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27 March 2025

Clare Collett

Senior Environment Officer

Main Roads Western Australia

Dear Clare,

Please find attached a brief memorandum (memo) style report to address regulator comments on the Carter's freshwater mussel survey for the Great Eastern Highway Bypass Interchanges Project Area. Potential indirect and direct impacts have been outlined, as well as planned management to control these impacts.

If you have any queries, please do not hesitate to contact me or the Manager of Aquatic Ecology (Jess Delaney, jess@biologicenv.com.au).

Yours sincerely,

KIM NGUYEN
Senior Aquatic Ecologist

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1 Introduction

Main Roads Western Australia (Main Roads) has applied for a Native Vegetation Clearing Permit (NVCP) for the Great Eastern Highway Bypass Interchanges (GEHBI) Project (the Project). In 2022, Biologic completed a targeted survey for Carter's freshwater mussel (*Westralunio carteri*; CFM) in the Helena River and two wetlands (Wetland East and Wetland West) adjacent to the NVCP (Biologic, 2022a). This work was undertaken to support the NVCP application. Clearing is expected to intersect with the western edge of Wetland East (Figure 1).

During regulatory review of the targeted survey report, DWER received advice from DBCA on the potential impacts and proposed management measures for the population of CFM identified within Wetland East. DBCA noted the potential impacts to CFM associated with the Project include:

- a reduction in riparian vegetation and thus shading, resulting in increased water temperatures and reduced ability for CFM to persist when water levels recede
- erosion and sedimentation resulting from earthworks adjacent to wetland east during construction
- contamination and/or water quality impacts during construction
- increased water turbidity resulting from disturbed sediments may lead to liberation of sediment analytes which are detrimental to CFM
- alteration of hydrological regimes resulting from construction operations.

In addition, the regulators were concerned about the anoxic conditions present on the western edge of Wetland East (Biologic, 2022a), and the potential for the proposed clearing and land use to exacerbate these conditions. This memo addresses these regulator comments and provides discussion on the potential impacts to CFM from the Project in relation to Main Roads planned mitigation measures.

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Habitat Assessment
- Suitable habitat available
- Habitat not suitable - hard substrate
- Habitat not suitable - not perennial
- Habitat not suitable - soft/anoxic substrate
- Habitat not assessed

IBRA Region
- Jarrah Forest
- Swan Coastal Plain

IBRA Subregion
- Northern Jarrah Forest
- Perth

Perth

Helena River

Military Rd

Roe Hwy

LEGEND
- Biologic (2022) Survey Area
- NVCP Application Area
- Local Road
- State Road

Surface Hydrology
- Minor
- Major

Biologic (2022) Carter's freshwater mussel record

Biologic

Scale 1:2,000

0 25 50 75 Meters

Coordinate System: GDA 1994 MGA Zone 50 Transverse Mercator Created: 05/03/2025

Perth

MAIN ROADS
GEHBI Project CFM Response to Comments Memo

Figure 1. NVCP application area and context

2 Existing Conditions at Wetland East

2.1 Habitat conditions for Carter's Freshwater Mussel

Habitat assessments undertaken at Wetland East found conditions were suitable for CFM except on the western edge of the wetland (Biologic, 2022a). While water quality and sediments were appropriate for CFM, this section of the wetland was covered in an anoxic layer comprised of fine, organic material. Decomposition at the macro scale is the conversion of organic matter from large physical forms to small particles, soluble compounds, and gases (Findlay, 2013). Decomposition can be driven by anaerobic bacteria, that consume large volumes of dissolved oxygen (DO) as part of this process, creating hypoxic and/or anoxic conditions. The build-up of organic material, which consists of decaying macrophytes, algae, and woody debris, generally occurs in the absence of flushing flows that remove such material.

Decaying organic material generally forms a soft sludge. Excessively soft substrates limit the spatial distribution of CFM, particularly juveniles that need firm substrates to avoid being swept away by currents (Klunzinger, 2012). Juvenile freshwater mussels are also more sensitive to anoxic conditions compared to adults (Strayer & Malcolm, 2012).

2.2 Cause of Localised Anoxic Conditions

While the source for the anoxic conditions at Wetland East is unknown, decomposition is a natural process, with particulate plant litter a major input in many ecosystems (Findlay, 2013). Leaf breakdown rates in streams varies with litter inputs (litter quality, quantity and timing), as well as biotic (microbial and invertebrate assemblages) or abiotic differences among streams (LeRoy & Marks, 2006). Despite the Helena River flowing in the winter of 2022, rainfall was not of sufficient magnitude to flush Wetland East. Therefore, there is the potential that the accumulation and decay of leaf litter along the western edge of the wetland has led to anoxia due to a lack of flushing flows.

2.3 Historical Disturbance

The NVCP application area was largely historically cleared for the original construction of Roe Highway in 1983, including the majority of vegetation along the western edge of the eastern wetland (Figure 2). As such, the vegetation along the western edge of Wetland East is mostly regrowth, though some remnant vegetation remains intact.

Figure 2: Aerial imagery of historic clearing in 1983

3 Potential Impacts from the Project

3.1 Direct Impacts to Carter's Freshwater Mussels and Suitable Habitat

The clearing for the Project in the vicinity of Wetland East will affect the western edge of the wetland only, which was considered unsuitable for CFM due to the anoxic substrate (Biologic, 2022a). Direct impacts to individuals may still occur in the north-western edge of Wetland East, where the Project is within 16 m of known live records of CFM, and where suitable habitat exists within 10 m of the proposed clearing area (Biologic, 2022a). CFM are frequently found along the banks, rather than in deeper water (Ma, 2018; Ma *et al.*, 2022), and may move with the water's edge following winter rainfall. Such direct impacts may occur when water levels are at their peak and CFM individuals move into the area, when the CFM would be at their closest to the Project area. To mitigate this risk, all high-risk construction activities, such as clearing and excavations adjacent to Wetland East, will be timed to occur in summer. By timing such activity over lower rainfall months, and where water levels are at their lowest, the possibility of CFM interacting with Project-related activity is considerably reduced.

Despite the impact area containing no suitable CFM habitat, clearing of the wetland foreshore area is recommended between 1 November to 30 April to reduce potential indirect impacts on nearby individuals. Although it is considered highly unlikely CFM will be in the

impact area when the area is cleared, it is recommended that the wetland foreshore within the clearing area will be inspected for CFM prior to clearing commencing.

3.2 Indirect Impacts – Exacerbation of Anoxic Conditions

Many factors contribute to the decomposition rate of organic matter, including litter availability and type (LeRoy & Marks, 2006), as well as oxygen availability, which affects the composition of decomposer invertebrates and microbes (Findlay, 2013). If unmanaged, clearing could result in excess leaf litter and large woody debris (LWD) entering Wetland East. If this material is not flushed quickly, then these higher inputs of organic material would be left to decay in the wetland, further contributing to the current anoxic conditions within Wetland East. However, Main Roads are proposing mitigation and management measures to ensure the clearing does not lead to excessive litter and debris inputs into Wetland East. This includes:

- Vegetation to be felled in a manner that ensures vegetative debris is directed away from the wetland
- No cleared vegetation will be stockpiled within 50 m of the high water mark of any nearby wetlands
- Cleared vegetation will not be stored for more than 12 hours within 50 m of the high water mark of any nearby wetlands.

Clearing activity may also temporarily create deleterious water quality conditions, by increasing sedimentation and total suspended solids (TSS). Increased sedimentation and TSS above natural conditions can lead to lower DO, worsening any anoxic areas. However, clearing is planned to be managed to minimise such conditions (see section 3.4).

3.3 Indirect Impacts – Reduction in Riparian Vegetation

While Wetland East is a permanent wetland, the water level retracts naturally over summer months. However, clearing of vegetation may accelerate drying conditions at Wetland East, due to a reduction in shade exposing the wetland to evaporation. CFM can only survive water emersion (for as long as 62 days) where there is riparian vegetation available to provide shade (Lymbery *et al.*, 2020). Freshwater mussels are also sensitive to high water temperatures (Klunzinger, 2012). CFM are also strongly associated with the presence of woody debris, likely due to the protection it provides from high flows (Ma, 2018). Vegetation clearing can also disrupt the processes that provides LWD habitat for CFM, as although buildup of LWD due to inadequate flushing can cause anoxic conditions, LWD in appropriate densities is considered key habitat for CFM. A loss of shade can increase water temperatures in the shallow banks, where the presence of CFM is strongly associated (Ma, 2018).

Although freshwater mussels are mostly considered sessile, Lymbery *et al.* (2020) found that CFM could move up to 85 cm over three days, following retreating water levels. This indicates the CFM's potential for active habitat selection (Ma, 2018), though CFM are unlikely to be able to retreat from rapid or large scale changes in water quality, and water temperature. It should be noted that areas proposed for clearing mostly overlap with areas already assessed as unsuitable for this species, and the current vegetation would only provide shade for CFM in the late afternoon, after the hottest part of the day.

3.4 Indirect Impacts – Erosion and Sedimentation

Increases in turbidity and TSS are a considerable threat to CFM, along with increased salinity and a drying climate (Klunzinger, 2012; Klunzinger *et al.*, 2015; Morgan *et al.*, 2011). High turbidity and suspended solids have a negative effect on the filtration ability of mussels. Fine sediments also fill interstices of more coarse sediments, causing a hardpan layer that is difficult for mussels to burrow into (Brim Box & Mossa, 1999). Sedimentation can reduce DO, clog mussel gills, as well as interfere with filter feeding (Brim Box & Mossa, 1999). Accumulation of silt can also smother juvenile mussels.

If unmanaged, clearing activity could temporarily create deleterious water quality conditions, by increasing sedimentation and total suspended solids (TSS), which can lead to lower DO available for aquatic biota including CFM. The reduction of DO from sedimentation and increases in TSS may exacerbate low DO conditions that already exist within Wetland East. However, Main Roads propose to manage erosion and sedimentation through the installation of control structures. These structures include sediment fences, booms and silt fences, to be used when working over or adjacent to areas of surface water to protect the quality of surface water from construction impact. Again, high-risk construction activities, such as clearing and excavations within 50 m of the wetland will be timed to occur during summer/lower rainfall months (1 November to 30 April). This timing should reduce the likelihood of project-related sedimentation within the wetland occurring. Disturbed areas will also be stabilised as soon as is practicable after ground disturbing activities are completed. To further manage potential impacts from erosion and sedimentation, daily inspections will be undertaken of:

- Erosion and sediment control structures, to verify proper installation and effectiveness, and as far as practicable, including immediately before and following a 12 mm or greater rainfall event
- Disturbed areas and stockpiles within 100 m of the wetland to confirm appropriate installation of erosion and sediment control features.

Monthly water quality monitoring at the wetland will be undertaken, which will be compared against baseline data. This monitoring will occur immediately before clearing occurs

(baseline) and then for twelve months following clearing commencing. The inclusion of detailed water quality analysis will assist in early detection of high sediment and turbidity levels above CFM thresholds. In the absence of site-specific guideline values (SSGVs), water quality data should be compared against the ANZG (2018) default guideline values (DGVs) for the protection of aquatic ecosystems in the South West (wetlands), as well as known tolerance limits for CFM, and baseline and control levels. While specific tolerance research has not been undertaken, distribution studies recorded CFM within a turbidity of 0 to 106.5 NTU (Klunzinger *et al.*, 2015).

It is considered that any increase in turbidity and TSS caused by the clearing activities would be relatively short-lived given the scale and nature of the clearing proposed and that the area has been largely cleared before. If the water quality of the wetland was altered by the clearing works, the duration of the impact will be dependent on the amount of follow up rainfall received and the intensity of associated flushings.

3.5 Indirect Impacts – Increased Turbidity and Liberation of Analytes

Elevated TSS has the potential to carry contaminants such as metals or nutrients within sediment particles, which can become mobilised and impact aquatic biota (Wright & Welbourn, 1994). Mobilisation of metals and other toxicants from sediments can then be transported and bioaccumulated up the food chain (Gál *et al.*, 2008). CFM are known to bioaccumulate toxins such as organochlorine pesticides (Storey & Edward, 1989). If contaminants are mobilised and taken up by CFM, there is the potential for fauna that predate on CFM to be impacted, such as rakali (*Hydromys chrysogaster*). Acute toxicity may also have lethal effects on individuals; however, such thresholds are not known. The targeted survey undertaken by Biologic (2022a) only recorded in situ water quality parameters, so baseline concentrations of dissolved metals and nutrient analytes are currently unknown.

Other contaminants related to construction activity may also be introduced to Wetland East, such as hydrocarbons through fuel spills and leakage from machinery. Any additional inputs of hydrocarbons and other contaminants into Wetland East have the potential to extend to areas which support CFM, and therefore have the potential to adversely impact populations. However, in addition to the sedimentation structures described above, Main Roads propose to manage for such spills through the implementation of appropriate barriers and/or bunding.

As mentioned above, monthly water quality monitoring is planned to occur for 12 months following the commencement of clearing when TSS and turbidity levels are expected to be highest. The water quality analysis suite will include dissolved metals and other toxicants, including hydrocarbons, and should be able to detect changes to water quality resulting from clearing. Baseline data will be collected prior to construction activities.

3.6 Indirect Impacts – Alteration of Hydrological Regimes

While water sources feeding into Wetland East are not currently known, minimal changes to hydrology are expected as proposed clearing will mostly occur along previously cleared areas. Monthly water quality monitoring will be designed to include observations of decaying organic material.

4 Conclusion

No CFM habitat is present within the area to be impacted by the GEHBI project and no CFM individuals are expected to be impacted directly by the project's clearing.

Vegetation clearing will have a minimal impact on the population of CFM in Wetland East, as the shading vegetation adjacent to where the majority of the CFM population was found will not be impacted. CFM individuals may be indirectly impacted by changes to water quality due to project clearing; however, given the scale, nature and timing of this clearing and the management and monitoring proposed, these impacts are not expected to be significant.

Main Roads plans to mitigate and manage impacts to Wetland East through the clearing and construction phases of the Project (Table 1). Construction management techniques will ensure that there is no off-site transport of sediment or water runoff into Wetland East during construction. The final road and drainage design will ensure that road runoff is directed into a drainage basin on the western side of Roe Highway and not into wetland east. Accordingly, the road operation will have no further impact on the wetlands.

As a further preventative measure, subject to approval from DBCA, if monitoring indicates individuals are being affected by a change in water quality, relocation of CFM should be considered. Translocation of CFM at Wetland East was recommended by Biologic (2022b) in the event that a vegetation buffer could not be retained; however, regulators were not supportive of translocation. However, as a further preventative measure, relocation within the same wetland may be appropriate to provide an additional buffer between individuals and the proposed clearing and construction activities. These individuals could then be monitored, along with water quality and water levels.

Although no habitat is present, a pre-clearance inspection for buried mussels within the impact areas should also be considered in case individuals have inadvertently moved into the area.

Table 1: Potential impacts to Carter's freshwater mussel at Wetland East, and planned management to mitigate risk

Potential Impacts	Proposed Management
Direct impact to individuals	• All suitable habitat avoided. • Time high-risk construction activities, such as clearing and excavations adjacent to the wetland, between 1 November to 30 April where water levels are at their lowest
Exacerbation of pre-existing anoxic conditions	• Vegetation to be felled in a manner that ensures vegetative debris is directed away from the wetland • No cleared vegetation will be stockpiled within 50 m of the high water mark of nearby wetlands • Cleared vegetation will not be stored for more than 12 hours within 50 m of the high water mark of nearby wetlands • Barriers to prevent sedimentation that may cause smothering
Reduction in riparian vegetation and shading	• All of the clearing to occur in area assessed as unsuitable for CFM • Area to be cleared for project are previously cleared areas or vegetation classified as degraded • Clearing to occur on the western side of the wetland, which provides minimal shading to the wetland itself
Erosion and sedimentation	• Installation of control structures during clearing and construction (sediment fences, booms and silt fences) to be used when machines are working over or adjacent to areas of surface water • Timing of high-risk construction activities, such as clearing and excavations adjacent to the wetland will occur between 1 November to 30 April. • Disturbed areas to be stabilised as soon as is practicable after ground disturbing activities are completed • Daily inspection of erosion and sediment control structures, to verify proper installation and effectiveness • Daily inspection of disturbed areas and stockpiles for appropriate installation of erosion and sediment control features • Monthly water quality monitoring at the wetland, compared to control and baseline and water quality guidelines to identify project related water quality impacts
Liberation of analytes	• Monthly water quality monitoring at the wetland, compared to control and baseline and water quality guidelines to identify project related water quality impacts. Inclusion of dissolved metals and hydrocarbons recommended

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Appendix A: Important Note

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