

Aquatic habitat assessment

CLIENT: ROADS & MARITIME SERVICES

TABULAM BRIDGE AQUATIC HABITAT ASSESSMENT



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Cover photo: View of existing Tabulam Bridge from downstream.

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ASSESSMENT

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EXECUTIVE SUMMARY

NSW Roads and Maritime Service (RMS) are seeking to remove the existing Tabulam Bridge and construct a new bridge immediately downstream. GHD has been engaged by RMS to design the new bridge and will be preparing an environmental assessment for the project. GHD have contracted Hydrosphere Consulting to prepare an assessment of the potential aquatic impacts of the proposed works.

The proposed works includes the removal of the existing bridge – primarily of timber construction with four instream concrete piers - and the construction of a new bridge – a nine span 8 concrete pier (3 instream) construction. Both the construction of the new bridge and the removal of the existing bridge will require work to be undertaken within the river channel and there is a requirement to provide heavy load access (beyond the current bridge capacity) across the width of the river at this location.

Three options for providing temporary cross-river access and instream works platforms have been assessed in this report as follows:

- Option 1: Erection of a full channel width temporary construction bridge;
- Option 2: Construction of a central rock fill work platform/island, linked to either bank by temporary bridge connections; and
- Option 3: Use of work barges with associated docking/loading facilities.

It is envisaged that the program of works will take approximately 18 to 24 months to complete.

The works site is within a long, broad stretch of the Clarence River. The habitat is likely to vary in response to flood events, however the environment at the time of assessment is considered to accurately reflect the long-term habitat features of the reach. The site is relatively shallow, dominated by soft substrates and has very high macrophyte cover. Although some zonation was apparent, the study area has a high degree of habitat homogeneity. There were no particular habitat features within the areas to be directly affected that are unique to the reach.

There are no significant long-term impacts to the aquatic environment envisaged as a result of the new bridge or removal of the existing bridge. The main risks are related to the temporary instream access arrangements required during the works, where the three options above differ in the degree of risk posed to the aquatic environment. Option 1 (temporary bridge) is the preferred approach for a temporary works platform as the bridge has a minimal instream footprint and can be constructed with the least bankside disturbance. This significantly reduces the potential of aquatic and riparian vegetation destruction, has lower risks for sedimentation and turbidity, and is unlikely to result in any appreciable alteration of stream flows or aquatic fauna passage. The other options (rockfill work platform or barge-based construction) are less favourable but are still unlikely to create a significant impact.

Two aquatic species of conservation significance (Eastern Freshwater Cod - *Maccullochella ikei* and Purple Spotted Gudgeon - *Mogurnda adspersa*) could potentially occur at the site, but it is not regarded to be important habitat for either species. The assessment of impact significance under the Environmental Protection and Biodiversity Conservation Act 1999 for *M. ikei* and 7-part tests under the Fisheries Management Act 1994 for both *M. ikei* and *M. adspersa* indicate that there is unlikely to be a significant effect on these species due to the proposed works for any of the options if the recommended environmental management measures are properly implemented. Numerous other fish and other aquatic fauna are likely to be present on site, however the local viability of those species is similarly considered not to be at risk if the habitat impacts are minimised.

The piers of the new bridge will have similar (minimal) habitat value to the old bridge and the hydraulic effects of the new structure are likely to be similar – leading to minor scour and channel deepening between

and immediately downstream of some of the piers, but with no significant implications for habitat types or diversity within the reach. Riparian rehabilitation works may provide a long-term improvement in habitat quality due to increased bankside woody debris and shading. The long-term implications of the project for the aquatic environment are neutral to slightly positive.

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1. INTRODUCTION

1.1 Terms of Reference

NSW Roads and Maritime Service (RMS) are seeking to remove the existing Tabulam Bridge over the Clarence River and construct a new bridge immediately downstream. GHD has been engaged by RMS to design the new bridge and will be preparing an environmental assessment for the project. Hydrosphere Consulting was engaged by GHD to prepare an assessment of aquatic impacts of the proposed works.

1.2 General Site Description

The Bruxner Highway crosses the Clarence River at Tabulam, NSW via the Tabulam Bridge. The bridge is primarily a timber structure, supported by concrete piers located in the river with the approaches supported by timber trestles, that is approximately 300 metres long and a width of 4.6 m between kerbs (RMS, 2014).

The Clarence River is the largest eastern flowing river in NSW with a total catchment of over 20,000 km². The river has two major catchments; the Mann/Nymboida which has its headwaters to the south west of Grafton and the Clarence River itself which starts on the slopes of the Great Dividing Range and Border Ranges north of Bonalbo before flowing in a generally southerly direction through Tabulam, joined by the Mann River downstream of Cangai, through Copmanhurst and Grafton before it flows in a north easterly direction discharging into the Pacific Ocean at Yamba/Iluka.

The width (during non-flood conditions) of the Clarence River at the Tabulam Bridge crossing is approximately 100 metres; however this can fluctuate dramatically according to rainfall and river levels. The region experiences a subtropical climate, with warm humid summers and mild winters. There is a high degree of seasonal variation in rainfall demonstrating a clear wet/dry seasonal pattern, which is typical of a subtropical environment. The highest rainfall typically occurs during summer and in early autumn with lowest rainfall occurring in late winter and early spring. Subsequently, catchment flows are typically highest from December through until June and lowest from July to November. During the field survey (July 2014) the river level was low, with the Tabulam river level gauge (located beneath the existing bridge) reading 0.11 m (~112.4m AHD).

The pool over which the bridge crosses is a relatively long, straight pool approximately 2.2 km long and is aligned NNE-SSW upstream to downstream. At the upstream end of the pool is a riffle section followed by a glide/run section before entering the pool. Approximately half way down the pool is a large shallow sandy/gravel bar before a small tributary (Tabulam Rivulet) enters the pool from the east approximately 200 metres upstream from the existing bridge. The existing bridge is located approximately 300 m upstream from the bottom of the pool. At the bottom of the pool the main flow exits the pool to the west via a shallow riffle section with a large shallow backwater on the eastern side.

For the purposes of this report the 'study site' is defined as approximately 40 metres upstream to approximately 240 metres downstream of the existing Tabulam Bridge and the 'proposed works site' is approximately 20 metres upstream of the existing bridge to approximately 80 metres downstream as outlined in Figure 1.

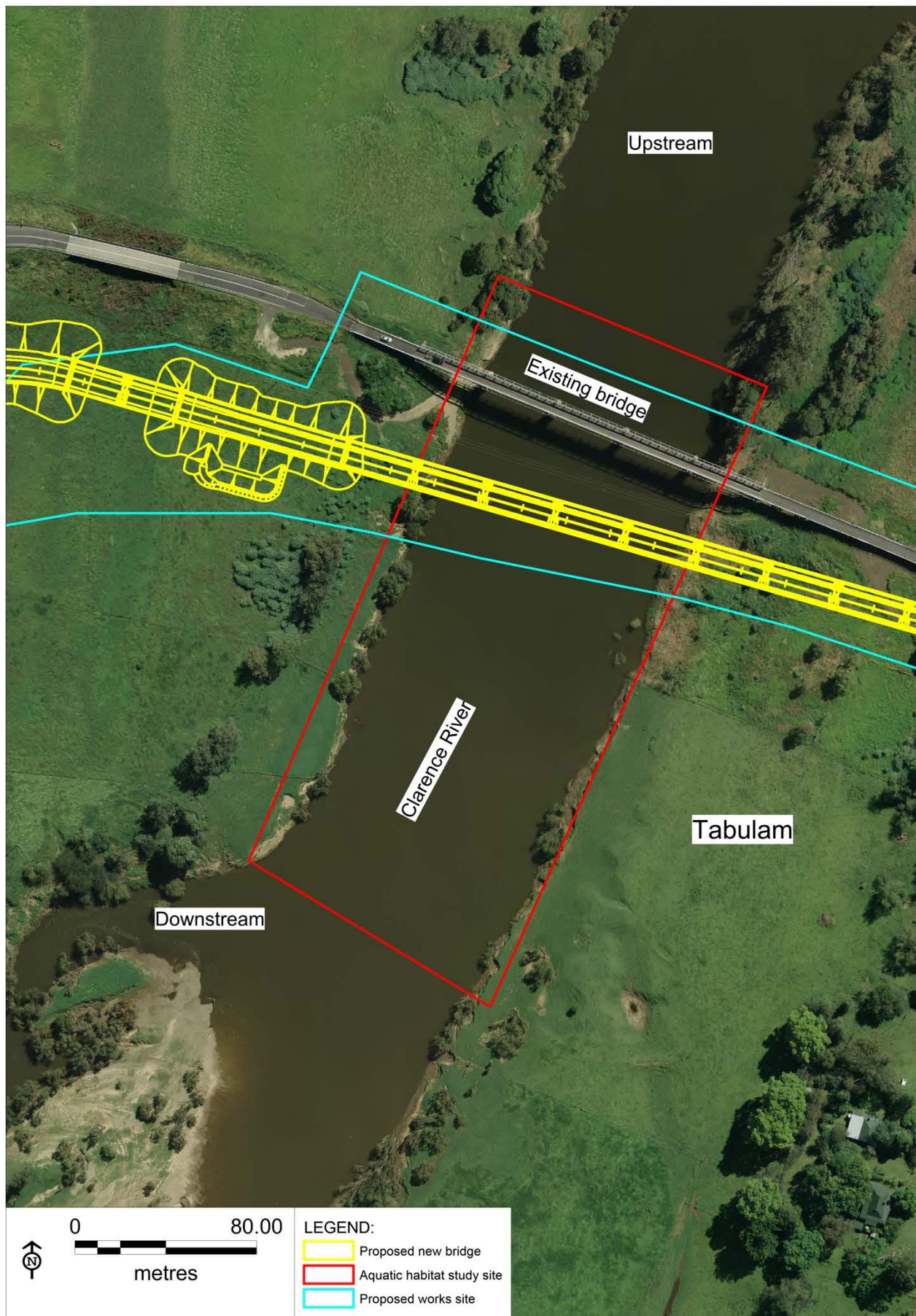


Figure 1: Study site and proposed works site

1.3 Proposed Works

Although the final construction/ removal methodology is yet to be determined and may be subject to change by the construction contractor of the day, the following description is considered indicative of the likely approach.

It is envisaged that the complete works, including construction of new bridge and removal of existing bridge, is likely to take 18 to 24 months.

1.3.1 New Bridge Design

The proposed new bridge is of a nine span eight pier design. Three piers are located instream (within the 'normal' river width), are all concrete in construction and will be 9 x 6 m wide at normal water level. Some rock scour protection will be placed around the base of the piers on the stream bed. The width of the bridge deck will be approximately 12 m and will be significantly above normal river levels (Figure 2).

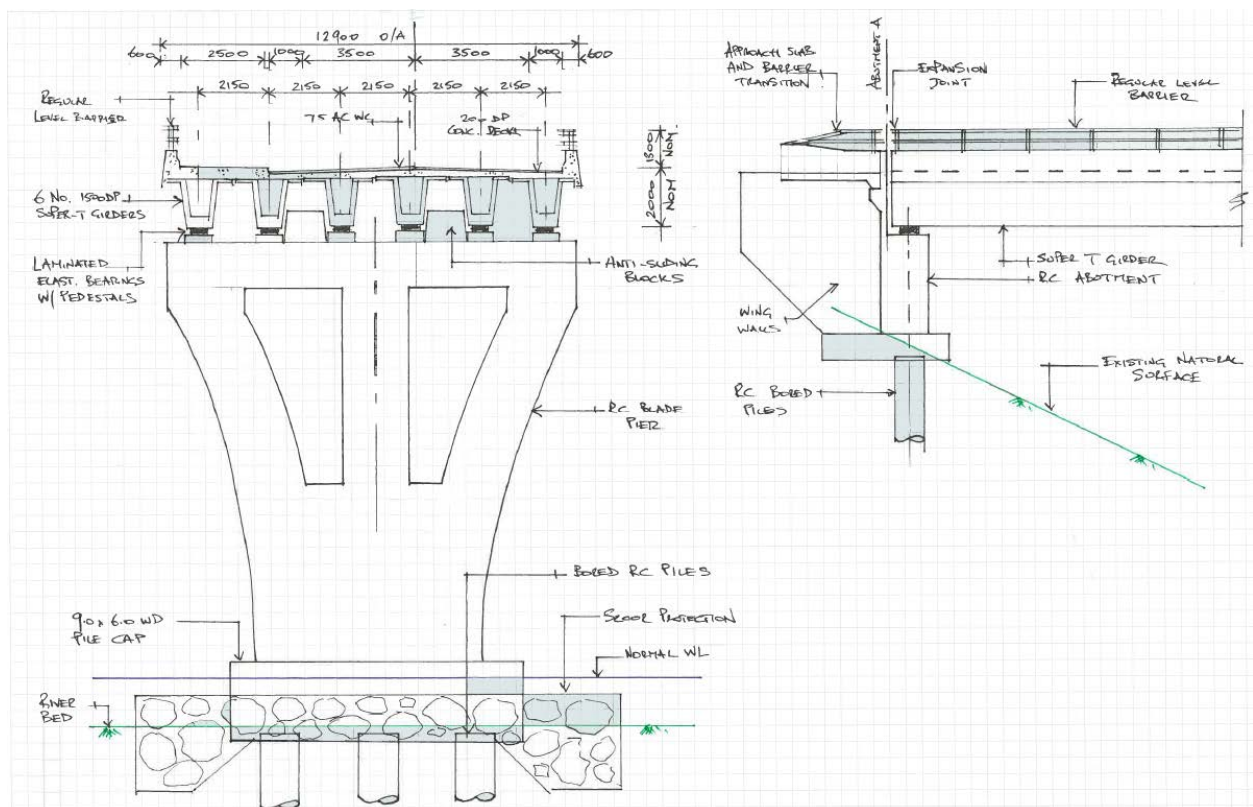


Figure 2: Design concept for new bridge (source: GHD)

1.3.2 Construction of new bridge

Temporary work access along the bridge alignment across the full river width would need to be established (see Section 1.3.4). There are three main construction activities described by Myers (2014):

- Bored piling works, consisting of driving of permanent steel casings into the river bed, which are subsequently excavated through drilling, reinforced and filled with concrete;
- Substructure construction, consisting of the casting of pile caps and subsequent forming and pouring of the concrete support columns; and
- Girder erection, where the 55-60 tonne girders are placed in sequence between the columns to form the main structure of the bridge.

Large construction elements will be lifted and manoeuvred using a combination of bankside and work platform cranes. The crane sizing is dependent on the access arrangements (see Section 1.3.4) and there will be numerous other items of heavy plant required to access the instream works site (see Myers 2014).

1.3.3 Removal of existing bridge

The existing bridge (Figure 3) will be dismantled piece by piece prior to removal off site to a yet to be determined location. An on-site area would be required to stockpile the timber as it is removed, including an area to dismantle the trusses into smaller, more manageable pieces to transport off site. The existing 11 kV over-head power lines on the downstream side of the bridge will limit the access to the existing bridge from either the upstream side or from on the bridge itself. The mass concrete piers in the river will be removed from top down by an excavator/rock-breaker that will work away at the pier slowly breaking it up into pieces for removal offsite. The piers will be removed to below water level approximately to the river bed. Similar to the construction of the new bridge, a suitable temporary work platform will be required to support the removal activities.



Figure 3: Existing bridge (view towards eastern bank)

1.3.4 Temporary Instream Work Platforms and Heavy Load Access

The existing Tabulam Bridge needs to be kept in service whilst the new bridge is constructed. This single lane bridge does not have sufficient capacity to handle heavy construction loads and therefore alternative cross-river access, suitable for heavy loads is required at the works location. In addition to providing load access across the river, the construction of the new bridge and eventual removal of the new bridge will require a stable platform on which to undertake instream works. Three broad options to meet these requirements are considered in this report:

- Option 1: Erection of a full channel width temporary construction bridge;
- Option 2: Construction of a central rock fill work platform/island, linked to either bank by temporary bridge connections; and
- Option 3: Use of work barges with associated docking/loading facilities.

A review of potential temporary construction access options for this project is provided in Myers (2014).

Option 1: Temporary Bridge

A temporary bridge would be erected from one side of the river to the other, parallel and downstream of the new bridge. A perpendicular extension of the same construction as the temporary bridge would need to be added at each new bridge pier location to facilitate pier access, piling works and subsequent pile cap and pier construction. The supports for the temporary bridge are typically 600 mm diameter steel casings which are progressively installed from the temporary bridge itself as it is extended from one bank to the other. The substructure of this bridge is likely to consist of prefabricated steel sections with precast concrete panels for the running surface. This running surface is likely to be around 2-3 m above normal river level, however this will be subject to hydrological studies and may be higher to provide greater flood immunity. The overall width of the temporary bridge is likely to be around 15 m. Some clearing of bankside vegetation and installation of rock protection may be necessary to enable construction of the temporary bridge abutments. Apart from the pylons themselves, there will be no low-flow obstruction of the river.

For removal of the old bridge a similar system would be employed, with a temporary bridge erected upstream and parallel to the old bridge. This will extend enough to access all the instream piers of the existing bridge but is not likely to need to extend the full width of the river.

Option 2: Rock platform and connecting bridges

This option consists of the formation of an instream rock fill platform/island in the middle of the river downstream and under the new bridge alignment. This platform is likely to consist of various grades of rock fill material which will be placed on the river bed and built up to a level of approximately 2 m above the normal water level of the river (subject to hydrological studies) and will be armoured sufficiently to provide full containment of this material. This work platform will be connected to each bank via temporary bridges of similar construction to Option 1. This configuration will provide an open channel along both banks which will provide bypass river flows and allow unobstructed fish passage. A minimum channel width of 10 m (at the low-flow water surface) for both the left and right banks has been established as project criteria to achieve these aims.

For removal of the old bridge a work platform will also be required. It is not envisaged that the full length of the river will need to be spanned at this time and therefore it is assumed that a single rock platform extending from the eastern bank, upstream and parallel to the old bridge will be constructed. This platform will not extend the full width of the river and therefore the river will remain unobstructed on the western bank providing for bypass flows and fish passage at that location. It is assumed that a minimum of 20% of the low-flow water surface will remain open at this location.

Given that the cross-sectional area of open river channel width will be reduced by this option, there is increased potential for bank erosion along the remaining open section. It is likely that river bank stabilisation (e.g. placement of rock protection, sheet piling, gabions or such like) will be required in order to limit bank erosion along the full length of constricted section. Any areas of open or unstable bank material within this section up to the water levels anticipated during the project, should be stabilised to prevent erosion at elevated water levels.

Option 3. Floating Barges

This method relies on large dumb barges to provide the necessary transport of materials across the waterway and to act as work platforms throughout the construction/ removal process. Access to, and loading of the barges would be via sizable load out wharves which would need to be constructed on both banks of the river (to provide full cross-river access). These wharves will need to protrude into the river channel to allow sufficient water depth for barge to approach the wharf and to minimise the crane extension required to place heavy loads in the centre of the barge. The load out wharves would need to be of substantial construction to allow operation of large cranes and are likely to be protected by steel sheet piling.

The barges themselves are likely to be manoeuvred by a combination of tender vessels and winch cables. As such, minimal disturbance of the river channel is envisaged although some temporary anchor points within the river channel may be required. Although the draught of the laden barges is unknown at this stage, it is assumed that sufficient water depth exists to allow operation without the need to dredge the river bed.

Demotion of the old bridge would also be conducted from barges and it is assumed that the same construction load out wharves would be utilised for this phase of work.

2. LEGISLATIVE CONTEXT FOR THE ASSESSMENT

The following legislation is

2.1 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) lists a number of threatened species, populations or ecological communities to be considered in deciding whether there is likely to be a significant impact on threatened biota, or their habitats, as the result of an activity. If a significant impact is deemed likely, an assessment of significance that addresses the requirements of section 5A of the EP&A Act must be completed to determine the significance of the impact.

The presence of and potential for threatened species, populations and ecological communities listed under the TSC Act in the study area was assessed as part of this study. Assessments of significance in accordance with section 5A of the EP&A Act completed for two species as detailed in Appendix 1. The assessments concluded there would be no significant impacts on threatened species, populations or communities, or their habitats, as a result of the proposal. Therefore a species impact statement, under the TSC Act, is not required.

2.2 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) aims to conserve, develop and share the fishery resources of the State for the benefit of present and future generations.

The FM Act requires a permit be sought for certain works including dredging or reclamation, and works that block fish passage or harm marine vegetation. Pursuant to section 199 of the FM Act, a public authority (other than a local government authority) must, before it carries out or authorises the carrying out of dredging or reclamation work, give the Minister written notice of the proposed work, and consider any matters concerning the proposed work that are raised by the Minister within 28 days after the giving of the notice (or such other period as is agreed between the Minister and the public authority).

Dredging is defined under the Act as any work that involves excavation of 'water land' (defined under the FM Act as land submerged by water either permanently or intermittently), or any work that involves the removal of material from water land. Reclamation refers to using any material (such as sand, soil, silt, gravel, concrete, oyster shells, tyres, timber or rocks) to fill in or reclaim water land, or depositing any such material on water land for the purpose of constructing anything over water land (such as a bridge), or draining water from water land for the purpose of its reclamation.

The proposal would involve dredging and reclamation during the construction of the crane pad and bridge support prop footings. Pursuant to Clause 199 of the FM Act, Roads and Maritime does not require a permit for dredging or reclamation. However notification of the Minister (via the Department of Primary Industries (DPI, Fisheries NSW)) is required.

The FM Act also lists a number of aquatic threatened species, populations or ecological communities to be considered in deciding whether there is likely to be a significant impact on threatened biota, or their habitats, as the result of an activity. If a significant impact is deemed likely, an assessment of significance that

addresses the requirements of section 5A of the EP&A Act must be completed to determine the significance of the impact.

This study assesses the presence of and potential for threatened species, populations and ecological communities listed under the FM Act in the study area. Assessments of significance in accordance with section 5A of the EP&A Act were completed for a number of species as detailed in Appendix 1. The assessments concluded there would be no significant impacts on threatened species, populations or communities, or their habitats, as a result of the proposal. Therefore a species impact statement, under the FM Act, is not required.

2.3 National Parks and Wildlife Act 1974

The National Parks and Wildlife Act 1974 (NPW Act) aims to conserve nature, objects, places or features (including biological diversity) of cultural value within the landscape. The NPW Act also aims to foster public appreciation, understanding and enjoyment of nature and cultural heritage, and provides for the preservation and management of national parks, historic sites and certain other areas identified under the Act. The NPW Act is administered by the NSW Office of Environment and Heritage (OEH).

All native fauna and some native flora are protected under the NPW Act. Potential impacts on native flora and fauna are discussed in Sections 4, 5 and 6.

2.4 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), a referral is required to the Australian Government for proposed 'actions that have the potential to significantly impact on matters of national environmental significance or the environment of Commonwealth land.'

The proposal site was assessed for the presence of and potential for threatened species, populations, ecological communities and migratory species listed under the EPBC Act as part of this study. Assessment of significance in accordance with the requirements of the EPBC Act found there would be no significant impacts on threatened species, populations or communities, or their habitats, as a result of the proposal.

A summary of the assessment of the proposal's impact on matters of national environmental significance is provided in Appendix 1. No significant impacts are anticipated and accordingly, there is no requirement based on the outcomes of this study to refer the project to the Commonwealth Department of the Environment.

3. ASSESSMENT METHODOLOGY

The assessment of aquatic flora and fauna impacts encompasses the construction and removal activities proposed for the project. The environmental risks and recommended mitigation measures are detailed for the project and identified separately for the three individual instream access options described above in Section 1.3.4.

3.1 Desktop Review

A desktop review of relevant information was undertaken to determine the aquatic fauna, flora and habitat likely to be present at the site and the potential impacts of the proposed works. Information reviewed included:

- Published and unpublished research and reports;
- Aerial photography; and
- NSW Department of Primary Industries Fisheries Threatened Species Records Viewer results.

Riparian vegetation was mapped using the most recent available aerial photography supplied by GHD.

3.2 Field Survey

A field survey of the proposed works site was conducted on 17th July 2014 by Mick Howland and Uriah Makings of Hydrosphere Consulting. The survey extended from approximately 40 m upstream of the existing bridge to approximately 240 m downstream of the proposed new bridge and consisted of:

- Aquatic habitat survey - A total of 49 samples sites were surveyed from a boat over 6 transects traversing the river within the works area. At each site the depth; vegetation species, cover and height; substrate type; and presence of woody debris were recorded. Water clarity was such that virtually all habitats across all depths at the site could be visually assessed visually from the surface, however, samples of vegetation (and sediment) were also obtained by grapple.
- Side-scan echo sounder survey - an echo sounder survey of the area immediately upstream and immediately downstream of the proposed works site was also carried out (Figure 4). The survey utilised both side- and down-imaging (Figure 5) to record submarine habitat features, indications of substrate type and water depth throughout the entire study area. The sonar was monitored during the survey to highlight areas of interest, with sonar files logged for later verification. This method ensured that all aquatic habitat types present at the site were identified and appropriately characterised during the field inspection;
- Depth data collected during the sonar survey were utilised to produce a bathymetric map of the study area (Figure 7) which further assisted in mapping of aquatic habitat features.
- Bankside woody debris (that was not recorded in the transect surveys) was located by GPS (with reference to aerial photography) and recorded. Dominant species and approximate location of riparian vegetation was also recorded.

Data collected from these methods were used to supplement the visual assessment in producing an overall understanding of the distribution of aquatic vegetation and other habitat features within the study area.

3.3 Aquatic Vegetation Mapping

As outlined above, six transects were surveyed for aquatic vegetation over an area of approximately 2.8 ha. Vegetation between these sites was inferred using comprehensive depth data, side-scan and down-scan imaging records and additional field observation notes. Data were imported into MapInfo to produce a detailed vegetation distribution map of the study site (Figure 7).

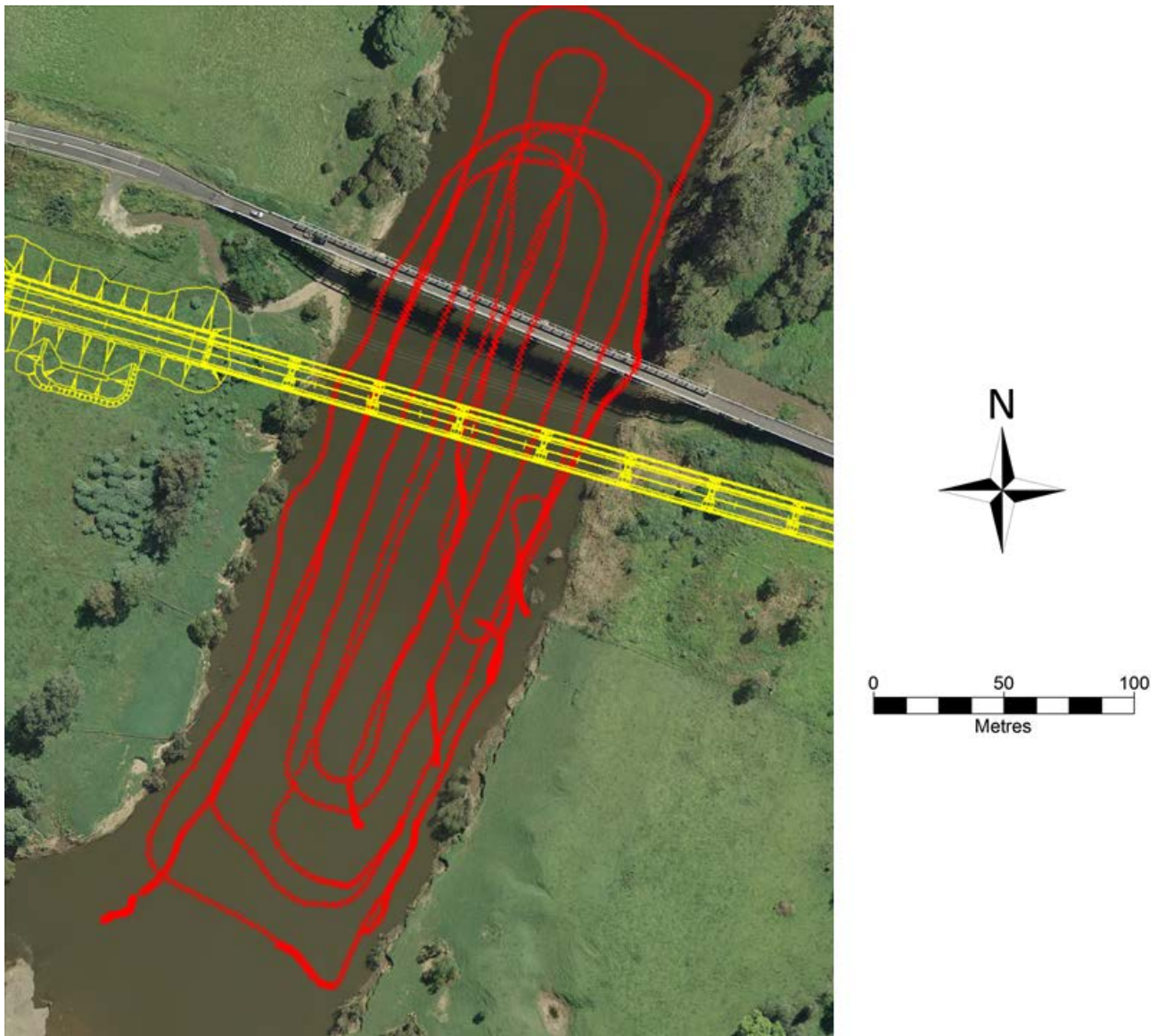


Figure 4: Area surveyed using side-scan sonar

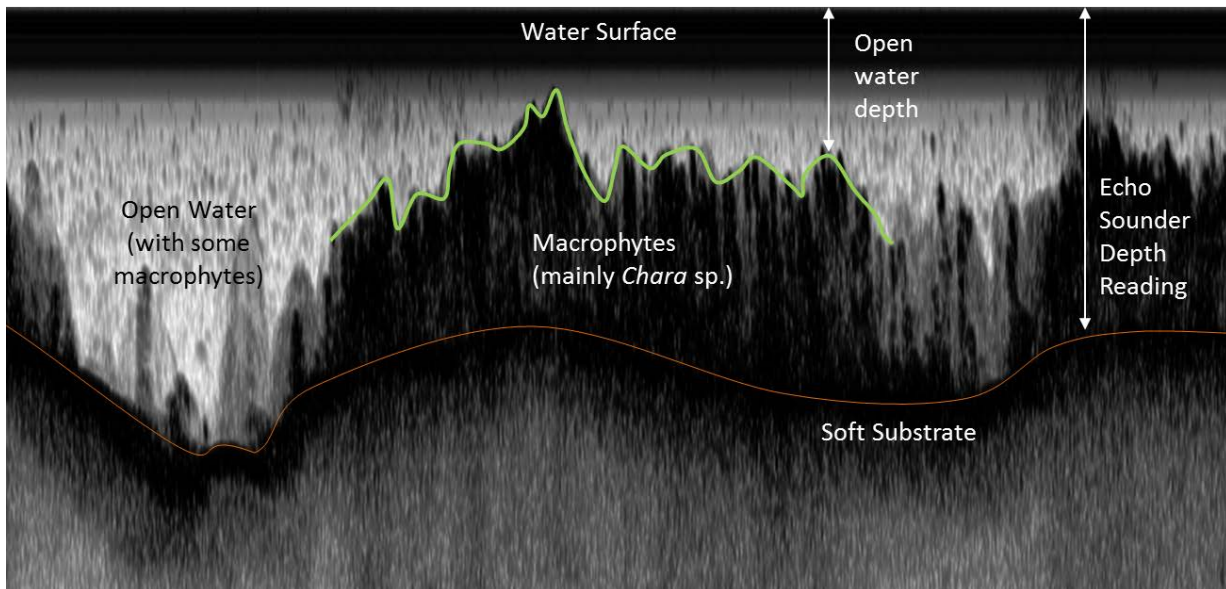


Figure 5: Example of down-imaging output showing aquatic vegetation, substrate type and depth

4. AQUATIC HABITAT

Freshwater streams and rivers provide a diverse range of habitats that support a range of aquatic ecosystems. These ecosystems evolve around and are sustained by the instream and riparian habitat features of the waterway as well as water quality.

Waterways and their associated ecosystems are dynamic and linear in nature. The 'river continuum concept' acknowledges the fact that habitats, water quality and also other features such as fish passage barriers in one part of waterway, are likely to influence aquatic ecosystems in areas downstream and potentially upstream of a particular impact site. As such, it is important when considering and assessing the effects of an activity on aquatic habitat, that consideration is given to the habitats upstream and downstream of the proposed activity as well as the hydrological connection between sites.

4.1 Substrate and Depth

The substrate of the river bed throughout the study site was generally a soft sediment substrate. The nature of the substrate varied from a fine silt mud through coarse sandy mud to areas towards the bar/riffle section at the downstream end of the pool where it was cobble and pebble sized rocks interspersed by coarse sandy sediment. The aquatic vegetation growth proliferated over the mud/sandy mud substrate which in turn would encourage further settlement of fines. Of note, was the absence of large boulder/bedrock substrates, which is a preferred habitat of *M. ikei*.

In general the depth of the study area was relatively shallow with majority of the study area < 2.5 m in depth (Figure 6). The downstream end of the study area, towards the bottom of the pool, was generally the shallowest being mostly < 2 m. There were a number of deeper areas, ~ 3.5 m, downstream of the existing bridge, likely to be partially due to increased scour from flow constriction between the existing bridge piers.

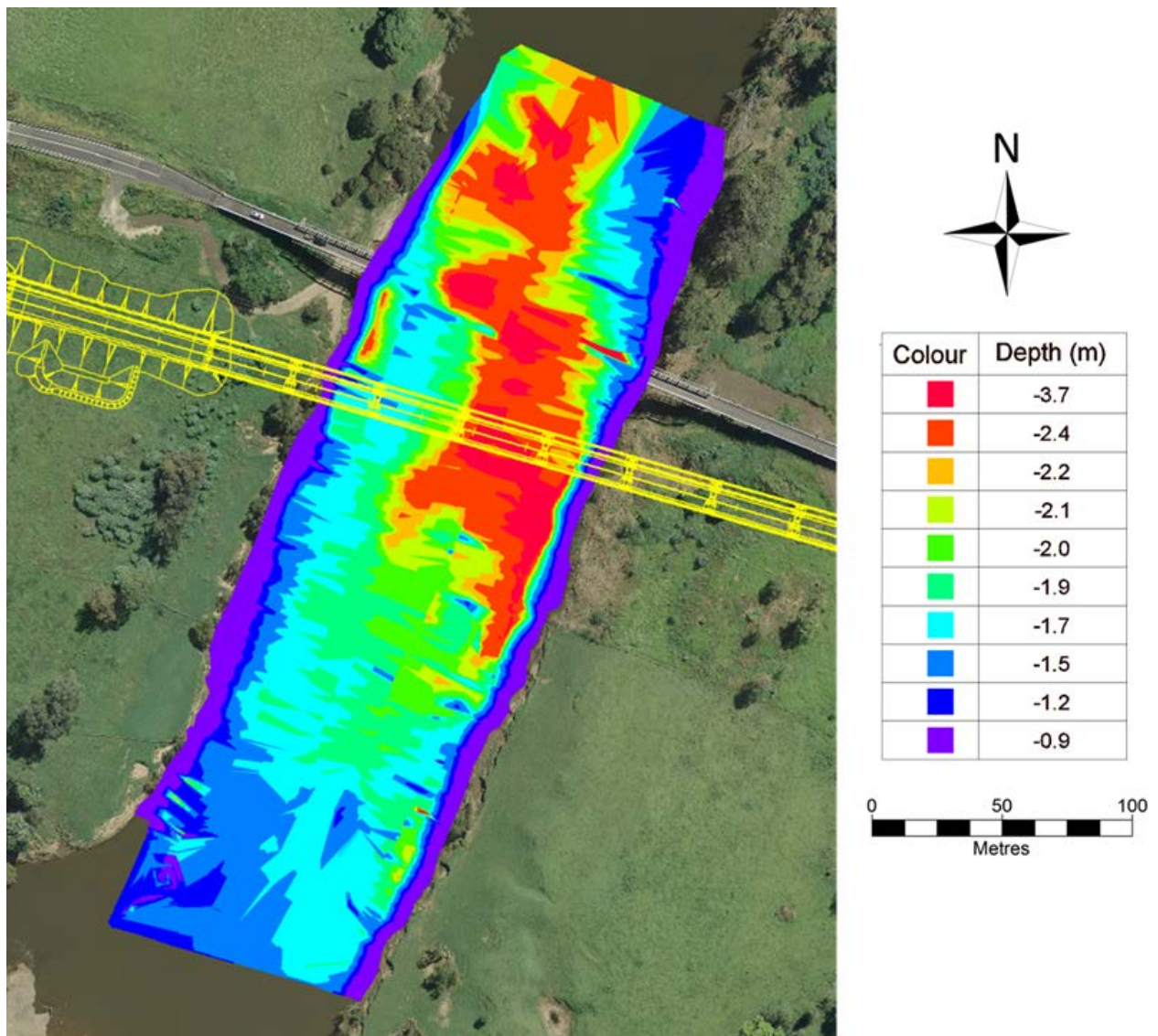


Figure 6: Study area bathymetry at the time of field survey (depths relative to gauge 204002)

4.2 Aquatic Vegetation

Field survey results revealed significant areas of aquatic vegetation occurring within the study area (Figure 7). The vegetation consisted of charophytes and six species of macrophytes (Table 1). The most dominant vegetation present throughout the area were charophytes *Chara spp./Nitella spp.* (Figure 7). Coverage of charophytes at survey sites ranged from 5 – 100% and heights within the water column ranged from approximately 0.3 m to 3.2 m above the river bed. Significant areas of charophytes were also intermixed with *Hydrilla verticillata* or *Najas tenuifolia* (Figure 7).

Aquatic vegetation along the fringing shoreline (particularly the eastern bank) was dominated by the floating emergent *Ludwigia peploides spp. montevidensis* which was generally underlain by *Chara spp./Nitella spp.* Intermixed with the *Ludwigia peploides spp.* along the shoreline was the sparsely distributed waterlily *Nymphaeoides spp.* There were some smaller areas where *Vallisneria nana*, *Potamogeton crispus* (towards southern end of pool), *H. verticillata* and/or *N. tenuifolia* were also present underneath the *L. peploides montevidensis*. Although not mapped, the shallow downstream end of the pool contained meadows of *V. nana* and *P. crispus*. None of the vegetation species recorded were listed as threatened species, endangered ecological communities, critical habitat or identified as noxious weeds.



Figure 7: Aquatic habitat features identified during field survey

Although a large area of aquatic vegetation was present during the field survey, this may change overtime due to the very dynamic environment. Vegetation species type, relative density, distribution and health at a given time is a product of the recent and prevailing environmental conditions and subsequently fluctuate according to conditions. Influencing conditions are typically governed by the seasons and dominant weather events (i.e. floods, droughts).

Table 1. Recorded aquatic vegetation.

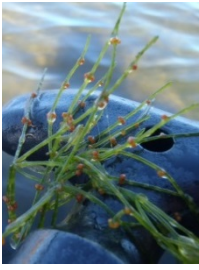
Photo	Common Name	Scientific Name	Type
	Ribbonweed	<i>Vallisneria nana</i>	Submerged macrophyte
	Waternymph	<i>Najas tenuifolia</i>	Submerged macrophyte
	Curly Pondweed	<i>Potamogeton crispus</i>	Submerged macrophyte
	Hydrilla (*see note)	<i>Hydrilla verticillata</i>	Submerged macrophyte
	Water Primrose	<i>Ludwigia peploides ssp. montevidensis</i>	Floating attached macrophyte
	Charophytes	<i>Chara spp./Nitella spp.</i>	Submerged charophyte

Photo	Common Name	Scientific Name	Type
	Waterlily	<i>Nymphoides sp.</i>	Floating attached macrophyte

* Note: GHD (2014) recorded *Egeria densa* at the site during terrestrial ecology surveys. This species was not recorded during the aquatic habitat surveys, however *Hydrilla verticillata* and *Egeria densa* possess similar botanical features and are separated by seasonal floristic features (which were not present at the time of field survey). Due to the potential for cross-identification of the species the presence of *Egeria densa* cannot be discounted, however both species provide similar structural habitat.

4.3 Large Woody Debris (LWD)

Only a limited amount of LWD was observed in the study area during the field survey. A total of seven areas of LWD (each area consisting of one or more individual snags) were observed either instream or on the bank immediately above the current water level (Figure 7). LWD at the site study ranged from small logs to large complex tree snags standing instream (Figure 8).



Figure 8: Instream large woody debris near eastern bank downstream of proposed new bridge.

LWD plays an important role in the healthy functioning and sustainability of many freshwater rivers and creeks. It performs significantly important ecological, riverine and river morphological functions within rivers including:

- Providing shelter and structure to aquatic organisms to hide from predators, ambush prey and refuge from strong flows;
- Providing structure for algae and aquatic macrophytes to colonise;
- Providing structure for fish spawning sites;
- Providing refuge, nesting and roosting sites for birds;
- A source of organic nutrients and food for detritivores;

- Stabilisation of river banks and channels; and
- Promotion of different geomorphological features such as scour holes, bars, islands and channels.

LWD is important habitat with many fish species (Table 2) living in around LWD structure including Australian Bass, gudgeons and in particular Eastern Freshwater Cod (see Section 5.1.2). Eastern Freshwater Cod exhibit a very close association with LWD using it as holding structure, feeding grounds and also use the hard surface of LWD to lay eggs. Purple Spotted Gudgeon (Section 5.1.3) also is known to utilise woody debris.

The small amount of LWD within the pool is likely to be a significant aquatic fauna habitat feature of the study site. LWD in the study is likely to provide important resident habitat for many fish species and given the relatively long and shallow nature of the pool and sparse hard cover, LWD is also likely to provide good refuge habitat for migrating species such as Australian Bass and Sea Mullet. Additionally, LWD in the study area may provide some refuge structure for fish and other aquatic fauna during flood flows.

Removal of LWD from NSW rivers and streams is listed as a key threatening process under the Fisheries Management Act 1994. A threat abatement plan for this threatening process has been prepared which identifies actions required to manage the removal of LWD so as to abate, ameliorate or eliminate its adverse effects on threatened biodiversity.

4.4 Riparian Vegetation

For the purposes of this report, riparian vegetation is defined as riparian vegetation (mainly trees) that provide aquatic fauna habitat characteristics such as: undercut banks/roots; instream structure (roots or branches) or; canopy shading of water.

Riparian vegetation at the study site was initially identified through aerial photography interpretation which was subsequently confirmed by field observations. There was a relatively modest area of riparian vegetation identified at the study site (Figure 7). The majority of the riparian trees (primarily *Callistemon sp.*) were present on the western bank downstream of the existing bridge and overlapping the likely footprint of the proposed bridge (Figure 9). There was also a significant area of bank vegetation on the eastern side upstream of the existing bridge.

Riparian vegetation provides important ecological and riverine functions similar to woody debris including:

- Habitat for terrestrial fauna;
- Habitat and refuge structure for aquatic fauna (riparian vegetation higher up the bank- not providing aquatic habitat value during low flows- can become important refuge habitat for aquatic fauna during flood flows);
- Regulating microhabitats (e.g. shading regulates water temperatures particularly during warm seasons);
- Stabilising banks and;
- Promotion of different geomorphological features such as bars, islands and channels.

Riparian vegetation not only provides habitat for aquatic organisms such as shrimp and crayfish, riparian vegetation is an important habitat feature for many fish species. In particular, many smaller fish species such as gudgeons, take refuge in the shadows and bankside structure. Similarly, larger fish (particularly Australian Bass and Eastern Freshwater Cod) also utilise shade and bankside structure to ambush prey. Riparian vegetation also provides habitat structure for turtles (often use low branches to bask or catch prey) and platypus (which are known to utilise undercut banks, root systems, and thick riparian vegetation to disguise their den entrances).

Although riparian vegetation was relatively sparse within the study area, there are significant areas of similar habitat within close vicinity to the study site and throughout the wider Clarence River.



Figure 9: Riparian vegetation and bank structure on western bank of new bridge alignment

The riparian condition on the eastern bank (Figure 10) under the new bridge alignment was poor and offered little in terms of fish habitat apart from the dense sub-surface macrophyte growth.



Figure 10: Riparian condition of the eastern bank with alignment of new bridge (bank shadowing is from existing bridge).

4.5 Waterway Classification

The habitat type and waterway classification system used in this assessment is based on that described in '*Policy and guidelines for fish habitat conservation and management*, NSW DPI (2013)'. The waterway classification scheme (Appendix 2) factors in the functionality of a waterway as fish habitat. The habitat type classification describes the type of habitat relating to the sensitivity of the habitat.

The aquatic habitat present within the Clarence River at the proposed works site includes large areas of native aquatic vegetation and woody debris larger than 300 mm in diameter which is characteristic of a Type 1 habitat - 'highly sensitive key fish habitat'. The river at this location is a permanently flowing or flooded freshwater waterway and hosts potential habitat of threatened species (Eastern Freshwater Cod; Purple Spotted Gudgeon) which is characteristic of a 'Class 1- major key fish habitat' waterway under the NSW DPI waterway classification (NSW DPI, 2013a).

5. AQUATIC FAUNA

No aquatic fauna surveys were undertaken as part of this engagement, however, given the habitat present at and within the vicinity of the proposed works site and knowledge of aquatic communities in other parts of the Clarence River, a range of aquatic fauna species have been identified as having the potential to inhabit or utilise the instream habitat of the proposed works site. Table 2 provides a list of fish species, as well as crustaceans, turtles and platypus likely to occur in this location. The number and composition of species at the site at a given time is generally a factor of habitat present (this can change quite significantly particularly after a flood event) and season.

Table 2: Aquatic fauna species likely to be present within and/or in the vicinity of the proposed works site.**Fish**

Common Name	Species Name	Preferred habitat	Likelihood Within proposed works site	Likelihood Within vicinity
Australian Bass	<i>Macquaria novemaculeata</i>	Wd, Am, Ps, Rv	Likely	Likely
Australian Smelt	<i>Retropinna semoni</i>	G, R, Am	Possible	Possible
Duboulay's Rainbowfish	<i>Melanotaenia duboulayi</i>	Am, Rv, Wd, G, R, Ps, Pm	Likely	Likely
Dwarf Flatheaded Gudgeon	<i>Philypnodon macrostomas</i>	R, G, Ps	Likely	Likely
Eastern Freshwater Cod	<i>Maccullochella ikei</i>	Rb, Wd, G	Possible	Likely
Eel-tailed Catfish	<i>Tandanus tandanus</i>	Ps, Am, Pm	Likely	Likely
Empire Gudgeon	<i>Hypseleotris compressa</i>	Am, Ps, Pm, Rv	Possible	Possible
Flatheaded Gudgeon	<i>Philypnodon grandiceps</i>	G, Ps, Am, Rv	Likely	Likely
Firetail Gudgeon	<i>Hypseleotris galii</i>	G, Ps, Am, Rv	Likely	Likely
Freshwater Herring	<i>Potamalosa richmondia</i>	G, R, Ps, Am	Likely	Likely
Freshwater Mullet	<i>Myxus petardi</i>	Am, G, R, Ps	Likely	Likely
Goldfish*	<i>Carassius auratus</i>	Am, Ps, Pm	Possible	Possible
Mosquitofish*	<i>Gambusia holbrooki</i>	Am, Ps, Pm	Possible	Possible
Olive Perchlet	<i>Ambassis agassizii</i>	Am, Rv, Wd, Ps	Likely	Likely
Southern Blue-eye	<i>Pseudomugil signifer</i>	G, R	Likely	Likely
Purple Spotted Gudgeon	<i>Mogurnda adspersa</i>	Am, Rv, Wd	Unlikely	Unlikely
Sea Mullet	<i>Mugil cephalus</i>	Am, G, R, Ps	Likely	Likely
Striped Gudgeon	<i>Gobiomorphus australis</i>	Am, Wd, G, R, Rb, Rv	Likely	Likely
Western Carp Gudgeon		Am, G, R	Possible	Possible

Eels

Common Name	Species Name	Preferred habitat	Likelihood Within proposed works site	Likelihood Within vicinity
Short-finned Eel	<i>Anguilla australis</i>	Wd, Rb, Am, Pm, Ps, Rv	Likely	Likely

Crayfish

Common Name	Species Name	Preferred habitat	Likelihood Within proposed works site	Likelihood Within vicinity
Smooth Crayfish	<i>Cherax spp.</i>	Rv, Pm, Rb, Wd, Am	Likely	Likely

Shrimp

Common Name	Species Name	Preferred habitat	Likelihood Within proposed works site	Likelihood Within vicinity
Macrobrachium	<i>Macrobrachium spp.</i>	Am, Wd, G	Likely	Likely
Riffle Shrimp	<i>Australatya striolata</i>	R	Unlikely	Likely

Other

Common Name	Species Name	Preferred habitat	Likelihood Within proposed works site	Likelihood Within vicinity
Snake-necked turtle	<i>Chelodina longicollis</i>	Ps, Pm, Am	Likely	Likely
Platypus	<i>Ornithorhynchus anatinus</i>	Rv, Am, G	Likely	Likely

* Exotic invasive species

Glide (G), Riffle (R), Sandy Pool (Ps), Muddy Pool (Pm), Aquatic Macrophytes (Am), Woody Debris (Wd), Rock/Boulders (Rb), Riparian Vegetation (Rv)

Around 20 fish species are known to inhabit the Clarence River (presently or historically) that may potentially be present or utilise habitat within or within the vicinity of the proposed works site. Of these, two species have conservation significance; Eastern Freshwater Cod (*Maccullochella ikei*) - listed as an endangered species under the *Fisheries Management Act 1994* (FM Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and; Purple Spotted Gudgeon (*Mogurnda adspersa*) - listed as vulnerable under the FM Act (See Section 5.1 below). Additionally, Australian Bass and Eel-tailed Catfish are considered to be recreational important angling species. Locally, most of these species are likely to be present throughout much of the freshwater reaches of the Clarence River and its tributaries.

There is potential for six shrimp and crayfish species to be present at the site; none of which have conservation significance. Glass shrimp and *Macrobrachium spp.* generally inhabit stream fringes around structure such as aquatic macrophytes, woody debris and riparian vegetation whilst riffle shrimp are generally associated with shallow, pebbly riffle habitats. A number of crayfish (*Cherax spp.* and *Euastacus spp.*) may occur at the site, although none have been confirmed in the study area. Crayfish (particularly juveniles) and shrimp are an important food source for many fish species (including the Eastern Freshwater Cod and Purple Spotted Gudgeon), eels and birds.

Freshwater turtles are known to inhabit freshwater habitats characteristic of those encountered at the study site. The *Emydura macquarii* species of turtle has many subspecies distributed widely across Australia. Of these is *E. macquarii binjing* (Clarence River Turtle) is found exclusively throughout the Clarence River drainage. The Eastern Snake-necked (Long-necked) Turtle (*Chelodina longicollis*) is one of the most common and widely distributed turtles in Australia with its range covering the entirety of New South Wales and Victoria and extending into South Australia and Queensland. Due to the popularity of turtles as pets (and escape or release to the environment) combined with their propensity to move overland, there is a possibility of other turtle species outside their natural range being present at the proposed works site. Freshwater turtles are not listed under the TSC Act or EPBC Act however are protected under the NPW Act.

Although no platypus (*Ornithorhynchus anatinus*) were sited during field survey (no surveys for this species were undertaken), given their known distribution and the habitat present in the pool at the site it would be reasonable to expect the presence of platypus within the pool. Platypus are not listed under the TSC Act or EPBC Act however are protected under the NPW Act. Platypus are very secretive and inconspicuous animals, spending most daylight hours resting in dens dug into the sides of riverbanks covered by riparian vegetation. They generally feed nocturnally and around dawn and dusk and can often feed along several hundred metres of a waterway during a single session.

5.1 Significant Species

5.1.1 Assessments of Significance

The proposed works will damage habitats that are potentially utilised by both *M. ikei* and *M. adspersa*. As such an assessment of impact significance for *M. ikei* is requirement under the EPBC Act 1999 and for both

species under the FM Act 1994. These assessments are included in Appendix 1. Although, *M. adspersa*, in particular, is regarded as unlikely to occur at the site, the assessments for both species have been undertaken applying the precautionary principle and assume that they may be present. Results from the assessments of significance indicate that if identified mitigation measures are carefully planned and executed the proposed works are unlikely to have a significant impact on *M. ikei* or *M. adspersa*.

5.1.2 Eastern Freshwater Cod (*Maccullochella ikei*)

A search of the NSW Fisheries Threatened and Protected Species Record Viewer was undertaken for the upper Clarence River. Results revealed two records of Eastern Freshwater Cod (*Maccullochella ikei*) - listed as an endangered species under the Fisheries Management Act 1994 (NSW) and Environment Protection Biodiversity Conservation Act 1999 (Commonwealth) - within the mid to upper Clarence River. One record is approximately 10km downstream and the other a considerable distance upstream of the proposed works site (Figure 12).



Figure 11: Eastern Freshwater Cod (*Maccullochella ikei*). Source: NSW DPI (2012)

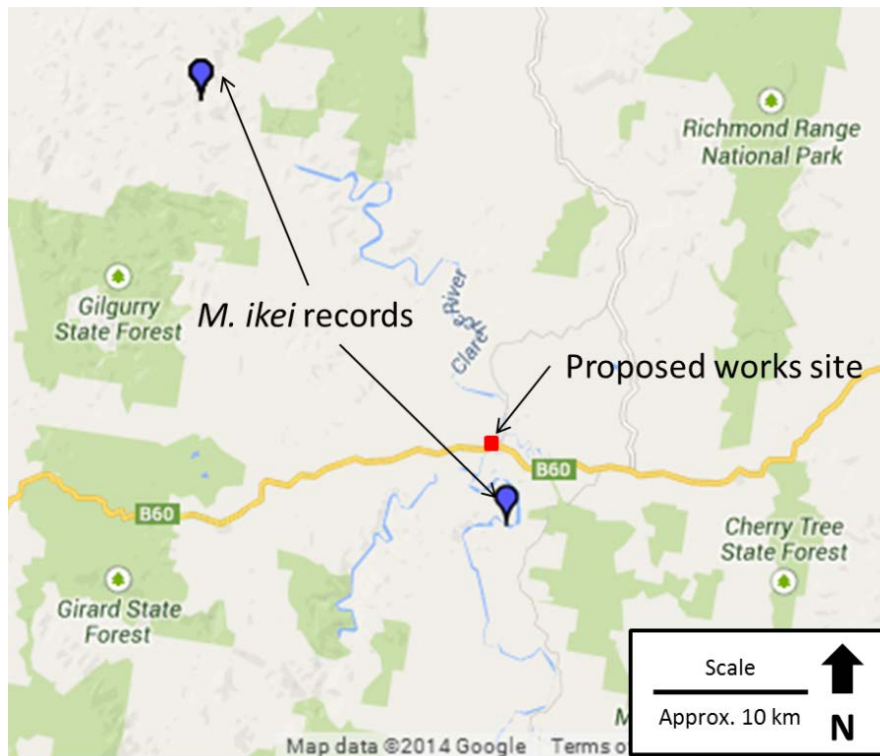


Figure 12: Results from NSW Fisheries Threatened Species Records Viewer

M. ikei are found in clear, flowing freshwater streams with a rocky substrate. They generally reside in deep slow flowing pools with good instream structure with a distinct preference for woody debris and large boulders. They are opportunistic carnivorous feeders preying on a range of animals including, fish, shrimp, crayfish, frogs and even terrestrial animals such as birds and small reptiles. They generally feed during low light periods moving out of their holding structure into other areas to hunt and forage.

M. ikei are relatively sedentary species with generally exhibit high home-site fidelity (Butler, 2009). Most inter-pool movements (which have been recorded up to 20 km) of this species are generally associated with an increase in stream discharge and more likely to occur in winter and spring than summer (Butler, 2009). These inter-pool movements are most likely associated with spawning movements with male fish generally relocating to suitable sites for the breeding season (generally spring) before often returning to their home site post spawn.

Nesting sites are most often located under large boulders and bedrock shelves in pool-run habitats (Butler, 2009). Large (~ 3 mm) adhesive eggs are laid on the suitable surface before the female leaves and the care of the nest is undertaken exclusively by the male. The male guards the nest until the eggs have hatched and larvae have left.

In accordance with the FM Act a *M. ikei* Threatened Species Recovery Plan (the plan) was prepared by NSW Fisheries in 2004. The main objective of the plan is to ensure the recovery and natural viability of *M. ikei* populations in their former range in the Clarence and Richmond River catchments. It considers the conservation requirements of the species across its known range and provides detailed recovery actions to be implemented.

The recovery plan identifies and discusses the current major threats to *M. ikei*, namely, habitat degradation, introduced fish and illegal fishing. Although introduced fish and illegal fishing are significant threats to *M. ikei*, habitat degradation is the threat most relevant and closely associated with construction activities. Habitat degradation of *M. ikei* includes the following:

- Sedimentation - Deposition of sediments causes infilling of deep pools and smothers aquatic vegetation and rocky substrates.
- Large woody debris removal - Large woody debris provides shelter for *M. ikei*.
- River flows - Larger fish species, such as *M. ikei*, are at the top of the aquatic food chain and are often the most vulnerable to changes in natural flow variability and habitat condition. These fish typically have greater or higher flow requirements to complete their life cycle.
- Fish passage barriers - Restrict critical life cycle movements such as movements to suitable spawning and feeding habitats. Barriers can also interrupt natural gene flow causing populations to fragment.
- Riparian vegetation - The state of riparian vegetation has a direct influence on river health through factors such as bank stability, soil conservation, water quality and the availability of food and shelter for many terrestrial and aquatic plants and animals.
- Water pollution - Water pollution can take many forms including changes to water temperature, turbidity, pH, biological oxygen demand (BOD), nutrients and heavy metals, and the introduction of toxic man-made or natural materials. Pollution can severely impact general aquatic health.

Key threatening processes listed under the FM Act 1994 relevant to *M. ikei* include:

- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams
- The introduction of fish to fresh waters within a river catchment outside their natural range

- Removal of large woody debris from New South Wales rivers and streams
- Degradation of native riparian vegetation along New South Wales water courses

5.1.3 Purple Spotted Gudgeon (*Mogurnda adspersa*)

Although not present on the NSW Fisheries Threatened and Protected Species Record Viewer and despite no recent recorded sightings, the Clarence River catchment is within the recognised historical distribution of *M. adspersa* (Figure 14). *M. adspersa* are listed as threatened under the FM Act. *M. adspersa* is a small, robust, benthic native freshwater fish of the Eleotridae family growing up to 12 cm but are more commonly around 6 cm. They are a euryphagous carnivore feeding on small crustaceans, small fish, insect larvae, worms, tadpoles and some plant matter.



Figure 13: Purple Spotted Gudgeon (*Mogurnda adspersa*). Source: Gunther Schmida (NSW DPI, 2013)

Two populations of *M. adspersa* historically occurred in NSW (Figure 14); an eastern population found in coastal catchments north of the Clarence River, and a western population found patchily distributed throughout Murray-Darling Basin drainages (Pusey *et al.*, 2004; Dixon 2006a; Llewellyn 2006). Although *M. adspersa* are reported as historically occurring possibly as far south as the Clarence River, there was no actual survey data to support this (Pusey *et al.*, 2004), rather, phylogeographical studies suggest that their potential for occurrence in the Clarence is explained by historic river re-arrangement and biogeography of the region (Faulks *et al.*, 2008). However, a more recent study, Brooks (2009), has revealed historic *M. adspersa* records within the Clarence River catchment including within Swan Creek (north-east of Grafton) and Orara River (south east of Grafton) although a fish survey during this study failed to record any at Swan Creek and did not visit Orara River site. A search of the Atlas of Living Australia (2013) revealed two records of *M. adspersa* within the Clarence River (Figure 15) from 1904 and 1997, although there is significant spatial uncertainty around these.

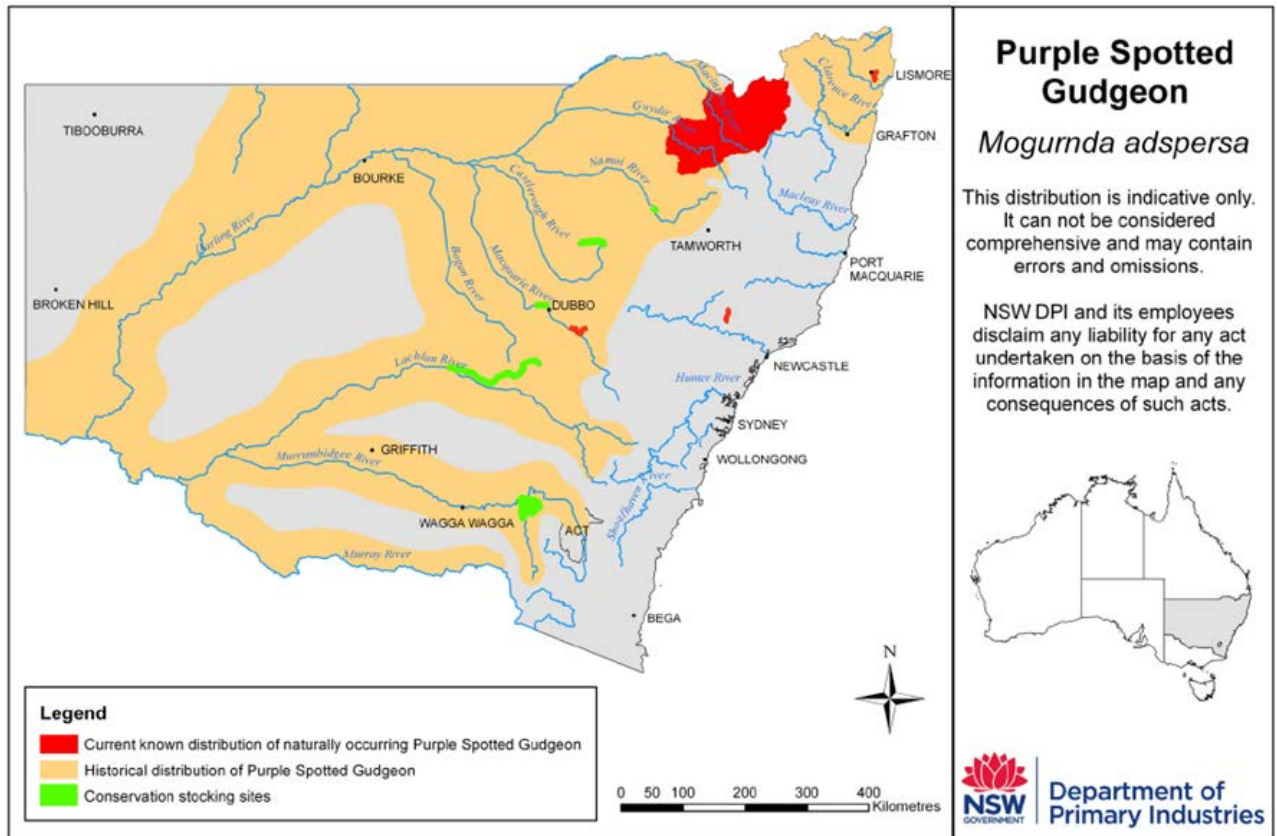


Figure 14: Map showing the distribution of Purple Spotted Gudgeon (*M. adspersa*) in NSW. (NSW DPI, 2013b)

Further, there have also been very few recent records of the species within the other eastern catchments with the only reported known current distribution in Tucki Tucki Creek (NSW DPI, 2013b) (Figure 14). There were unconfirmed records of the presence of *M. adspersa* in the Tweed and Brunswick River catchments by research students prior to 2006 (Dixon, 2006a). Within the Richmond River catchment there are reports of *M. adspersa* present in Sandy and Iron Pot Creeks and another unnamed water body south west of Lismore (Brooks, 2009) and the confirmed reports of a population in Tucki Tucki Creek (Figure 14) (Miles, 2013; NSW DPI, 2013b).

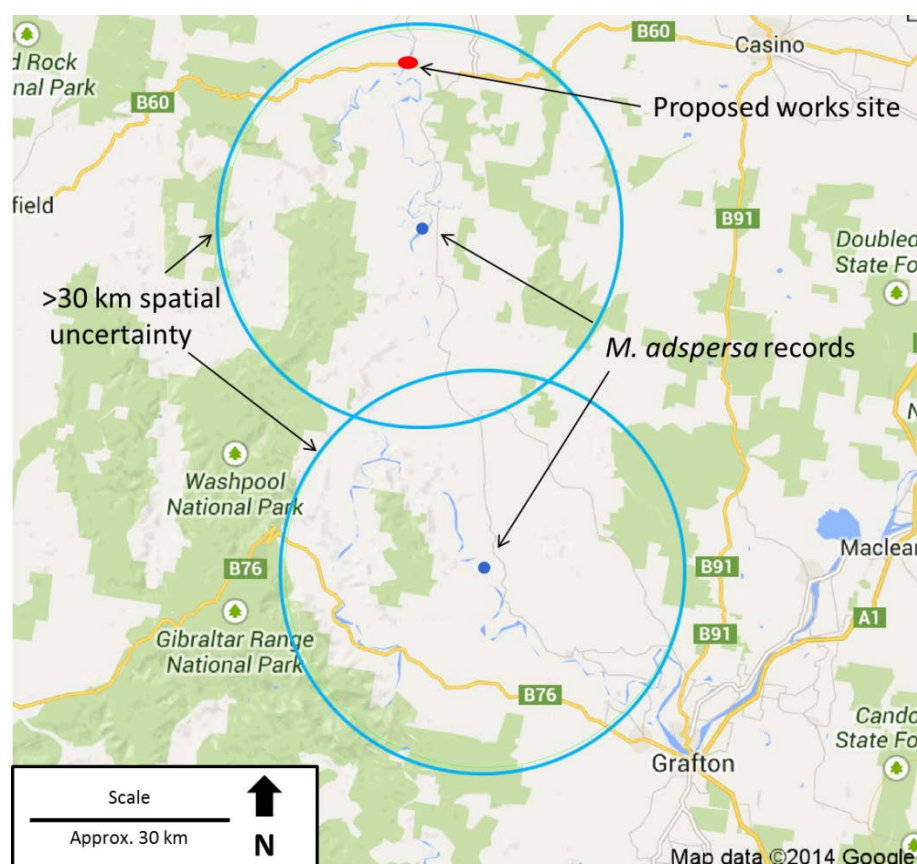


Figure 15: Atlas of Living Australia (2013) Clarence River *M. adspersa* records

M. adspersa are usually found in slow flowing sections of rivers, creeks and billabongs with good instream structure over a variety of substrates. They have a particular affinity for small, relatively shallow, small slow flowing pools with aquatic macrophytes and overhanging vegetation (Miles, 2013) being generally found in smaller tributaries rather than larger rivers. Interestingly they are often found in association with Duboulays Rainbowfish (*M. duboulayi*) (Miles, 2013).

The spawning season of *M. adspersa* in South East Queensland spans from spring to late summer, favouring temperatures over 18°C, although appears to be concentrated between November and February (Pusey *et al.*, 2004). There is no discerned migration associated with spawning although adults may seek suitable spawning habitat and juveniles may undergo a mass dispersal phase. Eggs are generally laid on rocks, woody debris, plant matter and other relatively hard substrates.

M. adspersa is susceptible to a range of threats including (NSW DPI, 2013b):

- Predation by introduced fish such as Eastern Gambusia (*Gambusia holbrooki*);
- Habitat degradation, particularly the loss of aquatic plants; and
- Fluctuations in water levels as a result of river regulation, resulting in deleterious effects on reproduction and recruitment.

Key threatening processes listed under the FM Act 1994 relevant to *M. adspersa* include:

- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams;
- The introduction of fish to fresh waters within a river catchment outside their natural range; and
- Degradation of native riparian vegetation along New South Wales water courses.

6. KEY IMPACTS AND MITIGATION MEASURES

Freshwater streams and rivers provide a diverse range of habitats that support a range of aquatic ecosystems. These ecosystems evolve around and are sustained by the instream and riparian habitat features of the waterway as well as water quality.

Waterways and their associated ecosystems are dynamic and linear in nature. The 'river continuum concept' acknowledges the fact that habitats, water quality and also other features such as fish passage barriers in one part of waterway, are likely to influence aquatic ecosystems in areas downstream and potentially upstream of a particular impact site. As such, it is important when considering and assessing the effects of an activity on aquatic habitat, that consideration is given to the habitats upstream and downstream of the proposed activity as well as the hydrological connection between sites.

6.1 Habitat removal/disturbance

6.1.1 Riparian Vegetation

Within the proposed works footprint there is only a relatively small amount of riparian vegetation present due to historical clearing, cattle access and the generally disturbed nature of the site. A relatively small area of riparian vegetation may need to be cleared for access and the construction of temporary instream work platforms, construction of the new bridge and removal of the existing bridge. This may result in a reduction of local aquatic habitat features including shading, bank structure and the potential to contribute to LWD.

Although, in any case, there is only likely to be a relatively small area of riparian vegetation cleared, the area of vegetation to be removed is likely to differ between the temporary platform options:

- Option 1 - Clearing is likely to be restricted to the temporary bridge abutments, directly beneath the bridge and access points. Some bank erosion controls may be required could result in further clearing.
- Option 2 – Although the temporary linking bridges are likely to be a similar construction to Option 1, the restricted channels at each bank will increase erosion potential and therefore scour protection is likely to be required. Clearing to facilitate bank protection works (e.g. rock armouring) along the channel length on each bank as well as for the bridge approaches is envisaged.
- Option 3 - Clearing of vegetation for the construction of the bank side work pads and loading wharves. Some localised bank protection works and associated vegetation removal may be required to reduce bank scour downstream of these structures. This will require a suite of standard environmental protection measures including erosion and sediment controls designed, installed and maintained in accordance the Blue Book requirements and RMS QA Specification G38.

Given the modest levels of riparian vegetation within the reach, any destruction is considered as potentially significant and therefore should be minimised. Rehabilitation of any areas cleared of riparian vegetation (or appropriate offsets in accordance with OEH requirements) is recommended (Section 6.1.4). Given these measures, which are easily implemented, temporary clearing of riparian vegetation is likely to result in only locally minor and short-term impacts. Such rehabilitation could potentially increase the habitat value of the area and therefore have a long-term, although relatively minor positive impact on riparian vegetation habitat within the reach.



Figure 16: Example of cattle access and poor vegetation cover in the study area.

6.1.2 Aquatic Vegetation

As shown in Section 4.1, at the time of the field survey (July 2014), the stream bed immediately upstream, within and downstream of the proposed works site is almost entirely covered by aquatic vegetation of varying species and is dominated by *Chara spp./ Nitella spp.* None of the species recorded are of conservation significance, however, all perform important ecosystem services in the river and provide potential habitat for numerous invertebrate and fish species including *M. ikei* and *M. adspersa*. *M. ikei* are known to utilise aquatic vegetation as habitat for foraging and feeding purposes, whilst *M. adspersa* are strongly associated with the presence of macrophytes.

The proposed works are likely to include several activities during both the construction of the new bridge and the removal of the existing bridge (See Section 1.3) with the potential to impact on aquatic vegetation including:

- Temporary instream works - construction of instream work platforms for both construction of new bridge and removal of existing bridge) over any areas of aquatic vegetation will likely result in the destruction of vegetation directly under the footprint of the work platforms:
 - o Option 1 - Stream bed disturbance will be restricted to width of pylons. Some shading of aquatic vegetation from temporary platform may occur, although only temporary and is considered to be insignificant. Channel scour (and resultant vegetation loss) is not expected to be significant.
 - o Option 2 – Burial under the rock platform will result in the complete destruction, although only temporary loss, of aquatic vegetation within the works footprint. The constricted bypass channels may promote scouring during flow events resulting in destruction of present vegetation and unfavourable growth conditions (deep water, coarser sediment) at scour areas. The fill used for the platforms also has the potential to introduce fine sediment, which if not fully contained could result in downstream turbidity and sedimentation (which can reduce sunlight and/or smother aquatic vegetation). Sediment accretion, potentially smothering vegetation, may occur on the downstream side of the structure.
 - o Option 3 - Construction of wharves projecting partway into the river channel will result in the complete destruction, although only temporary, of aquatic vegetation within each wharf footprint. Barges are likely to damage vegetation by shading, running a ground, the use of stream bed anchor points and damage from propellers (depending on the means of propulsion and/or the use of motorised tender boats).

- Construction of the new bridge - The instream piers and any associated form/foundation work will result in the destruction of any aquatic vegetation in their direct footprint. Shading by the bridge structure may reduce future aquatic vegetation growth within the immediate vicinity of the bridge although this impact is likely to be similar to the existing bridge and is not considered significant.
- Removal of old bridge - some disturbance around the piers during removal is expected (in addition to the work platform impacts), but is likely to be minimal. The shading due to the new bridge will be largely, but not totally, offset by the removal of the old (narrower) bridge.
- Site disturbance - any turbid water or sediment discharged from the works site has the potential to impact aquatic vegetation not only within the works site but large areas downstream.

The impact of the direct destruction of aquatic vegetation during the construction phase of the works is likely to be significant but temporary in the immediate area. Although having a localised effect, the short-term loss of this habitat is not considered to pose a significant threat to the aquatic ecosystem in this area and conditions are expected to resemble pre-construction conditions relatively quickly following completion of works.

The expected direct effects on aquatic vegetation within the proposed works are likely to have a negligible negative impact on *M. ikei* due to the close proximity to large areas of similar habitat. *M. adspersa* are known to be associated with areas of aquatic vegetation where it may be used for predatory cover, feeding and to some extent breeding. Again, due to the close proximity to large areas of similar suitable habitat the expected effect on aquatic vegetation within the proposed works is likely to have a negligible negative impact on *M. adspersa*.

A more widespread concern is the potential for increased sediment runoff from disturbed ground and turbid water discharges to downstream reaches of the river. Such issues have the potential to either completely bury aquatic vegetation or to blanket vegetation in fine silt or reduce light penetration through the water column such that photosynthesis is reduced. Under such conditions a significant reduction in aquatic vegetation cover, particularly in deeper or slower moving sections would be expected and the impact would be considered to be proportionally worse. Mitigation measures to address this risk are outlined in Section 6.1.4.

6.1.3 LWD and other hard habitat structures

During the field survey several clumps of large woody debris were present (Figure 7) throughout the proposed works site. As discussed in Section 4.3, LWD plays many important aquatic ecosystem roles including providing important habitat for threatened fish species including *M. ikei* and *M. adspersa*. The historical impact of removing LWD, both directly and through clearing riparian vegetation which is the main source of LWD has been recognised as a key threatening process under Schedule 6 of the FM Act 1994.

The main areas of LWD within the study area were located away from the new bridge alignment, with only minor branches on the right bank of the new alignment and a single tree branch wedged against the old bridge (2nd pier from the east). Side-scan sonar imaging did not locate any large fish in these areas. Although not conclusive, it is considered that large fish such as *M. ikei* are not utilising any of the LWD likely to be directly affected. Should LWD be present at the time of construction and need to be removed it is recommended that the mitigation measures identified in Section 6.1.4 are applied. If such measures are implemented the likely impact on LWD is expected to be negligible. There is not considered to be a significant difference in the impacts on LWD between the 3 temporary platform options.

The piers of the existing bridge are constructed of a mass concrete which provides minimal cover and subsequently minimal aquatic habitat value. The piers may indirectly play a role in creating habitat by trapping LWD and creating scour holes during floods. However, the new bridge piers are physically similar and expected to play a similar, habitat role to the existing piers. Consequently, the removal of the existing

piers is expected to have neutral or maybe temporary minor negative impact on hard structure habitat within the proposed works area.

6.1.4 Mitigation Measures

The following are general measures recommended to address issues associated with habitat disturbance due to the proposed works:

- Riparian vegetation disturbance/removal should be kept to a minimum and any riparian vegetation disturbance/removal as a result of the proposed works should be rehabilitated to pre-construction (or better) condition:
 - o Placement of matching soil types, contouring and stabilisation of banks subjected to earthworks;
 - o Targeted planting of riparian natives such as *Callistemon* and *Lomandra*; and
 - o Exclusion of cattle from regeneration areas.
- Instream work areas should be kept to a minimum;
- Instream work pads should be fully contained by sufficient means prior to their construction in order to minimise work platform footprint, reduce sediment loads and limit turbid runoff and;
- Disturbance of LWD should be avoided where possible. Any LWD likely to be disturbed should be relocated in accordance with DPI (Fisheries) requirements and sufficiently secured in close proximity to provide comparative habitat value.

6.2 Aquatic fauna disturbance

Construction works within or within the vicinity of waterways have the potential to disturb aquatic fauna. Disturbance may be through burial during excavation and filling (e.g. construction of the temporary work platforms), noise/vibration impacts or through direct contact or displacement/relocation. The proposal requires instream works at the new bridge and around the existing bridge and therefore some aquatic fauna in the direct footprint and immediate vicinity of the works will be disturbed.

The extent of disturbance may differ between the temporary platform options:

- Option 1 - The temporary bridge will have a relatively small instream works footprint and therefore is likely to cause only a minimal disturbance to aquatic fauna.
- Option 2 – The instream footprint of work pad and bank protection works is likely to cause considerable but localised disturbance and displacement of aquatic and benthic fauna.
- Option 3 - Construction of wharves and use of barges and tender boats will cause localised disturbance, with some displacement due to the footprint of the load out wharves and periodic disturbance due to the operation of the barges.

The temporary displacement of fish due to habitat disturbance is inevitable, however direct mortality of large numbers of fish or any significant change to fish abundance or community structure is unlikely. Some fish and crustaceans utilising bank undercuts in the direct footprint of the access roads/platforms may risk burial, but are more likely to flee due to noise, vibration and ground disturbance prior to this.

Noise and vibration may potentially present a disturbance to aquatic fauna, in particular, turtles and platypus. Although no platypus were sighted during site visits they may be present within the vicinity of the proposed works and use the site for feeding or as thoroughfare. Platypus are very secretive and inconspicuous animals feeding nocturnally and around dawn and dusk. They spend most daylight hours resting in dens dug into the sides of riverbanks. Construction noise and vibration may potentially disturb any platypus in the

vicinity of the proposed works. If any platypus dens are present within the footprint of the works they may risk burial or at least displacement from these dens during construction works. No targeted surveys for platypus were undertaken, however observation of the banks indicated that there was a low probability of burrows within the area to be impacted.

Similarly, turtles may utilise bank hollows and woody debris for resting and foraging. No banks considered suitable for egg laying are within the footprint of the works.

Fish, platypus and turtles are expected to return to the area post works and therefore, considering mitigation measures in Section 6.2.1, the any likely impact is expected to be minor and temporary.

6.2.1 Mitigation measures

The following measures are recommended issues associated with fauna disturbance:

- Banks within the direct footprint of any works should be inspected for platypus dens by qualified ecologist immediately prior to and during breaking ground along the banks.
- Fauna handling is to be conducted in accordance with the RTA Biodiversity Guidelines (Guide 9: Fauna handling; RTA, 2011).
- Minimise the river bank works footprint to reduce the potential for encountering platypus or turtles.
- Ensure that initial excavation and fill of the affected banks is gradual to allow resident fish and other fauna to move to safety.

6.3 Aquatic fauna barriers to passage

Many of the species of fish that occupy freshwater reaches are for at least a part of their lifecycle considered to be migratory or undertake broad scale (non-migratory) movements. Species such as Australian Bass, various species of mullet and eels are well known for their catadromous (fresh to salt water) migrations to spawn. Anadromous (salt to fresh) migrations are also suspected for a number of species however, most other freshwater species in the upper Clarence River spend their entire lifecycle in freshwater, some are relatively sedentary such as Eel-tailed Catfish and Eastern Freshwater Cod whilst others, such as Australian Smelt and several gudgeons, undertake migrations within freshwater reaches (potadromous). Regardless of the type or size of migrations, whether annual (spawning) or diurnal (foraging for example), all species display a propensity to move longitudinally between habitats at some stage in their life cycle.

Other aquatic fauna such as platypus and turtles also require movement from one type of habitat to another. Platypus can have large home ranges and have been known to move between creek catchments (Gardner & Serena, 1995). They can also feed along several hundred metres of waterway in a single session, therefore, requiring passage through a creek or stream. Turtles also readily move from one habitat to another during feeding. Neither platypus nor turtles were observed at the proposed works site, although their presence is likely at the proposed works site and therefore their passage through the site must be considered.

Different phases of the project may present different fauna passage barriers as follows:

- The new bridge structure is not considered to be a fauna passage barrier. The bridge piers will present minimal obstruction of the river channel. The bridge deck is sufficiently high to minimise impacts on fish passage during flooding and also only have minor shading effects, similar to the current bridge.
- Temporary work platforms:
 - o Option 1 – The temporary bridge will not pose a physical passage barrier. The structure may present some shading of the water and the pylons may create some turbulence however neither are expected to be a significant behavioural barrier to aquatic fauna movement.

- o Option 2 - The construction of a temporary instream rock platform may present a partial physical barrier. However, the provision of 10 m wide (at low flow level) open passage channels at each bank spanned by temporary bridges, is considered to be sufficient to allow suitable passage through the site. This measure will ensure that at least 20% of the river channel remains open to fish passage throughout the project. During periods of high flow, higher water velocity through the channels may present a hydraulic impediment to upstream migrations of some species but is unlikely to constitute a complete or long-term barrier.
- o Option 3 - The barge option is not expected to create a significant behavioural, physical or hydraulic barrier.

6.3.1 Mitigation Measures

The following measures are recommended to ensure that the project does not form a barrier to longitudinal fauna movement:

- The works should be undertaken such that at least 20% of stream width remains as natural open channel at any one time. Whilst this width may be higher than is required for hydraulic connectivity (i.e. to ensure that flow velocities are not limiting), this width is considered necessary to ensure that behavioural effects due to avoidance of noise/vibration/habitat edge effects are also minimised.

6.4 Altered stream flows

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a major factor contributing to loss of biological diversity and ecological function in aquatic ecosystems (Dixon, 2006b). Alteration to natural flow regimes can occur through reducing or increasing flows, altering seasonality of flows, changing the frequency, duration, magnitude, timing, predictability and variability of flow events, altering surface and subsurface water levels and changing the rate of rise or fall of water levels (Dixon, 2006b).

Stream flow alterations can negatively affect a range of ecosystems and species. Both *M. ikei* and *M. adspersa* are particularly susceptible to changes in stream flow. The proposed works must be carried out in way that does not significantly alter downstream flows.

The new bridge structure is not expected to alter stream flows. Similarly, none of the proposed temporary instream work platform options are expected to significantly alter stream flow, although, it should be noted that Option 2 is likely to alter hydraulic characteristics through the work site by concentrating discharge within the bankside channels. This will result in higher velocity flows in these locations which may promote scouring of the bank and stream bed at these locations if sufficient erosion control measures are not implemented. However, due to the temporary nature any such flow alteration is considered minimal and not expected to have a significant negative impact.

6.4.1 Mitigation Measures

In order to reduce the impact on stream flows it is recommended that:

- A minimum of 20% of the river channel (in accordance with the fauna passage criteria) remains unrestricted to ensure that river discharge through the site is unlikely to be significantly affected.

6.5 Water quality

6.5.1 Sedimentation

The majority of the stream bed substrate in the works area appeared to be a very muddy or sandy-mud substrate. Sediments of this nature, due to their fine diameter, are particularly susceptible to re-suspension when disturbed. Any instream works, therefore present the risk of re-mobilising any fine grained sediment

deposited on the stream bed. The re-suspension and remobilising of the sediments can potentially result in the release of highly turbid water downstream of the works site. Depending on the volume, downstream transport of turbid water has the potential to re-distribute nutrients, increase oxygen demand, smother instream habitats and change bathymetry of the stream bed. This has the potential to negatively impact local and downstream aquatic ecosystems.

Different stages of the works have the potential to pose sedimentation risks as outlined below:

- Temporary work platform
 - o Option 1 - Installation and removal of pylons will result in localised re-suspension of fine bed materials. Vibrations from machinery may cause ongoing disturbance of fine sediments around base of pylons. The volume of re-suspended material is likely to be minor.
 - o Option 2 - Installation and removal of pylons for the temporary bridges will result in localised re-suspension of fine bed materials. Placement of rock fill instream will cause significant disturbance of the river bed and has the potential to introduce fine sediments with the fill. The concentration of flow along each bank may exacerbate bed scour and bank erosion within and downstream of the channels, and consequently downstream sedimentation. The alteration of flow around the platform and through the channels and subsequent formation of 'eddies' or backwaters on the downstream side of the structure, which are depositional environments, may result in increased bed sedimentation in this area. Removal of the rock fill will also again disturb bed sediments and release any additional trapped sediment.
 - o Option 3 - Construction and removal of the loading wharves will result in re-suspension of fine bed materials around the footprint of the works. Dependent on the draft of the barge, depth of water, means of propulsion, any need for channel deepening and the use of motorised tender boats this option has the potential to cause relatively significant turbidity impacts although this will be highly dependent on these factors.
- Construction of new bridge and removal of existing bridge will cause disturbance and re-suspension of bed sediments in the immediate works areas. No significant ongoing sedimentation impact is envisaged as a result of the new bridge structure.

Additionally, tracking of machinery into the works site has the potential to expose bare soils which has the potential to exacerbate erosion and subsequently turbid runoff during rainfall events. The proposed works should be undertaken in a way to limit the release sediments or turbid water downstream.

6.5.2 Spills/Debris

The use of construction machinery has the inherent risk of potential fuel/hydraulic fluid spillage.

Other works such as concrete pouring, grit blasting or painting may also introduce the risk of contaminants due to the spillage of concrete, fine debris, chemical treatments or paint. The close proximity to a waterway exacerbates the potential impact of such risks. The risk is not expected to significantly differ between the three work platform options.

The removal of the existing bridge poses the additional risk of deposition of construction and/or bridge debris within the river. Appropriate mitigation measures must be implemented to minimise these risks.

6.5.3 Mitigation Measures

The following mitigation measures are recommended to protect water quality:

- Screening or netting around and/or under work areas to contain debris, litter and other materials;
- Use of grit blasting and painting enclosures;

- Minimising volumes of fuels, lubricants and other fluids within the instream work site and ensuring all fluids are stored within containment bunds and that hydrocarbon booms are utilised as required to minimise risk of spills to the waterway; and
- Ensuring that all work platforms, access roads and bank clearing areas associated with the project should be subject to strict spill, runoff and turbidity controls to reduce water quality risks to the downstream environment. This will require a suite of standard environmental protection measures including erosion and sediment controls designed, installed and maintained in accordance the Blue Book requirements and RMS QA Specification G38.

6.6 Aquatic weeds

Construction works within the vicinity of waterways bring the inherent risk of the introduction of aquatic weeds. The introduction of aquatic weeds may occur through the importation of seeds or plant material on construction machinery and/or imported materials.

6.6.1 Mitigation Measures

The following measures are recommended to reduce the risk of aquatic weed introduction:

- Ensure that imported fill materials (particularly from riverine sources) are weed free.
- Equipment brought to site should be inspected and if necessary washed before entering the site to ensure they are free of excess soil and material that may contain weed material or seeds.

7. SUMMARY OF IMPACTS AND MITIGATION MEASURES

The new bridge structure is not considered to have any significant long term environmental impacts, however, the construction of the new bridge as well as removal of the old bridge will lead to a number of temporary risks for the aquatic environment (Table 3). The construction phase of the works and in particular the construction (and removal) of any instream work platforms pose the greatest potential risks for aquatic environmental impacts. The key environmental risks associated with the works for the aquatic environment are:

- Habitat removal and disturbance including clearing of riparian vegetation, disturbance and destruction of aquatic vegetation and removal of LWD (Section 6.1);
- Aquatic fauna disturbance including disturbance and displacement of platypus, turtles, fish and other aquatic fauna (Section 6.2);
- Aquatic fauna passage barriers, regarding physical, behavioural and hydraulic barriers to aquatic fauna passage including migrating/dispersing fish, platypus and turtle movement (Section 6.3);
- Altered stream flows (Section 6.4);
- Water quality, in particular sedimentation and turbidity, but also industrial liquids spills, construction debris and general litter (Section 6.5); and
- Aquatic weeds, in particular, the potential for the introduction or exacerbation of aquatic weeds in the waterway (Section 6.6).

With regards to the two potentially occurring threatened species, *M. ikei* and *M. adspersa*, the most substantial potential impacts are habitat removal/disturbance and sedimentation and turbidity.

Apart from the long-term implications of the presence of the new bridge and removal of the old bridge, there three broad options for the provision of suitable temporary work platforms to enable the works to be undertaken. These are outlined in Section 1.3.4 and discussed in Myers (2014):

- Option 1: Erection of a full channel width temporary construction bridge.
- Option 2: Construction of a central rock fill work platform/island, linked to either bank by temporary bridge connections.
- Option 3: Use of work barges with associated docking/loading facilities.

The potential impact to the aquatic environment associated with each of the temporary work platform options and ranked in Table 3.

Table 3: Ranking of potential impacts associated with temporary work platform options. Impact is ranked* from 1 (lowest) to 5 (highest)

Impact	Option 1: Temporary Bridge	Option 2: Rock platform	Option 3: Barge/Wharves
Riparian vegetation removal and disturbance	1	2	2
Aquatic vegetation damage and disturbance	1	3	2
Large woody debris removal	2	3	2
Aquatic fauna disturbance	1	3	3
Aquatic fauna passage barriers	1	2	1
Altered stream flow	1	1	1
Turbidity and sedimentation	2	3	2
Spills and debris	2	2	2
Aquatic weeds	1	1	1

* Impact rankings are as follows:

- 1 – Negligible
- 2 – Minor and temporary
- 3 – Larger scale but temporary
- 4 – Widespread with potential for on-going impact

As demonstrated in Table 3, different phases of the works pose different environmental risks. To address the identified risks to the aquatic environment a suite of recommendations have been identified and are outlined below.

7.1 Habitat removal and disturbance (aquatic vegetation and LWD removal)

1. Riparian vegetation disturbance/removal should be kept to a minimum and any riparian vegetation disturbance/removal as a result of the proposed works should be rehabilitated to pre-construction (or better) condition:
 - a. Placement of matching soil types, contouring and stabilisation of banks subjected to earthworks;

- b. Targeted planting of riparian natives such as *Callistemon* and *Lomandra*; and
 - c. Exclusion of cattle from regeneration areas and/or protection of individual plantings.
2. Instream work areas should be kept to a minimum;
 3. Instream work pads should be fully contained by sufficient means prior to their construction in order to minimise work platform footprint, reduce sediment loads and limit turbid runoff and;
 4. Disturbance of LWD should be avoided where possible. Any LWD likely to be disturbed should be relocated in accordance with DPI (Fisheries) requirements and sufficiently secured in close proximity to provide comparative habitat value.

7.2 Aquatic fauna disturbance

5. Banks within the direct footprint of any works should be inspected for platypus dens by qualified ecologist immediately prior to and during breaking ground along the banks.
6. Fauna handling is to be conducted in accordance with the RTA Biodiversity Guidelines (Guide 9: Fauna handling) (RTA, 2011).
7. Minimise the river bank works footprint to reduce the potential for encountering platypus or turtles.
8. Ensure that initial excavation and fill of the affected banks is gradual to allow resident fish and other fauna to move to safety.

7.3 Aquatic fauna barriers to passage

9. The works should be undertaken such that at least 20% of stream width remains as natural open channel at any one time. Whilst this width may be higher than is required for hydraulic connectivity (i.e. to ensure that flow velocities are not limiting), this width is considered necessary to ensure that behavioural affects due to avoidance of noise/vibration/habitat edge effects are also minimised.

7.4 Altered stream flows

10. A minimum of 20% of the river channel (in accordance with the fauna passage criteria) remains unrestricted to ensure that river discharge through the site is unlikely to be significantly affected.

7.5 Water quality

11. All construction and demolition debris would be prevented from entering the waterway where possible and should be contained within the immediate work area and removed from the river channel as soon as practical;
12. Screening or netting around and/or under work areas to contain debris, litter and other materials;
13. Use of grit blasting and painting enclosures;
14. Minimising volumes of fuels, lubricants and other fluids within the instream work site and ensuring all fluids are stored within containment bunds and that hydrocarbon booms are utilised as required to minimise risk of spills to the waterway; and
15. Ensuring that all work platforms, access roads and bank clearing areas associated with the project should be subject to strict runoff and turbidity controls to reduce water quality risks to the downstream environment. This will require a suite of standard environmental protection measures including erosion and sediment controls designed, installed and maintained in accordance the Blue Book requirements and RMS QA Specification G38.

7.6 Aquatic weeds

16. Ensure that imported fill materials (particularly from riverine sources) are weed free.
17. Equipment brought to site should be inspected and if necessary washed before entering the site to ensure they are free of excess soil and material that may contain weed material or seeds.

Overall, the final new bridge structure is not expected to have any significant environmental impacts, the phase with the highest potential risks is the construction phase and in particular the establishment and subsequent removal of any instream works platforms.

Option 1 (temporary bridge) is the preferred approach for an instream works platform as the bridge has a minimal instream footprint and can be constructed with the least bankside disturbance. This significantly reduces the potential of aquatic and riparian vegetation destruction, has lower risks for sedimentation and turbidity, and is unlikely to result in any appreciable alteration of stream flows or aquatic fauna passage.

Option 2 (instream work platform/island) has highest potential for damage to the aquatic environment due to direct burial of a large area of aquatic habitat, greatest potential for loss of riparian vegetation (due to likely bank protection works and significant amount of foreign material to be placed and removed from the river).

Option 3 (Barges and load out wharves) is potentially low impact, however the load out wharves will need to extend into the river channel and water depths within parts of the river may be limiting for barge access, thereby necessitating localised dredging works. Although these requirements are currently unknown, the overall aquatic environmental risks of this option are greater than Option 1.

8. CONCLUSIONS

The works site is within a large broad stretch of the Clarence River. Although the habitats present are likely to vary in response to flood events, the environment at the time of assessment is considered to accurately reflect the long-term habitat features of the reach. The site is relatively shallow, dominated by soft substrates and has very high macrophyte cover. Although, some zonation was apparent, the study area has a high degree of habitat homogeneity. There were no particular habitat features within the areas to be directly affected that are unique to the reach.

Two aquatic species of conservation significance (*Maccullochella ikei* and *Mogurnda adspersa*) could potentially occur at the site, but it is not regarded to be important habitat for either species. The assessment of impact significance under the Environmental Protection and Biodiversity Conservation Act 1999 for *M. ikei* and 7-part tests under the Fisheries Management Act 1994 for both *M. ikei* and *M. adspersa* indicate that there is unlikely to be a significant effect on these species due to the proposed works for any of the options if the recommended environmental management measures are properly implemented. Numerous other fish and other aquatic fauna are likely to be present on site, however the local viability of those species is similarly considered not to be at risk if the habitat impacts are minimised.

Although there are no significant long-term impacts envisaged resulting from the completed new bridge, there is some potential for substantial albeit localised and temporary impacts associated with the construction works, depending somewhat on the final temporary work platform option. Option 1 (temporary bridge) is the preferred approach for an instream works platform as the bridge has a minimal instream footprint and can be constructed with the least bankside disturbance. This significantly reduces the potential of aquatic and riparian vegetation destruction, has lower risks for sedimentation and turbidity, and is unlikely to result in any appreciable alteration of stream flows or aquatic fauna passage.

The long-term implications of the project for the aquatic environment are neutral to slightly positive. The piers of the new bridge will have similar (minimal) habitat value to the old bridge and the hydraulic effects of the new structure are likely to be similar – leading to minor scour and channel deepening between and immediately downstream of some of the piers, but with no significant implications for habitat types or

diversity within the reach. Riparian rehabilitation works may provide a long-term improvement in habitat quality due to increased bankside woody debris and shading.

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1 PROPOSED WORKS

NSW Roads and Maritime Service (RMS) are seeking to remove the existing Tabulam Bridge and construct a new bridge immediately downstream. The proposed new bridge is of a nine span eight pier design. Three piers are located instream (within the 'normal' river width), are all concrete in construction and will be 9 x 6 m wide at normal water level. Some rock scour protection will be placed around the base of the piers on the stream bed. There are three instream temporary work platform arrangements being considered for the construction and removal phases of the project. Preliminary assessment of the options has indicated that the instream rockfill platform option is likely to have the greatest impact on the aquatic environment. The flowing assessments of significance are based on this 'worst case' option.

The width (during non-flood conditions) of the Clarence River at the Tabulam Bridge crossing is approximately 100 metres; however this can fluctuate dramatically according to rainfall and river levels. The pool over which the bridge crosses is a relatively long, straight pool approximately 2.2 km long and is aligned NNE-SSW upstream to downstream.

An aquatic habitat survey was conducted at the site in July 2014. Results from the survey revealed that the majority of the stream bed within the proposed works area was dominated by aquatic vegetation, in particular, charophytes. The area was relatively shallow, <3.5m, and the stream bed substrate was generally of a muddy consistency. There were few areas of riparian vegetation along the banks and scattered woody debris throughout the site. However, habitat features are considered semi-permanent are likely to change in response to flooding. No large rocky boulder habitat was observed.

2 EASTERN FRESHWATER COD (*MACCULLOCHELLA IKEI*)

Background

Maccullochella ikei is a large, elongated, strongly built predatory native freshwater fish similar in appearance to Murray Cod (*M. peelii*). This species can grow up to 41 kg but is more commonly less than 5 kg and 66 cm and become sexually mature at 4 - 5 years old (0.7 - 1.5 kg; NSW DPI, 2012).

M. ikei are endemic to only the Clarence and Richmond River systems in Northern NSW where they were historically abundant before a significant decline in populations in the 1920's and 1930's. By the 1970's the species was considered extinct in the Richmond River catchment and only one small isolated self-sustaining population in the Clarence River. A conservation stocking program started in the 1980's resulting in an increase in the abundance and distribution of the species. *M. ikei* are now common in the Mann & Nymboida Rivers with the potential distribution of *M. ikei* encompassing much of the remaining freshwater reaches of the Clarence and Richmond River catchments.

M. ikei are found in clear, flowing freshwater streams with a rocky substrate. They generally reside in deep slow flowing pools with good instream structure with a distinct preference for woody debris and large boulders. They are opportunistic carnivorous feeders preying on a range of animals including, fish, shrimp, crayfish, frogs and even terrestrial animals such as birds and small reptiles. They generally feed during low light periods moving out of their holding structure into other areas to hunt and forage.

M. ikei are relatively sedentary species with generally high home-site fidelity (Butler, 2009). Most inter-pool movements (which have been recorded up to 20 km) of this species are generally associated with an increase in stream discharge and more likely to occur in winter and spring than summer (Butler, 2009). These inter-pool movements are most likely associated with spawning movements with male fish seeking suitable sites for the breeding season (generally during late winter early spring).

Nesting sites are most often located under large boulders and bedrock shelves in pool-run habitats (Butler, 2009). Large eggs are laid on the suitable surface before the female leaves and the care of the nest is undertaken exclusively by the male.

Assessment of Significance under the Environmental Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act* (EPBC Act) 1999 provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places. The Act lists threatened species or ecological communities that are recognised as a matter of national environmental significance and includes Eastern Freshwater Cod (*Maccullochella ikei*) which is listed as 'Endangered' under the Act.

Under the EPBC Act an action will require approval from the Minister if the action has, will have, or is likely to have, a significant impact on a matter of national environmental significance. In order to determine whether an action is likely to have a significant impact, an assessment against the following impact criteria is required.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

a) Lead to a long-term decrease in the size of a population

M. ikei distribution is restricted to the Clarence and Richmond River catchments of northern NSW. Within these catchments they are generally associated with slow flowing pools with good instream structure and have a distinct preference for woody debris and large boulders. There are no published records of *M. ikei* occurring at the proposed works site, however, the Fisheries NSW Threatened Species records viewer has records of *M. ikei* occurring both upstream and downstream of the proposed works site. Although there was

no preferred *M. ikei* habitat evident at the proposed works site, *M. ikei* are well dispersed throughout the upper Clarence River and it can be reasonably expected that *M. ikei* may occur within the vicinity of and periodically utilise the proposed works site for feeding, foraging and inter and intra-pool migration.

The proposed works may result in some minor and temporary impacts on aquatic habitat within the proposed works site (impacts and recommended mitigations measures are detailed below in Section b) Reduce the area of occupancy of this species).

Considering the mitigation measures recommended below, the marginal nature and only likely periodic use of the habitat and close vicinity to other more preferable *M. ikei* habitat, the proposed works are unlikely to lead to a decrease in any *M. ikei* populations.

b) Reduce the area of occupancy of the species

Habitat within the direct footprint of the proposed works is not characteristic of the documented habitat preferences for resident *M. ikei*, however the area may be utilised intermittently for or inter-pool migration purposes. It is possible, but not likely - due to the proximity of more suitable habitat downstream and upstream (inferred from inspection of aerial photography), that *M. ikei* may permanently reside within the close vicinity of the proposed works. The proportion of habitat that is consistent with the habitat preferences of this species and will be directly affected by the proposal is considered negligible. In any case, any displacement of *M. ikei* from the immediate footprint of the proposed works is expected to be only temporary and individuals disturbed are expected to be able to utilise the large volumes of similar habitat in the immediate area.

The proposed works have the potential to disturb fine stream bed sediments which may lead to increased volumes of turbid water. The risk of downstream sedimentation is seen as the largest potential risk to *M. ikei* from the proposed works. Any increased downstream load of sediments has the potential infill deep holes (preferred *M. ikei* habitat), smother suitable habitat substrate, aquatic vegetation and spawning sites thereby displacing individuals and effectively reducing the area of occupancy of the species. Suitable mitigation measures will need to be implemented to minimise this risk and it is recommended that the following measures are adopted:

- The temporary work platforms to be constructed within the river should be constructed in such a way to minimise the footprint of the platforms and ensure that the fill required to construct these platforms is contained and does not contribute to the sediment load or turbidity within the Clarence River.
- All sources of sediment run-off and turbid water are controlled throughout the duration of the proposal. This will require a suite of standard environmental protection measures including erosion and sediment controls designed, installed and maintained in accordance with the Blue Book requirements and RMS Specification G38;
- Open fish passage along the natural river bed is maintained throughout the duration of the project. In order to reduce behavioural as well as physical obstruction to fish movement it is recommended that at least 20% of the river channel remains unimpeded at all times;

Overall, given the minor and temporary nature of expected impacts of the proposed works, the marginal nature of the habitat within the footprint of the proposed works and considering the mitigation measures proposed, it is unlikely the proposed works will reduce the area of occupancy of *M. ikei*.

c) Fragment an existing population into two or more populations

Although there are no published records of *M. ikei* occurring at the proposed works site, there are records of individuals both upstream and downstream of the site. Therefore, it is expected that a population of *M. ikei* occurs in the stretch of the Clarence River within the vicinity of the proposed works site.

Instream work pads are required as a part of the proposed works however are only temporary and it is recommended that the work pads only occur over <80 % of the width of the river in order to reduce behavioural as well as physical obstruction to fish movement. The work pads will be temporary in nature, with full recovery of the habitat likely after removal (after approx. 18 months). As such it is expected that proposed works are unlikely to pose a significant barrier to fish passage therefore is unlikely that the proposed works will result in the fragmentation of an existing *M. ikei* population.

d) Adversely affect habitat critical to the survival of a species

Habitat within the direct footprint of the works is not characteristic of the documented habitat preferences for resident *M. ikei*. The habitat within the proposed works site may be utilised intermittently for feeding or inter and intra-pool migration purposes. It is possible, but not likely - due to the close proximity of more suitable habitat downstream - that *M. ikei* may permanently reside within the close vicinity of the proposed works.

The construction of temporary instream work pads is likely to result in the temporary destruction of a relatively small area of aquatic vegetation. Any aquatic vegetation affected is expected to return to a similar pre-construction condition following works with only a small area of potential instream habitat likely to be temporarily disturbed with a minimal long term impact. Any areas of riparian vegetation disturbed should be rehabilitated to at least pre-construction condition.

The area of potential habitat within the proposed works areas is not considered to be important to the long-term survival of *M. ikei* due to the type of habitat (lack of features characteristic of known preferred habitat such as large boulders), the relatively very small area being affected, and close proximity to areas of more suitable habitat near the site. Therefore it is highly unlikely that the proposed works will adversely affect habitat critical to the survival of *M. ikei*.

e) Disrupt the breeding cycle of a population

M. ikei spawn within in a well-defined period with spawning events generally occurring in late winter - early spring (August-September) (Butler & Rowland, 2009). Individuals (in particular males) may travel considerable distances to find appropriate spawning sites. Females lay eggs on a hard surface, such as boulders or logs before the male spawns and guards the nest until larvae hatch. There is very limited potential habitat characteristic of known *M. ikei* spawning habitat within the proposed works site and therefore it is not expected that *M. ikei* would utilise the site for spawning purposes. Although, some individuals may travel through the proposed works pre and post-spawning. The proposed works are unlikely to pose a significant barrier (only minor and temporary) to fish movement if following the recommendations of this assessment (see below) and therefore is unlikely to create a barrier sufficient to restrict the movement of fish.

As detailed above the proposed works have the potential to disturb fine stream bed sediments generating increased volumes of turbid water. Downstream loads of sediment have the potential to smother suitable breeding substrates and *M. ikei* eggs. To minimise this risk the mitigation measures above (in section 'reduce the area of occupancy of the species') should be implemented.

Due to the apparent absence of habitat characteristic of known *M. ikei* spawning habitat within the proposed works site, insignificant restriction of fish passage and the implementation of suitable sedimentation mitigation measures it is expected the proposed works are unlikely to disrupt the breeding cycle of a *M. ikei* population.

f) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The construction of temporary instream work pads is likely to result in the temporary destruction of a relatively small area of aquatic vegetation. Any aquatic vegetation affected is expected to return to a similar pre-construction condition following works with only a small area of potential instream habitat likely to be temporarily disturbed with a minimal long term impact. Any areas of riparian vegetation disturbed should be rehabilitated to at least pre-construction condition.

Habitat within the direct footprint of the proposed works is not characteristic of the documented habitat preferences for resident *M. ikei*, however, this area may be utilised intermittently for feeding or inter or intra-pool migration purposes. The habitat within the proposed works area is not unique or restricted in distribution, with large areas of similar habitat occurring in the immediate vicinity of the work site as well as other locations in the upper Clarence River.

A relatively small area of habitat is likely to be affected within the footprint of the proposed works. Any associated impact is considered to be minor and temporary with habitat expected to return to or rehabilitated post construction to at least pre-construction condition. As such the proposed works are unlikely to lead to decline in *M. ikei* populations.

g) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

Several invasive fish species including Mosquitofish and Goldfish are already established within the Clarence River. The works are not expected to exacerbate the introduction of any exotic fish species.

Invasive aquatic weeds may have the potential cause degradation of *M. ikei* habitat. The introduction of aquatic weeds may occur through the importation of seeds or plant material on construction machinery and/or imported materials. The following measures are recommended to reduce the risk of aquatic weed introduction:

- Ensure that imported fill materials (particularly from riverine sources) are to be weed-free.
- Equipment brought to site should be inspected and if necessary washed before entering the site to ensure they are free of excess soil and material that may contain weed material or seeds.

h) Introduce disease that may cause the species to decline

There are currently no known diseases that threaten *M. ikei*, however, the introduction of exotic fish species may also pose the threat of introducing disease that may affect *M. ikei*. It is unlikely that the proposed works are to exacerbate the threat of exotic fish species and is therefore also unlikely to introduce disease that may cause a decline in *M. ikei*.

i) Interfere with the recovery of the species.

Although not directly in conflict with the recovery of *M. ikei*, the proposed works have the potential to have a negative impact on *M. ikei*. The recommended control and restoration measures identified within this assessment are considered appropriate to ensure the proposed works do not hinder the success of the recovery of *M. ikei*.

Conclusion regarding significance under the EPBC Act 1999

It is concluded that if the recommended mitigation measures identified in this assessment are implemented effectively, the proposed works are unlikely to have a significant effect on the Eastern Freshwater Cod (*M. ikei*). On this basis, referral of the project to the Department of Environment in relation to potential impacts on *M. ikei* is not required.

Assessment of Significance (7-part test) under the Fisheries Management Act 1994:

The objectives of the Fisheries Management Act 1994 (FM Act) are to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. To meet the primary objectives,

Part 7 of the FM Act deals with the protection of aquatic habitats and Part 7A deals with threatened species conservation.

Where a proposed development is in the potential range of a listed threatened species, population or ecological community under the FM Act and/or the EPBC Act, and the area has not been declared a critical habitat, an assessment of significance ('7 part test') must be undertaken to determine whether the proposal is likely to have a significant impact on the listed threatened species, population or ecological community. *M. ikei* are listed as 'Endangered' under the FM Act 1994 and may potentially occur within the vicinity of the proposed works. The following aspects (labelled a to g) are discussed in order to determine whether a significant impact to *M. ikei* is likely to occur due to the proposed activities.

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

M. ikei spawn within in a well-defined period with spawning events generally occurring in late winter - early spring (August-September) (Butler & Rowland, 2009). Individuals (in particular males) may travel considerable distances to find appropriate spawning sites. Females lay eggs on a hard surface, such as boulders or logs before the male spawns and guards the nest until larvae hatch. There is very limited potential habitat characteristic of known *M. ikei* spawning habitat within the proposed works site and therefore it is not expected that *M. ikei* would utilise the site for spawning purposes.

Habitat within the direct footprint of the proposed works is not characteristic of the documented habitat preferences for resident *M. ikei*. Although, the aquatic vegetation, substrate and LWD throughout the entire work area may potentially be utilised intermittently for feeding (generally occurs during low light conditions, i.e. dawn, dusk and night) or inter-pool migration purposes. It is possible, but not likely - due to the proximity of more suitable habitat downstream, that *M. ikei* may permanently reside within the close vicinity of the proposed works.

M. ikei are known to undertake sporadic inter-pool movements- particularly during a rise in stream flows and during spawning period- and regular intra-pool movements, generally for feeding. Any instream work pads will cover only a portion of the river (<80%) at a time allowing flow and fish passage through the site. The proposed works are unlikely to alter stream morphology through the works area and are not expected to restrict fish passage sufficiently to create a barrier for any extended period of time.

The proposed works have the potential to disturb fine stream bed sediments generating increased volumes of turbid water and the risk of downstream sedimentation with being seen as the biggest risk to *M. ikei* from the proposed works. An increased downstream load of sediments has the potential infill deep holes (preferred *M. ikei* habitat), smother suitable habitat substrate, aquatic vegetation and nest sites. Suitable mitigation measures will need to be implemented to minimise this risk and it is recommended that the following measures are adopted:

- The temporary work platforms to be constructed within the river should be constructed in such a way to minimise the footprint of the platforms and ensure that the fill required to construct these platforms is contained and does not contribute to the sediment load or turbidity within the Clarence River.
- All sources of sediment runoff and turbid water are controlled throughout the duration of the project. This will require a suite of standard environmental protection measures including erosion and sediment controls designed, installed and maintained in accordance the Blue Book requirements and RMS QA Specification G38.;
- Open fish passage along the natural river bed is maintained throughout the duration of the project. In order to reduce behavioural as well as physical obstruction to fish movement it is recommended that at least 20% of the river channel remains unimpeded at all times;

All reasonable measures should be undertaken during works to ensure minimal impact on *M. ikei*. With the adoption of the above recommendations and confirmation of the appropriateness of the standard of the implementation of these measures it is considered that impacts on this species will be minor and temporary in nature. As such, the proposed works are expected to be unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

N/A- No endangered populations occur in the study area.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

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

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

N/A- No endangered ecological communities occur with the proposal area.

d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Habitat within the direct footprint of the works is not characteristic of the documented habitat preferences for resident *M. ikei*. The habitat within the proposed works site may be utilised intermittently for feeding or inter and intra-pool migration purposes. It is possible, but not likely - due to the close proximity of more suitable habitat downstream - that *M. ikei* may permanently reside within the close vicinity of the proposed works.

Aquatic vegetation is expected to return to a similar pre-construction condition following works with only a small area of potential instream habitat likely to be temporarily disturbed with a minimal long term impact. Any areas of riparian vegetation disturbed should be rehabilitated to at least pre-construction condition. It is expected any *M. ikei* disturbed by the works will return to and re-utilise the affected area post construction.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

A small area of potential habitat will be temporarily isolated during construction works, however, no habitat is expected to become permanently fragmented or isolated as result of the proposed works.

It is recommended that open fish passage along the natural river bed is maintained throughout the duration of the project. In order to reduce behavioural as well as physical obstruction to fish movement it is recommended that at least 20% of the river channel remains unimpeded at all times.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

The area of potential habitat within the proposed works areas is not considered to be important to the long-term survival of *M. ikei* due to the type of habitat (lack of features characteristic of known preferred habitat such as large boulders) , the relatively very small area being affected, and close proximity to areas of more suitable habitat near the site.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

N/A - No critical habitats have been declared for *M. ikei* at the time of preparation of this document.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

In accordance with the FM Act a *M. ikei* Threatened Species Recovery Plan (the plan) was prepared by NSW Fisheries in 2004. The overall objective of the plan is to ensure the recovery and natural viability of *M. ikei* populations in their former range in the Clarence and Richmond River catchments. The plan identifies and discusses the current major threats to *M. ikei*, namely, habitat degradation, introduced fish and illegal fishing.

Although not directly in conflict with the objectives of the recovery plan, the proposed works have the potential to have a negative impact on *M. ikei*. The recommended control and restoration measures identified within this assessment are considered appropriate to ensure the proposed works do not hinder the success of the plan.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

Schedule 6 of the *Fisheries Management Act 1994* lists eight key threatening processes, of these, four are relevant to the proposed works and are addressed below:

Relevant Key Threatening Process	Is the proposal likely to be or exacerbate the KTP? - Likely	Is the proposal likely to be or exacerbate the KTP? - Possible	Is the proposal likely to be or exacerbate the KTP? - Unlikely	Comments
Degradation of native riparian vegetation along NSW watercourses	-	-	✓	A small number of individual plants may need to be removed from within the footprint of the works.
Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams	-	-	✓	Temporary instream work pads will be installed during construction however any impacts are considered to be temporary and negligible in nature.
Introduction of fish to waters within a river catchment outside their natural range	-	-	✓	The works are not expected to exacerbate the introduction of any exotic fish species.
Removal of large woody debris from NSW rivers and streams	-	-	✓	No removal of woody debris is expected to be required during construction works.

Conclusions regarding significance under the FM Act

While the proposed works may impose some minor and temporary impacts, it is considered unlikely the proposed works would have a significant impact on the local population *M. ikei* and therefore a species impact statement is not required.

Conclusions and recommended mitigation measures

M. ikei have been recorded from both upstream and downstream of the study area and this species is well dispersed through the Clarence catchment, it is therefore likely that *M. ikei* could occur within the project area. Despite this, the habitat characteristics preferred by *M. ikei* are generally absent within the immediate works area and the paucity of large woody debris and hard substrate means that the reach to be affected is considered marginal as a resident habitat for this species.

Due to the lack of suitable substrate, *M. ikei* are unlikely to permanently reside or breed within the immediately affected area although suitable habitat occurs both upstream and downstream of the site. Protection of water quality and ensuring that other habitat related factors such as river sediment load and flow conditions are unaffected is important to ensure the project does not have negative impacts on the species.

Migration and dispersal is also a key consideration. Despite being relatively sedentary, having high home site fidelity and no known obligatory migratory requirements, this species still requires unobstructed passage along rivers for the purposes of dispersal and in order to access new habitats and food resources. In order to minimise any potential impact in this regard it is important that the project does not pose physical or behavioural barriers to movement through this reach.

It is concluded that the impact to *M. ikei* will not constitute a significant impact under the EPBC Act 1999 and the FM Act 1994 if the following recommendations are correctly implemented:

1. The temporary work platforms to be constructed within the river should be constructed in such a way to minimise the footprint of the platforms and ensure that the fill required to construct these platforms is contained and does not contribute to the sediment load or turbidity within the Clarence River.
2. All sources of sediment runoff and turbid water are controlled throughout the duration of the project. This will require a suite of standard environmental protection measures including erosion and sediment controls designed, installed and maintained in accordance with the Blue Book requirements and RMS QA Specification G38;
3. Open fish passage along the natural river bed is maintained throughout the duration of the project. In order to reduce behavioural as well as physical obstruction to fish movement it is recommended that at least 20% of the river channel remains unimpeded at all times;
4. All sources of contaminants such as fuels, hydraulic fluids, lubricants, paints and chemical treatments are kept in minimal quantities within the river channel work site and are appropriately bunded;
5. All construction and bridge removal debris should be prevented from entering the water where possible and should be contained within the immediate works area and removed from the river channel as soon as practical;
6. Riparian vegetation to be rehabilitated to pre-construction condition;

7. Disturbance of LWD should be avoided where possible. Any LWD likely to be disturbed should be relocated in accordance with DPI (Fisheries) requirements to a site nearby in order to reduce loss of habitat value;

It is stressed that the careful planning and execution of the above mitigation measures is important in ensuring that the proposed works are unlikely to result in any significant impact on the Eastern Freshwater Cod (*Maccullochella ikei*). It should also be noted that there are opportunities to improve long-term habitat values for *M. ikei* along the river banks affected by the project, particularly with the partial burial of large woody debris at the water's edge, such measures would need to be undertaken in such a way to avoid exacerbation of bank erosion at the work margins.

Prepared by: Uriah Makings and Mick Howland, Hydrosphere Consulting, 20 August 2014

Review and approved by: Mick Howland, Hydrosphere Consulting, 20 August 2014

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3 PURPLE SPOTTED GUDGEON (MOGURNDA ADSPERSA)

Assessment of Significance (7-part test) under the Fisheries Management Act 1994

Background

Although not present on the NSW Fisheries Threatened and Protected Species Record Viewer and despite no recent recorded sightings, the Clarence River catchment is within the recognised historical distribution of *M. adspersa* (Figure 17). *M. adspersa* are listed as Vulnerable under the FM Act. *M. adspersa* is a small, robust, benthic native freshwater fish of the Eleotridae family growing up to 12 cm but are more commonly around 6 cm. They are a euryphagous carnivore feeding on small crustaceans, small fish, insect larvae, worms, tadpoles and some plant matter.

Two populations of *M. adspersa* historically occurred in NSW (Figure 17); an eastern population found in coastal catchments north of the Clarence River, and a western population found patchily distributed throughout Murray-Darling Basin drainages (Pusey *et al.*, 2004; Dixon 2006; Llewellyn 2006). Although *M. adspersa* are reported as historically occurring possibly as far south as the Clarence River, there was no actual survey data to support this (Pusey *et al.*, 2004), rather, phylogeographical studies suggest that their potential for occurrence in the Clarence is explained by historic river re-arrangement and biogeography of the region (Faulks *et al.*, 2008). However, a more recent study, Brooks (2009), has revealed historic *M. adspersa* records within the Clarence River catchment including within Swan Creek (north east of Grafton) and Orara River (south east of Grafton) although a fish survey during this study failed to record any at Swan Creek (did not visit Orara River site). Additionally, a search of the Atlas of Living Australia (2013) revealed two records of *M. adspersa* within the Clarence River (Figure 18) from 1904 and 1997, although there is significant spatial uncertainty around these.

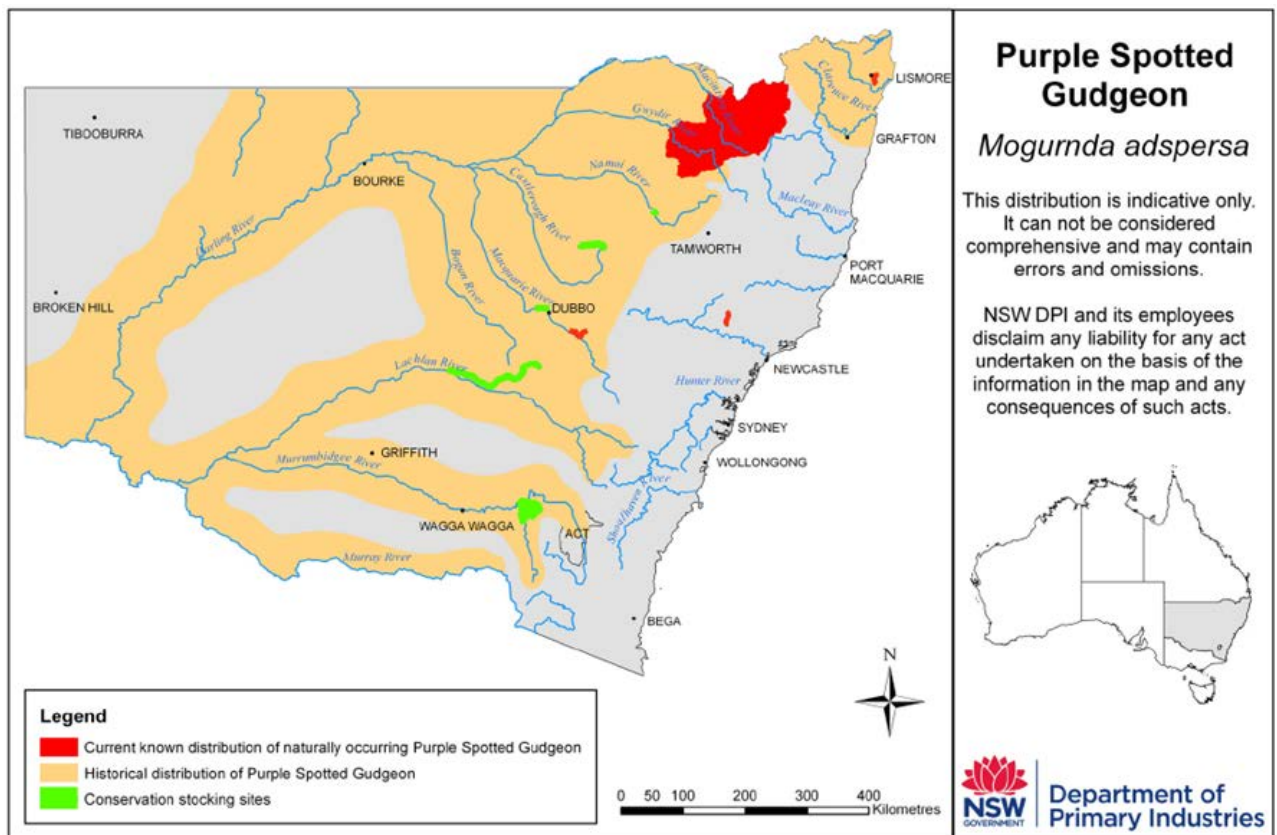


Figure 17: Map showing the distribution of Purple Spotted Gudgeon (*M. adspersa*) in NSW. (NSW DPI, 2013b)

Further, there have also been very few recent records of the species within the other eastern catchments with the only reported known current distribution in Tucki Tucki Creek (NSW DPI, 2013b) (Figure 17). There were unconfirmed records of the presence of *M. adspersa* in the Tweed and Brunswick River catchments by research students prior to 2006 (Dixon, 2006). Within the Richmond River catchment there are reports of *M. adspersa* present in Sandy and Iron Pot Creeks and another unnamed water body south west of Lismore (Brooks, 2009) and the confirmed reports of a population in Tucki Tucki Creek (Figure 17) (Miles, 2013; NSW DPI, 2013b).

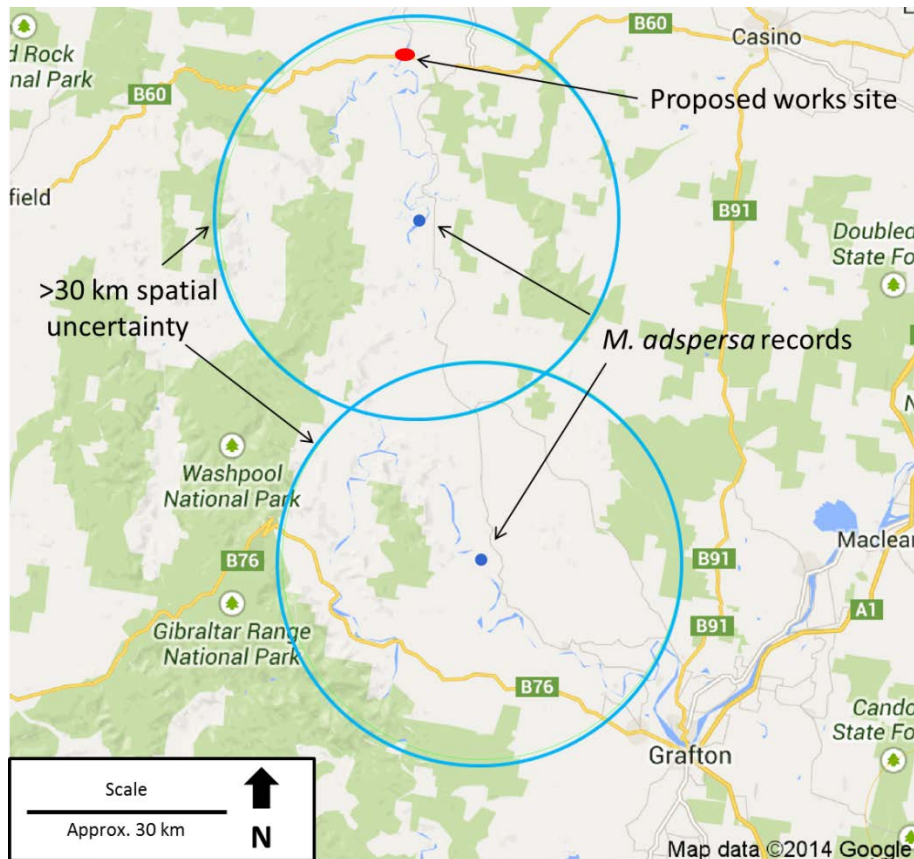


Figure 18: Atlas of Living Australia (2013) Clarence River *M. adspersa* records

M. adspersa are usually found in slow flowing sections of rivers, creeks and billabongs with good instream structure over a variety of substrates. They have a particular affinity for small, relatively shallow, small slow flowing pools with aquatic macrophytes and overhanging vegetation (Miles, 2013) being generally found in smaller tributaries rather than larger rivers. Interestingly they are often found in association with Duboulay's Rainbowfish (*M. duboulayi*) (Miles, 2013).

The heavy macrophyte growth within the works site does provide large areas of potential habitat, but lacks many of the other features considered as ideal for this species. During large floods it is likely that much of the macrophyte growth would be temporarily depleted through scour or burial, and there are few semi-permanent features such as extensive bank undercutting, trailing vegetation and dense woody debris that would make this highly attractive for *M. adspersa*.

The spawning season of *M. adspersa* in South East Queensland spans from spring to late summer, favouring temperatures over 18°C, although appears to be concentrated between November and February (Pusey *et al.*, 2004). There is no discerned migration associated with spawning although adults may seek suitable spawning habitat and juveniles may undergo a mass dispersal phase. Eggs are generally laid on rocks, woody debris, plant matter and other relatively hard substrates.

Particular threats to *M. adspersa* include predation by introduced fish (such as Mosquitofish); habitat degradation (particularly the loss of aquatic macrophytes) and; anthropogenic fluctuations in river levels resulting poor reproduction and recruitment success (NSW DPI, 2013; Pusey *et al.*, 2004).

Proposed Works

NSW Roads and Maritime Service (RMS) are seeking to remove the existing Tabulam Bridge and construct a new bridge immediately downstream. The proposed new bridge is of a nine span eight pier design. Three piers are located instream (within the 'normal' river width), are all concrete in construction and will be 9 x 6 m wide at normal water level. Some rock scour protection will be placed around the base of the piers on the stream bed. Instream work pads, likely to be constructed of rock, will be installed pre-construction for both the construction of the new bridge and the removal of the existing bridge.

The width (during non-flood conditions) of the Clarence River at the Tabulam Bridge crossing is approximately 100 metres; however this can fluctuate dramatically according to rainfall and river levels. The pool over which the bridge crosses is a relatively long, straight pool approximately 2.2 km long and is aligned NNE-SSW upstream to downstream.

An aquatic habitat survey was conducted at the site in July 2014. Results from the survey revealed that the majority of the stream bed within the proposed works area was dominated by aquatic vegetation, in particular, charophytes. The area was relatively shallow, <3.5m, and the stream bed substrate was generally of a muddy consistency. There were few areas of riparian vegetation along the banks and scattered woody debris throughout the site. However, habitat features are considered semi-permanent are likely to change in response to flooding.

- a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction**

The spawning season of *M. adspersa* in South East Queensland spans from Spring to late summer, favouring temperatures over 18°C, although appears to be concentrated between November and February (Pusey *et al.*, 2004). There is no discerned migration associated with spawning although adults may seek suitable spawning habitat and juveniles may undergo a mass dispersal phase. Eggs are generally laid on rocks, woody debris, plant matter and other relatively hard substrates.

M. adspersa are particularly susceptible to fluctuations in water levels resulting in negative effects on reproduction and poor recruitment success. The works will be undertaken across only a portion of the river at a time allowing flow and fish passage through the site. The proposed works are unlikely to alter stream morphology through the works area and will not restrict fish passage sufficiently to create a barrier for any extended period of time.

The proposed works have the potential to disturb fine stream bed sediments generating increased volumes of turbid water and the risk of downstream sedimentation. An increased downstream load of sediments has the potential infill pools, smother suitable habitat substrate, aquatic vegetation and nest sites. Suitable mitigation measures will need to be implemented to minimise this risk and it is recommended that the following measures are adopted:

1. The temporary work platforms to be constructed within the river should be constructed in such a way to minimise the footprint of the platforms and ensure that the fill required to construct these platforms is contained and does not contribute to the sediment load or turbidity within the Clarence River.
2. All sources of sediment runoff and turbid water are controlled throughout the duration of the project. This will require a suite of standard environmental protection measures including erosion and sediment controls designed, installed and maintained in accordance the Blue Book requirements and RMS QA Specification G38.

All reasonable measures should be undertaken during works to ensure minimal impact on *M. adspersa*. With the adoption of the above recommendations and confirmation of the appropriateness of the standard of the implementation of these measures it is considered that impacts on this species will be minor and temporary in nature. As such, the proposed works are expected to be unlikely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction**

N/A- No endangered populations occur in the study area

- c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

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

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

N/A- No endangered ecological communities occur with the proposal area.

- d) in relation to the habitat of a threatened species, population or ecological community:**

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Due to the construction of instream works pads, a relatively small area of aquatic vegetation is expected to be temporarily removed as a result of the proposed works. To minimise the area of aquatic vegetation impacted it is recommended that the temporary work platforms to be constructed within the river should be constructed in such a way to minimise the footprint of the platforms and ensure that the fill required to construct these platforms is contained and does not contribute to the sediment load or turbidity within the Clarence River.

The piers of the existing bridge will be removed however the piers of the new bridge are expected to have a similar (low) habitat value and. The new piers may restrict aquatic vegetation growth in their vicinity however the removal of the existing piers is likely to allow previously restrict growth in that area. Therefore a minimal, if not neutral, impact is envisaged.

Post works, aquatic vegetation is expected to return to a similar pre-construction condition following works with only a small area of potential instream habitat likely to be temporarily disturbed with a minimal long term impact. Any areas of riparian vegetation disturbed should be rehabilitated to at least pre-construction condition. Large woody debris may be removed and relocated in accordance with DPI Fisheries requirements to a nearby suitable location.

It is expected any *M. adspersa* disturbed by the works will return to and re-utilise the affected area post construction.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

During the construction works a small area of potential habitat within the footprint of the works will become temporarily isolated (i.e. the area that is occupied by the instream work pads). However, aquatic vegetation is expected to return to adequate pre-construction condition. Additionally, the proposed works is not expected to create any significant barrier to fish passage. However, it is recommended that open fish passage along the natural river bed is maintained throughout the duration of the project. In order to reduce behavioural as well as physical obstruction to fish movement it is recommended that at least 20% of the river channel remains unimpeded at all times.

A small area of potential habitat will be temporarily isolated during construction works, however, no habitat is expected to become permanently fragmented or isolated as result of the proposed works.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

The habitat affected by the proposed works is considered marginal for this *M. adspersa* is not considered to be important to the long-term survival of the species. The macrophyte beds and bank habitats are not unique within this part of the Clarence River, with a relatively insignificant proportion likely to be temporarily lost as part of the works.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

N/A - No critical habitats have been declared for *M. adspersa* at the time of preparation of this document.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

There is currently no recovery plan in place for *M. adspersa*.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

Schedule 6 of the Fisheries Management Act 1994 lists eight key threatening processes, of these, four are relevant to the proposed works and are addressed below:

Relevant Key Threatening Process	Is the proposal likely to be or exacerbate the KTP? - Likely	Is the proposal likely to be or exacerbate the KTP? - Possible	Is the proposal likely to be or exacerbate the KTP? - Unlikely	Comments
Degradation of native riparian vegetation along NSW watercourses	-	-	✓	A small number of individual plants may need to be removed from within the footprint of the works.
Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams	-	-	✓	Temporary instream work pads will be installed during construction however any impacts are considered to be temporary and negligible in nature.
Introduction of fish to waters within a river catchment outside their natural range	-	-	✓	The works are not expected to exacerbate the introduction of any exotic fish species.
Removal of large woody debris from NSW rivers and streams	-	-	✓	LWD present in the in the proposed works area at the time of construction and removal may be removed and relocated in accordance with DPI fisheries requirements.

Conclusion and recommended mitigation measures

Only a small number of records exist for *M. adspersa* in the Clarence River reflecting the significant decline of this species in the southern end of its range and probably also sampling equipment bias which is known significant affect catch records for this species. The Clarence River is the most southern, east coast drainage in which it is known to occur.

The species has been found to be highly adaptable within Queensland waters, being found in major rivers, headwater creeks and lagoons and even upper estuarine environments, however, it is regarded as having a strong preference for dense cover associated with undercut banks, woody debris and heavy macrophyte growth. The species is also considered to be more often associated with slow flowing waterways, fine substrate composition, submerged creek margin vegetation and sometimes detrital leaf accumulations.

The heavy macrophyte growth within the works site does provide large areas of potential habitat, but lacks many of the other features considered as ideal for this species. During large floods it is likely that much of the macrophyte growth would be temporarily depleted through scour or burial, and there are few semi-permanent features such as extensive bank undercutting, trailing vegetation and dense woody debris that would make this highly attractive for *M. adspersa*.

On the basis of this it is concluded that the affected habitat is marginal for this species, however the presence of *M. adspersa* cannot be discounted. The main potential impacts of bridge construction and demotion on this species would relate to the temporary burial and destruction of the macrophyte beds and bankside cover associated with temporary work platforms. The macrophyte beds and bank types are not unique within this part of the Clarence River, with a relatively insignificant proportion likely to be temporarily lost as part of the works.

It is concluded that the impact to *M. adspersa* will not constitute a significant impact under the FM Act 1994 if the following recommendations are correctly implemented:

1. The temporary work platforms to be constructed within the river should be constructed in such a way to minimise the footprint of the platforms and ensure that the fill required to construct these platforms is contained and does not contribute to the sediment load or turbidity within the Clarence River.
2. All sources of sediment runoff and turbid water are controlled throughout the duration of the project. This will require a suite of standard environmental protection measures including erosion and sediment controls designed, installed and maintained in accordance the Blue Book requirements and RMS QA Specification G38;
3. Open fish passage along the natural river bed is maintained throughout the duration of the project. In order to reduce behavioural as well as physical obstruction to fish movement it is recommended that at least 20% of the river channel remains unimpeded at all times;
4. All sources of contaminants such as fuels, hydraulic fluids, lubricants, paints and chemical treatments are kept in minimal quantities within the river channel work site and are appropriately bundled;
5. All construction and bridge removal debris should be prevented from entering the water where possible and should be contained within the immediate works area and removed from the river channel as soon as practical;

It should be noted that although rehabilitation of the affected macrophytes beds is not likely to be required (and is not recommended), there are opportunities to improve habitat values for *M. adspersa* along the river

banks affected by the project through targeted bank rehabilitation activities such as planting of trailing vegetation as well as partial burial of large (and fine) woody debris. With the addition of such measures the project is considered neutral to slightly beneficial to this species in the long-term.

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Review and approved by: Mick Howland, Hydrosphere Consulting, 20 August 2014

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APPENDIX 2: AQUATIC HABITAT CLASSIFICATION

Table A 1: Waterway Classification Scheme (NSW DPI, 2013)

Classification	Description	Characteristics
Class 1	Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.
Class 2	Moderate key fish habitat	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present.
Class 3	Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats.
Class 4	Unlikely key fish habitat	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools post rain events (e.g. dry gullies or shallow floodplain depressions with no aquatic flora present).

Table A 2: Habitat classification scheme (NSW DPI, 2013)

Classification	Description	Characteristics
Type 1	Highly sensitive key fish habitat	Posidonia australis (strapweed) Zostera, Heterozostera, Halophila and Ruppia species of seagrass beds >5m² in area Coastal saltmarsh >5m² in area Coral communities Coastal lakes and lagoons that have a natural opening and closing regime (i.e. are not permanently open or artificially opened or are subject to one off unauthorised openings) Marine park, an aquatic reserve or intertidal protected area SEPP 14 coastal wetlands, wetlands recognised under international agreements (e.g. Ramsar, JAMBA, CAMBA, ROKAMBA wetlands), wetlands listed in the Directory of Important Wetlands of Australia Freshwater habitats that contain instream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act

Classification	Description	Characteristics
Type 2	Moderately sensitive key fish habitat	Zostera, Heterozostera, Halophila and Ruppia species of seagrass beds <5m² in area Mangroves Coastal saltmarsh <5m² in area Marine macroalgae such as Ecklonia and Sargassum species Estuarine and marine rocky reefs Coastal lakes and lagoons that are permanently open or subject to artificial opening via agreed management arrangements (e.g. managed in line with an entrance management plan) Aquatic habitat within 100 m of a marine park, an aquatic reserve or intertidal protected area Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1 Weir pools and dams up to full supply level where the weir or dam is across a natural waterway
Type 3	Minimally sensitive key fish habitat	Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no in-fauna Coastal and freshwater habitats not included in TYPES 1 or 2 Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation

References

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