



Environmental Impact Statement – Chapter 29: EIS Synthesis, Project justification and conclusion

# Warragamba Dam Raising

Reference No. 30012078 Prepared for WaterNSW 10 September 2021

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# 29 EIS synthesis, Project justification, and conclusion

This chapter provides a summary of the Project including a description of activities that approval is being sought, unavoidable impacts, mitigation measures and an overall justification for the Project based upon the technical assessments in the EIS. The relevant Secretary's Environmental Assessment Requirements (SEARs) are shown in Table 29-1.

Table 29-1.	Secretary's	Environmental	Assessment	Requirements:	EIS synthesis
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Desired performance outcomes	Secretary's Environmental Assessment Requirements <sup>1</sup>	Where addressed
2. Environmental impact statement The project is described in sufficient detail to enable clear	<ul> <li>(p) a chapter that synthesises the environmental impact assessment and provides:</li> <li>a succinct but full description of the project for which approval is sought</li> </ul>	Section 29.1
understanding that the project has been developed through an iterative process of impact identification and assessment and project refinement to	<ul> <li>a description of any uncertainties that still exist around design, construction methodologies and/or operational methodologies and how these will be resolved in the next stages of the project</li> </ul>	Section 29.4
impacts so that the project, on balance, has the least adverse	<ul> <li>a compilation of the impacts of the project that have not been avoided</li> </ul>	Section 29.5
environmental, social and economic impact, including its cumulative impacts.	<ul> <li>a compilation of the proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction and operation) or offset these impacts</li> </ul>	Section 29.6
	<ul> <li>a compilation of the outcome(s) the proponent will achieve</li> </ul>	Section 29.8
	<ul> <li>the reasons justifying carrying out the project as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts.</li> </ul>	Section 29.10

1. This chapter specifically addresses SEARs requirement 2 (p) in addition to those general requirements of the SEARs applicable to all chapters and as identified as such in Chapter 1 (Section 1.5, Table 1-1).

## 29.1 The Project seeking approval

This EIS considers the potential impacts of constructing and operating the Project. A detailed Project description is provided in Chapter 5 (Project description) and summarised as follows.

Warragamba Dam Raising is a project to provide flood mitigation to reduce the significant existing risk to life and property in the Hawkesbury-Nepean Valley downstream of the dam. This would be achieved through raising the level of the central spillway crest by around 12 metres and the auxiliary spillway crest by around 14 metres above the existing full supply level (FSL) for temporary storage of inflows. The spillway crest levels and outlets control the extent and duration of the temporary upstream inundation. There would be no change to the existing maximum volume of water stored for water supply.

The NSW Government announcement in 2016 proposed that the dam wall be raised by 14 metres. Subsequently, the SEARs required the Project to be designed, constructed and operated to be resilient to the future impacts of climate change and incorporate specific adaptation actions in the design.

Peer reviewed climate change research found that by 2090 it is likely an additional three metres of spillway height would be required to provide similar flood mitigation outcomes as the current flood mitigation proposal. Raising the dam side walls and roadway by an additional three metres may not be feasible in the future, both in terms of engineering constraints and cost. The current design includes raising the dam side walls and roadway by 17 metres

now to enable adaptation to projected climate change. Any consideration of raising spillway heights is unlikely before the mid to late 21<sup>st</sup> century and would be subject to a separate planning approval process.

The 17 metre raising height of the dam abutments (side walls) and roadway have been considered and accounted for in the EIS and design. The potential maximum height and duration of upstream inundation remains consistent with what was originally proposed in 2016. The Project would include the following main activities and elements:

- demolition or removal of parts of the existing Warragamba Dam, including the existing drum and radial gates
- thickening and raising of the dam abutments
- thickening and raising of the central spillway
- new gates or slots for discharge of water from the flood mitigation zone (FMZ)
- modifications to the auxiliary spillway
- operation of the dam for flood mitigation
- environmental flow infrastructure.

The Project would take the opportunity, during the construction period for the dam raising, to install the physical infrastructure to allow for management of environmental flows as outlined in the NSW Government's 2017 *Metropolitan Water Plan.* However, the actual environmental flow releases do not form part of the Project and are subject to administration under the *Water Management Act 2000*.

The Project would delay downstream flooding, which would reduce current downstream flood peaks and increase the time taken for downstream water levels to recede. The dam would be subject to the following operational regimes, depending on the water level:

- Normal operations would apply when the reservoir level is at or lower than the full supply level (FSL), which is when the water level in the dam is at or below 116.7 metres Australian Height Datum (mAHD).
- Flood operations would apply when the water level is higher than the FSL. The flood mitigation zone (FMZ) would have sufficient storage to temporarily capture about 1,000 gigalitres of water during a flood event. For larger floods the FMZ would be filled and uncontrolled discharge would occur over the central spillway, and potentially, auxiliary spillway of the dam.

Operational objectives in order of priority are to:

- maintain the structural integrity of the dam
- minimise risk to life
- maintain Sydney's water supply
- minimise downstream impact of flooding to properties
- minimise environmental impact
- minimise social impact.

Project construction and operational elements are summarised in Table 29-2. A layout of the proposed works is shown in Figure 29-1, and future dam operations shown in Figure 29-2.

The design and construction approach presented in this EIS is based on a concept design and is indicative only. It is subject to change during the detailed design once Project approval is obtained. Detailed construction methodologies would be developed by the contractor(s) delivering the Project. Issues raised during exhibition of the EIS may result in changes to the concept design and construction methodology and if so, these would be identified in a preferred infrastructure report.

The Project does not include a detailed operational protocol for the operation of the FMZ or the environmental flow release regime. These activities would be subject to separate approvals, as appropriate.

Proiect element	Summary of design
Dam wall	- Extension of the left abutment
Bann Wan	- Thickening and increasing the height of the abutments to about 147.5 mAHD
Central snillway	- Thickening and increasing the height of the central spillway to about 128.7 mAHD
	- Replacing the existing radial and drum gates with slots or conduits
	- Modifying the dissinator walls either side of the spillway
Auxiliary spillway	Replacing the existing fuse plugs with a concrete crest
	- Strengthening and increasing in height sections of the spillway and the flin hucket
	- Erosion protection downstream of the spillway
Environment flow	- New multi-level offtake
release infrastructure	- Rehabilitation of existing infrastructure
	- New valve house and release structures
Other	- New bridges across the central and auxiliary spillway
other	- Vehicle and pedestrian access across the top of the dam, connecting to the approaches and road
	network on either side of the dam
	- New control and instrumentation equipment including mechanical, electrical and communications
	elements
	- New landscaping and urban design features for areas disturbed by construction and for other
	areas which require improved integration to the new dam structure
	- Ancillary works to tie existing services into the raised dam.
	- Modifying the two lift towers
	- Maintaining the eel passageway on the left bank
Construction program	A construction period of 4.5 to 5 years
Construction activities	Construction stages would include:
	<ul> <li>early works</li> </ul>
	<ul> <li>enabling works and demolition</li> </ul>
	<ul> <li>thickening and raising dam abutments</li> </ul>
	<ul> <li>thickening and raising the central spillway</li> </ul>
	<ul> <li>auxiliary spillway modifications</li> </ul>
	<ul> <li>other infrastructure and elements</li> </ul>
	<ul> <li>environmental flow infrastructure</li> </ul>
	<ul> <li>demobilisation and site restoration.</li> </ul>
Construction ancillary	Key construction facilities would be located on WaterNSW land and include:
facilities	<ul> <li>Haviland Park</li> </ul>
	<ul> <li>Twenty Third Street – materials storage and handling areas</li> </ul>
	<ul> <li>Left bank – materials storage and handling areas</li> </ul>
	<ul> <li>terrace gardens near valve house – batch plant.</li> </ul>
Construction materials	Approximate quantities of construction materials include:
	<ul> <li>621,000 cubic metres of concrete</li> </ul>
	<ul> <li>10,880 tonnes of reinforcing steel</li> </ul>
	<ul> <li>22,013 square metres of steel and timber formwork</li> </ul>
	<ul> <li>24,380 cubic metres of engineering fill.</li> </ul>
Construction workforce	A construction workforce comprising trades, subcontractors, construction, engineering, functional
	and administrative staff. There would be a variable workforce across standard working hours, with a
	reduction in personnel works carried out outside standard working hours. There would be a total
	peak workforce of around 500 personnel.
Construction hours	Most noisy activities (including materials delivery) would occur between 7 am – 6 pm on weekdays
	hours during warmer months
Traffic generation	At neak construction, there would up to:
	■ 500 workers
	<ul> <li>250 light vehicles per day.</li> </ul>
	<ul> <li>104 beavy vehicles per day</li> </ul>
Operation	Operation of the dam for fleed mitigation during and after major reinfall quests
	operation of the dam for hood mitigation during and diter major faintail events

## Table 29-2. Project description summary

## Figure 29-1. Project works



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#### Figure 29-2. Project operation



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## 29.2 Existing environment

The Project construction site is in the Wollondilly local government area (LGA) at the existing Warragamba Dam, which is around 65 kilometres west of the Sydney CBD. The impacts and the benefits of the Project would be experienced at the construction site, as well as upstream and downstream of Warragamba Dam. The locations of the dam and upstream and downstream study areas are shown in Figure 29-3.

#### 29.2.1 Existing operations

Warragamba Dam has a capacity of about 2,027 gigalitres and is operated for water supply to the Sydney region. The dam provides water to the Prospect water filtration plant, which supplies treated water to approximately 80 percent of Sydney's population. Water from the dam is also supplied to the townships of Warragamba, Penrith, and the Lower Blue Mountains through smaller filtration plants at Warragamba and Orchard Hills. Water is also released into the Warragamba River to provide a secure water supply to the population of North Richmond and as environmental flows. While the dam provides some flood mitigation capacity when the water level is below the full supply level, it is not formally operated for flood mitigation.

Current operations comprise:

- fixed low flow releases of 22 megalitres per day in winter and 30 megalitres per day in summer, of which five megalitres per day is for the dilution of sewage treatment plant outfalls
- operational releases
- flows during heavy rainfall when the dam has filled, and water flows over the spillway.

During and after major rainfall events when inflows exceed outflows, the water level in the dam may increase above the full supply level resulting in the temporary inundation of the upstream catchment. For example, in the 1 in 100 chance in a year flood event up to about 1,548 hectares of the upstream catchment would experience temporary inundation. Currently when inflows cause the storage levels to rise above full supply level (FSL) the dam is operated per H14 rules or protocol. The H14 rules are designed to incrementally open the drum and radial gates to minimise rapid increases in the rate of rise of downstream flooding.

#### 29.2.2 Upstream

Lake Burragorang is the reservoir formed by Warragamba Dam. The major tributaries of Lake Burragorang are the Kedumba River, Coxs River, Wollondilly River, and Nattai River. A three-kilometre area around Lake Burragorang is designated a Schedule 1 – Special Area, which limits public access to protect the catchment and water quality of the lake. Entry to Schedule 1 – Special Areas on foot, or by vehicle (including cars, motorcycles, bicycles, and horses) is generally not allowed. The catchment of Lake Burragorang was originally owned and managed by WaterNSW, however, over the past 40 years, has been gradually transferred to the National Parks and Wildlife Service (NPWS) and incorporated into national parks and state conservation areas. The national parks and state conservation areas potentially impacted by the Project include the Blue Mountains National Park, Burragorang State Conservation Area, Nattai National Park, Nattai State Conservation Area and Yerranderie State Conservation Area. In 2000, the Greater Blue Mountains area was placed on the World Heritage list. About 0.03 percent of the overall Greater Blue Mountains World Heritage Area (GBMWHA) is contained in the upstream impact area.

Areas of the upstream catchment have been disturbed from historical clearing for agriculture, logging and mining – however, these activities have largely ceased. Most of the catchment contains intact native vegetation that has experienced minimal disturbance and has no or low weed infestation. Eighteen (18) plant community types (PCTs) were identified in the upstream study area of which six were listed as endangered under the NSW *Biodiversity Conservation Act 2016* and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Seventy-two (72) threatened flora species and 16 threatened fauna species were either recorded or assumed present in the upstream study area.

Sites that are part of the local Gundungurra Aboriginal people's creation story are also located in the upstream catchment area. All the physical heritage and creation story sites have a high cultural significance to the local Aboriginal people. In the areas surveyed for the EIS, many previously unknown Aboriginal heritage sites were identified. While most of these sites were open camp sites (which generally have a low level of scientific significance); highly significant rock art sites, shelters with evidence of occupation and a stone axe were discovered.

#### 29.2.3 Construction site

Warragamba Dam is located adjacent to the township of Warragamba – which was established for the construction of the dam between 1948 and 1960. The closest residences to the dam in Warragamba are about 200 metres from the auxiliary spillway and about 600 metres from the dam wall. The area immediately around the dam was cleared and disturbed for construction of the dam. However, native vegetation has regenerated and been replanted. A small area of a remnant threatened ecological community remains on the left bank and native vegetation around the dam is potential habitat for numerous threatened flora and fauna species. On the right bank of the dam there are operational facilities, the Warragamba Dam Visitor Centre, the State heritage listed Haviland Park, and other parks. Immediately downstream of the dam is the Warragamba River, which is impacted both from previous water supply schemes, the construction of Warragamba Dam and an altered flow regime.

#### 29.2.4 **Downstream**

Warragamba Dam discharges into the Warragamba River, which joins the Nepean River about 3.7 kilometres downstream of the dam. The Nepean River then flows through a 14 kilometre long gorge within the Blue Mountains National Park before reaching the developed floodplain area around Penrith. Upstream of Penrith at Yarramundi, the Nepean River becomes the Hawkesbury River, which continues past the townships of Richmond and Windsor. At Windsor, South Creek flows into the Hawkesbury River and downstream of Windsor, Cattai Creek joins the river. The Sackville gorges begin downstream of Cattai Creek's inflow. The Sackville gorges restrict flows during flood events and are largely responsible for the significant flooding of the Hawkesbury-Nepean Valley. Downstream of Sackville, the Colo River and Macdonald River flow into the Hawkesbury River. Downstream of Wisemans Ferry, coastal and tidal processes dominate river hydrology.

Between Penrith and Cattai Creek the floodplain has experienced extensive clearing for urban and agricultural development. Key urban areas along this section of the Hawkesbury-Nepean River include: Emu Plains, Penrith, North Richmond, Richmond, Windsor and McGraths Hills. There are also many smaller townships and suburbs within the flood plain. The catchment of South Creek, which experiences backwater flooding during major flood events, has also been extensively developed for residential and commercial uses and is part of the North-West Growth Centre. Closer to the river and generally below the 1 in 100 chance in a year flood level, there are many agricultural enterprises including turf farming, market gardens, cattle grazing and horse agistment.

River water quality is impacted by urban and agricultural runoff, and discharges from sewage treatment plants. The river has experienced major blue-green algal blooms and excessive growth of aquatic weeds. Much of the riparian vegetation between Penrith and Cattai Creek has either been removed, lost through erosion or is heavily weed infested. Some bank areas are unstable and have experienced substantial erosion.

Important patches of remnant vegetation are present throughout the floodplain and large tracts of mostly intact native vegetation exist on the western bank of the river between Penrith and North Richmond, and downstream of Cattai Creek. There are also numerous important wetlands in the floodplain especially near Cattai Creek. The wetlands vary in condition, with their condition generally related to the proportion of vegetation in the catchment still present. The wetlands and native vegetation provide important habitat to a range of threatened flora and fauna species.

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Figure 29-3. Dam location and study area

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## 29.3 Avoidance and minimisation of impacts through design

The environmental and social impacts of the Project have been minimised through design and the construction methods chosen. The key avoidance of environmental and social impacts of the Project has occurred through the adoption of the preferred option, rather than other alternatives. Table 29-3 outlines design responses that have allowed for environmental impacts to be avoided or minimised.

Table 29-3. Adverse impacts avoided or minimised

Environmental aspect	Design/operational response
Upstream inundation	Provision of a 14 metre flood mitigation zone rather than a 20 metre FMZ. While a 20 metre FMZ would provide a greater reduction in flooding downstream compared to a 14 metre FMZ, the greater environmental costs from the longer period and extent of upstream temporary inundation were a major factor in discounting this alternative.
	Emptying the FMZ as soon as practicable. One of the key objectives of the discharge protocol for the flood mitigation zone would be to minimise the duration and extent of upstream temporary inundation.
Non-Aboriginal heritage, aquatic ecology	Provide for a smooth finish to the face of the dam.

## 29.4 Project uncertainties and approach to design refinements

The design and proposed operational protocols presented in this EIS are indicative and subject to further detailed design and development, which may further minimise impacts. The design serves to:

- confirm that the proposed performance and technical requirements can be achieved
- validate the feasibility and potential operational protocols for flood mitigation
- identify key risks, constraints and potential environmental impacts.

There are some uncertainties relating to technical requirements and Project operations, which would be resolved during detailed design. A summary of the uncertainties that have the potential to impact on the environment, and how these would be resolved, is provided in Table 29-4. The identified uncertainties are not expected to result in significant or unacceptable impacts to the environment that would not be capable of mitigation or management.

Key uncertainty	Category	Proposed resolution for uncertainty
Impacts of temporary inundation on vegetation	Biodiversity	There is little scientific information on the impacts of temporary inundation and the subsequent regenerative capacity of most plant communities and individual species in the upstream catchment. The Framework for Biodiversity Assessment is not suited to assessing impacts of temporary inundation, which has led to a conservative impact assessment.
		This uncertainty has been addressed through assuming a total loss of biodiversity values in the upstream impact area and offsetting of these in accordance with the FBA.
Extent of plant community types (PCTs)	Biodiversity	Before field surveys were undertaken for the EIS, previous vegetation mapping was based upon interpretation of aerial photography with minimal ground truthing. The field surveys found that there were large differences between the original vegetation mapping and what was surveyed in the field, including different PCTs and extents. While the field survey undertaken for the EIS covered over 50 percent of the 1 in 100 chance in a year flood extent, in other areas the extent and presence of the PCTs had to be assumed. This uncertainty has been addressed through assuming a total loss of biodiversity values in the upstream impact area and offsetting of these in accordance with the FBA.

Table 25 4. Resolution of Rey Troject aneer tanties	Table 29-4.	Resolution	of key	Project	uncertainties
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Key uncertainty	Category	Proposed resolution for uncertainty
Presence and distribution of threatened species	Biodiversity	Due to the large study area and the considerable survey requirements to conclusively determine the presence/absence of most threatened species, for most threatened species, the assessment assumed their presence – when this might not be the case. This uncertainty has been addressed through assuming a total loss of biodiversity values in the upstream impact area and offsetting of these in accordance with the FBA.
Unknown Aboriginal heritage items	Aboriginal cultural heritage	Due to the size of the potential impact area and access difficulties due to the low water level in the dam across the periods of survey, not all upstream areas were able to be visited. It is not considered necessary to survey 100 percent of the upstream area as certain landscapes can be reasonably discounted due to the previous survey findings and other areas are unsafe or impossible to access. However, an adequate sample of the different landforms and sites was undertaken for the EIS assessment.
		A precautionary position has been adopted which assumes a total loss of Aboriginal heritage values in the upstream impact area although in practice this is unlikely to occur. The Warragamba Offset Program will investigate land suitable for offsets and will prioritise land that, amongst other matters, protects Aboriginal cultural values and heritage.
Slots or conduits in the central spillway	Hydrology	<ul> <li>Two options to release water from the dam via the central spillway are currently being investigated. These are:</li> <li>gated conduits – the advantage of this alternative is that discharge rates from the dam would be able to be varied and controlled accurately. The disadvantages are that it would require complex operating procedures and maintenance requirements.</li> <li>slots – the advantages of this alternative are there would be no operating procedures and maintenance requirements. The disadvantage is that discharge rates would be predetermined by flow and design, and not able to be varied.</li> <li>A combination of slots and conduits is also being considered.</li> <li>The provision of conduits, slots or a combination of both would be determined during detailed design. Should potential impacts arise that have not been considered in the EIS, then an amendment report would be prepared and submitted to DPIE.</li> </ul>
Detailed operational protocol for the discharge of water from the flood mitigation zone	Hydrology	A framework operational protocol for the flood mitigation operations has been developed and is presented in the EIS. A detailed operational protocol would need to be developed during the detailed design of the Project and in consultation with relevant stakeholders up and downstream of the dam. The final operational protocol may result in some minor changes in the flooding impacts and benefits. The final operational protocol would be developed during the detailed design and in further consultation with relevant stakeholders.
Heights of spillways	Hydrology	The heights of the central and/or auxiliary spillways may change, resulting in minor changes in the upstream and downstream hydrology. However, any changes in hydrology are not expected to be significant. The final heights of the spillways would be determined during detailed design.

Key uncertainty	Category	Proposed resolution for uncertainty
Construction methodology	Construction	The EIS contains a description of the construction methodology. However, there may be minor changes to this, primarily in relation to the ancillary facilities required during construction. The final construction methodology would be determined once a construction contractor has been engaged.
Source of aggregates	Traffic	The Project would require large quantities of fine and coarse aggregates to produce concrete. The source of these aggregates has yet to be determined and would be confirmed by the construction contractor. If aggregates were sourced from locations other than the Southern Highlands, the southern access route may not be required for heavy vehicle access to the site.
Spoil management	Spoil	It is currently proposed that spoil unable to be beneficially reused on site would be emplaced on site or sent off-site for reuse or disposal. Spoil management options would be further developed and assessed in the CEMP.
Erosion protection immediately downstream of auxiliary spillway	Soils and water quality	Erosion protection requirements downstream of the auxiliary spillway have yet to be finalised. The erosion protection requirements and their design would be determined during detailed design.

There are other processes that could be used to ensure that uncertainties in the Project are assessed and mitigated including:

- a preferred infrastructure report
- construction and operational management plans
- Warragamba Offset Program
- Project approval conditions, which may require further assessment
- a modification to the Project approval if a significant change to the Project was required after initial planning approval such that it would not be consistent with the approval.

## 29.5 Compilation of adverse impacts

Potential Project construction and operational impacts are summarised in Table 29-5 and Table 29-6 respectively. Potential residual impacts (that is impacts that would still potentially occur despite the mitigation measures proposed) would be further reviewed during detailed design development and construction planning, and where necessary additional measures would be implemented to ensure these impacts are suitably mitigated.

Environmental aspect	Summary of adverse impacts
Air quality	Minor increase in dust levels in and around construction area
Biodiversity	Removal of about 22.42 ha of native vegetation of which 1.64 ha is a threatened ecological community listed under the <i>Biodiversity Conservation Act 2016</i> A total of 22.42 ha of suitable habitat for 17 threatened fauna and 51 threatened flora species would be cleared. However, it should be noted that further detailed surveys are planned and the number of threatened species likely to be present or use habitat is expected to decrease. Various indirect impacts such as increased risk of weeds, impacts of noise and lighting, etc.
Aquatic ecology	Construction may impact on the existing eel passageway. Temporary in stream structures and dewatering activities may impact on aquatic species.
Climate change risk	Climate change risks associated with increases in extreme rainfall and storm events, which may impact upon construction activities and construction ancillary facilities with potential delays to the construction program.
Flooding and hydrology	Based on preliminary construction planning, there would be no change in flooding upstream and downstream of the dam during construction.
Health and safety	No significant residual impacts anticipated provided mitigation measures are implemented.
Non-Aboriginal heritage	Direct impacts to State heritage item Haviland Park. Direct impacts to s170 and local heritage items associated with Warragamba Dam. Impacts to previously unknown non-Aboriginal heritage items that may be discovered during demolition or earthworks.
Aboriginal heritage	Approximately 33 ha would be directly disturbed during construction. There are no known Aboriginal cultural heritage sites or natural landscape features within the footprint of the proposed surface infrastructure. Potential impacts on unknown sites discovered during construction.
Noise and vibration	Exceedances of the interim construction noise guideline noise management levels affecting sensitive receptors. Off-site vibration impacts are not anticipated.
Social and economic	Moderate impacts to amenity including noise, dust, traffic and visual. Temporary changes to access to public recreation facilities and visitor's centre at dam. Potential impacts on tourism due to closure of the dam and recreational areas.
Soils and contamination	Potential disturbance of known contaminated soil on the right bank. Potential disturbance of unknown contaminated material.
Traffic and transport	Increase in the volume of worker and heavy vehicle traffic on the existing road network.
Landscape and visual impacts	Moderate visual impacts at dam wall.
Waste	<ul> <li>Moderate residual impacts include:</li> <li>generation of moderate quantities of unusable spoil</li> <li>impacts associated with poor waste management during construction.</li> </ul>
Water quality	Potential increased water quality risks relating to sedimentation and erosion from construction works on the dam wall.
Protected and sensitive lands	No material impacts.
Property and land use	Temporary closure of some public recreation areas
Sustainability	A sustainability management plan would be prepared for the Project.

## Table 29-5. Summary of construction impacts

Environmental aspect	Summany of advorse impacts
Air quality	No material impacts expected.
Biodiversity - Upstream	The Project's potential operational impacts would result from increased temporary inundation from mitigating large rainfall events in the study area. These impacts would involve changes to current temporary inundation extents, depths and durations, and rates of rising and receding flows.
	The upstream impact area has been defined as the area between 119.5 mAHD and 126.97 mAHD, and which covers an area of about 1,400 ha. This reflects the difference between the likely inundation level with the Project and the likely inundation level for the existing dam. Potential impacts include:
	<ul> <li>flood stress of native vegetation due to temporary inundation of around two weeks</li> <li>long term erosion</li> </ul>
	<ul> <li>changes to vegetation structure and floristics</li> </ul>
	<ul> <li>physical damage to vegetation</li> </ul>
	<ul> <li>loss of threatened species and their habitat.</li> </ul>
	The Project's ongoing operation would result in potential impacts associated with temporary inundation to native vegetation. Native vegetation types within the upstream impact area include areas of all 18 PCTs mapped in the study area. Endangered or critically endangered vegetation under the BC and/or EPBC Acts include:
	<ul> <li>HN527 (PCT 840): Forest Redgum-Yellow Box = 127.8 ha</li> </ul>
	<ul> <li>HN553 (PCT 941): Mountain Blue Gum - Thin-leaved Stringybark open forest = 104.5 ha</li> </ul>
	<ul> <li>HN557 (PCT 1401): Narrow-leaved Ironbark - Forest Red Gum = 14.7 ha</li> </ul>
	Loss of threatened flora species and their habitat
	<ul> <li>75 flora species credit species</li> </ul>
	<ul> <li>16 fauna species credit species</li> </ul>
Biodiversity -	The Project would result in a decrease in the extent, frequency and variability of
Downstream	downstream flooding, while some floodplain areas would be affected by the discharge of the FMZ and would be inundated for longer. For example:
	For a 1 in 10 chance in a year event there would be:
	<ul> <li>a reduction of about 1,042 ha of native vegetation in the catchment previously affected in this event</li> </ul>
	<ul> <li>an increased duration of inundation in the FMZ discharge area from 2.5 to 5 days (an increase of 2.5 days)</li> </ul>
	<ul> <li>an increased temporary inundation duration of up to 1,926 ha of wetland and floodplain habitats in the FMZ discharge area.</li> </ul>
	For a 1 in 100 chance in a year event there would be:
	<ul> <li>a reduction in peak flow changes from 9,500 m<sup>3</sup>/s to 4,000 m<sup>3</sup>/s.</li> </ul>
	<ul> <li>a reduction of about 1,018 ha of native vegetation in the catchment previously affected in this event.</li> </ul>
	<ul> <li>an increased duration of inundation in FMZ discharge area from 4 to 11 days (an increase of 7 days).</li> </ul>
	<ul> <li>an increased inundation duration of up to 1,926 ha of wetland and floodplain habitats in the FMZ discharge area.</li> </ul>
	Potential biodiversity impacts relate to:
	<ul> <li>reduction of flooding extent in wetland and floodplain vegetation communities and habitats</li> </ul>
	<ul> <li>bank erosion and slumping resulting in vegetation community and habitat degradation</li> </ul>
	<ul> <li>displacement of habitat for fauna dependent on riparian or wetland habitats.</li> </ul>

## Table 29-6. Summary of operational impacts

Environmental aspect	Summary of adverse impacts
	Impacts on PCTs with medium or higher risk:
	freshwater communities = 43.4 ha
	<ul> <li>floodplain and riparian communities = 45.7 ha</li> </ul>
	<ul> <li>dry sclerophyll and grassy communities = 3.2 ha</li> </ul>
	Impact on threatened flora and fauna species:
	Potential or likely impacts were determined for 18 threatened biota, which include:
	<ul> <li>five TECs</li> </ul>
	<ul> <li>12 threatened flora species</li> </ul>
	<ul> <li>six threatened fauna species.</li> </ul>
Climate change risk	Increase in extreme flood producing rains may result in:
	<ul> <li>reduced flood mitigation benefits of the FMZ</li> </ul>
	<ul><li>increased inundation frequency in the zone immediately above the full supply level</li></ul>
	(FSL), contributing to potential environmental impacts.
Flooding and	Upstream:
hydrology	The FMZ would have sufficient capacity to temporarily store up to about 1,000 gigalitres.
	The rate of discharge would be relatively constant at about 100 gigalitres per day, but for
	short periods may increase to about 230 gigalitres per day for large flood events. The spill
	rate over the dam wall would be substantially lower than the existing situation.
	Steep terrain extends upstream from the dam wall for at least 20 kilometres, and
	changes to flood extent would be contained to a relatively small area. However, the rate
	River and Coxs River enter Lake Burragorang. Project flooding changes are summarised
	below:
	the Project would increase flood extents, estimated to be about 283 hectares
	(51 percent) for 1 in 5 chance in a year event, 1,387 (111 percent) for 1 in 20 chance
	in a year event and 1,912 hectares (192 percent) for a 1 in 100 chance in a year
	event
	<ul> <li>temporary inundation depth and duration would be highest near the dam wall and</li> </ul>
	around the perimeter of the main lake, estimated to be about 5 days for the 1 in 5 chance in a year event
	However injundation denth and duration would be substantially less for upstream
	tributaries. For example, for upstream sections of the Kowmung and Cox's rivers
	the temporary durations were respectively estimated to be 1.3 days and less than
	half day for the 1 in 20 chance in a year event
	<ul> <li>changes to flood frequency would vary throughout the upstream catchment, for</li> </ul>
	example for the Kowmung and Cox's rivers the current 1 in 100 chance in a year
	event would respectively occur on average about once every 85 years and 70 years with the Project
	• there would be an overall decrease in fleed velocities, both in the tributaries and
	within Lake Burragorang.
	No declared wild rivers would be impacted by the Project.
	Downstream:
	Project changes include:
	<ul> <li>reduction to peak dam outflows and flood levels. Downstream of Warragamba Dam</li> </ul>
	there would be a reduction in peak flow from 4,500 cubic metres per second (m <sup>3</sup> /s)
	to 1,050m <sup>3</sup> /s for a 1 in 10 chance in a year event, and from 9,500 m <sup>3</sup> /s to 4,000
	m³/s for a 1 in 100 chance in a year event.
	<ul> <li>reduction in frequency of flooding. For example, the existing 1 in 5 chance in a year</li> </ul>
	outflow becomes about a 1 in 60 chance in a year of occurring, while the existing 1
	In 100 chance in a year outflow becomes a 1 in 1,500 chance in a year outflow.

Environmental aspect	Summary of adverse impacts
	<ul> <li>reduction to flood extents. Flood levels are substantially reduced for floods up to the 1 in 1,000 chance in a year event, however there is a relatively small reduction for the Probable Maximum Flood (PMF) event.</li> <li>flood velocities would generally be the same but for a shorter duration for larger flood events. However, during emptying of the FMZ there would be an increase in the duration of sustained bank-full velocities.</li> <li>downstream floodplain connectivity, conveyance or flood storage areas would not</li> </ul>
	<ul> <li>be significantly impacted as the Project does not involve construction in or modification of the floodplain.</li> <li>discharge of the FMZ would result in longer periods of low level flooding within the river channel. The FMZ would be emptied at a constant rate of 100 gigalitres per day (1,160 cubic metres per second), however this could be increased to around 230 gigalitres per day for larger floods (equivalent to about a 1 in 5 chance in a year event). The FMZ could be emptied within three to four days.</li> </ul>
Health and safety	No material impacts expected
Non-Aboriginal heritage	No material impacts expected
Aboriginal heritage	The Project would result in some upstream areas experiencing a greater extent and duration of temporary water inundation when the FMZ is operational compared to the existing dam.
	<ul> <li>184 sites already impacted by the dam (in the Existing upstream impact area – EUIA) would experience additional flooding impacts. A total loss of value was assessed.</li> </ul>
	<ul> <li>43 known additional sites (in the Project upstream impact area – PUIA) would experience new flooding impacts. A total loss of value was assessed.</li> </ul>
	The cultural values assessment considered 19 sites within and in proximity to the upstream Project study area. Most of the sites are located outside of the GBMWHA where it sits inside the upstream Project study area. Noting the constraints associated with assessing impacts, the cultural values assessment noted that from the perspective of the Aboriginal cultural knowledge holders, it was understood that the potential impacts of the Project on identified cultural values would be harmful.
Noise and vibration	No material impacts expected.
Social and economic	<ul> <li>Potential economic impacts include:</li> <li>property owners experiencing increased low level flooding from the discharge of the flood mitigation zone</li> <li>river users experiencing increased low level flooding from the discharge of the flood mitigation zone</li> <li>road users from the closure of low lying bridges during discharge of flood mitigation zone.</li> </ul>
Soils and contamination	Potential increased bank erosion due to discharge of the FMZ.
Traffic and transport	Longer period of closure of low lying bridges during discharge of flood mitigation zone.
Landscape and visual impacts	<ul> <li>Moderate visual impacts:</li> <li>from change or loss of vegetation in some areas experiencing increased temporary inundation</li> <li>at the dam site from a larger and more prominent structure.</li> </ul>
Waste	No material impacts expected.
Water quality	Potential minor increases in some water quality parameters in Lake Burragorang associated with temporary inundation of upstream vegetated areas and soil landscapes during flood events.

Environmental aspect	Summary of adverse impacts
Protected and sensitive lands	Increased duration and extent of temporary inundation of areas of upstream National Parks and State Conservation Areas during operation of the FMZ.
	The extent and duration of temporary inundation would depend on the size of the flood event and the location of the specific protected areas within the upstream study area. Durations of increased flooding would range from hours to up to two weeks.
	Increased duration and extent of temporary inundation of roads and Special Areas fire trails.
World Heritage areas	Increased duration and extent of temporary inundation of areas of the Greater Blue Mountains World Heritage Area during operation of the flood mitigation zone.
	The extent and duration of temporary inundation depends upon the size of the flood event and the location of the specific area of GBMWHA with the landscape.
	About 304 hectares of the GBMWHA occurs within the upstream impact area. This represents about 0.03 percent of the total area (1,032,649 hectares) of the GBMWHA.
Property and land use	Potential impacts on property and land use include:
	<ul> <li>minor increase in the extent of flooding of two private lots in a 1 in 100 year flood and probable maximum flood event</li> </ul>
	<ul> <li>increased duration of low level flooding of land in areas impacted by discharge of the FMZ.</li> </ul>
Sustainability	No material impacts expected.

## 29.6 Warragamba Offset Program

The proposed Warragamba Offset Program (described in Appendix F6 and Chapter 13) is the vehicle for offsetting the potential impacts of the Project in the upstream study area. The cornerstone of the Program is the Biodiversity Offset Strategy (BOS) required to be prepared under the NSW Framework for Biodiversity Assessment (FBA). The objective of the BOS is to provide a framework for the delivery of offsets for the potential impacts of the Project related to the upstream study area and the construction study area which were assessed in accordance with the FBA.

The process for identifying, prioritising and meeting project biodiversity credit requirements for construction related impacts would comprise the following activities:

- Assessment of Biodiversity Stewardship Agreement site options
- Purchase of credits from the market
- Supplementary measures (if required)
- Contribution to the Biodiversity Conservation Fund where biodiversity credits could not be sourced from Biodiversity Stewardship Agreement sites on WaterNSW/private land, or on the credit market.

The BOS would also facilitate achievement of a long-term conservation gains for the threatened species, populations and communities, and biodiversity-related matters with regard to national parks and World Heritage values impacted by the Project. The BOS includes the biodiversity offsets required under the FBA and set out in the SEARs, and offsets addressing potential loss of biodiversity-related World Heritage and national park values.

The Warragamba Offset Program will investigate land suitable for offsets and will prioritise land that:

- contains suitable credits
- improves or supports the Outstanding Universal Value for the GBMWHA
- supports the integrity of protected lands
- protects Aboriginal cultural values and heritage.

The Warragamba Offset Program provides for auditing of compliance with these four priorities.

The Warragamba Offset Program also encompasses non-biodiversity matters such as:

- geodiversity
- water catchment protection
- cultural heritage

- landscape, natural beauty and aesthetic values
- recreation and visitor use
- social and economic benefits derived from visitation to these areas.

The mitigation measures identified in Section 29.7 would contribute to offsetting impacts on protected lands and would support the Warragamba Offset Program.

WaterNSW is required to prepare an Environmental Management Plan (EMP) under Part 5A of the *Water NSW Act* 2014 before the temporary inundation of any land protected by the *National Parks and Wildlife Act 1974* can occur. This EMP would be separate to the offset strategy but would complement and support the strategy. The scope and content of the EMP has yet to be defined but would be consistent with the existing management plans for the national parks and the GBMWHA. The EMP would contribute to the maintenance and strengthening of protected lands values.

## 29.7 Compilation of environmental management measures

This section is a compilation of the proposed environmental management measures required to avoid, minimise (through design refinements or ongoing management during construction and operation) or offset impacts outlined in Section 29.5.

WaterNSW requires the construction contractor to implement an environmental management system in the form of a construction environmental management plan (CEMP) during construction of the Project. The CEMP would provide a structured approach to the management of environmental issues identified in the EIS. Implementing the CEMP would effectively ensure that the Project meets regulatory and policy requirements in a systematic manner and facilitate continual improvement of its performance. The strategies defined in the CEMP would be developed in consideration of the Project approval requirements, and the safeguards and mitigation measures presented in the EIS. The CEMP would establish the system for implementation, monitoring and continuous improvement to minimise impacts of the Project on the environment.

A detailed operational protocol for the operation of the FMZ will be developed in consultation with relevant downstream and upstream stakeholders.

There are different management plans, monitoring programs and operational procedures that would be developed and implemented during operation of the Project. These are addressed in relevant EIS chapters and summarised in Tables 29-7 to 29-21.

## 29.7.1 Air quality (Chapter 7)

Impact	ID	Measure	Timing	
Impact Impacts from ambient air quality from dust generation and deposition during construction	AQ1	<ul> <li>A construction air quality management plan will be developed and implemented to monitor and manage potential air quality impacts associated with the construction of the Project and activities at construction ancillary facilities. The management plan will identify Project construction activities with the potential to have air quality impacts and the controls required to avoid, minimise and mitigate these impacts. The plan will include measures to:         <ul> <li>minimise Project and cumulative dust generation from stockpiles, haulage routes, work activities, exposed ground surfaces and materials handling/storage</li> <li>minimise generator and vehicle emissions during construction</li> <li>inspect and address corrective actions</li> </ul> </li> </ul>	Pre- construction and construction	
		<ul> <li>modify or cease dust generating works during unfavor weather conditions</li> </ul>	<ul> <li>modify or cease dust generating works during unfavourable weather conditions</li> </ul>	
		<ul> <li>monitor dust levels</li> </ul>		
		<ul> <li>respond to complaints about dust and other air quality issues.</li> </ul>		
		The Plan will be implemented for the duration of construction.		

 Table 29-7. Air quality impacts and environmental management measures

Impact	ID	Measure	Timing
	AQ2	Demolition activities, including removal of hazardous materials will be planned and carried out in a manner that minimises the potential for dust generation. Removal of hazardous materials will be completed prior to the commencement of general demolition works.	Construction

#### Biodiversity (Chapters 8, 9 and 10) 29.7.2

Impact	ID	Measure	Timing		
Upstream					
General flora and fauna impacts	BUS1	Biodiversity offset strategy (See Appendix F6 - Biodiversity offset strategy).	Operation		
Construction area					
General flora and fauna	BC1	A flora and fauna management plan (FFMP) would be prepared as part of the CEMP. Native vegetation clearing would not occur until the FEMP is approved.	Pre- construction and construction		
	BC2	The FFMP will be prepared to manage the vegetation retained within the development site. The plan would include details on weed and pest management, nest-boxes and fauna habitat maintenance and monitoring procedures.	Pre- construction, construction and post- construction		
Degradation of freshwater wetland habitats	BC3	Install appropriate drainage infrastructure (for example, sediment basins, diversion drains), sediment and erosion controls prior to the commencement of construction.	Pre- construction		
	BC4	Clearing of vegetation would be timed to avoid periods when rain is forecast	Pre- construction and construction		
	BC5	Dust suppression activities to be undertaken where appropriate.	Pre- construction and construction		
	BC6	Stabilisation of disturbed areas, including revegetation in accordance with the FFMP, is to be undertaken as soon as practicable after disturbance.	Pre- construction, construction and post- construction phases		
	BC7	Emergency response protocols and procedures for implementation in the event of a contaminant spill or leak to be clearly articulated in the construction and operational environmental management plans.	Pre- construction and construction		
	BC8	Spill kits to be located to allow for timely response to uncontained spills. Site inductions are to include a briefing on the use of spill kits.	Pre- construction and construction		
	BC9	Bio-retention installed in base of channels and swales to capture and store stormwater consisting of bio-filtration layers, planting and subsoil collection and drainage.	Pre- construction and construction		
Vegetation removal or disturbance	BC10	Clearly identifying sensitive areas ('no-go zones') which cannot be impacted by construction and managing clearing such that clearing activities are constrained to these approved areas only.	Pre- construction and construction		

Table 29-8. Biodiversity impacts and environmental management measures

Impact	ID	Measure	Timing
	BC11	Site inductions will include a briefing regarding the local threatened species and communities on the site, and protocols to be undertaken if they are encountered.	Construction and post- construction.
Weed invasion and spread	BC12	Management of weeds in and adjacent to cleared areas will occur in accordance with the FFMP and CEMP. The plans will include details relating to the monitoring, management, and where necessary, eradication of weeds, disposal of green waste, and vehicle/plant weed wash down protocols, if required.	Pre- construction, construction, and post- construction.
	BC13	Management of noxious weeds is to be undertaken in accordance with the <i>Biosecurity Act 2017</i> .	Pre- construction and construction
	BC14	Equipment used for treating weed infestation will be cleaned prior to moving to a new area within the Project area to minimise the likelihood of transferring any plant material and soil.	Pre- construction and construction
	BC15	Soil stripped and stockpiled from areas containing known weed infestations are to be stored on cleared land at least 40 m from native vegetation.	Construction
Impacts to fauna and flora	BC16	Fauna microhabitat such as hollow logs and dead trees should be removed from areas to be cleared and relocated to adjacent woodland habitat.	Pre- construction and construction
	BC17	A nest box and connectivity management strategy would be prepared prior to clearing of hollow bearing trees and connecting links. The strategy would inform the installation of nest boxes and fauna crossings in and between retained native vegetation adjacent to the site, and the on-going monitoring and maintenance of nest boxes and crossings through the construction and operational phases. This strategy would be included within the FFMP.	Pre- construction and construction
	BC18	High visibility plastic fencing is to be installed to clearly define the limits of the works area.	Construction
	BC19	Undertake a prestart-up check for sheltering native fauna of all infrastructure, plant and equipment and/or during relocation of stored construction materials.	Construction
	BC20	Site inductions are to include a briefing regarding the local fauna of the site and protocols to be undertaken if fauna is encountered.	Construction
	BC21	If any animal is injured, contact the relevant local wildlife rescue agency (for example, WIRES) and/or prequalified veterinary surgery as soon as practical. Until the animal can be cared for by a suitably qualified animal handler, minimise stress to the animal and reduce the risk of further injury by:	Pre- construction, construction, and post- construction.
		<ul> <li>manding rauna with care and as little as possible</li> <li>covering larger animals with a towel or blanket and placing in a large cardboard box</li> </ul>	
		<ul> <li>placing smaller animals in a cotton bag or plastic bag (smaller reptiles and frogs), tied at the top</li> <li>keeping the animal in a quiet, warm and ventilated space.</li> </ul>	
	BC22	If any pits/trenches are to remain open overnight, they are to be securely covered, where reasonable and feasible. Alternatively	Construction

Impact	ID	Measure	Timing
		fauna ramps (logs or wooden planks) are to be installed to provide an escape for trapped fauna. Pits will be inspected prior to work recommencing and any fauna removed by the project ecologist or designated suitably qualified and licensed representative.	
	BC23	The extent of vegetation clearing is to be clearly identified on construction plans.	Pre- construction
	BC24	In circumstances where native vegetation or mature tree clearing is required outside of the biodiversity development site, the project ecologist will inspect the proposed area and provide advice on the impact to flora and fauna and appropriate management.	Construction
	BC25	Directional lighting will be used where lighting is required in construction areas.	Construction
	BC26	Maintenance of construction machinery and plant will be undertaken to minimise unnecessary noise.	Construction
	BC27	Speed limits will be developed to minimise potential for fauna to be struck by a vehicle within the development site. All vehicles and plant in operation during construction are to adhere to site rules relating to speed limits.	Construction
	BC28	<ul> <li>Where suitable for the species, and in line with established conservation programs (such as Saving our Species), threatened species translocation will be carried for species occurring within the development site (Red-crowned Toadlet and <i>Grevillea parviflora</i> subsp. <i>parviflora</i>).</li> <li>Translocation will be carried out in line with Office of Environment and Heritage Translocation operational policy (OEH 2019) and will involve stakeholders from relevant government agencies, and subject matter experts.</li> </ul>	Pre- construction
Bushfire risk connectivity	BC29	Bushfire awareness included in staff induction and in toolbox talks pre-commencement.	Pre- construction and construction
Invasion and spread of pathogens and disease	BC30	<ul> <li>Implementation of hygiene protocols to minimise risk of spreading pathogens and disease. Mitigations include vehicle and equipment washdowns, and follow relevant guidelines including:</li> <li>Best Practice Management Guidelines for Phytophthora cinnamomic within the Sydney Metropolitan Catchment Management Authority Area (Suddaby &amp; Liew 2008)</li> <li>Hygiene protocol for the control of disease in frogs (DECC 2008)</li> <li>Management plan for myrtle rust on national parks estate (OEH 2011).</li> </ul>	Pre- construction and construction.
Downstream			
Inundation of native vegetation	BDS1	Development of the operational protocol for the FMZ would seek to minimise potential impacts on downstream vegetation from temporary inundation subject to meeting operational priorities for protection of life and property.	Operation

#### Aquatic ecology (Chapter 11) 29.7.3

Impact	ID	Measure	Timing
Obstruction to fish passage	AE1	Access to the existing eel passageway would be maintained. Should construction activities require modification to the eel passageway, works should be carried outside of the period when likely to be used by juvenile eels.	Pre- construction Construction
Obstruction to fish passage	AE2	<ul> <li>Where required, temporary in stream structures would be constructed in accordance with the NSW DPI policy guideline and would be inserted during low-flow periods with management plans being submitted to NSW DPI detailing how high flow events would be managed.</li> <li>Dewatering of temporary in-stream structure would address the following matters: <ul> <li>NSW DPI would be notified seven days prior to any dewatering activities to assess the need for potential fish rescue activities and to make appropriate arrangements for this. A separate s37 permit may be required from NSW DPI to relocate fish</li> <li>water is to be pumped a minimum of 30 metres away from the waterway and should preferentially not re-enter the waterway. If water is to re-enter the waterway, water quality would be managed in accordance with the approved water quality criteria for construction of the Project.</li> </ul> </li> </ul>	Construction
Water quality	AE3	Water quality would be managed in accordance with the approved water quality criteria for construction of the Project.	Construction
Erosion and bank stability	AE4	Scour protection and other bank stability mechanisms would be installed in the Warragamba River below the dam to minimise erosion and destabilisation of streambanks.	Pre- construction Construction
Aquatic habitat impacts	AE5	Aquatic habitat would be protected in accordance with Section 3.3.2 Standard precautions and mitigation measures of the <i>Policy and</i> <i>guidelines for fish habitat conservation and management (2013</i> <i>update)</i> (Fairfull 2013).	Pre- construction Construction
Aquatic habitat impacts	AE6	Existing monitoring programs would be reviewed and revised as required to effectively monitor potential impacts of the Project. The review would include consultation with DPI Fisheries.	Pre- construction Construction Operation
Threatened species	AE7	Relevant safeguards and management measures detailed in the Draft referral guidelines for the endangered Macquarie perch, <i>Macquaria australasica</i> (DSEWPaC 2011) would be implemented as required.	Construction

Table 29-9. Aquatic ecology impacts and environmental management measures

## 29.7.4 Climate change (Chapter 14)

Impact	ID	Environmental management measure	Timing
Climate Risk – general	CC1	Development of a Climate Risk Management Sub-Plan. The sub-plan would detail the safeguards and management measures required to be implemented during the construction of the Project. The plan should include monitoring to assess progress on major residual risks and serve as a continuous improvement mechanism to manage climate change risks as they become more robust into the future.	Pre- construction
Climate change – changes in extreme rainfall during construction	CC2	Design of temporary infrastructure, for example, coffer dams, diversions, to accommodate climate projections	Detailed design
Climate change – changes in extreme rainfall during construction	CC3	Implement measures to protect the community from potential impacts associated with climate change during construction of the dam, which may include temporary flood barriers.	Detailed design
Climate change – changes in extreme rainfall during design life	CC4	Detailed design will consider inclusion of design / construction elements to allow the dam to be more readily upgraded in the future to allow for climate change scenarios.	Detailed design
Climate change – more intense extreme weather events during construction	CC5	CC5 Construction sequencing for major works to consider peak ECL season.	
Climate change – CC6 Climate change will be considered during health and safety management planning.			Pre- construction

### Table 29-10. Climate change impacts and environmental management measures

## 29.7.5 Flooding and hydrology (Chapter 15)

Table 29-11.	Flooding	and hydrology	impacts and	environmental	management	measures
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Impact	ID	Measure	Timing
Impacts during construction	HF1	A Construction Flood Management Plan will be developed to minimise any changes in hydrology up and downstream of the dam and minimise risks to the construction site. Construction activities will be sequenced in accordance with Dams Safety NSW guidelines to ensure dam safety during construction.	Pre- construction
		with the requirements of Dams Safety NSW.	
Impacts from operation of FMZ	HF2	A detailed operational protocol for the operation of the FMZ will be developed in consultation with relevant downstream and upstream stakeholders.	Pre-operation
Monitoring	HF3	<ul> <li>Investigate water monitoring systems to reflect Project changes in operational protocols.</li> <li>Investigate additional monitoring station downstream of the Kedumba River</li> </ul>	Pre-operation

## 29.7.6 Health and safety (Chapter 16)

Impact	ID	Measure	Timing
Dam failure due to design	HS1	The Project will be designed to meet relevant State, national and international dam safety guidelines and in consultation with the Dams Safety NSW.	Design
Safety risks during construction	HS2	A construction safety management plan will be prepared in consultation with relevant stakeholders and will address safety of the construction workforce and public during general construction, in the event of a flood and for other likely hazards or risks.	Pre- construction and construction
Risks from dangerous goods management	HS3	All dangerous goods and materials will be stored and handled on site in accordance with relevant Australian Standards.	Construction
Transportation of dangerous goods	HS4	Materials will be transported in accordance with the Dangerous Goods (Road and Rail Transport) Act 2008 (NSW), Dangerous Goods (Road and Rail Transport) Regulation 2014 (NSW) and relevant Australian Standards.	Construction
Compromise of dam integrity during construction	HS5	ANZEC Guideline overpressure and ground vibration limits, and WaterNSW dam infrastructure ground vibration limits will be met for all blasting activities.	Construction
Bushfire risk	HS6	Construction activities involving ignition or flammable sources will be managed to minimise fire risks. High risk construction activities relating to bushfire, such as welding and metal work, would not be undertaken on total fire ban days, and will be managed as appropriate.	Construction
Ground contamination	HS7	Ground contamination management measures are provided in Chapter 22 (Soils). These include requirements for additional surveys and a protocol for managing unexpected finds.	Construction

Table 29-12. Health and safety impacts and environmental management measures

## 29.7.7 Non-Aboriginal heritage (Chapter 17)

Table 29-13. Non-Aboriginal heritage impacts and environmental management measures

Impact	ID	Measure	Timing
Impacts on directly affected heritage items	NAH1	Where possible, consideration will be given to conserve and avoid impact to elements of primary significance and heritage items within the construction zone. Where impact and/or removal is unavoidable, the subsequent measures will be enacted.	Pre- construction
		Photographic archival recording and reporting would be carried out in accordance with the NSW Heritage Office's <i>How to Prepare</i> <i>Archival Records of Heritage Items</i> (1998a), and <i>Photographic</i> <i>Recording of Heritage Items Using Film or Digital Capture</i> (2006). The record would be prepared by a suitably qualified heritage consultant using archival-quality material. Records for SHR listed items would be held at the NSW Heritage Council and State Library. Records for LEP-listed items would be held by the local Council and local library. A copy of the record would be held by the owner of the asset.	
		Appropriate heritage interpretation would be incorporated into the design for the Project in accordance with the NSW Heritage Office's <i>NSW Heritage Manual</i> (1996), <i>Interpreting Heritage Places and</i>	

Impact	ID	Measure	Timing
		<i>Items Guidelines</i> (2005b), and <i>Heritage Interpretation Policy</i> (2005a).	
	NAH2	A heritage interpretation strategy for the Project will be incorporated into future designs and planning. Opportunities for interpretive displays in appropriate locations would be explored.	Design
	NAH3	An appropriately qualified and experienced heritage architect will provide independent review periodically throughout detailed design.	Design
	NAH4	The Project design will be sympathetic to impacted items (including retained significant elements) and surrounding heritage items by minimising impacts to sight lines, views and setting.	Design
	NAH5	Except for heritage significant elements affected by the Project, direct impact on other heritage significant items elements will be avoided.	Design and Construction
	NAH6	Where heritage significant items or elements are to be retained within the construction zone, detailed design will consider appropriate adaptive reuse or interpretive use to be developed in consultation with a heritage architect.	Design and Construction
	NAH7	A moveable heritage item strategy (including a salvage strategy) will be prepared for the Warragamba Supply Scheme. The strategy will be prepared by a suitably qualified heritage consultant in consultation with WaterNSW and include a comprehensive record of significant elements to be impacted. This will include items, machinery and equipment, and commemorative plaques and memorials contained within curtilage of the Warragamba Dam site. The moveable heritage item strategy will form part of a broader interpretation strategy for the Warragamba Supply Scheme.	Pre- construction
	NAH8	The fabric of primary and contributory significance of items proposed for removal will be identified and catalogued according to the significant fabric strategy prior to design development and will be re-used or salvaged where possible. Where not re-used within the design of the Project, the significant fabric strategy will indicate appropriate storage locations as well as appropriate off-site locations where the salvaged elements may be reused in the future. Where large elements are impacted a sample of fabric may be appropriate.	Pre- construction
	NAH9	Methodologies for the removal of existing structures and construction of new structures and infrastructure will be developed to minimise direct and visual impacts to other elements within the curtilages of the heritage items or to heritage items located near works.	Design and Construction
Impacts on heritage visual values	NAH10	Site remediation measures related to construction sites will be incorporated within the Urban Design and Landscape Plan. The objective of the remediation will be to minimise long-term impacts on the visual amenity of the items by recreating a sympathetic environment. A landscape scheme would be prepared for the SHR listed Haviland Park to re-instate planting and landscaping within and around the item's curtilage. The scheme will consider appropriate plantings. Any boundary wall treatment will be designed in consultation with a heritage architect.	Design and Construction

Impact	ID	Measure	Timing
Impacts on archaeological resources	NAH11	An archaeological research design will be prepared and implemented to identify the need for archaeological testing or monitoring. Archaeological mitigation measures recommended in the archaeological research design will be carried out in accordance with Heritage Council guidelines, and where identified in the archaeological research design, would be supervised by a suitably qualified Excavation Director. An Unexpected Finds Policy will be implemented during the Project to manage and mitigate potential impacts to the potential archaeological resource.	Pre- construction
Impacts from ancillary works	NAH12	Ancillary works required by the Project related to batch plant, laydown areas, power supply, drainage facilities and any other works will be designed and constructed to minimise impacts on heritage items and areas of archaeological potential as much as feasible within the context of the Project.	Pre- construction
Impacts to Haviland Park	NAH13	Design and construction within the SHR curtilage of Haviland Park will consider the recommendations of the Warragamba Supply Scheme CMP 2010 (Graham Brookes and Associates 2010) and the significant fabric strategy.	Design and Construction
Impacts to the Warragamba Supply Scheme	NAH14	Design and construction within the s170 curtilage of the Warragamba Supply Scheme will consider the recommendations of the Warragamba Supply Scheme CMP 2010 (Graham Brooks & Associates 2010) and the significant fabric strategy.	Design and Construction

#### Aboriginal cultural heritage (Chapter 18) 29.7.8

Table 29-14.	Aboriginal	cultural	heritage	impacts and	environmental	management	measures
	<u> </u>					<u> </u>	

Impact	ID	Measure	Timing
Consultation	ACH1	WaterNSW would continue consultation and engagement with the Registered Aboriginal Parties for the duration of the Project.	Pre- construction Construction
	ACH2	An independent facilitator would work with the RAPs and the wider Aboriginal community to develop an Aboriginal advisory group to guide the implementation of Recommendations 8 to 11 in the Cultural Values Assessment Report (Appendix 2 to Appendix K).	Pre- construction Construction Operation
Management of impacts on cultural heritage	ACH3	An Aboriginal Cultural Heritage Management Plan (ACHMP) would be developed for the Project and implemented as part of the Construction Environmental Management Plan (CEMP). The ACHMP would be developed and managed in consultation with the RAPs and relevant regulatory authorities. The AHMP would provide specific guidance on measures and controls to be undertaken to avoid and mitigate impacts on Aboriginal cultural heritage during construction.	Pre- construction Construction
	ACH4	Prior to the operation of the Project WaterNSW to review its assessment processes for works within the upstream catchment to include awareness to personnel undertaking an activity on its behalf of any potential Aboriginal cultural heritage values and objects in the area.	Construction Operation
	ACH5	A cultural heritage awareness and cultural competency training package would be developed and delivered to all WaterNSW staff. The training package would include a site-specific module	Pre- construction

Impact	ID	Measure	Timing
		developed in consultation with the relevant Aboriginal communities and RAPs.	
	ACH6	The site-specific Aboriginal cultural heritage awareness training package would be delivered as part of the site induction for all employees, contractor(s) and maintenance personnel involved in the construction works and ongoing site management and activities in the catchment of Lake Burragorang.	Construction Operation
	ACH7	WaterNSW would develop a formal agency-specific process and policy for undertaking cultural heritage assessments and engaging with the Aboriginal community in line with those developed by other state government agencies.	Operation
	ACH8	WaterNSW would consider engaging an in-house archaeological specialist support in line with other state government agencies.	Operation
Access to Country	ACH9	WaterNSW would develop and implement a policy to improve access for Aboriginal community members to Country they have cultural connections with that are under WaterNSW management.	Prior to operation
	ACH10	WaterNSW would facilitate bi-annual on-country visits open to Aboriginal community members with cultural connections to the area.	Ongoing
Site recording	ACH11	The unsurveyed portion of the PUIA would be surveyed should the Project be approved (survey would include provision for detailed recording of all shelter sites including 3D photogrammetry, planning, detailed photography and scale drawing of any art or other features present).	Prior to operation
	ACH12	The unsurveyed portion of the area above the PUIA within the upstream study area would be sample surveyed to identify sites and places of high significance should the Project be approved (survey would include provision for detailed recording of all shelter sites including 3D photogrammetry, planning, detailed photography and scale drawing of any art or other features present).	Prior to operation
	ACH13	Further detailed impact assessment and recording of all Aboriginal cultural heritage sites and places that are located within the PUIA, sites of high significance in the area above the PUIA within the upstream study area, and all art sites within the upstream study area would be carried out. This would include 3D photogrammetry and high resolution digital photographic records and would include the landscape context of sites and site complexes to capture archaeological and cultural values.	Prior to operation
Cultural values recording and education	ACH14	WaterNSW would consult with the RAPs and the Aboriginal community with regard to carrying out a comprehensive specialist research audit of the holdings of national and international collection institutions to identify cultural materials removed from Country in the Study Area. Subject to proceeding with the audit, WaterNSW would facilitate an access visit for Aboriginal community members to any cultural materials identified in Sydney and Canberra based collection institutions.	Prior to operation
	ACH15	In consultation with the RAPs and the Aboriginal community, WaterNSW would develop interpretative materials on the Aboriginal cultural values and history of the cultural landscape of the Study Area including: a permanent exhibition at the	Prior to operation

Impact	ID	Measure	Timing
		Warragamba Dam Visitor Centre; interpretative signage and audio posts within the Warragamba Dam grounds; and facilitate the provision of Aboriginal-led cultural events (i.e. tours and talks) through the Warragamba Dam Visitor Centre.	
	ACH16	In consultation with the RAPs and the Aboriginal community, WaterNSW would develop a cultural values project to record the Gurrangatch-Mirrigan Dreaming Story route through the photographic recording of specific cultural locations within the Study area (prior to any further impacts), oral history recordings with Aboriginal community members, and documentary research.	Prior to operation
	ACH17	In consultation with the RAPs and the Aboriginal community, WaterNSW would undertake a heritage study of the Aboriginal traditional and historical occupation of the Study area through photographic recording of specific sites (prior to any further impacts), historical documentary research, and oral history interviews.	Prior to operation

#### Noise and vibration (Chapter 19) 29.7.9

Impact	ID	Measure	Timing
Impact Construction noise and vibration	NV1	<ul> <li>A construction noise and vibration management plan (CNVMP) will be prepared. The CNVMP will include processes and responsibilities to assess, monitor, minimise and mitigate noise and vibration impacts during construction. The CNVMP will be implemented for the duration of the construction of the Project. The plan will: <ul> <li>identify relevant performance criteria in relation to noise and vibration</li> <li>identify noise and vibration sensitive receptors and features near the Project</li> <li>include standard and additional mitigation measures from relevant guidelines and details about when each will be applied</li> <li>describe the process(es) that will be adopted for carrying out location and activity specific noise and vibration impact assessments to assist with the selection of appropriate mitigation measures</li> <li>consider cumulative construction noise impacts and construction noise fatigue</li> <li>include protocols that will be adopted to manage works required outside standard construction hours, in accordance with relevant guidelines including for management of respite periods</li> <li>detail monitoring that will be carried out to confirm Project performance in relation to noise and vibration performance criteria.</li> </ul> </li> </ul>	Pre- construction
	NV2	Detailed noise assessments will be carried out for all ancillary facilities required for construction of the Project. The requirement for temporary noise walls within ancillary facilities and adjacent to construction works, and the requirement for other appropriate noise management measures, is to be assessed and implemented	Pre- construction

Impact	ID	Measure	Timing
		prior to the commencement of activities that have the potential to cause noise or vibration impacts.	
	NV3	<ul> <li>All residents affected by noise from the construction of the Project and whom may be expected to experience an exceedance of the construction NMLs, will be consulted about the Project prior to the commencement of the activity, with the highest consideration given to those that are predicted to be most affected by the works.</li> <li>The information provided to the residents will include: <ul> <li>general sequencing and locations of construction work</li> <li>the hours of the Project works</li> <li>construction noise and vibration impact predictions for the works</li> <li>construction noise and vibration mitigation measures likely to be implemented on site</li> </ul> </li> </ul>	Pre- construction
		Community consultation regarding construction noise and vibration will be detailed in the Community Involvement Plan for the construction of the Project and will include a complaint's handling process. The community will be able to provide feedback via a 24- hour, toll-free Project information and complaints line, a dedicated email address and postal address for the Project. For out of hours works, consultation with affected residents will take place with consideration to Strategy 2 of the ICNG.	
Impacts form out of hours works	NV4	Noisy work and vibration intensive activities (those activities that exceed the vibration criteria) will be scheduled to be undertaken during standard construction hours as far as possible. Works or activities that cannot be undertaken during standard construction hours will be scheduled as early as possible during the evening and/or night-time periods. Where required, respite measures will be implemented for noisy work and vibration intensive activities.	Construction
Construction vehicle noise	NV5	Construction vehicle movements (on and off site) will be managed to avoid or minimise noise impacts. Materials delivery to the construction site would only occur during the day. Mitigation measures for vehicle movements outside of standard construction hours are to be included in the CNVMP.	Construction
Vibration from construction activities	NV6	Vibration generating activities will be managed to minimise the potential for impacts on structures and sensitive receptor(s), including maximising safe working distances where practicable, or use of alternate methods to minimise vibration where safe working distances cannot be achieved. Where alternatives cannot be implemented, vibration monitoring will be undertaken and receptors notified in advance of works.	Construction
Impacts from blasting	NV7	<ul> <li>A blast management plan (BMP) will be developed for the Project. This would provide for design and monitoring of trial blasts to confirm site specific conditions and validate local propagation characteristics (develop site specific 'site laws') and confirm the Maximum Instantaneous Charges (MICs) and blast designs to meet vibration and overpressure limits.</li> <li>The BMP would include: <ul> <li>limiting criteria</li> <li>identified blast sensitive receivers (community and onsite structures)</li> <li>performance indicators</li> </ul> </li> </ul>	Pre- construction Construction

Impact	ID	Measure	Timing
		<ul> <li>monitoring protocols</li> <li>roles and responsibilities</li> <li>blasting controls</li> <li>protocols for community consultation, incidents and complaints</li> <li>contingency protocols</li> <li>reporting requirements.</li> </ul>	
	NV8	<ul> <li>The BMP will consider the following with regard to overpressure and ground vibration:</li> <li>Blast timing: restriction of blasting to between the hours of 9.00 am to 5.00 pm Monday to Saturday with no blasting outside of these times, including on Sundays and Public Holidays.</li> <li>Blast monitoring and inspection including: monitoring at key sensitive sites and trial blasts to assist in the development of</li> </ul>	Pre- construction Construction
		<ul> <li>'site laws' based on monitoring data.</li> <li>Regular condition surveys and blast monitoring at heritage structures and modification of blast design to meet blast limits at these sites where required.</li> </ul>	
	NV9	Mitigation controls will be incorporated into design. A program will be developed for the ongoing monitoring and maintenance of plant and equipment.	Operation

## 29.7.10 Socio-economic, land use and property (Chapter 21)

Table 29-16. Socio-economic, land use and property impacts and environmental management measures

Impact	ID	Mitigation/enhancement measures	Timing		
Property and land use					
Construction — Temporary disruption of tourism and recreation uses due to the potential temporary closure of the Warragamba Dam Visitor Centre and Haviland Park.	SE18	<ul> <li>Local communities and visitors would be notified about construction activities, the temporary closure of recreation venues, changes in the traffic arrangements and heavy vehicle routes during the construction period.</li> <li>Assess options to continue functions of the Visitor Centre at alternative locations to ensure public safety during construction.</li> <li>Ongoing consultations with relevant NSW Government agencies and local government to identify and implement appropriate solutions to reduce disruption of areas surrounding the Project site.</li> <li>Consult with the local community to select a legacy project to be delivered upon construction completion:</li> <li>Upgrade the viewing platform on Eighteenth Street with a shelter, interpretive signage and other enhancements.</li> <li>Develop options to deliver tourism to Warragamba during construction, such as viewpoints, tours or display materials.</li> <li>Provide alternative BBQ and picnic facilities within the Wollondilly Shire to offset the temporary closure of facilities within the construction area.</li> </ul>	Construction		

Impact	ID	Mitigation/enhancement measures	Timing
Construction — Delayed travel time in accessing properties due to increased construction traffic.	SE19	Implement the Construction Traffic Management Plan developed as part of the Traffic and Transport Assessment (refer to Chapter 24 and Appendix O of the EIS). Installation of temporary traffic control measures and signage for safe movement of vehicles, pedestrians and cyclists accessing local community facilities, shopping centres and schools. Local communities would be notified about construction activities, the potential temporary closure of recreation venues, changes in the traffic arrangements and heavy vehicle routes during the construction period. Provide support to Wollondilly Council to assist with project- related administration and enquiries.	Construction
Operation Upstream — Community concern regarding effects on World Heritage listed areas	SE20	Regular engagement with local communities (as per a Community and Stakeholder Engagement Plan) to explain actual impacts/benefits, understand concerns and identify mitigation measures. Ensure that environmental impacts are offset, where possible, with a Biodiversity Offset Strategy. Consultation with GBMWHA Advisory Committee and State/Federal government agencies regarding impacts and mitigation measures. Implementation of environmental management plan (EMP) measures which also aid in maintaining the environmental condition of the GBMWHA.	Operation
Operation Upstream — Community concern regarding effects on National Parks	SE21	Regular engagement with local communities (as per a Community and Stakeholder Engagement Plan) to explain actual impacts/benefits, understand concerns and identify mitigation measures. Ensure that environmental impacts are offset, where possible, with a Biodiversity Offset Strategy. Consultation with GBMWHA Advisory Committee, NPWS and State/Federal government agencies regarding impacts and mitigation measures. Implementation of EMP measures which also aid in maintaining the environmental condition of the National Parks.	Operation
Operation Upstream — Two private properties due to temporary and partial inundation of land	SE22	Regular engagement with the two impacted property owners (as per a Community and Stakeholder Engagement Plan) to explain actual impacts and benefits, understand concerns and identify mitigation measures.	Operation
Operation Upstream — Changed access to properties at Yerranderie	SE23	Regular engagement with local communities (as per a Community and Stakeholder Engagement Plan) to explain actual impacts/benefits, understand concerns and identify mitigation measures. Consultation with GBMWHA Advisory Committee, NPWS, and Yerranderie Management Committee and State/Federal government agencies regarding impacts and mitigation measures.	Operation
Operation Downstream —	SE24	WaterNSW will support the relevant NSW Government agencies and local government to build community awareness	Operation

Impact	ID	Mitigation/enhancement measures	Timing
Reduction in the impacts of flooding in the LGAs of Liverpool (primarily limited to Wallacia), Penrith, Blacktown, Hawkesbury, and The Hills (primarily limited to Wisemans Ferry)		on flood risks and specifically the effect which the Project has upon flood risk.	
Operation Downstream — Decreased frequency but increased duration of inhibited access to and from low lying property due to longer duration of the FMZ discharge	SE25	Work with relevant agencies to develop and implement updated emergency evacuation plans. Inform stakeholders on the duration of inhibited access to and from properties due to releases from the FMZ.	Operation
Environment			
Construction — Temporary negative visual impacts	SE26	Implement impact mitigation measures as outlined in Appendix P (Landscape and visual impact assessment.) Reduce visual impacts through appropriate landscaping and incorporation of other screening solutions where appropriate. Develop options to deliver tourism to Warragamba during construction, such as viewpoints, tours or display materials.	Construction
Post-Construction — Positive landscape character	SE27	Consult with the local community to select a legacy project to be delivered upon construction completion. Provide information regarding the Project to tourism related agencies to assist them promote the area as a tourism attraction. Rehabilitation and landscaping of the cleared and disturbed areas.	Post construction
Community health and we	ellbeing		
Construction — Temporary pressure on existing medical and emergency services due to influx of construction workforce	SE28	Engage with medical and emergency service providers as part of ongoing planning and Project development. Provision of appropriate onsite medical response facilities and personnel. Develop and implement safety protocols including an emergency response plan. Provide support to Wollondilly Council to assist with project- related administration and enquiries.	Pre- construction and construction
Operation Upstream — Health effects associated with heightened anxiety	SE29	Regular engagement with local communities (as per a Community and Stakeholder Engagement Plan) to explain actual impacts/benefits, understand concerns and identify mitigation measures.	Operation
Operation Downstream — Enhanced safety of residential areas due to reduced extent and frequency of floods, including	SE30	WaterNSW will support the relevant NSW Government agencies and local government to build community awareness on flood risks and specifically the effect which the Project has upon flood risk. Publicly disclose the benefits of the Project to stakeholders via various appropriate communication channels as outlined in the Project's Community and Stakeholder Engagement Plan.	Operation

Impact	ID	Mitigation/enhancement measures	Timing
<ul> <li>reduced risk of post-flooding infectious disease</li> <li>Enhanced safety due to improved ability to evacuate communities</li> <li>Reduced levels of flood risk awareness, reduced (individual) flood disaster planning and increased complacency</li> <li>Improved access to key services, and health facilities</li> </ul>		WaterNSW will support the relevant NSW Government agencies involved in the <i>Hawkesbury-Nepean Valley Flood Risk</i> <i>Management Strategy</i> .	
Operation Downstream — Occasional reduced access to services and health facilities during discharge of water from the FMZ	SE31	Work with relevant NSW Government agencies and local government to build community awareness on flood risks and specifically the effect which the Project has upon flood risk. WaterNSW will support the relevant NSW Government agencies involved in the <i>Hawkesbury-Nepean Valley Flood Risk</i> <i>Management Strategy</i> .	Operation
Operation Estuary — Occasional reduced access to services and health facilities	SE32	WaterNSW will support the relevant NSW Government agencies involved in the <i>Hawkesbury-Nepean Valley Flood Risk Management Strategy</i> .	Operation
Way of life			
Construction — Temporary generation of employment opportunities	SE33	<ul> <li>Provide a clear and efficient process for people to access information about employment and provide an opportunity to register interest in the Project.</li> <li>Liaise with local job network providers to provide information on employment opportunities to local job seekers.</li> <li>Develop a framework to increase the representation of young people, Aboriginal and Torres Strait Islander people and women in the construction industry by providing employment pathways, training and skills development.</li> <li>Provide support to Wollondilly Council to assist with project-related administration and enquiries.</li> </ul>	Construction
Construction — Temporary generation of commercial opportunities for businesses	SE34	Develop a local procurement policy to encourage the Project's contactors, where possible, source their workforce and their suppliers for goods and services locally. Provide a process for local businesses to register interest in project-related supplier and service provider opportunities. Work with the local networks and local businesses to organise and plan for how to benefit from the incoming workforce. Work with government stakeholders to build businesses' capacity through business development and mentoring.	Construction

Impact	ID	Mitigation/enhancement measures	Timing
		Work with the local networks and local businesses to organise and plan for how to benefit from the Project. Liaise with local job network providers to provide information on employment opportunities to local job seekers. Provide support to Wollondilly Council to assist with project-	
Construction — Perceived temporary negative effects on Tourism industry	SE35	related administration and enquiries. Local communities and visitors to be notified about construction activities, the potential temporary closure of recreation venues, changes in the traffic arrangements and heavy vehicle routes during the construction period. Assess options to continue functions of the Visitor Centre at alternative location/s while ensuring public safety during construction. Ongoing consultations with relevant NSW Government agencies and local government to identify and implement appropriate solutions to reduce disruption of areas surrounding the Project site. Work with the local networks and local businesses to organise and plan for how to benefit from the Project. Consult with the local community to select a legacy project to be delivered upon construction completion. Upgrade the viewing platform on Eighteenth Street with a shelter, interpretive signage and other enhancements. Develop options to deliver tourism to Warragamba during construction, such as viewpoints, tours or display materials. Provide alternative BBQ and picnic facilities within the Wollondilly Shire to offset the potential temporary closure of facilities within the construction area.	
P-Construction — Increase in visitation numbers to the Dam	SE36	Consult with the local community to select a legacy project to be delivered upon construction completion. Provide information regarding the Project to tourism related agencies to assist them promote the area as a tourism attraction. After construction, add project information to the Visitor Centre display.	Post construction
Construction — Temporary impacts on community sentiment, cohesion, and resentment	SE37	<ul> <li>Work with the Dam Fest committee to support its ongoing success during the four-year construction phase.</li> <li>Workforce fundraising to contribute to local Warragamba initiatives as voted by the community.</li> <li>Development and implementation of a Code of Conduct for the workforce.</li> <li>Actively engage with local communities to understand concerns and expectations and identify mitigation measures.</li> <li>Provision of regular Project construction updates to the community.</li> <li>Liaise with local job network providers to provide information on employment opportunities to local job seekers. Consult with the local community to select a legacy project to be delivered upon construction completion. Develop options to deliver tourism to Warragamba during construction, such as</li> </ul>	Construction

Impact	ID	Mitigation/enhancement measures	Timing
		viewpoints, tours or display materials. Develop and implement a Local Industry Participation Plan for construction. Develop and implement a Construction CSEP which includes a complaints management process and provision of timely information to communities. On-site parking for all construction vehicles.	
<ul> <li>Operation Upstream —</li> <li>Reduced tourism visitation due to perceived environmental impacts</li> <li>Reduction in revenue for nature-based recreation businesses due to perceived environmental impacts</li> <li>Diminished enjoyment of community values</li> <li>Polarisation of community sentiment resulting in reduced community cohesion</li> </ul>	SE38	Implementation of EMP measures which also aid in maintaining the environmental condition of the catchment.	Operation
Operation Downstream — Positive economic effects due to reduced flood related damage to property Reduced risk of people permanently and temporarily losing access to housing and accommodation Improved confidence in housing market and potential reduction in insurance premiums Potential reduction in insurance premiums at	SE39	WaterNSW will support the relevant NSW Government agencies and local government to build community awareness on flood risks and specifically the effect which the Project has upon flood risk. Publicly disclose the benefits of the Project to stakeholders via various appropriate communication channels as outlined in the Project's Community and Stakeholder Engagement Plan. WaterNSW will support the relevant NSW Government agencies involved in the <i>Hawkesbury-Nepean Valley Flood Risk Management Strategy</i> .	Operation

Impact	ID	Mitigation/enhancement measures	Timing
<ul> <li>individual properties</li> <li>Reduction in flood related economic losses for agricultural and industrial businesses</li> <li>Occasional additional economic losses for agricultural and industrial businesses</li> <li>Reduction in flood related economic losses for tourism and recreation related businesses</li> <li>Occasional additional economic losses for tourism and recreation related businesses</li> <li>Occasional additional economic losses for tourism and recreation related businesses</li> <li>Improved community cohesion due to improved ability to control flood related risk and plan communities accordingly</li> </ul>			
<ul> <li>Operation Estuary —</li> <li>Positive economic effects due to reduced flood related damage to property</li> <li>Occasional potential and additional economic losses for fishing and aqua-culture businesses</li> </ul>	SE40	WaterNSW will support the relevant NSW Government agencies to support the <i>Hawkesbury-Nepean Valley Flood Risk</i> <i>Management Strategy</i> . WaterNSW will support the relevant NSW Government agencies and local government to build community awareness on flood risks and specifically the effect which the Project has upon flood risk. Publicly disclose the benefits of the Project to stakeholders via various appropriate communication channels as outlined in the Project's Community and Stakeholder Engagement Plan.	Operation

## 29.7.11 Soils (Chapter 22)

Table 29-17. Soils impacts and environmental management measures

Impact	ID	Environmental management measure	Timing
Impacts on site	S1	Prior to ground disturbance, further investigations are	Construction
workers and/or		recommended to assess and manage potential contamination risk.	

Impact	ID	Environmental management measure	Timing
Impact local community through disturbance of known or potential contaminated land(s) or material.	ID	<ul> <li>Environmental management measure</li> <li>Any contamination would be managed through implementation of an unexpected finds protocol, as discussed below.</li> <li>Site works should be managed to avoid disturbance of known buried contamination (identified as Site A', which is within the boundary of one of the proposed laydown areas) through implementation of adequate protocols to ensure restrictions on ground disturbance in potentially affected areas. The location of this area will be identified on design drawings.</li> <li>Further investigations and management of potential contamination will be undertaken in accordance with NSW regulatory provisions and NSW Environment Protection Authority (EPA) endorsed guidelines, such as (but not limited to):         <ul> <li>National Environment Protection (Assessment of Site Contamination) Measure 1999 (April 2013), EPHC 2013, Canberra</li> <li>NSW EPA Waste Guidelines</li> <li>Contaminated Land Guidelines - Consultants Reporting on Contaminated Land (NSW EPA 2020)</li> <li>Managing Land Contamination: Planning Guidelines SEPP 55 –</li> </ul> </li> </ul>	Timing
	S2	<ul> <li>Remediation of Land (DUAP 1998)</li> <li>Should demolition of existing structures within the construction footprint be required then management of hazardous materials would need to be managed through appropriate controls in accordance NSW regulatory provisions, NSW EPA and SafeWork NSW guidelines such as (but not limited to): <ul> <li>Code of Practice – How to Safely Remove Asbestos (SafeWork NSW 2019)</li> <li>Code of Practice – How to Manage and Control Asbestos in the Workplace (SafeWork NSW 2019)</li> <li>Construction and demolition waste: A management toolkit, EPA, 2020</li> <li>NSW EPA Waste Guidelines</li> <li>NSW Health and Safety Act and Regulations</li> <li>Protection of the Environment and Operations Act 1997</li> </ul> </li> <li>These controls will be detailed in the CEMP.</li> <li>A hazardous materials assessment will be carried out prior to and during the demolition of buildings. Demolition works will be undertaken in accordance with the relevant Australian Standards and relevant NSW WorkCover Codes of Practice, including the Work Health and ancillary services, not all hazardous materials may have been assessed during previous surveys. Areas of the dam that are to be disturbed as part of the construction works will be assessed for hazardous building materials prior to commencing works. A protocol for managing unexpected finds of hazardous materials will be included in the CEMP.</li> </ul>	Pre- construction
	53	Areas of contamination, if they were to be uncovered during site works could be managed through implementation of an unexpected finds protocol, otherwise initial intrusive assessments could be carried out to gain a better understanding of the potential for contamination to exist in areas that will be disturbed. Soil contamination if identified is likely to be able to be managed	Pre- construction Construction

Impact	ID	Environmental management measure	Timing
		<ul> <li>through either offsite disposal or on site capping and management.</li> <li>The protocol will include: <ul> <li>cease work in the vicinity</li> <li>initial assessment by an appropriately qualified professional</li> <li>further assessment and management of contamination, if confirmed, in accordance with section 105 of the <i>Contaminated Land Management Act 1997</i>.</li> </ul> </li> </ul>	
	S4	Potentially contaminated areas directly affected by the Project will be investigated and managed in accordance with section 105 of the <i>Contaminated Land Management Act 1997</i> .	Pre- construction Construction
	S5	Asbestos handling and management will be undertaken in accordance with an Asbestos Management Plan (as part of the CEMP).	Pre- construction Construction
Unexpected finds	S6	Any unexpected contamination finds will be managed through an unexpected finds protocol which will be detailed in the CEMP.	Pre- construction Construction
Accidental spills during construction	S7	Procedures to address spills, leaks will be developed as part of the CEMP and implemented during construction of the Project.	Pre- construction Construction
Impacts to soil and water quality	S8	Measures will be implemented to appropriately store dangerous goods and reduce the potential for environmental contamination due to spills and leaks.	Pre- construction Construction
	S9	A construction soil and water management plan will be prepared for the Project including procedures to manage potentially contaminated stormwater runoff.	Pre- construction Construction
	S10	Development of an operational protocol that balances the multiple objectives from the FMZ, upstream inundation, environmental flows and downstream riverine requirements. The outcome will be to minimise as much as possible the inundation durations in upstream areas and reduce downstream flooding.	Operation

## 29.7.12 Traffic and transport (Chapter 24)

Table 29-18. Traffic and transport impacts and environmental management measures

Impact	ID	Environmental management measure	Timing		
Impacts from construction traffic	TT1	A construction traffic management plan (CTMP) will be prepared which will detail processes to minimise delays and disruptions and identify and respond to changes in road safety due to Project construction works. The CTMP will be prepared in accordance with applicable guidelines and relevant standards, guides and manuals. The CTMP will:	Pre- construction		
				<ul> <li>include a construction contingency plan to manage traffic in the event of emergency road closures due to flood, fire, and/or road accidents, road repair works and bridge load limits</li> </ul>	
		<ul> <li>ensure all relevant stakeholders are considered during all stages of the Project</li> </ul>			
		<ul> <li>provide safe routes for pedestrians and cyclists during construction</li> </ul>			

Impact	ID	Environmental management measure	Timing
		<ul> <li>comprehensively communicate changes in traffic conditions on roads or paths to community, emergency services, public transport operators, other road user groups and other affected stakeholders</li> <li>identify measures to manage the movements of construction- related traffic to minimise traffic and access disruptions in the public road network</li> <li>minimise the use of local roads by the Project's heavy vehicles and identify haulage routes</li> <li>propose a car parking strategy for construction staff</li> <li>consider truck telematics to assist the project managers and road network managers to ensure mass limits are adhere to and to reduce congestion/improve safety during peak construction periods</li> <li>speed management of construction related vehicles to cross Blaxland Crossing Bridge and continuous monitoring of bridge performance</li> </ul>	
Worker vehicle impacts	TT2	Carpooling will be encouraged to minimise number of employee vehicles travelling to the site.	Construction
Off-site queuing of heavy vehicles	TT3	Queueing of heavy vehicles will be permitted only within the site perimeter.	Construction
Access to construction area	TT4	All construction traffic will use Production Avenue to access the site.	Construction
Safety of intersection	TT5	The Warradale Road/Production Avenue intersection will be reviewed against the latest relevant Austroads guidelines (for example, sight distances) and appropriate modifications made in consultation with Wollondilly Shire Council to ensure compliance.	Pre- construction
	TT6	Temporary traffic signals will be installed at Warradale Road/Production Avenue intersection.	Pre- construction
Impacts on road condition	TT7	Regular inspection and maintenance will be carried out on Park Road, Silverdale Road, Farnsworth Avenue, Production Avenue and Warradale Road.	Construction
	TT8	A road dilapidation report will be prepared in consultation with the relevant road authority for the Park Road, Silverdale Road, Farnsworth Avenue, Production Avenue and Warradale Road.	Pre- construction
Out-of-hours heavy vehicle movements	TT9	Heavy vehicle site access will be restricted to the standard working hours only. No heavy vehicle access will be permitted for periods outside standard working hours unless required for an emergency, delivery of oversize plant or for other justifiable reason as detailed in the construction traffic management plan.	Construction
Road safety	TT10	A Stage 1 road safety audit (RSA) will be undertaken at the detailed construction traffic management plan development stage.	Pre- construction
Impacts on visitor parking	TT11	Provision of using existing car park facilities on Farnsworth Avenue for visitor centre and Haviland Park will be considered.	Construction
	TT12	Parking strategy will be developed to understand the demand and supply of parking spaces for the visitor centre and Haviland Park during the construction stage.	Construction
Safety of school buses	TT13	Consideration will be given to ensure that the operation of general construction traffic will be minimised during periods of school bus operations.	Construction

Impact	ID	Environmental management measure	Timing
Bridge and road closures during flood mitigation zone discharge	TT14	WaterNSW will keep the Bureau of Meteorology (BoM) informed of the discharge volumes from the FMZ. BoM will then combine these releases with other inflows and rainfall forecasts and tell the SES, TfNSW and Councils what the forecast river levels are at agreed gauge locations according to the NSW Flood Warning Service Level Specification.	Operation
Source of construction materials	TT15	Consideration shall be given for materials recovery and re-use opportunities from nearby construction sites such as Western Sydney Airport (WSA), metro or rail tunnels	Construction
Alternate mode to transfer construction materials	TT16	Consideration shall be given to use alternate modes such as rail, where possible, to transfer the construction materials from long distance to reduce number of constructions related heavy vehicle movements on roads	Construction

# 29.7.13 Visual amenity (Chapter 25)

#### Table 29-19. Visual amenity impacts and environmental management measures

Impact	ID	Environmental management measure	Timing
Construction impacts on visual amenity	VA1	Promote public awareness that the site would be closed and provide signs to direct people to Eighteenth Street Lookout.	Construction
Construction impacts on visual amenity	VA2	The clifftop walkway and dam wall pedestrian access will be reinstated to provide an enhanced visitor/ tourist experience and to continue to provide access to the raised dam crest.	Construction
Construction impacts on visual amenity	VA3	Ensure that a similar level of pedestrian amenity is reinstated after construction of ancillary facilities	Construction Design
Construction impacts on visual amenity	VA4	Enhance the quality of all public domain areas that were closed for the duration of construction	Construction Design
Construction impacts on visual amenity	VA5	Provide signage/ interpretation panels referencing the construction scope and construction program.	Construction
Upstream impacts on visual amenity from potential vegetation loss	VA6	Vegetation management – see Section 29.7.2 (BC1 – BC9)	Operation
Downstream impacts on visual amenity from potential vegetation loss	VA7	Vegetation management – see Section 29.7.2 (BDS1)	Operation
Downstream impacts on visual amenity from potential vegetation loss	VA8	Vegetation management – see Section 29.7.2 (BC1, BC2)	Operation

## 29.7.14 Waste management (Chapter 26)

Impact	ID	Environmental management measure	Timing
Generation and disposal of waste	W1	<ul> <li>A construction waste management plan (CWMP) will be prepared for the Project prior to construction and will detail appropriate waste management procedures. The CWMP will:</li> <li>document expected waste types and volumes for the Project</li> <li>describe procedures for managing office and Project waste materials including separation, treatment, reuse and recycling and disposal in accordance with relevant guidelines</li> <li>detail waste reporting requirements including the implementation of a waste register</li> <li>detail the process for identifying waste re-use sites including approval requirements</li> <li>where practicable, structures would be deconstructed rather than demolished to allow as much material as possible to be re-used or recycled off-site.</li> </ul>	Construction Operation
Disposal of spoil	W2	A spoil management plan will be prepared for the Project. The plan will detail spoil management measures including spoil haulage routes and spoil disposal sites.	Construction

## 29.7.15 Water quality (Chapter 27)

Table 29-21. Water quality impacts and environmental management measures

Impact	ID	Environmental management measure	Timing
General water quality impacts	WQ1	Continuation, monitoring and, where necessary, modification of water quality management measures to address operational impacts of the Project. These include:	Existing and ongoing
		<ul> <li>Monitoring DOC levels in the raw water supply for drinking water purposes to identify any increases in DOC levels so that adaptive management can be implemented via the SCRAMS (Sydney Catchment Aquatic Real-time Management System)</li> </ul>	
		<ul> <li>sourcing raw drinking water from other dams when the FMZ at Warragamba Dam is in operation or NOM levels are high.</li> </ul>	
		<ul> <li>when NOM levels are high in Lake Burragorang, consider adjusting the blend of water being provided to Prospect WFP so a greater proportion of water is supplied from storages with lower NOM levels.</li> </ul>	
		<ul> <li>adjusting treatment processes at WTPs to increase the removals of NOMs – this could include increased doing with ferric chloride, reducing chlorination and increasing chloramination (which does not produce THMs)</li> </ul>	
		<ul> <li>implementation of the National Parks EMP – which would have as one its objectives erosion control and revegetation of areas impacted by the operation of the FMZ</li> </ul>	
		<ul> <li>continued implementation of other erosion management programs in the upper catchment areas such as WaterNSW Grazing and Erosion Program</li> </ul>	
		<ul> <li>sourcing raw water supply for drinking water purposes from other dams when sediment levels are high.</li> </ul>	
		<ul> <li>sourcing raw water supply for drinking water purposes from other dams when algal blooms occur</li> </ul>	

Impact	ID	Environmental management measure	Timing
		<ul> <li>use of the multi-level offtake to withdraw water from less turbid locations in the water column</li> <li>use of the multi-level offtake to withdraw water from lower in the water column as algal blooms only occur in surface layers</li> <li>use of the multi-level offtake to withdraw water from locations in the water column where pathogen concentrations are low</li> <li>adjusting processes at Water Filtration Plants to increase the removal of algae in raw water supply for drinking water purposes</li> <li>adjusting processes at Water Filtration Plants to increase the removal of pathogens in raw water supply for drinking water purposes</li> <li>adjusting processes at water filtration plants to increase the removal of pathogens in raw water supply for drinking water purposes</li> <li>adjusting processes at water filtration plants to increase the removal of pathogens in raw water supply for drinking water purposes</li> </ul>	
Sedimentation and erosion control, vegetation clearing, management of hazardous material and other water quality risks	WQ2	<ul> <li>purposes.</li> <li>The construction environmental management plan will include management measures for minimising water quality impacts from (as relevant): <ul> <li>process water management</li> <li>concrete batching plants</li> <li>controlled blasting activities</li> <li>hydro-blasting activities</li> <li>underwater excavations</li> <li>dewatering activities (such as the dissipation pool) and any water diversions</li> <li>use of epoxy resins</li> <li>discharge of concrete cooling pumping system</li> <li>use of sediment basins and water treatment plants</li> <li>road and bridge upgrades (including piling).</li> <li>material storage areas</li> <li>demolition and other construction activities.</li> </ul> </li> <li>Vegetation clearing: <ul> <li>erosion and sedimentation control measures to be designed, installed, and operated in accordance with <i>Managing Urban Stormwater: Soils and Construction</i> (Landcom 2004)</li> <li>mulch stockpiles would be managed in accordance with <i>Management of Tannins from Vegetation Mulch</i> (Roads and Maritime Service (RMS) 2012).</li> </ul> </li> <li>Other water quality management measures are identified in the following chapters: <ul> <li>Soils (Chapter 22, Section 22.10): S8, S9</li> <li>Flooding and hydrology (Chapter 15, Section 15.10): H1.</li> </ul> </li> </ul>	Construction
Construction water quality impacts	WQ3	A construction water quality monitoring program will be developed	Construction
Water quality impacts on raw water for drinking water purposes	WQ4	While the risks to the quality of raw water supply for drinking water purposes have been assessed to be low, further monitoring is recommended to confirm the risk assessment and enhance adaptive responses to any changes in water quality due to the Project.	Pre-operation

Impact	ID	Environmental management measure	Timing
Quality of raw water for drinking water impacts	WQ5	The SCARMS and SCARISS (Sydney Catchment Aquatic Real-time Information Support System) will be updated to include the raised dam, new outlets, and operation of the FMZ.	Pre-operation
Catchment impacts	WQ6	The Catchment to Customer Risk Assessment will be reviewed and updated to reflect any new or changed risks to the quality of raw water supply for drinking water purposes from the operation of the FMZ. Implementation of the EMP as required under the Water NSW Act.	Pre-operation

## 29.8 Compilation of performance outcomes

The Project design has been prepared in consideration of the 'desired performance outcomes' provided in the SEARs. The following summary demonstrates how each performance outcome would be achieved by the Project.

#### 1. Environmental impact assessment process

• The process for assessment of the proposal is transparent, balanced, well focussed and legal.

#### **Project outcome:**

- The EIS has been prepared in accordance with Part 3 of Schedule 2 to the EP&A Regulation.
- Matters of national environmental significance were identified as being potentially impacted by the Project and consequently the Project was referred to the then Commonwealth Department of Environment and Energy (DoEE<sup>1</sup>). The Project was determined to be a controlled action and approval under the EPBC Act was required. DoEE provided assessment requirements to DPIE and these have been included in the SEARs. The EIS and technical studies have been prepared to comply with EPBC assessment requirements.

#### 2. Environmental impact statement

• The Project is described in sufficient detail to enable clear understanding that the Project has been developed through an iterative process of impact identification and assessment and Project refinement to avoid, minimise or offset impacts so that the Project, on balance, has the least adverse environmental, social and economic impact, including its cumulative impacts.

#### **Project outcome:**

- The Project has been described in detail in Chapter 5 (Project description).
- The merits of the Project and concept design options were considered in the context of a range of alternatives based on how well they performed regarding flood mitigation, environmental, engineering, social and economic factors (refer to Chapter 4, Project alternatives and options). The Project has the highest net benefit compared with other alternatives assessed.

#### 3. Assessment of key issues

• Key issue impacts are assessed objectively and thoroughly to provide confidence that the Project would be constructed and operated within acceptable levels of impact.

#### **Project outcome:**

- The consultation process, feedback received and where issues are addressed are detailed in Chapter 6 (Consultation).
- The assessment of key issues has been conducted objectively and thoroughly. The implementation of environmental management and mitigation measures would ensure the Project is constructed and operated within acceptable levels of impact.

<sup>&</sup>lt;sup>1</sup> DoEE ceased to exist on 1 February 2020 when the Department of Agriculture, Water and the Environment (DAWE) commenced operation. The Environment portfolio within DoEE was incorporated into DAWE.

#### 4. Consultation

• The Project is developed with meaningful and effective engagement during Project design and delivery.

#### Project outcome:

 Consultation has been undertaken to inform the design process and EIS preparation (refer to Chapter 6, Consultation). The Construction Contractors would respond to complaints in a timely and effective engagement during Project design and appropriate manner so that stakeholders' concerns are managed effectively and promptly.

#### 5. Air quality

• The Project is designed, constructed and operated in a manner that minimises air quality impacts (including nuisance dust and odour) to minimise risks to human health and the environment to the greatest extent practicable.

#### **Project outcome:**

• Effective management of dust and other emissions during construction to minimise any increases in dust levels.

#### 6. Biodiversity

- The Project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity.
- Offsets and/or supplementary measures are assured, which are equivalent to any remaining impacts of Project construction and operation.

#### **Project outcome:**

- Where possible impacts on biodiversity have been minimised, however there would be unavoidable impacts on terrestrial biodiversity, particularly at the construction site and in the upstream catchment.
- The Warragamba Offset Program and National Parks EMP would offset any impacts from the construction and operation of the Project.

#### 7. Climate change risk

• The Project is designed, constructed and operated to be resilient to the future impacts of climate change.

#### **Project outcome:**

- One of the key justifications and objectives of the Project is to reduce flooding risk from large rainfall events which are predicted to increase in size and frequency with climate change.
- The height of the abutments of the dam wall would be constructed to allow future raising of the spillway to maintain the flood mitigation benefits if predicted climate change impacts are realised.

#### 8. Flooding

- The Project minimises impacts on existing flooding characteristics.
- Construction and operation of the Project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure.

#### **Project outcome:**

- The Project would significantly:
  - reduce downstream flooding impacts to infrastructure and residential areas
  - reduce flooding hazard
  - reduce flooding damages
  - reduce risk to life from flooding
  - improve evacuation opportunities.
- The Project would meet appropriate design standards relating to effectively managing the risk of dam failure.
- During construction of the Project there would be no change in flooding impacts from the existing situation.

#### 9. Health and safety

• The Project avoids or minimises any adverse health impacts arising from the Project. The Project avoids, to the greatest extent possible, risk to public safety.

#### **Project outcome:**

• There would be no adverse health impacts from the construction or operation of the Project.

#### 10. Heritage

• The design, construction and operation of the Project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places.

#### **Project outcome:**

- The Project would have unavoidable impacts on many Aboriginal archaeological and cultural heritage sites some of which have high scientific significance and all of which have high cultural significance to local Aboriginal communities. Measures to mitigate impacts would effectively record and disseminate Aboriginal cultural heritage. There would be increased involvement of Aboriginal people in the management of Aboriginal heritage in the catchment.
- Non- Aboriginal heritage impacts would be minimised and avoided where possible. Where impacts are unavoidable, appropriate recording and interpretation of impacted items would be undertaken. Design and rehabilitation would be undertaken to minimise impacts and potentially enhance heritage values.

#### 11. Noise and vibration - amenity

Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively
managed to minimise adverse impacts on acoustic amenity. Increases in noise emissions and vibration affecting
nearby properties and other sensitive receivers during operation of the Project are effectively managed to
protect the amenity and well-being of the community.

#### **Project outcome:**

- Feasible and reasonable management measures would be implemented during construction to ensure noise impacts would not result in a significant change to the existing noise environment.
- The Project would not result in in any additional noise impacts during operation

#### 12. Noise and vibration - structural

- Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on the structural integrity of buildings and items including Aboriginal places and environmental heritage.
- Increases in noise emissions and vibration affecting environmental heritage as defined in the Heritage Act 1977 during operation of the Project are effectively managed.

#### **Project outcome:**

• Vibration intensive construction works would be managed to avoid or minimise adverse impacts on the structural integrity of buildings and heritage items.

#### 13. Protected and sensitive lands

• The Project is designed, constructed and operated to avoid or minimise impacts on protected and sensitive lands.

#### **Project outcome:**

- One of the objectives of the operational protocols for the FMZ would be minimising upstream inundation to protected lands, however, impacts would be unavoidable.
- The Warragamba Offset Program would minimise and offset any impacts on protected and sensitive land. The National Parks EMP would support and complement the Warragamba Offset Program.

#### 14. Socio-economic, land use and property

- The Project minimises adverse social and economic impacts and capitalises on opportunities potentially available to affected communities.
- The Project minimises impacts to property and business and achieves appropriate integration with adjoining land uses, including maintenance of appropriate access to properties and community facilities, and minimisation of displacement of existing land use activities, dwellings and infrastructure.

#### **Project outcome:**

- The Project would significantly:
  - reduce downstream flooding impacts to infrastructure and residential areas
  - reduce flooding hazard
  - reduce flooding damages
  - reduce risk to life from flooding
  - improve evacuation opportunities.
- Construction impacts and disruption on the local Warragamba community would be minimised.
- Opportunities for local workers and businesses during construction would be realised.
- Tourism and visitation facilities would be improved
- The public has a greater understanding of the benefits and how the impacts of the Project would be mitigated or offset.

#### 15. Soils

- The environmental values of land, including soils, subsoils and landforms, are protected.
- Risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination.

#### Project outcome:

- No existing contaminated sites would be disturbed.
- Any contaminated or hazardous materials encountered during demolition and construction would be identified and appropriately managed and disposed of.
- Upstream and downstream erosion would be minimised or identified and mitigated.

#### 16. Sustainability

- The Project reduces the NSW Government's operating costs and ensures the effective and efficient use of resources.
- Conservation of natural resources is maximised.

#### **Project outcome:**

- Opportunities would be taken to reduce material use and maximise the use of materials with low embodied environmental impact, where practical
- Water and electricity efficiency measures would be implemented and conservation of natural resources maximised.

#### 17. Transport and traffic

- Network connectivity, safety and efficiency of the transport system near the Project are managed to minimise impacts.
- The safety of transport system customers is maintained.
- Impacts on network capacity and the level of service are effectively managed.
- Works are compatible with existing infrastructure and future transport corridors.

#### **Project outcome:**

- The performance of the local traffic network would not be significantly impacted during construction.
- Access to properties would generally be maintained during construction.
- With the Project, bridges and evacuation routes would generally be closed less often during flooding, and there would be a longer time to closure allowing for greater evacuation capacity.

#### 18. Visual amenity

• The Project minimises adverse impacts on the visual amenity of the built and natural environment (including public open space) and capitalises on opportunities to improve visual amenity.

#### Project outcome:

- The visual impacts of the Project upstream would be minimised and mitigated through rehabilitation where appropriate.
- The modified dam would have a similar visual appearance to the existing dam.
- The visual amenity in and around the dam would be the same or improved.

#### 19. Waste

• All wastes generated during the construction and operation of the Project are effectively stored, handled, treated, reused, recycled and/or disposed of lawfully and in a manner that protects environmental values.

#### Project outcome:

- Uncontaminated spoil would be recycled or reused either on-site or off site.
- Off-site waste re-use would be managed in accordance with relevant NSW EPA resource recovery exemptions. Waste would be disposed of at appropriately licensed facilities.

#### 20. Water - hydrology

- Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised.
- The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved).
- Sustainable use of water resources.

#### **Project outcome:**

- The Project would have no long-term impacts on surface water and groundwater hydrology. Any impacts would be flood related and short-term.
- The Project would have minimal impacts on downstream flood dependent ecosystems.
- The Project would aim to minimise the use of potable water.

#### 21. Water quality

- The Project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the Project to the extent of the Project impact including estuarine and marine waters (if applicable).
- The Project should not adversely affect drinking water quality.

#### Project outcome:

- The Project would not result in any exceedance of water quality objectives downstream when the FMZ is being discharged.
- The Project would not result in any exceedance of drinking water quality guidelines and/or a reduction in drinking water availability from the dam.

## 29.9 Project benefits

The main benefits of the Project are:

- a significant reduction in flood heights and extents for the critical range of major floods events. For example, for the 1 in 100 chance in a year flood, a reduction of flood heights of about 5.2 metres at Penrith, 3.1 metres at Richmond and 4.1 metres at Windsor
- a significant reduction in the number of residential properties impacted by flooding in the critical range of major floods events. For example, for the 1 in 100 chance in a year flood there would an estimated reduction of 5,180 properties (68 percent reduction)
- flood damage estimates would typically be reduced by approximately 74 to 80 percent for floods up to about the 1 in 200 chance in a year event, reducing to approximately 50 percent for a 1 in 2,000 year chance in a year event.
- increased opportunities for evacuation as evacuation routes would experience less flooding and a longer period before closure due to flooding. For example, for the 1 in 100 chance in a year flood the Windsor Bridge crossing would remain open for an additional 18 hours
- a reduction in the risk to life due to reduced flooding extents and greater evacuation opportunities
- potentially lower flood insurance premiums for some residential and commercial premises.

Other benefits of the Project include:

- the facility to provide variable environmental flow releases from Warragamba Dam that would contribute to improved water quality and aquatic ecology downstream of the dam and in the Hawkesbury-Nepean River
- improved amenity around the dam after the rehabilitation of Haviland Park and other public access areas
- employment and business opportunities during construction of the Project.

## 29.10 Project justification and conclusion

Due to the unique characteristics of the hydrology and topography of the Hawkesbury-Nepean Valley, the extent, duration and depth of major flood events is considerably higher than other typical coastal river systems. The combination of large upstream catchments and narrow downstream sandstone gorges results in floodwaters backing up behind natural choke points such as the Sackville Gorge. A major flood event would result in high flood damages, potential loss of life and major social and economic disruption. If a flood similar to the largest flood since European settlement were to occur in 2041 (the 1867 flood was a 1 in 500 chance in a year flood) it is estimated that there would be \$7 billion in damages and 158,000 to 171,000 people would need to be evacuated (Infrastructure NSW 2019). Climate change may further increase this flood risk as it has the potential to increase the severity and frequency of the flood hazard in the Hawkesbury-Nepean Valley.

Many alternatives to reduce flood risk and damages in the Hawkesbury-Nepean have been investigated over the last 20 years. This culminated in the establishment of the Hawkesbury-Nepean Valley Flood Management Taskforce in 2014, which undertook a detailed assessment of alternatives and developed a flood strategy for Hawkesbury-Nepean Valley. *Resilient Valley, Resilient Communities — the Hawkesbury-Nepean Valley Flood Risk Management Strategy* (the flood strategy) (Infrastructure NSW (INSW) 2017) is a comprehensive long-term framework for the NSW Government, local councils, businesses and the community to work together to reduce and manage the flood risk in the Hawkesbury-Nepean Valley. The flood strategy developed nine outcomes to address flood impacts and risks of which the Project was the preferred infrastructure alternative as it had the highest net benefit. Other alternatives did not achieve the same flood mitigation, were too costly, had higher environmental/social impacts, had impacts on water supply and/or did not deliver regional benefits.

The Project would greatly reduce flood extents, durations and depths for flood events up to the 1 in 500 chance in year event and particularly for flood events between the 1 in 50 chance in a year and 1 in 500 chance in a year flood events where the highest proportion of flood damages occur. On an annual average the Project would reduce flood damages by 75 percent. It is not feasible nor practical to mitigate flood events larger than the 1 in 500 chance in a year

flood. However, while the Project would only result in a relatively minor increase in the flood extents for the larger events, it would delay the peak of a flood event which would allow considerably more people to be evacuated particularly from flood islands and reduce the overall risk to life from a major flood event.

The Project would result in impacts in the upstream catchment of Lake Burragorang. Areas of the catchment already have the potential to experience temporary inundation during major flood floods, however, the Project would result in an increase in the extent, depth and duration of temporary duration. Areas of the Lake Burragorang catchment that would experience increased temporary inundation include national parks, State conservation areas and the GBMWHA.

Catchment areas contain intact native vegetation, threatened ecological communities and threatened flora and fauna species. The presence of many threatened species was also assumed due to the survey requirements and the large potential impact area. Consequently, a conservative assessment of biodiversity impacts was undertaken, with an overall conclusion that there would be potential impacts on many threatened ecological communities and species. Mitigation of biodiversity impacts would be addressed principally through the Warragamba Offset Program which would be established for the Project. This would be complemented by an environmental management plan prepared under the Water NSW Act 2014 to address the temporary inundation of national park estate and State conservation areas in the Lake Burragorang catchment.

Some Aboriginal heritage sites would experience either increased temporary inundation or are in new areas that could experience temporary inundation due to the Project. While many sites would only experience relatively minor impacts from infrequent short term inundation, other highly significant sites such as rock art sites may experience more substantial impacts. The local Aboriginal people generally consider all cultural and physical heritage sites to be of high cultural significance. Impacts on Aboriginal heritage sites would be unavoidable and measures to record and disseminate information on these sites have been proposed.

The downstream impacts of the Project include a reduction in flooding frequency of some flood dependent vegetation and increase inundation of some low lying areas during the discharge of the flood mitigation zone. These impacts are not expected to be significant.

During construction of the Project there would be amenity impacts to some sensitive receivers in Warragamba due to noise, dust and traffic movements generated by construction. Appropriate mitigation measures would be implemented to minimise these impacts.

The construction and operation of the Project would result in temporary and permanent impacts on the environment. These impacts would be minimised through the implementation of the mitigation and management measures that aim to ensure the best possible environmental outcomes are achieved during its construction and operation. There would be some potential residual impacts that would be further reviewed during detailed design and construction planning, and where necessary additional measures would be implemented to ensure these impacts are suitably mitigated. Residual upstream impacts on biodiversity, National Parks, State Conservation Areas and the GBMWHA would be mitigated and offset through the National Parks EMP and the Warragamba Offset Program.

The Project is consistent with the Project objective which is 'to reduce flood risk to life, property and social amenity from regional floods in the Hawkesbury-Nepean Valley now and in the future'.

A consideration of the Project against the objects of the EP&A Act is outlined in Table 29-22.

Table 29-22. Project justification with regard to the objects of the Environmental Planning and Assessment Act 1979

EP&A Act Object	Comment
a. To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources	The Project would result in significant benefits to the social and economic welfare of communities in the Hawkesbury-Nepean Valley through the reduction in flooding extents and durations from major flood events. This in turn would lead to a reduction in flood damages, loss of housing and social infrastructure and social disruption potentially experienced by the community. The Project would also reduce the risk to life from major flood events through reducing the extent and duration of flooding and providing a longer period for safe evacuation by road.
	The Project would have impacts on the upstream environment through the increase in extent and temporary inundation of the Lake Burragorang catchment. The Warragamba Offset Program, National Parks EMP and other

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EP&A Act Object	Comment
	measures would be implemented to mitigate and offset impacts on the environment.
b. To facilitate ecologically sustainable development by environmental and social considerations in decision making about environmental planning and assessment	<ul> <li>The Project is considered to be consistent with the four principles of ecologically sustainable development:</li> <li>precautionary principle: This EIS was prepared adopting a conservative approach which includes an assessment of the worst case impacts and scenarios. This includes assuming that the dam was at full supply level when a flood event occurs – and assuming the presence of many threatened species in the upstream catchment, even though they weren't found during field surveys</li> <li>intergenerational equality: The Project would provide intergenerational equality in terms of flood protection for communities in the Hawkesbury-Nepean Valley as climate change is predicted to increase the future frequency and size and extreme rainfall events</li> <li>conservation of biological diversity and ecological integrity: The design and assessment of the Project has been undertaken with the aim of identifying, avoiding, minimising and mitigating impacts to biodiversity and ecological integrity. Consistent with the TSC Act/BC Act, EPBC Act and the SEARs, a biodiversity offset strategy has been developed to compensate for the unavoidable loss of ecological values because of the Project. The Warragamba Offset Program, National Parks EMP and other measures would be implemented to mitigate and offset impacts is demonstrated in the design features incorporated into the Project. The cost of mitigation measures has been incorporated into the Project cost, as well as the extent of investigations undertaken to inform this EIS.</li> </ul>
c. To promote the orderly and economic use and development of land	The Project is one component of the overall the Hawkesbury-Nepean Valley Flood Risk Management Strategy, which includes measures to 'lock in' current flooding planning levels and controls to maintain the reduction in flood risk benefits from the Project. While the Project and the Hawkesbury-Nepean Valley Flood Risk Management Strategy would not result in the increase in land available for development (that is, it would not allow development on previous flood prone land), it would reduce flood risk on existing developable land and would allow greater confidence in the orderly and economic use and development of land.
d. To promote the delivery and maintenance of affordable housing	Not applicable to this Project.
e. To protect the environment including the conservation of native animals and plants, ecological communities and their habitats	Where impacts to native vegetation are unavoidable, mitigation including the conservation of measures have been proposed to minimise the potential for indirect impacts. Threatened and other species threatened flora species would be impacted by the Project. Consistent with the BCA Act 2016, EPBC Act 1999 and the SEARs, a biodiversity offset strategy has been developed to compensate for the unavoidable loss of ecological values because of the Project. The Warragamba Offset Program, National Parks EMP and other measures would be implemented to mitigate and offset impacts on the environment.
f. To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage)	The Project could result in partial loss of value to Aboriginal heritage and cultural sites in the upstream catchment from temporary inundation during flood mitigation operations. Measures have been developed to mitigate some of these impacts.

EP&A Act Object	Comment
	The Project would result in a reduction in flood risk to downstream Aboriginal and non-Aboriginal heritage sites and consequently would support the promotion of sustainable management of built and cultural heritage.
g. To promote good design and amenity of the built open space	The Project would result in a reduction in flood risk and damages to build open space facilities downstream of the dam.
environment	Open space facilities impacted by construction at Warragamba Dam (for example, Haviland Park) would be rehabilitated and potentially enhanced after construction.
h. To promote the proper construction and maintenance of buildings, including the protection of the health and	The Project is one component of the overall the Hawkesbury-Nepean Valley Flood Risk Management Strategy – which includes measures to 'lock in' current flooding planning levels and controls to maintain the reduction in flood risk benefits from the Project.
safety of their occupants	While the Project and the Hawkesbury-Nepean Valley Flood Risk Management Strategy would not promote the proper construction and maintenance of buildings, it would reduce flood risk to many residential areas in the Hawkesbury-Nepean Valley, increasing the protection and safety of their occupants
i. To promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State	Consultation has been undertaken with the relevant local councils and government agencies throughout the development of the Project and the preparation of this EIS. All levels of government have been encouraged to be actively involved in and to contribute to the evolution of the Project through historical and continuing consultation activities.
	The Project would also be assessed and require approval from the DAWE under the EPBC Act.
j. To provide increased opportunity for community participation in environmental planning and assessment	Community consultation has been carried out through all stages of the Project development, with targeted consultation commencing with the development of the Hawkesbury-Nepean Valley Flood Risk Management Strategy. Community feedback has been considered during the preparation of the EIS. Community consultation would continue through the detailed design, construction and operational stages, should the Project be approved.

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