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# Appendix F

## Aquatic Ecology Addendum Assessment

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## Memorandum

2 August 2024

To: Amanda Weston  
Planning & Environment Manager  
Alinta Energy

From: Andrea McPherson

**Subject: Oven Mountain Pumped Hydro Project – Aquatic Ecology Addendum Assessment**

Dear Amanda,

EMM Consulting Pty Limited (EMM) prepared the Environmental Impact Statement (EIS) for the Oven Mountain Pumped Hydro Energy Storage Project (the Project) which was exhibited in September to October 2023. An aquatic ecology impact assessment (AEIA) was prepared by EMM's subconsultant Stantec (2023) and exhibited with the EIS.

Since submission of the EIS, components of the Project have been revised and as a result, an Amendment Report has been prepared to address these changes. A separate Response to Submissions (RtS) report is also being submitted for the Project, which addresses comments raised by government agencies and councils, special interest groups and the community.

This letter includes an Addendum to the AEIA that incorporates the Project changes relevant to potential aquatic ecology impacts, and responds to the relevant submissions raised in relation to aquatic ecology.

Yours sincerely



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# 1 Introduction

OMPS Pty Ltd (OMPS) is proposing to develop the Oven Mountain Pumped Hydro Energy Storage Project (the Project), an off-river pumped hydro energy storage system (referred to as the 'pumped hydro system') located approximately half-way between Kempsey and Armidale, adjacent to the Macleay River in northern NSW. The Project is located within the New England Renewable Energy Zone (REZ) and the Armidale Regional Local Government Area (LGA), proximate to its border with Kempsey Shire LGA. At a basic level, the Project will consist of upper and lower water reservoirs and an underground tunnel connecting them via a hydro-electric power station.

The Project has been declared by the New South Wales (NSW) Government to be critical State significant infrastructure (CSSI) under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). Infrastructure projects are declared to be CSSI if, in the opinion of the NSW Minister for Planning, they are essential to the State for economic, environmental, or social reasons. An Environmental Impact Statement (EIS) was prepared for the Project and publicly exhibited in September to October 2023.

An Amendment Report is being submitted to address changes in the Project design following exhibition of the EIS, and a Submissions Report is being prepared to respond to comments raised on the EIS. This Addendum Aquatic Ecology Impact Assessment (AEIA) has been prepared as an input to the Submissions Report and the Amendment Report and addresses the Project changes as relevant to aquatic ecology. The new Project incorporating the design changes is hereafter referred to as the 'Amended Project'.

## 2 The Amended Project

### 2.1 Overview of Amended Project

An overview of the key Project amendments is given in Table 2.1. Of the proposed Project changes, the most direct influence on aquatic ecology is the additional inclusion of temporary bridge structures on the Macleay River highlighted in bold in the table below. Further, changes to the water balance and consideration of the surface water receiving environment due to the Amended Project is a key aspect relevant to the assessment of aquatic impacts, and therefore has been a focus of this report.

**Table 2.1 Overview of the Project amendments in comparison to the Project as exhibited in the EIS**

Project element	Description of change	Summary of the Project as exhibited in the EIS	Summary of the Amended Project
<b>Internal roads and bridges</b>			
Eastern Access Road (EAR) realignment	Realignment of the EAR to reduce need for earthworks, improve road safety and address drainage issues.	Approximately 11.4 kilometres (km).	Approximately 12.1 km.
<b>Temporary bridges</b>	<b>A temporary bridge will be utilised prior to the construction of the two permanent bridges (referred to as Eastern Access Temporary Bridge). A secondary, temporary access is proposed via the construction of a new, temporary bridge crossing of the Macleay River about 600 m upstream and north-west of Georges Junction (referred to as Western Access Temporary Bridge). This amendment is proposed to reduce the period of internal road construction and therefore overall construction period and improve effectiveness of emergency response measures (access and egress).</b>	<b>One temporary bridge: Eastern Access Temporary Bridge. Two permanent bridges near Smiths Bluff.</b>	<b>Two temporary bridges: Eastern Access Temporary Bridge (EATB) and Western Access Temporary Bridge (WATB). Two permanent bridges near Smiths Bluff.</b>
Upper Dam Access Road (UDAR) refinement	Realignment of the UDAR (including removal of a large north south connecting section of road) in response to regulator feedback to avoid known habitat and potentially significant impacts to the threatened Brush tailed Rock Wallaby.	Approximately 7.1 km.	Approximately 6.4 km.

Project element	Description of change	Summary of the Project as exhibited in the EIS	Summary of the Amended Project
<b>Construction</b>			
Temporary or fly camps	While fly camps were previously anticipated for the project, up to three fly camps are confirmed to be required and located near Smiths Bluff (Eastern fly camp), the intersection of the Main Access Road and the EAR (Western fly camp), and the upper reservoir (within spoil emplacement area) (Southern fly camp). The camps will each accommodate about 20 workers and up to 90 workers depending on the ultimate configuration, and would be established within the first year of construction. All services will be trucked in and out of the sites, with no permanent facilities or services proposed.	Temporary or fly camps may be required. The location and size will be documented during the detailed design phase.	Three temporary or fly camps will provide small scale temporary work accommodation for workers completing initial road works until the main accommodation camp is completed. Proposed locations in proximity of EATB, WATB, and Upper reservoir.
Blasting and rock crushing/processing	Allowing blasting as a construction method for road works and other above-ground works. Rock processing/crushing facilities will be required in the lower reservoir (LR) and upper reservoir (UR) areas to process rock for use in dams.	Blasting required for tunnels and portals.	Blasting required for tunnels and portals, reservoirs and road works.
<b>Construction envelope</b>	<b>Updates to the construction envelope to accommodate stakeholder feedback, design changes and refined construction requirements.</b>	<b>Approximately 780 hectares (ha).</b>	<b>Approximately 768 ha.</b>
Disturbance footprint	Updates to the disturbance footprint to accommodate stakeholder feedback, design changes and refined construction requirements.	Approximately 330 ha.	Approximately 367 ha.
<b>Spoil and materials</b>			
Laydown/stockpile areas	There will be four areas used for stockpiling and material laydown. One area is located along the main access road (between transmission towers 14–16), one area is located in proximity to the batching plant, one area is located near Georges Junction, and one is located near the Eastern Access Temporary Bridge on the eastern side of the Macleay River. The largest of the four areas has also been flagged as available for other ancillary uses, to provide further flexibility as the detailed design progresses.	There will be two areas used for stockpiling and material laydown, covering a total area of 114,000 square metres (m <sup>2</sup> ).	There will be four areas used for stockpiling and material laydown, covering a total area of 119,600 m <sup>2</sup> .
Spoil emplacement	Revised spoil estimates were derived following changes to the underground arrangement and sizing. This, in addition to incorporating agency feedback, required changes to the conceptual landform design. The conceptual landform design presents reduced height and slopes however requires a greater disturbance area as a result.	Three permanent spoil emplacement locations to store around 2.9 million cubic metres (Mm <sup>3</sup> ) plus dead storage within the reservoirs with approximate capacity 300,000–400,000 cubic metres (m <sup>3</sup> ).	Two permanent spoil emplacement locations to store around 3.55 Mm <sup>3</sup> . Use of dead storage in reservoir is not anticipated unless required for any surplus material.
Operational footprint	Updates to the operational footprint to accommodate design changes (including permanent spoil emplacement and transmission alignment along the UDAR).	Approximately 270 ha.	Approximately 280 ha.

Project element	Description of change	Summary of the Project as exhibited in the EIS	Summary of the Amended Project
<b>Underground arrangement and sizing</b>			
Underground arrangement and sizing for improved generation capacity.	The Project will provide up to around 900 megawatt (MW) of electricity generating capacity and at least eight hours of energy storage at full generating capacity.	Up to 900 MW and between 8 and 12 hours of energy storage. Underground arrangement and tunnel sizes reflect lower energy storage capacity.	Up to 900 MW and at least 8 hours of energy storage. Underground arrangement and tunnel sizes reflect greater energy storage capacity. Re-location of Main Access Portal (MAT) portal to align with amended arrangement.

## 2.2 Response to submissions

An overview of the key agency submissions made on the EIS relevant to aquatic ecology, and how they have been addressed in this Addendum, is provided in Table 2.2.

**Table 2.2 Aquatic ecology response to submissions summary**

Submitter	Sections of submission pertaining to aquatic ecology	Response summary	Section issue is addressed
DPI Fisheries	The construction of waterway crossings should be in accordance with DPI Fisheries Guideline document: <i>Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings</i> . This is to ensure that the works are designed and constructed in accordance with best management practice and with minimal impact on the aquatic environment within the immediate vicinity of the proposed works.	A commitment is made to construct waterway crossings in accordance with DPI Fisheries Guideline document: <i>Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings</i> .  Where instream work is required, effort will be made to minimise impacts to flow, instream connectivity and release of soils into the system.	Section 6, Table 6.1 (see AE06)
	DPI Fisheries anticipate construction methodology will ensure that bridge/road crossing construction maintains fish passage during all stages of the project such that temporary blockages to fish passage during construction will not be required. Detailed Design Plans, Construction Environmental Management Plans and Soil and Water Management Sub Plans will be required for waterway crossings in Key Fish Habitats to minimise impacts on the aquatic environment.	A CEMP and related sub plans will be drafted prior to construction commencing. These plans will contain provisions for managing impacts and monitoring water quality, key fish habitat and fish passage during Project construction.	Section 6, Table 6.1 (see AE06)
	The new river pump infrastructure should include the use of extraction screen technology to reduce the impacts of pump infrastructure removing and damaging eggs, larvae, and juvenile fish from the Macleay River. The EIS makes reference to works taking place in accordance with the DPI documents <i>A guide to modern fish-protection screening in Australia and Design specifications for fish-protection screens in Australia</i> . Final designs and specifications of the fish protection screening infrastructure will be required by DPI Fisheries to review.	The design and application of the screen will consider how the use of extraction screen technology to reduce the impacts of pump infrastructure removing and damaging eggs, larvae, and juvenile fish from the Macleay River.  In addition to the listed recommendations in the EIS chapter and Appendix J – Aquatic Ecology. The provided guidelines will be reviewed and where applicable will be incorporated into the design.  DPI Fisheries will be consulted throughout the Macleay River pump and fish screen detailed design process.	Section 6, Table 6.1 (see AE04)
	Consideration should also be given to the use of screens for water pumped from the lower intake structure within the lower reservoir to the upper reservoir and at the upper intake structure within the upper reservoir to the underground tunnels to reduce the likelihood of native fish and eels which form populations within the reservoirs passing through the turbines resulting in injury and mortalities.	No fish screens are proposed for the reservoir intakes. Screens on the closed loop pumped hydro project main waterway intakes is not feasible given the scale of the generation flow. Fish screening on the Macleay River pump station will limit the potential for fish entering the lower reservoir. Fish exclusion measures for the Macleay River pump station will follow DPI guidelines.	N/A

Submitter	Sections of submission pertaining to aquatic ecology	Response summary	Section issue is addressed
	<p>The department is supportive of the daily extraction limit of 86.4 ML/day, high flow access above 50<sup>th</sup> percentile (597 ML at Georges River Junction Gauge), pumping to cease if 30-day steam flows are below the 5-year ARI, and extraction restrictions during first 7-days of first flow event above 50<sup>th</sup> percentile following an extended dry period or drought. However, it is not clear from the Surface Water Assessment report of what the definition of an extended dry period or drought is that would trigger restrictions on pumping for the first 7 days above the 50<sup>th</sup> percentile. Special consideration should also be given to implementation of such rules such as cease to pump or restrictions on extraction following extensive bushfires in the catchment which have caused extensive fish kills previously.</p>	<p>SWA updated to further clarify the definition of extended drought conditions and additional controls included to cease pumping under ‘special circumstances’.</p>	<p>Refer SWA (Section 5.5.5)</p>
	<p><i>NSW Biodiversity Offsets Policy: Key Fish Habitat &amp; Aquatic Offsets</i></p> <p>The EIS and Aquatic Ecology Report contains very little discussion regarding the loss of Key Fish Habitat and whether an Aquatic Biodiversity Offsets Strategy is required to ensure a minimum 2:1 offset for impacted Type 1 3 Key Fish Habitats. Quantification using GIS, map or aerial photographs of the direct loss and alienation of Key Fish Habitat within Fingerboard Crossing Creek and the Macleay River water intake should be undertaken as per steps outlined within the NSW Biodiversity Offsets Policy for Major Projects, Fact Sheet Aquatic Biodiversity (<a href="http://www.environment.nsw.gov.au/resource/biodiversity/14817aqoffs.pdf">http://www.environment.nsw.gov.au/resource/biodiversity/14817aqoffs.pdf</a>).</p>	<p>Assessment and quantification of impacts to Key Fish Habitat has been completed and provided with this Addendum.</p> <p>Currently sites are being investigated as biodiversity stewardship site to help address BDAR assessment outcomes. There may be fish habitats as part of these location that would benefit from improving habitat availability that may help to balance the impacts in relation to this project. As these sites are only in early phase of consideration, it is requested that if suitable location be identified an Aquatic Biodiversity Offsets Strategy be conditioned as a post approval requirement.</p>	<p>Section 6.2</p>
	<p>DPI Fisheries policy advocates the use of terrestrial buffer zones as per the <i>Policy and Guidelines for Fish Habitat Conservation and Management</i> (Update 2013) available on the Department’s website at <a href="http://www.dpi.nsw.gov.au/fisheries/habitat/publications/policies,-guidelines-and-manuals/fish-habitat-conservation">http://www.dpi.nsw.gov.au/fisheries/habitat/publications/policies,-guidelines-and-manuals/fish-habitat-conservation</a> which states that “NSW DPI will generally require riparian buffer zones to be established and maintained for developments or activities in or adjacent to TYPE 1 or 2 habitats or CLASS 1–3 waterways.” The department anticipate that adequate riparian buffer zones will be maintained adjacent to the watercourses as part of this project. Construction footprints for roads adjacent to the Macleay River should ideally provide for 100 m riparian buffer zones, particularly given the topography of this region.</p>	<p>A review of riparian buffer zones has been completed and provided with this Addendum, including a figure identifying the preferred/recommended buffer zones and where the project will encroach into these buffers.</p>	<p>Section 5</p>

Submitter	Sections of submission pertaining to aquatic ecology	Response summary	Section issue is addressed
	<p>The EIS makes reference to a safety exclusion zone surrounding the Macleay River pumping facility and intake for the safety of river users. Considering the importance of the Macleay River for recreational fishers, particularly targeting freshwater bass, DPI Fisheries anticipate that safety exclusion zones within the river are only in place during the construction of the intake facility, and that open public access for watercraft and fishers along the length of the river past the water intake facility will be maintained during the operational phase of the project.</p>	<p>Safety exclusion zones are needed to protect the pumping facility at any time needed for operation as well as during construction. Engagement with Crown Lands and DPI Fisheries will be carried out during detailed design as part of the preparation of project management plans prior to construction.</p>	<p>N/A</p>
	<p>As raised within the EIS, DPI Fisheries would like to see further sampling of areas of potential aquatic habitats of Southern Purple Spotted Gudgeon, <i>Mogurnda Adspersa</i>, that are likely to be directly or indirectly impacted upon just prior to construction activities.</p>	<p>A commitment is made to carry out further sampling for Southern Purple Spotted Gudgeon prior to construction.</p> <p>The Client is committed to undertaking another survey prior to construction focussing around:</p> <ul style="list-style-type: none"> <li>• Georges Creek</li> <li>• Dykes river</li> <li>• and a possibly a control – lower in the catchment to see if eDNA is working and or is a negative return.</li> </ul> <p>Survey effort may include eDNA, habitat assessment and fish surveys. To better understand the distribution of the species in the region.</p> <p>Southern purple spotted gudgeon (SPSG) habitat is identified in Georges Creek and Dykes river. The majority of the SPSG is restricted to the adjacent tributaries of the upper Macleay river and or lower reaches. Also Georges Creek is has been identified as the most upstream key fish habitat area in the Macleay catchment. Previous survey effort did not detect and or positively identify SPSG within extensive survey area of the Macleay River (inclusive at the confluence of Georges Creek).</p> <p>George Creek will be relatively untouched by the project with the exception of a bridge crossing the Georges Creek just before ethe confluence with Macleay River.</p> <p>Additionally, there may be some low-risk indirect impacts from the development of the transmission line that will run along the ridgeline east of Georges Creek. However, these can likely be manage through standard Erosion control procedures.</p>	<p>Section 6, Table 6.1 (see AE01)</p>

Submitter	Sections of submission pertaining to aquatic ecology	Response summary	Section issue is addressed
<b>DPIE Fisheries cont.</b>	Baseline monitoring of aquatic biodiversity (including fish diversity, abundance and habitat monitoring), surface water impacts, stormwater and water quality and geomorphology (particularly below the lower reservoir) should be undertaken prior to, during and after construction and operation to allow for the establishment of an adaptive management framework that ensures project specific management plans are in place to mitigate potential impacts resulting from this development.	<p>Baseline monitoring commenced in August 2021 and is ongoing. A commitment is made to conduct ongoing monitoring through construction and operation of the Project.</p> <p>Additional baseline assessment will be undertaken before construction, during and after construction to monitor for change and identify impacts.</p> <p>A monitoring and management plan will be drafted to confirm monitoring requirements and actions as required by the project before construction commences.</p> <p>This will include but not be limited to:</p> <ul style="list-style-type: none"> <li>• survey effort</li> <li>• locations of survey sites</li> <li>• screen maintenance investigation</li> <li>• corrective actions.</li> </ul>	Section 6.1, Table 6.1 (see AE01)
<b>DPE Water Cont.</b>	<p><i>Surface water modelling and ecological assessment</i></p> <p>3.1 Recommendation – prior to determination: The proponent should provide:</p> <ul style="list-style-type: none"> <li>• ...an updated impact assessment on ecologically significant flows and consequences for critical life stages of flow dependent species, eg. fish.</li> </ul>	An updated assessment to be more inclusive of other species and wider ecological impacts particularly to critical life stages has been carried out.	Section 4.3
	<p><i>Geomorphology/riparian land</i></p> <p>3.3. Recommendation – prior to determination: The proponent should provide further detail on the riparian habitat features to be impacted and include detail on how, where and when the proposed mitigating measures are to be implemented.</p>	<p>Riparian buffers will be mapped along the Macleay river and relevant tributaries of the river with appropriate buffer zones. This is addressed in the updated SWA report. Impact areas will be provided for Riparian related riparian habitat.</p> <p>Effort have been made in the design to minimise proximity to the Macleay River. While some impacts can not be avoided, efforts to improve habitat and riparian cover are being considered as part of related offset strategies.</p>	Section 5

### 3 Assessment approach

This Addendum AEIA should be read in conjunction with the Amendment Report and the AEIA prepared by Stantec/Aquatic Ecological Services (13 March 2023) for the EIS and original Project design, and a description of the existing aquatic environment. Other relevant reports that have been considered in this Addendum are an updated Surface Water Assessment (EMM 2024a), which includes a Discharge Impact Assessment (EMM 2024b) not previously completed as part of the EIS.

Additional mapping was undertaken to determine if further impacts needed to be assessed based on the proposed project changes, as well as review of additional information received from the surface water assessments for potential interactions with the receiving aquatic environment. Additional assessment was also completed where necessary to respond to issues raised by DPI Fisheries submissions on the EIS, as described in Section 2.2.

The assessment structure of this Addendum therefore considers:

- Assessment of the Amended Project, with focus on the key aspects relevant to aquatic ecology:
  - Permanent and temporary crossing structures (potential impacts to fish passage and habitat disturbance).
- Assessment of issues requiring more detailed response to submissions raised by DPI Fisheries, noting that this assessment is based on the Amended Project and updated surface water studies:
  - Consideration of adverse effects of pumping on native fish populations that may inhabit Macleay River and the reservoirs, and impacts of flow modifications on fish life cycles (due to increase in construction water take and ongoing operational water requirements for the Amended Project).
  - Riparian buffer zones and impacts.
  - Mitigation, monitoring and offsetting recommendations.

## 4 Aquatic impacts

### 4.1 Fish passage and habitat – crossing structures

Crossing structures have potential to temporarily or permanently blockages to fish passage and impact riparian and key fish habitat.

The Amended Project has proposed changes to crossings of the Macleay River, namely:

- to include an additional temporary bridge structure to cross the Macleay River about 600 m north east of Georges Junction
- re-location of the temporary bridge at Smiths Bluff immediately north of the proposed permanent bridge.

The location of the permanent bridges across the Macleay River and Carrolls Creek (i.e. Smiths Bluff bridge) remain unchanged.

#### 4.1.1 Policy and guidance for waterway crossings

The original assessment undertaken for the EIS identified the Type and Class of key fish habitat for each waterway impacted by the Project. Preferred crossing structures for these waterways has been determined in Table 4.1 based on the *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (2013 update). The bridges proposed by the Amended Project have considered this guidance and the detailed design phase of the Project will ensure waterway crossings are designed in a manner that minimises impacts to fish passage and aquatic habitats.

**Table 4.1 Key fish habit and class ranking for crossing structures based on DPI Fisheries policy document**

Waterway	Key fish habitat	Preferred waterway crossing*
Macleay River	Type 1 Class 1	Bridge.
Peach Tree Creek	Type 2 Class 2	Bridge preferred, box culverts accepted.
Carrolls Creek	Type 2 Class 1	Bridge.
Fingerboard Creek and Unnamed Waterways (Lower Dam, Reservoir and Access Roads)	Type 2 to Type 3 Class 2 to Class 4	Class 2: • Bridge preferred, box culverts accepted. Class 4: • Culverts and fords preferred.
Fingerboard Creek and Unnamed Waterways (Upper Dam and Reservoir)	Type 2 to Type 3 Class 3 to Class 4	Class 3: • Box culverts preferred. Class 4: • Culverts and fords preferred.
Unnamed Waterways (Eastern Access Road)	Type 2 to Type 3 Class 3 to Class 4	Class 3: • Box culverts preferred. Class 4: • Culverts and fords preferred.

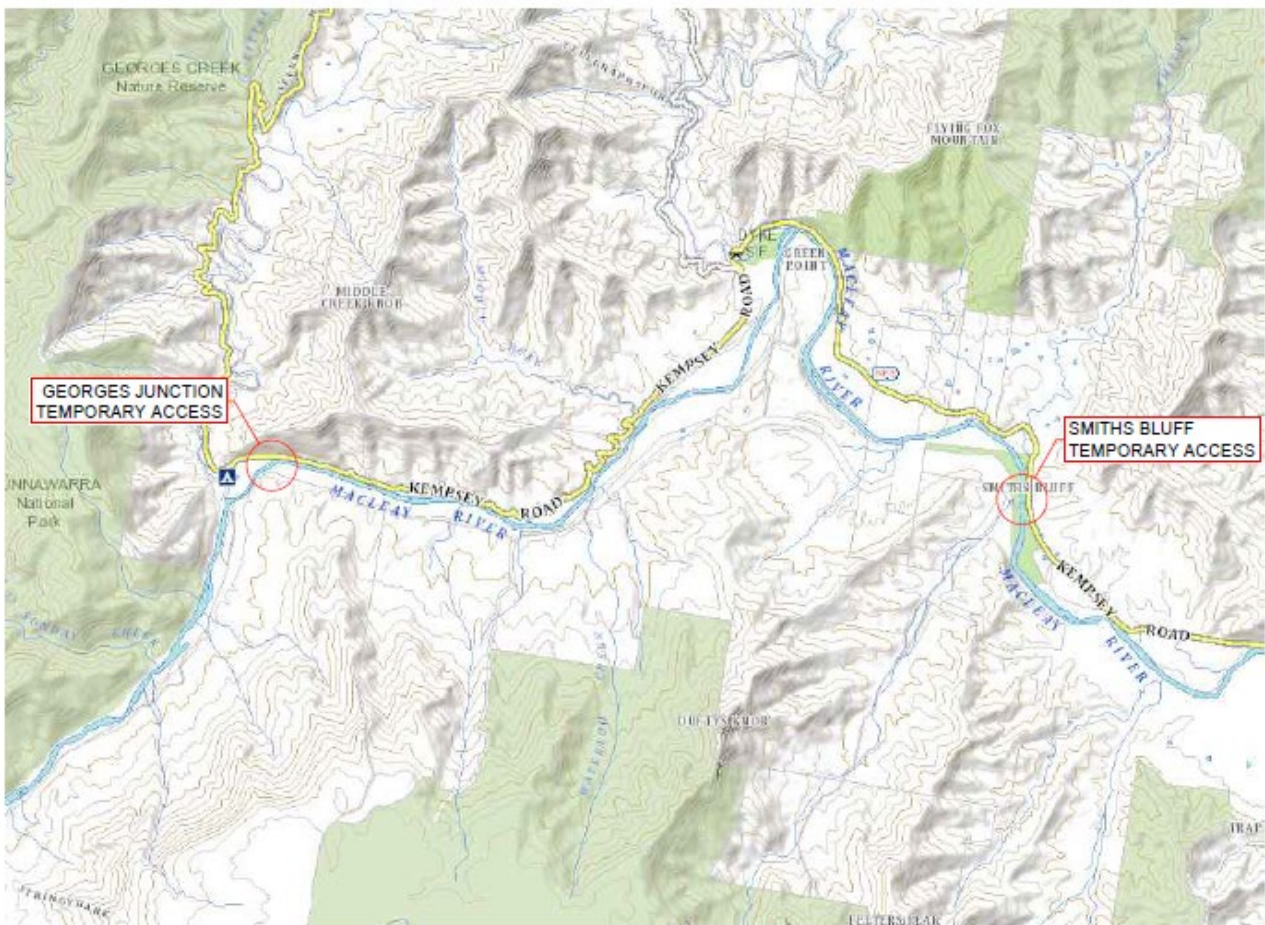
Waterway	Key fish habitat	Preferred waterway crossing*
Georges Creek	Type 1 Class 1	Bridge.

\* List from Table 3 of Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update)

#### 4.1.2 Description of proposed crossings

##### i Temporary structures

Two temporary bridges will be constructed during the construction phase until the permanent crossing structures are completed due to access requirements. The temporary crossing structures are located 600 m north east Georges Junction (referred to as the Western Access Temporary Bridge (WATB)), and on the Macleay River just downstream of the Georges Creek Confluence and Smiths Bluff near the downstream extent of the Project Area on the Macleay River (referred to as the Eastern Access Temporary Bridge (EATB)) (Figure 4.1). The purpose of the EATB will be to connect Kempsey Road to the Eastern Access Road prior to the construction of the permanent bridge. The purpose of the WATB will be to provide access to the Project site to allow road construction activities to be co-ordinated which will reduce the overall Project construction timing. The WATB will be removed at Project construction completion and not replaced with a permanent structure, whereas the EATB crossing will be removed once the permanent bridge structure is completed just south of the temporary structure and will be the main access into the Project Area.



**Figure 4.1** Temporary crossing structure locations

Both temporary structures will be single spanning structures (Table 4.2) and will be decommissioned prior to operation. The temporary structures at Smiths Bluff will be in place until the permanent crossing has been completed. The temporary structures for the crossing of Macleay River upstream of Georges Junction will be in place until the early road works are completed (this is assumed could be for approximately 4 years).

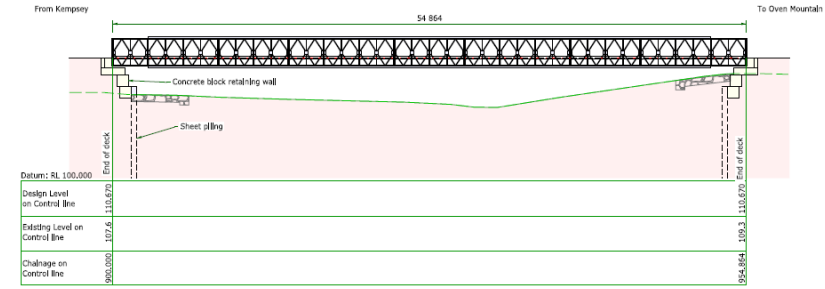
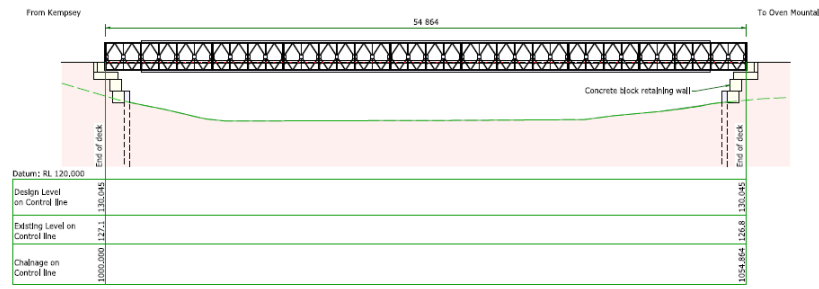
**Table 4.2 Proposed temporary structures**

Structure	Georges Junction	Smiths Bluff
layout		
Plan		

Structure **Georges Junction**

Structure **Smiths Bluff**

Elevation



## ii Permanent structures

The permanent structures are as proposed in the EIS and will be multi-spanning bridges that will have a wider span pushing the abutment structures further back into high bank providing more channel open for the flow of water during higher flow periods.

### 4.1.3 Impacts to fish passage and habitat

The permanent structures are as proposed in the EIS and will be multi-spanning bridges that will have a wider span pushing the abutment structures further back into high bank providing more channel open for the flow of water during higher flow periods. The Project will endeavour to minimise the time in which the temporary structures are in place.

Both temporary structures will span the width of the Macleay River main channel without additional piers and or piles within the channels for support. Both structures will span the channel so that the low flow channel will be unimpeded maintaining habitat connectivity during low flow conditions. The abutments do encroach into the channel and may influence on the hydraulic function on this section of the river.

The impact to fish movement across this temporary structure will not be significantly impeded as the spanning structure is an open structure, however adverse conditions may make crossing more challenging, given the narrowing of the river channel in these locations. However, some habitat will be lost due to the temporary bridge abutments, access, and scour protection as such for completeness it is assumed that the temporary bridge structures should be included as part of estimating impacts to key fish habitat and aquatic offsets.

While the temporary structures will be removed and rehabilitated the habitat will be lost and or modified for the period in which the structures are in place for potentially the duration of the construction phase.

### 4.1.4 Mitigation in design

As outlined in the EIS (Mitigation Measures), the Project has committed to ensuring all waterway crossings comply with *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge 2003) and Policy and guidelines for fish habitat conservation and management (Department of Primary Industries 2013). This includes:

- Minimising ground disturbance during the wet season, and or periods of heavy rainfall.
- For smaller class streams (2–4) minimise the time in which streams are blocked, impounded, and or restricted water flow.
- For all Class 1 waterways water flow and connectivity should be maintained during construction.
- Designs structures need to meet high flow and low flow condition suitable to maintain fish passage for all conditions.
- Installation of any scour protection should not impede the connectivity of the water and or become a barrier for fish to pass through the structure, additionally scour protection should only be where needed.

Updated mitigation measures for the Amended Project are detailed in Section 6.1.

## 4.2 Adverse effects of pumping on native fish populations that may inhabit Macleay River and the reservoirs.

DPI Fisheries provided comments on the EIS and AEIA requesting additional clarification around how the Project will reduce mortality impacts on species that may become established within the reservoirs. Additional concerns were raised in regard to common native fish species known within the region. This section builds off the previous studies undertaken and elaborates further on the relevant concerns identified.

Screening between reservoirs will be minimal due to the hydraulic requirements to produce adequate flow to generate power. The two reservoir intake structures, one at each reservoir, include:

- Upper intake: a morning glory, vertical-type intake structure situated at the upper dam and reservoir.

This near surface water intake does not have screening for the purposes of minimising fish intake, however the structure is located in open water appose to the edges of the reservoir reducing the likely interaction with eggs and larvae that are less like to directly interact with these life stages, additionally the upper intake structure is placed as such the entirety of the upper reservoir can be drained for access and maintenance.

- Lower intake: a lateral intake structure, with head gates and stoplog slots, and an intake channel, at the lower dam and reservoir.

The lower intake structure will draw water from the reservoir into the tailrace tunnel during pumping mode and to release water into the lower reservoir during generation mode. As with the upper intake structure, the lower intake structure will employ trash racks to prevent foreign objects being introduced to the waterways. The lower intake structure will be laterally oriented and founded in rock. A lower intake gate shaft with head gates and stoplog slots will also be constructed to allow for inspection and maintenance of the lower gate seals. The flow rate through the lower intake structure is intended to be less than 2 m/s at maximum flow.

Essentially due to the high turn over of water and regular fluctuation in height of the water it is unlikely fish populations will likely be able to establish and maintain significant numbers due to the lack of habitat and food availability. As the system is an off-river closed-loop system there should be minimal opportunities for fish species to reestablish in the reservoir locations. While screens at the river intake will not be completely restricting all larvae and or egg the screening will significantly reduce risk of transferring species into the reservoir.

Additionally, the Project will need to conduct intake screen assessments to determine if fish larvae and or eggs are being captured by the screens at the intake of the Macleay River.

Periodic monitoring will still need to occur in the reservoirs to understand if a fish population has reestablished in the reservoir and upper catchment for Fingerboard Creek. If a population has established with the reservoirs efforts to destock the reservoirs may be required.

As a mitigation measure, the Project will undertake a de-stocking effort on Fingerboard Creek during the dry season to minimise the initial presence of species within the reservoir sections. This will involve pushing species downstream of the reservoir locations and then blocking off access for the species to move back upstream.

## 4.3 Flow modifications on the life cycle of fish

To account for modification to flow and water quality impacts an additional range of species have been reviewed for how the Project construction and operation may affect the various life stages for more common species found within the MacLeay River catchment. A select number of species have been used as proxy species for the likely aquatic biodiversity may be impacted by the Project, these species are listed in Table 4.3.

Flow modifications for the Amended Project need to be considered in 3 Phases: the initial fill, construction water and the operational top-up (Table 4.4). Additionally discharges need to be considered for modifications to the water quality. Each is discussed in the following sections.

**Table 4.3 Local Catchment representative species with life cycle and interaction information**

Proxy Species	Habitat	Migratory	Lifecycle requirements	Project influence	Information resources
Australian Long Fin Eels, <i>Anguilla reinhardtii</i>	Longfin Eels prefer flowing waters, and commonly occur in riverine habitats, from river mouths to headwater streams. They also inhabit in lakes, swamps and floodplains, and deep freshwater reservoirs.		Australian Long Fin Eels, <i>Anguilla reinhardtii</i> .	Longfin Eels prefer flowing waters, and commonly occur in riverine habitats, from river mouths to headwater streams. They also inhabit in lakes, swamps and floodplains, and deep freshwater reservoirs.	
Cox's Gudgeon, <i>Gobiomorphus coxii</i>	The species is found in coastal freshwaters and inland up to about 700 m altitude. Juveniles are often found at lower altitudes. Recorded within the project area.	Yes, but restricted to freshwater. Capable of migrating up the wet surfaces of waterfalls and dams aided by their broad pectoral fins and pelvic fins which, when spread out, form a cup-shaped disc similar to pelvic fins of most gobies.	It is believed that juveniles are initially washed downstream and over spring and summer complete an upstream migration. They are able to climb waterfalls by rotating their pectoral fins so that the inside surfaces of the fins are pressed against the wall creating suction. Adults are commonly found around 15 cm in length.	While the project may interact with larvae and juveniles and adults. As juveniles and adults they have adapted to high flow environments and can successfully move across challenging terrain and conditions via their fin adaptations. Juvenile may interact with the intake during the summer period based on the initial fill estimate time of pumping.	Martin F. Gomon, <i>Gobiomorphus coxii</i> in Fishes of Australia, accessed 4 July 2024, <a href="https://fishesofaustralia.net.au/home/species/4143">https://fishesofaustralia.net.au/home/species/4143</a>

Proxy Species	Habitat	Migratory	Lifecycle requirements	Project influence	Information resources
<i>Australian Smelt</i> <i>Retropinna semoni</i>	<p>Endemic to coastal drainages of south-eastern Australia.</p> <p>A schooling species found in slow-flowing and still freshwater habitats such as lakes, swamps and billabongs in large lowland floodplain rivers, upland rivers and streams, small coastal streams, dune systems, lakes, dams and weirs, and brackish river estuaries. Individuals shoal near the surface or around the cover of aquatic plants and woody debris.</p> <p>Recorded within the project area.</p>	Restricted to freshwater.	<p>The species completes its entire lifecycle in freshwater. Individuals mature in their first year and spawn between July and March.</p> <p>Demersal eggs are laid amongst aquatic vegetation. Fecundity may be low, although numbers of 100–1,000 eggs have been reported depending on the size of the female.</p> <p>To 10 cm, commonly to 7cm.</p>	The intake may interact with eggs and larvae, eggs are laid on to aquatic vegetation.	Gomon, M.F. & Bray, D.J. 2024, <i>Retropinna semoni</i> in Fishes of Australia, accessed 4 July 2024, <a href="https://fishesofaustralia.net.au/home/species/2087">https://fishesofaustralia.net.au/home/species/2087</a>

Proxy Species	Habitat	Migratory	Lifecycle requirements	Project influence	Information resources
Southern Purple spotted gudgeon <i>Mogurnda adspersa</i>	<p>Not recorded within the project area.</p> <p>Widespread in most major coastal drainages of eastern Australia.</p> <p>Inhabits muddy and sandy areas of slow flowing or still waters of small streams, rainforest streams, large rivers, dune lake systems and quiet weedy pools and billabongs, creeks and billabongs freshwater rivers, creeks and billabongs. Individuals usually occur near cover, often sheltering among aquatic vegetation, rocks, snags, and other woody debris.</p> <p>Slow flowing waters among weed where suitable hard objects are available for spawning. Primarily a bottom dweller, rarely swims continuously. Longer distances accomplished by a series of jerky darts.</p>	<p>Migrate from deeper water and spend winter in sheltered situations. An ambush predator, lying motionless on bottom until suitable prey approaches. Amazing jumping ability.</p>	<p>Oviparous, benthic spawners. Spawning occurs between pairs in Spring from November to March. Females prepare to lay eggs when water temperatures reach 20°C. Females batches of 30–1,300 sticky eggs per breeding season, depositing them onto rocks, logs or broad-leafed aquatic vegetation. The male parent guards the eggs and continuously fans them with his pectoral and anal fins until they hatch after 3–9 days.</p> <p>Eggs are deposited in clusters on solid objects such as rocks, wood, broad leafed plants.</p> <p>To around 12 cm SL, commonly to 8 cm.</p>	<p>While the survey effort did not detect this species, the Project is located within the upper reaches of their known distribution. Georges Creek which enters the MacLeay River downstream of the intake location is the upper most identified key fish habitat for this species.</p> <p>Based on the known distribution of the species it is unlikely the project will directly interact and or impact on this species, however additional studies will be undertaken before construction to further inform of the species distribution.</p>	<p>Native Fish Australia (2024) Southern Purple spotted gudgeon, Accessed 20 June 2024  <a href="https://www.nativefish.asn.au/home/page/Southern-Purple-Spotted-Gudgeon">https://www.nativefish.asn.au/home/page/Southern-Purple-Spotted-Gudgeon</a></p>

**Table 4.4 Proposed extraction conditions – Macleay River table 5.2 SWA (EMM 2024a)**

Water take	Volume required	Estimated extraction period	Cease to pump trigger <sup>1</sup>	Pumping rate	Additional conditions
Construction water	Up to 1,000 ML/year	4–5 years	13 ML/day <sup>2</sup>	2.8 ML/day	<ul style="list-style-type: none"> <li>Water must only be taken when there is a visible flow in the water source at the location where water is to be taken.</li> </ul>
Initial storage fill	6,250 ML	3–12 months	597 ML/day	Up to 86.4 ML/day (1 m <sup>3</sup> /s)	<ul style="list-style-type: none"> <li>The 50<sup>th</sup> percentile streamflow value is to be maintained.</li> <li>Pumping to cease if 30 day streamflow total<sup>1</sup> below 5 year ARI value of 1,936 ML.</li> </ul>
Operational top-up	Up to 130 ML/year	Ongoing	597 ML/day	Up to 86.4 ML/day (1 m <sup>3</sup> /s)	<ul style="list-style-type: none"> <li>No extraction for first seven days following a flow event greater than 50<sup>th</sup> percentile streamflow<sup>1</sup> value following extended dry period or drought<sup>3</sup>.</li> <li>Water must only be taken when there is a visible flow in the water source at the location where water is to be taken.</li> <li>Consideration of special circumstances<sup>4</sup>.</li> <li>The 50<sup>th</sup> percentile streamflow value is to be maintained.</li> <li>Pumping to cease if 30-day streamflow total<sup>1</sup> below 5 year ARI value of 1,936 ML.</li> <li>No extraction for first seven days following a flow event greater than 50<sup>th</sup> percentile streamflow<sup>1</sup> value following extended dry period or drought<sup>3</sup>.</li> <li>Water must only be taken when there is a visible flow in the water source at the location where water is to be taken.</li> <li>Consideration of special circumstances<sup>4</sup>.</li> </ul>
			13 ML/day <sup>2</sup>	10% of streamflow	<ul style="list-style-type: none"> <li>In accordance with the rules of the Macleay WSP.</li> <li>Maximum pumping rate of 10% of the observed streamflow in the Macleay River.</li> <li>Water must only be taken when there is a visible flow in the water source at the location where water is to be taken.</li> </ul>

Notes:

1. Streamflow measured at Macleay River at D/S Georges River Junction (206024) stream gauge.
2. 'Very low flow' conditions for the Macleay Gorges Water Source as defined in the Macleay WSP.
3. Extended dry period or drought refers to the 30-day streamflow total below 5-year ARI (1,936 ML).
4. Special circumstances to be assessed on a case-by-case basis with the corresponding protocols to be documented in the SWMP.
5. Construction water will be required until construction of the Project is complete. Construction water may be required for more than the estimated 4-5 years if the construction program experiences delays.
6. The operational top-up volume is based on the water balance modelling described in the SWA. Actual operational top-up volumes may exceed this value on occasion. OMPS will hold all water entitlements prior to take occurring.
7. All values are based on a constant rate over a 24 hour period.

### 4.3.1 Construction water

Water take will be required to meet construction demand for the Project. The SWA has predicted the potential impacts on baseflow to the Macleay River and adjoining watercourses. It is estimated the maximum reduction realised in the fourth year of construction at approximately 193 ML/yr, representing approximately 4% reduction from the pre-Project baseflow conditions. Following construction of the Project, water infiltration from Project infrastructure is predicted to increase baseflow contributions by approximately 400 ML/yr, representing an increase of approximately 6% compared to the pre-Project baseflow conditions. Given the relatively low (and short-term during construction) reduction in baseflow, reduced baseflow is not anticipated to have a significant impact, given the relatively small impact of the take of water for construction it is not expected to have a measurable impact on fish species and or stages of the local species life cycle. As the total volumes of pumping will occur periodically, not all at once, and only when there is visible flow.

Additional considerations in regard to the location and types of pumps used for construction water has yet to be completed. Where larger more consistent volumes of water are required i.e. the concrete batching plant. The project designer will need to consider more robust fish friendly installations that align with the NSW Fisheries *The practical guide to modern fish-protection screening in Australia* (Boys 2021 and Boys et al. 2021). Any installation of pumps need to consider disturbance areas that may not have been addressed otherwise.

The proposed locations of these construction pumps will be provided to DPI Fisheries when the final designs have been submitted for review/approval.

### 4.3.2 Initial fill

The initial fill will see the most water collected to fill the storages; this will occur for 3–12 months. The duration is limited to the availability of flow condition for the MacLeay River. This phase will have the highest impact on the Aquatic ecology of the immediate section of the MacLeay River. As discussed in the SWA report the take of water will be considerably minor in the overall volumes of the catchment and current water allocations. However, the controls described in the above table limit the periods in which pumping can occur that will protect environmental flows for periods where conditions are in low flow conditions.

The intake screen will be designed with fish friendly features to minimise losses of larvae, eggs and small bodied fish. While the final designs are being determined there is commitment from the Project to design and incorporate minimally impactful structures for the river intake, in general accordance with *The practical guide to modern fish-protection screening in Australia* (Boys, Rayner, Kelly, Doyle, & Baumgartner, 2021) and *Design specifications for fish protection screens in Australia* (Boys, 2021).

It is predicted that pumping will occur from approximately December through March to meet the pumping limitations. Many of the reviewed proxy species for the wider catchment biodiversity suggests that there may be some interactions during the initial fill of spawning periods (Australian Smelt), and juvenile movements of other species (Table 4.3). There is no way of removing all interactions with species present in the system however the restrictions around pumping periods will mean adequate water levels are present in the Macleay River, where there is adequate space to move around the intake structure and utilise natural available in the wider channel.

In addition to the pumping controls the fish friendly intake and screen designs will further limit the potential impacts to small, bodied fish, eggs and larvae within the Macleay River system. As several factors require consideration when designing an effective fish-protection screen, OMPS will continue to consult with NSW DPE Water and NSW DPI Fisheries over the fish screen design moving forward and into detail design. The implementation of appropriate fish screens is expected to mitigate the potential risks associated with pump operation.

### 4.3.3 Operational Top up

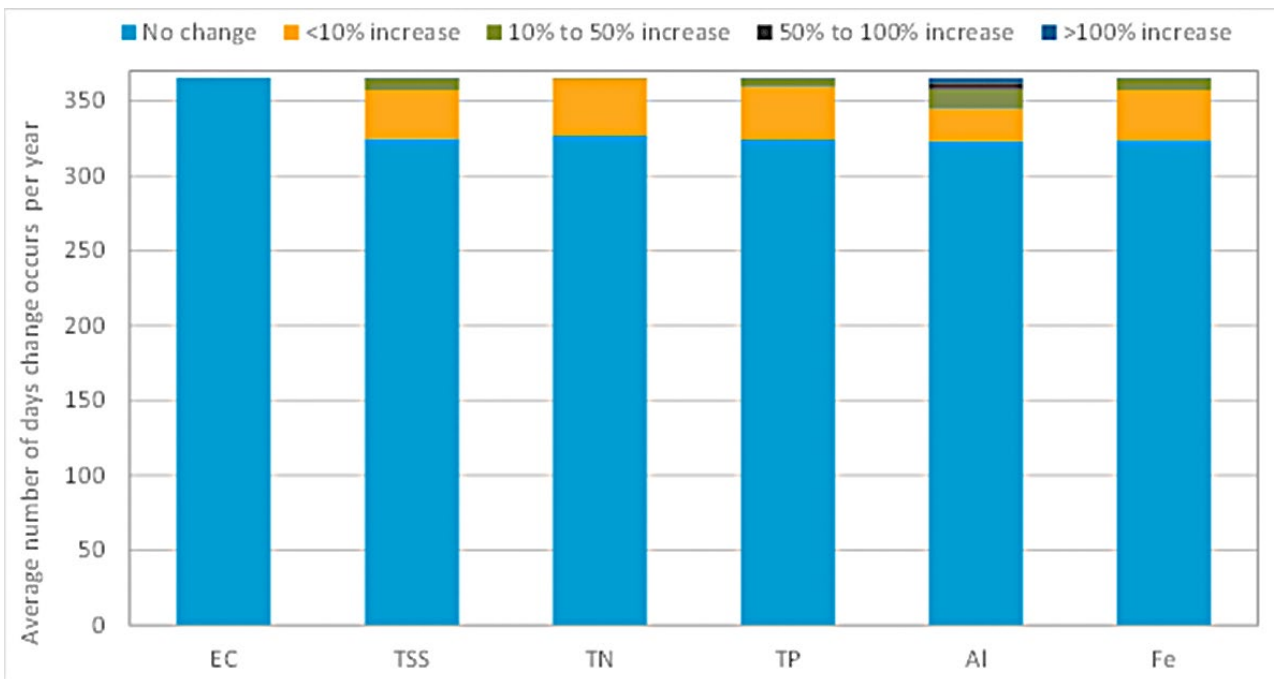
Currently the design for operational top up of water through the loss of evaporation has yet to be confirmed. There are two avenues of design utilise the larger pump and volume for top up of the system and then be restricted to the current proposed controls of the pumping regime and or reduce the pump size and therefor pump volume collected over a longer period that may allow for more frequent pumping occurrences across less prohibited pumping regimes. These details have yet to be confirmed but it being considered that with the reduction of the pump requirements to maintain the reservoir levels a smaller pump size and slower take volumes are an option for the operation phase.

Given the small volumes of water predicted to be taken each year for operational top up the impact is considered overall negligible to the wider system and will have less of an impact of taking water compared to any other phases of water taking (Table 4.4).

### 4.3.4 Discharges

While discharges will occur during constructions the other all impact is considered quite low, where impacts to water quality will be limited to the immediately downstream environment and will dilute the further downstream from the Project Area. This is based on the Discharge Impact Assessment (EMM, 2024b) that assessed the worse case scenario that did not include the usage of sediment basins and are assumed for particular events. Another way of determining how much the receiving environment will be impacted is to look at the number of days the system is exposed to high run off events. Figure 4.2 depicts the number of days a measurable change occurs in the system, which suggests:

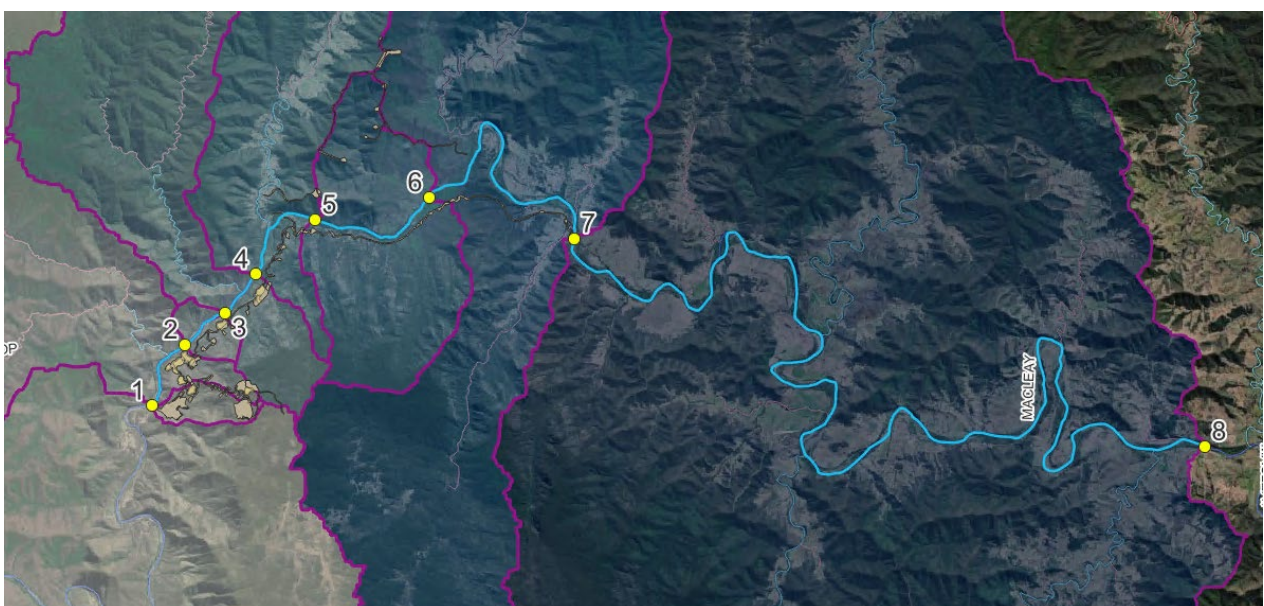
- **No impacts** to water quality are predicted to occur for approximately **330 days per year (90% of the time)**. When water quality impacts do occur, they generally result in less than a 10% increase to existing/WQO values. Negligible impacts are predicted during typical discharge conditions.
- Water quality impacts that result in more than a 10% increase to existing/WQO values are expected to occur infrequently. All water quality impacts are predicted to be short term with impacts only occurring during and immediately following rainfall, when discharges are occurring.
- The modelled water quality in the Macleay River is predicted to be similar to the baseline water quality observed in minor watercourses and the Macleay River adjacent to the Project area (as indicated by the baseline WQ monitoring). This indicates that while pollutant concentrations in the Macleay River may be elevated compared to the WQOs, the concentrations are predicted to be within water quality ranges that occur naturally within the catchment.
- Aluminium is a bit higher than what is typically observed in the Macleay but is similar to the minor watercourses across the catchment area due to dilution effects.



**Figure 4.2** Average change to daily pollutant concentrations on a yearly basis.

While the model applied does not look directly at mixing zones, the model looks at the broader Macleay River system. When a typical discharge from a typical rain event is reviewed the model suggests that the discharge does not have a measurable change on the receiving environment for Salinity, TSS, TN, TP (Figure 4.3 and Table 4.5). Where Aluminium and Iron increase by 1 µg/L or 0.001 mg/l from Upstream of the Project Area (1) to the downstream extent (6,7 and 8) of the Project Area (Figure 4.3 and Table 4.5).

Based on the additional assessment undertaken to date it is not expected that the Project will have measurable change and or impact to the various life stages of common aquatic species, under normal conditions. During more extreme events there is potential to have localised influence on the water quality however the predictions are based on extreme events. Additionally the take of water is unlikely to adversely effect the life cycle of these species with the water take controls in place to minimise the effects of flow and maintain adequate environmental flows.



**Figure 4.3** Discharge assessment locations

**Table 4.5 Event based WQO exceedances – 50<sup>th</sup> percentile (typical) construction discharge conditions**

Assessment location	Salinity	TSS	TN	TP	Aluminium	Iron	
WQO	300 µS/cm	10 mg/L	350 µg/L	25 µg/L	55 µg/L	200 µg/L	Location detail
1	160.0	10.0	350	25	55	200	Upstream of Project Area.
2	160.0	10.0	350	25	55	200	Within Project Area, immediate discharge.
3	160.0	10.0	350	25	55	200	Within Project Area, immediate discharge.
4	160.0	10.0	350	25	55	200	Within Project Area, immediate discharge.
5	160.0	10.0	350	25	56	200	Within Project Area, immediate discharge.
6	160.0	10.0	350	25	56	201	Within Project Area, immediate discharge.
7	160.0	10.0	350	25	56	201	Downstream extent of Project Area.
8	160.0	10.0	350	25	56	201	40 km downstream of the Project Area.

## 5 Riparian impacts

The Project will impact on an extensive area of riparian habitat, mostly on minor waterways for stream orders of 1–3. The impacts are best relayed through review of Figure 5.1. However, Table 5.1. summarises the area impact to riparian habitat around the Macleay River. Impact areas have been calculated for all other streams across the Project area and are summarised in Table A.1 (Annexure A). Riparian buffers were applied as per Table 5.2.

These losses are the result of a combination of Project components, this has been summarised in Table 5.1.

It should be noted that the loss of riparian habitats have been addressed as part of the clearing impacts in the BDAR.

It has been requested by DPI Fisheries that a Buffer Area be applied to the Macleay River of 100 m. This has been reviewed and the majority of the 100 m buffer around the Project area except for the bridge structures, and a few locations of the access road will remain mostly intact.

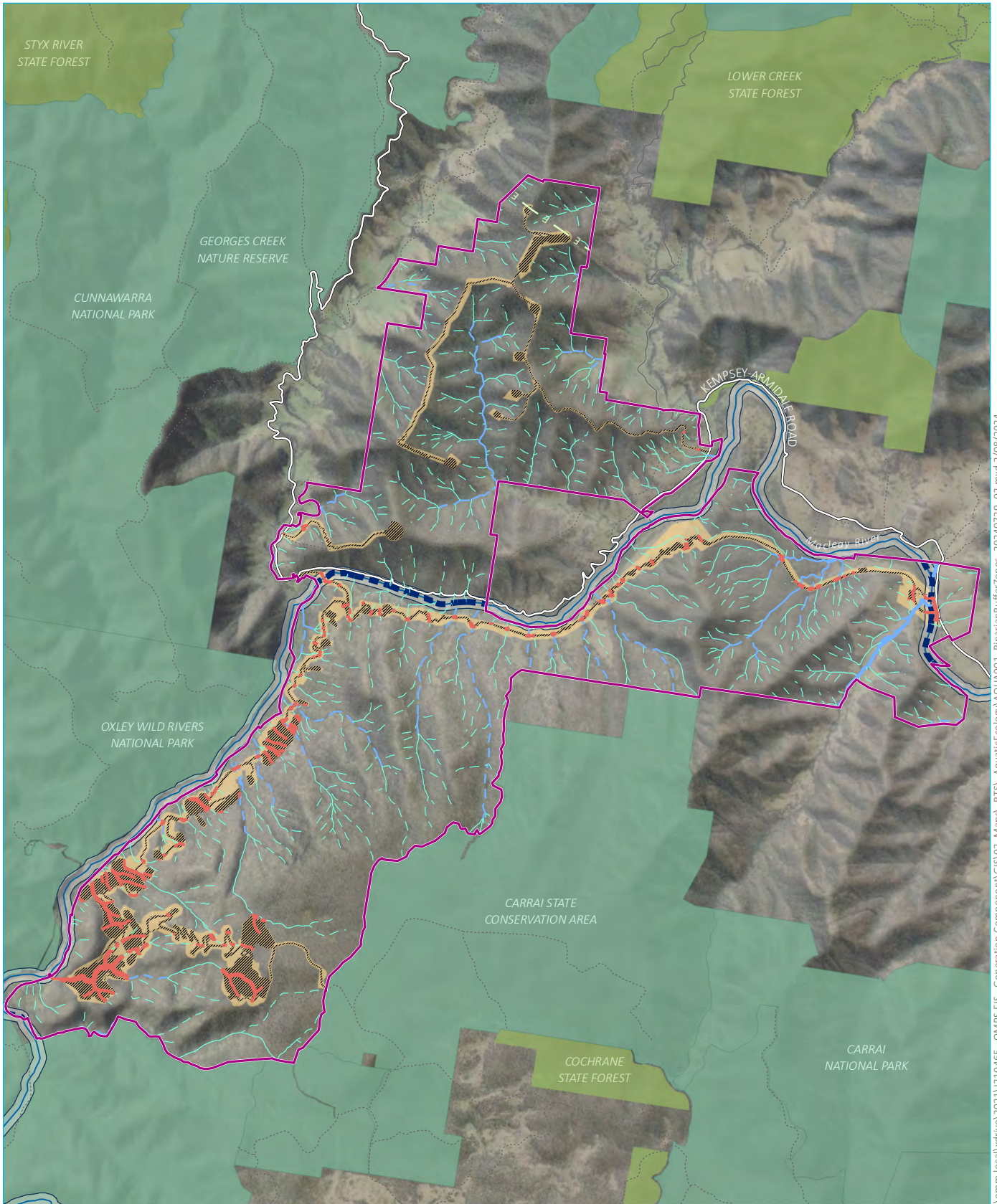
Additional mitigations the detailed Project design will consider is minimising disturbance footprints and maintain adequate buffers around all watercourses where possible in accordance with Table 5.2.

**Table 5.1 Macleay River riparian impacts**

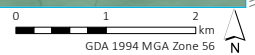
Location	Project area	Impact in ha
Macleay River	Easter access road	0.84
	Eastern temporary bridge	0.91
	Lower dam	0.17
	Western access temporary bridge	0.54
	<b>Total</b>	<b>2.45</b>

**Table 5.2 Watercourse buffers based on the water management Act and DPI Fisheries recommendations**

Watercourse type	VRZ width (each side of the watercourse)
1 <sup>st</sup> order	10 m
2 <sup>nd</sup> order	20 m
3 <sup>rd</sup> order	30 m
4 <sup>th</sup> order	40 m
Macleay River	100 m



Source: EMM (2024); DFSI (2020); GA (2011); SMEC (2022)



**KEY**

- |                               |                 |                            |
|-------------------------------|-----------------|----------------------------|
| Project area                  | Strahler stream | Existing environment       |
| Impacted riparian buffer zone | 1st order       | Macleay River              |
| Disturbance footprint         | 2nd order       | Kempsey-Armidale Road      |
| Construction envelope         | 3rd order       | Minor road                 |
| Macleay River 100m buffer     | 4th order       | Vehicular track            |
|                               | 5th order       | Existing transmission line |
|                               | 6th order       | NPWS reserve               |
|                               | 9th order       | State forest               |

**Riparian habitat buffers**

Oven Mountain Pumped Hydro Energy Storage Project  
 Aquatic Ecology Addendum Assessment  
 OMPS Pty Ltd  
 Figure 5.1



\\emm.local\vdwh\2021\210465 - OMPS EIS - Generation Component\GIS\02\_Maps\RTS\_AquaticEcology\AQ04000\_RiparianBufferZones\_20240729\_02.mxd 2/08/2024

## 6 Mitigation and offsets

### 6.1 Updated mitigation measures

The mitigation measures identified in the EIS are applicable to the Amended Project. Some updates have been recommended based on the review of potential aquatic impacts and feedback from DPI Fisheries and these have been identified in the table by **bold text**.

**Table 6.1 Mitigation measures for aquatic, subterranean and groundwater-dependent ecology impacts**

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Potential impacts on the Southern Purple-spotted Gudgeon and the Manning River Helmeted Turtle.	AE01	<ul style="list-style-type: none"> <li>Undertake further field sampling to document the presence/absence of the Southern Purple-spotted Gudgeon and the Manning River Helmeted Turtle (e.g. targeted habitat sampling, eDNA sampling) to expand their known range, reducing impact on the overall population.</li> <li><b>Additional survey prior to construction will focus on:</b> <ul style="list-style-type: none"> <li><b>Georges Creek</b></li> <li><b>Dykes river</b></li> <li><b>a suitable control site.</b></li> </ul> </li> <li><b>Survey effort may include eDNA, habitat assessment and fish surveys. To better understand the distribution of the species in the region.</b></li> </ul>	Prior to construction	OMPS and contractor
Short-term minor decrease in surface water volume and flow within the Macleay River and associated tributaries as a result of reservoir construction and filling.	AE02	<ul style="list-style-type: none"> <li>The baseflow of the Macleay River should be maintained during dry conditions in accordance with the relevant licensing provisions (SPAL) approved for the Project.</li> <li>Surface water, flow and quality should be monitored upstream and downstream of the water extraction site within the Macleay River, prior to, during and post-construction to detect changes outside of expected ranges and in accordance with the relevant licensing provisions (i.e. the SPAL).</li> <li>Ensure Project-specific management plans are prepared and implemented, prior to construction.</li> </ul>	Prior to, during and post-construction	OMPS and contractor
Initial and short-term periodic degradation in surface water quality (including breach of relevant WQO; salinity, nutrients and/or metal concentrations) due to evapoconcentration within the Macleay River as a result of water extraction.	AE03	<ul style="list-style-type: none"> <li>Sediment control devices should be used around construction areas (e.g. silt fences in areas where construction runoff may enter waterway).</li> <li>Surface water, flow and quality triggers should be established for the Macleay River to detect changes in salinity and other parameters relevant to aquatic ecology, particularly during initial filling of the reservoirs, and to further inform monitoring programs.</li> <li>Surges of water after rainfall naturally flush waterways to prevent stagnation; therefore it is recommended that the SPAL considers filling of the reservoirs should be delayed post-initial flush where feasible.</li> <li>Ensure Project-specific management plans are prepared and implemented, prior to construction.</li> <li><b>Sediment basins should be installed to minimise transfer of high turbid surface waters in to the receiving environment.</b></li> <li><b>Sediment basins must be installed off-line for existing and or diverted watercourses.</b></li> </ul>	Prior to construction	OMPS and contractor

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Aquatic fauna mortality attributed to extraction of water from the Macleay River.	AE04	<ul style="list-style-type: none"> <li>Water extraction infrastructure should be designed, constructed and operated in alignment with Boys (2021) and Boys et al. (2021), and "fish friendly" end-of-pipe screens should be selected to minimise mortality of fish, Platypus, amphibians and turtles, and to prevent infrastructure damage.</li> <li><b>The design and application of screening to the Macleay River pump facility will be provided to DPI Fisheries for review prior to construction.</b></li> <li><b>Intake Screens will be regularly checked for obstruction and effectiveness to ensure the fish friendly aspects of the pump are effective for the protection of aquatic species.</b></li> </ul>	Prior to, during and post-construction	OMPS and contractor
Disturbance of waterway beds and banks as a result of water extraction.	AE05	<ul style="list-style-type: none"> <li>Ensure water extraction infrastructure is raised off the sediment to minimise erosion of the benthos.</li> </ul>	Prior to, during and post-construction	OMPS and contractor
Disturbance of waterway beds and banks, decrease in short to medium term water and sediment quality, short-term impediment of fish passage and impacts to potential Platypus burrow habitat as a result of the construction and installation of bridge/road crossings and power transmission lines.	AE06	<ul style="list-style-type: none"> <li>Ensure all waterway crossings comply with <i>Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings</i> (Fairfull and Witheridge 2003) and Policy and guidelines for fish habitat conservation and management (Department of Primary Industries 2013).</li> <li>Ensure Project management plans contain provisions for managing impacts and monitoring water quality, key fish habitat and fish passage during Project construction, in particular, bridge/road and transmission line waterway crossing installation.</li> <li>Ensure the sections of waterway to be impacted by Project construction (i.e. bridge/road crossings, water extraction infrastructure installation) are surveyed for Platypus burrows and individuals and, if Platypus are located, that relocation surveys are undertaken prior to clearing and construction works.</li> <li>Ensure Project-specific management plans are prepared and implemented, prior to construction.</li> <li><b>Ensure during construction of permanent and temporary structures that flow is maintained for Class 1 waterways and impacts to flow is minimised as much as practicably possible to maintain habitat connectivity for aquatic species.</b></li> <li><b>Where possible, construct structures during slower flows to minimise the movements of soil and sediments into the river.</b></li> <li><b>Ensure the removal of temporary bridges include site rehabilitation including:</b> <ul style="list-style-type: none"> <li><b>Reinstatement of bank profiles.</b></li> <li><b>Reinstatement of banks with natural and locally material where required.</b></li> <li><b>Revegetation of riparian buffer with locally appropriate vegetation.</b></li> </ul> </li> </ul>	Prior to and during construction	OMPS and contractor

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Additional surveys and monitoring to identify any potential Project-specific impacts to aquatic vertebrate fauna species not yet identified from the Macleay River within the Project area.	AE07	<ul style="list-style-type: none"> <li>If practical, undertake follow up aquatic vertebrate fauna monitoring using a boat electrofisher as some areas with deeper water couldn't be accessed due to lack of boat access at the time of the field surveys.</li> <li>Alternatively, purchase historic monitoring data from the DPI Fisheries.</li> </ul>	Prior to construction	OMPS
Erosion, siltation, scouring and degradation of the riparian zone, including an increase in instability of waterway banks and beds, as a result of construction activities.	AE08	<ul style="list-style-type: none"> <li>Ensure Project-specific management plans and relevant licenses contain provisions for managing water quality, water flow, aquatic habitat and riparian habitat, and include erosion and sediment management and mitigation measures such as silt fencing and sediment capture downslope of construction areas.</li> <li>Ensure construction staff use specific tracks when accessing and moving through riparian corridors.</li> <li>Fence off areas of riparian vegetation to exclude cattle and livestock.</li> <li>Ensure Project-specific management plans are prepared and implemented, prior to construction.</li> </ul>	Prior to and during construction	OMPS and contractor
Decrease in short to medium term water and sediment quality as a result of Project activities adjacent to the Macleay River.	AE09	<ul style="list-style-type: none"> <li>Ensure Project-specific management plans contain provisions for the management of construction pollutants (i.e. hydrocarbons, chemicals) to ensure that no contamination of waterways (or nearby soil) occurs.</li> <li>Ensure Project-specific management plans are prepared and implemented, prior to construction.</li> </ul>	Prior to and during construction	OMPS and contractor
in short to medium term water and sediment quality as a result of runoff and sedimentation attributed to inadequate post-construction rehabilitation and/or stabilisation methods.	AE10	<ul style="list-style-type: none"> <li>Ensure Project-specific management and rehabilitation plans contain provisions for managing water and sediment quality, downslope of constructed areas, post Project construction.</li> <li>Undertake periodic monitoring or inspection of adjacent aquatic and riparian habitat during and postconstruction.</li> <li>Ensure Project-specific management plans are prepared and implemented, prior to construction.</li> </ul>	Prior to and during construction	OMPS and contractor

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Loss and/or reduced recruitment of native riparian plants, including potential loss of habitat and exacerbation of existing weed infestations, due to vegetation clearing, construction activities and water extraction during water extraction.	AE11	<ul style="list-style-type: none"> <li>• Ensure that aquatic and riparian zones are progressively rehabilitated, if necessary, and managed in accordance with Project rehabilitation plans, and that adjacent disturbed areas are also rehabilitated (weed management, native vegetation planning, erosion control/prevention, fencing of waterways, etc.), where practicable.</li> <li>• Ensure Project-specific management plans and relevant licenses contain provisions for managing water quality, water flow, aquatic habitat and riparian habitat, and include erosion and sediment management and mitigation measures such as silt fencing and sediment capture downslope of construction areas. Ensure construction staff use specific tracks when accessing and moving through riparian corridors.</li> <li>• Fence off areas of riparian vegetation to exclude cattle and livestock.</li> <li>• Ensure Project-specific management plans are prepared and implemented, prior to construction.</li> <li>• <b>Where possible apply the recommended buffer areas as described in the Aquatic Ecology Addendum memo, Table 6.2.</b></li> </ul>	Construction and post-construction	Contractor
Decrease in short to medium term water and sediment quality.	AE12	<ul style="list-style-type: none"> <li>• Consider developing site-specific water and sediment quality criteria for use in future monitoring.</li> </ul>	Prior to and during construction	OMPS and contractor
Risk of a lack of understanding and subsequent challenging by relevant regulatory departments and stakeholders of management approaches and aquatic offset strategy.	AE13	<ul style="list-style-type: none"> <li>• Consultation with relevant regulatory departments should be undertaken as soon as practicable to ensure management of the Project in relation to aquatic, subterranean and groundwater dependent ecology, aligns with expectations, including but not limited to the DPI Fisheries and the Natural Resources Access Regulator (NRAR).</li> <li>• Consult with the DPI Fisheries regarding the implementation of an aquatic offset package if feasible for the Project, in alignment with <i>NSW Biodiversity Offsets Policy for Major Projects Fact sheet: Aquatic biodiversity</i> (Department of Primary Industries 2014).</li> </ul>	Prior to and during construction	OMPS and contractor
<b>Native fish exposure to between reservoir pump and turbine infrastructure.</b>	<b>AE14</b>	<ul style="list-style-type: none"> <li>• <b>To ensure there is minimal presence of native species captured in the reservoir before construction fingerboard creek should be destocked of fish and other aquatic species and then the lower channel is to be cut off from the upper channel and related disturbance.</b></li> <li>• <b>Effort should focus on destocking and relocation of native species in regions of refuge and should be carried out in period of low and or no flow.</b></li> <li>• <b>Any exotic species are to be disposed of in accordance with relevant biosecurity measures.</b></li> </ul>	<b>Operation</b>	<b>OMPS</b>

Impact/risk	ID#	Measure(s)	Timing	Responsibility
Overall impacts to aquatic ecology.	AE15	<p>An aquatic ecology monitoring and management plan will be prepared and implemented. The plan will confirm monitoring requirements and provide for an adaptive management framework by the project before construction commences.</p> <p>This will include but not be limited to:</p> <ul style="list-style-type: none"> <li>• Survey effort.</li> <li>• Locations of survey sites.</li> <li>• Screen maintenance investigation.</li> <li>• Trigger actions and corrective actions.</li> </ul>	Pre-construction Construction Operation	OMPS and contractor

## 6.2 Offsetting requirements

The Project has direct impacts on Fingerboard Crossing Creek and the Macleay River. Direct and indirect loss of Key Fish Habitat has been considered and is predicted to occur:

- As a result of the footprint of the lower reservoir within Fingerboard Crossing Creek.
- The footprint of the water intake within the Macleay River.
- Isolation and reduction of aquatic habitat upstream of the lower reservoir and particularly downstream of the upper reservoir due to the resultant loss of flow (indirect impacts).

Quantification of impacts that may require offset has been calculated for the Amended Project and presented in Table 6.2 below. They have been calculated based on the following criteria:

- Direct Loss of stream, through the removal of a watercourse (Table 6.2).
- Although not directly lost the function of the watercourse is significantly altered (603.61 linear m).
- Excludes watercourse crossings, as it is assumed the crossing design can meet the preferred crossing structure.
- Impact area is based on an estimate of the channel width (Table 6.2).
- Only watercourses of a Strahler stream order >2 are included, based on policy guidance (Fisheries NSW *Policy and Guidelines for Fish Habitat Conservation and Management* (2013 update)).
- Footprint excludes – diversions, avoidance and assuming where the disturbance footprint falls is a loss of habitat.
- Impact calculation included temporary bridge structures for the MacLeay River.
- All area calculations are estimations and are subject to change.

**Table 6.2 Estimate aquatic impact calculations for offset strategy**

Stream feature	Linear meters of impacted waterways categorised by Strahler Stream order number				Corresponding survey sites
	1	2	3	9	
1 (Fingerboard Creek)	1306.15	1470.73	1869.61	0	UW02-04, Uw02-03, UW02-01, OM03
2	111.37	0	0	0	
3	525.89	930.01	0	0	UW03-01
4	369.13	0	0	0	
5	757.34	183.69	0	0	UW04-01
6	251.52	418.43	0	0	UW06-01, UW05-03
10	70.62	370.92	0	0	UW10-01
11	79.43	0	0	0	
13	240.05	174.16	0	0	
15	902.05	265.50	0	0	
16	132.06	0	131.11	0	
17	38.89	105.47	0	0	
18	27.87	0	0	0	
38	154.71	0	0	0	
40	112.59	0	0	0	
41	8.07	0	0	0	
Macleay River	0	0	0	30	Temporary bridge structures only
Total Linear length in meters	5088	3919	2007	30	
Policy requirement	Excluded in policy	Excluded in policy	included	included	
Estimate width	-	-	5 m	50 m	
Area conversion m <sup>2</sup>	-	-	10,003.6	1,500.00	

An Aquatic Biodiversity Offset Strategy is recommended for where habitat is lost and cannot be:

- Avoided in the design.
- Diverted to a naturally designed channel.

The Amended Project would result in direct impacts to key fish habitat where impacts cannot be avoided in the design. Offsetting can be either on-site or off-site. Opportunities exist for offsets on-site and these will be further investigated by the proponent as part of further discussion with DPI Fisheries on offsetting requirements. The strategy would include information on what type of habitat needs to be offset and where those offsets would be.

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# Annexure A

Impact to Riparian buffers

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## A.1 Riparian impact calculations

**Table A.1 Summarised riparian impact calculations**

Stream and Project feature	Stream order 1	Stream order 2	Stream order 3	Stream order 9	Totals in ha
<b>1</b>	<b>Subtotal</b>	<b>3.173993</b>	<b>6.568408</b>	<b>7.083088</b>	<b>16.825489</b>
		1.000492	2.846417		3.846909
Lower dam	1.092901	2.375267	6.824326		10.292494
Lower dam shaft access road		0.177065			0.177065
Main access road and Upper Reservoir access road	0.544391	1.081571	0.258762		1.884724
Transmission tower access and pads	0.536209	0.088088			0.624297
<b>2</b>	<b>Subtotal</b>	<b>0.182068</b>			<b>0.182068</b>
Batching plant/lower site office/mechanical workshop	0.182068				0.182068
<b>3</b>	<b>Subtotal</b>	<b>1.181903</b>	<b>3.334011</b>		<b>4.515914</b>
Accommodation camp	0				0
Batching plant/lower site office/mechanical workshop		0.672359			0.672359
Lower reservoir site office access road		0.096217			0.096217
Lower spoil replacement area	0.96844	2.565435			3.533875
Main access road and Upper Reservoir access road	0.114579				0.114579
Transmission tower access and pads	0.098884				0.098884
<b>4</b>	<b>Subtotal</b>	<b>0.767847</b>			<b>0.767847</b>
Batching plant/lower site office/mechanical workshop	0.758897				0.758897
Main access road and Upper Reservoir access road	0.00895				0.00895
<b>5</b>	<b>Subtotal</b>	<b>1.66469</b>	<b>0.74494</b>		<b>2.40963</b>
Accommodation camp			0		0
Batching plant/lower site office/mechanical workshop	0.679002	0.729627			1.408629
Main access road and Upper Reservoir access road	0.31569	0.015313			0.331003
Stockpile	0.182518				0.182518
Transmission tower access and pads	0.48748				0.48748

Stream and Project feature	Stream order 1	Stream order 2	Stream order 3	Stream order 9	Totals in ha
<b>6</b>	<b>Subtotal</b>	<b>1.081875</b>	<b>1.602946</b>		<b>2.684821</b>
		0.206842			0.206842
Batching plant/lower site office/mechanical workshop			0.695615		0.695615
Batching plant access road			0.038917		0.038917
Main access road and Upper Reservoir access road	0.596785	0.293631			0.890416
Stockpile	0.244892	0.574783			0.819675
Transmission tower access and pads	0.033356				0.033356
<b>7</b>	<b>Subtotal</b>		<b>0.115915</b>		<b>0.115915</b>
Main access road and Upper Reservoir access road			0.115915		0.115915
<b>8</b>	<b>Subtotal</b>	<b>0.260172</b>	<b>0.000061</b>	<b>0.191199</b>	<b>0.451432</b>
Main access road and Upper Reservoir access road				0.191199	0.191199
Transmission tower access and pads	0.260172	0.000061			0.260233
<b>9</b>	<b>Subtotal</b>		<b>0.246762</b>		<b>0.246762</b>
Main access road and Upper Reservoir access road			0.246762		0.246762
<b>10</b>	<b>Subtotal</b>	<b>0.142266</b>	<b>1.374936</b>		<b>1.517202</b>
Accommodation camp	0.032947	1.267216			1.300163
Main access road and Upper Reservoir access road	0.05073	0.10772			0.15845
Transmission tower access and pads	0.058589				0.058589
<b>11</b>	<b>Subtotal</b>	<b>0.22306</b>			<b>0.22306</b>
Accommodation camp	0.09347				0.09347
Easter access road	0.084673				0.084673
Main access road and Upper Reservoir access road	0.044917				0.044917
<b>12</b>	<b>Subtotal</b>	<b>0.141212</b>			<b>0.141212</b>
Easter access road	0.141212				0.141212
<b>13</b>	<b>Subtotal</b>	<b>0.497442</b>	<b>0.520421</b>	<b>0.370617</b>	<b>1.38848</b>
<Null>	0.497442	0.520421			1.017863
Easter access road				0.306454	0.306454

Stream and Project feature	Stream order 1	Stream order 2	Stream order 3	Stream order 9	Totals in ha
Transmission tower access and pads			0.064163		0.064163
<b>15</b>	<b>Subtotal</b>	<b>1.834895</b>	<b>0.964402</b>	<b>0.152222</b>	<b>2.951519</b>
Easter access road	0.189322	0.14281	0.152222		0.484354
Potential laydown/stockpile area	0.695359	0.53087			1.226229
Transmission tower access and pads	0.950214	0.290722			1.240936
<b>16</b>	<b>Subtotal</b>	<b>0.319402</b>		<b>1.023418</b>	<b>1.34282</b>
Easter access road	0.055331		0.206785		0.262116
Potential laydown/stockpile area			0.031098		0.031098
Transmission tower access and pads	0.264071		0.785535		1.049606
<b>17</b>	<b>Subtotal</b>	<b>0.06262</b>	<b>0.551945</b>	<b>0.19087</b>	<b>0.805435</b>
Easter access road		0.141749	0.180609		0.322358
Transmission tower access and pads	0.06262	0.410196	0.010261		0.483077
<b>18</b>	<b>Subtotal</b>	<b>0.478062</b>	<b>0.218077</b>		<b>0.696139</b>
Easter access road	0.425125	0.218077			0.643202
Transmission tower access and pads	0.052937				0.052937
<b>19</b>	<b>Subtotal</b>	<b>0.072159</b>			<b>0.072159</b>
Western access temporary bridge	0.072159				0.072159
<b>20</b>	<b>Subtotal</b>	<b>0.235556</b>	<b>0.179847</b>		<b>0.415403</b>
Easter access road	0.182105	0.13683			0.318935
Western access temporary bridge	0.053451	0.043017			0.096468
<b>21</b>	<b>Subtotal</b>	<b>0.378911</b>			<b>0.378911</b>
Easter access road	0.378911				0.378911
<b>22</b>	<b>Subtotal</b>	<b>0.072543</b>			<b>0.072543</b>
Easter access road	0.072543				0.072543
<b>23</b>	<b>Subtotal</b>		<b>0.137931</b>		<b>0.137931</b>
Easter access road			0.137931		0.137931
<b>24</b>	<b>Subtotal</b>	<b>0.256893</b>			<b>0.256893</b>
Easter access road	0.256893				0.256893

Stream and Project feature	Stream order 1	Stream order 2	Stream order 3	Stream order 9	Totals in ha
<b>25</b>	<b>Subtotal</b>		<b>0.193167</b>		<b>0.193167</b>
Easter access road			0.193167		0.193167
<b>26</b>	<b>Subtotal</b>		<b>0.307066</b>		<b>0.307066</b>
Easter access road			0.307066		0.307066
<b>27</b>	<b>Subtotal</b>	<b>0.053991</b>	<b>0.150232</b>		<b>0.204223</b>
Easter access road	0.053991	0.150232			0.204223
<b>28</b>	<b>Subtotal</b>		<b>0.184496</b>		<b>0.184496</b>
Easter access road			0.184496		0.184496
<b>29</b>	<b>Subtotal</b>	<b>0.058617</b>			<b>0.058617</b>
Easter access road	0.058617				0.058617
<b>30</b>	<b>Subtotal</b>		<b>0.212103</b>		<b>0.212103</b>
Easter access road			0.212103		0.212103
<b>31</b>	<b>Subtotal</b>		<b>0.198466</b>	<b>0.222574</b>	<b>0.42104</b>
Easter access road		0.222574	0.198466		0.42104
<b>32</b>	<b>Subtotal</b>		<b>0.318859</b>		<b>0.318859</b>
Easter access road			0.318859		0.318859
<b>33</b>	<b>Subtotal</b>	<b>0.078518</b>	<b>0.430649</b>		<b>0.509167</b>
Easter access road	0.078518	0.430649			0.509167
<b>34</b>	<b>Subtotal</b>	<b>0.123916</b>			<b>0.123916</b>
Easter access road	0.123916				0.123916
<b>35</b>	<b>Subtotal</b>	<b>0.281453</b>	<b>0.246709</b>		<b>0.528162</b>
Easter access road	0.281453	0.246709			0.528162
<b>36</b>	<b>Subtotal</b>	<b>0.192758</b>			<b>0.192758</b>
Easter access road	0.192758				0.192758
<b>37</b>	<b>Subtotal</b>	<b>0.153209</b>	<b>0.844558</b>	<b>0.540245</b>	<b>1.538012</b>
Easter access road	0.153209	0.844558	0.540245		1.538012
<b>38</b>	<b>Subtotal</b>	<b>0.35678</b>			<b>0.35678</b>
Easter access road	0.094227				0.094227
Fly camp	0.262553				0.262553
<b>39</b>	<b>Subtotal</b>	<b>0.0148</b>			<b>0.0148</b>
Northern transmission tower access and pads	0.0148				0.0148
<b>40</b>	<b>Subtotal</b>	<b>0.219278</b>	<b>0.00966</b>		<b>0.228938</b>

Stream and Project feature	Stream order 1	Stream order 2	Stream order 3	Stream order 9	Totals in ha
Laydown area	0.108917				0.108917
Northern transmission tower access and pads	0.110361	0.00966			0.120021
<b>41</b>	<b>Subtotal</b>	<b>0.032585</b>			<b>0.032585</b>
Northern transmission tower access and pads	0.032585				0.032585
<b>Macleay</b>	<b>Subtotal</b>			<b>2.454014</b>	<b>2.454014</b>
Easter access road				0.836891	0.836891
Eastern temporary bridge				0.909483	0.909483
Lower dam				0.171727	0.171727
Western access temporary bridge				0.535913	0.535913
<b>Grand Total</b>	<b>14.593474</b>	<b>18.464984</b>	<b>10.965816</b>	<b>2.454014</b>	<b>46.478288</b>