined L4A with a targeted VHR/VHP to high risk residents outside North Wagga delivers the best outcome for the community. However, there may be challenges for some households due to accessibility issues which could result in additional costs above the assumed $120,000/property raising.
  - L4B by itself or in combination with any other strategies is too expensive to be cost effective, regardless of the size of potential benefits.
  - VHR and VHP delivers positive outcomes for the community where it is applied to high risk properties where the risk reduction is greater than the cost of the actions. This suggests a strategic approach to the application of these policies based on estimated risk reduction. Further, the VHP policy could be more efficient where the purchase applies only after flooding. A pre-emptive policy would immediately "destroy" the value of the property with certainty, compared to the comparatively low probability of this. An alternative would be to purchase a property pre-emptively but maintain it as part of the housing stock until it is damaged by a flood event which could be in, say, 10 years' time.
- In implementing the proposed levee it is important to recognise that water is diverted to other parts of the floodplain, potentially negatively impacting on some properties. However, where negative impacts occur these are typically only result in minor increases flood depths. The risk reduction benefits of the levee substantially outweighs the potential negative impacts on some properties.

1 Project Overview

Wagga Wagga has experienced riverine flooding on numerous occasions requiring large scale evacuations and causing considerable damage, loss of property, loss of revenue, disruption of services, disruption of lifestyle and significant inconvenience.

Understanding the chance of different sized floods occurring is important for managing flood risk. The chance of a flood event can be described using a variety of terms, but a common method is the Annual Exceedance Probability (AEP).[3] A flood with a 1% AEP has a 1 in 100 chance of being exceeded in any year. Other terms that express the same idea, such as a '1 in 100 year flood' can be misinterpreted as only occurring once in every 100 years.[4]

Since early settlement, Wagga Wagga has experienced numerous large floods, with four events (1852, 1853, 1870 and 1891) in the 1800's equalling or exceeding 10.5m at the Hampden bridge gauge. Following significant flooding in the 1950's the CBD Levee was constructed to provide flood protection to the township of Wagga Wagga.

The CBD Levee has recently been upgraded to a 1% AEP level of protection. There are a number other levees on the floodplain, including one encircling North Wagga and providing a level of protection of approximately an 12% AEP event, one at Gumly Gumly protecting for flood breakouts north of Lamprey Avenue (up to a 10% AEP level of protection), and the Riverina Water County Council (RWCC) which protects Wagga Wagga's potable water supply.

Wagga Wagga City Council (the Council) has commissioned a range of studies to understand the existing and future flood risk and identify options to manage this risk. The 2018 Floodplain Risk Management Study and Plan conducted by WMA Water analysed the flood risks and options to manage these risks. Since this report WMA Water has undertaken additional modelling which has informed our economic analysis.

Options considered in this study

A range of typical floodplain risk management measures have been previously assessed as to their appropriateness for providing additional protection for Wagga Wagga (table 1.1).

3 https://arr.ga.gov.au/__data/assets/pdf_file/0006/40398/New-ARR-Probability-Terminology_final.pdf

4 https://www.chiefscientist.qld.gov.au/publications/understanding-floods/chances-of-a-flood

1.1 Flood Risk Management Measures considered

Flood modification	Property modification	Response modification
Levees	Land zoning	Community awareness
Temporary Defences	Voluntary purchase	Flood warning
Channel Construction	Building & development controls	Evacuation planning
Channel Modification	Flood proofing	Evacuation access
Major Structure Modification	House raising	Flood plan/ recovery plan
Drainage Network Modification	Flood access	
Drainage Maintenance		
Retarding Basins		

Source: WMAwater (2018), Wagga Wagga Revised Murrumbidgee River, Floodplain Risk Management Study and Plan, April.

Many of these management measures were deemed to be not appropriate for Wagga Wagga and were not considered further.

1.2 Options considered for the case study

For this study, a number of options have been considered for feasibility assessment:

- **PR1: Voluntary House Raising** (VHR) and **Voluntary House Purchase** (VHP) for eligible properties on the floodplain (e.g. North Wagga, Oura and Gumly Gumly).
- **L4B: North Wagga Levee System Upgrade** to withstand a 5% AEP (1 in 20 chance) flood event combined with increase in some road heights and bridges to provide a safe evacuation route for residents from North Wagga. This would also include conveyance improvements through Wilks Park. The North Wagga Levee system would be upgraded first (Stage 1, option L4A) and, at a later stage, the surrounding works would be constructed (Stage 1).
- A combined approach that is staged and includes
  a) Upgrading the existing North Wagga Levee system (**option L4A**)[5] and offering Voluntary House Raising and Purchase to those outside the levees, only where it is cost effective to do so.
  b) Increasing the road heights and bridges along Hampden Ave to provide a safe evacuation route (**Stage 2 of option L4B**)

VHP and VHR for those inside the North Wagga Levee system, only where it is cost effective to do so.

5 This includes the "temporary" embankments along Hampden Ave that were added in 2012.

Project objective

The central task for this project is to assess feasibility of the options above. The analysis considers the impacts across the whole floodplain but with specific focus on residential and non-residential properties impacted in the LGA. The options are expected to provide protection for some properties but the levee raising option has the potential to negatively impacts on other properties, as flood waters are diverted to other parts of the floodplain. The negative impacts could result from increased flooding upstream, environmental and social impacts, and to a lesser degree, a reduced level of flood protection for critical facilities in the broader region. There could also be negative impacts arising for some properties next to a levee bank that could face a loss in 'amenity value' with a higher levee structure.

2 Cost Benefit Analysis Methodology

The feasibility assessment needs to be undertaken in line with the NSW Government's *Guide to Cost-Benefit Analysis* (TPG 23-08).[6] In August 2023, the NSW Government also released specific guidance on conducting a CBA to assess different options that seek to manage flood risks. A specific Excel based tool has also been developed which specifies assumptions for the different parameters required to be modelled.[7]

Overview of a CBA

CBA is a tool designed to place the benefits and costs of particular actions or proposals on a common basis so that they can be compared and understood. It provides a basis on which the NSW Government can assess the net benefits of decisions around flood mitigation and adaptation.[8]

CBA provides a technique that allows a systematic treatment of trade-offs arising from Government decisions and the changes that they entail. It allows for quantification and valuation of the full range of potential impacts that might arise from changes in flood mitigation. It involves aggregation of these impacts across the various types of costs and benefits and through time into a single metric — *the expected present value of net benefits*[9] from a change relative to a 'reference case' (sometimes referred to as 'base case' or 'business as usual'). In the reference case, there may be specific responses that Government will take in the event of a flood (e.g. sandbagging, dredging). Any 'new' actions required will form part of the options to be evaluated.

A CBA framework is focused on the social welfare of the community. The policy option that delivers the highest *net social welfare* (across the community) is considered to be the best for society. The CBA does not place a greater weight on any particular group of residents within the community. As part of the CBA, however, we report on how impacts differ across the floodplain.

CBA is designed to take account of the full range of potential benefits and costs of particular actions. In this sense, it is wholistic and designed to include, for example, the

6 https://www.treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis

7 https://flooddata.ses.nsw.gov.au/flood-projects/nsw-flood-damage-assessment-tool-dt01

8 In this report we use the term 'mitigation' to mean a range of current and future options which help the community to 'adapt' to flood risks.

9 The expected value is the probability weighted value. In this case the options will provide different levels of protection for each flood event. Each flood event has a specific probability of occurrence.

environmental, health and economic impacts of particular actions. A CBA places each of these impacts on a common basis so that they can be compared and understood.

A CBA framework also considers the timing of each of the impacts. Under a CBA approach, future impacts are 'converted' into today's terms so that they can be meaningfully compared. A CBA, for example, will enable an evaluation of policies that deliver different streams of benefits and costs over time.

The key principles of a CBA are presented in box 2.1.

2.1 Key steps in a CBA

- **Articulating the decision that the CBA is seeking to evaluate.** For example, in relation to flood mitigation, the decision may relate to whether to build a levee and to what height, or whether evacuation routes are improved or both. The way in which the CBA is framed and the information requirements will differ depending on the decision being evaluated.
- **Establishing the reference case** (or 'base case') against which to assess the potential socioeconomic and environmental impacts of changes. In the case of flood mitigation in the case study region, the natural reference case is no change from the policies in place today and no specific new flood mitigation investment. This would mean, for example, that existing Council planning controls such as land use restrictions for flood areas would remain as they currently are.
- **Quantifying the changes** from the base case resulting from the possible scenarios being considered. This will focus on the incremental changes to a range of factors (for example, environmental, economic, social) resulting from the decision. The changes may be certain or could also be defined in probabilistic terms. The quantification should focus on key changes that will be utilised in the valuation stage. For flood mitigation these changes will include changes in the *likelihood* of flood events and changes in the *consequences* of flood events.
- **Placing values on the changes** and aggregating these values in a consistent manner to assess the outcomes.
- **Generating the Net Present Value (NPV)** of the future net benefits cashflow stream, using an appropriate discount rate, and deciding on the **Decision Rule** on which to assess the different options.
- **Undertaking sensitivity analysis** on a key range of variables, particularly given the uncertainties related to specific environmental benefits and costs.

Deciding on which option is better for society. In practice, additional information, aside from the CBA, may also be utilised when deciding on the preferred option.

It is important to note that a CBA does not consider ***equity issues.*** For example, the construction of a raised levee bank may reduce flood impacts in one part of the Wagga Wagga LGA but may increase flood risks for residents upstream. A CBA focuses on

comparing the ***aggregate gains in total versus the total losses***, irrespective of which specific part of the community benefits or loses.

The feasibility analysis will, therefore, need to provide transparent information on the impacts of the alternative options. This will enable other information to be presented, in addition to the CBA results, to assist decision makers to assess the options. However, having a robust CBA will provide objective evidence on the quantum of positive and negative impacts on the community, thereby, reducing the need for subjective judgements.

Note that the issue of ***how to fund*** selected options is a separate task to the CBA. The CBA evaluates which options would generate the greatest welfare improvement. Once the options are selected the decision maker then needs to consider how best to fund the options (e.g. via rate increases, a differential flood levy on property owners on different parts of the floodplain, direct grants from state/federal governments).

Application of CBA to responses to mitigate the impacts of flooding

The basic framework for evaluating the costs of flood events and the costs of mitigation options should capture the following.

- The costs of flood events under the base case as well as each mitigation strategy, which comprises:
  - the *probability* of a given flood height/velocity occurring
  - the *consequences* of a given flood height/velocity occurring, such as:
    - property damage
    - loss of life/injury.
- The costs of each mitigation strategy including:
  - capital costs
  - ongoing operating costs
  - environmental impacts (e.g. biodiversity loss due to associated land clearing).

The costs of flood events under alternative strategies and the costs of the actions that form part of a strategy should be measured over a period of time (e.g. 30 years) and will be discounted back to 2023 dollars. The Treasury Guidelines require the use of a 5 per cent real discount rate, with sensitivity being undertaken at 3 per cent and 7 per cent.[10]

Further all costs should be measured as *economic costs.* Economic costs differ from financial costs because:

- economic costs include costs to those outside of the direct proponent
- economic costs do not include financial transfers, and
- resources used are valued at their opportunity cost, which may differ from their market price.

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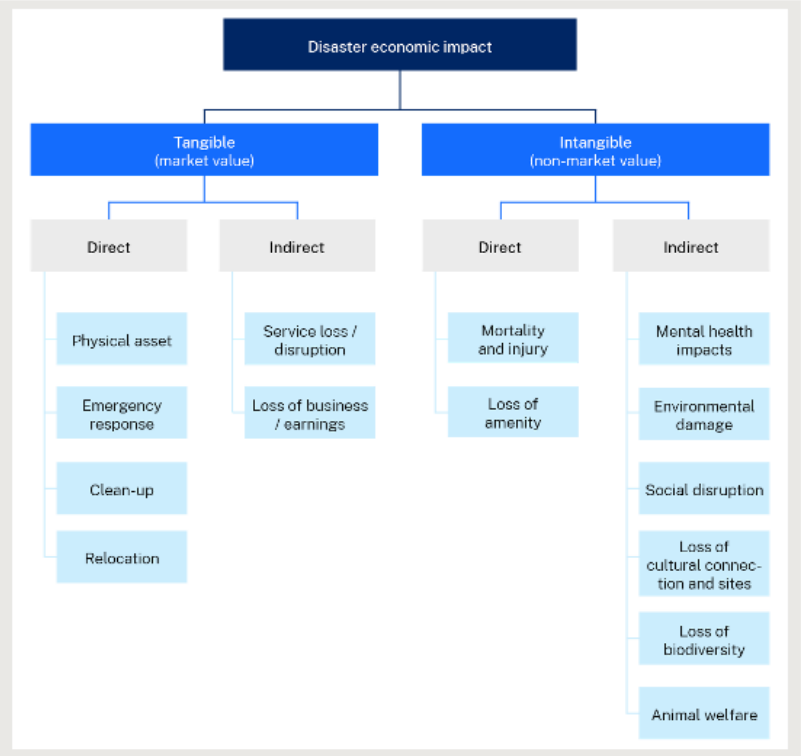
10 See page 94 of Treasury Guidelines https://www.treasury.nsw.gov.au/sites/default/files/2023-04/tpg23-08_nsw-government-guide-to-cost-benefit-analysis_202304.pdf

NSW Government Guidelines

The NSW Government's Disaster CBA Framework (TPG23-17, August 2023) presents different categories of impacts that should be considered in the analysis.

2.2 Categories of disaster impacts



Data source: NSW Treasury (2023), *Disaster Cost-Benefit Framework TPG23-17*, p25.

The specific assumptions for the different categories embedded in the Excel based calculator are summarised in Appendix B. Some key assumptions, such as the updated 'stage damage curves', are significantly higher than previously used (e.g. in WMA Water's April 2018 Floodplain Risk Management Study and Plan). Therefore, the results and findings from the previous studies could be substantially different to those reported in the earlier reports.

3 Current risks

This chapter presents information on the flood risks in the absence of any future actions/investments and how the risks change under the options considered. We utilise a number of sources to estimate the risks such as:

- A spatial GIS file of building footprint based on satellite imagery. The information was provided by Council.
- A spatial GIS file of 'properties' in the Wagga Wagga LGA, sourced from the NSW Government.[11]
- A spatial GIS file of 'Meshblocks' in the Wagga Wagga LGA, sourced from the ABS.[12] The MBs identify different categories including Residential, Commercial, Industrial, Education, Hospital/Medical, Primary Production, Parkland and Other.
  - This is combined with datasets of dwelling and population numbers for each Meshblock as reported in 2021 Census.
- A dataset of properties, land values and property sales in NSW sourced from the NSW Land Valuer General.[13]
- There has been some manual reclassification of properties as new information is obtained (e.g. from Google Earth and from Council's visual inspections of properties). This includes two newly built properties currently not reflected in GIS files. Some manual adjustments has also been undertaken to incorporate information on existing house raisings and also the potential for a house to be raised.

The spatial files noted above have been overlaid with spatial GIS flood layers provided by WMA Water, modelled for eight different flood events.[14] WMA Water has undertaken in line with the *Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR 2017). The results in this chapter reflect the case where the existing levees do not "fail" under the flood event.

The results presented in this chapter may differ to WMA Water's April 2018 *Floodplain Risk Management Study and Plan*. This reflects, for example, updated population and dwelling numbers, as well as, updated flood modelling conducted by WMA Water.

11 https://datasets.seed.nsw.gov.au/dataset/nsw-property-web-service

12 https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/access-and-downloads/digital-boundary-files

13 http://www.valuergeneral.nsw.gov.au/land_value_summaries/lv.php

14 This includes AEP events 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2% and PMF. For context, the AEP 1% equates to a 1 in 100 year event and AEP 20% equates to a 1 in 5 year event.

Existing flood risks with no new actions

Based on the 2021 Census the Wagga Wagga LGA has 67,609 persons and 28,151 dwellings, with an area of 4,826 sqkm.[15] The largest flood event, the Probable Maximum (PMF) flood event, floods around 154 sqkm or 3.2% of the LGA.[16]

The *potential* impact differs throughout the floodplain. Table 3.1 presents the suburbs that are impacted (to some extent) by the PMF flood event and the total number of persons, dwellings and land area in each suburb.

3.1 Characteristics of suburbs potentially impacted (to some extent) by PMF event

Suburb	Persons [a]	Dwellings [a]	Total Suburb Area
	no.	no.	sqkm
Gobbagombalin	2 184	767	44
Eunanoreenya	165	65	39
Alfredtown	80	32	75
North Wagga	679	291	17
Forest Hill (NSW)	3 081	938	35
Oura	246	95	142
Yarragundry	72	35	65
East Wagga Wagga	213	130	11
Gumly Gumly	450	149	12
Moorong	175	61	19
Wagga Wagga	7 198	3 960	9
Euberta	130	55	105
Bomen	40	15	28
Cartwrights Hill	169	77	3
Ashmont	3 747	1 674	2
Lake Albert (NSW)	6 291	2 519	25
Kooringal (NSW)	7 404	3 304	5
Boorooma	1 741	601	2
Estella	2 541	1 023	2
Brucedale	184	62	49
Turvey Park	3 572	1 536	4
Downside	124	46	80
San Isidore	349	122	5
Total	**40 835**	**17 557**	**777**

[a] This represents the total number of persons/dwellings in the suburb, not those impacted by each flood event.

Source: ABS 2021 Census QuickStats, https://www.abs.gov.au/census/find-census-data/quickstats/2021/SAL13024

15 https://abs.gov.au/census/find-census-data/quickstats/2021/LGA17750

16 A small proportion of land is within the flood extent but above the flood height. This land does not form part of our estimate of the flooded area in the PMF.

Land area impacted

Table 3.2 calculates the land area impacted (i.e. the flood extent) under the flood events modelled for this study, assuming no upgrades to the levees. North Wagga, for example, has a large proportion of area impacted by the three different flood events. In the Wagga Wagga suburb the PMF inundates 8.25sqkm (of the total 8.90sqkm in the suburb), but this falls to 1.92sqkm for the AEP 1% event. For other suburbs, such as Euberta, all flood events only impact on a small proportion of land.

3.2 Land area inundated, by suburb

Suburb	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqkm	Sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm
Alfredtown	16.22	14.39	13.95	13.53	13.03	11.76	9.90	5.97
Ashmont	0.60	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Bomen	2.17	1.84	1.78	1.72	1.66	1.42	1.07	0.00
Boorooma	0.23	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Brucedale	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cartwrights Hill	0.93	0.72	0.68	0.65	0.62	0.59	0.56	0.44
Downside	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
East Wagga Wagga	9.91	8.63	7.41	6.36	5.21	2.85	2.51	2.21
Estella	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Euberta	5.91	5.49	5.27	4.97	4.63	2.94	2.69	1.54
Eunanoreenya	18.82	17.42	17.26	17.13	16.96	16.03	13.86	7.73
Forest Hill	12.95	10.54	10.29	10.03	9.58	6.76	5.34	2.72
Gobbagombalin	20.55	17.01	16.30	15.98	15.72	15.00	13.91	9.25
Gumly Gumly	9.35	8.72	8.65	8.55	8.10	3.80	3.19	2.09
Kooringal	0.35	0.14	0.01	0.01	0.00	0.00	0.00	0.00
Lake Albert	0.48	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Moorong	9.04	8.58	8.26	8.19	8.12	7.85	7.37	6.07
North Wagga Wagga	15.56	15.35	15.28	15.19	15.10	14.83	13.54	10.17
Oura	11.08	9.88	9.68	9.50	9.26	8.41	7.05	4.83
San Isidore	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turvey Park	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wagga Wagga	8.20	5.82	2.03	1.91	1.88	1.82	1.69	1.45
Yarragundry	10.28	9.76	9.60	9.39	9.13	7.54	5.54	1.77
Total	**152.85**	**134.45**	**126.43**	**123.08**	**118.99**	**101.60**	**88.21**	**56.25**

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

Table 3.3 presents the land area inundated by ABS Meshblock 2021 category.[17] The flood inundation occurs predominately on land classified for Primary Production. This is followed by Residential land. In the PMF event, there is also land used for hospital/medical services. In the AEP 5% to PMF events, there is also inundation of land providing educational services.

17 https://www.abs.gov.au/census/guide-census-data/mesh-block-counts/latest-release

3.3 Land area inundated. By Meshblock

Meshblock	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm
Residential	8.49	5.53	3.53	3.41	3.26	2.17	1.49	1.11
Commercial	0.88	0.45	0.15	0.14	0.13	0.07	0.05	0.03
Education	0.21	0.11	0.08	0.04	0.01	0.01	-	-
Hospital/Medical	0.04	-	-	-	-	-	-	-
Industrial	3.61	2.73	1.47	1.33	0.90	0.40	0.27	0.14
Parkland	2.69	2.34	0.90	0.82	0.81	0.78	0.72	0.71
Primary Product	132.29	118.82	116.06	113.14	109.74	94.34	82.26	51.50
Other	4.65	4.46	4.25	4.19	4.15	3.84	3.41	2.75
Total	**152.85**	**134.45**	**126.43**	**123.08**	**118.99**	**101.60**	**88.21**	**56.25**

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

Buildings impacted

Building footprint in GIS format based on satellite imagery was provided by Council. This includes small structures such as sheds and garages, as well as, residential dwellings, commercial/industrial and other buildings. A single 'property' (ie block of land) may have multiple buildings on it. Table 3.4 presents the total building footprint impacted in those suburbs with a building. If only a portion of the building is flood exposed we assume that the whole building is defined to be 'impacted'. Therefore, the calculations in the table are likely to be a slight overestimate.

3.4 Area of building footprint impacted, by suburb

Suburb	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqm	sqm	sqm	sqm	sqm	sqm	sqm	sqm
Alfredtown	1 769	1 322	1 296	919	919	0	0	0
Ashmont	106 252	3 936	0	0	0	0	0	0
Bomen	4 456	2 809	2 700	2 700	2 323	924	313	0
Boorooma	14 306	1 437	0	0	0	0	0	0
Cartwrights Hill	8 305	4 952	4 539	4 539	4 192	3 946	3 946	3 946
East Wagga Wagga	540 292	490 836	307 825	285 523	166 514	57 178	30 385	16 855
Estella	3 655	2 130	0	0	0	0	0	0
Eunanoreenya	21 123	13 444	11 545	11 166	9 974	6 237	4 015	1 541
Forest Hill	13 289	5 825	5 697	5 641	5 250	4 579	3 834	633
Gobbagombalin	7 385	3 200	3 200	3 200	3 200	2 014	1 328	787
Gumly Gumly	81 908	78 300	75 917	73 997	55 497	13 071	5 064	1 520
Kooringal	27 766	4 454	0	0	0	0	0	0
Lake Albert	4 986	0	0	0	0	0	0	0
Moorong	36 270	25 570	1 578	1 558	534	435	427	396
North Wagga Wagga	119 950	117 970	116 271	110 181	106 985	92 561	26 522	7 156

Suburb	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqm	sqm	sqm	sqm	sqm	sqm	sqm	sqm
Oura	36 741	29 770	28 931	28 185	27 725	17 169	1 044	6
Turvey Park	2 628	0	0	0	0	0	0	0
Wagga Wagga	1 422 539	912 859	25 708	25 669	25 382	23 767	18 338	13 718
Total	**2 453 621**	**1 698 816**	**585 208**	**553 277**	**408 494**	**221 881**	**95 216**	**46 558**

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

Road area impacted

Inundated road area is determined using road corridor information provided in GIS format by Council. Table 3.5 presents the area (sqkm) impacted under each AEP

3.5 Road area inundated

PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm
8.184	6.815	5.221	4.994	4.698	3.863	3.014	1.787

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

Change in risks due to options

Option L4B - upgrade North Wagga Levee system and associated works

Table 3.6 presents the change in area inundated from the levee project. As expected, the levee project significantly reduces the inundation area in North Wagga Wagga for the AEP 20% to the AEP 2% events. There is also a reduction in inundation area in East Wagga Wagga (and a number of other suburbs) for the AEP 20% to AEP 5% events. There is also an increase in inundation area for some flood events in some areas, although these increases are typically minor (non-material).

3.6 Change in land area inundated due to Option L4B, by suburb

Suburb	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqkm	sqkm	Sqkm	sqkm	sqkm	sqkm	sqkm	sqkm
Alfredtown	0.000							
Ashmont								
Bomen	0.001	0.001						
Boorooma		-0.001						
Brucedale	0.000							
Cartwrights Hill				-0.001	-0.002	-0.002		
Downside								
East Wagga Wagga		0.009	0.011	0.019	0.014	-0.047	-0.044	-0.021
Estella								
Euberta			-0.000	-0.001	-0.000	0.003	0.002	0.003

Suburb	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqkm	sqkm	Sqkm	sqkm	sqkm	sqkm	sqkm	sqkm
Eunanoreenya	0.000		0.001	0.001	0.002	-0.002	-0.003	-0.092
Forest Hill	0.000	0.001	0.001	0.001		-0.004	-0.007	
Gobbagombalin	-0.001	0.001		-0.002	-0.001	0.003	0.006	0.022
Gumly Gumly	0.000	0.002	0.002	0.002	0.003	-0.004	-0.002	-0.022
Kooringal		0.012						
Lake Albert	0.001	0.000						
Moorong		0.000			-0.001	0.003	0.001	0.012
North Wagga Wagga		-0.000	-0.000	0.003	-0.456	-0.754	-0.134	-0.306
Oura	0.000							
San Isidore								
Turvey Park								
Wagga Wagga	0.001	0.043	-0.003	0.001			-0.001	0.007
Yarragundry				-0.001	-0.000	0.010	0.010	0.002
Total	**0.005**	**0.067**	**0.011**	**0.022**	-0.442	-0.794	-0.171	-0.395

Note: A blank indicates that there was no flooding in the suburb for the flood event or there is no impact of the levee project. The data has been rounded to the 3rd decimal place.

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

Table 3.7 presents the change in area inundated by Meshblock category. The levee project provides additional protection from residential land in the AEP 1% event and smaller. Commercial/Industrial land also gets some protection in the AEP 5% events and smaller. Some Meshblocks experience an increase in flooding in the larger flood events.

3.7 Change in land area inundated due to Option L4B, by Meshblock

Meshblock	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm
Residential	0.000	0.034		-0.003	-0.268	-0.459	-0.022	
Commercial	0.001	0.007	0.000	0.000	0.001	-0.003	-0.002	
Education		0.000	0.000	0.008	-0.004	-0.006		
Hospital/Medical								
Industrial		0.016	0.001	0.002	0.003	-0.015	-0.025	-0.002
Parkland		0.002	-0.003	0.001	-0.018	-0.028	0.004	0.008
Primary Product	0.002	0.007	0.012	0.012	-0.155	-0.282	-0.127	-0.410
Other	0.001	0.001		0.000		-0.002	0.001	0.008
Total	**0.005**	**0.067**	**0.011**	**0.022**	-0.442	-0.794	-0.171	-0.395

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

Table 3.8 presents data on the building footprint impacted by the Option L4B. The option results in a substantial reduction in the buildings impacted in North Wagga Wagga for the AEP 1% and smaller events. There is also a substantial reduction in the building footprint impacted in East Wagga Wagga for the AEP 5% and AEP 10% events. However, there is also an increase in the building footprint impacted in some events, such as the AEP 0.2% (the '1 in 500' year event) in the Wagga Wagga CBD.

3.8 L4B change in area of building footprint impacted, by suburb

Suburb	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqm	sqm	sqm	sqm	sqm	sqm	sqm	sqm
Alfredtown	0	0	0	0	0	0	0	0
Ashmont	0	0	0	0	0	0	0	0
Bomen	0	0	0	0	0	0	0	0
Boorooma	0	0	0	0	0	0	0	0
Cartwrights Hill	0	0	0	0	0	0	0	0
East Wagga Wagga	0	353	0	182	155	-5 278	-3 230	0
Estella	0	0	0	0	0	0	0	0
Eunanoreenya	0	0	0	0	0	0	0	0
Forest Hill	0	0	0	0	0	0	0	0
Gobbagombalin	0	0	0	0	0	0	0	0
Gumly Gumly	0	0	0	0	0	0	0	0
Kooringal	0	8	0	0	0	0	0	0
Lake Albert	0	0	0	0	0	0	0	0
Moorong	0	0	0	0	0	0	0	0
North Wagga Wagga	0	0	19	-450	-50 282	-68 485	-5 470	-759
Oura	0	0	0	0	0	0	0	0
Turvey Park	0	0	0	0	0	0	0	0
Wagga Wagga	0	12 717	0	0	0	0	0	543
Total	**0**	**13 078**	**19**	**-268**	**-50 127**	**-73 763**	**-8 700**	**-216**

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

The protection provided by option L4B is largely related to Residential buildings, with protection also to buildings on primary production land, industrial land and also education facilities. In the AEP 0.2%, option L4B results in increased residential, commercial/industrial building damage in Wagga Wagga and East Wagga suburbs.

3.9 L4B change in area of building footprint impacted, by Meshblock

Meshblock type	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqm	sqm	sqm	sqm	sqm	sqm	sqm	sqm
Residential	0	10 840	19	-621	-41 190	-56 841	-564	0
Commercial	0	2 177	0	0	64	-770	0	0
Education	0	0	0	0	-2 067	-2 705	0	0
Hospital/Medical	0	0	0	0	0	0	0	0
Industrial	0	61	0	182	0	-1 125	-3 230	0
Parkland	0	0	0	0	0	0	0	45
Primary Product	0	0	0	171	-6 934	-12 324	-4 906	-804
Other	0	0	0	0	0	0	0	543
Total	**0**	**13 078**	**19**	**-268**	**-50 127**	**-73 763**	**-8 700**	**-216**

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

Option L4A – upgrade North Wagga Levee system only

Option L4A is very similar in nature to option L4B, except it delivers a lower level of protection, both in North Wagga Wagga and in surrounding suburbs. Comparing table 3.10 and table 3.6, we see that the total flooded area in the LGA is higher in all flood levels if only the levee is constructed, although for AEP 1%, AEP 5% and AEP 10% floods this is still preferable to no levee.

However, a few suburbs have a smaller flood extent with L4A compared to L4B during small floods (up to AEP 2%). These include Euberta, Gobbagombalin, Moorong and Yarragundry.

3.10 Change in land area inundated due to Option L4A, by suburb

Suburb	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm
Alfredtown	0.000							
Ashmont		0.000						
Bomen	0.001	0.001	0.001	0.001	0.001			
Boorooma	0.000	-0.002						
Brucedale	0.000							
Cartwrights Hill			0.001	0.000	0.000	-0.000		
Downside								
East Wagga Wagga		0.021	0.115	0.056	0.042	0.019	0.001	
Estella								
Euberta		0.001		0.001	-0.003	0.002	0.000	
Eunanoreenya	0.001	0.000	0.003	0.002	0.004	0.001		
Forest Hill (NSW)	0.000	0.002	0.002	0.004	0.001			
Gobbagombalin		0.006		-0.002	-0.002	0.002		0.000
Gumly Gumly	0.001	0.002	0.004	0.005	0.009			
Kooringal (NSW)		0.026						
Lake Albert (NSW)	0.001	0.000						
Moorong		0.001			-0.002	0.003		-0.000
North Wagga Wagga		-0.001	0.001	0.004	-0.284	-0.715	-0.075	0.014
Oura	0.000							
San Isidore								
Turvey Park	0.000							
Wagga Wagga	0.001	0.089	-0.001	0.000	-0.001			
Yarragundry		0.002		-0.000	-0.002	0.007	0.001	
Total	**0.008**	**0.149**	**0.126**	**0.070**	**-0.236**	**-0.682**	**-0.072**	**0.014**

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

Table 3.11 shows the changes brought about by the levee split by Meshblock category. Most of the benefits are accruing in the AEP 10% through AEP 2% floods, primarily in residential, parkland and primary production.

Compared to L4B, L4A provides less protection than L4B in residential, commercial, industrial and primary production Meshblocks, but in some cases, higher protection to parkland and 'other' Meshblocks.

3.11 Change in land area inundated due to Option L4A, by Meshblock

Meshblock type	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm	sqkm
Residential	0.001	0.068	0.001	-0.002	-0.238	-0.438	-0.022	
Commercial	0.001	0.016	0.000	0.001	0.002	0.002		
Education		0.000	0.002	0.023	-0.005	-0.006		
Hospital/Medical								
Industrial		0.038	0.092	0.012	0.009	0.007		
Parkland	0.000	0.007	-0.001	0.000	-0.023	-0.022	-0.001	0.000
Primary Production	0.005	0.020	0.030	0.034	0.020	-0.226	-0.050	0.014
Other	0.001	0.000	0.001	0.001	-0.001			
Total	**0.008**	**0.149**	**0.126**	**0.070**	**-0.236**	**-0.682**	**-0.072**	**0.014**

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

Focussing on buildings, L4A has substantially positive impacts in North Wagga Wagga in AEP 5%, AEP 2%, and marginal benefits in AEP 10%. East Wagga Wagga has slight increases in building area flooded across many flood types, and the levee results in a large increase in building area flooded in Wagga Wagga for large floods.

Again, not completing the extra works which are part of L4B results in decreased protection in North Wagga Wagga, and increased additional flooding in other suburbs due to redirected flows.

3.12 L4A change in area of building footprint impacted, by suburb

Suburb	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
	sqm	sqm	sqm	sqm	sqm	sqm	sqm	Sqm
Alfredtown	0	0	0	0	0	0	0	0
Ashmont	0	0	0	0	0	0	0	0
Bomen	0	0	0	0	0	0	0	0
Boorooma	0	-8	0	0	0	0	0	0
Cartwrights Hill	0	0	0	0	0	0	0	0
East Wagga Wagga	0	5 493	1 018	2 333	155	3 524	0	0
Estella	0	0	0	0	0	0	0	0
Eunanoreenya	0	0	0	0	0	0	0	0
Forest Hill (NSW)	0	0	0	0	0	0	0	0
Gobbagombalin	0	0	0	0	0	0	0	0
Gumly Gumly	0	0	0	9	0	0	0	0
Kooringal (NSW)	0	3 847	0	0	0	0	0	0
Lake Albert (NSW)	0	0	0	0	0	0	0	0
Moorong	0	0	0	0	0	0	0	0

Suburb	PMF	AEP 0.2%	AEP 0.5%	AEP 1%	AEP 2%	AEP 5%	AEP 10%	AEP 20%
North Wagga Wagga	0	0	19	754	-44 381	-68 004	-5 115	95
Oura	0	0	0	0	0	0	0	0
Turvey Park	0	0	0	0	0	0	0	0
Wagga Wagga	0	30 376	0	0	0	0	0	0
Total	**0**	**39 708**	**1 037**	**3 096**	**-44 226**	**-64 480**	**-5 115**	**95**

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

3.13 L4A change in area of building footprint impacted, by Meshblock

Meshblock type	PMF_B	500Y_B	200Y_B	100Y_B	50Y_B	20Y_B	10Y_B	5Y_B
	sqm	sqm	sqm	sqm	sqm	Sqm	sqm	sqm
Residential	0	23 851	19	-621	-40 399	-52 683	-564	0
Commercial	0	6 831	0	0	64	0	0	0
Education	0	0	0	0	-2 759	-2 705	0	0
Hospital/Medical	0	0	0	0	0	0	0	0
Industrial	0	9 026	1 018	2 333	0	2,745	0	0
Parkland	0	0	0	0	0	0	0	0
Primary Production	0	0	0	1 384	-1 133	-11 837	-4 551	95
Other	0	0	0	0	0	0	0	0
Total	**0**	**39 708**	**1 037**	**3 096**	**-44 226**	**-64 480**	**-5 115**	**95**

Source: CIE summary based on WMA Water flood modelling, assuming no levee failure.

VHR and VHP options

These options do not change the *frequency* or *extent* of flood events but change the *consequence* of each event. The next section presents additional information on the reduction in risk (i.e. Annual Average Damage) associated with these options. The precise application of this policy could change. Therefore, we presented a number of scenarios to guide the assessment of this policy.

4 Economic Benefits

This chapter presents the economic benefits from the reduction in flood risks associated with each option. The calculations draw on the results from the flood modelling (presented in the previous chapter) and utilise the NSW Government's Flood Damage Assessment Tool. For the central case results we assume that:

- For residential properties, the 'largest building' on the lot is classified as the main residence, with other buildings on the site assumed to be of lesser value (such as sheds/garages). The largest building was based on the building footprint estimated from the building data in GIS format and structural/contents damage was calculated based on the depth of the flood. Dwellings on rural zoned land were treated as residential properties as well.
- For commercial/industrial properties, all buildings on the lot were treated equally and structural/contents damage was calculated based on the depth of the flood.

Benefits from risk reduction

The primary benefit of the levee upgrade options comes through the reduction in expected flood damages over the evaluation period of 50 years. The majority of damage is incurred by residential and commercial properties. These damages are split into four components:

- Structural damage to the building
- Internal damage, primarily damage to contents
- External damage, including damage to roads
- Intangible damage, which includes:
  - Injury and mortality, and
  - Mental health costs to residents and government.

Specific assumptions for the calculation of each of the four main damage types are presented in table 4.1. The assumptions are designed to be in line with the August 2023 *Flood Damage and Cost Benefit Assessment Tool* which was developed by the NSW Government to assess flood risk mitigation measures consistent with Flood Risk Management Measures Guide MM01.[18]

18 https://www.environment.nsw.gov.au/topics/water/floodplains/floodplain-guidelines

4.1 Calculation assumptions

Assumptions	Central case
Which buildings are included	Damages are measured for the largest building on each residential property, based on flood height. It is assumed that any damage done to other buildings on a property are included in the external damages. For commercial/industrial properties, full damages are calculated for each building. Note there are some cases which have been identified of multi-unit residential properties. In these cases, all buildings have been treated as if they were the largest.
Structural damage	Damage is drawn from stage damage curves for each building type and size combination. See Appendix B for these curves. Where the largest building is under 50 square metres, structural damage is given by the damage from a 'small' building, scaled down linearly according to size.
Internal damage	Calculated the same way as structural damage. The stage damage curve for commercial buildings is always zero, so these incur no internal damage.
External damage	A single external damage figure of $17,000 applies to each property, irrespective of the number of buildings on the lot.
Intangible damage	Injuries and fatalities are only included for the largest building on each property, calculated primarily using flood depth and velocity. Other intangibles are scaled with size for buildings under 50 square metres. This category does not apply to commercial/industrial properties.
Other parameters	Drawn from Flood Risk Management Guide MM01 (DPE, 2022) and ABS. For details see Appendix B.

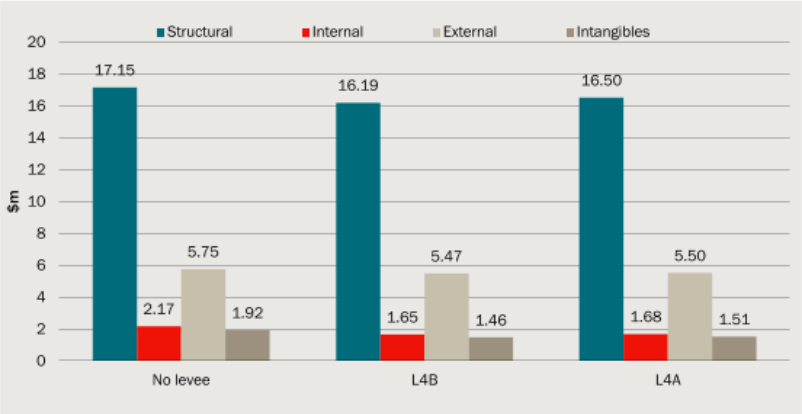
Source: The CIE.

Risk reduction - Options L4B and L4A

Chart 4.2 shows the reduction in AAD achieved by the levee upgrade with and without the surrounding works, split by damage type.

- On average the North Wagga Levee system on its own (i.e. option L4A) reduces AAD by $1.8m ever year in the central case, resulting in total risk reduction of $26.4m in present value terms over the 30 year period.
- Including the surrounding works reduce AAD by a further $0.5m, increasing total risk reduction to $34.6m.

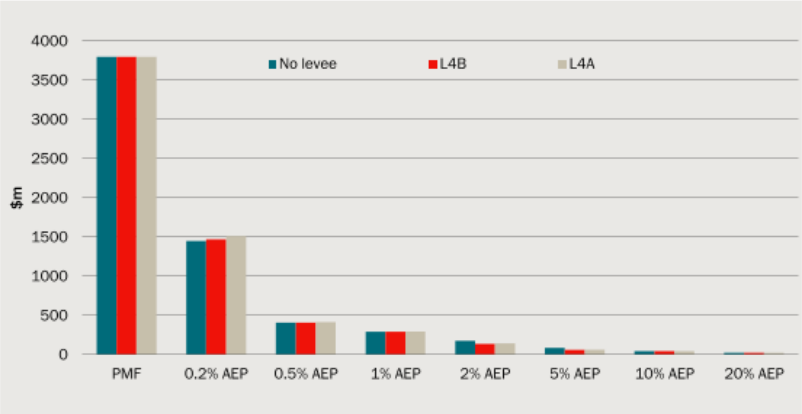
4.2 Impact of the L4B on annual average damage for a single year



Data source: The CIE.

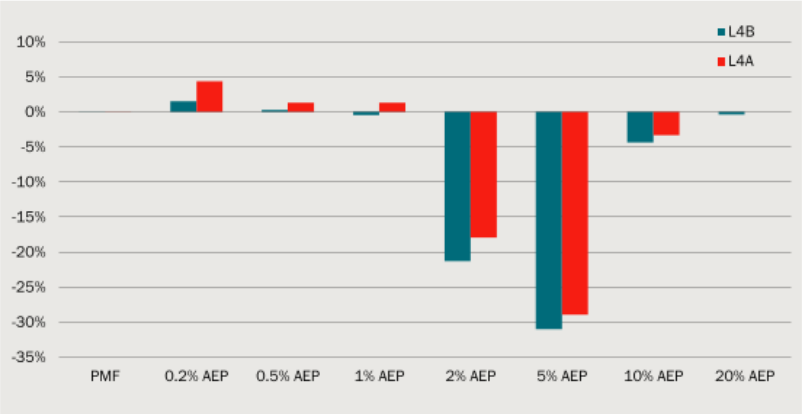
Breaking this damage down into contributions from each flood event, we can see that the benefits of the levee options are mostly achieved in the AEP 2% and the AEP 5% events. Chart 4.3 shows the level of damage in each flood event, and chart 5.4 shows the percentage change.

4.3 Total damage by AEP



Data source: The CIE.

4.4 Percentage change in damage in L4A and L4B relative to the base case



Data source: The CIE.

Table 4.5 shows the breakdown of damage in each AEP into damages from residential buildings, commercial buildings, and other damage types.

4.5 Detailed damage breakdown of L4A and L4B

	PMF	0.2% AEP	0.5% AEP	1% AEP	2% AEP	5% AEP	10% AEP	20% AEP
	$m	$m	$m	$m	$m	$m	$m	$m
No levee								
Residential	1557.6	484.1	108.8	87.3	66.1	32.4	6.5	0.9
Commercial	1989.8	864.8	238.2	148.7	62.4	17.3	11.7	6.9
Public	125.2	35.4	25.3	21.8	17.2	11.8	8.7	5.8
Injuries and fatalities	380.7	32.5	14.2	8.3	4.1	0.8	0.1	0.0
Mental health	57.1	24.9	5.6	4.7	3.7	1.6	0.3	0.0
Road repair	46.2	38.5	29.5	28.2	26.5	21.8	17.0	10.1
L4A								
Residential	1557.7	504.7	108.1	86.6	34.2	10.7	5.2	0.9
Commercial	1990.1	905.8	244.0	153.2	66.5	17.7	11.7	6.9
Public	125.2	35.8	25.4	21.7	15.0	11.1	8.7	5.8
Injuries and fatalities	380.8	35.1	13.7	8.1	1.9	0.6	0.1	0.0
Mental health	57.1	26.0	5.5	4.7	1.7	0.5	0.3	0.0
Road repair	46.3	38.8	29.6	28.3	26.6	20.4	16.9	10.1
L4B								
Residential	1557.7	490.4	108.0	84.7	33.0	10.4	5.1	0.9

	PMF	0.2% AEP	0.5% AEP	1% AEP	2% AEP	5% AEP	10% AEP	20% AEP
Commercial	1990.0	879.7	240.1	150.1	62.9	16.4	11.3	6.9
Public	125.2	35.6	25.3	21.7	15.0	11.1	8.7	5.8
Injuries and fatalities	380.8	33.0	13.8	6.7	1.9	0.5	0.1	0.0
Mental health	57.1	25.3	5.5	4.6	1.6	0.5	0.3	0.0
Road repair	46.2	38.6	29.5	28.2	25.7	20.2	16.9	10.1

Note: There is some overlap between these categories. Residential damages include injuries, fatalities, and mental health.
Source: The CIE.

Risk reduction – VHR in North Wagga Wagga

Voluntary House Raising aims to reduce the damage to property in the flood plain area and reduce the risk to life of residents and potential rescuers. Residents would still have to evacuate as they do now.

There is a range of eligibility criteria for the VHR scheme. This includes, for example:

- Funding is only available for properties with buildings that were approved and constructed prior to 1986.
- Properties which are benefiting substantially from other floodplain mitigation measures –such as houses already protected by a levee or those that will be –may not be funded for VHR.
- VHR should generally return a positive net benefit in damage reduction relative to its cost. Consideration may be given to lower benefit-cost ratios where there are substantial social and community benefits or VHR is compensatory work for the adverse impacts of other mitigation works.
- Some houses may be unsuitable for raising due to construction methods.

For the purposes of the report we have modelled the VHR to apply to all targeted residential properties, noting that around 44 homes in North Wagga Wagga have already been raised. A further 59 homes have been identified as not being feasible to raise.

We have also assumed that the house will be raised 3m above the ground level for that property.

Raising houses will reduce structural, contents and intangible damages for a flood of the same size. Chart 4.6 shows the distribution of reduction in risk (i.e. AAD) per property in North Wagga Wagga before and after raising dwellings to 3m above ground level.[19]

19 Note that only the largest building on each property was modelled as being raised to 3m off the ground. This does not apply to smaller buildings such as multiple sheds on the property.

4.6 Distribution of building AAD in North Wagga Wagga

Data source: The CIE

In total, there were 165 residential buildings raised in this analysis, with an average reduction in AAD by $12,154 per year for each raised building. However, there is a substantial level of variation across all the buildings of North Wagga Wagga, as indicated in the chart above.

Risk reduction – VHP in North Wagga Wagga

Voluntary House Purchase aims to reduce the number of people living in flood area and reduce the risk to life of residents and potential rescuers. The NSW Government has provided some further information about the scheme, particularly in relation to the February/March 2022 flooding in the Northern Rivers region. The factsheet for the Home Buyback Scheme states that,

> Homes being prioritised for a Home Buyback are in areas with more frequent, high and fast floods. There is a severe risk of future flood damage and a high risk to life in these areas. This includes the greatest risk to life to both residents and emergency response agencies sent to rescue them.[20]

Under the Scheme, a selection of the highest risk properties will be identified as potential candidates for further the buyback scheme. The buyback price is the market value of the property immediately prior to any flooding (i.e. pre-damage price).

For the purpose of this report, we have assumed that the policy applies to all residential properties in North Wagga Wagga. The purchase is assumed to occur immediately, rather than a delayed or staggered approach. Therefore, this would immediately eliminate the risks in North Wagga Wagga from current levels. The benefits (in terms of risk reduction) are equal to $50.5m in present value terms.

20 https://www.nsw.gov.au/sites/default/files/2023-05/NRRC-Home-Buyback-Fact-Sheet-and-FAQs-May-2023.pdf

Risk reduction – combined options

For this study we have conducted further analysis of two alternative combined options. Note that the risks for each property changes following the levee construction. This changes the number of properties where it is cost effective to apply the VHP and VHR.

VHR and VHP

For this option we assume that the levee is not constructed. Instead, there is a combination of house raising and purchase which could apply in North Wagga Wagga, and to a limited extend other suburbs in the flood area.

- the house purchase option is applied to only those residential properties where the risks (AADs) currently exceed the proposed purchase price (assumed to be $400,000).
- the house raising option is then applied to the next group of properties where the risks are between $120,000 to $400,000.

This is likely to be the most economically feasible approach, if Council is seeking to provide a house purchase option for some owners which would eliminate the risks for these properties, including any risk to life.

4.7 Reduction in risk from combination of raising and purchasing

Region	Base Case AAD	Houses raised	Houses purchased	Project Case AAD	Risk reduction
	$m	no.	no.	$m	$m
North Wagga Wagga	57.2	78	19	27.6	29.6
All other suburbs	244.9	37	7	232.6	12.3
Total	302.1	115	26	260.2	41.9

Source: The CIE.

Combined VHR VHP and levee

For this option, the levee is constructed, and optionally the surrounding works. This provides protection for the North Wagga Wagga residents but it may increase the risk to properties outside North Wagga Wagga. The VHR and VHP options would then apply to residents *outside* North Wagga Wagga. We then assess the updated risks for properties outside North Wagga Wagga and apply the same $400,000 and $120,000 threshold rules noted above.

4.8 Reduction in risk from combination of levee, VHP and VHR

Chosen levee option	Base Case AAD	Houses raised	Houses purchased	Project Case AAD	Risk reduction
	$m	No.	No.	$m	$m
L4A	302.1	37	7	263.3	38.8
L4B	302.1	38	6	255.5	46.7

Note: Base case AADs are drawn from across the entire Wagga Wagga region, rather than just North Wagga Wagga.

5 Economic Costs

This chapter presents the economic costs associated with the options. The focus in this chapter is on the capital and ongoing operating costs with the options. There are also likely be some costs associated with loss of biodiversity due to clearing needed at Wilks Park for option L4B.[21] These additional biodiversity costs have not been accounted for in the costs below and will increase the costs further. Given this the costs below are likely to be an underestimate of the costs for L4B.

Voluntary house raising option – North Wagga Wagga

The cost of the house raising depends on a range of factors such as the types of homes and the height above ground level to which the property is raised. For the purpose of our analysis the Council has advised a construction cost of **$120,000 per property**, based on the recent experience in the Lismore flooding. The cost of $120,000 does not include any costs of improving the accessibility of the property (e.g. ramps). Therefore, the costs would be higher if residents required to improve access. Assuming that 165 homes are raised this equates to **$19.8m**.

We have assumed that this can raise the existing property by around 3m above ground level, although alternative raising levels are considered in the sensitivity analysis section later in this report.

Voluntary house purchase – North Wagga Wagga

For this option we have assumed that it would apply to all residential properties in North Wagga Wagga. Council has advised that, on average, the cost would be **$400,000/property**. This estimate aligns with the average property price estimate of $401,158/property based on publicly available data from the NSW Land Valuer General which indicates that there have been 19 residential property transactions in North Wagga Wagga in the calendar years 2022 and 2023.[22] Assuming that 266 homes are purchased equates to **$106m**.

There would also be additional costs if these homes are required to be demolished and, for example, turned into public land.

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21 See separate report by NGH Consulting (2023), *Assessment of Environmental Constraints, North Wagga Flood Mitigation Options*, February.

22 https://valuation.property.nsw.gov.au/embed/propertySalesInformation

Option L4B and L4A

The option L4B is the high cost option and involves the construction of:

- A raised embankment
- Proposed road to adjoin existing abutment of Wiradjuri Bridge
- Proposed Bridge No.1 of 75m
- Proposed Bridge No.1 of 200m
- A 2.5m pathway adjacent to the proposed road.
- Concrete path to connect to the existing ATP network.

The estimated cost of the project (L4B) is **$86m (in present value terms)** including both the upfront capital costs and ongoing maintenance costs. These costs do not include the biodiversity offset costs associated with any land clearing required.

Upgrading the North Wagga Levee systems on their own (L4A) costs approximately **$10m.**

The detailed assumptions underpinning the cost estimates are available in a separate document from Council.

Combined options

As noted earlier, there are three separate options:

- The VHR and VHP options combined. This is applied to properties both in North Wagga Wagga and to properties in other flood impacted suburbs. It only applies to high risk properties where the estimated benefit exceeds the costs. The cost of this option is **$24.2m**, assuming that 115 houses are raised and 26 houses purchased.
- The L4A levee option, with the VHR and VHP options to high risk properties outside North Wagga Wagga. The lack of surrounding works means slightly more floodwater is deviated into surrounding suburbs, but only enough to justify the purchase of one additional property. A total of 37 houses are assumed to be raised and 7 purchased, with a combined cost of **$17.5m.**[23]
- The L4B levee option, with the VHR and VHP options combined. The L4B levee provides protection for properties in North Wagga Wagga. The VHR and VHP options would apply to properties outside this protection, and only applies to high risk properties where the estimated benefit exceeds the costs. The cost of this option is **$93.0m**, assuming that 38 houses are raised and 6 houses purchased.

Note that the number of properties raised and purchased in these options are also influenced by the discount rate chosen. Under the lower discount rate, this increases the value of the AAD reduction, therefore, there are more homes that exceed the $120,000 and $400,000 thresholds.

23 We assume that the North Wagga Levee system is upgraded first and then we calculate the resulting AADs for the properties outside of North Wagga Wagga.

6 *Cost benefit analysis results*

Table 6.1 shows a summary of the overall costs and benefits of each option and combination of options modelled to date.

- **The best options are L4A, and a combination of L4A with VHR and VHP applied to high risk properties outside North Wagga Wagga.**

The high cost of L4B prevents it from being a worthwhile investment, even though it does achieve noticeable gains on top of L4A.

The majority of properties are not at sufficiently high risk to justify their purchase or raising, meaning that an optimal solution (from a cost effectiveness perspective) must target the highest risk properties for inclusion in VHP or VHR.

6.1 Summary of results

Option	Total benefit	Total cost	Net benefit	BCR
	$m	$m	$m	
L4A	26.4	10.3	**16.1**	**2.57**
L4B	34.6	86.0	**-51.4**	**0.40**
VHR	29.4	19.8	**9.6**	**1.48**
VHP	50.5	106.4	**-55.9**	**0.47**
L4A + VHR + VHP	38.8	17.5	**21.3**	**2.21**
L4B + VHR + VHP	46.7	93.0	**-46.3**	**0.50**
VHR + VHP	41.9	24.2	**17.7**	**1.73**

Source: The CIE.

VHR in North Wagga Wagga

A large number of residential properties in North Wagga Wagga are impacted by the floods, meaning that for many of them it is worthwhile to spend the $120,000 to raise the building by 3 metres. Table 6.2 shows the overall results from raising all homes which can be raised in North Wagga.

Overall, the option to raise every residential building in North Wagga results in benefits which exceed costs by **$9.6m**, with a benefit-cost ratio of **1.5**.

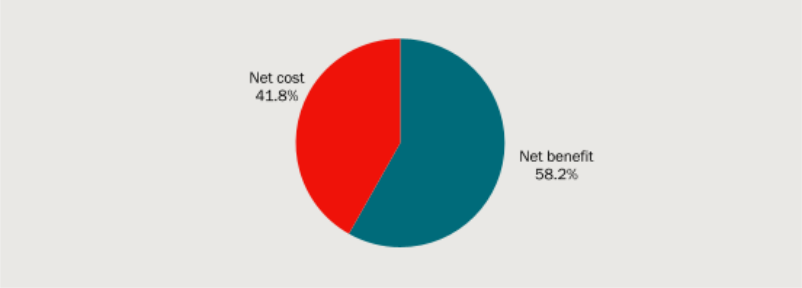
6.2 CBA results for voluntary house raising

Discount Rate (p.a.)	Project Cost	Base Case AAD	Project Case AAD	Total Benefit	Net Benefit	BCR
	$m	$m	$m	$m	$m	
0.03	19.8	74.4	36.2	38.2	18.4	1.9
0.05	**19.8**	**57.2**	**27.9**	**29.4**	**9.6**	**1.5**
0.07	19.8	45.3	22.1	23.3	3.5	1.2

Source: The CIE.

However, not every building sustains enough damage on average on floods for the investment to be worthwhile. Chart 6.3 shows that the proportion of buildings for which house raising constitutes a net economic benefit is slightly over half. If the program were restricted to only those buildings with expected damage over 30 years greater than $120,000, the net benefit would increase to $14m.

6.3 Proportion of raised building which receive net benefits from VHR scheme



Note: This only includes the buildings in North Wagga Wagga which can be raised and have not already been raised.
Data source: The CIE.

VHP in North Wagga Wagga

Unlike the house raising option, most residential properties in North Wagga on average do not sustain enough damage over 30 years to make the $400,000 purchase economical. Table 6.4 shows the impact of purchasing every residential property in the suburb.

For each building purchased, the entire stream of AAD is avoided. However, this does not entirely eliminate damage in the area, as there are still non-residential properties that would be damaged.

Comparing to the outcome of house raising in table 7.2, we can see that the house purchasing option delivers an additional $21.1m in benefits. The costs increase by $280,000 per property for the 266 properties purchased, overshadowing the marginal additional reduction in AAD.

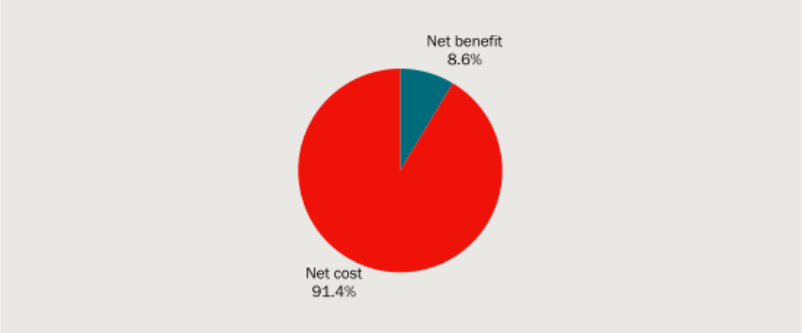
6.4 CBA results for voluntary house purchase

Discount Rate (p.a.)	Project Cost	Base Case AAD	Project Case AAD	Total Benefit	Net Benefit	BCR
	$m	$m	$m	$m	$m	
0.03	106.4	74.4	8.7	62.9	-43.5	0.59
0.05	**106.4**	**57.2**	**6.7**	**50.5**	**-55.9**	**0.47**
0.07	106.4	45.3	5.3	39.2	-67.2	0.37

Source: The CIE.

The maximum potential gains from the VHP option would be realised by only purchasing the houses where expected damage exceeds the purchase price of $400,000. There are only 19 such buildings across North Wagga Wagga. Purchasing only these properties would lead to a net gain of $10.8m.

6.5 Proportion of properties which receive net benefits from VHP scheme



Data source: The CIE.

Option L4B

The cost of building the raised embankment and all other components of the L4B option outweighs the benefits from the risk reduction. This option only substantially impacts floods in the 5 per cent and 2 per cent AEPs, with larger floods being unaffected. Table 6.6 shows the net benefit every year of the examination period of 30 years.

Table 6.7 shows the main CBA results for this option. The L4B option generates a **net loss** of $51.4m, with a corresponding BCR below 1. Table 7.7 shows that the levee does not have a positive return even if we (very generously) assume every building incurs the same level of structural and internal damage.

6.6 Cost and benefits of L4B over time

Year	Project Cost	Base Case AAD	Project Case AAD	Residual Value	Total Benefit	Net Benefit
	$	$	$	$	$	$
2023	85 467 682	0	0	0	0	-85 467 682
2024	0	0	0	0	0	0
2025-2053	35 000	26 686 233	24 770 512	0	2 215 721	2 180 721
2054	35 000	26 686 233	24 770 512	9 689 255	11 904 976	11 869 976

Source: The CIE using NSW Treasury Flood Damage and Cost Benefit Assessment Tool.

6.7 CBA results of L4B

Discount Rate (p.a.)	Project Cost	Base Case AAD	Project Case AAD	Residual Value	Total Benefit	Net Benefit	BCR
	$m	$m	$m	$m	$m	$m	
0.03	86.2	513.5	471.4	3.9	46.0	-40.1	0.53
0.05	**86.0**	**395.1**	**362.7**	**2.1**	**34.6**	**-51.4**	**0.40**
0.07	85.9	313.0	287.3	1.2	26.9	-59.0	0.31

Source: The CIE using NSW Treasury Flood Damage and Cost Benefit Assessment Tool.

Option L4A

Removing the additional works around the levee (road improvements, bridges, etc) drastically reduces the cost of the project. The corresponding drop in benefits is small relative to the size of this change in cost.

Yearly total benefits fell from $2.2m to $1.8m (tables 6.6 and 6.8 respectively), with total cost falling from $86m to $10m. This results in a final net benefit of **$16.1m**, and a BCR of **2.57**.

6.8 Costs and benefits of L4A over time

Year	Project Cost	Base Case AAD	Project Case AAD	Residual Value	Total Benefit	Net Benefit
	$	$	$	$	$	$
2023	10 000 000	0	0	0	0	-10 000 000
2024	0	0	0	0	0	0
2025-2053	20 000	26 986 233	25 197 254	0	1 788 979	1 768 979
2054	20 000	26 686 233	25 197 254	1 133 675	2 922 654	2 902 654

Source: The CIE using NSW Treasury Flood Damage and Cost Benefit Assessment Tool.

6.9 CBA results of L4A

Year	Project Cost	Base Case AAD	Project Case AAD	Residual Value	Total Benefit	Net Benefit
	$	$	$	$	$	$
2023	10 000 000	0	0	0	0	-10 000 000
2024	0	0	0	0	0	0
2025-2053	20 000	26 986 233	25 197 254	0	1 788 979	1 768 979
2054	20 000	26 686 233	25 197 254	1 133 675	2 922 654	2 902 654

Source: The CIE using NSW Treasury Flood Damage and Cost Benefit Assessment Tool.

Combined options

The combined options target properties that are high-risk, with raising or purchasing only being undertaken when it would result in a positive return. Consequently, by design, these options perform better than the blanket approach modelled in the individual risk mitigation strategies.

Table 6.10 shows the outcome of purchasing and raising at-risk properties across all of Wagga Wagga. The net benefit of $17.7m is the highest out of any option, with a BCR above 1.7.[24]

6.10 CBA results of combined targeted VHR and VHP options

Discount Rate (p.a.)	Project Cost	Base Case AAD	Project Case AAD	Total Benefit	Net Benefit	BCR
	$m	$m	$m	$m	$m	
0.03	37.7	392.7	328.9	63.9	26.2	1.69
0.05	**24.2**	**302.1**	**260.2**	**41.9**	**17.7**	**1.73**
0.07	18.9	239.3	209.7	29.7	10.8	1.57

Source: The CIE using NSW Treasury Flood Damage and Cost Benefit Assessment Tool.

This is a better result than using the levee L4B option to protect North Wagga Wagga and purchasing or raising properties in other parts of the township. Table 6.11 shows that the cost of this option remains prohibitively high, generating a **net cost** of $46.3m. Note that this is an improvement over L4B on its own, which had a net cost of $51.4m.

6.11 CBA results of combined L4B and VHR and HP outside North Wagga Wagga

Discount Rate (p.a.)	Project Cost	Base Case AAD	Project Case AAD	Total Benefit	Net Benefit	BCR
	$m	$m	$m	$m	$m	
0.03	97.6	392.7	346.4	46.3	-51.2	0.47
0.05	**93.0**	**302.1**	**255.5**	**46.7**	**-46.3**	**0.50**

[24] Note that this BCR is smaller than that of L4A, even though VHR and VHP combined have a higher net benefit. This is because the cost is greater for VHR and VHP than for L4A.

Discount Rate (p.a.)	Project Cost	Base Case AAD	Project Case AAD	Total Benefit	Net Benefit	BCR
	$m	$m	$m	$m	$m	
0.07	90.3	239.3	216.9	22.5	-67.8	0.25

Source: The CIE using NSW Treasury Flood Damage and Cost Benefit Assessment Tool.

Finally, supplementing the already worthwhile L4A option with judicious use of VHR and VHP outside North Wagga Wagga results in the best net benefit out of the options modelled, at **$21.3m**. Table 6.12 shows the CBA results for this option.

6.12 CBA results of combined L4A and VHR and VHP outside North Wagga Wagga

Discount Rate (p.a.)	Project Cost	Base Case AAD	Project Case AAD	Total Benefit	Net Benefit	BCR
	$m	$m	$m	$m	$m	
0.03	22.1	392.7	355.8	37.0	14.9	1.68
0.05	**17.5**	**302.1**	**263.3**	**38.8**	**21.3**	**2.21**
0.07	15.0	239.3	221.5	17.9	2.8	1.19

Source: The CIE using NSW Treasury Flood Damage and Cost Benefit Assessment Tool.

A Flood probability terminology

Annual exceedance probability (AEP) should be used to assess the likelihood of a disaster occurring. AEP estimates the probability of a particular type of disaster, equal to or larger than a given magnitude, occurring in any year. The table below presents the AEP flood events modelled and their common equivalent presentation in 1 in X years.

A.1 Flood probabilities modelled

AEP	AEP
%	1 in X years
20	5
10	10
5	20
2	50
1	100
0.5	200
0.2	500
PMF	PMF

Source: WMA Water.

There are also alternative ways of expressing these probabilities which are a discussed further by Geosciences Australia.[25]

Average annual damage (AAD) estimates the expected yearly damage cost arising from all occurrences of a given natural hazard. AAD streamlines the calculation of expected damage and enables a like-for-like comparison between different risk mitigation options.

The expected AAD of any given year is the integration of the natural hazard risk density curve over all probabilities. Denoted by *D(p)*, the damage which occurs at the event with probability p, in the catchment with area A. The concept of AAD can be applied to all types of disasters.

$$AAD = \iint_{A\,p} D(p)dpdA$$

The NSW Government's *Disaster Cost-Benefit Framework TPG23-17* (section 3.5.2) issued in August 2023 presents an example of this calculation.

25 https://arr.ga.gov.au/__data/assets/pdf_file/0006/40398/New-ARR-Probability-Terminology_final.pdf

B CBA Tool Assumptions

This section discusses the key parameter values required to be used in the NSW Government's Flood Damage Assessment Tool and the assumptions adopted for this study.[26]

B.1 Residential

Type: Example	Description and potential quantification approach	Default Parameters used within the Flood CBA Tool
Direct Tangible: Avoided residential property and content damages (structural, internal and external)	Avoided property damage costs due to external and internal flooding. Data is needed on the ground and floor level of each property for accurate measurement as internal flooding causes most damage. Stage-Damage Curves calculate the amount of damage that is incurred for a property, using inputs such as land use type, building types, and flood characteristics such as depth and velocity	Property sizes (floor area, per m2): ▪ Detached dwelling (single and double storey): 90 (small), 180 (medium), 240 (large), 220 (default) ▪ Unit or apartment: 100 ▪ Townhouse: 160 Structural replacement value (per m2): ▪ Detached dwelling (single storey): $2,280 ▪ Detached dwelling (double storey): $2,620 ▪ Unit: $2,730 ▪ Townhouse: $2,620 Contents value for residential properties (per m2): $550. External damage for residential properties (if ground flood depth exceeds 0.3 metres): $17,000 Damage downscale for units and townhouses: 30% Section 1.2.2 of Technical Note: Flood CBA Tool provides residential damage curve default values.

Source: NSW Treasury Flood Damage and Cost Benefit Assessment Tool

26 https://flooddata.ses.nsw.gov.au/flood-projects/nsw-flood-damage-assessment-tool-dt01

B.2 Direct Tangible damages

Type: Example	Description and potential quantification approach	Default Parameters used within the Flood CBA Tool
Direct Tangible: Avoided **RESIDENTIAL** property and content damages (structural, internal and external)	Avoided property damage costs due to external and internal flooding. Data is needed on the ground and floor level of each property for accurate measurement as internal flooding causes most damage. Stage-Damage Curves calculate the amount of damage that is incurred for a property, using inputs such as land use type, building types, and flood characteristics such as depth and velocity	Property sizes (floor area, per m2): ▪ Detached dwelling (single and double storey): 90 (small), 180 (medium), 240 (large), 220 (default) ▪ Unit or apartment: 100 ▪ Townhouse: 160 Structural replacement value (per m2): ▪ Detached dwelling (single storey): $2,280 ▪ Detached dwelling (double storey): $2,620 ▪ Unit: $2,730 ▪ Townhouse: $2,620 Contents value for residential properties (per m2): $550. External damage for residential properties (if ground flood depth exceeds 0.3 metres): $17,000 Damage downscale for units and townhouses: 30% Section 1.2.2 of Technical Note: Flood CBA Tool provides residential damage curve default values.
Direct Tangible: Avoided **Commercial and Industrial** property and content damages	Commercial property damage depends on use. For instance, an electronics retailer would be expected to incur higher damages than a grocer. MM01 provides a practical approach categorising commercial property damage based on commercial use. The stage damage curve for commercial property is based on the square metreage of each property, which can be sourced from the local council. Data on the ground and floor levels of each property is also needed to determine when flooding overtops the external and internal components of the structure.	Property sizes (floor area, per m2), non-residential buildings: ▪ Average (default): 418 ▪ Low-to-medium value: 186 ▪ Medium-to-high value: 650 ▪ School: 17,000 ▪ Hospital: 28,000 ▪ Other public (government) buildings: 2,200 Section 1.2.3 of Technical Note: Flood CBA Tool provides commercial damage curve default values.
Direct Tangible: Avoided public infrastructure property and content damages	Public assets and infrastructure include high value assets such as bridges, roads, railways, and utility infrastructure (e.g. sewerage system, transmission lines and underground cabling).	Infrastructure damage uplift of total residential damage: 10% (drops to 5% if road damage is considered). External damage, road repair cost (per m2): $5.65. Section 1.2.4 of Technical Note: Flood CBA Tool provides public buildings stage-damage curve default values.

Type: Example	Description and potential quantification approach	Default Parameters used within the Flood CBA Tool
	Valuing infrastructure damage can be challenging. One approach is to apply an uplift to residential damages. Practitioners may also estimate the total replacement value of the asset and account for the AEP level at which the asset is inundated. Assets may fall into multiple AEP levels depending on the scale and nature of the asset, as well as the land that it encompasses. Additional detail may be needed to apportion asset replacement values across each AEP level. Geoscience Australia has developed the National Exposure Information System (NEXIS) dataset to capture exposure information for physical infrastructure assets and populations. Future improvements to the dataset will aim to provide replacement values for infrastructure assets at the local government level (Geoscience Australia, 2022).	
Direct Tangible: Avoided transport damage (roads, railways, train stations, bridges)	Transport infrastructure is vulnerable to flood damage, particularly when inundated for prolonged periods (Bureau of Transport Economics, 2001). Direct impacts include the cost of reconstruction and removing debris (The World Bank, 2016) as well as damage to the underlying structures (Tao & Mallick, 2020). Semi-rural and rural roads tend to be less resilient to flood damage, as they typically use more cost-effective materials.	External damage, road repair cost (per m2): $5.65.
Direct Tangible: Avoided vehicle damages	Flood water can compromise a vehicle's structural and electrical integrity leading to them being written off. Both commercial and private use vehicles should be considered.	Section 1.2.4 of Technical Note: Flood CBA Tool provides further guidance.
Direct Tangible: Avoided agricultural losses (crops and livestock)	Loss of crops and livestock will depend on the type of crop and the nature and duration of the flooding event. The season can also be relevant, as a crop has a higher value prior to harvest than when just planted. Under extended conditions of inundation, fungal and bacterial pathogens can further impact the crop, including through soil borne diseases.	May be included as a bespoke element.

Type: Example	Description and potential quantification approach	Default Parameters used within the Flood CBA Tool
Direct Tangible: Avoided emergency services costs	An agricultural profile of the study area is required. The Australian Exposure Information Platform provides a summary of agriculture commodities by region.	Agriculture commodity (expected annual output per ha, per year):
Direct Tangible: Avoided clean-up costs	Clean-up costs relate to the time (opportunity cost of labour) and materials involved in cleaning up a property (residential or commercial). Estimated costs should reflect the extent of expected damage (e.g. ground floor flooding only).	Residential clean-up if affect by over-floor flooding (per property): $4,500. Non-residential clean-up cost and loss of trading: 30% of direct damage.

Source: NSW Treasury Flood Damage and Cost Benefit Assessment Tool

B.3 Intangibles

Type: Example	Description and potential quantification approach	Default Parameters used within the Flood CBA Tool
Direct Intangible: Avoided mortality and injury	Floods have recorded one of the highest instances of fatalities, injuries and morbidities, among disasters in Australia (Commonwealth of Australia, 2020a).	Value of statistical life (Commonwealth Department of the Prime Minister and Cabinet, 2022) 2022 dollars:
Direct Intangible: Avoided environmental damages	Cost estimates should include the likely injury and loss of life. One method is the UK DEFRA Wallingford method, which estimates the potential reduction in risk to life associated with changes to flood behaviour (such as flood hazard: H1-H6). The method can be used to estimate losses across a study area but should not be used to estimate risk to life at the property scale.	
Indirect Tangible: Avoided business activity interruptions and loss of production	Lost production and forgone profit (difference between the price that a producer would have received and the marginal cost of production) due to business disruption. Lost production does not include damaged inputs or inventory, as these would have already been accounted for in commercial property and contents damage.	Non-residential indirect costs, comprising of clean-up costs and loss of trading: 30% of direct damages.
Indirect Tangible: Avoided service losses (damage to infrastructure and telecommunication networks)	Displacement should be considered as some lost production may be picked up by a non-flood affected business (e.g. revenue lost by a supermarket in a flood zone may be offset by increased revenue to another supermarket.	N/A
Indirect Tangible: Avoided accommodation and relocation costs	Some businesses may benefit, particularly if their goods or services are related to flood recovery.	Relocation cost (per week): $0

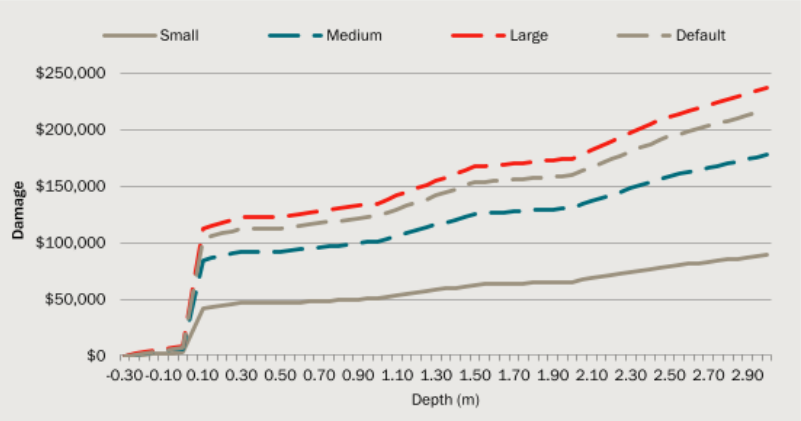
Type: Example	Description and potential quantification approach	Default Parameters used within the Flood CBA Tool
Indirect Intangible: Avoided stress, mental health and other health related impacts	Impacts may be estimated based on the cost of treatment, cost of work absenteeism and presenteeism and estimated increased prevalence due to floods. Longer displacements and higher levels of direct damage are associated with greater mental health impacts than brief displacements (Shih, 2022).	Mental health impacts based on food level, cost per household (2022 dollars):
Indirect Intangible: Avoided loss of social and cultural values	Further details are provided in Technical Note: Flood CBA Tool.	

Source: NSW Treasury Flood Damage and Cost Benefit Assessment Tool

Stage damage curves

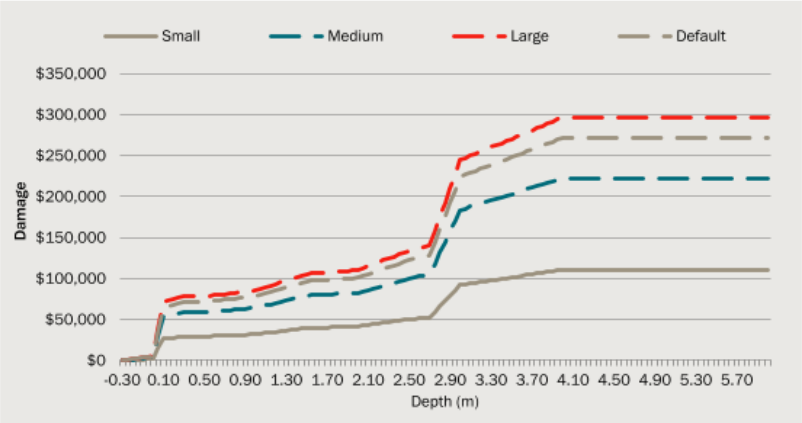
This section presents the stage damage curves used to determine residential and commercial structural and internal damages. Note that commercial internal damages are assumed to be zero everywhere, so that curve has been omitted.

B.4 Residential single story structural damage curve



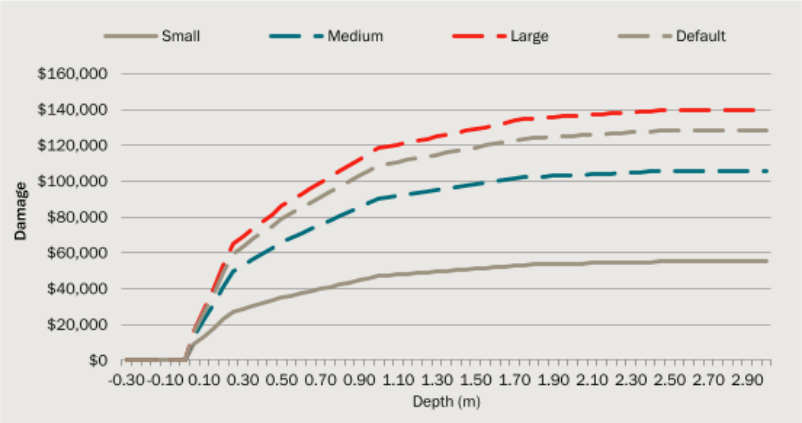
Data source: NSW Treasury Flood CBA Tool.

B.5 Residential double storey structural damage curve



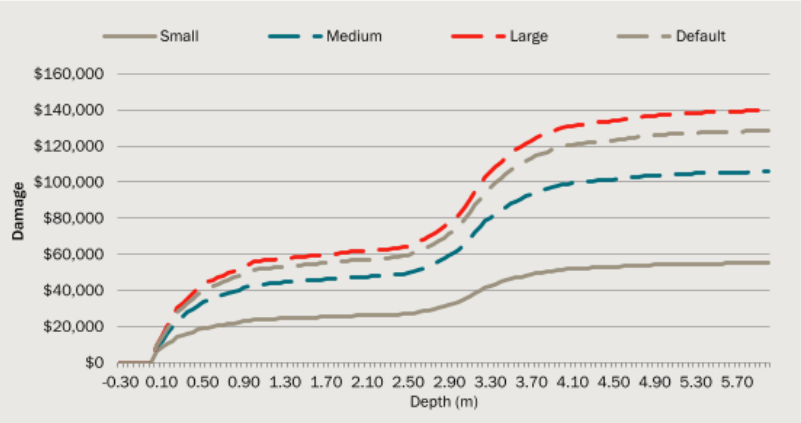
Data source: NSW Treasury Flood CBA Tool.

B.6 Residential single story internal damage curve



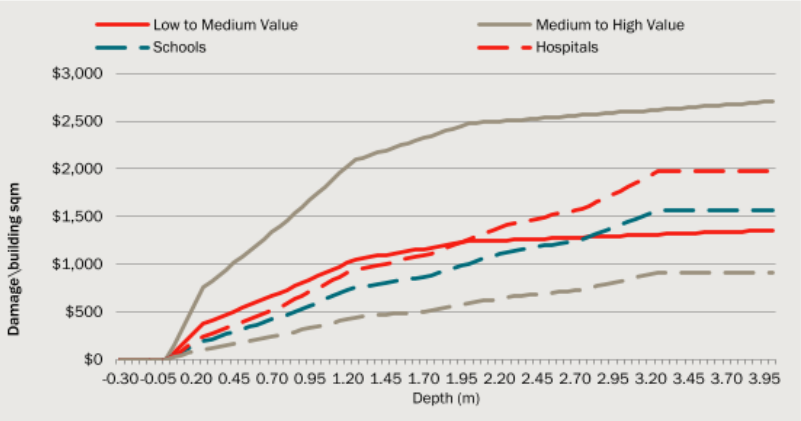
Data source: NSW Treasury Flood CBA Tool.

B.7 Residential double story internal damage curve



Data source: NSW Treasury Flood CBA Tool.

B.8 Commercial structural damage curve

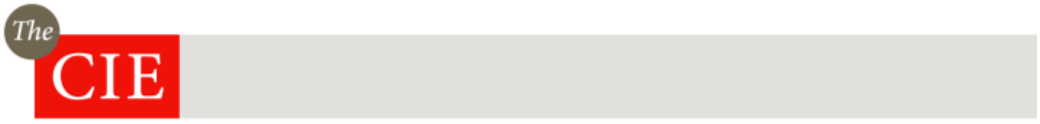


Note: Commercial structural damage is given on a per square metre basis, as opposed to residential stage damage curves, which sorts buildings into size classes.

Data source: NSW Treasury Flood CBA Tool.

B.9 Option L4B Works required

Source: Wagga Council



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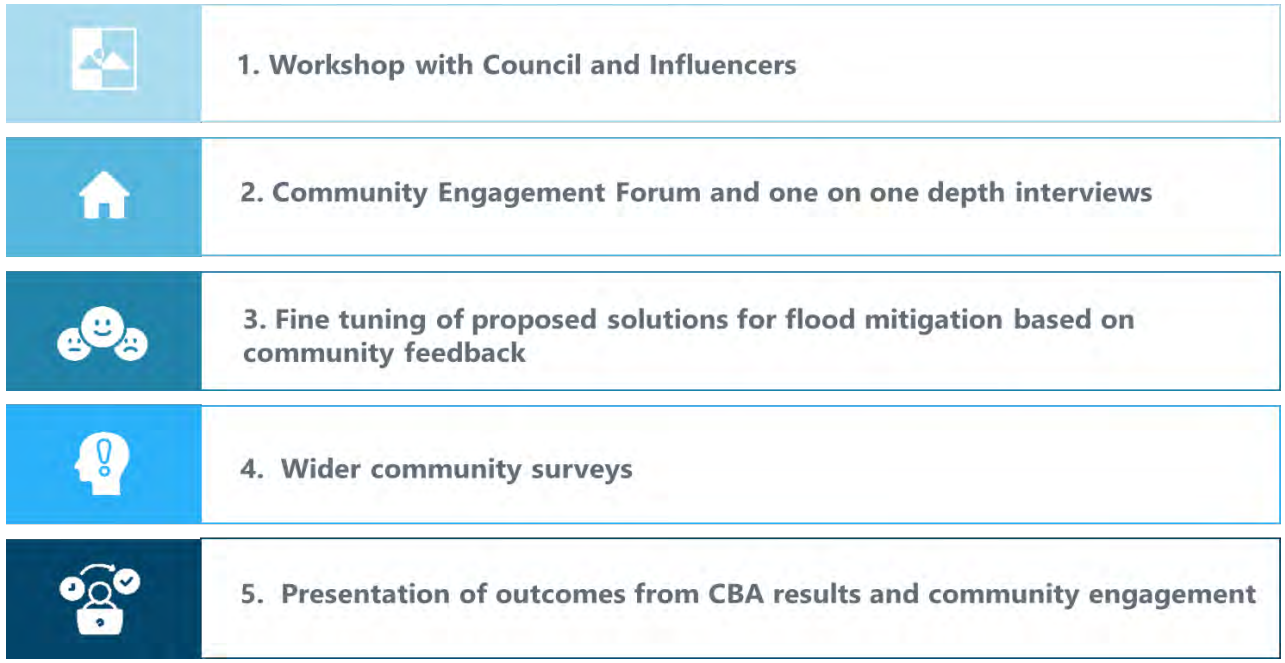
North Wagga Flood Risk Mitigation: **Community Engagement Surveys**

February 2024

An overview of the Community Engagement Program



This presentation details the feedback from the Community surveys.

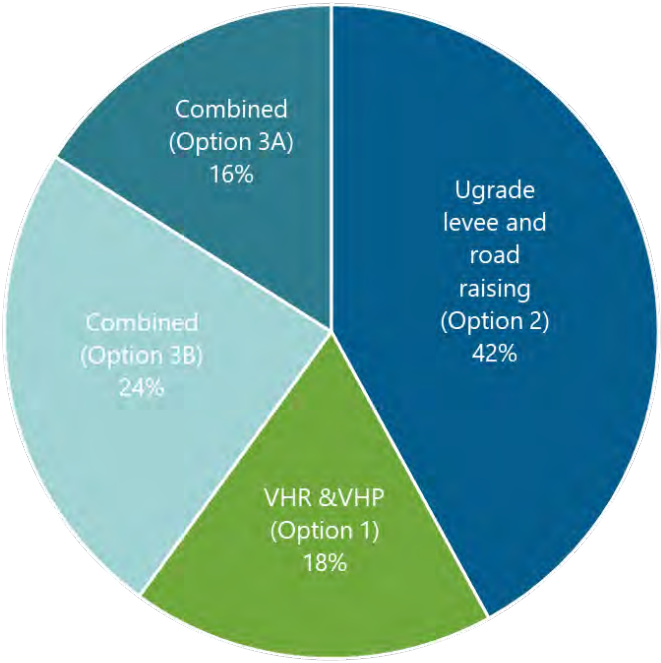
WOOLCOTT RESEARCH & ENGAGEMENT 2

Recap of findings from the Community Forum

Wagga Wagga City Council

WOOLCOTT RESEARCH & ENGAGEMENT

Conclusions from the forum



- Option 2, Upgrading the Levee and Road Raising was the most popular (21/50 participants), however this was mostly amongst North Wagga residents (19/50 participants).
- A similar number preferred a Combined Option (either 3A or 3B) – 20/50 participants.
- Therefore, an option that included the levee was selected by 41 of the 50 participants (82%).
- House Raising and Voluntary Purchase as a standalone solution, appeared to be the least preferred (9/50 participants).

Findings from the Community Survey

Wagga Wagga City Council

WOOLCOTT RESEARCH & ENGAGEMENT

Research Methodology

Two surveys were conducted from December 23- 31 January 24. The Open Survey closed on the 9th February.

- Representative Community Survey (Main Survey) n=401
- Open online survey via Council Website (Open Survey) n=245

- Residents for the Main Survey were sourced via a combination of random telephone interviews and through an online research only panel.

- All respondents were required to be owners of a home in Wagga Wagga LGA

- As an adjunct to the Main survey, the survey was posted on the Council website to allow residents who weren't contacted as part of the main study to have their say.

**Results have been weighted in analysis to be representative of the population in terms of location.

Who we spoke to

		Main survey %	Open Survey %
Gender	Male	47	47
	Female	53	51
	Other (non gender specific/prefer not to say)	0	2
Age	18-34	16	11
	35-49	18	31
	50-69	33	43
	70+	33	15
CALD	Speak a language other than English at home	3	1
ATSI	Identify as being Aboriginal and/or Torres Strait Islander	4	6

Unweighted Base: All Respondents – Main Survey (n=401), Open Survey (n=245)

Who we spoke to

Unweighted Base: All Main Survey Respondents (n=401) Open Survey (n=245)

Location	Main Survey %	Open Survey %
Wagga Urban		
Ashmont	6	5
Boorooma/Estella	6	5
Bourkelands/Tatton	6	4
Glenfield Park	8	4
Kooringal	10	4
Mount Austin	4	2
Tolland	5	2
Turvey Park	6	4
Wagga Central	10	5
Flood Impacted		
Forest Hill/Gumly/East Wagga	6	2
North Wagga/Bomen/Cartwrights Hill	5	46
South and Rural Wagga		
Rural West Wagga - Collongullie/Currawarna/ Galore/Gobbagombalin/ Uranquinty	9	6
Rural East Wagga - Humula/Ladysmith/Tarcutta/ Mangoplah/Oura	5	1
Lake Albert	10	6
Springvale/Lloyd	4	1

Voluntary House Purchase

Voluntary House Raising

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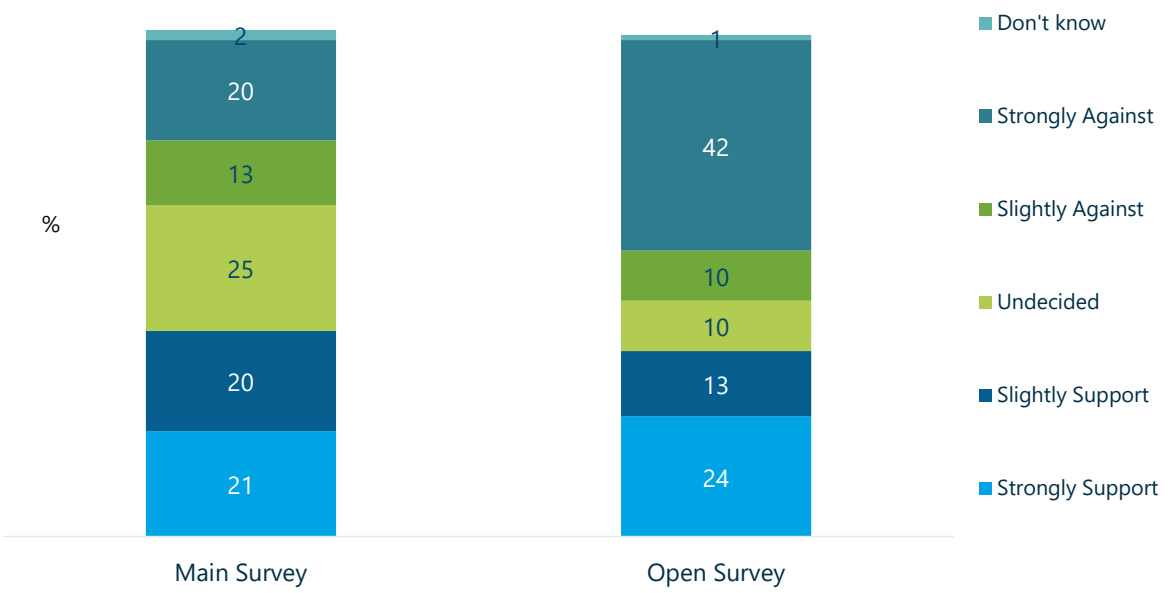
Degree of Support for Voluntary House Raising (VHR) and Voluntary House Purchase (VHP)

In the Main Survey strong support was high in Wagga Urban (23%) and significantly lower in the flood impact areas (5%); in the Open Survey flood impacted residents were significantly more likely to be slightly against (23%).

Assumptions:

- All homes within North Wagga that can be raised take up Voluntary House Raising (160 homes)
- The remainder take up Voluntary House Purchase (100 homes)
- Total estimated cost $60 million
- The cost will be higher depending on how many homes outside North Wagga are raised or purchased.



Q1. How supportive are you of Council implementing this option of Voluntary House Purchase and Voluntary House Raising?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

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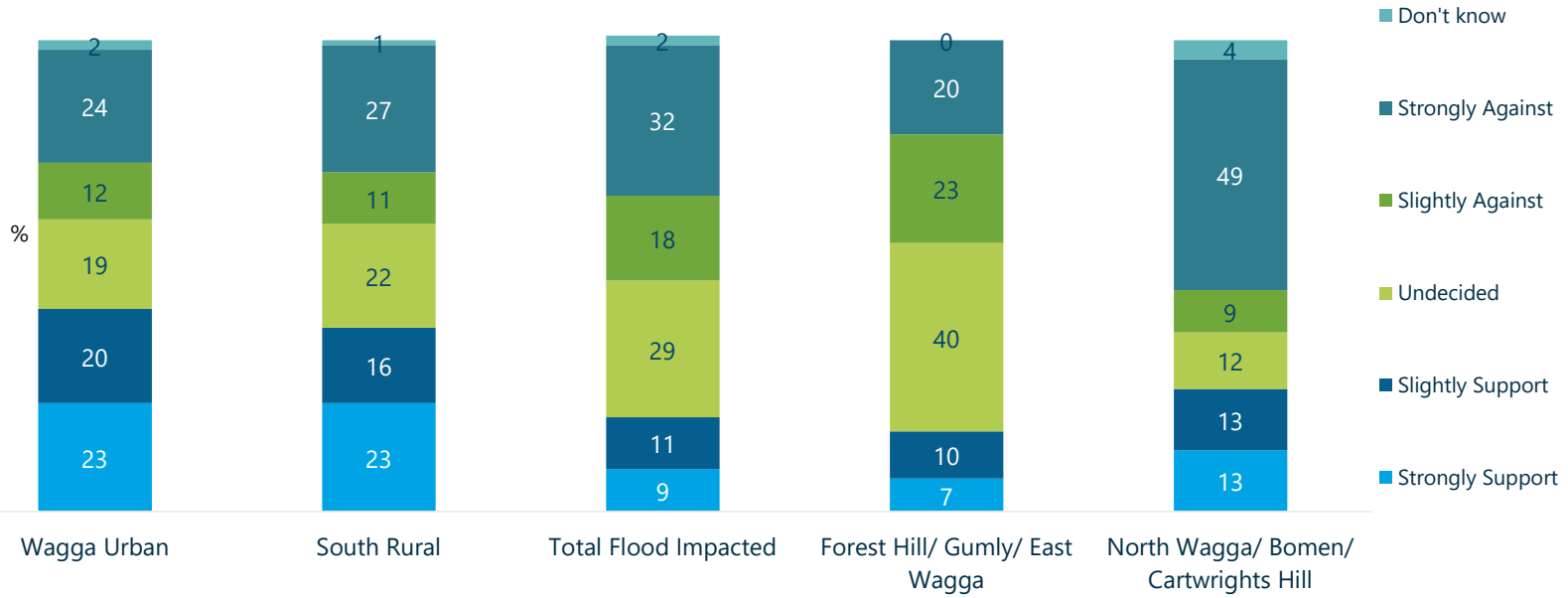
Degree of Support for Voluntary House Raising (VHR) and Voluntary House Purchase (VHP) - By location

Respondents from Forest Hill/Gumly/East Wagga were significantly more likely to be undecided about Option 1, while those from North Wagga/Bomen/Cartwrights Hill were significantly more likely to be strongly against this option.



Q1. How supportive are you of Council implementing this option of Voluntary House Purchase and Voluntary House Raising?
Base: All Respondents n=646 (Wagga Urban n=329, South Rural n=149, Flood Impacted n=161, Forest Hill/Gumly/East Wagga n=30, North Wagga/Bomen/Cartwrights Hill n=131)

Reasons for and against VHP & VHR

REASONS FOR:

	Main Survey %	Open Survey %
It's voluntary/gives people choice to move to out of a flood risk area or stay in their home	21	14
House raising is good/no need to leave the area	16	10
It helps people/NFI	14	7
There shouldn't be houses there/reducing the number of houses there is a good thing	6	6
House purchase/relocation is a good thing	6	5
It reduces the risk to people/fixes the problem	4	14
People chose to live in North Wagga knowing the risks/their problem not ours	3	0
Cost is reasonable/helps people financially	0	10
Other	7	8
Don't know/need more information	13	4
Nothing/I don't like it/I'm against it	23	48

REASONS AGAINST:

	Main Survey %	Open Survey %
Costs too much/increased rates/funds could be spent elsewhere	21	24
Ruins the North Wagga community/shortage of land elsewhere/don't want to move	17	14
People chose to live in North Wagga knowing the risks/their problem not ours	12	15
Unfair that others have to pay	11	0
There are better options than this/this option is not effective/feasible	9	18
I doubt homeowners would get market value/they would be offered a low price	6	5
Government shouldn't buy houses/land that can't be used	4	2
Timeframe is too long/will take too long	3	1
House purchase/buy back is a bad thing	3	1
Many houses can't be raised/doesn't suit elderly	0	12
Other	12	13
Don't know/need more information	12	5
Nothing/I like it/I'm not against it	15	14

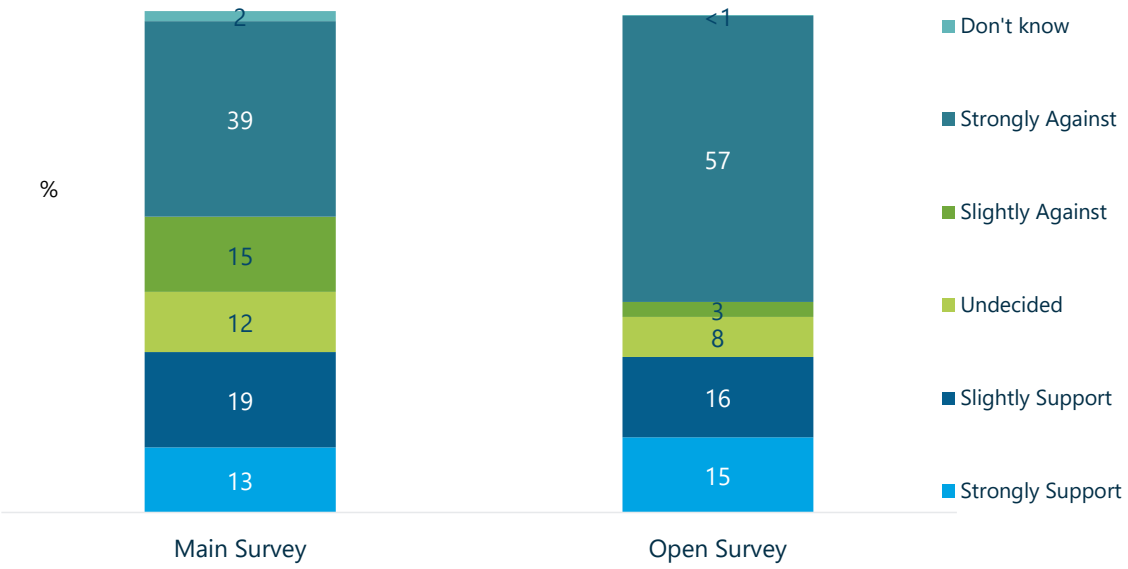
Q2/3. What do you like/dislike about this option?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

Degree of Support for Voluntary House Raising and Voluntary Purchase with an associated SRV

Assumptions:

- Council might have to fund part of this cost through a special rate variation.
- It could mean an additional $128 per household on average on Council rates for seven years in the urban area of Wagga
- An extra $45 per year on average on Council rates for the Villages for seven years.

Within the Open Survey Flood impacted residents were more likely to be slightly against this (11%).



Q4. How supportive are you of Council implementing this option of Voluntary House Purchase and Voluntary House Raising?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

Levee Upgrade

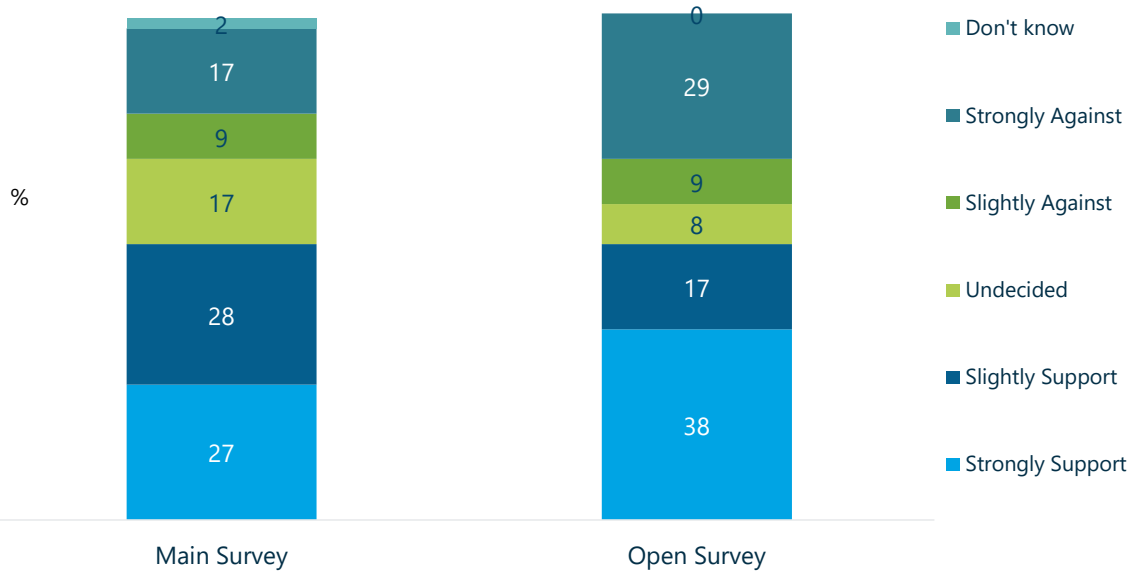
- Stage 1 - raising the levee to a 5% AEP level (or 1 in 20 chance of a flood event) to provide North Wagga with a greater level of protection.
- Stage 2 - the 'surrounding works' - raising a portion of Hampden Ave to provide a safe evacuation route for North Wagga residents and raising a section of Mill St to provide an evacuation route for residents within the East St Levee.
- Also involve the building of bridges and excavation works to offset the levee and embankment and enable equivalent water flow.
- The timing of stage 2 is unknown and subject to funding availability.

Degree of Support for Levee and Surrounding Works

Assumptions:

- When both Stages 1 and 2 are implemented, in the majority of floods there would be a benefit (i.e avoid flooding in a 5% AEP level or 1 in 20 chance of a flood event) to 237 properties, but in the most extreme floods (i.e. in a 0.5% AEP or 1 in 200 chance (overtopping the main city levee) there could be a small negative impact on up to 697 properties.
- The cost estimate is:
  - Stage 1: $10.3 million
  - Stage 2: $75.7 million

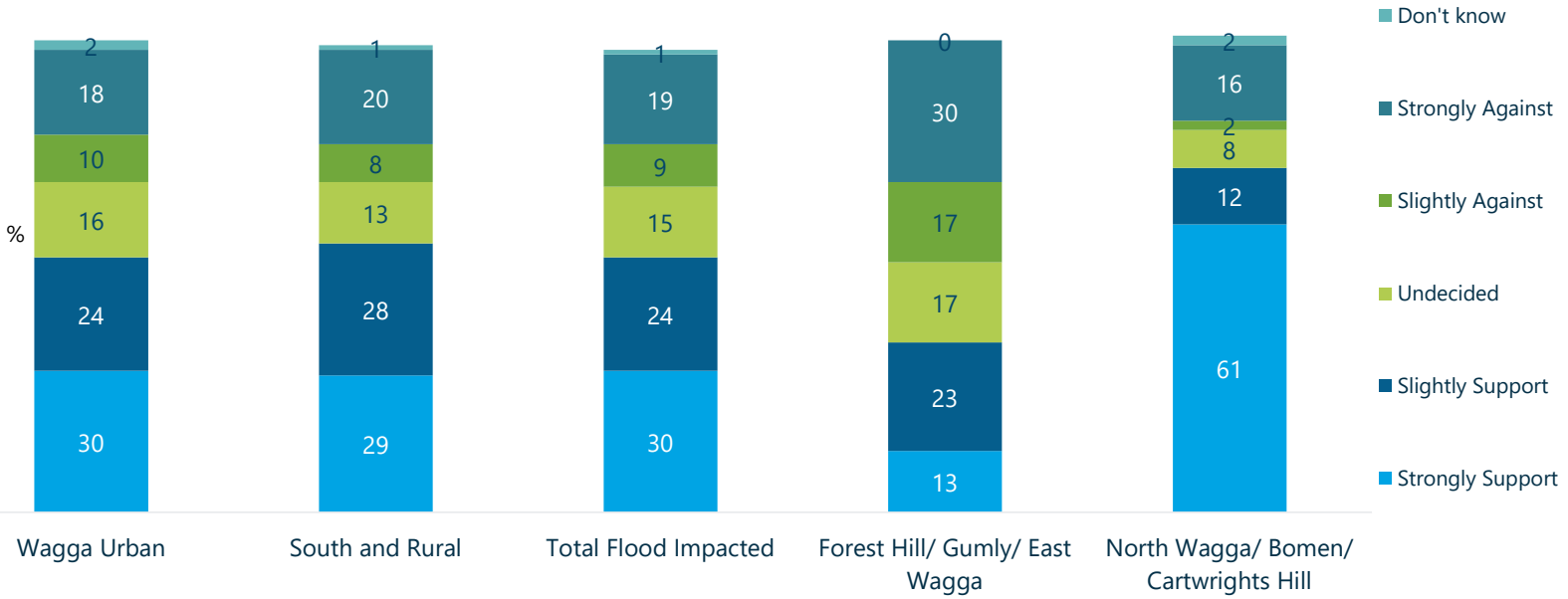
A larger percentage of those from the open survey were in strong support of Stage 1 and 2 as a whole compared to main survey respondents.



Q5. How supportive are you of Council implementing this option as a whole – Stages 1 and 2?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

Degree of Support for Levee and Surrounding Works - By location

Residents from Forest Hill/Gumly/East Wagga were significantly less likely to be in strong support of implementing Stages 1 and 2. Those from North Wagga/Bomen/Cartwrights Hill were significantly more likely to strongly support this option as a whole.



Q5. How supportive are you of Council implementing this option as a whole – Stages 1 and 2?
Base: All Respondents n=646 (Wagga Urban n=329, South Rural n=149, Flood Impacted n=161, Forest Hill/Gumly/East Wagga n=30, North Wagga/Bomen/Cartwrights Hill n=131)

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Reasons for and against Levee and Surrounding Works

REASONS FOR:

	Main Survey %	Open Survey %
People can stay in their houses/preserves North Wagga community	19	16
Stage 1/Raising the levee is good NFI	18	18
This option is cheaper/the better option	12	12
Helps people/gives reassurance/safety	11	18
Community solution/will benefit people outside N.Wagga too	11	7
Stage 2/Improved roads, bridges, evacuation route is good	9	4
Gives N.Wagga people more time to evacuate	8	4
It is fair/Wagga city had their levee increased so should N.Wagga	4	2
Long term/good future planning	4	3
Other	4	5
Don't know/need more information	9	0
Nothing/I don't like it/I'm against it	22	33

REASONS AGAINST:

	Main Survey %	Open Survey %
Costs too much/increased rates/funds could be spent elsewhere	28	16
Impacts on other areas outside the levee/just moves the problem	12	14
Won't solve the issue/there is still a risk of flooding/band aid approach	12	8
Unfair that others have to pay/taxpayers have to pay	11	15
Requires a lot of work/will take too long	6	3
People chose to live in North Wagga knowing the risks	4	10
Don't like the idea of raising the levee	3	8
Stage 2 is unnecessary/extra cost	0	12
The two stages shouldn't go together/overkill/waste of money	2	2
Other	1	12
Don't know/need more information	12	1
Nothing/I like it/I'm not against it	26	23

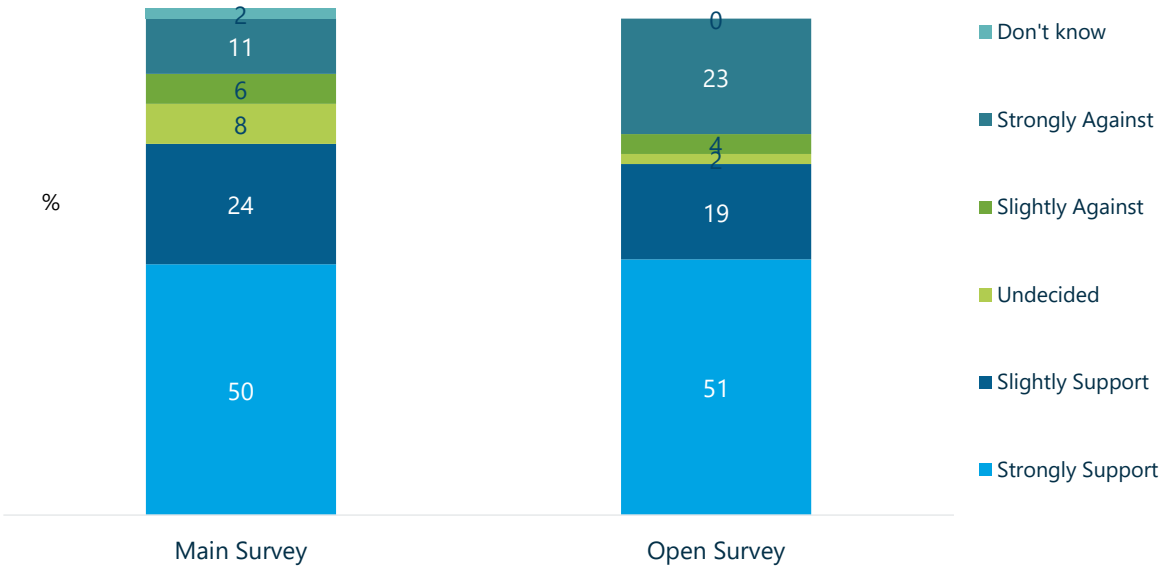
Q6/7. What do you like/dislike about this option?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

Degree of Support for Upgrading the Levee

- Completing Stage 1 (upgrading the levee only)

Assumptions:

- Council could complete Stage 1 with existing funds.



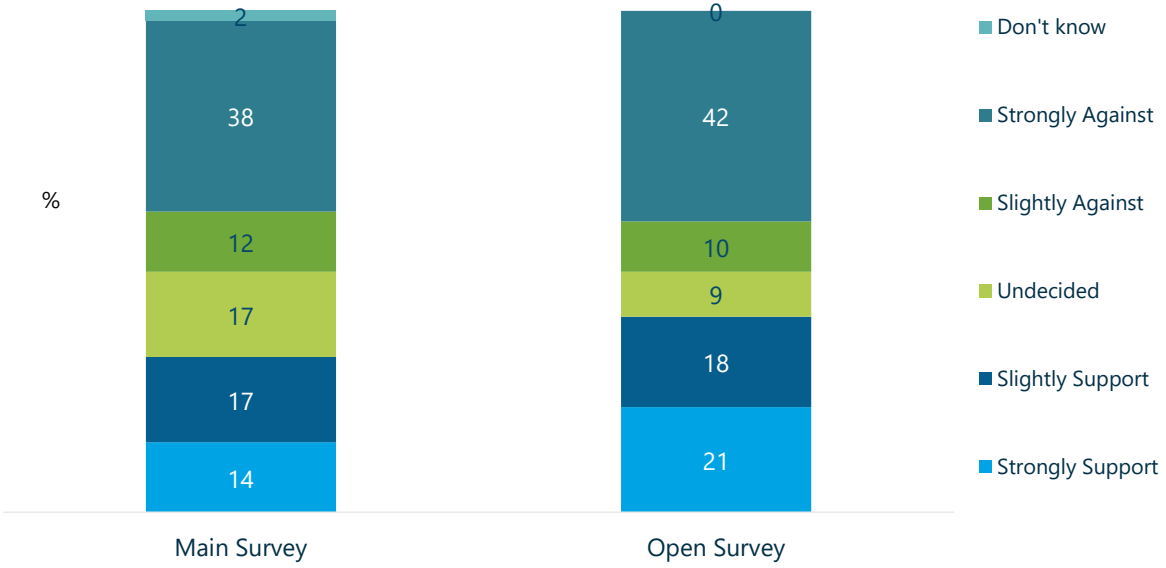
Q8. Taking the funding of these stages separately, how supportive are you of Council implementing Stage 1 of this option (upgrading the levee only) using existing funds?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

Degree of Support for the Surrounding Works
- Completing Stage 2 (the surrounding works – road raising, bridges and excavation)

Assumptions:

- Stage 2 is contingent upon Government funding and a special rate variation for Council to fund its share.
- It could mean an additional $173 per household on average on Council rates for seven years in the urban area of Wagga
- An extra $61 per year on average on Council rates for the Villages for seven years.

Flood impacted residents were less likely to be against this in the Open Survey (3%), with again no significant differences in the main survey by location



Q9. How supportive are you of Council implementing Stage 2 of this option (the surrounding works – road raising, bridges and excavation), with the associated special rate variation?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

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Combined Option

Option 3 would include three projects:

- Project 1
  - Upgrading the existing North Wagga Levees (stage 1)
  - Offering VHR and VHP to those outside the levee boundary (e.g. including eligible houses in and around North Wagga, Oura, Gumly Gumly).
- Project 2
  - 'Surrounding works' – raising roads, bridges and excavation between Wagga and North Wagga along Hampden Ave.
- Project 3
  - Offering VHR and VHP to residents inside the North Wagga Levee system, where the risk reduction is greater than the cost of the action.

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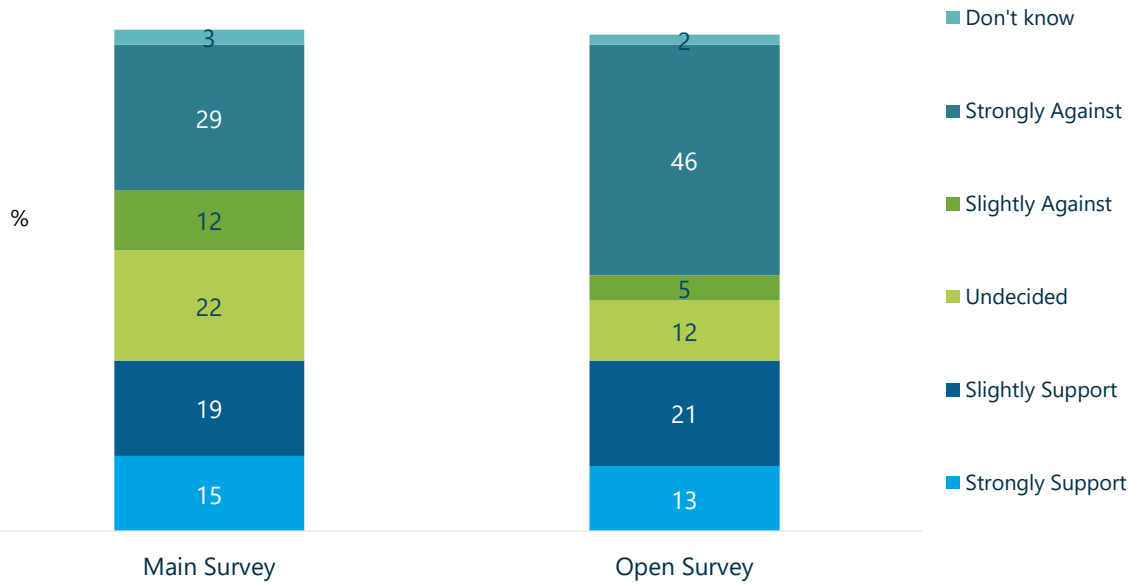
Degree of Support for a Combined Option

Assumptions:

- In the majority of floods there would be a benefit (i.e. avoid flooding in up to 5% AEP level or 1 in 20 chance of a flood event) to 237 properties, but in the most extreme floods (i.e. 0.5% AEP or 1 in 200 chance (overtopping the main city levee) there could be a small negative impact (increased flood height) on up to 697 properties.
- The cost estimate is:
  - Project 1 $20M
  - Project 2 $75.7M
  - Project 3 $10M

Flood impacted residents were significantly more likely to support this in the Open Survey (50%), with again no significant differences in the main survey by location



Q10. How supportive are you of Council implementing Option 3 as a whole?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

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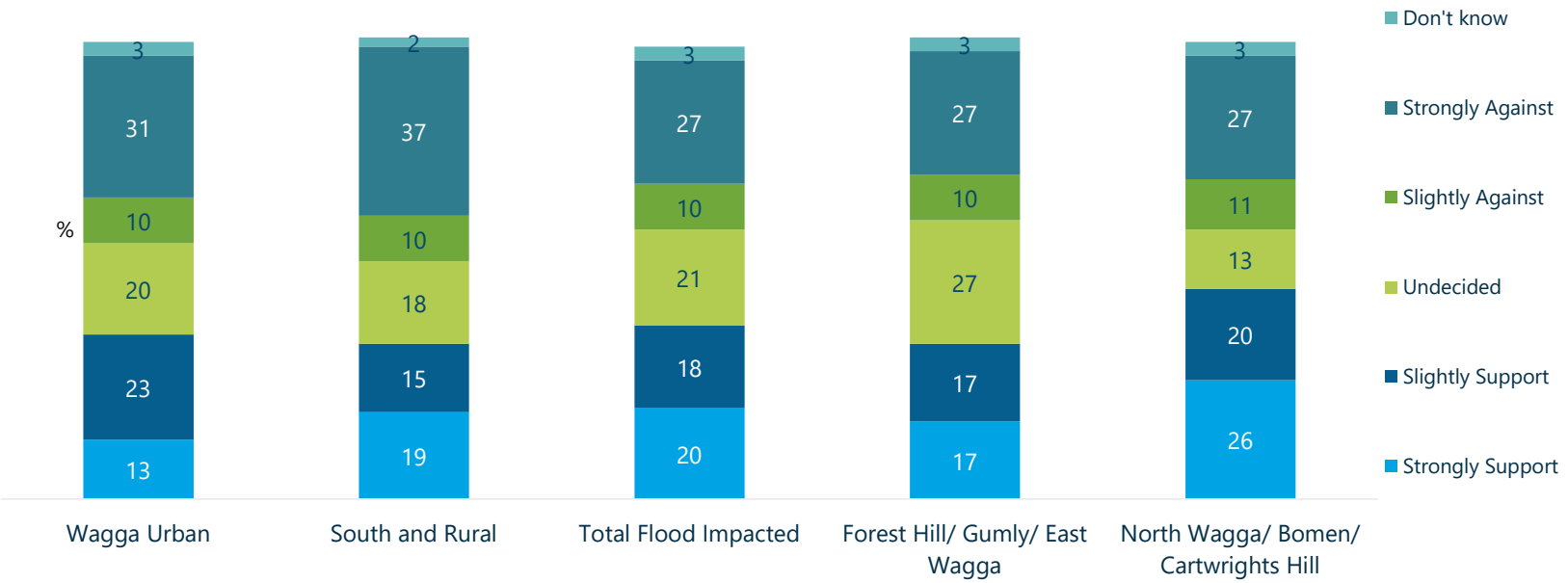
Degree of Support for a Combined Option - By location

North Wagga/Bomen/Cartwrights Hill residents were significantly more likely to be in strong support of a combined option



Q10. How supportive are you of Council implementing Option 3 as a whole?
Base: All Respondents n=646 (Wagga Urban n=329, South Rural n=149, Flood Impacted n=161, Forest Hill/Gumly/East Wagga n=30, North Wagga/Bomen/Cartwrights Hill n=131)

Reasons for and against Combined Option

REASONS FOR:

	Main Survey %	Open Survey %
All inclusive option/variety of solutions/there's a benefit for everyone	22	21
It's voluntary/gives people choice to move out of flood risk area or stay in their home	13	7
It reduces the risk/fixes the problem/helps people	7	10
Cost is cheaper by combining the options	6	2
Raising the levee is good	5	21
Improving roads and bridges/providing escape routes is good	4	1
House purchase/relocation is good	4	4
House raising is good	4	4
Other	2	4
Don't know/need more information	17	3
Nothing/I don't like it/I'm against it	37	40

REASONS AGAINST:

	Main Survey %	Open Survey %
Costs too much/increased rates/funds could be spent elsewhere	32	22
Unfair that others have to pay/taxpayers have to pay	18	12
Doesn't make sense to combine options 1 and 2/double dipping/overkill	11	10
Not feasible/not practical/not going to fix the problem	8	19
Raising the levee is bad	7	3
People chose to live in North Wagga knowing the risks	6	9
Don't trust the council with money/to do the right thing/get it done	4	4
House purchase/relocation is bad	3	2
Moving people from N.Wagga destroys the community/don't want to move	0	3
Other	5	14
Don't know/need more information	18	2
Nothing/I like it/I'm not against it	13	9

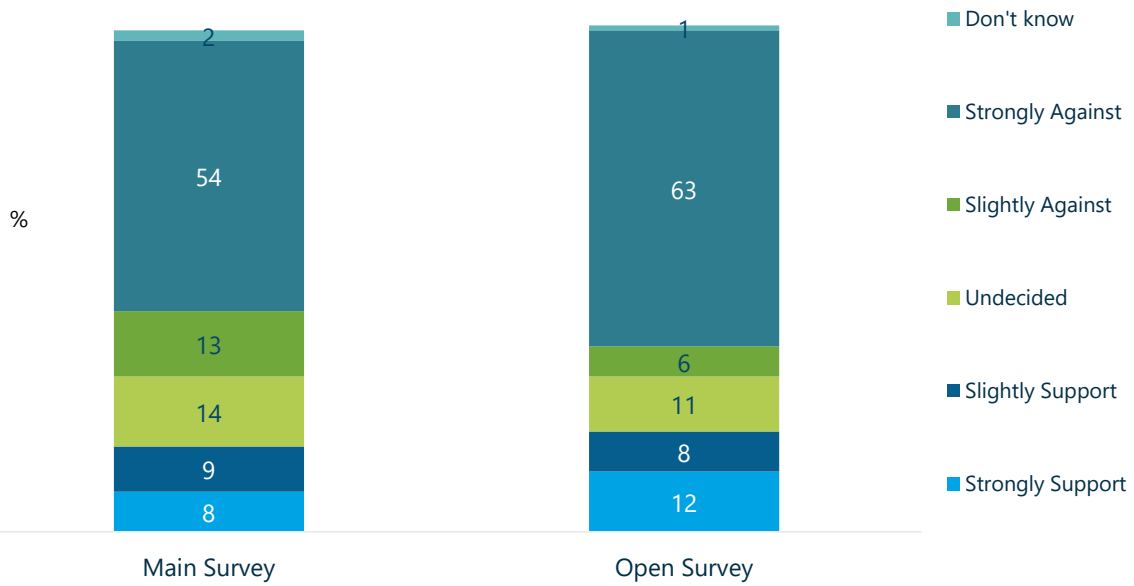
Q11/12. What do you like/dislike about this option?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

Degree of Support for a Combined Option with a SRV

Open Survey flood impacted residents were less likely to be against a SRV (55%) and more likely to be undecided (29%)

Assumptions:

- Council will have to fund part of this through an SRV.
- This could be $321 extra per year for seven years for residents in Urban Wagga
- Around $114 a year extra for seven years for village residents.

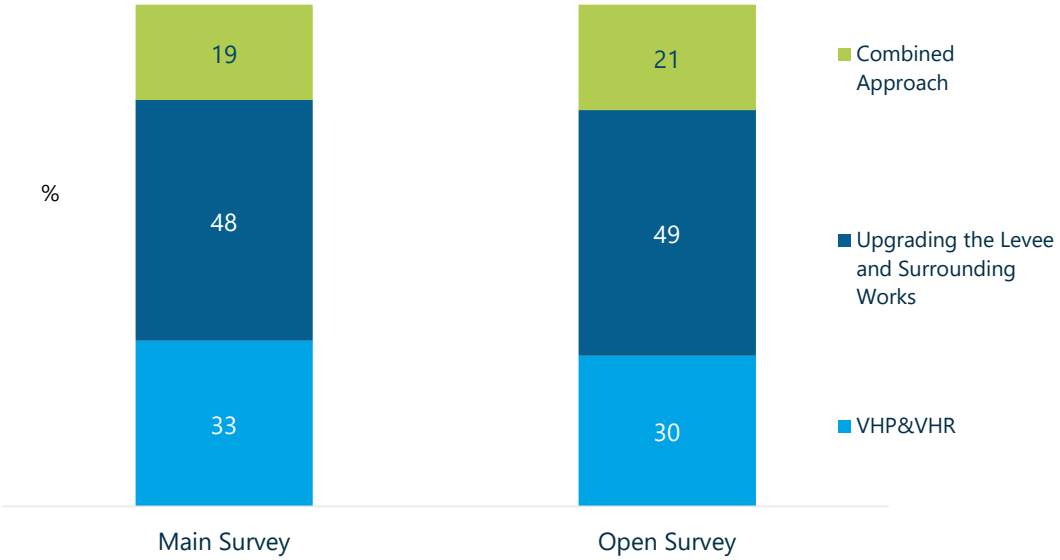


Q13. How supportive are you of Council implementing this option with an associated SRV?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

Preferred Option

Preferred Option - % ranked first

In the Open Survey flood impacted residents were significantly more likely to rank VHR/VHP last (59%) and less likely to rank the combined approach last (26%)

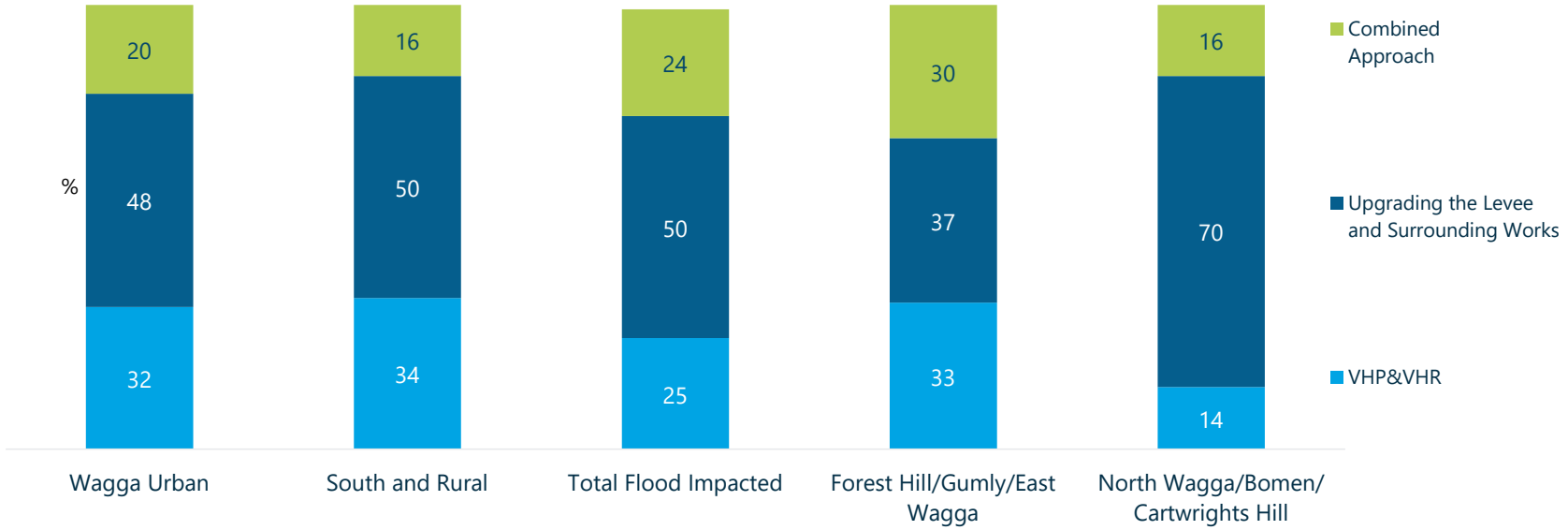


Q14. Now that you have been introduced to each of the three options being considered, please rank the three options in order of preference, Which option would be your most preferred? And which would be your least preferred option?
Base: All Respondents (Main survey respondents N=401; Open Survey n=245)

Preferred Option - % ranked first

- By location

Respondents from North Wagga/Bomen/Cartwrights Hill were significantly more likely to rank VHP/VHR last (70%) and upgrading the levee with surrounding works first (70%).



Q14. Now that you have been introduced to each of the three options being considered, please rank the three options in order of preference, Which option would be your most preferred? And which would be your least preferred option?
Base: All Respondents n=646 (Wagga Urban n=329, South Rural n=149, Flood Impacted n=161, Forest Hill/Gumly/East Wagga n=30, North Wagga/Bomen/Cartwrights Hill n=131)

Conclusions

- Within the community forums there was support for the upgrading of the levee along with VHP and VHR in Oura, Gumly Gumly and the floodplains at the least.
- The community survey seems to support this view, with Option 2, particularly Stage 1 (upgrading the levee only) whereby it is funded by Council, having strong appeal (74%).

% Strongly/slightly supporting	Main Survey %	Open Survey %
Option 1		
VHR and VHP	41	37
VHR and VHP (funded by SRV)	31	31
Option 2		
Levee Upgrade and Surrounding Works (Stage 1 & 2)	**55**	**55**
Stage 1: Levee upgrade only (funded by Council)	**74**	**70**
Stage 2: Surrounding works (funded by SRV)	31	39
Option 3		
Stage 1 & 2 plus VHR and VHR for those inside and outside the levee	34	34
Combined option (funded by SRV)	17	20

Conclusions

- In terms of overall preference, Option 2 again comes through as the most popular option in both the main and particularly, the open survey.
- However, amongst flood impacted residents, a combined option that includes VHR & VHP also has strong appeal.

Option 1 Voluntary House Raising and Purchase appeals as:

- It's voluntary/ gives choice
- No need to leave the area
- Helps people

However,

- The cost is unappealing
- Ruins the NW community/ shortage of land elsewhere
- People live there knowing the risks, so it is not others' problem

Option 2 levee upgrade (both stage 1 and 2) appeals as:

- People can stay in their houses and it preserves the community
- Stage 1 only is a good option

However,

- The cost of Stage 2 is unappealing
- It is felt to be unfair to ask others/taxpayers to pay

The Option 3 (combined approach), is felt to be:

- All inclusive/ benefits everyone
- Includes levee raising which is good

However,

- It costs too much/funds could be spent elsewhere
- Unfair that everyone must pay
- Not feasible/practical/going to fix the problem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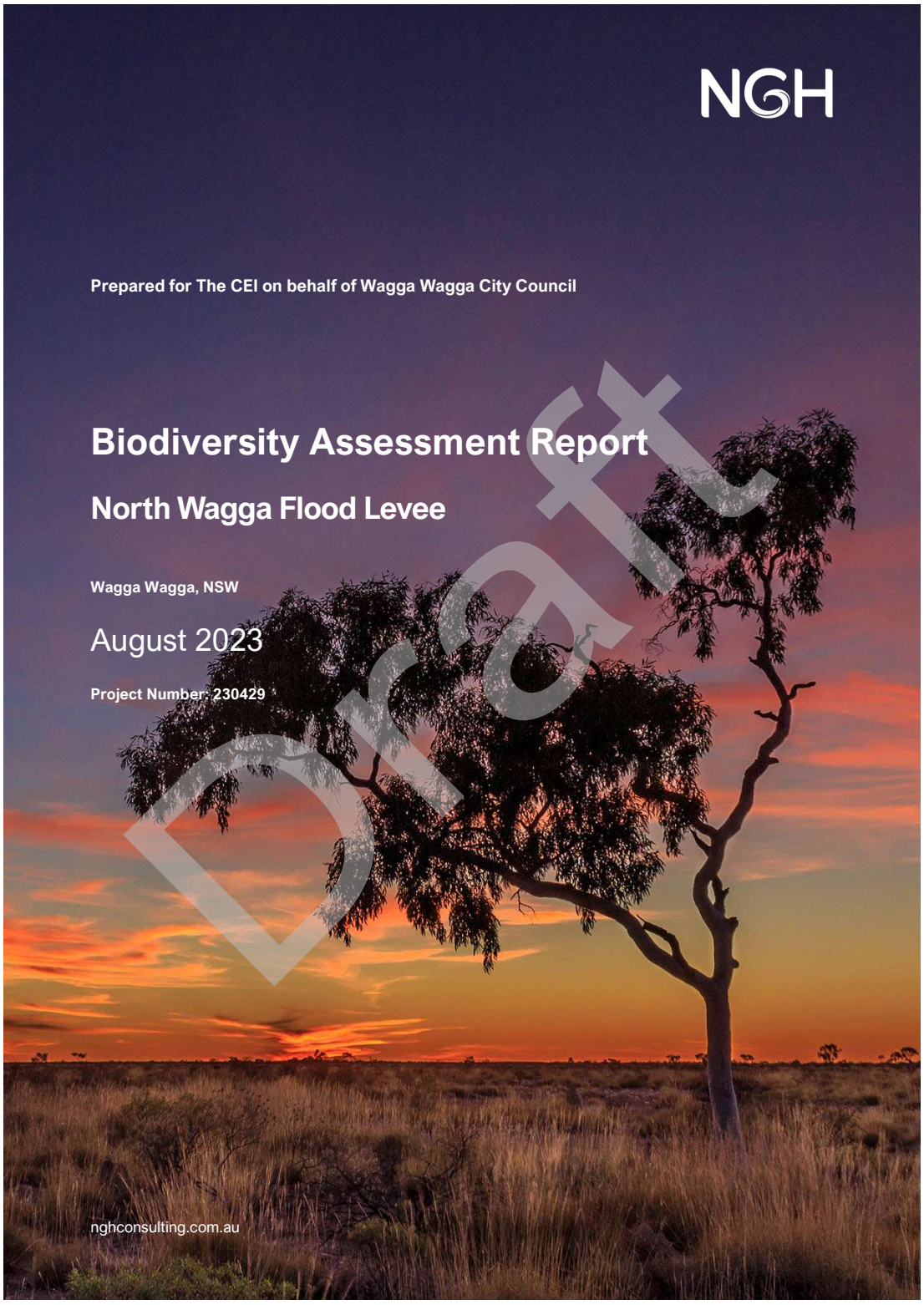
NGH
Prepared for The CEI on behalf of Wagga Wagga City Council
Biodiversity Assessment Report
North Wagga Flood Levee
Wagga Wagga, NSW
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Biodiversity Assessment Report
North Wagga Flood Levee

Document verification

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Draft V1.0	10/08/2023	James H. and Dylan R.	Bianca Heinze/ Julie Gooding	Julie Gooding
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Acronyms and abbreviations

AEP	Annual Exceedance Probability
AOBV	Areas of Outstanding Biodiversity Value
BA	Biodiversity Assessment
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BDAR	Biodiversity Development Assessment Report
Biosecurity Act	*Biosecurity Act 2015* (NSW)
BOM	Australian Bureau of Meteorology
BOS	Biodiversity Offset Scheme
BV	Biodiversity Values
CEEC	Critically Endangered Ecological Community
DPE	Department of Planning and Environment
DPI	Department of Primary Industries
DPIE	Department of Planning, Industry and Environment (NSW)
EA	Excavation Area
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwth)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
FR	Flood Runner
FM Act	*Fisheries Management Act 1994* (NSW)
GDE	Groundwater Dependent Ecosystems
ha	hectares
HBT	Hollow Bearing Tree
KFH	Key Fish Habitat
km	kilometres
KTP	Key Threatening Process
LGA	Local Government Area
LLS	Local Land Services
m	metres
MNES	Matters of National Environmental Significance
NSW	New South Wales

OEH	Office of Environment and Heritage (NSW)
OLA	Off Leash Area
PCT	Plant Community Type
PMST	Protected Matters Search Tool
REF	Review of Environmental Factors
sp./spp.	Species/multiple species
TEC	Threatened Ecological Community
TISEPP	*Transport and Infrastructure State Environmental Planning Policy 2021*
WWCC	Wagga Wagga City Council
Wagga Wagga LEP	*Wagga Wagga Local Environment Plan 2010*

Executive Summary

This Biodiversity Assessment will assess the potential direct and indirect impacts of the proposal on any threatened species or communities, Maters of National Environmental Significance and Areas of Outstanding Biodiversity Value that occur within the study area. The outcome of this assessment will help guide the proposal towards the most appropriate planning approval pathway. The proposal is located in the North Wagga suburb of Wagga Wagga in NSW.

The proposal involves the raising of existing levee banks and the installation of a raised road and bridge connecting North Wagga to the Wagga Wagga town centre via Hampden Bridge. The development footprint includes four distinguishable areas:

- Two existing levees that surround residential areas of North Wagga.
- Two areas where excavation is proposed.

The total area being assessed is 20.53 hectares (ha). The proposal is located within 50m and 1,600m of the Murrumbidgee River main channel with roadway crossings also proposed.

The proposal is being assessed under Part 5 of the *NSW Environmental Planning and Assessment Act* (EP&A act). Wagga Wagga City Council (WWCC) is the proponent and determining authority.

Database searches were completed for records of Commonwealth and State listed threatened species, populations, and ecological communities. Searches were conducted on 24 July 2023 and included the use of Protected Matters Search tool and review of NSW BioNet Atlas records. Relevant literature was reviewed, which included DPIE, OEH and EPBC Threatened Species Profiles. Further desktop assessment was conducted using geospatial information software and publicly available data from State and Federal government organisations.

A preliminary site assessment was completed on 10 February 2023 by an NGH Ecologist to assess the biodiversity constraints within the proposed development footprint. Field survey methodology for assessing vegetation included gathering rapid assessment points and using the LLS endorsed step point method for assessing native groundcover.

A total of 19.99 ha of vegetation would be impacted by the proposal through removal or disturbance. A total of 18.19ha of native vegetation would be removed by the proposal. This includes vegetation in Plant Community Types 5, 9, 47, 74 and 796. The largest impact to vegetation would be in the plant community type 796 – Derived Grassland of the NSW South Western Slopes. No threatened ecological communities will be impacted by the proposal.

No Areas of Outstanding Biodiversity value are present within the development footprint. A total of 16 threatened species were considered likely to occur within the development footprint. These species were assessed using the NSW Biodiversity Conservation Act (BC Act) Test of Significance to determine if impacts to these species would be significant. These tests revealed that the proposal will significantly impact on the habitat of Barking Owl, Superb Parrot, Squirrel Glider in the Wagga Wagga Local Government Area - Endangered population and Squirrel Glider.

Hence, under the NSW BC Act further assessment is required for these species through either a Biodiversity development Assessment Report (BDAR) or Species Impact Statement (SIS).

The proposal is likely to increase impacts from and form part of two key threatening processes, clearing native vegetation and the removal of hollow bearing trees. Mitigation measures have been recommended to minimise impacts by the proposal.

1. Introduction

The purpose of this Biodiversity Assessment report (BA) is to assess the potential direct and indirect impacts of the proposal on any threatened species or communities, Maters of National Environmental Significance (MNES) and Areas of Outstanding Biodiversity Value (AOBV) that occur within the study area.

The proposal is being assessed and determined under Part 5 of the *Environmental Protection and Assessment Act 1979* (EP&A Act). Wagga Wagga City Council (WWCC) is the proponent and determining authority under Part 5 of the EP&A Act. Division 5.1 of the EP&A Act requires that the significance of the impact of the proposal on terrestrial and aquatic threatened species, populations and threatened ecological communities be assessed. A significant impact on threatened entities is defined under Section 7.2 of the *Biodiversity Conservation Act* (BC Act). For Part 5 activities, this includes an assessment of whether an activity is likely to affect a threatened entity according to the NSW Test of Significant (ToS) or impact a declared area of Outstanding Biodiversity Value (AOBV).

The outcome of this BA will guide the proposal towards the most appropriate planning approval pathway and determine if further assessment is required.

The following definitions are used in this report:

- **Proposal:** All works involved in the construction and operation of the proposed flood management works.
- **Development footprint:** Area of land directly impacted by the construction of the proposal.
- **Study Area:** Area of land within a 10km buffer applied to the development footprint.

1.1. Proposal background

Wagga Wagga City Council (WWCC) completed a review of the Murrumbidgee River Floodplain Risk Management Study and Plan (WMA Water, 2018) focusing on the areas of Wagga Wagga impacted by riverine flooding. Most of the recent flood damage in urban parts of Wagga Wagga occur in the suburb of North Wagga and surrounds. This review resulted in investigations into upgrading the North Wagga Levee to 5% Annual Exceedance Probability (AEP) level of protection. Equivalent upgrades are also proposed to Hampden Bridge, Hampden Avenue (as embankment) and conveyance improvements through Wilks Park to connect Wagga Wagga town centre to North Wagga during a flooding event.

North Wagga is located within the Wagga Wagga Local Government Area (LGA). Wagga Wagga is the largest inland town in New South Wales, with Sydney approximately 380km northeast. North Wagga is located in the NSW South Western Slopes IBRA region and the Lower Slopes IBRA subregion.

1.2. The Proposal

The proposal is to raise the existing levee banks surrounding North Wagga and install a raised road and bridge connecting North Wagga to the Wagga Wagga town centre via Hampden Bridge. Soil for the works is proposed to be excavated from excavation areas 1 and 2 (EA1, EA2) and the Flood Runner (FR) – an anabranch which flows during periods of high flow in the Murrumbidgee River (See Figure 1-1 and Figure 1-1 Map of proposal including development footprint and excavation areas location.

Table 1-1 Proposed works locations and details below). The FR is a straight depression that occasionally conveys flood waters and tends to have a relatively uniform morphology.

The works would include the following activities:

- Geotechnical investigation and survey of the preferred alignment.
- Excavation of soil from EA1, EA2 and the Flood runner (FR) to provide the soil for the construction of the levees to a 1 in 20-year event (soil would be sourced from areas within Wilks Park and Wilks Park Off-Leash Area (Wilks Park OLA) on the northeastern side of Hampden Avenue).
- Construction/raising of levee.
- Establish laydown areas including amenities, temporary fencing, and signage.
- Establish environmental controls.
- Vegetation trimming and removal where required.

Figure 1-1 Map of proposal including development footprint and excavation areas location.

Table 1-1 Proposed works locations and details

ID	Location	Length (m)	Structure
Levee 1 (L1)	Existing Levee ring around North Wagga	4,500m	Earthen Bank
Levee 2 (L2)	Existing Levee surrounding limited number of houses East of North Wagga	1,262m	Earthen Bank
Flood Runner (FR)	Adjacent to Wilks Park	400m x 200m	Excavation of soil for proposed works 50m wide x 800m long x 2.5m deep
Excavation Areas EA1 and EA2	Wilks Park and cleared area between Hampden Avenue and Parken Pragan Lagoon - Wilks Park OLA	500m**	Excavation points for proposed works to a depth between 2.5–5m
Flood Management Structure	Hampden Avenue	700m	Bridge/raised road/embankment

**Maximum extent

1.2.1. Development footprint

The development footprint includes four distinguishable areas:

- Two existing levees that surround residential areas of North Wagga.
- Two areas where excavation is proposed (see Figure 1-1.)

The total area being assessed is 20.53 ha. The proposal is located within 50m and 1,600m of the Murrumbidgee River main channel with roadway crossings also proposed.

The associated soil landscapes of the subject land are Farnham and Kurrajong Plain (DPIE, 2023). Annual rainfall is 500–550mm. Soils are moderately moist to moist during winter and spring but dry in summer and early autumn (DPIE, 2023).

The Murrumbidgee River varies in flow and river heights, determined in the summer months by dam releases due to planned water delivery to the environment and irrigators (DPI Water, 2017). Water quality over the summer months tends to be high (DPI Water, 2017). The main water quality issues, include turbidity, variable nutrient flushes from adjoining farming land and salt load (DPI Water, 2017). Turbidity is strongly related to rainfall and surface runoff from cultivated areas of the catchment (DPI Water, 2017).

1.3. Legislative context

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The objects of this Act are:

a) *To provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance,*

b) *To promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources,*

c) *To promote the conservation of biodiversity, and*

d) *To provide for the protection and conservation of heritage,*

e) *To promote a co–operative approach to the protection and management of the environment including governments, the community, landholders and indigenous peoples,*

f) *To assist in the co–operative implementation of Australia's international environmental responsibilities,*

g) *To recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity, and*

h) *To promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in co–operation with, the owners of the knowledge.*

Approval by the Commonwealth environment minister is required if an action is likely to have a significant impact on a MNES or if it listed as a matter of national significance.

There are listed Wetlands of International importance, Threatened Ecological Communities, Threatened Species, Listed Migratory Species and Listed Marine Species noted in the Protected Matters Search that would need consideration within the BA.

State Environmental Planning Policy (Transport and Infrastructure) 2021 (TISEPP)

TISEPP aims to facilitate the effective delivery of infrastructure across the state, including for roads and road infrastructure facilities. Division 7 of TISEPP permits development for the purpose of flood mitigation work (including levees) to be carried out on by, or on behalf of, a public authority without consent on any land.

Given the proposal involves the construction of a levee, being carried out by WWCC, the provisions of the TISEPP apply and the proposal is permissible without development consent under Part 5 of the EP&A Act. However, in section 5.5 and 5.7 of the EP&A Act and section 171 of the EP&A Regulation 2021 contains and obligation to consider the likely impact of an activity on the environment and to prepare an EIA demonstrating how the environmental factors were taken into consideration in an EIA.

The proposal is not located on land reserved under the *National Parks and Wildlife Act 1974* and does not require development consent or approval under the State Environmental Planning policy (Resilience and Hazards) 2021 and State Environmental Planning Policy (Planning Systems) 2021.

Biodiversity Conservation Act 2016 (BC Act)

The purpose of this Act is to maintain a healthy, productive and resilient environment for the greatest well–being of the community, now and into the future, consistent with the principles of ecologically sustainable development.

The BC Act regulates the clearing of native vegetation in NSW. Under Part 7 of the BC Act, an assessment of the potential impacts of the proposed activity on threatened species, populations, ecological communities

and critical habitat listed in the BC Act must be undertaken. This includes assessment of the potential for a significant impact under section 7.3 (Test of Significance) and whether an impact is likely on an AOBV.

Biosecurity Act 2015

The objects of this Act are the following:

a) *To promote biosecurity as a shared responsibility between government, industry and communities,*
b) *To provide a framework for the timely and effective management of the following:*
    i. *Pests, disease, contaminants and other biosecurity matter that are economically significant for primary production industries.*
    ii. *threats*
    iii. *community activities and infrastructure,*
c) *to provide a framework for risk–based decision–making in relation to biosecurity,*
d) *to give effect to intergovernmental biosecurity agreements to which the State is a party, to provide the means by which biosecurity requirements in other jurisdictions can be met, so as to maintain market access for industry.*

Any person who deals with biosecurity matter or a carrier and who knows, or ought reasonably to know, the biosecurity risk posed or likely to be posed by the biosecurity matter, carrier or dealing has a biosecurity duty to ensure that, so far as is reasonably practicable, the biosecurity risk is prevented, eliminated or minimised. The proposal may pose biosecurity risk for ecological communities in the vicinity through introduction of invasive flora or pathogens, these can be transported on machinery or within materials.

Wagga Wagga Local Environmental Plan 2010 (Wagga Wagga LEP)

This Plan aims to make local environmental planning provisions for land in Wagga Wagga in accordance with the relevant standard environmental planning instrument under section 3.2 of the Act.

The particular aims of this Plan are as follows:

a) *To protect, enhance and conserve agricultural land through the proper management, development and conservation of natural and man-made resources,*
b) *To encourage a range of housing, employment, and recreational and community facilities to meet the needs of existing and future residents of Narrandera,*
c) *To promote the efficient and equitable provision of public services, infrastructure and amenities,*
d) *To conserve environmental heritage.*

The study area includes zoning such as RE1 Public Recreation, RU5 Village, C2 Environmental conservation and RU1 Primary Production under the Wagga Wagga LEP 2010.

According to part 2 division 7 of the TISEPP, flood mitigation work is a development permitted without consent. Levees fall under the definition of flood mitigation works; therefore, the proposal is permitted without consent.

2. Methodology

2.1. Desktop assessment

Database searches were completed for records of Commonwealth and NSW listed threatened species, populations, and ecological communities. Searches were conducted on 24 July 2023 and included the following:

- EPBC Act Protected Matters Search tool records within Study Area (EPBC Act listed entities)
- NSW BioNet Atlas Search within the Study Area (BC Act listed entities)
- DPI NSW WeedWise database was searched to identify any Priority Weeds relevant to the Wagga Wagga LGA listed under the Biosecurity Act 2015.
- Register of Areas of Outstanding Biodiversity Value (DPE, 2023)

Relevant literature was reviewed, which included DPIE, OEH and EPBC Threatened Species Profiles. Further desktop assessment was conducted using geospatial information software and publicly available data from State and Federal government organisations. Information was used from the following databases:

- NSW Biodiversity Values (BV) Map (Department of Planning and Environment, 2018)
- Department of Primary Industries (DPI) Key Fish Habitat and Threatened Fish Distributions (DPI, 2016)
- NSW DPE Vegetation Information System, State Vegetation Mapping (NSW Department of Planning and Environment, 2022)
- Bureau of Meteorology's (BOM) National Atlas of Groundwater Dependent Ecosystems (GDEs). (Bureau of Meterology, 2017)

2.2. Field assessment

A preliminary site assessment was completed on 10 February 2023 by an NGH Ecologist to assess the biodiversity constraints within the proposed development footprint.

This site assessment aimed to:

- Identify any areas of suitable habitat for threated flora or fauna.
- Record habitat features i.e., hollow-bearing trees, woody debris, watercourses etc.
- Determine Plant Community Types (PCTs) according to the Department of Planning and Environment (DPE) BioNet Vegetation Classification (DPE, 2022).
- Assess the percentage of native ground cover in grassland areas via the Local Land Services (LLS) endorsed step point method (Office of Environment and Heritage, 2015).

Field survey methodology for assessing vegetation included gathering rapid assessment points and using the LLS endorsed step point method for assessing native groundcover.

2.3. Hollow Bearing Tree Inventory

WWCC provided NGH with a Hollow Bearing Tree (HBT) Inventory for the whole of Wilks Park that had been surveyed previously in 2023 by WWCC staff. This HBT inventory provided GPS locations of HBTs, along with size and number of hollows.

Limitations

The following are factors that limited the field survey:

- No targeted threatened species surveys were undertaken. Likelihood of threatened species presence were undertaken by database records and habitat assessments.
- Due to the timing and duration of the survey, not all fauna and flora species would have been visible or present within the study area. Absence of any fauna or flora species during survey, including threatened species, may not rule them out of requiring further survey effort.
- Two step point method assessments were completed, one at Wilks Park and one in the Wilks Park OLA. Vegetation condition was extrapolated based on having a similar condition to these step point assessment.
- HBTs have been identified from the ground based on apparent entrances and no hollows were inspected to confirm internal dimensions.

3. Results

3.1. Desktop assessment

Database searches were completed for records of Commonwealth and NSW listed threatened species, populations, and ecological communities. The databases used and results are outlined in Table 3-1. A habitat evaluation table was compiled using the results of the BioNet records and Commonwealth PMST searches to evaluate the possible impacts of the proposed works on threatened entities (Appendix A).

Table 3-1 Results summary of database searches and mapping

Database	Date	Search Area	Results
Protected Matters Search Tool (PMST)	24/07/2023	Study Area	The search results returned the following threatened entities that *have the potential* to occur within the study area: • 3 ecological communities • 8 flora spp. • 19 bird spp. (3 migratory spp.) • 4 mammal spp. • 1 reptile sp. • 1 insect sp. • 6 fish spp. • 2 amphibians spp.
BioNet Atlas	24/07/2023	Study Area	The search returned records of the following threatened species within a 10km radius of the Development Footprint: • 10 ecological communities • 6 flora spp. • 40 bird spp. (8 migratory spp.) • 4 mammal spp.

			• 1 reptile sp. • 1 insect sp. • 6 fish spp. • 2 amphibian spp. See Figure 3-1 Map showing NSW BioNet search results, Biodiversity Values mapped land and State Vegetation Type Mapping surrounding the development footprint. below
Biodiversity Values Mapping	V.15 16/05/2023	Development Footprint	No Biodiversity Values (BV) mapped land occurs in the Development Footprint. Areas of BV mapped land occur within the study area including biodiverse riparian land along the Murrumbidgee River. (see Figure 3-1 Map showing NSW BioNet search results, Biodiversity Values mapped land and State Vegetation Type Mapping surrounding the development footprint. below)
State Vegetation Type Mapping	01/12/2022	Development Footprint	A total of three (3) plant community types (PCTs) are mapped within the Development Footprint including vegetation formations such as forested wetlands, freshwater wetlands, grasslands and grassy woodlands. Communities include: • **PCT 5** - River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion. • **PCT 9** - River Red Gum - wallaby grass tall woodland wetland on the outer River Red Gum zone mainly in the Riverina Bioregion • **PCT 74** - Yellow Box - River Red Gum tall grassy riverine woodland of NSW South Western Slopes Bioregion and Riverina Bioregion See Figure 3-1 Map showing NSW BioNet search results, Biodiversity Values mapped land and State Vegetation Type Mapping surrounding the development footprint. below.
Groundwater Dependent Ecosystems (GDEs)	15/07/2019	Development Footprint	Two (2) terrestrial GDEs occur within the Development Footprint. These are:

			1. River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion. 2. Yellow Box - River Red Gum tall grassy riverine woodland of NSW South Western Slopes Bioregion and Riverina Bioregion. One Aquatic GDE occurs within the Development Footprint: 1. Floodplain Waterbody See Figure 3-2 below.
Key Fish Habitat/Wetlands	28/07/2017	Development Footprint	The Development Footprint intersects areas of Key Fish Habitat (KFH). The Development Footprint also intersects two mapped wetlands both of which are floodplain wetlands. See Figure 3-3 below.
NSW WeedWise	24/07/2023	LGA	Search revealed 94 species (groups of species I.e. genera) that are: • Prohibited matters. • Prohibited on certain dealings. • Excluded from local government areas. • Subject to Biosecurity Zone controls. • Subject to a Control Order.
Areas of Outstanding Biodiversity Value (AOBV)	24/07/2023	Development Footprint	No declared AOBV or areas identified as having high biodiversity value as listed under the BC Act are present within the Development Footprint.

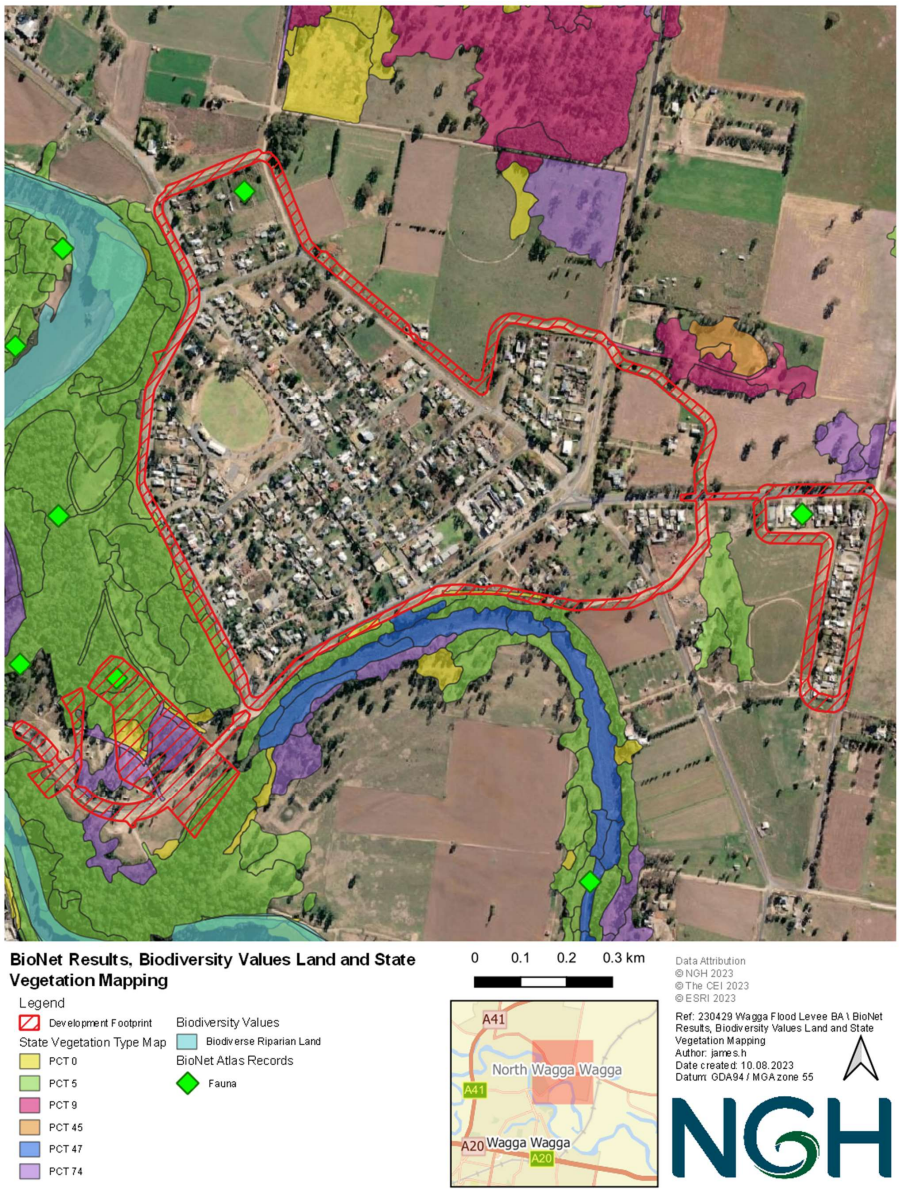


Figure 3-1 Map showing NSW BioNet search results, Biodiversity Values mapped land and State Vegetation Type Mapping surrounding the development footprint.

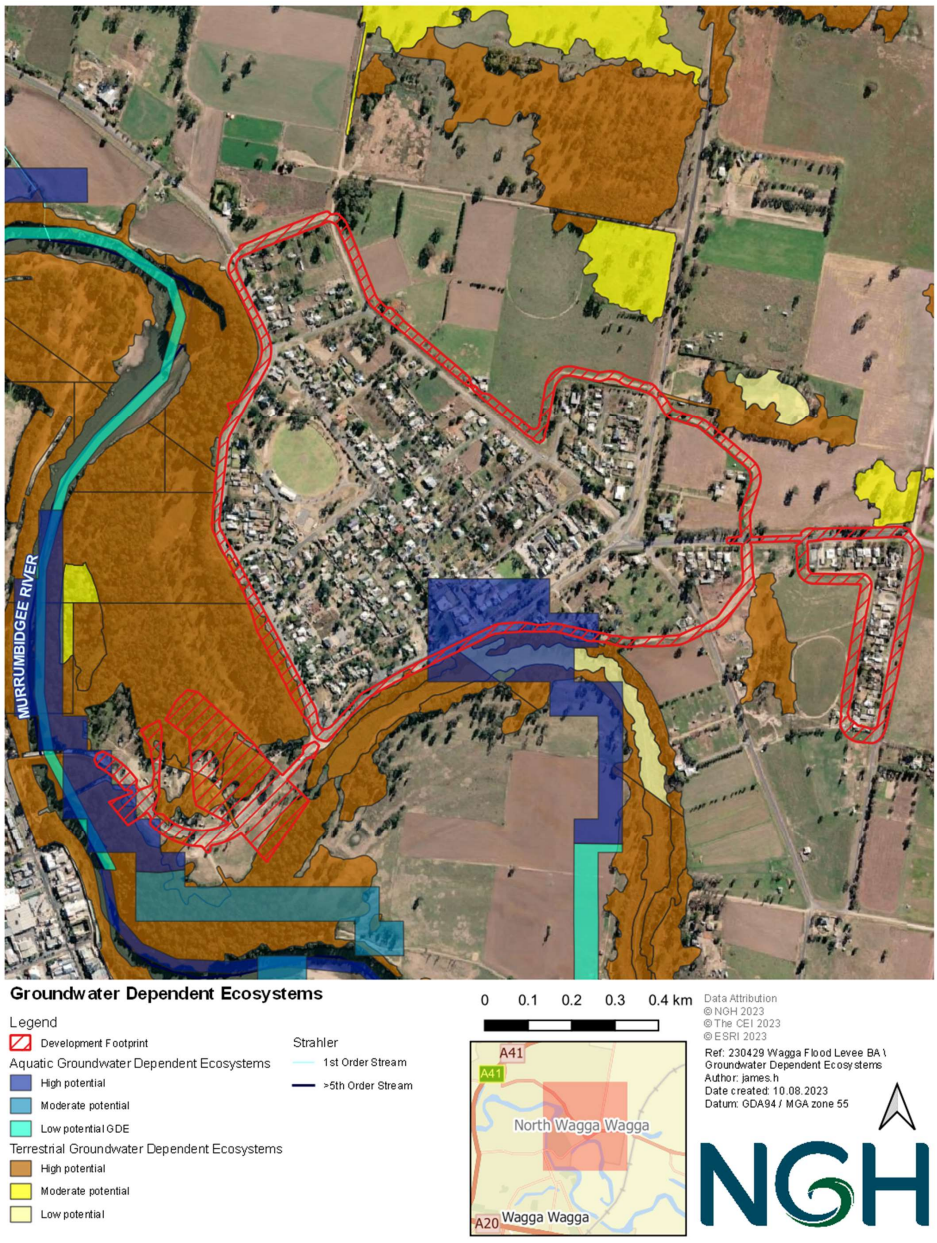


Figure 3-2 Map showing Groundwater Dependent Ecosystems surrounding the development footprint.

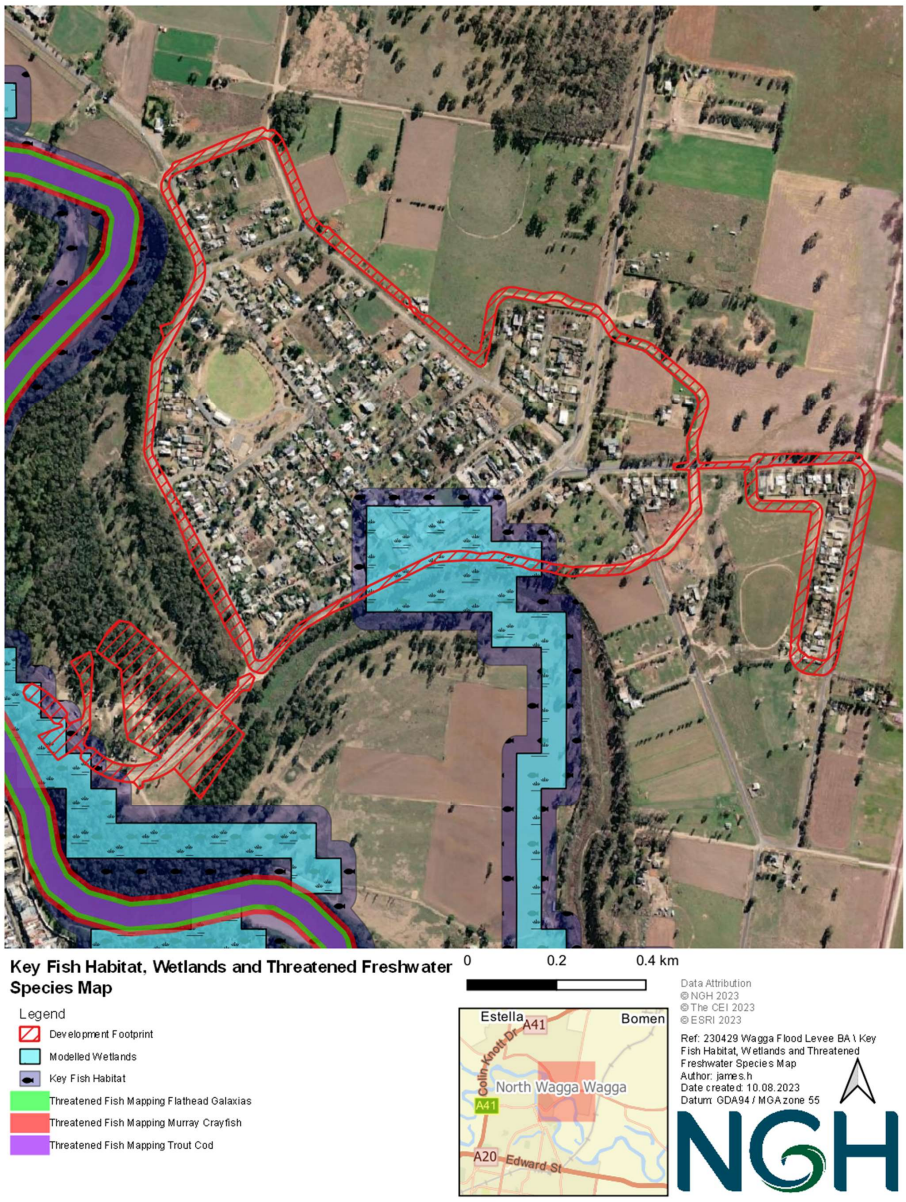


Figure 3-3 Map showing Modelled Wetlands, Key Fish Habitat and Threatened Freshwater Species Map surrounding the development footprint.

3.2. Field assessment

A preliminary site assessment was completed on 10 February 2023. The site is most comprised of derived grasslands along roadsides and existing levees. A portion of the southwestern area of the development footprint occurs within Wilks Park (see Figure 1-1), a 33 hectare moderate to good condition woodland with a diversity of plant communities and riparian woodland along 1.5 km of the Murrumbidgee River. Wilks Park contains 141 hollow bearing trees with a recorded total of 968 hollows from small to extra-large in size. The area surrounds the largely urban/rural suburb of North Wagga with mostly residential land and some recreational and rural land uses.

Ecologists were faced with limitations including access based (due to flooding) and time based (due to survey duration).

3.2.1. Native vegetation

Four (4) PCTs were identified within the development footprint during the field visit. These are shown in Figure 3-4 below. The communities include the following:

- PCT 5 – *River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion.*
- PCT 9 - *River Red Gum - wallaby grass tall woodland wetland on the outer River Red Gum zone mainly in the Riverina Bioregion*
- PCT 74 - *Yellow Box - River Red Gum tall grassy riverine woodland of NSW South Western Slopes Bioregion and Riverina Bioregion*
- PCT 796 - *Derived grassland of the NSW South Western Slopes*.

Two step point method assessments were taken at Wilks Park. The assessments confirmed the grassland and woodlands included native composition. Step point method results are displayed in Table 3-2 below.

Table 3-2 Results of step point method survey for assessing native groundcover

Cover type	Native (%)	Exotic (%)	Bare Ground (%)	Litter (%)
Woodland Survey	51	23	3	23
Grassland Survey	49	51	0	0

3.2.2. Exotic vegetation

Various compositions of exotic vegetation occurred within the study area. These areas are dominated by the species Annual Meadow Grass (**Poa annua*), **Paspalum sp.*, and Wireweed (**Polygonum aviculare*). Areas of exotic grassland are estimated to contain roughly 15% native species (*Cynodon dactylon.* and *Chloris truncata*).

NOTE: Rapid assessments were undertaken for exotic areas by the NGH ecologist on site. No step point method assessments were taken in these zones. Step point method assessments will be required if exotic vegetation needs to be mapped at a more refined scale.

3.2.3. Planted native vegetation

Planted native vegetation identified within the study area consisted of Couch Grass (*Cynodon dactylon*). This grass was evident on the on the pre-existing levee. A row of around 8 planted Yellow Box (*Eucalyptus melliodora*) occurred to the south of Hampden Avenue. These trees were included as part of PCT 74.

3.2.4. Threatened Ecological Communities

The following two Critically Endangered Ecological Communities (CEECs) were identified to be associated with PCTs 74 and 796 recorded within the Development Footprint:

- (**BC Act**) *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions* (Box-gum Woodland).
- (**EPBC Act**) *White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (Box-gum Woodland).

PCT 74 and PCT 796 are both associated with the BC Act Box-gum Woodland Threatened Ecological Community (TEC) and the EPBC Act Box-gum Woodland TEC. An assessment of these PCTs against the BC Act listing criteria and EPBC Act listing criteria are shown below in Table 3-3 and Table 3-4 respectively.

These PCTS were found not to meet the criteria for Box-Gum Woodland TEC under the BC Act and EPBC Act.

Table 3-3 BC Act Box Gum Woodland TEC assessment for PCT 74 and 796

BC Act Requirement	PCT 74	PCT 796
1. **Is, or was previously, at least one of the most common overstorey species White Box, Yellow Box or Blakely's Red Gum?**	No. River Red Gum (*E. camaldulensis*) is the most common overstorey species with abundant large remnant trees. Yellow Box (*E. melliodora*) is present but in low numbers and is not in considered to be dominant. The site is on the floodplain of the Murrumbidgee River which typically is characterised by River Red Gum and it is unlikely to have supported dominance of White Box, Yellow Box or Blakely's Red Gum in the past.	No. The dominant surrounding species are remnant and regenerating River Red Gum (*E. camaldulensis*). The site is on the floodplain of the Murrumbidgee River which typically is characterised by River Red Gum and it is unlikely to have supported dominance of White Box, Yellow Box or Blakely's Red Gum in the past.
2. **The site is in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands or NSW**	N/A - Initial canopy species criteria not met; further assessment not required.	N/A - Initial canopy species criteria not met; further assessment not required.

South Western Slopes Bioregions		
3. The site has a mainly grassy ground layer.	N/A - Initial canopy species criteria not met; further assessment not required.	N/A - Initial canopy species criteria not met; further assessment not required.
4. The site contains the listed characteristic species (including as part of the seedbank)	N/A - Initial canopy species criteria not met; further assessment not required.	N/A - Initial canopy species criteria not met; further assessment not required.
5. Or, If the site has been degraded, is there potential for assisted natural regeneration of the tree layer or understory.	N/A - Initial canopy species criteria not met; further assessment not required.	N/A - Initial canopy species criteria not met; further assessment not required.
Conclusion	**Does not form part of Box-gum Woodland TEC**	**Does not form part of Box-gum Woodland TEC**

Table 3-4 EPBC Act Box Gum Woodland TEC assessment for PCT 796

EPBC Requirement	PCT 796
Is, or was previously, at least one of the most common overstory species White Box, Yellow Bo or Blakely's Red Gum.	No. The dominant surrounding species are remnant and regenerating River Red Gum (*E. camaldulensis*). The site is on the floodplain of the Murrumbidgee River which typically is characterised by River Red Gum and it is unlikely to have supported dominance of White Box, Yellow Box or Blakely's Red Gum in the past.
Does the patch have a predominantly native understory	N/A - Initial canopy species criteria not met; further assessment not required.
Is the Patch 0.1ha or greater in size	N/A - Initial canopy species criteria not met; further assessment not required.
There are 12 or more native understory species (excluding grasses).	N/A - Initial canopy species criteria not met; further assessment not required.
Is the Patch 2 ha or greater in size	N/A - Initial canopy species criteria not met; further assessment not required.
Does the patch have an average of 20 or more mature trees per hectare (mature trees at least 125cm DBH)	N/A - Initial canopy species criteria not met; further assessment not required.
Is there natural regeneration of Yellow Box	N/A - Initial canopy species criteria not met; further

plus mature trees at least 125cm DBH	assessment not required.
Conclusion	Does not form part of Box-gum Woodland TEC

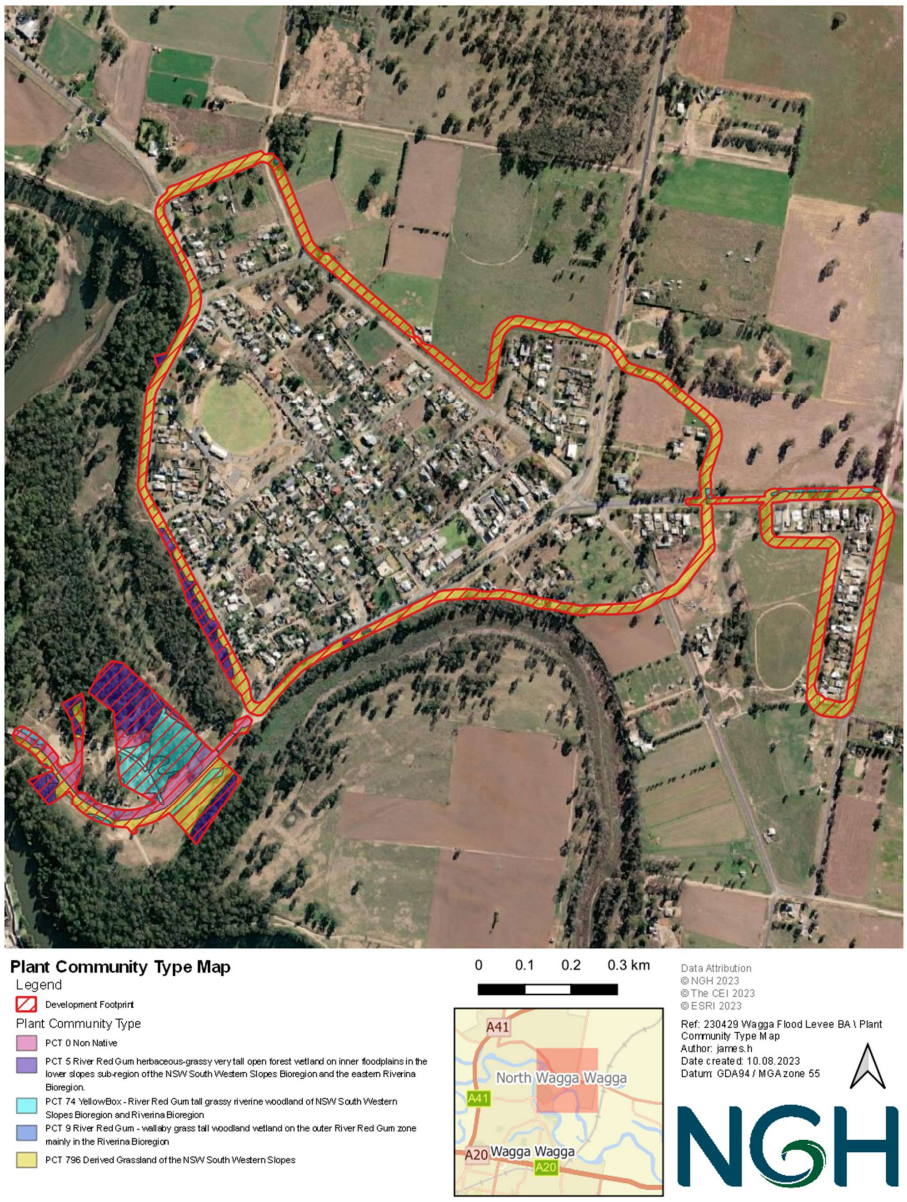


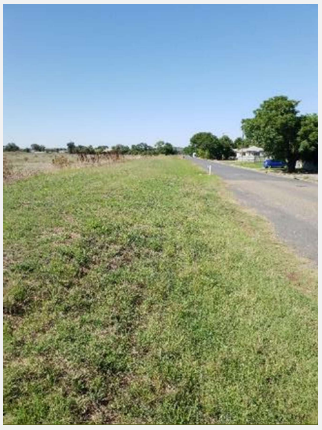
Figure 3-4 Plant Community Type map

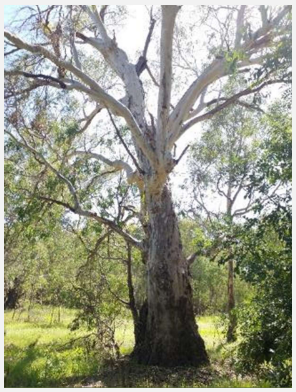
3.2.5. Terrestrial habitat

The flora and fauna habitat recorded in the development footprint consists of:

- Woodland, Riparian Woodland
- Floodplain transition Forest.
- Grassland.

Table 3-5 Terrestrial habitat identified within the development footprint

Habitat / feature	Description	Image
Woodland (PCT 5, 9, 74)	Remnant woodland was identified in the study area. This woodland occurred in both large and small stands. Woodland provides valuable foraging and breeding habitat for native fauna. Remnant trees had numerous large hollows and are important habitat for threatened squirrel glider, superb parrot and other threatened species breeding in the area. PCT 5 - The Inland Riverine Forests is found within this forested wetland that will be impacted by the proposed works. This PCT will provide suitable habitat for threatened species and will be the most impacted. PCT 74 - Floodplain Transition Woodlands with weed dominated ground cover but native trees present. Large amounts of HBTs found within this PCT.	
Grassland (PCT 796)	The vegetation present is largely non-native but is mapped as native as a precautionary approach. This makes up a majority of the vegetation mapped within the development footprint and would provide limited habitat for threatened species. Native grasses did occur in low to moderate densities. Native grasses provide foraging resources for native species. Most of the site was dominated by exotic perennial grasses - exotic grasses provide a low resource for foraging and refuge. Grasses within the development footprint at the time of the site assessment provided a very low foraging and refuge resource due to the recent mowing of the site.	

Woody debris	Fallen timber was observed in a few disturbed locations throughout the study area. One area contained timber piles from pushed up vegetation. Fallen timber provides shelter and foraging resources for several native fauna species including small reptiles and ground-foraging birds.	
Hollow-bearing trees (HBTs)	HBTs occurred within the survey area. HBTs are an increasingly rare resource for fauna. HBTs take up to 100 years to start forming, many fauna species are dependent on hollow-bearing trees for breeding, nesting and roosting including a number of threatened species. HBTs within townships are generally low density and therefore provide a high-level of biodiversity value.	

3.2.6. Aquatic habitat

The Parken Pregan Lagoon is an ephemeral man-made tributary of the Murrumbidgee River. The edges of this waterway are likely to impacted by the proposed works. This area was flooded during the field survey. As such information about aquatic habitat type and condition was not collected. Impacts to aquatic habitat have not been thoroughly assessed and may require further investigation. Impacts to aquatic habitat may be exacerbated if a flood event coincides with construction works around Parken Pregan Lagoon. Mitigation measures have been outlined in Section 7.

The Murrumbidgee River and Parkan Pregan lagoon is listed as Key Fish Habitat (Figure 3-3). A search of the NSW threatened fish distributions (DPI, 2016) identified three threatened aquatic species and one EEC listed under the NSW Fisheries Management Act (FM Act) occur within the locality. These are;

- Murray Crayfish (*Euastacus armatus*)
- Flathead Galaxia (*Galaxias rostratus*)
- Trout Cod (*Maccullochella macquariensis*)
- Murray River EEC -*The aquatic ecological community in the natural drainage system of the lower Murray River catchment*

A habitat evaluation was completed for these species and is presented in Appendix A. None of these species are considered to be directly impacted by the proposal however there may be indirect impacts related to sedimentation or works being undertaken during a flooding event.

3.2.7. Threatened flora

No threatened flora species were identified during the site inspection; however, no targeted threatened species survey were undertaken. A search of the NSW BioNet Atlas found records of the following 3 flora species within 2km of the development footprint:

- Claypan Daisy *Brachyscome mulleriodes* (1889)
- Small Purple-pea *Swainsona recta* (1900)
- Woolly Ragwort *Senecio garlandii* (2008)

A habitat evaluation was completed for these species and is presented in Appendix A. Two of the three flora species are records more than 100 years old and were located in areas that are now suburban areas. The Woolly Ragwort record from 2008 is also situated in an area of urban Wagga Wagga however suitable rocky habitat for this species does not occur in the development footprint. No threatened flora are considered to occur within the development footprint.

3.2.8. Threatened Fauna

No threatened species were identified during the site inspection; however, no targeted threatened species survey were undertaken. A search of the NSW BioNet Atlas found records of the following 21 fauna species within 2km of the development footprint:

- Barking Owl *Ninox connivens* (2000)
- Bilby *Macrotis lagotis* (1912)
- Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae* (2019)
- Dusky Woodswallow *Artamus cyanopterus cyanopterus* (2011)
- Flame Robin *Petroica phoenicea* (2019)
- Freckled Duck *Stictonetta naevosa* (2003)

- Grey-crowned Babbler (eastern subspecies) *Pomatostomus temporalis temporalis* (2016)
- Grey-headed Flying-fox *Pteropus poliocephalus* (2019)
- Latham's Snipe *Gallinago hardwickii* (1977)
- Little Eagle *Hieraaetus morphnoides* (2018)
- Little Lorikeet *Glossopsitta pusilla* (2015)
- Regent Honeyeater *Anthochaera Phrygia* (1977)
- Scarlet Robin *Petroica boodang* (1978)
- Sharp-tailed Sandpiper *Calidris acuminata* (1999)
- Southern Myotis *Myotis Macropus.* (2000)
- Spotted Harrier *Circus assimilis* (2013)
- Superb Parrot *Polytelis swainsonii* (2018)
- Squirrel Glider *Petaurus norfolcensis* (2017)
- Turquoise Parrot *Neophema pulchella* (2014)
- White-bellied Sea-Eagle *Haliaeetus leucogaster* (2019)
- White-throated Needletail *Hirundapus caudacutus* (2019)

A habitat evaluation was completed for these species and is presented in Appendix A.

Based on this assessment, the following species were considered to potentially occur within the development footprint and have the potential to be impacted by the proposed works.

- Parrots
    - Superb Parrot (*Polytelis swainsonii*): BC-V, EPBC-V
    - Turquoise Parrot *(Neophema pulchella)*:BC-V
    - Little Lorikeet (*Glossopsitta pusilla*): BC-V.
- Passerine Birds
    - Varied Sittella (*Daphoenositta chrysoptera*):
    - Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*): BC-V, EPBC-V
    - Hooded Robin *(south-eastern form*): BC-V, EPBC-E
    - Scarlet Robin (*Petroica boodang*): BC-V
    - Diamond Firetail *(Stagonopleura guttata)*: BC-V, EPBC-V
- Raptors
    - Little Eagle (*Hieraaetus morphnoides*): BC-V
    - Black Falcon (*Falco subniger*: BC-V
    - Barking Owl (*Ninox connivens*): BC-V.
- Arboreal Mammals
    - Squirrel Glider (*Petaurus norfolcensis*): BC-V
    - Squirrel Glider in the Wagga Wagga Local Government Area: BC-E
- Bats
    - Grey-headed Flying-fox (*Pteropus poliocephalus*): BC-V, EPBC-V
    - Inland Forest Bat (*Vespadelus baverstocki)*: BC-V
    - Southern Myotis (*Myotis macropus*): BC-V.

Tests and Assessments of Significance have been completed for these groups of species. Refer to Section 4.1

3.2.9. Priority weeds

Plants restricted in trade and movement due to the potential to cause harm to the NSW environment, economy and community under the NSW Biosecurity Act are called 'Priority Weeds'. Weeds of National Significance are weeds that are considered 'the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts.' (DPI, 2022).

Several Priority Weeds for the Riverina were identified during the site assessment including Caltrop (**Tribulus terrestris*), Khaki weed (**Alternanthera pungens*), Horehound (**Marrubium vulgare*), and Lippia (**Phyla canescens*). In NSW, reasonable steps must be undertaken to prevent, eliminate or minimise any biosecurity risk or threat from priority weeds (DPI, 2019).

3.2.10. Hollow bearing trees

A total of 141 hollow bearing trees (HBTs) are recorded within and surrounding the development footprint (See Figure 3-5 and Appendix B). The proposed works will result in the removal of 17 HBTs. All HBTs being impacted contain multiple hollows, with a large portion between the medium and large size (Table 3-6). A total of 83 hollows will be destroyed as a result of the proposed works. There are 124 HBTs to be retained within the area, containing a total of 885 hollows.

Table 3-6 Hollow-bearing trees to be removed

HBT ID	Small <6cm	Medium 6–12cm	Large 12–18cm	Extra Large >18cm	Total
HBT 116	0	2	2	2	6
HBT 115	0	2	2	1	5
HBT 114	0	3	2	1	6
HBT 113	0	2	1	0	3
HBT 112	0	3	1	0	4
HBT 98	0	2	3	0	5
HBT 97	3	4	2	0	9
HBT 25	0	2	0	0	2
HBT 24	0	2	1	0	3
HBT 23	0	2	1	2	3
HBT 22	0	2	2	2	6
HBT 20	0	0	2	2	4
HBT 13	0	3	2	2	7
HBT 6	2	4	1	0	7
HBT 5	1	2	0	0	3
HBT 3	2	3	1	0	6
HBT 2	2	2	0	0	4

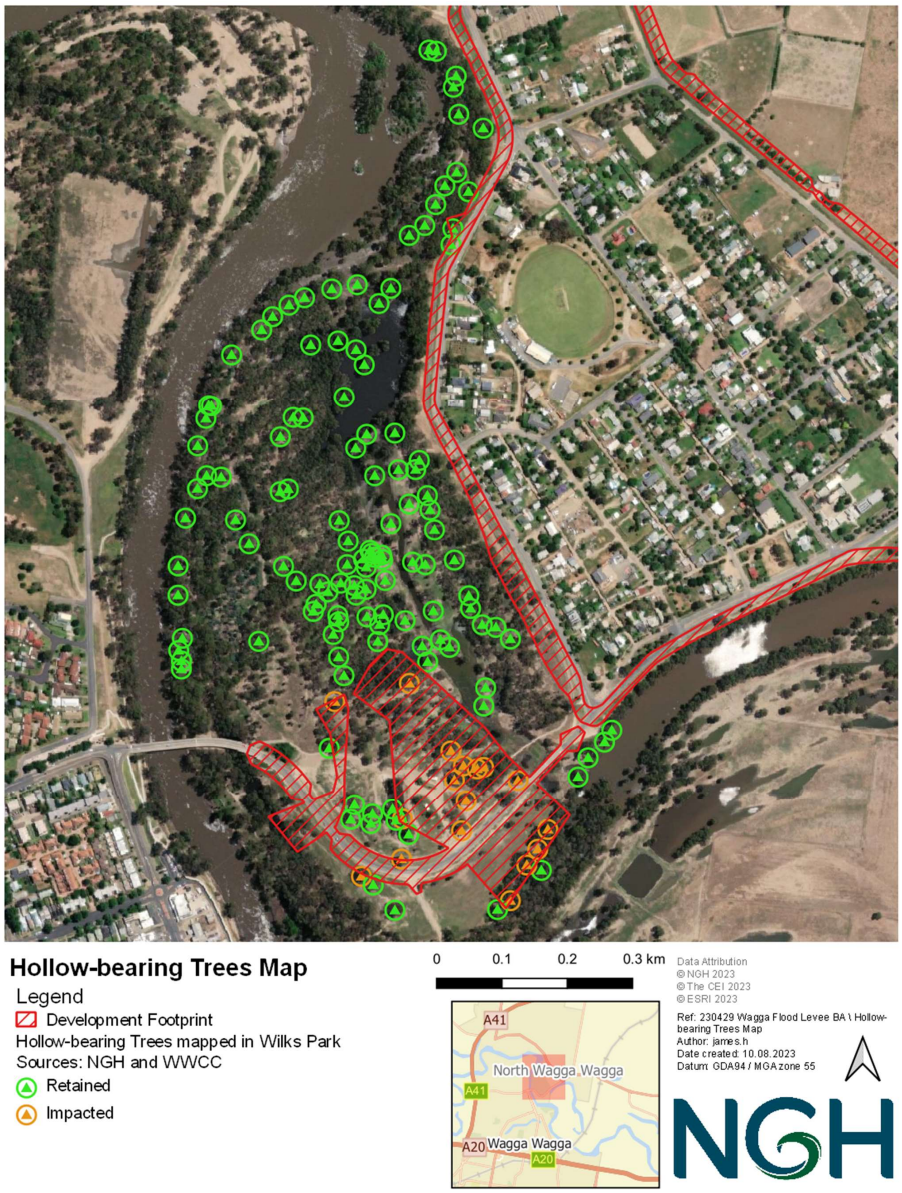


Figure 3-5 Hollow-bearing trees being impacted and retained by the proposed works

4. Assessment of Impacts

4.1. Vegetation

The total area being assessed is 20.53 hectares. A total of 19.98 ha of vegetation will be impacted by the proposal through removal or disturbance. A total of 18.19 ha of native vegetation will be removed by the proposal. The breakdown by PCT of these impacts can be found below in Table 4-1.

The majority of impacts occur to PCT 796 low condition derived grasslands which is mostly comprised of areas along the existing levee or roadsides. 5.71 ha of moderate - good condition Riparian Woodland habitat (PCTs 5, 9 and 74) would be impacted by clearing or soil excavation works. The surrounding patch of woodland within Wilks Park covers an area of 33 ha and the removal of 5.71ha of vegetation results in impacts to around 17.3% of this woodland patch. The proposed works would also increase fragmentation through Wilks Park. At its greatest extent a 393 m wide clearing of vegetation could occur through the centre of suitable woodland habitat. Wilks Park is an isolated remnant of Riverine Woodland within a cleared urban and semi-rural landscape and further fragmentation of isolated patches can lead to direct habitat loss, habitat fragmentation and habitat degradation.

A total of 17 HBTs will be removed as a result of the proposal out of a total 141 within the patch of Wilks Park, which equates to 12.1% removed within the patch. All HBTs being impacted contain multiple hollows, with a large portion between the medium and large size. A total of 83 hollows would be impacted as a result of the proposed works representing 11.6% of hollows present within Wilks Park. HBTs are an important resource for breeding habitat for many threatened fauna species. A decrease in the availability of hollows can lead to significant loss of hollow-dependent animal species diversity and abundance (NSW Scientific Committee, 2021)

Table 4-1 Vegetation impacts

Vegetation	Zone	Development Footprint (ha)
PCT 74 - Yellow Box-River Red Gum tall grassy riverine woodland of NSW South Western Slopes Bioregion and Riverina Bioregion	Moderate – good condition	2.48
PCT 9 - River Red Gum - wallaby grass tall woodland wetland on the outer River red Gum zone mainly in the Riverina Bioregion	Moderate – good condition	0.002
PCT 5 – River Red Gum herbaceous - grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion	Moderate – good condition	3.23
PCT 796 – Derived Grassland of the NSW South Western Slopes	Low Condition	12.48
Exotic Dominated	Bare ground	1.80
TOTAL VEGETATION REMOVAL		19.99

4.2. Threatened species

4.2.1. Terrestrial flora

No threatened flora entities were recorded during survey, and none are considered likely to occur within the development footprint or be impacted by the proposed works.

4.2.2. Terrestrial fauna

Sixteen threatened fauna species were considered to occur and rely on the habitat within the development footprint (Section 3.2.8). 17 HBTs would be removed by the proposed works along with 5.71 ha of Riverine Woodland and thus may impact the hollow dependent fauna residing in the area.

Part 7.3 of the *Biodiversity Conservation Act 2016* (BC Act) specifies five factors to be taken into account in deciding whether a development is likely to significantly affect threatened species, populations or ecological communities, or their habitats, listed at the state level under the BC act. These are;

> *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,*
>
> *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,*
>
> *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*
> >
> > *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*
> >
> > *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,*
>
> *d. whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),*
>
> *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 threatening process.*

A Test of Significance was undertaken for the 16 fauna species considered to occur within the habitats in the development footprint (Appendix C). A summary of the results of the ToS are shown in Table 4-2.

The removal of native vegetation is considered to have a significant impact on four entities;

- Squirrel Glider (*Petaurus norfolcensis*)
- Squirrel Glider in the Wagga Wagga Local Government Area
- Superb Parrot (*Polytelis swainsonii*)
- Barking Owl (*Ninox connivens*)

Table 4-2 Tests of Significance Summary

Threatened Species	Significant impact questions -					Likely Significant Impact?
	a	*b*	*c*	*d*	*e*	
Superb Parrot	**Yes**	**n/a**	**Yes**	**No**	**Yes**	**Yes**
Turquoise Parrot	No	n/a	Partially	No	Yes	No
Little Lorikeet	No	n/a	No	No	Yes	No
Varied Sitella	No	n/a	No	No	Yes	No
Brown Treecreeper	No	n/a	Yes	No	Yes	No
Hooded Robin	No	n/a	No	No	Yes	No
Scarlet Robin	No	n/a	No	No	Yes	No
Diamond Firetail	No	n/a	No	No	Yes	No
Little Eagle	No	n/a	No	No	Yes	No
Black Falcon	No	n/a	No	No	Yes	No
Barking Owl	**Yes**	**n/a**	**No**	**No**	**Yes**	**No**
Squirrel Glider	**Yes**	**n/a**	**Yes**	**No**	**Yes**	**Yes**
Squirrel Glider in the Wagga Wagga LGA	**Yes**	**n/a**	**Yes**	**No**	**Yes**	**Yes**
Grey-headed Flying Fox	No	n/a	No	No	Yes	No
Inland Forest Bat	No	n/a	No	No	Yes	No
Southern Myotis	No	n/a	No	No	Yes	No

4.2.3. Threatened ecological communities

No TECs were recorded within the development footprint, and none are considered likely to occur within the development footprint or be impacted by the proposed works.

4.2.4. Aquatic species

The waterways surrounding the development footprint provide habitat for threatened fish species listed in section 3.2.6. No aquatic species are considered to be directly impacted by the proposal however there may be indirect impacts related to sedimentation or works being undertaken during a flooding event. Erosion and sediment control measures should be implemented, and physical barriers and sediment traps would be required to mitigate impacts on aquatic biodiversity. An emergency erosion and sediment plan should be developed in case of a flood event coinciding with proposed works.

4.3. Priority weeds

Several Priority Weeds for the Riverina were identified during the site assessment including Caltrop (*Tribulus terrestris*), Khaki weed (*Alternanthera pungens*), Horehound (*Marrubium vulgare*), and Lippia (*Phyla canescens*). Further inspection will be required to confirm absence of other priority weeds throughout the development footprint, and map extent of the priority species identified during the site inspection.

The proposed works have the potential to introduce priority weeds or spread weed seeds from other exotic weed species within and out of the development footprint.

The Biosecurity Act dictates that all priority weeds are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any land managers or authorities who deal with any priority has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable. Other exotic flora species that were identified within the study area are common within the region and are often encountered within disturbed areas.

Mitigation measures have been recommended to control the spread of weed seed species by the proposed works and are outlined in Section 33.

5. Biodiversity Offset Scheme evaluation table

Under the BC Act, a Part 5 assessment must determine if the proposed activity is likely to significantly affect threatened species, populations or communities. Further assessment is required if the activity is likely to affect a threatened entity according to the NSW Test of Significant (ToS) or impact a declared area of Outstanding Biodiversity Value (AOBV). Further assessment can either be prepare a Species Impact Statement (SIS) or opt into the Biodiversity Offset Scheme (BOS) and prepare a Biodiversity Development Assessment Report (BDAR). A BDAR must be prepared under the Biodiversity Assessment Methodology (BAM) by an accredited BAM Assessor.

A summary of the results of the assessments are provided in Table 5-1 below.

Table 5-1 Summary of results of 5-part Tests of Significance.

Species	Significant Impact (yes/no)
Superb Parrot (*Polytelis swainsonii*)	YES
Turquoise Parrot *(Neophema pulchella)*	NO
Little Lorikeet (*Glossopsitta pusilla*)	NO
Varied Sittella (*Daphoenositta chrysoptera*)	NO
Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)	NO
Hooded Robin *(south-eastern form)*	NO
Scarlet Robin (*Petroica boodang*)	NO
Diamond Firetail *(Stagonopleura guttata)*	NO
Little Eagle (*Hieraaetus morphnoides*)	NO
Black Falcon (*Falco subniger)*	NO
Barking Owl (*Ninox connivens*)	YES
Squirrel Glider (*Petaurus norfolcensis*)	YES
Squirrel Glider in the Wagga Wagga Local Government Area	YES
Grey-headed Flying-fox (*Pteropus poliocephalus*)	NO
Inland Forest Bat (*Vespadelus baverstocki)*	NO
Southern Myotis (*Myotis macropus*)	NO

Based on this BA, the proposal is considered likely to trigger a significant impact on the;

- Squirrel Glider
- Squirrel Glider in the Wagga Wagga Local Government Area
- Barking Owl
- Superb Parrot

Hence, under the NSW BC Act further assessment is required for these species through either a Biodiversity development Assessment Report (BDAR) or Species Impact Statement (SIS).

No EPBC Act assessments of significance were undertaken for Commonwealth listed species however these should be undertaken following further assessment. The outcomes of these assessments may also trigger an EPBC referral if a significant impact is identified.

Alternatively, investigations could occur to alter the proposal design to minimise impacts on native vegetation and HBTs. Reducing impacts on excavation within native vegetation areas could reduce the impacts to threatened entities and negate the need for a BDAR or a SIS.

Table 5-2 Biodiversity Offset Scheme Evaluation

Question		Answer	Result
1	Will it be carried out in a declared Area of Outstanding Biodiversity?	**No** – The development footprint does not occur within any declared Areas of Outstanding Biodiversity.	No Areas of Outstanding Biodiversity are present within the development footprint. Hence, this will not trigger the BOS.
2	Are threatened entities likely to be significantly impacted by the proposed works	**Yes –** Four threatened entities likely to be significantly impacted by the proposal.	BOS triggered by significant impact to threatened species, ecological communities and their habitats according to the test in section 7.3 of the BC Act.

6. Key threatening processes

A threat may be listed as a key threatening process (KTP) under the NSW BC Act if it; adversely affects threatened species or ecological communities or could cause species or ecological communities to become threatened. KTPs relevant to the proposal are discussed in Table 6-1 below.

Table 6-1 Table showing KTPs relevant to the proposal

KTP	Relevance
Clearing of native vegetation	The clearing of native vegetation is considered a major contributor to the loss of biodiversity. In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation and off–site impacts such as downstream sedimentation. The proposal will remove 18.19ha of native vegetation which will increase the impacts of this KTP. As such the proposed action is part of this KTP.
Invasion and establishment of exotic vines and scramblers	The proposal has the potential to spread exotic species from the development footprint to other parts of the study area through the transfer and introduction of plant material and soil on machinery. Mitigation measures have been recommended to prevent the spread of weeds on site.
Invasion of native plant communities by exotic perennial grasses	The understorey in the development footprint is already dominated by exotic vegetation, however, weed spread would need to be minimised off-site by following mitigation measures.
Loss of Hollow-bearing Trees	The density of hollow-bearing trees required to sustain viable populations of vertebrates is controlled by the diversity of competing fauna species at a site, population densities, number of hollows required by each individual over the long-term, and the number of hollows with suitable characteristics occurring in each tree. The presence, abundance and species richness of hollow-using fauna are correlated with the density of hollow-bearing trees; suggesting that the availability of hollows is often a limiting environmental factor. In some instances, it is the prey species of a threatened predator that is limited by hollow availability. The distribution and abundance of hollow-bearing trees in NSW has been reduced and fragmented by extensive clearing of native vegetation during the past two centuries, primarily for agriculture. The proposal would increase the impacts of this KTP through the removal of 17 HBTs, which have abundant hollows. These biodiversity features are a rare and limited resource within the existing landscape.

7. Mitigation measures

These safeguards are a tool to assist with minimising the impacts on biodiversity during the proposed works.

Table 7-1 Safeguards and mitigation measures

Impact	*Environmental safeguards*	*Responsibility*	*Timing*
Spread of weeds	All weed material containing seed heads, weeds that contain toxins, and weeds that are able to reproduce vegetatively should be disposed of at an appropriate waste management facility or otherwise properly treated to prevent weed growth.	WWCC	Construction Operation
	All herbicides should be used in accordance with the requirements on the label. Any person undertaking pesticide (including herbicide) application should be trained to do so and have the proper certificate of completion/ competency or statement of attainment issued by a registered training organisation.	WWCC	Construction
	Plant equipment and machinery should be cleaned of all biological matter prior to entering the site and prior to leaving the site. Implementation of designated washdown area.	WWCC	Prior to construction Prior to leaving site
Unexpected threatened species finds.	The site induction should include measures to make employees aware of potential threatened flora and fauna during works and understand the procedures if threatened fauna are detected, this will be recorded as a part of the induction procedure and toolbox talks: o Stop work, o Alert an Ecologist or suitably qualified person for assessment and possible re–location during works.	WWCC	Construction
Removal of hollow-bearing trees	17 HBTs will be removed as a result of the proposed works. Pre-clearance checks are to be undertaken where all hollows are to be inspected by a suitably qualified	WWCC	Prior to

	fauna spotter catcher. Where arboreal fauna are identified hollows will be cleared appropriately. All HBTs in the development footprint must be inspected before excavation/removal can commence.	Subcontractor	construction
	Clearing works to avoid the breeding season of threatened parrots between May and January.	WWCC Subcontractor	Prior to construction
	Salvage and appropriate relocation of any large hollows to trees without hollows	WWCC	Prior to construction
	Suitable artificial nest boxes to be installed at a ratio of 1:1 for hollows removed for microbats, threatened birds and squirrel glider.	WWCC	Prior to construction
Fallen timber removal	All fallen timber within the proposal area is to be remain within the proposal area	WWCC	Construction
Vegetation clearing	All woodland to be impacted is to be surveyed by an ecologist or suitably qualified person to record the presence of any nesting fauna.	WWCC	Prior to construction
	Vegetation to be retained within the proposal area is to be clearly marked.	WWCC	Prior to construction
	Exclusion zones at the extent of the works corridor to limit works encroachment on remnant vegetation.	WWCC	Prior to construction
	Revegetation of groundcover and midcover habitat with endemic native plants representative of PCT 5 and PCT 74 in strategic areas to enhance foraging habitat.	WWCC	Prior to leaving site
Erosion and sedimentation	Clearing of vegetation within the riparian/floodplain zone is likely to result in excess sedimentation or erosion and will require physical barriers and sediment traps to mitigate impacts on aquatic biodiversity. An emergency erosion and	WWCC	Construction and operation

	sediment plan should be developed in case of a flood event coinciding with proposed works.		

8. Conclusion

The proposal will impact on a total of 19.99 ha of vegetation through removal or disturbance. Of this, 18.19 ha is native vegetation and is comprised mostly of derived grasslands but includes some areas of moderate to good condition riparian woodland. The largest impacts to vegetation will be within PCT 796 derived grasslands, a total of 12.48 ha. This PCT is mostly comprised of areas along existing levees or roadsides.

The excavation works surrounding Hampden Avenue will impact 5.71 ha of moderate - good condition riparian woodland habitat (PCTs 5, 9 and 74 are those affected). The proposed works would increase fragmentation through Wilks Park and impact around 17.3% of the riparian woodland patch. The landscape is historically fragmented from the existing road reserve and further vegetation clearing can lead to direct habitat loss, habitat fragmentation and habitat degradation for threatened species.

The proposed works will result in the removal of 17 HBTs out of a total 141 within the patch of Wilks Park, which equates to 12.1% removed within the patch. All HBTs being impacted contain multiple hollows, with a large portion between the medium and large size. A total of 83 hollows would be impacted as a result of the proposed works representing 11.6% of hollows present within Wilks Park.

No TECs were recorded within the development footprint, and none are considered likely to occur within the development footprint or be impacted by the proposed works. Threatened species tests of significance were undertaken for 16 entities with the results indicating a significant impact likely for the following four entities:

- Squirrel Glider (*Petaurus norfolcensis*)
- Squirrel Glider in the Wagga Wagga Local Government Area
- Superb Parrot (*Polytelis swainsonii*)
- Barking Owl (*Ninox connivens*)

No EPBC Act assessments of significance were undertaken for Commonwealth listed species however these will be undertaken following further assessment. The outcomes of these assessments may also trigger an EPBC referral if a significant impact is identified.

Based on this BA, the proposal is considered to incur significant impacts on threatened species. Hence, under the NSW BC Act further assessment is required for these species through either a Biodiversity development Assessment Report (BDAR) or Species Impact Statement (SIS).

An alternative to requiring a BDAR or SIS would be to redesign or alter the location of excavation to avoid impacts on native vegetation and HBTS. Mitigation measures have been recommended to minimise impacts by the proposal.

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Appendix A Species habitat evaluation table

The tables in this appendix present the habitat evaluation for threatened species, ecological communities, and endangered populations listed within 10km of the development footprint in the Atlas of NSW Wildlife[1] and those identified as potentially occurring in the area according to the Commonwealth EPBC Protected Matters Search Tool (PMST).[2]

The likelihood of occurrence is based on presence of habitat, proximity of nearest records, and mobility of the species (where relevant).

The assessment of potential impact is based on the nature of the proposal, the ecology of the species, and its likelihood of occurrence. The following classifications are used:

Presence of habitat

Present:	Potential or known foraging, roosting, nesting, refuge, movement corridor (including movement of genetic material) or other habitat is present within the study area.
Marginal:	Limited habitat with some features that may be used by species within the study area.

Absent: No potential foraging, roosting, nesting, or other habitat is present within the study area.

Likelihood of occurrence

Low	It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (10km). It may be an occasional visitor, but habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area, or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
Moderate	Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however, may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
High	It is highly likely that a species inhabits the study area and is dependent on identified suitable habitat (i.e. for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10km) and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the study area during regular seasonal movements or migration.
Recorded	Species was recorded during the field investigations or has recorded previously.

[1] The NSW Bionet Atlas is administered by the Department of Planning and Environment (DPE) and is an online database of fauna and flora records that contains over four million recorded sightings.
[2] This online tool is designed for the public to search for matters protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is managed by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW).

Potential to be Impacted

Low	The proposal would not impact this species or its habitats. No Test of Significance (ToS) or Assessment of Significance (AoS) is necessary for this species.
Moderate	The proposal could impact this species or its habitats however the impacts are considered manageable such that no direct or indirect impacts are likely. Test of Significance (ToS) or Assessment of Significance (AoS) may be required for this species.
High	The proposal is likely to impact this species or its habitats. A ToS has been applied to these entities.

Key: V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory

A.1 FLORA

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Flora								
Austrostipa wakoolica **A Spear-grass**	-	E	Grows on floodplains of the Murray River tributaries, in open woodland on grey, silty clay or sandy loam soils; habitats include the edges of a lignum swamp with box and mallee; creek banks in grey, silty clay; mallee and lignum sandy-loam flat; open Cypress Pine forest on low sandy range; and a low, rocky rise.	PMST	Marginal	Low	Low	Silty clays present onsite although no lignum swamp or open cypress pine forest present.
Brachyscome muelleroides **Claypan Daisy**	V	V	Grows in damp areas on the margins of claypans in moist grassland with Pycnosorus globosus, Agrostis avenacea and Austrodanthonia duttoniana. Also recorded from the margins of lagoons in mud or water, and in association with Calotis anthemoides. Victorian collections have generally come from open positions on the Murray River floodplain, swampy River Red Gum (Eucalyptus camaldulensis) Forest and damp depressions. Occurs in the Wagga Wagga, Narranderra, Tocumwal and Walbundrie areas. Also occurs in north-central Victoria	1 (1889) PMST	Present	Low	Low	No current records within locality. Historic record (pre 1900 within suburban area) is no longer present. The habitat present is suitable however understory is highly disturbed and it is unlikely that the species is present onsite.

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			(only along the Murray from Tocumwal to the Ovens River)					
Caladenia arenaria **Sand-hill Spider-orchid**		E	Occurs in woodland with sandy soil, especially that dominated by White Cypress Pine (*Callitris glaucophylla*).	PMST	Absent	Low	Low	No suitable habitat will be impacted.
Lepidium aschersonii **Spiny Peppercress**	V	V	Found on ridges of gilgai clays dominated by Brigalow (Acacia harpophylla), Belah (Casuarina cristata), Buloke (Allocasuarina luehmanii) and Grey Box (Eucalyptus A-IIIagittateA-III). In the south has been recorded growing in Bull Mallee (Eucalyptus behriana). Often the understorey is dominated by introduced plants. The species grows as a component of the ground flora, in grey loamy clays. Vegetation structure varies from open to dense, with sparse grassy understorey and occasional heavy litter. Occurs in the marginal central-western slopes and north-western plains regions of NSW (and potentially the southwestern plains).	PMST	Absent	Low	Low	No suitable habitat will be impacted.
Lepidium monoplocoides	E	E	Collected from widely scattered localities, with large numbers of historical records but	PMST	Marginal	Low	Low	Some suitable tree species in the

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Winged Pepper-cress			few recent collections. There is a single collection from Broken Hill and only two collections since 1915, the most recent being 1950. Also previously recorded from Bourke, Cobar, Urana, Lake Cargelligo, Balranald, Wanganella and Deniliquin. Recorded more recently from the Hay Plain, south-eastern Riverina, and from near Pooncarie. Occurs on seasonally moist to waterlogged sites, on heavy fertile soils, with a mean annual rainfall of around 300-500mm. Predominant vegetation is usually an open woodland dominated by *Allocasuarina luehmannii* (Bulloak) and/or eucalypts, particularly *Eucalyptus largiflorens* (Black Box) or *Eucalyptus populnea* (Poplar Box). The field layer of the surrounding woodland is dominated by tussock grasses. Recorded in a wetland-grassland community comprising *Eragrostis australasicus, Agrostis avenacea, Austrodanthonia duttoniana, Homopholis proluta, Myriophyllum crispatum, Utricularia dichotoma* and *Pycnosorus globosus*, on waterlogged grey-brown clay. Also recorded from a *Maireana pyramidata* shrubland.					floodplain area being impacted although the site is mainly dominated by alluvial clays and the species has not been recorded within the area.

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Senecio garlandii **Woolly Ragwort**	V	-	Woolly Ragwort occurs on sheltered slopes of rocky outcrops.	2 (2001–2008)	Absent	Low	Low	No rocky outcrops will be impacted by the proposed works.
Swainsona murrayana **Slender Darling-pea, Slender Swainson, Murray Swainson-pea**	V	V	Found throughout NSW, it has been recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree. The species has been collected from clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams. Grows in a variety of vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with *Maireana* species. Plants have been found in remnant native grasslands or grassy woodlands that have been intermittently grazed or cultivated.	PMST	Marginal	Low	Low	Site is dominated by River Red gum woodland and a swampy grassland. Limited levels of bladder saltbush or blackbox. The soil is mainly silty and alluvial clay rather than the brown cracking clays required by the species.
Swainsona recta **Small Purple-pea**	E	E	It has been recorded previously at Carcoar, Culcairn and Wagga Wagga but is thought to be extinct from these areas. Populations are still present in Queenbeyan, the ACT and Wellington–Mudgee areas. Plants are	2 (1900) PMST	Absent	Low	Low	No current records within locality. Historic records (pre 1900 within suburban area) are no longer present

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			commonly found on railway easements. It occurs in the grassy understory of woodlands, and open–forests dominated by Blakely's Red Gum Eucalyptus blakelyi, Yellow Box E. melliodora, Candlebark Gum E. rubida and Long–leaf Box E. goniocalyx. They are found in dry sclerophyll forests, grasslands, and grassy woodlands.					Species habitat is within dry sclerophyll forests, grasslands and grassy woodlands. A floodplain riparian area will be impacted.
Threatened Ecological Communities								
Coolac-Tumut Serpentinite Shrubby Woodland in the NSW South Western Slopes and South Eastern Highlands Bioregions	E	-	Vegetation growing on soils derived form serpentinite in the Coolac-Tumut area Coolac-Tumut Serpentinite Shrubby Woodland consists of an overstorey of drooping sheoak (*Allocasuarina A-VlagittateA-VIA-VIe*) with the shrubs hickory wattle (*Acacia implexa*), grasstrees (*Xanthorrhoea glauca*) and *Ricinocarpos bowmanii.*The groundlayer is consists of a range of native grasses and herbs, often including kangaroo grass (*Themeda australis*), wiregrasses (*Aristida* spp.), wallaby grasses (*Rytidosperma* spp.), *Senecio quadridentatus*, rock fern (*Cheilanthes seiberi*) and *Carex breviculmis*. Scattered	Bionet	Absent	Low	Low	No associated PCTs

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			trees of white box (*Eucalyptus albens*) and bundy (*Eucalyptus nortonii*) can occur.					
Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	E	-	Community occurs on brown loam or clay, alluvial or colluvial soils on prior streams and abandoned channels or slight depressions on undulating plains or flats of the western slopes. Community often occurs upslope from River Red Gum communities above frequently inundated areas of the floodplain. It also occurs on colluvium soils on lower slopes and valley flats. Less than 5% of the original extent is estimated to remain. Shrubs include Wilga, Deane's Wattle, Hop Bush, Cassia, Water Bush and Sifton Bush.	Bionet	Absent	Low	Low	No associated PCTs
Grey Box (Eucalyptus A-VIlagittateA-VII) Grassy Woodlands and Derived Native Grasslands of	-	E	The Grey Box (Eucalyptus A-VIlagittateA-VII) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia predominantly occurs on the drier edge of the temperate grassy eucalypt woodland belt and ranges from central New South Wales through northern and central Victoria into South Australia. Patches that are disjunct	PMST	Absent	Low	Low	No associated PCTs

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
South-eastern Australia			from the main belt of the ecological community occur to the south of the Great Dividing Range in Victoria, around Melton and Sunbury to the west of Melbourne (Oates and Taranto, 2001), and also to the west of the Murray River coastal plain in South Australia, around the Flinders and Mount Lofty Ranges near Adelaide (Robertson, 1998). The Grey Box (E. A-VIIIagittateA-VIII) Grassy Woodlands and Derived Native Grasslands of SouthEastern Australia ecological community is relatively less well studied and understood in comparison with other grassy woodland systems in south-eastern Australia. The ecological community also occupies a complex position in the landscape.					
Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt	E	-	Inland Grey Box Woodland occurs on fertile soils of the western slopes and plains of NSW. The community generally occurs where average rainfall is 375- 800 mm pa and the mean maximum annual temperature is 22- 26°C. There is a correlation between the distribution of Eucalyptus A-VIIIagittateA-VIII communities and soils of Tertiary and	Bionet	Absent	Low	Low	No associated PCTs

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
South Bioregions			Quaternary alluvial origin, largely corresponding with the Red Brown Earths. The majority of remnant patches of Inland Grey Box Woodland survive with trees largely intact but with the shrub or ground layers degraded to varying degrees through grazing or pasture modification. Some species that are part of the community appear intolerant to heavy grazing by domestic stock and are confined to the least disturbed remnants.					
Mallee and Mallee-Broombush dominated woodland and shrubland, lacking Triodia, in the NSW South Western Slopes Bioregion	CE	-	The variant of the community dominated by Bull Mallee and White Mallee tends to occur on plains to the east and north of West Wyalong on red earths including the aeolian soil known as parna. The variant dominated by Blue Mallee – Bull Mallee – Green Mallee tends to occur on low hills and rises in sandy loam soils over substrates including gravel ferricrete (ironstone) and mixed sedimentary, metamorphic and granitic substrates The third variant, Broombush - Green Mallee – Blue Mallee, occurs in loamy sands on rocky rises of sandstone and other	Bionet	Absent	Low	Low	No associated PCTs

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			sedimentary rock types, mainly to the south west of West Wyalong.					
Murray River EEC-The aquatic ecological community in the natural drainage system of the lower Murray River catchment.	FM listed – E		The lower Murray River endangered ecological community includes all native fish and aquatic invertebrates within all natural creeks, rivers, and associated lagoons, billabongs and lakes of the regulated portions of the Murray River (also known as the River Murray) downstream of Hume Weir, the Murrumbidgee River downstream of Burrinjuck Dam, the Tumut River downstream of Blowering Dam and all their tributaries anabranches and effluents including Billabong Creek, Yanco Creek, Colombo Creek, and their tributaries, the Edward River and the Wakool River and their tributaries, anabranches and effluents, Frenchmans Creek, the Rufus River and Lake Victoria.	FM	Present	Low	Low	The EEC is present within the area. Although the proposed works are unlikely to have a significant impact on the EEC based on the type of works. Impact of waterways will be limited if standard erosion and sedimentation controls are implemented.
Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar	E	-	Typically, it occurs on red-brown earths and heavy textured grey and brown alluvial soils within a climatic belt receiving between 375 and 500 mm mean annual rainfall. The structure of the community varies from low	Bionet	Absent	Low	Low	No associated PCTs

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions			woodland and low open woodland to low sparse woodland or open shrubland, depending on site quality and disturbance history. The tree layer grows up to a height of about 10 metres and invariably includes *Acacia pendula* (Weeping Myall or Boree) as one of the dominant species or the only tree species present. The understorey includes an open layer of chenopod shrubs and other woody plant species and an open to continuous groundcover of grasses and herbs. The structure and composition of the community varies, particularly with latitude, as chenopod shrubs are more prominent south of the Lachlan River district, while other woody species and summer grasses are more common further north. In some areas the shrub and canopy stratum may have been reduced or eliminated by clearing or heavy grazing, leaving derived grassland that may still constitute this community.					
Sandhill Pine Woodland in the Riverina, Murray-Darling Depression and	E	-	I n the Riverina bioregion and the far south-western portion of the NSW South Western Slopes bioregion, the community is typically associated with prior streams and aeolian source-bordering dunes, which are scattered	Bionet	Absent	Low	Low	No associated PCTs

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
NSW South Western Slopes bioregions			within an extensive alluvial clay plain dominated by chenopod shrublands. Sandhill Pine Woodland typically occupies red-brown loamy sands with alkaline sub-soils on the alluvial plain of the Murray River and its tributaries, and on parts of the sandplain in south-western NSW. The structure of the community varies depending on past and current disturbances, particularly clearing, logging, grazing and soil erosion, with species composition of sites being influenced by their size, recent rainfall or drought conditions and by their disturbance history, including grazing, land clearing and fire. The number and relative abundance of species will change with time since fire, and may also change in response to changes in fire frequency or grazing regime. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. At any one time, above-ground individuals of some species may be absent, but the					

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			species may be represented below ground in soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. Sandhill Pine Woodland shares a number of species with another endangered ecological community listed under the Threatened Species Conservation Act 1995: *Allocasuarina luehmannii* Woodland in the Riverina and Murray-Darling Depression bioregions. These two ecological communities inhabit similar soils and landforms and have similar geographic distributions. They may be distinguished on the basis of the relative abundance of their tree species and subtle differences in composition of their understorey. When tree abundance is assessed at the hectare scale, White Cypress Pine is the most abundant tree species in Sandhill Pine Woodland, whereas in *Allocasuarina luehmannii* Woodland, Buloke (*A. luehmannii*) is the most abundant tree species.					

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland / ***White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner***	CE	CE	Characterised by the presence or prior occurrence of White Box, Yellow Box and/or Blakely's Red Gum and a generally grassy understorey. The trees may occur as pure stands, mixtures of the three species or in mixtures with other trees, including wattles. Commonly co-occurring eucalypts include Apple Box (*E. bridgesiana*), Red Box (*E. polyanthemos*), E. macrorhyncha), Coastal Grey Box (*E. moluccana*), Candlebark (*E. rubida*), Bundy (*E. goniocalyx*), Broad-leaved Stringybark (*E. goniocalyx*), Youman's Stringybark (*E. youmanii*) and others. The understorey in intact sites is characterised by native grasses and a high diversity of herbs; the most commonly encountered include Kangaroo Grass (*Themeda australis*), Poa Tussock (*Poa sieberiana*), wallaby grasses (*Rytidosperma* spp.), spear-grasses (*Austrostipa* spp.), Common Everlasting (*Chrysocephalum apiculatum*), Scrambled Eggs (*Goodenia pinnatifida*), Small St John's Wort (*Hypericum gramineum*), Narrow-leafed New Holland Daisy (*Vittadinia muelleri*) and blue-bells (*Wahlenbergia* spp.)	PMST / Bionet	Absent – Some Yellow Box present however River Red Gum is the dominant overstory species and based on the age of the trees and landscape formation, River Red Gum has likely been the dominant overstory species historically.	Low	Low	No characteristic vegetation and landscape.

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Weeping Myall Woodlands	-	E	Species assemblage Weeping Myall trees often occur in monotypic stands, however other vegetation may also occur in the ecological community, though not as dominant species. These include: Western Rosewood (Alectryon oleifolius subsp. Elongatus); Poplar Box (Eucalyptus populnea); or Black Box (Eucalyptus largiflorens) (NSW Scientific Committee 2005; Keith 2004). Grey Mistletoe (Amyema quandang) commonly occurs on the branches of Weeping Myall trees throughout the ecological community's range (NSW Scientific Committee 2005). Other species commonly present in the community are listed in Appendix 1. Weeping Myall goes through regular cycles of senescence (aging and death) and regeneration. Weeping Myall trees are also susceptible to defoliation by Bag-shelter Moth (Ochrogaster lunifer) caterpillars and are often lopped for domestic stock fodder. Therefore, the ecological community can be dominated by Weeping Myall trees that are in a living, defoliated or dead state. The understorey of Weeping Myall Woodlands often includes an open layer of shrubs above an open ground	PMST	Absent	Low	Low	No associated PCTs

Species	Listing		Habitat	No. of Records within 10km	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			layer of grasses and herbs, though the ecological community can exist naturally either as a shrubby or a grassy woodland (Beadle 1948; Keith 2004). In many areas, however, the shrub layer has disappeared through overgrazing and dieback events and the woodland now has a primarily grassy understorey (Beadle 1948). The ground layer includes a diversity of grasses and forbs, and varies in species composition and cover depending on past and current grazing regimes, and the occurrence of recent rain (NSW Scientific Committee 2005). In the southern part of the distribution of Weeping Myall Woodlands (south of the midLachlan region), chenopods, such as saltbushes, native cotton bushes, bluebushes, goosefoots and copperburrs, were originally an important component of the understorey. As chenopods are generally highly palatable, they have largely disappeared in areas that have been grazed by stock and/or feral animals for substantial periods of time. In the northern parts of the ecological community, chenopod shrubs are a less prominent component of the understorey					

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Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Amphibians (3)								
Crinia sloanei **Sloane's Froglet**	E	E	This species is typically associated with periodically inundated areas in grassland, woodland and disturbed habitats. Sloane's Froglet lives and breeds in temporary and permanent waterbodies including oxbows off creeks and rivers, farm dams, large and small natural wetlands, constructed frog ponds and temporary puddles. It prefers wetlands that contain riparian and aquatic vegetation. Most often it has been found in waterbodies that contain grasses and reeds that are of medium height and have small stem diameters, such as couch (Elymus repens), watercouch (Paspalum pasplodes) or the Common Spikerush (Eleocharis acuta). Waterbodies containing this type of vegetation are essential for Sloane's Froglet as it lays its eggs attached to vegetation (Knight 2013b). Gilgai and other depressions are favoured habitat on clay plains, while elsewhere they are generally restricted to temporary ponds in	PMST	Present	Moderate	Low	There are no recent records of the species in the area. Species unlikely to be impacted by the proposed works.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			the river valley and up to 8km on either side of large rivers.					
Litoria raniformis **Southern Bell Frog**	E	V	Currently, the species is known to exist only in isolated populations in the Coleambally Irrigation Area, the Lowbidgee floodplain and around Lake Victoria. Usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. They are also found in irrigated rice crops, particularly where there is no available natural habitat. Breeding occurs during the warmer months and is triggered by flooding or a significant rise in water levels. During the breeding season animals are found floating amongst aquatic vegetation (especially cumbungi or Common Reeds). Tadpoles require standing water for at least 4 months for development and metamorphosis to occur but can take up to 12 months to develop. Outside the breeding season animals disperse away from the water and take shelter beneath ground debris such as	PMST	Present	Low	Low	Species habitat is present although the species is known to only exist in isolated populations not within the Wagga Wagga region. Hence, it is unlikely the species is present in the area..

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			fallen timber and bark, rocks, grass clumps and in deep soil cracks.					
Aves (24)								
Anthochaera A-llagitta **Regent Honeyeater**	CE	CE	The Regent Honeyeater is a flagship threatened woodland bird whose conservation will benefit a large suite of other threatened and declining woodland fauna. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes	1 (1980) PMST	Absent	Low	Low	The species inhabits dry open forest and woodland and the area being impacted is River Red Gum riverine woodland. Only one historic record.
Aphelocephala leucopsis **Southern Whiteface**	-	V	Southern Whiteface forage almost exclusively on the ground, favouring habitat with low tree densities and an herbaceous understory litter cover. Birds mainly feed on insects, spiders, and seeds, largely gleaned from the bare ground or leaf litter (Higgins & Peter 2002; Antos & Bennett 2006; Antos et al. 2008).	PMST	Absent	Low	Low	Large tree densities within the development footprint. No records within the area.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Artamus cyanopterus cyanopterus **Dusky Woodswallow**	V	-	Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland.	57 (1977-2017)	Absent	Low	Low	Inhabits mainly dry, open woodlands and farmland on the edge of forest. Most records are outside of the township with the closest record over 1km away. Floodplain area is unlikely to provide suitable habitat for the species.
Botaurus poiciloptilus **Australasian Bittern**	E	E	In NSW, this species occurs along the coast and is frequently recorded in the Murray–Darling Basin, notably in floodplain wetlands of the Murrumbidgee, Lachlan, Macquarie and Gwydir Rivers. Occurs in permanent freshwater wetlands with tall, dense vegetation. Favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, , Bolboschoenus) or cutting grass (Gahnia) growing over muddy or peaty substrate. Breeding occurs in summer from October to January; nests are	PMST	Marginal	Low	Low	No species sightings in Area. The habitat is not a wetland area. It will be of low quality for the species although may be opportunistically used if the species is in the area.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			built in secluded places in densely–vegetated wetlands on a platform of reeds.					
Burhinus grallarius **Bush Stone-curlew**	E	-	Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights. Nest on the ground in a scrape or small bare patch.	5 (1979–2010) PMST	Marginal	Moderate	Low	Records are located on the other side of town with the closest being approximately 7km away. The site is unlikely to provide suitable habitat for the species.
Callocephalon fimbriatum **Gang-gang Cockatoo**	V	E	In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands,particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas. May also occur in sub-alpine Snow Gum (Eucalyptus pauciflora) woodland and occasionally in temperate rainforests. Favours old growth forest and woodland attributes for nesting and roosting. Nests are located in hollows that are 7cm in diameter or larger in	3 (1979) PMST	Marginal	Moderate	Low	Three historic records in the area. Suitable foraging and breeding habitat will be impacted. Species has not been recorded in the area for over 40 years.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			eucalypts and 3 metres or more above the ground.					
Calyptorhynchus lathami lathami **South-eastern Glossy Black-Cockatoo**	V	V	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (*Allocasuarina littoralis*) and Forest Sheoak (*A. torulosa*) are important foods. Inland populations feed on a wide range of sheoaks, including Drooping Sheoak, Allocasuaraina diminuta, and A. gymnathera. Belah is also utilised and may be a critical food source for some populations. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also recorded in open woodlands dominated by Belah (*Casuarina cristata*). Feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina* species), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites. A single egg is laid between March and May.	4 (2005-2007) PMST	Present	Moderate	Moderate	Suitable foraging and breeding habitat will be impacted. No hills or rocky rises are present on site. Species is likely to use habitat but not rely on the habitat.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Chthonicola sagittata **Speckled Warbler**	V	-	The Speckled Warbler has a patchy distribution throughout south–eastern Queensland, the eastern half of NSW and into Victoria. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside.	2 (1977-2020)	Marginal	Low	Low	Records are over 7km away from the development footprint. The species does inhabitant Eucalyptus dominated woodlands. Although no rocky ridges or gullies are present within the development footprint.
Circus assimilis **Spotted Harrier**	V	-	Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland,	6 (1977–2019)	Present	High	High	Species record within 1.5km of the proposal area. Species is found to occur within inland riparian woodlands on the

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months.					edge of wetlands. The species may be impacted by the proposed works and AOS is required.
Climacteris picumnus victoriae **Brown Treecreeper (eastern subspecies)**	V	V	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	37 (1978–2019) PMST	Present	High	High	Records within the impact area suitable habitat present. The species will be impacted by the proposed works. An AOS and TOS will be required.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Daphoenositta chrysoptera **Varied Sittella**	V	-	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland.	3 (1985–2021)	Present	High	High	Suitable habitat present in proposal area. Recent records within the area. Both breeding and foraging habitat will be impacted.
Epthianura albifrons **White-fronted Chat**	V	-	Usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feeding mainly on flies and beetles caught from or close to the ground.	8 (1977–1992)	Absent	Low	Low	Avoids largely wooded habitat. Records are over 30 years old. Species is unlikely to inhabit the proposal area.
Falco hypoleucos **Grey Falcon**	V	V	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey.	PMST	Absent	Low	Low	No records in the area. Wagga is not arid or semi-arid. The species is unlikely to be present.
Falco subniger **Black Falcon**	V	-	The Black Falcon inhabits woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees.	13 (1978–2019)	Present	High	High	Closest record is approximately 1.5km away from the proposal area in similar vegetation. Species is likely to use the proposal area and may be impacted by the

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
								proposed works a ToS is required.
Glossopsitta pusilla **Little Lorikeet**	V	-	NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability. Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophoras, Melaleucas and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species. Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards. Roosts in treetops, often distant from feeding areas. Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth–barked Eucalypts. Entrance is small (3cm) and usually high above the ground (2–15m). These nest sites are often used	49 (1979–2015)	Present	High	High	The species has been recorded Within 1km of the proposal area and is known to inhabit riparian areas. A ToS is required.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like Allocasuarina. Nesting season extends from May to September.					
Grantiella picta **Painted Honeyeater**	V	V	Inhabits Boree/ Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus *Amyema*.	PMST	Marginal	Low	Low	Limited box gum woodlands will be impacted No mistletoe was recorded on site). No records within the area. Species unlikely to be impacted by proposed works.
Haliaeetus leucogaster **White-bellied Sea-Eagle**	V	-	White–bellied Sea–Eagles are a common sight in coastal and near coastal areas of Australia. Birds form permanent pairs that inhabit territories throughout the year. Their loud "goose–like" honking call is a familiar sound, particularly during the breeding season. Birds are normally seen, perched high in a tree, or soaring over waterways and adjacent land. White–bellied Sea–Eagles build a large stick nest, which is used for many seasons in succession. The nest can be located in a tree up to 30m above the ground,	1 (2019)	Marginal	Low	Low	Woodland Present. Unlikely to be dependant on habitat.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			but may be also be placed on the ground or on rocks, where there are no suitable trees.					
Hieraaetus morphnoides **Little Eagle**	V	-	The Little Eagle occurs as a single population throughout NSW. It occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.	28 (1978–2019)	Present	High	High	Numerous records with records within 1km. Riparian woodlands present.
Lathamus discolor **Swift Parrot**	E	CE	Migrates to the Australian south-east mainland between February and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Forest Red Gum *E. tereticornis*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*	21 (1996–2021) PMST	Present	Moderate	Moderate	Suitable foraging habitat and nearby records.
Leipoa ocellata **Malleefowl**	E	V Check	Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich	PMST	Absent	Low	Low	No suitable habitat and no nearby records.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			mallee found in higher rainfall (300–450mm mean annual rainfall) areas. Utilises mallee with a spinifex understorey, but usually at lower densities than in areas with a shrub understorey. Less frequently found in other eucalypt woodlands, such as Inland Grey Box, Ironbark or Bimble Box Woodlands with thick understorey, or in other woodlands such dominated by Mulga or native Cypress Pine species.					
Lophochroa leadbeateri **Major Mitchell's Cockatoo**	V	-	Inhabits a wide range of treed and treeless inland habitats, always within easy reach of water. Feeds mostly on the ground, especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines. Normally found in pairs or small groups, though flocks of hundreds may be found where food is abundant. Nesting, in tree hollows, occurs throughout the second half of the year; nests are at least 1km apart, with no more than one pair every 30 square kilometres.	2 (1998–1999) PMST	Present	Moderate	Moderate	Historic records and potentially suitable foraging and breeding habitat. Habitat is present species is only moderately likely to be present.
Melanodryas cucullata cucullata	V	E	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee,	13	Present	High	High	Suitable habitat present. Multiple records In the area.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Hooded Robin (south-eastern form)			often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.	(1979–2007) PMST				Species is likely to be impacted by the proposed works.
Petroica boodang **Scarlet Robin**	V	-	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat.	9 (1977–2017)	Present	High	High	Suitable habitat present. Multiple records In the area. Species is likely to be impacted by the proposed works.
Melithreptus gularis gularis **Black-chinned Honeyeater (eastern subspecies)**	V	-	The subspecies is widespread, from the tablelands and western slopes of the Great Dividing Range to the north–west and central–west plains and the Riverina. Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark, White Box, Grey Box, Yellow Box and Forest Red Gum. Also inhabits open	3 (1977–2007)	Present	Low	Low	Suitable habitat present. Multiple records In the area. Species is likely to be impacted by the proposed works. Incidental reports also show a decline in the occurrence of birds with the species now only occasionally recorded at a site near Moree

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			forests of smooth–barked gums, stringybarks, ironbarks and tea–trees. Feeding territories are large making the species locally nomadic.					where once they were regular, and an apparent 10 year absence from a once regular recording site near Wagga Wagga. Absent from area.
Neophema chrysostoma **Blue-winged Parrot**	-	V	Foraging and staging habitats found from coastal, sub-coastal and inland areas, right through to semi-arid zones including grasslands, grassy woodlands, and semi-arid chenopod shrubland with native and introduced grasses, herbs and shrubs. Wetlands both near the coast and in semi-arid zones used for foraging and staging. Eucalypt forests and woodlands within the eastern South Australia and southern Victoria.	PMST	Marginal	Low	Low	Woodland Present. Unlikely to be dependent on habitat. No records in the area.
Neophema pulchella **Turquoise Parrot**	V	-	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. Prefers to feed in the shade of a tree and spends most of the day on the	5 (2007–2020)	Present	High	High	Suitable habitat present. Multiple records In the area. Species is likely to be impacted by the proposed works.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			ground searching for the seeds or grasses and herbaceous plants or browsing on vegetable matter. Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.					
Ninox connivens **Barking Owl**	V	-	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey found on these fertile riparian soils.	4 (1984–2004)	Present	High	High	Present suitable woodland with hollow bearing trees.
Oxyura australis **Blue-billed Duck**	V	-	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the	4 (1999–2001)	Marginal	Moderate	Low	Waterbody habitat will only be subject to indirect impacts. Water habitat has limited aquatic vegetation.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached					
Pachycephala inornata **Gilbert's Whistler**	V	-	Sparsely distributed over much of the arid and semi-arid zone of inland southern Australia, from the western slopes of NSW to the Western Australian wheatbelt. Occurs in a range of habitats within NSW, preferring a dense shrub layer. Widely recorded in mallee shrublands, box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests, though at this stage it is only known to use this habitat along the Murray, Edwards and Wakool Rivers. Found in association with an understorey of spinifex and low shrubs including wattles, hakeas, sennas and hop-bushes. In woodland habitats, the understorey comprises dense patches of shrubs, particularly thickets of regrowth Callitris. Parasitic 'cherries' (Exocarpus species) appear to be an important habitat component in Belah and Red Gum communities, though in the latter case other dense shrubs, such as Lignum and wattles, are also utilised. Forages on or near the ground in shrub thickets and in tops	5 (1979–1995)	Marginal	Low	Low	No dense shrub layer. Historic records. River red gum forest is present, but habitat quality may not be suitable.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			of small trees. Food consists mainly of spiders and insects such as caterpillars, beetles and ants, and occasionally, seeds and fruits are eaten. Breeding is August-November. Nests are usually built below about 2.5m (but up to 6m) above the ground in the fork of dense foliage of plants such as wattles or cypress pines.					
Petroica phoenicea **Flame Robin**	V	-	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys. The groundlayer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgelands at high altitudes.	18 (1977–2007)	Present	Moderate	Moderate	Winter foraging habitat present. No breeding habitat present. Records Within 1km of proposed works.
Polytelis swainsonii **Superb Parrot**	V	V	The Superb Parrot is found throughout eastern inland NSW. On the South–western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly	187 (1986–2020)	Present	High	High	Suitable habitat is present in the proposal area. Records within 500m of proposal area. Species may be impacted by the proposed works. ToS and Aos Required.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. Inhabits Box–Gum, Box–Cypress–pine and Boree Woodlands and River Red Gum Forest.					
Pomatostomus temporalis temporalis **Grey-crowned Babbler (eastern subspecies)**	V	-	Inhabits open Grey Box Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Woodlands on fertile soils in coastal regions. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts. Nests are maintained year round, and old nests are often dismantled to build new ones.	5 (2008–2020)	Marginal	Moderate	Moderate	Species has been recorded within 1km of the proposal area. The habitat is lacking in breeding habitat for the species in the form of dense shrub cover.
Rostratula australis **Australian Painted Snipe**	E	E	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	PMST	Absent	Low	Low	No mudflats or swamps. A river is present but not suitable habitat for the species.
Stagonopleura guttata **Diamond Firetail**	V	-	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary	19 (1979–2007)	Present	High	High	Closest record is over 3km from the proposal area. Suitable habitat will be impacted. Multiple records in

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. Areas critical to survival are those with low tree density, few large logs, and little litter cover but high grass cover for foraging, roosting and breeding.					the area. Species may be impacted. ToS required.
Stictonetta naevosa **Freckled Duck**	V	-	Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. Generally rest in dense cover during the day, usually in deep water.	1 (2003)	Marginal	Low	Low	The flowing river is unlikely to provide suitable habitat for the species.
Fish								
Bidyanus bidyanus **Silver Perch, Bidyan**	**V**	CE	Silver Perch were once widespread and abundant throughout most of the Murray-Darling river system. They have now declined to low numbers or disappeared from most of their former range. Only one remaining secure and self-sustaining population occurs in NSW in the central Murray River	PMST	Absent	Low	Low	Outside of existing self-sustaining population range.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			downstream of Yarrawonga weir, as well as several anabranches and tributaries.					
Murray Crayfish ***Euastacus armatus***	V	-	Murray Crayfish prefer cool, flowing water that is well oxygenated. The species is tolerant of water temperatures up to 27°C and moderate salinities, but are intolerant to low dissolved oxygen concentrations. They create burrows that vary in complexity, from deep burrows with multiple entrances to simple burrows under a rock or log	PMST	Absent	Low	Low	Indirect impacts of removing riparian vegetation and soil. May impact the fish in the area if standard erosion and sediment control measures are not followed.
Galaxias rostratus **Flathead Galaxias, Beaked Minnow, Flat-headed Galaxias, Flat-headed Jollytail, Flat-headed Minnow**	CE	CE	Flathead Galaxias are found in still or slow moving water bodies such as wetlands and lowland streams. The species has been recorded forming shoals. They have been associated with a range of habitats including rock and sandy bottoms and aquatic vegetation. Flathead Galaxias spawn in spring and lay slightly adhesive demersal eggs.	PMST	Present	Moderate	Moderate	Indirect impacts of removing riparian vegetation and soil. May impact the fish in the area if standard erosion and sediment control measures are not followed.
Maccullochella macquariensis **Trout Cod**	-	E	In the Murray River below Yarrawonga Weir, Trout Cod inhabit a large (60–100m wide), deep (>3m) flowing river section with a sand, silt and clay substrate that contains abundant snags and woody debris. Trout Cod are often	PMST	Present	Moderate	Moderate	Indirect impacts of removing riparian vegetation. May impact the fish in the area if standard erosion and

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			angled from within, under or adjacent to snags, branch piles, and steep clay banks, usually in areas of relatively fast current .Trout Cod were only found in snag piles that were typically opposite sandy beaches or on outside bends. There is a degree of overlap with the habitat requirements of Murray Cod and therefore competition between these two species is likely As a large proportion of the streams that the Trout Cod originally inhabited are now degraded, it is difficult to accurately determine the habitat requirements of the species.					sediment control measures are not followed..
Maccullochella peelii **Murray Cod**	-	V	Murray Cod are frequently found in the main channels of rivers and larger tributaries. The species is, therefore, considered a main-channel specialist. Murray Cod tend to occur in floodplain channels and anabranches when they are inundated but the species' use of these floodplain habitats appears limited. Juveniles less than one year old have been found in main river channels where it appears they settle at a late larval (newly born) stage.	PMST	Present	Moderate	Moderate	Indirect impacts of removing riparian vegetation. May impact the fish in the area if standard erosion and sediment control measures are not followed.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Macquaria australasica **Macquarie Perch**	FM listed	E	In the Murray-Darling Basin, the species was once typically found in the cool, upper reaches of drainage systems located in southern New South Wales, the Australian Capital Territory and northern Victoria. In east coast drainage systems, the species has been recorded naturally occurring in the Hawkesbury/Nepean, Georges and Shoalhaven rivers in New South Wales.	PMST	Absent	Low	Low	No suitable habitat will be impacted. Species is unlikely to be present within Wagga Wagga.
Nannoperca australis Murray-Darling Basin lineage **Southern Pygmy Perch (Murray-Darling Basin lineage)**	E FM listed	V	They are often found in small systems with a low flow rate and quiet vegetated areas in streams, billabongs, lakes. They prefer covered habitats and are not usually found in open water.	PMST	Absent	Low	Low	Proposal Area is outside of the DPI species distribution.
Migratory								
Actitis hypoleucos	-	M	The species utilises a wide range of coastal wetlands and some inland wetlands, with	PMST	Absent	Low	Low	No suitable habitat will be impacted.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Common Sandpiper			varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflat					
Apus pacificus **Fork-tailed Swift**	-	M	In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. The sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pine	10 (1980–2019) PMST	Marginal	Moderate	Low	Species is known to occur in riparian woodlands. Closest record over 4km away from proposal area. Species could utilise the habitat but is unlikely to rely on the habitat for survival.
Calidris acuminata **Sharp-tailed Sandpiper**	-	M	In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and	23 (1977–2019) PMST	Absent	Low	Low	No suitable habitat will be impacted. Recorded within 1km of the proposal area at the sewage farm but unlikely to use the area impacted.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry.					
Calidris ferruginea **Curlew Sandpiper**	E	CE M	It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes inland. It forages in or at the edge of shallow water, occasionally on exposed algal mats or waterweed, or on banks of beach-cast seagrass or seaweed.	2 (1977–1988) PMST	Absent	Low	Low	No suitable habitat will be impacted.
Calidris ruficollis **Red-necked Stint**	-	M	the Red-necked Stint is mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. Occasionally they have been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals. They also occur in saltworks and	5 (1977–1979)	Absent	Low	Low	No suitable habitat will be impacted.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			sewage farms; saltmarsh; ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats. They sometimes use flooded paddocks or damp grasslands. They have occasionally been recorded on dry gibber plains, with little or no perennial vegetation					
Calidris melanotos **Pectoral Sandpiper**	-	M	In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	PMST	Marginal	Low	Low	Possibly suitable floodplain habitat will be impacted. Although no records in the area.
Gallinago hardwickii **Latham's Snipe, Japanese Snipe**	-	M	In Australia, Latham's Snipe occurs in permanent and ephemeral wetlands up to 2,000m above sea-level. They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies)	19 (1977–2020) PMST	Absent	Low	Low	No suitable habitat will be impacted.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Hirundapus caudacutus **White-throated Needletail**	-	V M	In Australia, they mostly occur above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy, but they are less commonly recorded flying above woodland. They also commonly occur over heathland, but less often over treeless areas, such as grassland or swamp. When flying above farmland, they are more often recorded above partly cleared pasture, plantations or remnant vegetation at the edge of paddocks. Non-breeding roosting habitat includes within dense foliage or hollows in forests and woodlands.	2 (1996–2019) PMST	Absent	Low	Low	No suitable habitat will be impacted.
Motacilla flava **Yellow Wagtail**	-	M	Various landscapes such as lowlands, where forests are located or forest-steppe belts, and it is also attracted by swampy meadows or river valleys. Marshland with grass and rare shrubs is also suitable for it as a habitat.	PMST	Absent	Low	Low	No suitable habitat will be impacted.
Myiagra cyanoleuca **Satin Flycatcher**	-	E M	Satin Flycatchers are mainly recorded in eucalypt forests, especially wet sclerophyll forest, often dominated by eucalypts such as Brown Barrel, *Eucalypt fastigata*, Mountain Gum, *E. dalrympleana*, Mountain Grey Gum,	PMST	Present	Low	Low	Species is known to occur in eucalypt forest. Species could utilise the habitat but is unlikely to rely on the habitat for survival.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			Narrow-leaved Peppermint, Messmate or Manna Gum, or occasionally Mountain Ash, *E. regnans*.					
Numenius madagascariensis **Eastern Curlew, Far Eastern Curlew**	-	CE M	It generally occupies coastal lakes, inlets, bays and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats and sometimes saltmarsh of sheltered coasts.	PMST	Absent	Low	Low	No suitable habitat will be impacted.
Tringa nebularia ***Common greenshank***	-	M	They are diurnal and nocturnal feeders that feed by picking from the surface, probing, sweeping, and lunging at the edges of mudflats or shallows. They may walk along the shoreline and even chase small fish in the shallow water. Common greenshank roost both on the coast and inland, in estuaries and mudflats, mangrove swamps and lagoons, and in billabongs, swamps, sewage farms and flooded crops	4 (1977–-1997)	Absent	Low	Low	No suitable habitat will be impacted.
Tringa stagnatilis **Marsh Sandpiper**	-	M	The Marsh Sandpiper lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats	1 (1979)	Absent	Low	Low	No suitable habitat will be impacted.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			and also regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes. In north Australia they prefer intertidal mudflats (Higgins & Davies 1996), although surveys in Kakadu National Park recorded more birds around shallow freshwater lakes than in areas influenced by tide					
Mammals								
Dasyurus maculatus **Spotted-tailed Quoll**	V	E	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline	1 (2004) PMST	Present	Moderate	Low	Species typically occurs on flat rocks among boulder fields but is present within inland riparian zones. The species would have potential foraging and breeding habitat removed.
Macrotis lagotis **Bilby**	E	V	Once widespread in arid, semi-arid and relatively fertile areas, the Bilby is now restricted to arid regions and remains a threatened species. The Bilby prefers arid habitats because of the spinifex grass and acacia shrub. Bilbies are nocturnal omnivores	1 (1912)	Absent	Low	Low	No suitable habitat present

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			that do not need to drink water, as they get all their moisture requirements from their food, which includes insects and their larvae, seeds, spiders, bulbs, fruit, fungi, and very small animals. Most food is found by digging or scratching in the soil, and using their very long slender tongues. Unlike bandicoots, Bilbies are excellent burrowers and build extensive tunnel systems with their strong forelimbs and well-developed claws. A Bilby typically makes a number of burrows within its home range, up to about a dozen; and moves between them, using them for shelter both from predators and the heat of the day. The female Bilby's pouch faces backwards, which prevents her pouch from getting filled with dirt while she is digging. Bilbies have a very short gestation period of about 12–14 days, one of the shortest among mammals.					
Miniopterus orianae oceanensis **Large Bent-winged Bat**	V	-	Primary roost habitat are caves, also use mines, storm–water tunnels and other man–made structures. Young are also raised within caves. Maternity caves have specific temperature and humidity regimes. Outside of breeding season populations can disperse	1 (2007)	Marginal – no know roosting habitat.	Low	Low	No core breeding habitat impacted. Species may forage on occasions but not likely to rely on area for survival.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			up to 300m from maternity caves. Breeding colonies can reach numbers up to 150, 000 individuals. Foraging occurs within forests areas above treetops where insects are a primary food source.					
Myotis macropus **Southern Myotis**	V	-	The Large–footed Myotis is found in the coastal band from the north–west of Australia, across the top–end and south to western Victoria. It is rarely found more than 100km inland, except along major rivers. Generally, roost in groups of 10–15 close to water in caves, mine shafts, hollow–bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December.	2 (2000–2013)	Present	High	High	Suitable habitat will be impacted.
Nyctophilus corbeni **Corben's Long-eared Bat, South-eastern Long-eared Bat**	V	V	Inhabits a variety of vegetation types, including Mallee, Bulloke *Allocasuarina leuhmanni* and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the	PMST	Present	Low	Low	Species has no records in the area. Habitat is present although the species is unlikely to be in the area.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			western slopes and plains of NSW and southern Queensland. Roosts in tree hollows, crevices, and under loose bark.					
Petaurus norfolcensis **Squirrel Glider in the Wagga Wagga Local Government Area**	E	-	Inhabits dry sclerophyll forest and woodland and is generally absent from rainforest and closed forest. In NSW, potential habitat includes Box–Ironbark forests and woodlands in the west, the River Red Gum forests of the Murray Valley and the eucalypt forests of the northeast. Requires abundant hollow–bearing trees and a mix of eucalypts, acacias and banksias. Smooth–barked eucalypts are preferred as these eucalypts form hollows more readily than rough–barked and support a greater diversity of invertebrates. Squirrel Glider's forage in the upper and lower forest canopies and in the shrub understorey.	138 (1977–2019)	Present	High	High	Suitable habitat will be impacted. Records within 1km of the proposal area.
Petaurus norfolcensis **Squirrel Glider**	V	-	Inhabits dry sclerophyll forest and woodland and is generally absent from rainforest and closed forest. In NSW, potential habitat includes Box–Ironbark forests and woodlands in the west, the River Red Gum forests of the Murray Valley and the eucalypt forests of the northeast. Requires abundant hollow–bearing	138 (1977–2019)	Present	High	High	Suitable habitat will be impacted. Records within 1km of the proposal area.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			trees and a mix of eucalypts, acacias and banksias. Smooth–barked eucalypts are preferred as these eucalypts form hollows more readily than rough–barked and support a greater diversity of invertebrates. Squirrel Glider's forage in the upper and lower forest canopies and in the shrub understorey.					
Phascolarctos cinereus **Koala**	E	E	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.	4 (1965–2006) PMST	Present	Low	Low	Species has limited records in the area. Habitat is present although the species is unlikely to be in the area.
Pteropus poliocephalus **Grey-headed Flying-fox**	V	V	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.	37 (2013–2019) PMST	Present	High	High	Suitable habitat will be impacted. Records within the proposal area.
Saccolaimus flaviventris **Yellow-bellied Sheathtail-bat**	V	-	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	1 (2013)	Present	Moderate	Low	Species is adaptable to a range of environments. Limited records in the area. Unlikely to be impacted by the proposed works.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
Vespadelus baverstocki **Inland Forest Bat**	V	-	Distribution of this species, particularly in NSW, is very poorly known. Believed to occur widely in all the mainland states, generally in areas with annual rainfall less than 400 millimetres. Roosts in tree hollows, abandoned buildings, and in very small hollows in stunted trees only a few metres high. Habitat requirements are poorly known but has been recorded from a variety of woodland formations, including Mallee, Mulga and River Red Gum. Most records are from drier woodland habitats with riparian areas. However, other habitats may be used for foraging and/or drinking. Colony size ranges from a few individuals to more than sixty. Bats fly rapidly and cover an extensive foraging area and are presumed to feed on flying insects	1 (2007)	Present	Moderate	High	Suitable habitat will be impacted. Roosting Habitat is present
Reptiles								
Aprasia parapulchella **Pink-tailed Worm-lizard, Pink-tailed Legless Lizard**	V	V	Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by Kangaroo Grass (*Themeda australis*). Sites are typically	PMST	Marginal	Low	Low	Limited scattered rocks. No rock outcrops present within the proposal area. Understory not dominated by Kangaroo grass.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			well-drained, with rocky outcrops or scattered, partially buried rocks.					
Invertebrates								
Keyacris scurra **Key's Matchstick Grasshopper**	E	E	Typically found in native grasslands and grassy woodlands but it has also been recorded in other vegetation associations usually containing a native grass understory (especially kangaroo grass Themeda triandra) and known food plants (particularly Asteraceae). Has been observed to feed on a range of species including Aira caryophyllea (Silver hairgrass), Scirpus sp. (sedges), Wurmbea dioica (Early Nancy), Bulbine bulbosa (Native Leek), Calochilus paludosus (Red Beard Orchid), Rumex crispus (Curled Dock), Acetosella vulgaris/Rumex acetosella (Sorrel), Cerastium glomeratum (Mouse-ear Chickweed), Ranunculus lappaceus (Common Buttercup), Rosa rubiginosa (Sweet Briar), Acaena ovina (Orchid), Trifolium subterraneum (Subterranean Clover), Trifolium arvense (Haresfoot Clover), Poranthera microphylla, Stackhousia monogyna (Creamy Candles), Hibbertia	PMST	Absent – native understory low quality.	Low	Low	No suitable habitat will be impacted.

Species	Listing		Habitat	No. of Records Within 10km Locality	Presence of Habitat	Likelihood of Occurrence	Possible Impact	Justification
	BC Act	EPBC						
			sericea, Lavandula stoechas (Lavender), Salvia verbenaca (Vervain), Verbascum thapsus (Great Mullein), Sherardia arvensis (Field Madder), Galium tricornatum (Rough Fruited Bedstraw), Helichrysum apiculatum (Common Everlasting), Ozothamnus retusus or O. scaber (Helichrysum bilobum), Podolepis jaceoides (Podolepis acuminate) (Showy Copper-wire Daisy) and Craspedia uniflora.					

Appendix B Hollow-bearing tree inventory

ID	Easting	Northing	Small <6cm	Medium 6	Large 12-1	Extra Larg	Impact
Hbt 53	533939.5	6116040	1	3	1	1	No
Hbt 90	533857.3	6116019	3	4	3	2	No
Hbt 93	533794.8	6116024	3	3	2	3	No
Hbt 1	533944.1	6116899	6	3	1	1	No
Hbt 10	533943.2	6116664	6	4	2	2	No
Hbt 100	533553.9	6115951	2	3	2	1	No
Hbt 101	533549.8	6115980	0	3	2	2	No
Hbt 102	533555.4	6115998	0	2	1	2	No
Hbt 103	533548.7	6116064	2	4	1	0	No
Hbt 104	533548.9	6116109	0	5	2	2	No
Hbt 105	533560.3	6116182	0	4	4	2	No
Hbt 106	533578.5	6116228	0	1	0	0	No
Hbt 107	533614.8	6116245	1	1	0	0	No
Hbt 108	533636.8	6116180	1	0	0	0	No
Hbt 109	533657.5	6116143	0	3	1	1	No
Hbt 11	533926.4	6116632	2	4	5	1	No
Hbt 110	533672.3	6115994	0	3	1	0	No
Hbt 111	533780.1	6115830	2	3	0	1	No
Hbt 112	533971.9	6115781	0	3	1	0	Yes
Hbt 113	533985.9	6115803	0	2	1	0	Yes
Hbt 114	534006.7	6115798	0	3	2	1	Yes

ID	Easting	Northing	Small <6cm	Medium 6	Large 12-1	Extra Larg	Impact
Hbt 115	534016.4	6115801	0	2	2	1	Yes
Hbt 116	533966.5	6115826	0	2	2	2	Yes
Hbt 12	533969.5	6116627	4	4	0	0	No
Hbt 13	533902.7	6116617	4	4	0	0	No
Hbt 14	533874.5	6116536	0	3	0	1	No
Hbt 15	533856.4	6116512	3	2	1	1	No
Hbt 16	533833.8	6116419	2	2	0	0	No
Hbt 17	533803	6116368	0	3	2	1	No
Hbt 18	533821.3	6116442	0	3	1	0	No
Hbt 19	533793.6	6116455	2	4	2	0	No
Hbt 2	533932.9	6116901	9	10	2	0	No
Hbt 20	533784.1	6116535	3	2	0	0	No
Hbt 21	533823.1	6116541	2	3	1	0	No
Hbt 22	533966.6	6116603	6	4	2	0	No
Hbt 23	533918.1	6116271	4	3	2	3	No
Hbt 24	533912.4	6116257	0	4	2	1	No
Hbt 25	533880.7	6116313	0	5	3	2	No
Hbt 26	533837.5	6116311	2	3	1	2	No
Hbt 27	533820.8	6116290	0	3	3	1	No
Hbt 28	533886	6116256	3	3	1	0	No
Hbt 29	533849.8	6116247	2	3	1	0	No
Hbt 3	533974.5	6116861	8	5	1	0	No
Hbt 30	533902.5	6116204	2	3	0	0	No

ID	Easting	Northing	Small <6cm	Medium 6	Large 12-1	Extra Larg	Impact
Hbt 31	533934.5	6116195	0	3	2	0	No
Hbt 32	533930.4	6116217	3	1	0	0	No
Hbt 33	533941.3	6116164	0	5	0	0	No
Hbt 34	533971.7	6116118	3	2	1	0	No
Hbt 35	533993.8	6116064	0	4	2	2	No
Hbt 36	533996.5	6116044	0	3	2	1	No
Hbt 37	534014.5	6116019	0	5	2	0	No
Hbt 38	534035.3	6116015	2	4	1	0	No
Hbt 39	534057.5	6115997	0	2	2	2	No
Hbt 4	533978.5	6116802	4	5	6	2	No
Hbt 40	534019.7	6115923	0	4	1	0	No
Hbt 41	534016.8	6115895	2	0	2	1	No
Hbt 42	533930.8	6115962	2	2	1	0	No
Hbt 43	533964.3	6115985	0	2	2	0	No
Hbt 44	533950.4	6115996	0	2	0	1	No
Hbt 45	533922.6	6115986	0	2	1	0	No
Hbt 46	533896.3	6116025	0	0	3	0	No
Hbt 47	533865.9	6116087	0	4	0	2	No
Hbt 48	533861.9	6116119	0	3	3	1	No
Hbt 49	533860.5	6116126	2	0	0	1	No
Hbt 5	533970.3	6116844	4	2	1	0	No
Hbt 50	533874.6	6116174	3	2	0	0	No
Hbt 51	533907.7	6116115	3	2	0	0	No

ID	Easting	Northing	Small <6cm	Medium 6	Large 12-1	Extra Larg	Impact
Hbt 52	533927.2	6116111	0	4	1	0	No
Hbt 54	533742.4	6116521	1	3	1	0	No
Hbt 55	533718.7	6116510	4	7	1	2	No
Hbt 56	533751.8	6116449	2	2	1	1	No
Hbt 57	533740.3	6116336	4	4	2	1	No
Hbt 58	533725	6116337	2	4	2	2	No
Hbt 59	533705.4	6116307	0	3	1	1	No
Hbt 6	534015.9	6116781	7	5	4	0	No
Hbt 60	533717.6	6116227	0	0	0	3	No
Hbt 61	533705.1	6116223	0	3	4	2	No
Hbt 62	533693.6	6116492	0	2	2	0	No
Hbt 63	533676.8	6116472	3	3	0	0	No
Hbt 64	533630.8	6116434	2	2	1	0	No
Hbt 65	533599.9	6116355	4	2	0	0	No
Hbt 66	533595.7	6116356	0	3	1	0	No
Hbt 67	533591.5	6116335	2	2	0	0	No
Hbt 68	533578.8	6116293	0	3	0	0	No
Hbt 69	533592.5	6116247	2	0	0	0	No
Hbt 7	533975.3	6116713	4	3	4	0	No
Hbt 70	533710.2	6116109	4	3	1	2	No
Hbt 71	533729.6	6116086	2	2	2	0	No
Hbt 72	533755.9	6116039	0	2	2	3	No
Hbt 73	533760.1	6116050	0	2	1	0	No

ID	Easting	Northing	Small <6cm	Medium 6	Large 12-1	Extra Larg	Impact
Hbt 74	533778.2	6116069	2	4	2	3	No
Hbt 75	533765.8	6116081	0	3	3	2	No
Hbt 77	533818.6	6116079	0	7	0	0	No
Hbt 78	533821.3	6116065	2	4	2	0	No
Hbt 79	533836.7	6116073	4	2	2	0	No
Hbt 8	533957.2	6116693	5	3	5	2	No
Hbt 80	533836.8	6116107	0	4	2	1	No
Hbt 81	533845.2	6116128	0	3	2	0	No
Hbt 82	533832.7	6116120	0	3	4	2	No
Hbt 83	533849.4	6116122	0	4	3	2	No
Hbt 84	533842.4	6116133	0	3	3	1	No
Hbt 85	533807.6	6116111	0	2	2	0	No
Hbt 86	533809.1	6116147	4	4	2	2	No
Hbt 87	533795.3	6116178	0	3	5	1	No
Hbt 88	533862.9	6116034	0	3	2	0	No
Hbt 89	533837.9	6116031	0	3	4	2	No
Hbt 9	533993.3	6116684	2	6	0	2	No
Hbt 92	533786.3	6116004	3	3	2	1	No
Hbt 94	533793.4	6116033	0	3	3	0	No
Hbt 95	533794.6	6115970	0	3	3	2	No
Hbt 96	533802.8	6115941	10	6	4	3	No
Hbt 97	533788.7	6115901	3	4	2	0	Yes
Hbt 98	533902.9	6115929	0	2	3	0	Yes

ID	Easting	Northing	Small <6cm	Medium 6	Large 12-1	Extra Larg	Impact
Hbt 99	533553.9	6115964	2	3	2	2	No
Hbt76	533797.8	6116083	0	3	3	1	No
Hbt91	533854.4	6115993	5	3	4	2	No
Hbt 21	533902	6115697	0	2	2	2	No
Hbt 19	533877.1	6115736	0	2	2	0	No
Hbt 18	533882.6	6115718	0	2	2	1	No
Hbt 17	533843.7	6115713	0	2	1	1	No
Hbt 16	533846.5	6115728	0	2	2	2	No
Hbt 15	533813.1	6115720	0	2	1	0	No
Hbt 14	533818.7	6115743	0	3	2	1	No
Hbt 12	533847.5	6115619	0	0	2	3	No
Hbt 11	533880.7	6115581	0	0	1	3	No
Hbt 10	534212.7	6115858	0	3	2	2	No
Hbt 9	534201.6	6115839	2	2	3	2	No
Hbt 8	534176.4	6115815	0	0	2	3	No
Hbt 7	534161	6115786	2	2	0	0	No
Hbt 4	534104.8	6115642	2	1	0	0	No
Hbt 1	534037.9	6115582	3	0	0	3	No
Hbt 25	533982.7	6115702	0	2	0	0	Yes
Hbt 24	534069.2	6115780	0	2	1	0	Yes
Hbt 23	533989.8	6115749	0	2	1	2	Yes
Hbt 22	533890.7	6115659	0	2	2	2	Yes

ID	Easting	Northing	Small <6cm	Medium 6	Large 12-1	Extra Larg	Impact
Hbt 20	533892.4	6115720	0	0	2	2	Yes
Hbt 13	533829.5	6115633	0	3	2	2	Yes
Hbt 6	534114.8	6115704	2	4	1	0	Yes
Hbt 5	534099.4	6115674	1	2	0	0	Yes
Hbt 3	534082.6	6115650	2	3	1	0	Yes
Hbt 2	534057.4	6115595	2	2	0	0	Yes

Appendix C Tests of Significance

C.1 Squirrel Glider

Part 7.3 of the *Biodiversity Conservation Act 2016* (BC Act) specifies five factors to be taken into account in deciding whether a development is likely to significantly affect threatened species, populations or ecological communities, or their habitats, listed at the state level under the BC act.

This *Test of significance* (ToS) characterises the significance of likely impacts associated with the proposal on the listed species:

- Squirrel Glider (*Petaurus norfolcensis*): BC-V
- Squirrel Glider (*Petaurus norfolcensis*) in the Wagga Wagga Local Government Area - Endangered population

a) In the case of a threatened species, whether the proposed development 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 Squirrel Glider population in the Wagga Wagga LGA is listed as an endangered population (DPE, 2021). The NSW Scientific Committee Determination for the endangered population listing specifically lists Wilks Park as habitat where Squirrel Gliders are known to occur with five sightings between 1996 and 1998 (DPE, 2021). Wilks Park covers an area of 33 ha; 4.72 ha of this occurs within the development footprint consisting of River Red Gum Woodland that provides suitable breeding and foraging habitat for the Squirrel Glider. Numerous BioNet records (4) of Squirrel Glider records occur within Wilks Park, with records dating from 1996 to as recently as 2019. WWCC records also indicate Squirrel Glider has been detected in Wilks Reserve 2022 and 2023 (pers. comm.). The closest record occurs within 200 m of the development footprint. The population density of the Wilks Park Squirrel Glider population is not known, however based on the number and frequency of sightings a viable population is considered present. No targeted surveys were completed for this species within this study.

The Wagga Wagga LGA Squirrel Glider population has been listed as endangered in part due to the small, scattered remnants of habitat remaining in the Wagga Wagga LGA. Wilks Park is an isolated remnant of woodland, being surrounded by urban landscape (North Wagga and Wagga Wagga in the East and West) and semi-rural cleared landscapes to the North and South. There is some habitat connectivity to Wiradjuri reserve (where Squirrel Glider are also recorded (DPE, 2021) to the Northwest via a 60m leap across the Murrumbidgee River (within the upper limit of glide range for Squirrel Glider - NSW Scientific Committee, 2008) as well as a thin linear corridor along the banks of the Murrumbidgee River through the Wagga Wagga township to the South.

The home range of the Squirrel Glider is generally around 3 – 9 ha depending on food resources, and foraging distances range from 400m to 2.5km also depending on food resources (NSW Scientific Committee, 2008).

The proposed works would require removal of 17 hollow bearing trees (HBTs) of the 141 HBTs present within Wilks Park. Note that the HBT have been identified from the ground based on apparent entrances and no hollows were inspected to confirm internal dimensions. All HBTs to be removed contain multiple hollows of a medium to large entrance size which may provide suitable nesting habitat for Squirrel Glider. This equates to 12.1% of the total HBTs present within Wilks Park proposed to be impacted.

It is expected that 5.71 ha of River Red Gum Woodland vegetation providing foraging, nesting and connectivity would be impacted by the proposal. This is 17.3% of the Wilks Park woodland habitat.

The estimated impact to HBTs and available hollows across the study area in a small fragmented landscape is considered to have an adverse effect on the breeding habitat of the Wagga Wagga LGA endangered population at Wilks Park. Considering the available habitat within the Wagga Wagga LGA for this population is sparse and scattered with few remnant areas left, the Wilks Park habitat is highly likely to be an important habitat area. Threats to the Squirrel Glider population in the Wagga Wagga LGA include a loss of habitat through clearing of regenerating River Red Gums, lack of regeneration of other native plants, inability to recruit individuals, and includes the vulnerability to local extinction via stochastic events and predation from red foxes and domestic or feral cats. This wider trend reinforces the importance of the Wilks Park population and the loss of 17.3% of its breeding habitat could place the population at risk of extinction.

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

- **a. 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.**
- **b. 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.

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**
- **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**
- **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.**

i. The proposed works would require removal of 17 hollow bearing trees (HBTs) of the 141 HBTs present within Wilks Park. All HBTs removed contain multiple hollows of a medium to large entrance size which may be suitable nesting habitat for Squirrel Glider. In total 12.7% of the total HBTs present within the study area are proposed to be impacted.

5.71 ha of River Red Gum Woodland vegetation providing foraging, nesting and movement would be impacted by the proposal. This is 17.3% of the Wilks Park woodland habitat.

ii. The proposed works would increase fragmentation through Wilks Park. At its greatest extent a 393 m wide clearing of vegetation could occur through the centre of suitable woodland habitat. Squirrel Gliders need trees closely connected for movement and have a movement range of 50 -70m for gliding between trees (NSW Scientific Committee, 2008). The increase of clearing widths to over 300m in some areas would impact on movement of the Squirrel Glider through their habitat and potentially create a barrier for movement between the north and south of Wilks Park

iii. Considering, the available habitat within the Wagga Wagga LGA for this endangered population is sparse and scattered with few remnant areas left, the Wilks Park woodland habitat is considered an important habitat area. Threats to the Squirrel Glider population in Wagga Wagga LGA include loss of habitat through clearing of River Red Gums, lack of regeneration of other native plants, inability to recruit individuals, and include a vulnerability to local extinction via stochastic events and predation from red foxes and domestic or feral cats (DPE 2021). The Squirrel Glider population in the Wagga Wagga LGA appears to be small and disjunct and is likely to be at the western limit of its NSW distribution. The removal of 17.3% of this habitat and increase of fragmentation to this habitat is likely to have an

adverse effect on the long-term survival of the Squirrel Glider population in the Wilks Park locality.

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

There are no declared areas of outstanding biodiversity value (AOBV) within or adjacent to the proposal area. There are no direct or indirect impacts considered to occur to an AOBV

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

The BC Act lists numerous key threatening processes (KTP's). KTP's relevant to the proposal include the following:

- Clearing of native vegetation.
- Loss of Hollow-bearing Trees

Key Threatening processes (OEH, 2021)

Clearing of native vegetation.

The clearing of native vegetation is considered a major contributor to the loss of biodiversity. In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation and off–site impacts such as downstream sedimentation. Impacts to native vegetation from the proposed works would be very minor, the proposal would lead to a minor increase in this KTP.

Loss of Hollow-bearing Trees

The density of hollow-bearing trees required to sustain viable populations of vertebrates is controlled by the diversity of competing fauna species at a site, population densities, number of hollows required by each individual over the long-term, and the number of hollows with suitable characteristics occurring in each tree. The presence, abundance and species richness of hollow-using fauna are correlated with the density of hollow-bearing trees; suggesting that the availability of hollows is often a limiting environmental factor. In some instances, it is the prey species of a threatened predator that is limited by hollow availability. The distribution and abundance of hollow-bearing trees in NSW has been reduced and fragmented by extensive clearing of native vegetation during the past two centuries, primarily for agriculture. The proposal would increase this KTP through the removal of 17 HBT.

Conclusion

The impacts of the proposal on the vulnerable Squirrel Glider and the endangered Wagga Wagga population are considered significant and further assessment is required. A significant impact is considered based on the following conclusions:

- The magnitude of impact (12% of HBTs and 17% of River Red Gum woodland) is high particularly in the context of the endangered population of Wagga Wagga LGA
- The proposal would exacerbate fragmentation and isolation of habitat
- Clearing of HBTs is likely to increase the loss of hollow-bearing trees KTP

C.2 Parrots

This Test of Significance (ToS) characterises the significance of likely impacts associated with the proposal on the following listed species:

- Superb Parrot (Polytelis swainsonii) – BC-V, EPBC-V
- Turquoise Parrot (Neophema pulchella) – BC-V
- Little Lorikeet (Glossopsitta pusilla) – BC-V

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
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?
Superb Parrot The Superb Parrot inhabits Box-Gum, Box-Cypress-pine and Boree woodlands and River Red Gum Forest. Specifically in the Riverina Superb Parrots' nest in hollows of large trees (dead and alive) in tall riparian River Red Gum forest or woodland (DCCEEW, 2023; Threatened Species Scientific Committee , 2016; DPE, 2017). They feed in trees and understorey shrubs and on the ground and their diet consists mainly of grass seeds and herbaceous plants (DCCEEW, 2023; Threatened Species Scientific Committee , 2016; DPE, 2017). The Superb Parrot has been recorded within the study area 187 times between 1993 and 2021. The species has been recorded in Wilks Park approximately 50 m from the development footprint as recently as 2012. The Murrumbidgee River and Wagga Wagga are identified as a key biodiversity area for the Superb Parrot in the National Recovery Plan (Commonwealth of Australia, 2021). The proposed works will affect 5.71 ha of River Red Gum Woodland providing suitable foraging and breeding habitat for the species. This represents 17.3% of the available habitat within the study area. Superb Parrots nest in tree hollows with an entrance diameter of 6 cm or wider, and that are at least 3.5 m above the ground (DCCEEW, 2023; Threatened Species Scientific Committee , 2016; DPE, 2017). The Superb Parrot breeds between September and January (DCCEEW, 2023; Threatened Species Scientific Committee , 2016; DPE, 2017). The development footprint contains 17 hollow-bearing trees (HBTs) that will be impacted by the proposed works. These trees contain over 60 potentially suitable tree hollows for the species. 141 HBTs have been mapped in Wilks Park. The proposal would remove 12.1% of hollows suitable for Superb Parrot breeding habitat within Wilks Park. The protection of not only large habitat trees, but groups of large habitat trees, may be critical for maintaining breeding Superb Parrot. The Superb Parrot also faces issues from nest competition from other breeding pairs and competitive species. In the Murray-Riverina, nest sites are usually located no further than 10 km from foraging habitat, and in the South-west Slope Region, breeding and foraging habitats may coincide at some sites, and are no further than 10 km away at other sites (DCCEEW, 2023; Threatened Species Scientific Committee , 2016; DPE, 2017). Over 90 percent of the suitable habitat has been cleared with remaining patches occurring mostly along roadsides or in small, scattered remnant patches on private land (DCCEEW, 2023; Threatened Species Scientific Committee , 2016; DPE, 2017). The loss of large hollow bearing trees will continue to decline into the future unless urgent action is takes (DCCEEW, 2023; Threatened Species Scientific Committee , 2016; DPE, 2017).

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
Wilks Park is a 33 ha isolated remnant of River Red Gum Woodland within the urban environment of Wagga Wagga, surrounded by urban areas and fragmented rural landscapes. The proposed works are likely to have to have an adverse effect that could place the local population at risk of extinction due to the high proportion of suitable breeding habitat being impacted by the proposed works within Wilks Park.

Turquoise Parrot

The Turquoise Parrot lives in open woodland or riparian gum woodland, and often near ecotones between woodland and grassland, or coastal forest and heath (DPE, 2022; NSW Scientific Commitee , 2009). The Turquoise Parrot feeds mostly on seeds of grasses, forbs and native shrubs, taken on or near the ground; also on some flowers, nectar, fruits, leaves and scale-insects (DPE, 2022; NSW Scientific Commitee , 2009). The Turquoise Parrot has been recorded five times within the study area between 2007-2020. There are no records within the development footprint, the closest record is 1.9 km south (30 m spatial accuracy). The proposed works would impact 5.71 ha of River Red Gum Woodland that provides suitable breeding and foraging habitat for the species. The proposed activity will decrease the patch size of Wilks Park by 17.3%.

The Turquoise Parrot's nest is a cavity in a live or dead tree, stump, or log, often within 1-2 m of the ground. Hollows average entrance hole of 10 x 7 cm, with hollows being re-used (DPE, 2022; NSW Scientific Commitee , 2009). Breeding pairs of Turquoise Parrots defend a nest site and a small feeding area around the nest against members of their own species and breed between August and December (DPE, 2022; NSW Scientific Commitee , 2009). Breeding density can be four to seven pairs per hectare, with nests as little as 8 m apart. The Turquoise Parrot prefers to feed within 100 m of the nest but ranges up to 1.4 km away (DPE, 2022; NSW Scientific Commitee , 2009). It is non-migratory, with most movements of less than 10 km often along treed corridors (NSW Scientific Commitee , 2009). Wilks Park is an urban park with remnant woodland and is likely to provided suitable foraging habitat for Turquoise Parrot. Given that the species is gregarious, if Wilks Park supported a breeding population there would be a greater number of BioNet records. The species is inferred to be susceptible to habitat fragmentation. The proposed works will impact 17 HBTs, removing 61 suitable hollows for the species. 141 HBTs have been mapped in Wilks Park. The proposal would remove 12% of hollows suitable as breeding habitat for Turquoise Parrot within Wilks Park.

Wilks Park is a 33 ha isolated remnant of River Red Gum Woodland within the urban environment of Wagga Wagga, surrounded by urban areas and fragmented rural landscapes. It is likely that the removal of 17 trees and associated hollows or 17.3 % of woodland vegetation in Wilks Park will reduce the amount of breeding habitat for the species in the locality, however, it is unlikely that Wilks Park supports a breeding population of Turquoise Parrots, and the proposed works are unlikely to have significant adverse impacts that could place the local population at risk of extinction.

Little Lorikeet

The Little Lorikeet inhabits riparian habitats foraging primarily in the canopy of open *Eucalyptus* forest and woodland, yet also finds food in *Angophora, Melaleuca* and other tree species (DPE, 2022). The Little Lorikeet has been recorded within the locality (10km from the proposal area) 49 times between 1970 and 2015. Despite this, it is not listed on the Wagga Birdwatchers group website as recorded in Wagga Wagga area between 2009-2011 (Wagga Wagga

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
Birdwatchers, 2011). No records occur within the development footprint with the closest being 600 m south. The proposed works will impact 5.71 ha of River Red Gum Woodland that provides suitable foraging and breeding habitat for the species. The Little Lorikeet nests in proximity to feeding areas, if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts (DPE, 2022). Entrance is small (3 cm) and usually high above the ground (2–15 m) (DPE, 2022). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited (DPE, 2022). The Little Lorikeet breeds between May and September (DPE, 2022). The Little Lorikeet has been recorded to participate in large scale and very large-scale movements, with movements of the species in the order of approximately 200km (French et al., 2018). The species local population is unlikely to be fragmented by the clearing of 5.71ha of suitable foraging habitat. The proposed works will remove 17 hollow-bearing trees (HBT) with five HBT's containing ten appropriately sized small tree hollows. Ten suitable hollows will be removed from Wilks Park, reducing the amount of potential breeding habitat for the species. Despite this, 204 suitably sizes hollows in 124 HBTs remain within the area and will not be impacted by the proposed works. The removal of 12% of potential breeding habitat (HBTs) within Wilks Park could affect the reproduction of the population of Little Lorikeets within the locality to a degree, however based on the large scale movement of these species and lack of known nests in the proposal area, a viable local population is unlikely to be placed at risk of extinction.
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
N/A
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 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 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,
I. The excavation works surrounding Hampden Avenue will impact 5.71 ha of moderate - good condition Riverine Woodland habitat. PCTs 5, 9 and 74 are those affected. The proposal will remove 17 hollow bearing trees. II. The Superb Parrot and Little Lorikeet are highly mobile and can disperse over large scale

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
areas. The proposed clearing of 18.18ha will not fragment the habitat or impede movement to the extent that will impact the Superb Parrot or Little Lorikeet. The Turquoise Parrot is more restricted in its movements, preferring to forage locally to nesting habitat (NSW Scientific Commitee , 2009). Fragmentation of habitat in Wilks Park would occur with the removal of 5.71 ha of woodland vegetation within the centre of Wilks Park. However, the proposal would not restrict movement or isolate the species. III. No Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat. Wilks Park is an isolated remnant of woodland, being surrounded by urban landscape (North Wagga and Wagga Wagga in the East and West) and rural cleared landscapes to the North and South. The habitat being impacted is important to the long-term survival of the Superb Parrot as the trees act as crucial breeding ground for the species based on the area being a key biodiversity area. The Superb Parrot inhabits woodlands dominated by River Red Gums along the Murrumbidgee River which is listed as a Key Biodiversity Area for this species (Commonwealth of Australia, 2021) and hence the habitat modified is important to the long-term survival of the species. The habitat to be removed is also important to the Little Lorikeet and Turquoise Parrot as the habitat is suitable for the species to breed and forage however on a population level it is not crucial for the survival of the species.
d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),
No Areas of Outstanding Biodiversity (AOBV) will be impacted either directly or indirectly by the proposed works.
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 threatening process.
The BC Act lists numerous key threatening processes (KTP's). KTP's relevant to the proposal include the following: • Clearing of native vegetation. • Loss of Hollow-bearing Trees • Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species **Clearing of native vegetation.** The proposal will increase the impacts from and forms part of this KTP by removing greater than 10% of the remnant native vegetation in the study area. **Loss of Hollow-bearing Trees** The proposal works will impact 17 hollow bearing trees this will significantly reduce the breeding habitat present in the region. **Infection by Psittacine circoviral (beak and feather) disease affecting endangered psittacine species**

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
The proposal has potential to increase the likelihood of PBFD occurrence within the locality due to increased competition for hollows. The proposal will increase the impact from and forms part of all three listed KTPs above.

Conclusion

Mitigation Measure and Safeguards for threatened entities include:

- Threatened species find protocol; In the event a threatened species is identified breeding on site, works would cease, and further assessment and consultation would be conducted.
- Conducting works to avoid the breeding season of the species between May and January.
- Vegetation to be retained within the development footprint is to be clearly marked.
- Exclusion zones at the extent of the works corridor to limit works encroaching outside the corridor should be used.

Works should be conducted between mid-January and early April, outside the Superb Parrots Breeding period on the Edward and Murrumbidgee Rivers (DCCEEW, 2023). This will also fall outside of the breeding period for the other two species.

The proposed works will remove 5.71 ha of habitat potentially suitable for foraging and breeding for the Superb Parrot, Turquoise Parrot, and Little Lorikeet and would exacerbate the loss of hollow-bearing trees locally.

The proposed works are likely to have a significant impact on the Superb Parrot due to loss of breeding habitat in a Key Biodiversity Area.

The Little Lorikeet and Turquoise Parrot local populations may be impacted by the proposed works, but this impact is not deemed to be significant.

C.3 Raptors

This Test of significance (ToS) characterises the significance of likely impacts associated with the proposal on the following listed species:

- Barking Owl (*Ninox connivens*) – Vulnerable
- Little Eagle (*Hieraaetus morphnoides*) – Vulnerable
- Black Falcon (*Falco subniger*) – Vulnerable

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
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 following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats

The Barking Owl is flexible in its habitat use and can be found across woodland and open forests, including fragmented remnant vegetation and partly cleared farmland. Roosting occurs in tree canopies that provide shaded portions, which include tall midstorey trees with dense foliage such as *Acacia* and *Casuarina* species (OEH 2023). Foraging occurs across its habitat and extends into closed forests and large open areas. The species relies on an abundance of large and old Hollow Bearing Trees (HBTs) to roost with a preference for living eucalypts, although dead trees may also be used. The species displays nest site fidelity, often returning to old nest sites repeatedly over years if they remain undisturbed. Preferred food types include small arboreal mammals such as Squirrel Gliders and Common Ringtail Possums, but when a loss of tree hollows decreases these prey populations the Barking Owl becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Consequently, the species requires very large permanent territories within their habitats to compensate for sparse prey densities (OEH 2023). Four BioNet records occur within the study area, the closest record it 2.3 km away from the development footprint (spatial accuracy 10 m) and occurs in an urban, semi-urban matrix habitat similar to Wilks Park; - the record is from 2000.

The development footprint contains 14 large HBTs, supporting 35 suitably large entrance diameter tree hollows, that will be directly impacted by the proposed works. A total of 141 HBTS are recorded in Wilks Park with 119 providing suitable large hollows. The removal and disturbance of approximately 12% of potentially suitable nesting tree hollows is likely to reduce the species' regional habitat availability across breeding seasons, especially for a species that demonstrates strong nest site fidelity. The species' flexibility in its habitat use and large permanent territories and dispersal ability ensures the clearing of suitable habitat vegetation is unlikely to impact foraging behaviours. The fragmentation of habitat may increase any present individuals' foraging territory in an attempt to locate areas of higher prey densities. Although, this is unlikely to impact upon the species' foraging success. The substantial loss of suitable breeding habitat for the Barking Owl makes the proposed works likely to have an adverse effect on the life cycle of the species such that a viable local population of the species may be placed at risk of extinction.

The Little Eagle occupies open eucalypt forest, woodland or open woodland with a preference for *Acacia* woodlands and riparian woodlands across the Riverina (OEH 2023). The species nests in tall, large diameter-at-breast height (DBH) living tress within remnant patches of vegetation across their range. Breeding pairs build large stick nests during winter before females lay eggs in spring, where pairs provide parental care for young until they fledge in early summer. During nesting and breeding season, the species displays site fidelity and territoriality to occupied habitat trees. The species utilises its high dispersal ability to forage widely, and often many kilometres away from their nest. Prey items include juvenile rabbits, smaller birds, insects, reptiles and carrion (ACT Government 2023). The species has a total of 28 BioNet records occur within 10 km of the proposed works. No records occur within the development footprint, the closest record is 2.3 km away in open rural habitat. Breeding activity and habitat is unlikely to be impacted by the proposed works as the species is highly mobile and known to disperse widely to meet their nesting requirements (Larkin et al. 2020). The removal of 18.18 ha of native vegetation that provides suitable habitat for prey species may result in the decline of food availability for the Little Eagle, however it has been reported that habitat edges and open areas associated with human activities can benefit raptor species. Roadside microhabitats usually contain a high biomass of small mammals, insects and roadkill, and so the species choose habitat areas close to urban areas and have been reported to habituate to disturbances (Debus et al. 2007; Larkin et al. 2020). Therefore, it is unlikely that the proposed works will have an adverse effect on the life cycle of this species such that a viable local population of the Little Eagle is likely to be placed at risk of extinction.

The Black Falcon prefers sparse woodlands, scrub-dominated grasslands and farmland across arid areas. The species is highly mobile and are widely, but sparsely, distributed across most of New South Wales (OEH 2023). The Black Falcon nests along tree-lined creeks and rivers of inland drainage systems in tall

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
living trees with both parents providing care to young. Preferred prey includes smaller birds, small mammals, insects, reptiles and carrion with foraging able to occur far away from nests and roosts (BirdLife Australia 2023). Eight BioNet records occur within 10 km of the proposed works. The proposed works will impact 18.18 ha of native vegetation which could be considered suitable nesting and foraging habitat. The Black Falcon has been reported to have a preference for faster aerial hunting methods and avian prey, therefore, combined with the high dispersal ability of the species, the potential loss of terrestrial prey habitat is unlikely to impact the persistence of a local population (Czechura & Debus 1985). The species is considered to have flexible nesting requirements often laying eggs in abandoned stick nests and suitable structures created by other birds and fauna. The loss of tall living trees within the native vegetation to be removed by the proposed works will not adversely interrupt the breeding behaviours of the Black Falcon. Consequently, the proposed works is unlikely to have an adverse effect on the life cycle of the species such that a viable local population of Black Falcons will be placed at risk of extinction.
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.
N/A
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 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 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.
i. The excavation works surrounding Hampden Avenue will impact 5.71 ha of River Red Gum Woodland habitat - PCTs 5, 9 and 74. This represents a loss of 17.3% of the existing patch in Wilks Park. The proposal will remove 14 hollow bearing trees which provide 35 suitably large tree hollows that support the breeding behaviours of raptor bird species breeding, specifically the Barking Owl. This represents around 12% of available large hollows in the existing patch within Wilks Park. ii. The proposed works would increase fragmentation through Wilks Park. At its greatest extent a 393 m wide clearing of vegetation could occur through the centre of suitable woodland habitat. iii. Wilks Park is an isolated remnant of woodland, being surrounded by urban landscape (North Wagga and Wagga Wagga in the East and West) and rural cleared landscapes to the North and South. The impacted HBTS represent suitable breeding habitat for local populations of the Barking Owl and could impacts on the persistence of the species. The 5.71 ha of Riverine Woodland habitat that will be impacted by the proposed works represents only potential habitat within a broader landscape of suitable habitat for highly mobile raptor bird species. It is unlikely the removal of this

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
vegetation will result in an adverse impact on the long-term survival of these species in the locality.
d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly).
No areas of outstanding biodiversity will be impacted either directly or indirectly by the proposed works.
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 threatening process.
The BC Act lists numerous key threatening processes (KTPs). KTPs relevant to the proposal include the following (DPE, 2021): • Clearing of native vegetation • Loss of hollow-bearing trees *Clearing of native vegetation* The clearing of native vegetation is considered a major contributor to the loss of biodiversity. In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation and off–site impacts such as downstream sedimentation. Impacts to 18.18 ha of native vegetation from the proposed works would be minimal, therefore the proposed works would lead to a minor increase in this KTP. *Loss of hollow-bearing trees* The density of hollow-bearing trees required to sustain viable populations of vertebrates is controlled by the diversity of competing fauna species at a site, population densities, number of hollows required by each individual over the long-term, and the number of hollows with suitable characteristics occurring in each tree. The presence, abundance and species richness of hollow-using fauna are correlated with the density of hollow-bearing trees; suggesting that the availability of hollows is often a limiting environmental factor. In some instances, it is the prey species of a threatened predator that is limited by hollow availability. The distribution and abundance of hollow-bearing trees in NSW has been reduced and fragmented by extensive clearing of native vegetation during the past two centuries, primarily for agriculture. The proposal would increase this KTP through the removal of 17 HBTs.

Conclusion

Mitigation Measure and Safeguards for threatened entities include:

- Conducting works outside of the breeding period for these species between March and June
- Works to cease, and further assessment and consultation would be conducted.
- Salvage and appropriate relocation of any large hollows to trees without hollows.
- Revegetation in strategic areas of groundcover habitat to enhance foraging habitat.
- Vegetation to be retained within the development footprint is to be clearly marked.

Exclusion zones at the extent of the works corridor to limit works encroaching outside the corridor should be used. The proposed works will remove 5.71 ha of suitable foraging and breeding habitat for Barking Owl and less so for Little Eagle and Black Falcon.

The loss of approximately 12% of large hollows withing the patch remnant represents a significant impact to the Barking Owls breeding capabilities.

Provided mitigation measures and safeguards are abided by the proposed works are unlikely to have significant impact on the long-term survival of the Little Eagle and Black Falcon locally.

C.4 Passerine Birds

This Test of Significance (ToS) characterises the significance of likely impacts associated with the proposal on the following listed species

- Varied Sittella (*Daphoenositta chrysoptera*) -
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) – BC-V,
- Hooded Robin *(south-eastern form*) – BC-V, EPBC-E
- Scarlet Robin (*Petroica boodang*) – BC-V
- Diamond Firetail *(Stagonopleura guttata)* – BC-V

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
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 Passerine birds listed above have been recorded within the locality (10km from development footprint) and are considered likely to frequent the development footprint. These birds generally inhabit eucalypt forests and woodlands. The BioNet records for each species are listed below: • Varied Sittella – 3 records between 1985 and 2021 • Brown Treecreeper - 37 records between 1978 and 2019 • Hooded Robin – 13 records between 1979 and 2007 • Scarlet Robin – 9 records between 1977 and 2017 • Diamond Firetail – 19 records between 1979 and 2007 The Brown Treecreeper was recorded as recently as 2021 within Wilks Park adjacent to the development footprint (spatial accuracy of 5 m). These species breed throughout different times of the year. The breeding period of each species is listed below. • Varied Sittella – September - December (NSW Scientific Commitee, 2010; ESPD, 2019a; DPE, 2017b) • Brown Treecreeper – July - February (DPE, 2022; NSW Scientific Commitee, 2003; DCCEW, 2023) • Hooded Robin – July – November (NSW Scientific Commitee, 2003; DCCEW, 2023b) • Scarlet Robin – July – January (NSW Scientific Commitee, 2010; EPSD, 2019; DPE, 2017) • Diamond Firetail – August - January (DCCEW, 2023a; DPE, 2017a)

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
The Diamond Firetail, Hooded Robin, Scarlet Robin and the Varied Sitella build nests in the lower and midstory of suitable habitats. It is likely that 5.71 ha of good condition foraging habitat for these species will be impacted by the proposed works. The breeding habitat for these species within the proposal area is marginal for these species due to a degraded midstory and exotic dominated understory. The habitat is unlikely to be utilised by these species for breeding. According to the field step-point method results the woodland habitats contain 23% litter cover a microhabitat feature requirement suggesting these areas are suitable foraging habitat for these species. The Brown Treecreeper nests within tree hollows and has been recorded within Wilks Park (DPE, 2022; NSW Scientific Commitee, 2003; DCCEW, 2023) . The proposed works will impact 17 hollow bearing trees containing a total of 81 tree hollows of varying sizes. These hollows are to remain within the proposal area but will be on the ground. Hollows in standing dead or live trees and tree stumps are essential for nesting. (DPE, 2022; NSW Scientific Commitee, 2003; DCCEW, 2023). It is recommended that any hollows removed from trees be salvaged and relocated to live trees that do not otherwise have hollows. Despite this, the removal of this habitat will limit the availability of breeding and foraging habitat for these species in the area. Wilks Park is a 33 ha isolated remnant of woodland, being surrounded by urban landscape (North Wagga and Wagga Wagga in the East and West) and rural cleared landscapes to the North and South. These species all prefer contiguous patches of intact woodland and the proposed activity will decrease the patch size of Wilks Park by approximately 17.3%. The proposed works will remove 5.71 ha of woodland habitat in Wilks Park, this is approximately 17% of the current woodland habitat. Due to the already small size of the reserve further effects are likely to impact the passerine species in the area. The proposal is expected to adversely impact on Passerine birds by the removal of quality woodland habitat. Barret and Love (2012) state that most bird species do not cross gaps of more than 100 m when dispersing between patches. Given that the species generally do not disperse large distances it is expected that the proposal will adversely impact on the life cycle of the species in relation to dispersal. However, it is not considered that this will put a local population at risk of extinction.
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
N/A
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 ii. whether an area of habitat is likely to become fragmented or isolated from other areas of

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
habitat as a result of the proposed development or activity, and 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,
I. The excavation works surrounding Hampden Avenue will impact 5.71 ha of moderate- good condition Riparian Woodland habitat. PCTs 5, 9 and 74 are those affected. The proposal will remove 17 hollow bearing trees. II. The proposed works would increase fragmentation through Wilks Park. At its greatest extent a 393 m wide clearing of vegetation could occur through the centre of suitable woodland habitat. The Brown Tree Creeper is a sedentary species and is known to frequent Wilks Park. Although the landscape is historically fragmented (from the existing road reserve) the increase of clearing widths to over 300m in some areas would create a barrier to movement, with many species displaying a gap-crossing threshold of around 100m (Barret and Love, 2021). III. No Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the register of Critical Habitat. However, habitat critical to the survival of the species is present for the Brown Treecreeper, Diamond Firetail and Varied Sittella. Habitat critical to the survival of the Brown Treecreeper is listed in the federal conservation advice (DCCEW, 2023) as • *Relatively undisturbed grassy woodland with native understorey. (Habitat structure should be quite open at ground level so that birds are able to feed on or near the ground and maintain vigilance against predators. − The required degree of openness is mostly likely to be created by moderate levels of disturbance by fire and/or grazing)* • *Large living and dead trees which are essential for roosting and nesting sites and for foraging;* • *Fallen timber which provides essential foraging habitat and;* • *Hollows in standing dead or live trees and tree stumps are also essential for nesting.* No conservation advice has been released for the Scarlet Robin with in NSW. Wilks Park is known to be frequented by Brown Tree Creeper and given the condition of the woodland present and its scarcity in the broader landscape it is considered locally important to the assessed species.
d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),
No Areas of Outstanding Biodiversity will be impacted either directly or indirectly by the proposed works.
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 threatening process.
The BC Act lists numerous key threatening processes (KTP's). KTP's relevant to the proposal include the following (DPE, 2021): • Clearing of native vegetation. • Loss of Hollow-bearing Trees **Key Threatening processes**

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats
Clearing of native vegetation. The clearing of native vegetation is considered a major contributor to the loss of biodiversity. In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation and off–site impacts such as downstream sedimentation. Impacts to native vegetation from the proposed works would be very minor, the proposal would lead to a minor increase in this KTP. *Loss of Hollow-bearing Trees* The density of hollow-bearing trees required to sustain viable populations of vertebrates is controlled by the diversity of competing fauna species at a site, population densities, number of hollows required by each individual over the long-term, and the number of hollows with suitable characteristics occurring in each tree. The presence, abundance and species richness of hollow-using fauna are correlated with the density of hollow-bearing trees; suggesting that the availability of hollows is often a limiting environmental factor. In some instances, it is the prey species of a threatened predator that is limited by hollow availability. The distribution and abundance of hollow-bearing trees in NSW has been reduced and fragmented by extensive clearing of native vegetation during the past two centuries, primarily for agriculture. The proposal would increase this KTP through the removal of 17 HBT.

Conclusion

Mitigation Measure and Safeguards for threatened entities include:

- Threatened species find protocol; In the event a threatened species is identified breeding on site, works would cease, and further assessment and consultation would be conducted.
- Conducting works outside of the breeding period for these species between March and June.
- Revegetation in strategic areas of groundcover habitat to enhance foraging habitat
- A fauna spotter catcher is present to check for any other fauna potentially occupying hollows prior to felling.
- Vegetation to be retained within the proposal area is to be clearly marked.
- Exclusion zones at the extent of the works corridor to limit works encroaching outside the corridor should be used.

The proposed works will remove 5.71 ha of suitable foraging and breeding habitat for the Brown Treecreeper, Diamond Firetail, Hooded Robin, Scarlet Robin and the Varied Sitella. Provided mitigation measures and safeguards are abided by the proposed works are unlikely to have significant impact on the long-term survival of the species locally.

C.5 Bats

This *Five-part Test* characterises the significance of likely impacts associated with the proposal on the following species:

- Grey-headed Flying-fox (*Pteropus poliocephalus*): BC-V, EPBC-V
- Inland Forest Bat (*Vespadelus baverstocki)*: BC-V
- Southern Myotis (*Myotis macropus*): BC-V

f) In the case of a threatened species, whether the proposed development 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.

Grey-headed Flying-fox

This species is a canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, open forests, woodlands, Melaleuca swamps and Banksia woodlands. As such, it plays an important ecosystem function by providing a means of seed dispersal and pollination for many indigenous tree species (DPE, 2021). Grey-headed Flying-foxes also feed on introduced trees including commercial fruit crops (DPE, 2021). A total of 17 BioNet records of this species exist withing 1 km of the development footprint with records from as recently as 2019. A registered Grey-headed Flying Fox camp occurs 2.3 km southeast of the proposal area, the Wagga Wagga camp is located on the Murrumbidgee River and was last surveyed in 2015 to have up to 500 individuals (DCCEEW, 2014). The proposal area provides foraging resources (eucalypt blossoms) for this species within a short flying distance from a camp.

Grey-headed Flying-foxes congregate in large numbers at roosting sites (camps) that may be found in rainforest patches, Melaleuca stands, mangroves, riparian woodland or modified vegetation in urban areas (DPE, 2021). Individuals generally exhibit a high fidelity to traditional camps and return annually to give birth and rear offspring (DPE, 2021). They forage opportunistically, often at distances up to 30 km from camps, and occasionally up to 60-70 km per night, in response to patchy food resources (DPE, 2021). Given the proximity of the development footprint to the camp and the availability of nectar producing trees it is expected that the species will utilise the study area for foraging. Annual mating commences in January and conception occurs in April or May; single young is born in October or November (OEH, 2020). Relatively long-lived mammals, with the average age of reproductive animals being between six and 10 years. They have a low rate of recruitment as sexual maturity is reached after at least two to three years and generally only one offspring is produced each year (OEH, 2020).

It is unknown how frequently or abundantly the habitat within the development footprint is utilised by the species. The roost site will not be directly or indirectly impacted by the proposal as it is considered too far from the development footprint. Although the species is a nectarivore and the proposal intends to remove nectar producing trees that could provide as a foraging resource the species are known to forage a wide variety of fruits including introduced species and commercial crops. The proposal is unlikely to impact adversely on the breeding cycle of the species as the closest roost site is 2.3 km away. The proposal is also unlikely to impact adversely on the foraging ability of the species given that they are considered to forage a variety of native and introduced species. The proposal is therefore unlikely to have an adverse impact on the life cycle of the species such that a viable local population will be placed at risk of extinction.

Inland Forest Bat

The habitat requirements of this species are poorly known but it has been recorded from a variety of woodland formations, including Mallee, Mulga and River Red Gum (OEH, 2020). Most records are from drier woodland habitats with riparian areas (OEH, 2020). The species roosts in tree hollows, abandoned buildings and sometimes in very small hollows in stunted trees only a few metres high (OEH, 2020). These bats fly rapidly and cover an extensive foraging area and are presumed to feed

on flying insects (OEH, 2020). Given the site has a semi-arid climate and is located within the riparian zone it is considered to consist of suitable habitat for the species.

This species has been recorded once on NSW BioNet approximately 6 km from the development footprint (100 m spatial accuracy). Given that the species utilises a range of hollow sizes and types including tree hollows for roosting it is possible that the removal of 17 HBTs and their associated hollows will impact adversely on the roosting and thus breeding capability of the species. Within the impacted woodland patch 124 HBTs will remain and the loss equates to 12.1% of habitat lost. The small number of records suggests that the species does not occur in the locality in large numbers. It is inferred from this that although the loss of habitat will occur this will not result in adverse impacts such that a local population will be placed at risk of extinction.

Southern Myotis

The species generally roost in groups of 10-15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage (OEH, 2020). Forage over streams and pools catching insects and small fish by raking their feet across the water surface (OEH, 2020). In NSW females have one young each year usually in November or December (OEH, 2020).

This species has been recorded twice on NSW BioNet with the closest occurring 310 m from the development footprint (spatial accuracy 100 m). Given that the species utilises tree hollows for roosting it is possible that the removal of 17 HBTs and their associated hollows will impact adversely on the roosting and thus breeding capability of the species. Within the impacted woodland patch 124 HBTs will remain and the loss equates to 12.1% of habitat lost. The small number of records suggests that the species does not occur in the locality in large numbers however it may also be due to a lack of survey effort. It has been inferred from this that although the loss of habitat will occur this will not result in adverse impacts such that a local population will be placed at risk of extinction.

g) In the case of an endangered ecological community, or critically endangered ecological community, whether the proposed development or activity:

a. 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.

b. 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.

N/A

h) In relation to the habitat of a threatened species or ecological community:

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

v. 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

vi. 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.

- The excavation works surrounding Hampden Avenue will impact 5.71 ha of moderate -good condition Woodland habitat. (PCTs 5, 9 and 74 are those affected). The proposal will remove 17 hollow bearing trees which equates to 12.1% of HBTs within the patch.
- The proposed works would increase fragmentation through Wilks Park. At its greatest extent a 393 m wide clearing of vegetation could occur through the centre of suitable woodland habitat. The landscape is historically fragmented from the existing road reserve. However these bat species are highly mobile and fragmentation would not be a barrier to movement.
- The habitat to be removed occurs in an area of intact vegetation within an otherwise

extensively cleared landscape. The habitat being impacted is likely to be of least importance to Grey-headed Flying Fox because of the variety of foraging resources utilised by the species and the recorded roost site 2.3 km away. The habitat to be removed may be important to the long-term survival of Inland Forest Bat and Southern Myotis locally due to the density of hollows (approx. 22/ha) present in areas of the development footprint near Wilks Park. Further surveying is recommended to confirm if hollows are being used by the species.

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

No Areas of Outstanding Biodiversity will be impacted either directly or indirectly by the proposed works.

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

The BC Act lists numerous key threatening processes (KTP's). KTP's relevant to the proposal include the following:

- Clearing of native vegetation.
- Removal of hollow-bearing trees.

Key Threatening processes (DPE, 2021)

Clearing of native vegetation.

The clearing of native vegetation is considered a major contributor to the loss of biodiversity. In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'. Clearing can lead to direct habitat loss, habitat fragmentation and associated genetic impacts, habitat degradation and off–site impacts such as downstream sedimentation. Impacts to native vegetation from the proposed works would be very minor, the proposal would lead to a minor increase in this KTP.

Loss of Hollow-bearing Trees

The density of hollow-bearing trees required to sustain viable populations of vertebrates is controlled by the diversity of competing fauna species at a site, population densities, number of hollows required by each individual over the long-term, and the number of hollows with suitable characteristics occurring in each tree. The presence, abundance and species richness of hollow-using fauna are correlated with the density of hollow-bearing trees; suggesting that the availability of hollows is often a limiting environmental factor. In some instances, it is the prey species of a threatened predator that is limited by hollow availability. The distribution and abundance of hollow-bearing trees in NSW has been reduced and fragmented by extensive clearing of native vegetation during the past two centuries, primarily for agriculture. The proposal would increase this KTP through the removal of 17 HBT.

The proposed activity is part of and is likely to increase the impact of the abovementioned KTPs through the clearing of native vegetation including HBTs.

Conclusion

Mitigation actions:

- Bat boxes to be installed at a ratio of 1:1 for hollows removed
- Fauna spotter catcher to inspect all hollows prior to clearing and appropriately handle/relocate any fauna
- Mid-winter to be avoided for clearing as many microbats enter torpor and relocation may be fatal.

The impacts of the proposal on the assessed threatened species listed under the BC Act are considered manageable and further assessment is not required. A significant impact is considered unlikely, based on the following conclusions:

- The amount of habitat would be removed or disturbed by the proposal that is relatively small in the local context.
- No fragmentation or isolation of habitat would occur.
- No substantial contribution to any Key Threatening Process is expected.
- Mitigation measures have been recommended and can be implemented.

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Memorandum

DATE: 25 February 2024
SUBJECT: Flood Impacts of Flood Mitigation Options for Wagga Wagga
PROJECT NUMBER: 120012

1. OVERVIEW

Wagga Wagga City Council has considered the recommendations from the Wagga Wagga Revised Murrumbidgee River Floodplain Risk Management Study and Plan (FRMS&P) and is undertaking further evaluation of the following options for flood mitigation:

- PR1: Voluntary House Raising (VHR) and Voluntary House Purchase (VHP) for eligible properties on the floodplain (e.g. North Wagga, Oura and Gumly Gumly).
- L4B: North Wagga Levee System Upgrade to withstand a 5% AEP (1 in 20 chance) flood event combined with increase in some road heights and bridges along Hampden Ave to provide a safe evacuation route for residents from North Wagga. This would also include conveyance improvements through Wilks Park. The North Wagga Levee system would be upgraded first (Stage 1) and, at a later stage, the surrounding works would be constructed (Stage 2).
- A combined approach that is staged and includes a) Upgrading the existing North Wagga Levee system (Option L4A) and offering Voluntary House Raising and Purchase to those outside the levees, only where it is cost effective to do so. b) Increasing the road heights and bridges along Hampden Ave to provide a safe evacuation route (Stage 2 of Option L4B) c) VHP and VHR for those inside the North Wagga Levee system, only where it is cost effective to do so.

Both existing conditions and Option L4A (Stage 1 L4B) assume that the temporary banks added along Hampden Ave in 2012 would still be in place. With the addition of pumps the banks allow Hampden Ave to remain open slightly longer, for evacuation purposes, than if the banks were removed.

The following provides an overview of the flood impacts for key events, associated with the options under further evaluation. Flood modelling has been drawn from the FRMS&P with some amendments related to the treatment of freeboard in a floodplain management context. The revised modelling for this assessment has assumed that the entire levee freeboard remains in place during flood events, that is the levees are modelled at their crest heights including any spillways.

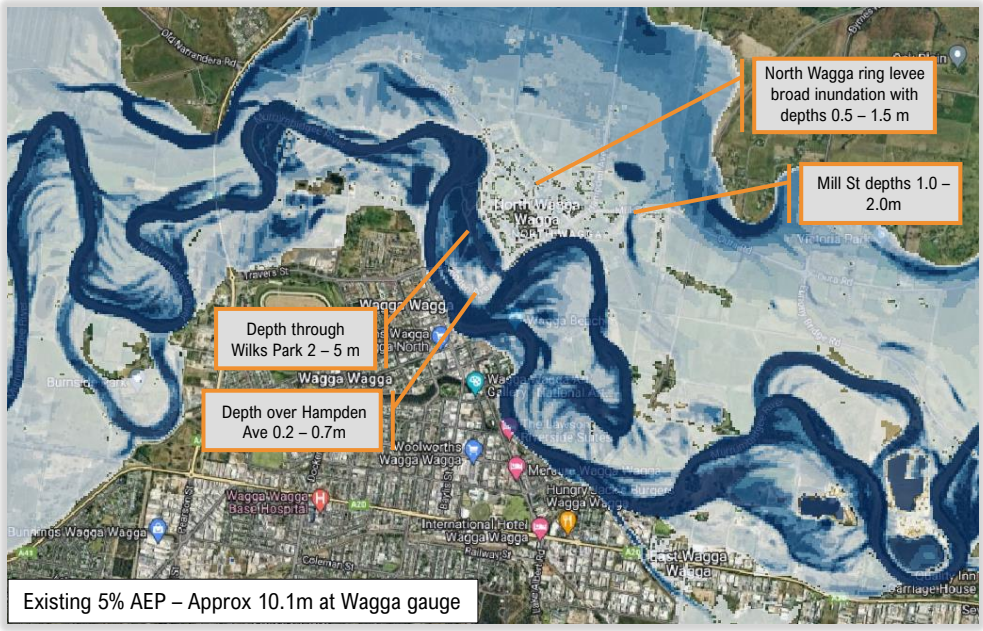
2. EXISTING CONDITIONS

2.1. Flood Behaviour

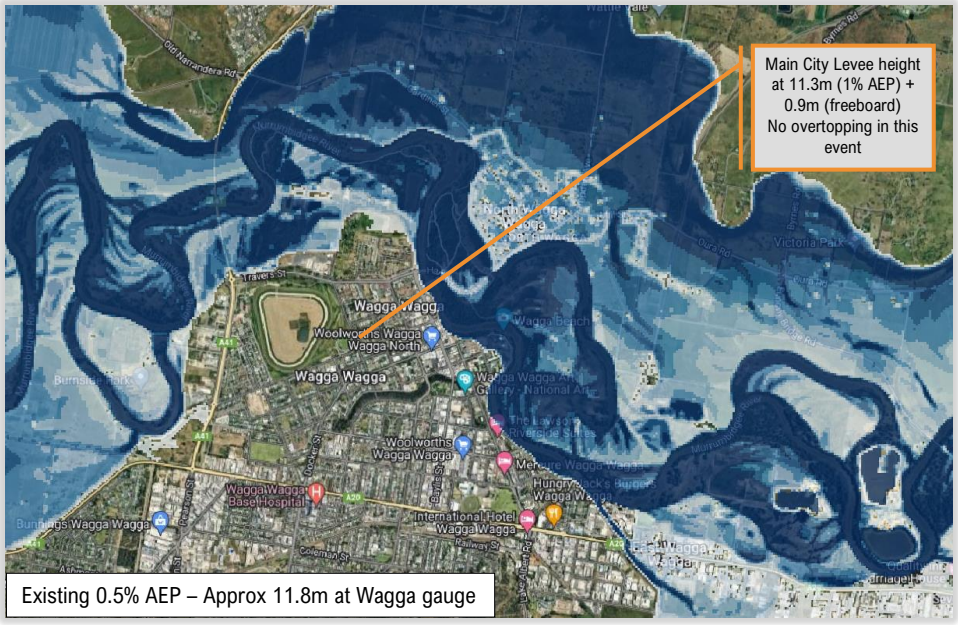
Hydraulic modelling has been undertaken for a range of design events including, 0.2EY, 10%, 5%, 2%, 1%, 0.5%, 0.2% AEP and an extreme event. Key features of the existing flood behaviour are described below.

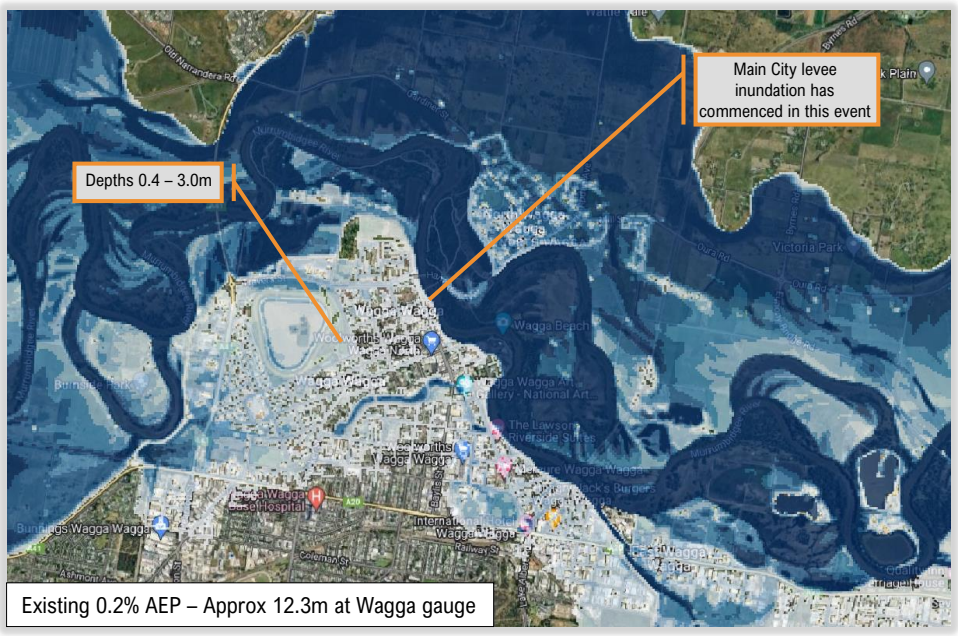

Northern flood runner has developed in this event
Mill St flowpath has activated. Depths approx. 0.2m
Depths through Wilks Park 1 – 3m
North Wagga Wagga
Wagga Wagga
East Wagga Wagga
Existing 0.2EY (1 in 5) – Approx 9.1m at Wagga gauge


North Wagga ring levee inundation has commenced in this event
Mill St depths exceed 1.0m
Depths through Wilks Park 2 – 5 m
Depths of up to 1.0m against Hampden Ave
North Wagga Wagga
East Wagga Wagga
Existing 10% AEP – Approx 9.7m at Wagga gauge


North Wagga ring levee broad inundation with depths 0.5 – 1.5 m
Mill St depths 1.0 – 2.0m
Depth through Wilks Park 2 – 5 m
Depth over Hampden Ave 0.2 – 0.7m
Existing 5% AEP – Approx 10.1m at Wagga gauge


North Wagga ring levee broad inundation with depths 0.7 – 2.3 m
Mill St depths 1.5 – 2.5m
Depths over Hampden Ave 0.7 – 1.4m
Existing 2% AEP – Approx 10.8m at Wagga gauge


Main City Levee height at 11.3m (1% AEP) + 0.9m (freeboard) No overtopping in this event
Existing 0.5% AEP – Approx 11.8m at Wagga gauge


Main City levee inundation has commenced in this event
Depths 0.4 – 3.0m
Existing 0.2% AEP – Approx 12.3m at Wagga gauge

2.2. Building Footprint Impacts

Flood modelling extents have been intersected with the building database, developed as part of the economic assessment, to determine the number of buildings footprints impacted by inundation. Table 1 provides the number of building footprints impacted at different depths for different size flood events.

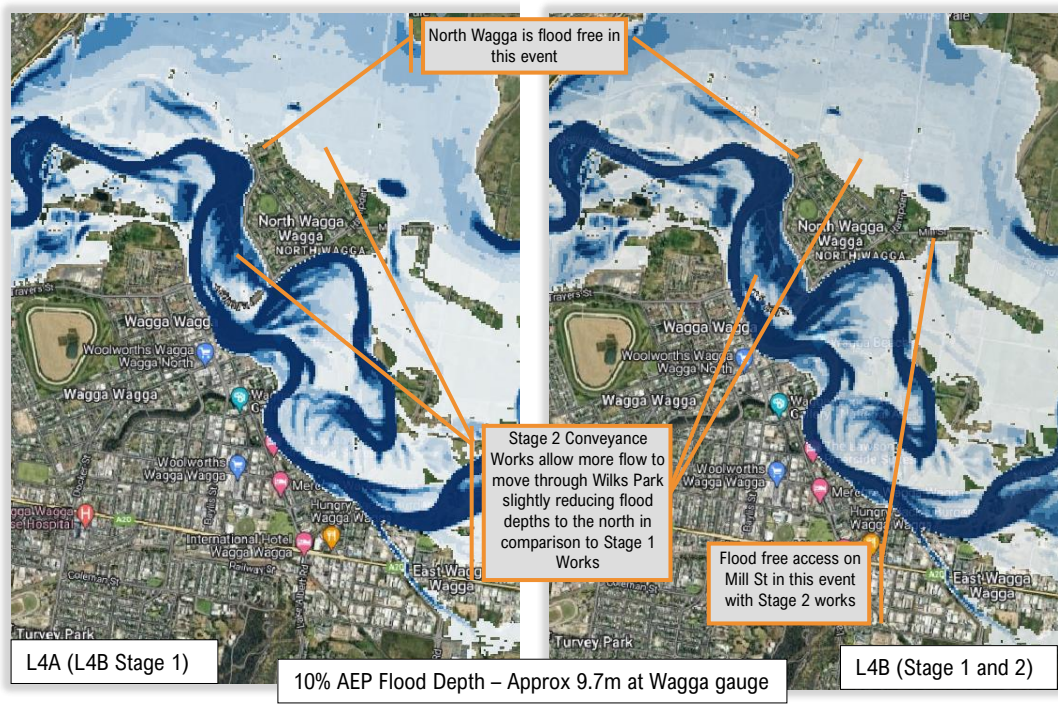
Table 1 Building Footprints Impacted – Existing Conditions

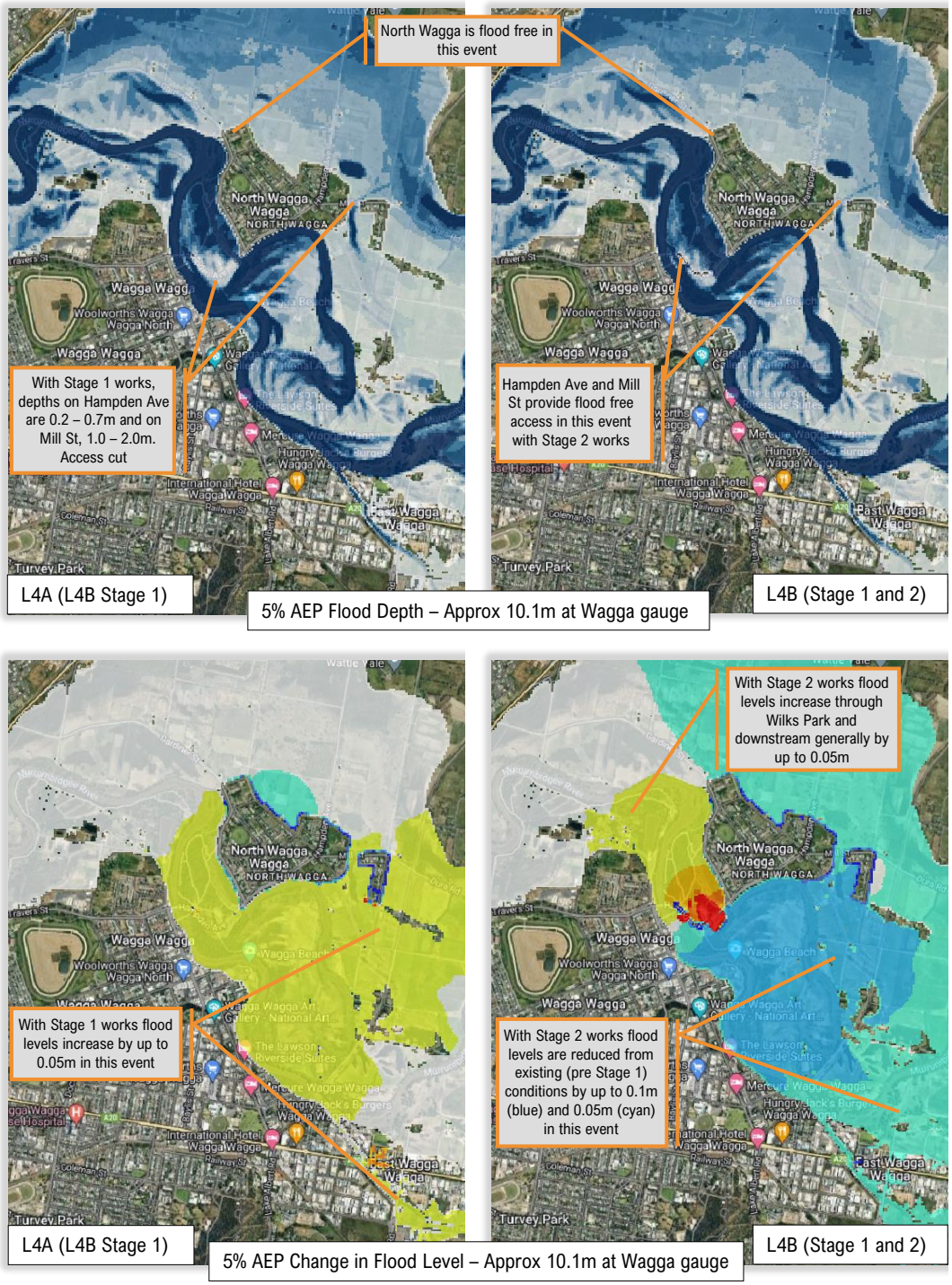
Depth (m)/Event (AEP)	PMF	0.2%	0.5%	1%	2%	5%	10%
0 – 0.03m	3	24	2	9	5	17	7
0.03 – 0.1m	14	70	7	40	47	75	33
0.1 – 0.5m	152	753	262	418	518	414	191
0.5 – 0.9m	166	1,349	423	439	510	347	106
0.9 – 1.2m	120	992	312	354	300	179	74
>1.2m	9,593	3,268	1,583	1,167	744	299	96
Total Number of Buildings	10,048	6,456	2,589	2,427	2,124	1,331	507

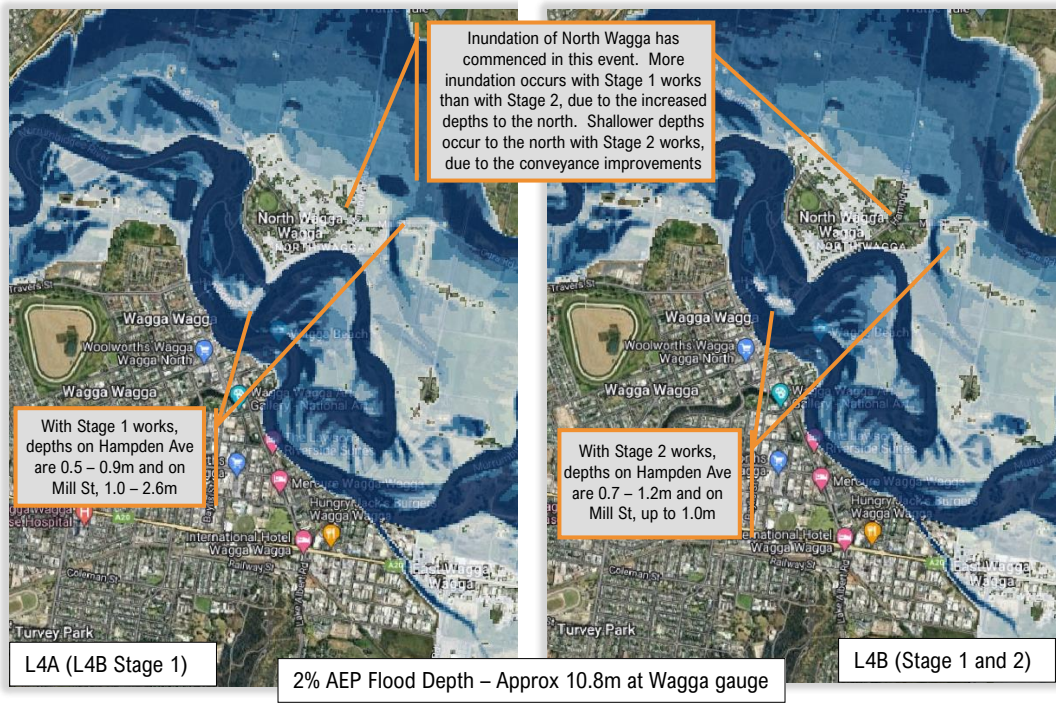
3. OPTION COMPARISON

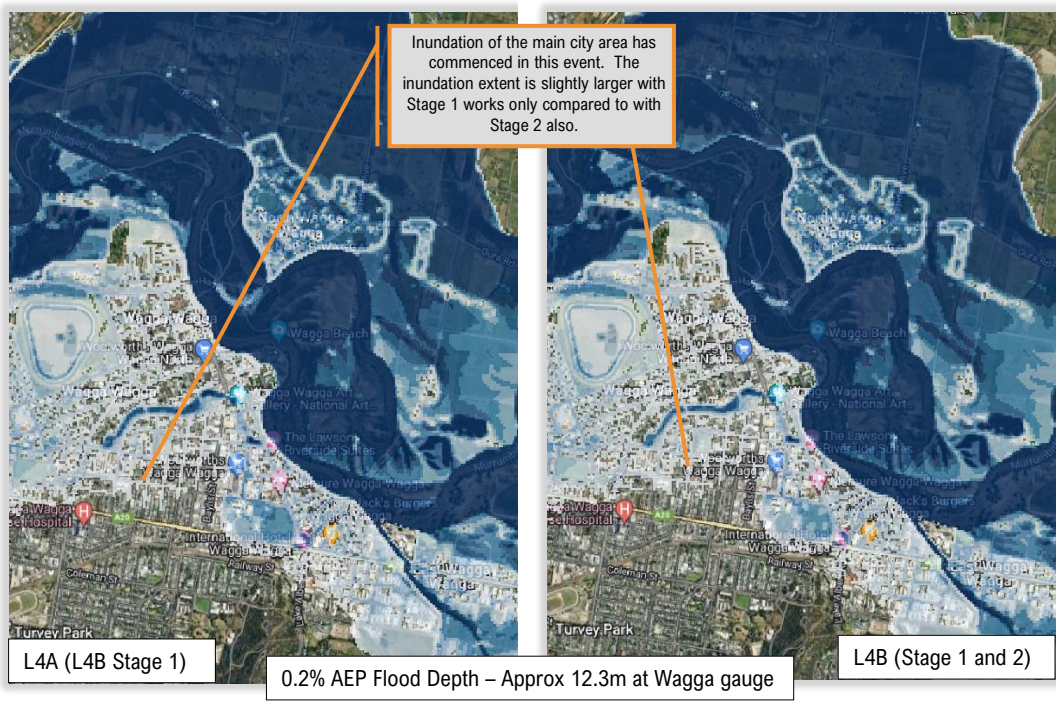
3.1. Flood Behaviour

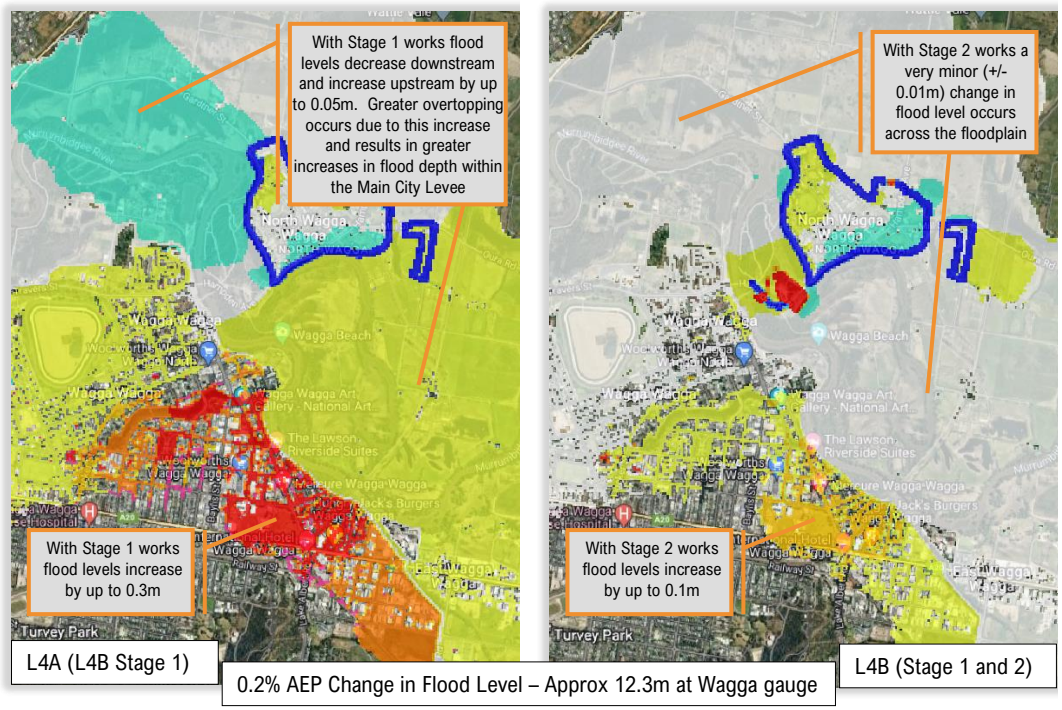
The implementation of each staged element of Option L4B, Stage 1 levee upgrade works (Option L4A) and Stage 2 associated works including road height increases and bridges through Hampden Avenue to provide a safe evacuation route for residents from North Wagga and conveyance improvements through Wilks Park, results in different impacts on flood behaviour. Under a staged approach the impacts occurring under Option L4A (Stage 1 L4B) will remain until the Stage 2 works, are implemented. The following provides an overview of these differing impacts on flood behaviour.




North Wagga is flood free in this event
With Stage 1 works, depths on Hampden Ave are 0.2 – 0.7m and on Mill St, 1.0 – 2.0m. Access cut
Hampden Ave and Mill St provide flood free access in this event with Stage 2 works
L4A (L4B Stage 1)
L4B (Stage 1 and 2)
5% AEP Flood Depth – Approx 10.1m at Wagga gauge
With Stage 1 works flood levels increase by up to 0.05m in this event
With Stage 2 works flood levels increase through Wilks Park and downstream generally by up to 0.05m
With Stage 2 works flood levels are reduced from existing (pre Stage 1) conditions by up to 0.1m (blue) and 0.05m (cyan) in this event
L4A (L4B Stage 1)
L4B (Stage 1 and 2)
5% AEP Change in Flood Level – Approx 10.1m at Wagga gauge


Inundation of North Wagga has commenced in this event. More inundation occurs with Stage 1 works than with Stage 2, due to the increased depths to the north. Shallower depths occur to the north with Stage 2 works, due to the conveyance improvements
With Stage 1 works, depths on Hampden Ave are 0.5 – 0.9m and on Mill St, 1.0 – 2.6m
With Stage 2 works, depths on Hampden Ave are 0.7 – 1.2m and on Mill St, up to 1.0m
L4A (L4B Stage 1)
L4B (Stage 1 and 2)
2% AEP Flood Depth – Approx 10.8m at Wagga gauge


Inundation of the main city area has commenced in this event. The inundation extent is slightly larger with Stage 1 works only compared to with Stage 2 also.
L4A (L4B Stage 1)
L4B (Stage 1 and 2)
0.2% AEP Flood Depth – Approx 12.3m at Wagga gauge



3.2. Building Footprint Impacts

Flood modelling extents for the options have been intersected with the building database, developed as part of the economic assessment, to determine the change in the number of building footprints impacted by inundation and the magnitude of that change. Table 2 provides the total number of building footprints with any impact or benefit, as well as the total number of building footprints with flood impacts, for different size flood events. The most notable change between the two options (L4A (Stage 1 L4B) and L4B (Stage 1 and 2)) is the increase in building footprints benefitted and decrease in building footprints impacted as a result of Option L4B (Stage 1 and 2). The most significant of these changes can be seen during the 5% AEP event, where the building footprints benefitted, increases from 627 (Option L4A) to 1,080 (Option L4B) and the building footprints impacted, reduces from 523 (Option L4A) to 110 (Option L4B).

Table 2 Building Footprints Impacted – Options

Event AEP	Option L4A (Stage 1 L4B)			Option L4B (Stage 1 and 2)		
	Net Total	Benefitted	Impacted	Net Total	Benefitted	Impacted
PMF	10,048	252	9,761	10,048	1,993	6,865
0.2%	6,580	586	5,831	6,515	490	5,819
0.5%	2,592	310	2,054	2,591	479	1,891
1%	2,442	532	1,710	2,427	588	1,635
2%	1,771	855	1,068	1,699	858	1,029
5%	792	627	523	729	1,080	110
10%	459	53	264	453	395	84

The above table shows building footprints with any change in flood level (including very minor). Table 3 provides the total number of building footprints with impacts or benefits greater than 0.01m, for different size flood events. A filter of 0.01m has been applied as +/- 0.01m is typically considered within the accuracy limits of the hydraulic model. The resulting numbers of building footprints in Table 3 shows that a large proportion of the building footprints identified in Table 2 are subject to a small change in inundation as a result of the options. However, the trends observed in Table 2 are similar when comparing the two options (L4A (Stage 1 L4B) and L4B (Stage 1 and 2)), with more impacted building footprints and less building footprints benefitted under L4A (Stage 1 L4B). Once filtering is applied, impacted building footprints are limited to the East Wagga Wagga, Eunanoreenya, North Wagga Wagga and Wagga Wagga areas, in addition to Ashmont, Gumly Gumly, Moorong and Kooringal in larger events.

Table 3 Building Footprints Impacted (Filtered +/- 0.01m) – Options

Event AEP	Option L4A (Stage 1 L4B)		Option L4B (Stage 1 and 2)	
	Benefitted	Impacted	Benefitted	Impacted
PMF	83	779	79	80
0.2%	278	4,299	195	1,197
0.5%	183	1,071	230	750
1%	306	849	338	582
2%	686	461	730	326
5%	571	178	798	29
10%	51	6	208	14

To understand the scale of the negative impacts to building footprints, Table 4 shows the number of building footprints which are newly flooded for the two options (L4A (Stage 1 L4B) and L4B (Stage 1 and 2)), for different size flood events. These building footprints were previously not inundated in the noted event and under either option, are now inundated in that event.

Table 4 Building Footprints Newly Impacted (Filtered +/- 0.01m) – Options

Event AEP	Option L4A (Stage 1 L4B)	Option L4B (Stage 1 and 2)
	Newly Impacted	Impacted
PMF	0	0
0.2%	123	59
0.5%	3	2
1%	18	3
2%	4	4
5%	25	0
10%	5	5

Table 5 shows building footprints which under existing conditions have inundation depths over 0.9m and under either option (L4A (Stage 1 L4B) and L4B (Stage 1 and 2)) is impacted by more than 0.01m. An existing depth of 0.9m has been selected as at this depth significant impacts are likely to have occurred.

Table 5 Building Footprints Impacted (Base >0.9m and Option >0.01m) – Options

Event AEP	Option L4A (Stage 1 L4B)	Option L4B (Stage 1 and 2)
PMF	779	80
0.2%	2,505	1009
0.5%	883	717
1%	639	501
2%	231	190
5%	76	8
10%	0	4

QUESTIONS WITH NOTICE