# APPENDIX G

## Aquatic Ecology and Water Quality Impact Assessment (frc environmental)

# Six Mile Creek Dam Safety Upgrade Project:

## Aquatic Ecology and Water Quality Impact Assessment

*Prepared for:*

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## Summary

frc environmental was commissioned by SMEC on behalf of Seqwater to undertake an assessment of potential risks to the aquatic ecological values of Six Mile Creek, and to identify impact mitigation strategies for the Six Mile Creek Dam Safety Upgrade Project (the Project). The scope of the study involved:

- describing the aquatic Environmental Values of Six Mile Creek and Lake Macdonald
- reviewing the legislative and policy framework for protecting aquatic ecological values in Queensland
- identifying potential sources of impact to the aquatic ecological values associated with the Project and assessing the level of risk to aquatic ecological values
- identifying likely impact mitigation strategies and assessing the effectiveness of each strategy, and
- providing recommendations regarding preferred impact mitigation strategies and other management controls to protect the aquatic ecological values of Six Mile Creek.

Six Mile Creek is a large tributary of the Mary River, originating inland from Noosa Heads and flowing for approximately 60 km north-west to join the Mary River approximately 4.5 km south of Gympie. Six Mile Creek Dam is in the upper reaches of Six Mile Creek at ATMD 55 km. The existing dam has a capacity of 8,018 megalitres at a Full Supply Level of 95.32 m, which will not change after the completion of the Project. The existing dam does not incorporate a fishway.

The aquatic ecological values of Six Mile Creek and Six Mile Creek Dam were assessed using a literature and database review, synthesis of existing data for aquatic habitat, water quality, aquatic plants, fish and turtles (including from past field surveys), field survey, and consultation with key experts. Overall, aquatic ecology and water quality data was assessed at 13 sites on Six Mile Creek and two sites on Lake Macdonald. Water quality data collected by Seqwater at an additional four sites was also assessed. Platypus and stygofauna were also assessed using a desktop approach.

Two threatened fish and two freshwater turtle species listed under the *Environment Protection and Biodiversity Act 1994* (i.e. aquatic Matters of National Environmental Significance) are known from the Mary River and Six Mile Creek:

- white-throated snapping turtle (*Elseya albagula*), critically endangered
- Mary River cod (*Maccullochella mariensis*), endangered

- Mary River turtle (*Elusor macrurus*), endangered, and
- Australian lungfish (*Neoceratodus forsteri*), vulnerable.

Mary River cod and Australian lungfish are known from Six Mile Creek downstream of Lake Macdonald, and it is possible that Mary River turtle and white-throated snapping turtle sometimes occur in the lower reaches of Six Mile Creek. Mary River cod are known to breed in Six Mile Creek downstream of Lake Macdonald. Within Lake Macdonald, and upstream of Lake Macdonald, platypus are known to occur, Mary River cod and Australian lungfish may occur but are unlikely to be breeding, and Mary River turtle or white-throated snapping turtle are likely to be rare or absent. Matters of State Environmental Significance downstream and upstream of Lake Macdonald (other than fish passage) include several categories of regulated vegetation and High Ecological Value (watercourse) waters.

The desktop assessment indicated that the alluvium of the Project area is *unlikely to be suitable* for stygofauna due to high clay content, low hydraulic conductivity and high total dissolved solids, and the Kin Kin sandstone is *suitable* for stygofauna due to the higher hydraulic conductivity.

The following sources of potential impact from the Project to the aquatic Environmental Values of Six Mile Creek and Lake Macdonald were identified:

- Impacts to water quality in Lake Macdonald and downstream of the lake
- Impacts to aquatic habitat in Lake Macdonald and downstream
- Impacts to aquatic fauna (injury, mortality or stranding) in Lake Macdonald
- Impacts to aquatic flora in Lake Macdonald and downstream of the lake
- Spread of biosecurity matters downstream of Lake Macdonald
- Impacts to stygofauna communities in shallow groundwater systems, and
- Barriers to fish passage at the dam wall.

The risks of, and mitigations for, each of the identified potential sources of adverse impact of the Project on the Environmental Values of Six Mile Creek were assessed using a risk-based approach.

Potential direct and indirect impacts of the Project are likely to affect both Lake Macdonald and Six Mile Creek downstream. As the Project is replacing an existing dam wall the long-term impact will be no change from current condition. Most sources of impact during the Project were assessed as having a low risk of impact when appropriate mitigations are applied. Most potential impacts will be temporary (i.e. for the duration of the drawdown and construction periods; approximately 2 to 3 years in total), and if appropriate mitigations are applied there will be no ongoing impacts to the aquatic environmental values of Lake Macdonald or Six Mile Creek.

However, the temporary loss of aquatic habitat in Lake Macdonald due to the drawdown of the lake for safety during construction still resulted in a moderate residual impact after mitigation measures were applied. There will be a temporary loss of approximately 97.2% of aquatic habitat (by water volume) in Lake Macdonald, which requires additional mitigation in the form of a comprehensive aquatic fauna salvage operation. This is an unavoidable risk given the safety requirements of the Project.

Matters of National Environmental Significance were also assessed against the Significant Impact Criteria for critically endangered, endangered and vulnerable aquatic species. The assessment indicates that, while there may be temporary impacts, a significant impact from the Project on aquatic species that are Matters of National Environmental Significance is unlikely.

Fish passage is currently not provided at the Six Mile Creek dam. While fishway options have been considered for the Six Mile Creek dam upgrade (e.g. frc environmental, 2016; Seqwater 2018), preliminary advice from the Department of Agriculture and Fisheries indicates that the risk of aiding upstream dispersal by the noxious fish, tilapia, outweighs the benefit of providing fish passage for native species. Off-site mitigation measures for fish passage are therefore proposed; specifically the provision of fish passage at Gympie Weir by installation of a suitable fishway.

# 1 Introduction

## 1.1 Scope and Objectives of Study

frc environmental was commissioned by SMEC on behalf of Seqwater to undertake an assessment of potential risks to the aquatic ecological values of Six Mile Creek, and to identify impact mitigation strategies for the Six Mile Creek Dam Safety Upgrade project (the Project). The scope of the study involved:

- describing the aquatic Environmental Values of Six Mile Creek and Lake Macdonald
- reviewing the legislative and policy framework for protecting aquatic ecological values in Queensland
- identifying potential sources of impact to the aquatic ecological values associated with the construction and operational phases of the project, and assessing the level of risk to aquatic ecological values associated with each source of impact
- identifying likely impact mitigation strategies to reduce the level of risk associated with each identified source of impact, and assessing the likely effectiveness of each strategy, and
- providing recommendations regarding preferred impact mitigation strategies and other management controls to protect the aquatic ecological values of Six Mile Creek.

# 2 Overview of the Mary River and Six Mile Creek and Lake Macdonald

## 2.1 Mary River

From its headwaters in the Sunshine Coast hinterland near the township of Conondale, the Mary River flows north for approximately 290 km past the towns of Kenilworth, Gympie, Tiaro and Maryborough, before flowing into the Great Sandy Strait near Hervey Bay (Map 2.1). The Mary River downstream of the confluence with Six Mile Creek is stream order 8.

The predominant land use in the Mary River Basin is grazing on cleared land; however, there are also forestry reserves, national parks, and rural and urban areas throughout the basin (Johnson 1997). There are numerous weirs and dams along the Mary River and its tributaries, including Gympie Weir, Borumba Dam, Lake Baroon, Tallegalla Weir, Teddington Weir and the Mary River Barrage (Map 2.1).

The Mary River has perennial flow, with flows greater than 10 ML/day occurring approximately 95% of time (Figure 2.1 and Figure 2.2). The 50$^{th}$ percentile flow is approximately 500 ML/day in the upper Mary River and approximately 900 ML/day in the lower Mary River.

Applicable Environmental Values (EVs) pursuant to the Environmental Protection (Water) Policy (DERM 2010) for the upland and lowland freshwaters of the Mary River are shown in Table 2.1. The Water Plan (Mary Basin) 2006 presents ecological outcomes for the Mary River:

- minimise changes to the low flow regime of the river, and
- minimise changes to the hydraulic habitat requirements of species such as the Mary River cod, Mary River turtle and lungfish.

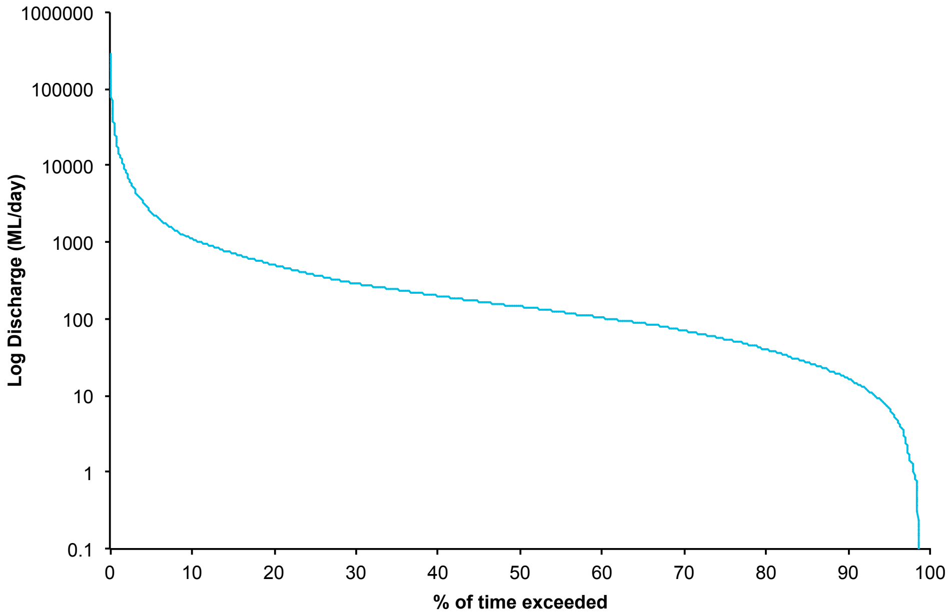



Figure 2.1 Flow duration curve since 1963 for the upper Mary River at Moy Pocket (gauging station 138111A).

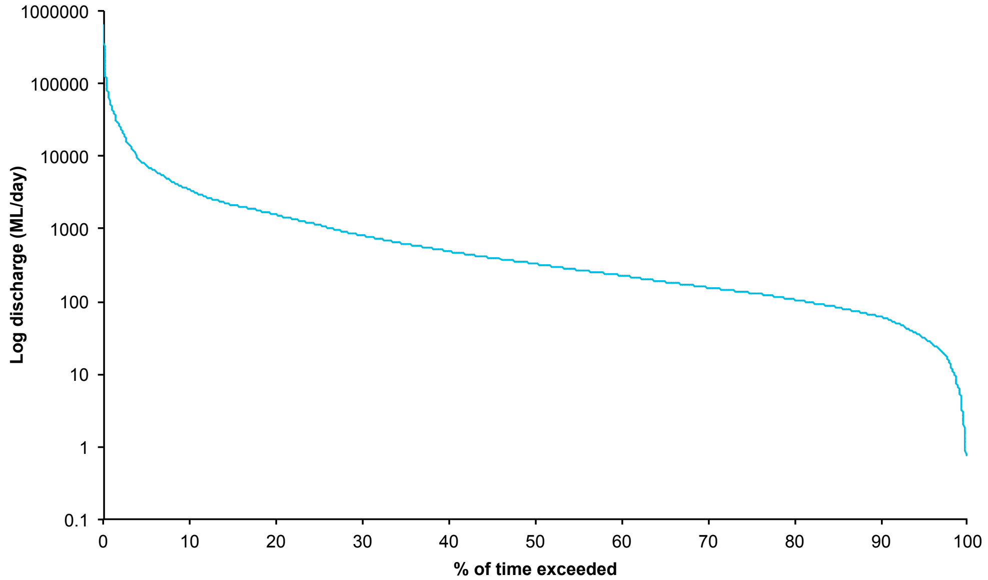



Figure 2.2 Flow duration curve since 1968 for the lower Mary River at Fisherman's Pocket (gauging station 138007A).

Table 2.1 Environmental Values pursuant to the EPP(Water) for the Mary River and Six Mile Creek.

| Environmental Value | Upper Mary River | Lower Mary River | Six Mile Creek |
|---|---|---|---|
| Aquatic ecosystems | ✓ | ✓ | ✓ |
| Irrigation | ✓ | ✓ | ✓ |
| Farm supply | ✓ | ✓ | – |
| Stock water | ✓ | ✓ | ✓ |
| Aquaculture | ✓ | ✓ | ✓ |
| Human consumers of fisheries | ✓ | ✓ | ✓ |
| Primary recreation | ✓ | ✓ | ✓ |
| Secondary recreation | ✓ | ✓ | ✓ |
| Visual recreation | ✓ | ✓ | ✓ |
| Drinking water | ✓ | ✓ | ✓ |
| Industrial use | ✓ | ✓ | – |
| Cultural and spiritual values | ✓ | ✓ | ✓ |

✓ EV applies

– EV does not apply


Lake Macdonald Dam Upgrade Project
Aquatic Ecology Risk Assessment

Map 2.1: Mary River Basin, showing location of Six Mile Creek in the Upper Mary River and existing impoundments

**LEGEND**

Mary River Basin

Sub-basins

Upper Mary River

Other Sub-basin

Catchment

Six Mile Creek

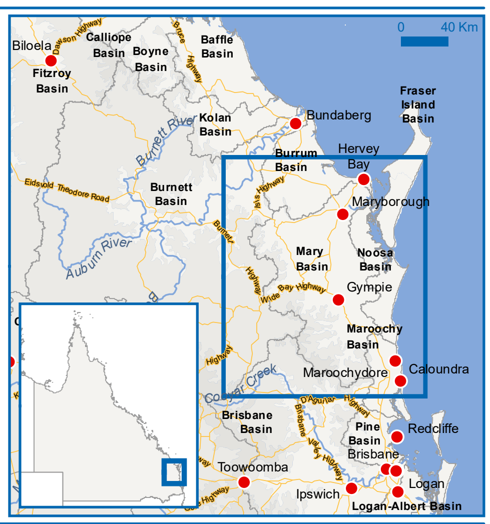
Impoundment

DNRME Gauging Station

Watercourse

Lake/Reservoir

Highway / Major Road





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**SOURCES**



| DATE | DRAWN BY | VERSION | PROJECTION |
|---|---|---|---|
| 2018-10-10 | LP | 01 | Coordinate System: GCS GDA 1994<br>Datum: GDA 1994<br>Units: Degree |

N

SCALE

0 3 6 12 18 24 30

Kilometers

Scale: 1:600,000 @ A3

## 2.2 Six Mile Creek

Six Mile Creek is a large (i.e. stream order 5) tributary of the Mary River, originating inland from Noosa Heads and flowing for approximately 60 km north-west to join the Mary River approximately 4.5 km south of Gympie at 36 km from the Mary River estuary (Map 2.1). Land uses in the catchment of Six Mile Creek include forestry, grazing, horticulture, rural residential and urban areas.

Six Mile Creek also has reasonably perennial, albeit variable, flow, with flows greater than 10 ML/day occurring approximately 80% of the time at the Cooran gauging station (AMTD 32.4 km) (Figure 2.3). Flow in Six Mile Creek is an order of magnitude lower than for the upper Mary River (i.e. the 50$^{th}$ percentile flow in Six Mile Creek is approximately 50 ML/day). Monthly median flows are highest in March and lowest through the late winter and spring months (Hydrobiology 2008), although there is high variability in the magnitude of daily and inter-annual flows (Figure 2.4 and Figure 2.5).

Applicable Environmental Values (EVs) pursuant to the Environmental Protection (Water) Policy (EPP) for Six Mile Creek are shown in Table 2.1. The aquatic ecosystems EV is described in detail in Section 3. The Water Plan (Mary Basin) 2006 presents ecological outcomes for the Six Mile Creek, including minimising changes to the low flow regime of the creek, and minimising changes to the hydraulic habitat requirements of species such as the Mary River cod and lungfish

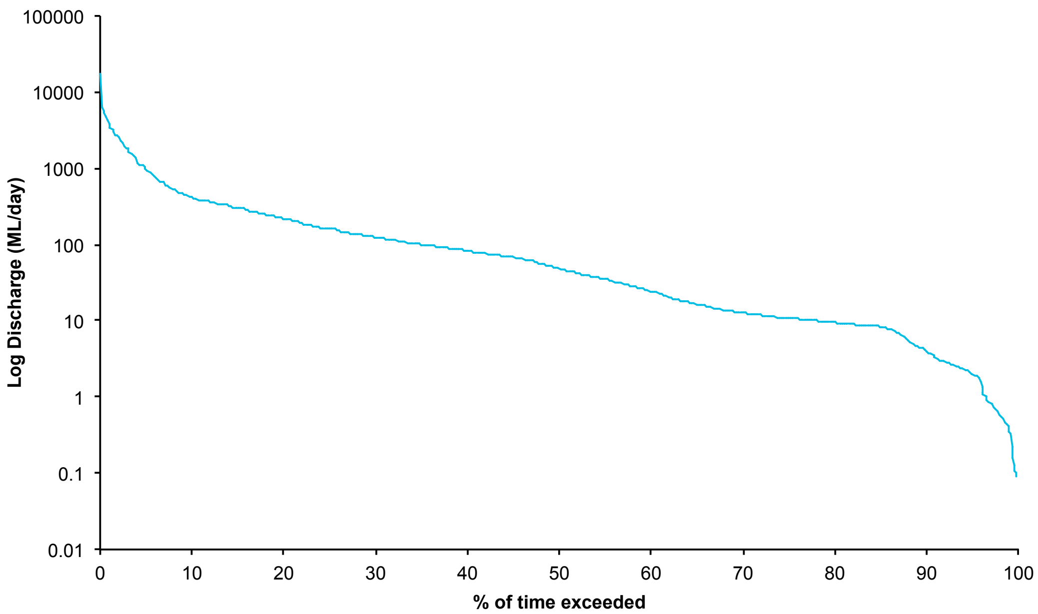



Figure 2.3 Flow duration curve since 1981 for Six Mile Creek at Cooran (gauging station 138107B).

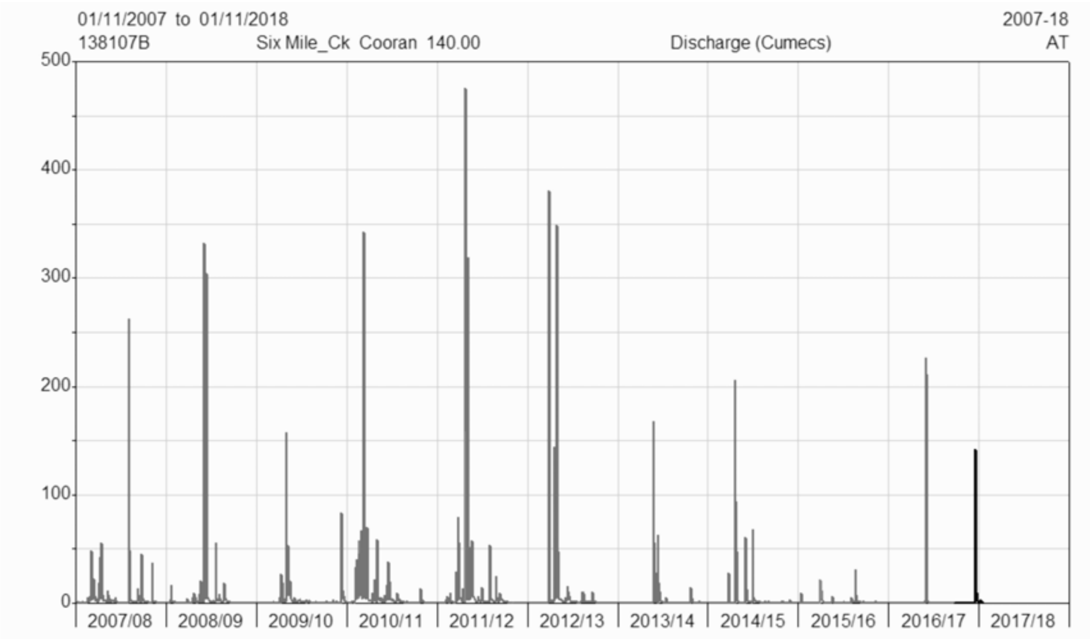



Figure 2.4 Daily flow from 2007 to 2017 in Six Mile Creek at Cooran (gauging station 138107B).

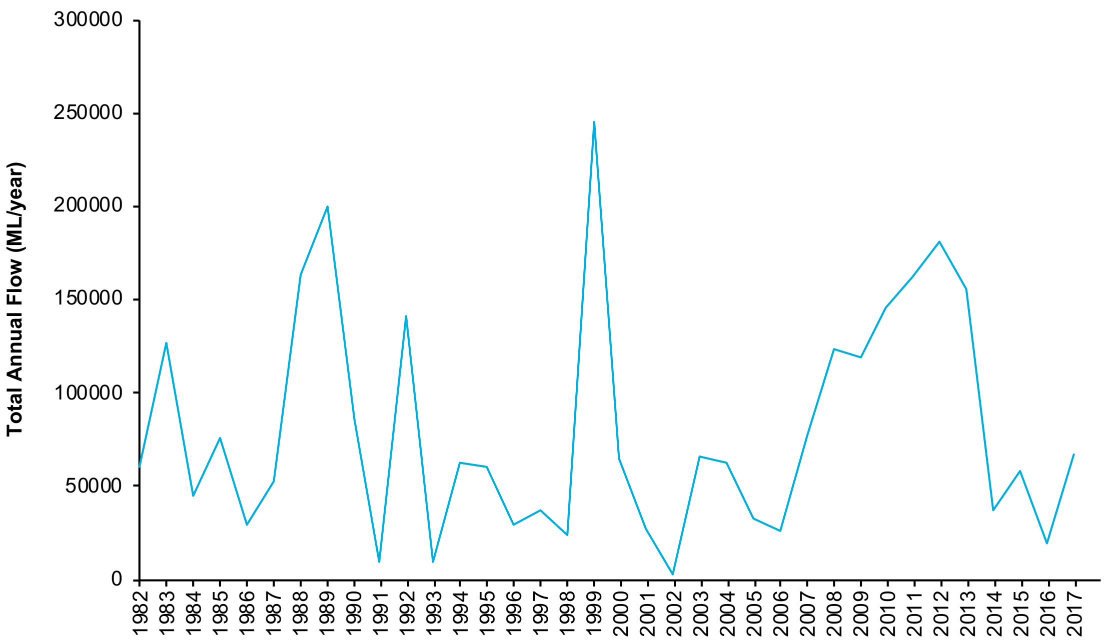



Figure 2.5 Total annual flow from 1982 to 2017 in Six Mile Creek at Cooran (gauging station 138107B)

## 2.3 Six Mile Creek Dam

Six Mile Creek Dam is located in the Noosa Shire local government area on the upper reaches of Six Mile Creek at ATMD 55 km, and is 95 km from the Mary River estuary. It was built in 1965 for the purpose of town water supply, and upgraded (i.e. 3.6 m was added to the original height of the dam to increase storage capacity) in 1980. The catchment area for the dam is approximately 49 $km^2$, with surrounding land uses including agriculture, forestry, rural residential, and a variety of uses such as conservation, tourism and recreational activities. Seqwater leases areas of land adjacent to Lake Macdonald to the Gerry Cook Fish Hatchery, which is managed by the Mary River Catchment Coordinating Committee (MRCCC). Seqwater also provides a range of recreation facilities at Lake Macdonald including parklands, picnic facilities, boat ramps, a viewing platform and a designated canoe trail, and allow unpowered boating (electric motors only) and fishing on the lake:

The existing dam is an ungated zoned earth and rock fill dam (Table 2.2). The spillway consists of anchored concreted slabs on compacted earth fill, with an uncontrolled ogee crest. The capacity of the dam is 8,018 megalitres (ML) at a Full Supply Level (FSL) of 95.32 m Australian Height Datum (AHD), creating an impoundment area of approximately 260 hectares (ha) at this level with a maximum depth of 10.5 m. The existing dam does not incorporate a fishway.

Total annual outflows (i.e. combined spillways flows and environmental releases via the outlet works) occur 75% of the time on average, with seasonal outflows highest in autumn (94% of the time on average) and lowest in spring (51% of the time on average). The Resource Operations Plan licences the SEQ Water Grid Manager and Queensland Bulk Water Supply to take a combined annual total of 3500 ML to be extracted from Six Mile Creek Dam when it is above the minimum operating volume of 22 ML / 87.7 m AHD, at prescribed rates for each water licence holder. Daily environmental releases are made from Six Mile Creek Dam through the outlet works pursuant to the Resource Operational Plan using the following in-flow / out-flow rules:

- 0.25 ML out-flow when in-flows are 1.0 – 10.0 ML,
- 2.0 ML out-flow when in-flows are 10.0 – 30 ML, and
- 5.0 ML out-flow when inflows are >30 ML.

Table 2.2 Key parameters of the existing dam

| Design Parameter | Existing Dam |
|---|---|
| Spillway type | Uncontrolled fixed ogee crest |
| Spillway Description | Concrete slab broad crest weir |
| Spillway crest elevation (low level) | Notch/initial: RL 95.32 m AHD |
| | Full width: RL 95.35 m AHD |
| Spillway crest elevation (high level) | Not applicable |
| Stilling basin floor elevation | RL 83.5 m |
| Energy dissipation method | Plunge pool/stilling basin |
| Full supply level | 8,018 ML |
| Dead storage | RL 87.7 m |
| Historical No Failure Yield | 7,118 ML/y |
| Maximum depth | 10.5 m |
| Area inundated at FSL | 260 ha |

# 3 Review of Applicable Legislation

## 3.1 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides the legal framework for the protection and management of nationally and internationally threatened flora and fauna (including migratory species), ecological communities, internationally important wetlands, heritage places, the Great Barrier Reef, and Commonwealth marine areas, which are collectively defined as Matters of National Environmental Significance (MNES). Water resources in relation to coal seam gas and large mining projects, and nuclear actions, are also regulated under the EPBC Act.

The EPBC provides protection for threatened flora, fauna and ecological communities by:

- identifying and listing of species and ecological communities as threatened
- developing conservation advice and recovery plans for listed species and ecological communities
- developing a register of critical habitat
- recognising key threatening processes
- where appropriate, reducing the impacts of these processes through threat abatement plans and non-statutory threat abatement advices, and by
- requiring approval for certain actions or activities that will, or are likely to, have a significant impact on an MNES or other protected matter.

Thirty-six species of freshwater fish and seven species of freshwater turtles[1] are listed as threatened under the EPBC Act, with four of these species known from the Mary River and Six Mile Creek[2]:

- white-throated snapping turtle (*Elseya albagula*), critically endangered
- Mary River cod (*Maccullochella mariensis*), endangered
- Mary River turtle (*Elusor macrurus*), endangered, and
- Australian lungfish (*Neoceratodus forsteri*), vulnerable.

1 EPBC Act list of threatened fauna (http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl#fishes_extinct_in_the_wild); viewed 29 March 2018.

2 The PMST (Appendix A) indicated that black rock cod (*Epinephelus daemelii*) may occur within 10 km of the Project area. However, this species is a marine fish associated with rocky reefs, and it is not known from freshwater habitats, and therefore would not occur in any habitat that is potentially influenced by the Project. Consequently, this species was not considered in this study.

The EPBC provides guidance on whether an action (e.g. a proposed development) is likely to have a significant impact on a MNES. Significant Impact Guidelines 1.1 (DEE 2013) provide guidance, in the form of assessment criteria, in relation to significant impacts on threatened species under the EPBC Act.

An action is likely to have a significant impact on a threatened species (i.e. critically endangered, endangered and vulnerable species) if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population (important population for vulnerable species)
- reduce the area of occupancy of the species (important population of a vulnerable species)
- fragment an existing population (important population of a vulnerable species) into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of a population (important population of a vulnerable species)
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a critically endangered, endangered or vulnerable species becoming established in the endangered, critically endangered or vulnerable species' habitat
- introduce disease that may cause the species to decline, and / or
- interfere with the recovery of the species.

Where assessment identifies that an action will have a significant impact on a threatened species, then the action will be determined as a 'controlled' action and require appropriate environmental assessment within the approval application process.

## 3.2 Queensland Environmental Protection Act 1994

The Queensland *Environmental Protection Act 1994* (EPA 1994) provides the legislative framework for ecologically sustainable development in Queensland, requiring people, companies and government to take all reasonable and practical steps to protect Environmental Values (i.e. avoid harm to the environment). The Act provides a range of mechanisms to achieve the objective of the Act, including establishing Environmental Protection Policies that present the strategies for protecting Environmental Values.

## 3.3 The Environmental Protection (Water) Policy 2009

The Environmental Protection (Water) Policy 2009 (EPP Water) supports the Act through:

- identifying High Ecological Value (HEV) waters
- identifying Environmental Values (EV) and management goals for water
- providing water quality guidelines and Water Quality Objectives (WQO) to enhance or protect the identified EV
- providing a framework for decision making about Queensland waters, and
- requiring the monitoring of, and reporting on, the condition of Queensland waters.

EVs for Queensland waters includes the protection of aquatic ecosystems. The components of aquatic ecosystems to be protected are generally specified under the EPP (Water) for a given waterway if WQOs have been listed under Schedule 1 of the EPP (Water). For the Mary River, the components of aquatic ecosystems to protected are:

- existing water quality (20th, 50th and 80th percentiles), habitat, biota (fish and macroinvertebrates), flow and riparian areas in HEV waters, and
- water quality and riparian vegetation for all other waters, with:
  - the median concentration of several independent samples to achieve the scheduled WQO for the appropriate water type for physico-chemical water quality parameters
  - the 95$^{th}$ percentile concentration of several independent samples to achieve the National WQO for the appropriate water type for toxicant water quality parameters, and
  - riparian vegetation to achieve the applicable vegetation code under the *Vegetation Management Act 1999*.

A defensible assessment of the Environmental Values for water within the framework established by the EPP (Water) would also include the assessment of protected matters relevant to aquatic ecology, including matters protected under the EPBC Act and Queensland's *Nature Conservation Act 1992*, *Fisheries Act 1994* and *Vegetation Management Act 1999*[3].

[3] These and other protected matters also comprise Matters of State Environmental Significance (MSES), which are components of Queensland's biodiversity of state interest defined under the State Planning Policy and the *Environmental Offsets Regulation 2014*. MSES comprise certain Environmental Values protected under Queensland Legislation, including the *Environmental Protection Act 1994*, *Nature Conservation Act 1992*, *Fisheries Act 1994* and *Vegetation Management Act 1999*.

## 3.4 Queensland Nature Conservation Act 1992

The *Nature Conservation Act 1992* provides for the conservation of Queensland's nature by declaring and managing a protected area network, protecting threatened species (wildlife) and their habitats, regulating the taking of wildlife and co-ordinating nature conservation with Traditional Owners and other land owners. Several freshwater species are protected wildlife under the *Nature Conservation Act 1992.*

Protected wildlife listed under the *Nature Conservation Act 1992* must be protected from threatening processes, and critical habitat for protected wildlife is required to be protected to the greatest extent possible.

## 3.5 Queensland Fisheries Act 1994

The *Fisheries Act 1994* provides for the management and protection of fisheries resources, including regulating development that might impact declared fish habitat areas and fish passage. Several fish species of special interest are listed as 'no take' species under the Act, including Australian lungfish.

Fisheries resources, including declared fish habitat areas, waterways providing for fish passage and marine plants which are MSES, contribute to the Environmental Values of waterways and wetlands.

Fish passage is applicable to the current study (assessable development), with development potentially impacting fish passage being either:

- accepted development, where the design of infrastructure strictly conforms to the Department of Agriculture and Fisheries' (DAF's) Accepted Development Requirements for Operational Work that is Constructing or Raising a Waterway Barrier Works (2017), or
- assessable development, where the proposed development requires assessment by DAF (via SARA) and the design of the development is required to demonstrate compliance with the State Development Assessment Provisions (SDAP State code 18).

## 3.6 Queensland Vegetation Management Act 1999

The *Vegetation Management Act 1999* (VMA 1999), as updated by the *Vegetation Management and Other Legislation Amendment Act 2018*, regulates the clearing of vegetation to conserve threatened regional ecosystems, protect biodiversity and maintain ecological processes, amongst other purposes.

The VMA 1999 provides for the chief executive to certify various classes of regulated vegetation maps, with regulated vegetation a MSES. Classes of vegetation under the VMA include: vegetation that is remnant and / or threatened (category B), high value regrowth vegetation (category C) or regrowth vegetation in a wetland, watercourse or drainage feature area within a Great Barrier Reef catchment (category R). Vegetation in wetland areas and vegetation intersecting a watercourse is also regulated vegetation under the VMA. Vegetation clearing and development is regulated for Category R vegetation areas, and Riverine Protection Permits are required to clear vegetation in watercourses.

## 3.7 Queensland Water Act 2000

The Queensland *Water Act 2000* provides for the sustainable management of water resources in Queensland, including requiring permits for works within watercourses and providing for the sustainable allocation of water for environmental purposes (i.e. environmental flows to protect ecological functions in rivers). Many of these functions are documented in Resource Operations Plans (ROP) or Water Plans for a catchment, which include ecological outcomes and obligations for water licence holders or water scheme operators. For example, in relation to the Project, Seqwater (as a water licence holder for Six Mile Creek Dam) is obliged to make specified environmental flow releases from the dam to meet ecological outcomes in Six Mile Creek.

## 3.8 Queensland Biosecurity Act 2014

The aim of the *Biosecurity Act 2014* is to manage risks associated with exotic pests and diseases that impact plant and animal industries including aquaculture and wild capture fisheries, tourism, infrastructure including water supply, shipping, biodiversity, and the natural environment. The Act seeks to provide a framework to minimise biosecurity risks and to support a 'risk-based' approach to biosecurity management.

The Act defines biosecurity matters (i.e. *prohibited* matters, which are not yet present in Queensland; and *restricted* matters, which are currently present in Queensland); establishes a General Biosecurity Obligation (GBO); and establishes specific obligations in relation to prohibited and restricted matter.

The GBO requires those who deal with a biosecurity matter or carries out an activity, and knows or ought reasonably to know, that the biosecurity matter or activity poses, or is likely to pose, a biosecurity risk are obliged to take all reasonable measures to minimise the likelihood of causing a biosecurity risk, and / or do whatever is reasonably required to minimise the adverse effects of dealing with a biosecurity matter. Specifically, they may not keep or possess, whether intentionally or otherwise, the biosecurity matter, or propagate, raise, distribute or transport the biosecurity matter.

Prohibited matter are listed in Schedule 1 of the Act, and restricted matter are listed in Schedule 2. Aquatic pests that are restricted biosecurity matters listed in Schedule 2 of the Act include[4]:

- various pathogens
- fish, including but not limited to eastern Gambusia (*Gambusia holbrooki*), carp (*Cyprinus carpio*) and tilapia (*Oreochromis mossambicus*)
- aquatic plants, including but not limited to salvinia (*Salvinia molesta*), water hyacinth (*Eichhornia crassipes*), and cabomba (*Cabomba caroliniana*), and
- other plants that are common weeds of riparian areas.

## 3.9 Local Government Plans

Six Mile Creek Dam, and Six Mile Creek, are located in the Noosa Shire Council (NSC) Local Government Area (LGA).

### Corporate Plan 2017-2037

The NSC Corporate Plan 2017-2037 presents a vision for the Noosa Shire, including for the shire's natural environment. The 20 year environment goal under the Corporate Plan is 'Our environment is protected, enhanced and values by the community'.

Over the next five years adopting an over-arching Environment Strategy (incorporating a Biodiversity Plan, Waterways and Wetlands Management Plan, amongst other sub-plans) and revitalising the Noosa River Plan are key focus areas identified in the Corporate Plan.

In 20 years, aspirational targets include (amongst others):

- The Noosa River is clean, has abundant fish life and the river maintains it's a rating

4 Reprint current from 3 July 2017, viewed 23 April 2018.

- Integrated catchment management practices have improved our waterways and wetlands
- Biodiversity in the Noosa Shire has been preserved, and
- The Noosa natural environment is protected and enhanced.

While the NSC Corporate Plan focuses on the Noosa River, protecting Mary River cod and lungfish (and white-throated snapping turtle and Mary River turtle if they occur) in Six Mile Creek will be a key contribution to achieving preservation of biodiversity in the LGA.

### Operational Plan 2018 – 2019

The NSC Operational Plan underpins the Corporate Plan, with the Operational Plan updated annually to present specific projects to be undertaken to progress the achievement of the Corporate Plan's vision. The Operational Plan is closely aligned with Councils annual budget priorities.

Priority projects under the current (i.e. 2018 – 2019) Operational Plan that support the Corporate Plan's environmental vision 'Our environment is protected, enhanced and valued by the community' include (amongst others):

- adopt an initiate implementation of Environmental Strategy, and
- adopt and implementation of Noosa River Management Plan.

Protection of water quality, habitat and aquatic biodiversity of Six Mile Creek and Six Mile Creek dam would contribute towards the implementation of NSC's Environmental Strategy (noting the Environmental Strategy is still being drafted).

# 4 Aquatic Ecological Values of Six Mile Creek and Lake Macdonald

The aquatic ecological values of Six Mile Creek and Lake Macdonald have been assessed using:

- literature and database review, including:
  - DNRM (2004) Mary Basin Draft Water Resource Plan: Environmental Conditions Report including Mary River, Burrum River and Beelbi Creek Catchments
  - The MNES Protected Matters Search Tool and the Species Profile and Threats (SPRAT) database
  - The MSES search tool, for relevant MSES including declared fish habitat areas, wetland protection areas, HEV waters, regulated vegetation in riparian areas)
  - Department of Environment and Science's (DES's) Wildlife Online database
  - Atlas of Living Australia
- **synthesis of existing data** for aquatic habitat, water quality, aquatic plants, fish and turtles, collected:
  - within the scope of the Northern Pipeline Interconnector Stage 2 (NPI2) Aquatic Habitat Monitoring Program
  - within the scope of baseline studies, including field surveys, completed for the Six Mile Creek Dam Upgrade Project (frc environmental 2016)
  - by Seqwater during routine water quality monitoring programs
- **field survey**, for macroinvertebrates because there was no recent existing data
- **consultation with key experts**, including academics, agency staff and other relevant stakeholders (frc environmental 2016).

Overall, aquatic ecology and water quality data was assessed at 13 sites on Six Mile Creek, and two sites on Lake Macdonald, for the Project (Table 4.1 and Map 4.1). Water quality data collected by Seqwater at an additional four sites was also assessed. Consultation with key experts was completed in 2015 / 2016 and was presented with the detailed baseline aquatic ecology study (frc environmental 2016). Data for observations of platypus was provided by SMEC.

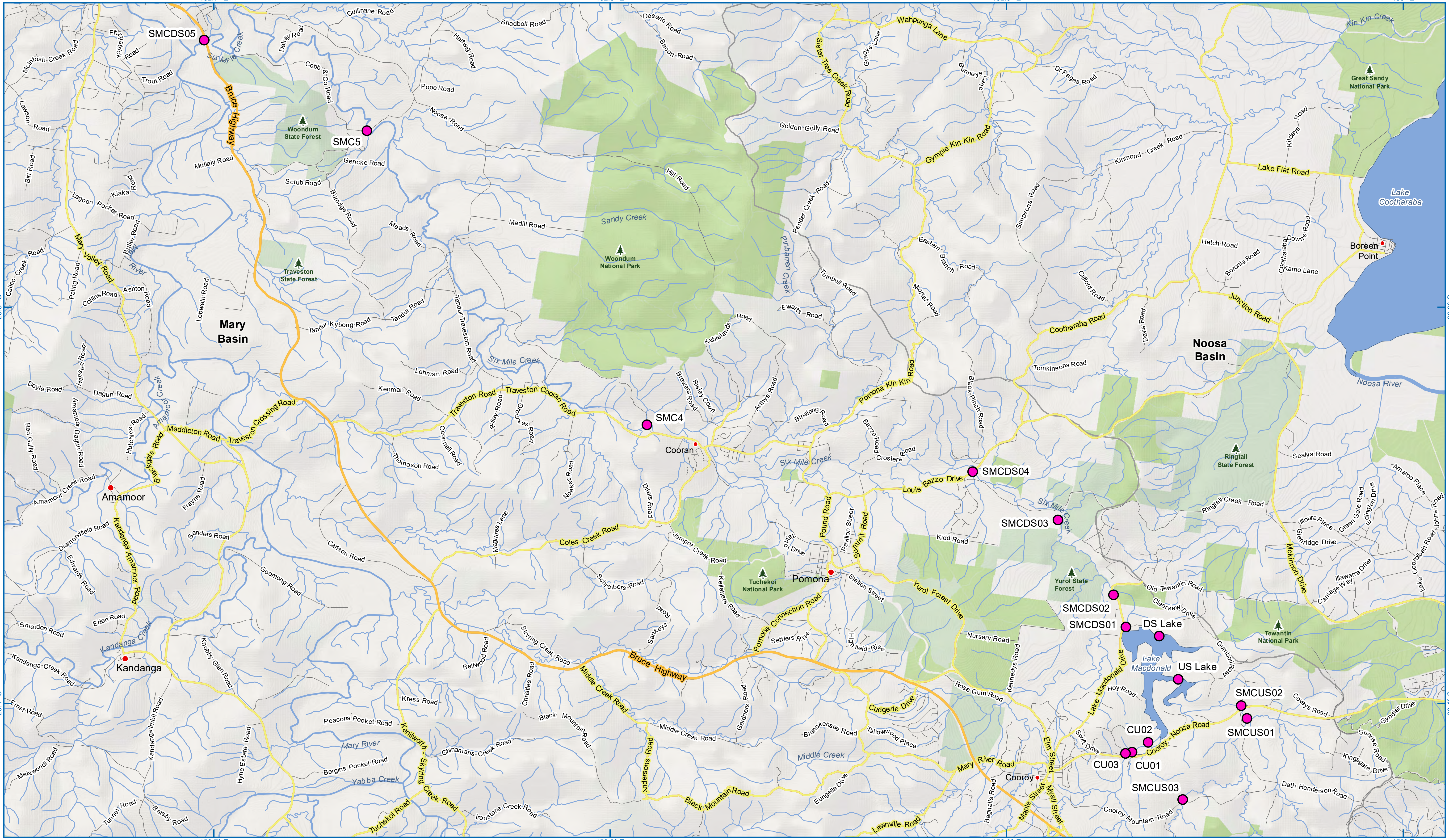
Table 4.1. Survey sites.

| Site | Description | Easting [a] | Northing [a] | Assessed Parameters [b] | Survey Dates |
|---|---|---|---|---|---|
| **Six Mile Creek – Downstream of Lake Macdonald** | | | | | |
| SMC4 | Six Mile Creek; approximately 19 km DS of the Lake Macdonald spillway | 480965 | 7087785 | H, WQ | Oct-13, Nov-14, Nov-15, Oct-16, Nov-17 |
| SMC5 | Six Mile Creek; approximately 28.5 km DS of the Lake Macdonald spillway | 473906 | 7095982 | H, WQ | Oct-13, Nov-14, Nov-15, Oct-16, Nov-17 |
| SMCDS05 | Six Mile Creek; approximately 45 km DS of the Lake Macdonald spillway | 469799 | 7098501 | H, WQ, F, T | Aug-15 |
| SMCDS04 | Six Mile Creek; approximately 7 km DS of the Lake Macdonald spillway | 489171 | 7086480 | H, WQ, F, T | Aug-15, Oct-15, Feb-18 |
| SMCDS03 | Six Mile Creek; approximately 4.5 km DS of the Lake Macdonald spillway | 491312 | 7085143 | H, WQ, P, F, T, M | Aug-15, Oct-15, Feb-18 |
| SMCDS02 | Six Mile Creek; approximately 1.5 km DS of the Lake Macdonald spillway | 492715 | 7083047 | H, WQ, P, F, T, M | Aug-15, Oct-15, Feb-18 |
| SMCDS01 | Six Mile Creek; directly DS of the Lake Macdonald spillway within the spillway stilling basin | 493026 | 7082149 | H, WQ, P, F, T, M | Aug-15, Oct-15, Feb-18 |
| **Lake Macdonald** | | | | | |
| DS Lake | Lake Macdonald; approximately 1 km US of the spillway | 493864 | 7081893 | H, WQ, F, T, M | Aug-15, Oct-15, Feb-18 |
| US Lake | Lake Macdonald; approximately 2.5 km US of the spillway | 494340 | 7080694 | H, WQ, F, T | Aug-15, Oct-15 |

| | | | | | |
|---|---|---|---|---|---|
| **Six Mile Creek – Upstream of Lake Macdonald** | | | | | |
| CU02 | Cooroy Creek; approximately 4 km US of the Lake Macdonald spillway | 493582 | 7078933 | H, WQ, F, T | Aug-15, Oct-15 |
| CU01 | Cooroy Creek; approximately 4.5 km US of the Lake Macdonald spillway | 493179 | 7078657 | H, WQ, F, T | Aug-15, Oct-15 |
| CU03 | Cooroy Creek; approximately 5 km US of the Lake Macdonald spillway | 493019 | 7078615 | H, WQ, F, T | Aug-15, Oct-15 |
| SMCUS02 | Six Mile Creek; approximately 5.5 km US of the Lake Macdonald spillway | 495930 | 7079951 | H, WQ, F, T | Aug-15, Oct-15 |
| SMCUS01 | Six Mile Creek; approximately 6 km US of the Lake Macdonald spillway | 496073 | 7079594 | H, WQ, F, T, M | Aug-15, Oct-15, Feb-18 |
| SMCUS03 | Six Mile Creek; approximately 11 km US of the Lake Macdonald spillway | 494453 | 7077331 | H, WQ, F, T | Aug-15, Oct-15 |

[a] WGS84 (Zone 56J)

[b] H = habitat; WQ = water quality; P = aquatic plants; M = macroinvertebrates; F = fish; T = turtles




# Lake MacDonald Dam Upgrade Project

## Map 4.1: Survey sites

**LEGEND**

- Sites
- Watercourse
- Lake/Reservoir
- Basin

**Road Network**

- Highway
- Main Road
- Local Road

**Protected Area**

- National Park
- Other Reserve

**SOURCES**

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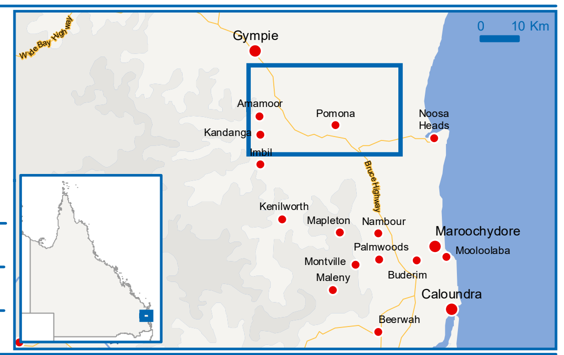


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## 4.1 Aquatic Habitat

### Assessment Methods

In addition to literature and databases described above, the aquatic habitat of Six Mile Creek and Lake Macdonald was assessed through the review of:

- Aquatic Conservation Values, as assessed by the Queensland Environmental Protection Agency using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM)
- DAF's Waterway barrier risk layer
- DES's Wetland*Maps* layer, and
- Queensland's floodplain assessment and groundwater-dependent ecosystem (GDE) layers.

The survey data that were synthesised were collected using the methods used for the NPI2 Aquatic Habitat Monitoring Program (for Seqwater), which were modified from State of the River methodology (Anderson 1993a, Anderson 1993b). The habitat assessment method was developed to specifically assess suitability of aquatic habitat for Mary River cod, Australian lungfish, Mary River turtle and white-throated snapping turtle at each site, which are the aquatic MNES potentially occurring in the Project area (Appendix A[5] and B). The habitat assessment included:

- habitat condition, and type and cover of key habitat features (e.g. pools, riffles, undercut banks, large woody debris)
- depth and width of streams
- substrate composition
- habitat sensitivities to various impacts, and
- identification of existing disturbances, including fish passage barriers.

[5] The PMST (Appendix A) indicated that black rock cod (*Epinephelus daemelii*) may occur within 10 km of the Project area. However, this species is a marine fish associated with rocky reefs, and it is not known from freshwater habitats, and therefore would not occur in any habitat that is potentially influenced by the Project. Consequently, this species was not considered in this study

## Results

Six Mile Creek is a low-gradient, low energy stream, with notophyll vine forest the dominant native riparian vegetation (DNRM 2004). Extensive deposits of large woody debris are an important natural feature of low energy streams, and are a common habitat element in Six Mile Creek (DNRM 2004). Medium length pools (i.e. between 6 and 12 channel widths in length) that are less than 2 m deep are common in Six Mile Creek, with riffles and shallow glides over sand also present (DNRM 2004).

With the exception of the Six Mile Creek Dam, disturbances along Six Mile Creek are relatively minor (DNRM 2004). Downstream of Lake Macdonald, flood flows have been reduced, low flows have been substantially reduced, and dry spells increased (DNRM 2004). As a result of the lower water levels in Six Mile Creek downstream of Lake Macdonald, large woody debris is more exposed (i.e. no longer providing as much submerged habitat for fish or turtles), riffles have declined, and consequently there is less suitable habitat for fish and turtle passage along this section of Six Mile Creek (DNRM 2004), although hydrological analysis by Hydrobiology (2008) suggest that the hydrological regime is not significantly different between current and pre-development scenarios. Sediment transport processes in the lower reaches of Six Mile Creek are likely to have been altered by Lake Macdonald, which captures over 90% of the incoming sediment load (DNRM 2004).

Six Mile Creek is a stream order 5 watercourse along its downstream reaches, with mapped floodplain and GDEs along or near Six Mile Creek (Map 4.2). The following Matters of State Environmental Significance, and aquatic conservation areas, are present (Map 4.3, 4.4, and 4.5):

- Matters of State Environmental Significance:
  - High Ecological Value (HEV) waters (waterways)
  - regulated vegetation: category R vegetation; vegetation intersecting a watercourse; and vegetation within 100m of a wetland
  - Waterways providing for fish passage (Six Mile Creek is identified as having major risk of impact to fisheries resources from waterway barrier works
- Aquatic Conservation Assessment:
  - riverine and lacustrine (i.e. Lake Macdonald) wetlands, and

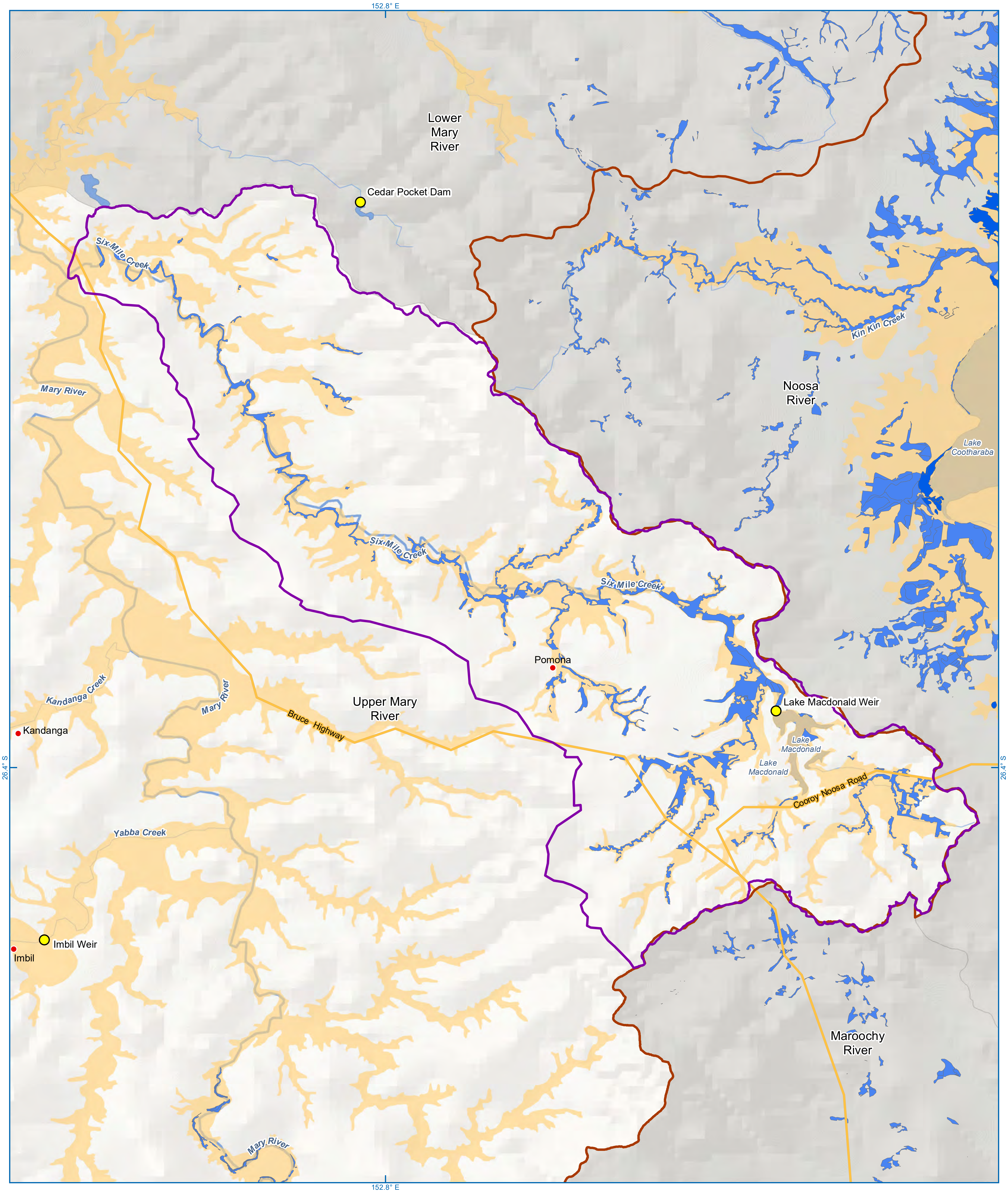
- very high and high conservation significance riverine areas in Six Mile Creek downstream of Lake Macdonald, and medium conservation significance riverine areas upstream of Lake Macdonald.

The detailed results of habitat surveys for each site from 2013 to 2018 are presented in Appendix C. The key habitat features of:

- Six Mile Creek *downstream* of Lake Macdonald include:
  - well-defined channel with high steep banks, and undercut banks present at most sites
  - substrate dominated by clay and silt, with gravel riffles present at most sites and bedrock present at some sites
  - high variation in flow, with riffles, runs and shallow and deep pools present at most sites
  - low abundance of submerged aquatic flora, except at site SMCDS01 immediately downstream of Six Mile Creek Dam where there was some *Cabomba caroliniana*[6] and *Nymphoides indica*
  - abundant large woody debris and leaf packs at each site
  - riparian vegetation is in good condition, providing shade and a supply of fine and large woody material
  - presence of suitable breeding locations for Mary River cod, but very limited breeding habitat for Australian lungfish
  - absence of suitable nesting habitat for Mary River and white-throated snapping turtle, and few places for turtle basking
  - an existing waterway barrier (i.e. rubble from the old road bridge) approximately 50 m downstream of the Six Mile Creek Dam
- within Lake Macdonald include:
  - a single flow habitat (deep pool)

[6] *Cabomba caroliniana* is a restricted biosecurity matter under the *Biosecurity Act 2014*

  - high abundance of submerged aquatic flora, predominantly *Cabomba caroliniana* and *Nymphoides indica*, and beds of emergent *Persicaria* spp. near lake margins
  - substrate dominated by silt, with some sand near banks
  - absence of suitable breeding locations for Mary River cod and Australian lungfish
  - absence of suitable nesting habitat for Mary River turtle and white-throated snapping turtle, and few places for turtle basking
  - limited large woody debris
- Six Mile Creek *upstream* of Lake Macdonald include:
  - well-defined channel with high steep banks, and undercut banks present at most sites
  - the flow habitats of some sites were influenced by impounded water; with site SMCUS03 having moderate diversity of flow habitats, with riffles, runs and deep pools all present
  - SMCUS01, SMCUS02 and Cooroy Creek sites were choked by *Cabomba caroliniana*
  - presence of potentially suitable breeding locations for Mary River cod, but very limited breeding habitat for Australian lungfish
  - limited suitable nesting habitat for Mary River and white-throated snapping turtle, and
  - turtle basking places present at most sites.




**Lake Macdonald Dam Upgrade Project**
**Aquatic Ecology Risk Assessment**

Map 4.2: Groundwater Dependent Ecosystems and Floodplains

**LEGEND**

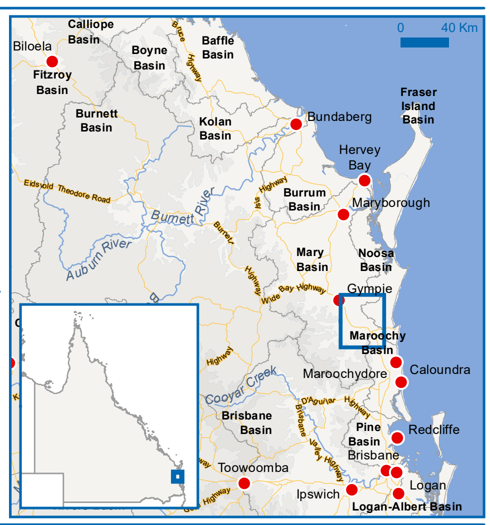
Mary River Basin

Sub-basins
- Upper Mary River
- Other Sub-basin

**Catchment**
- Six Mile Creek
- Impoundment

**Groundwater Dependent Ecosystems Surface Expression**
- Low Confidence
- Moderate Confidence
- High Confidence
- Known GDE
- Floodplain Areas

- Watercourse
- Lake/Reservoir
- Highway / Major Road





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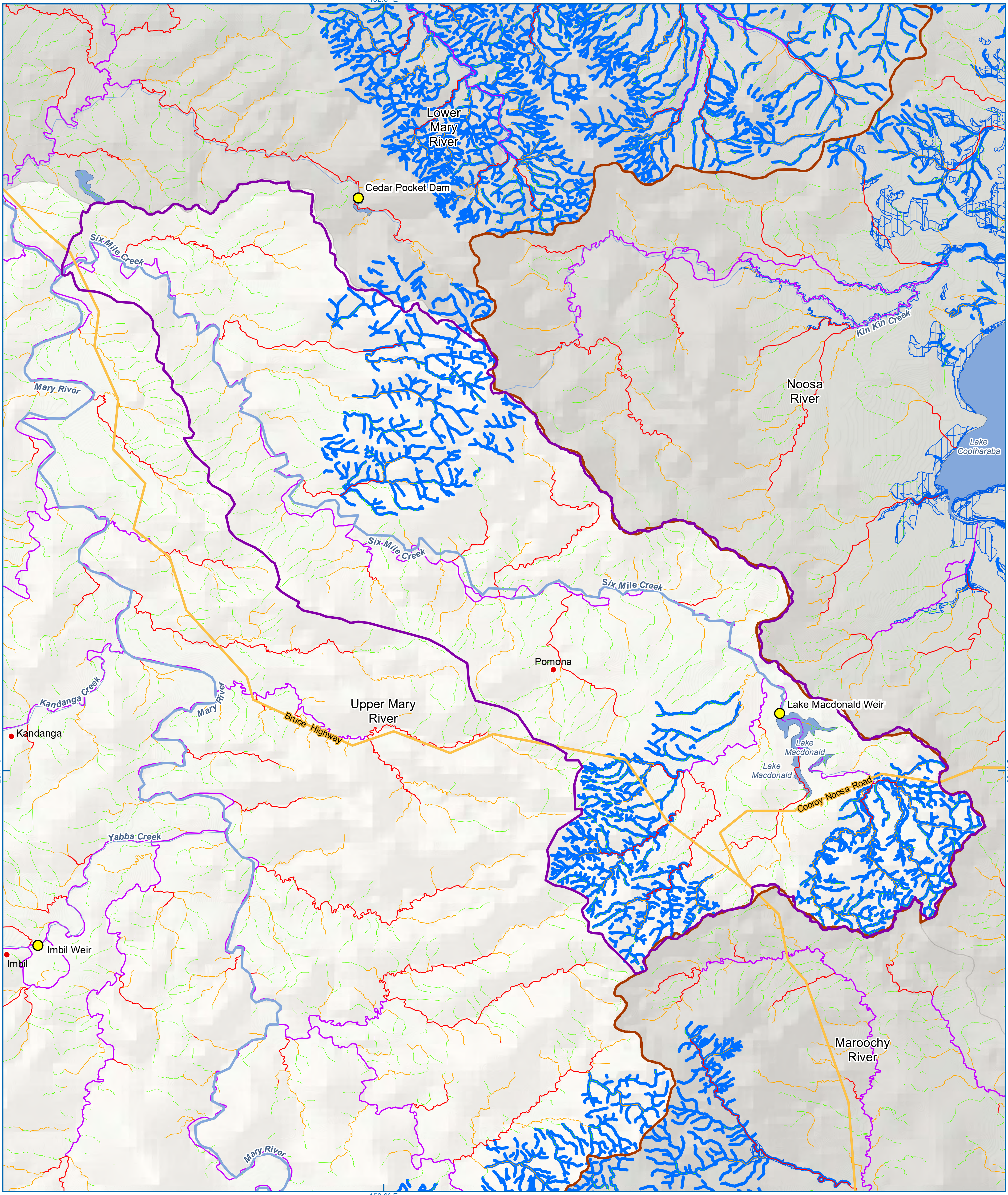
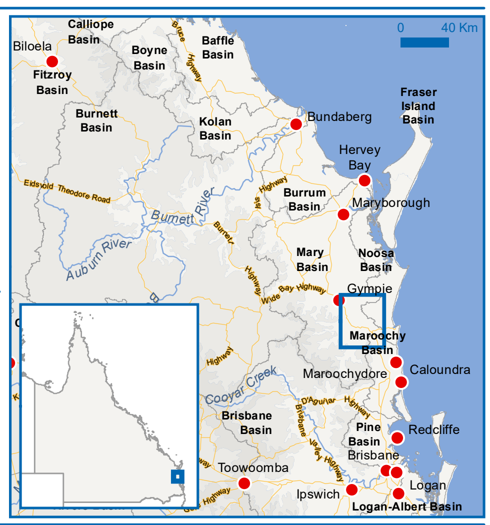



## Lake Macdonald Dam Upgrade Project
## Aquatic Ecology Risk Assessment

Map 4.3: Matters of State Environmental Significance (HEV Waters & Waterways Providing Fish Passage)

**LEGEND**

- Mary River Basin
- Sub-basins
  - Upper Mary River
  - Other Sub-basin
- **Catchment**
  - Six Mile Creek
  - Impoundment
- HEV Waters (Wetland)
- HEV Waters (Watercourse)
- **Waterway Barrier Works - Stream Risk of Impact**
  - Low
  - Moderate
  - High
  - Major
- Watercourse
- Lake/Reservoir
- Highway / Major Road





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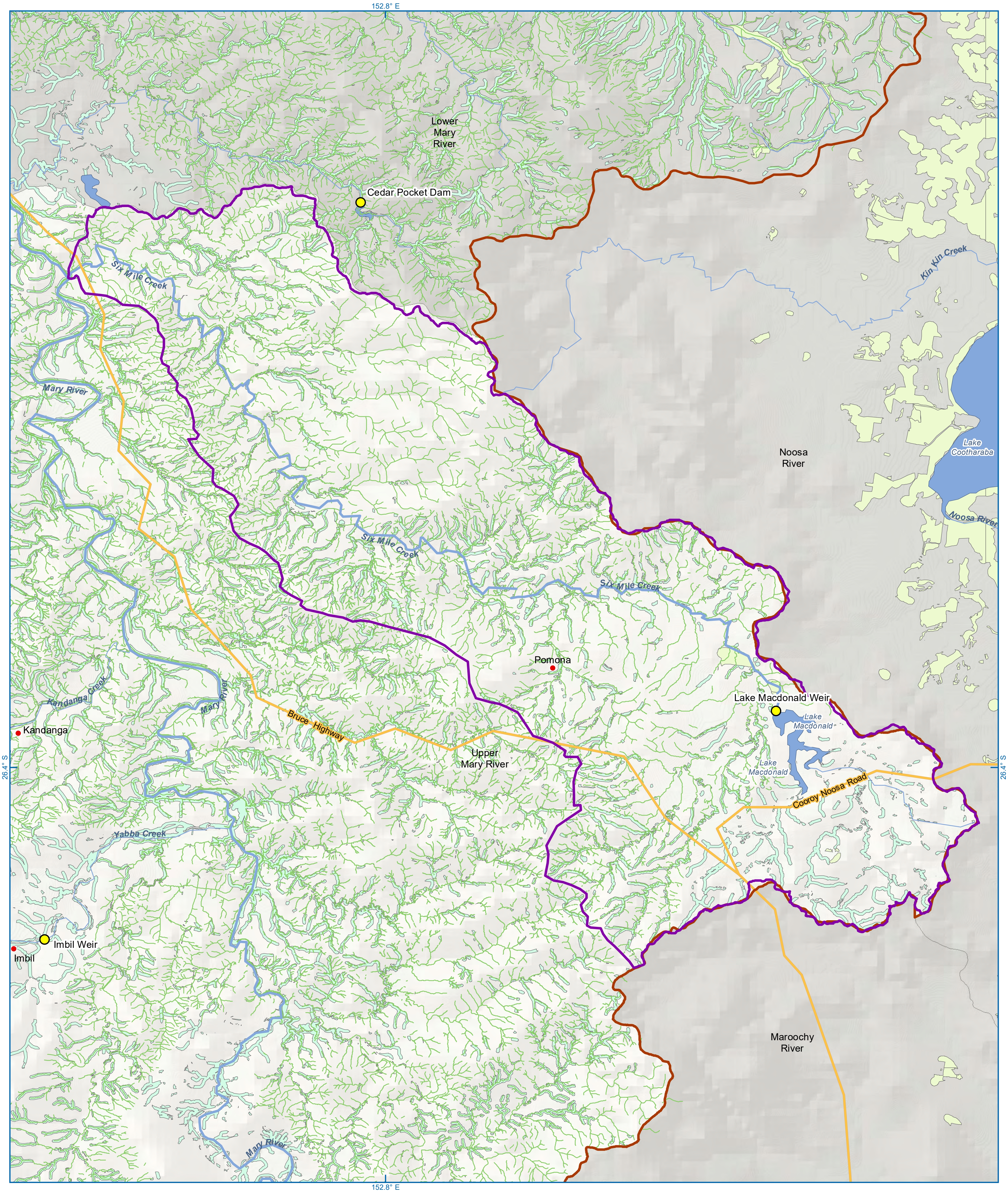



## Lake Macdonald Dam Upgrade Project
## Aquatic Ecology Risk Assessment

Map 4.4: Matters of State Environmental Significance (Regulated Vegetation)

**LEGEND**

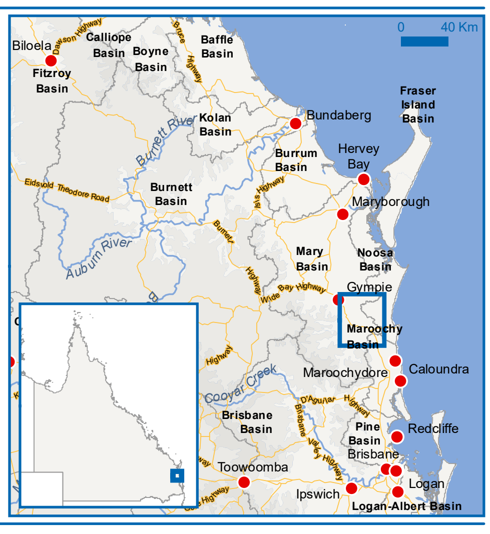
Mary River Basin

Sub-basins
- Upper Mary River
- Other Sub-basin

Catchment
- Six Mile Creek
- Impoundments

Regulated Vegetation
- Category R
- 100m from a Wetland
- Regulated Vegetation (Intersecting a Watercourse)

- Watercourse
- Lake/Reservoir
- Highway / Major Road





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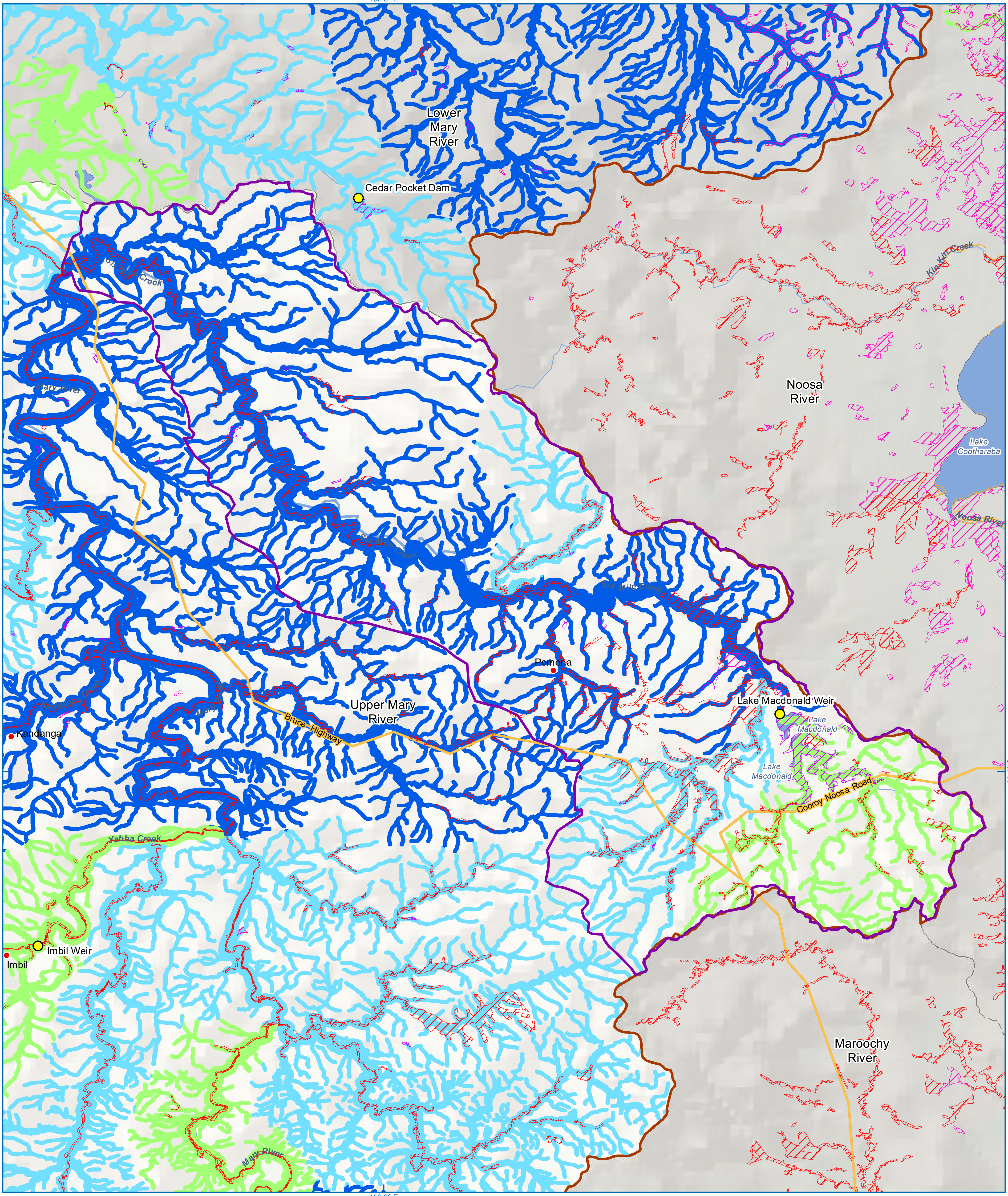


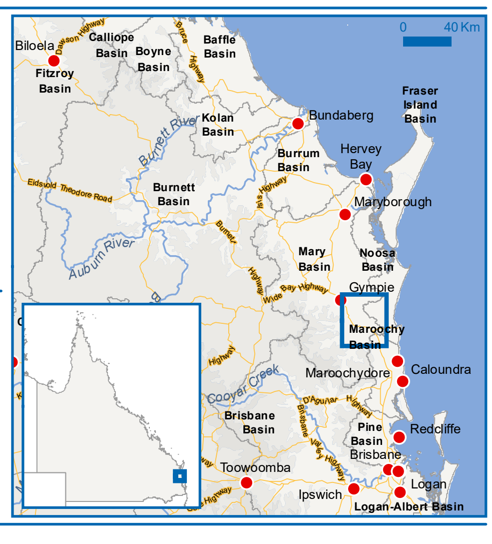


# Lake Macdonald Dam Upgrade Project
# Aquatic Ecology Risk Assessment

## Map 4.5: Aquatic Conservation Assessment (wetlands)

**LEGEND**

Mary River Basin

Sub-basins
- Upper Mary River
- Other Sub-basin

**Catchment**
- Six Mile Creek
- Impoundment

**AquaScore**
- Very High
- High
- Medium
- Low

**Wetlands**
- Palustrine
- Riverine
- Lacustrine
- Estuarine
- Marine

- Watercourse
- Lake/Reservoir
- Highway / Major Road


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## 4.2 Water Quality

### Assessment Methods

In addition to the data and information sources described above, water quality data from the Department of Natural Resources, Mines and Energy's (DNRME's) gauging station on Six Mile Creek at Cooran (station number 138107B) was also assessed.

Water quality data that was collected within the scope of the NPI2 AHMP and the baseline studies for the Six Mile Creek project was collected in accordance with the DES' *Monitoring and Sampling Manual* (DES 2018). Water temperature (°C), pH, dissolved oxygen (percent saturation and mg/L) and electrical conductivity (µS/cm) were measured in situ within 0.3 m of the water surface using a Hydrolab Quanta multi-parameter water quality meter. The meter was calibrated daily according to the manufacturer's instructions. Turbidity (NTU) was measured in situ within 0.3 m of the water surface using a HACH 2100Q turbidity meter, which was calibrated at the commencement of each field survey.

Water quality results were compared to the Water Quality Objectives (WQOs) for lowland streams as presented in the *Environmental Protection (Water) Policy 2009* Mary River Environmental Values and Water Quality Objectives Basin No. 138, including all tributaries of the Mary River (DERM 2010). These WQOs relate to protection of the aquatic ecosystem Environmental Value.

Table 4.2 Published WQOs for protection of aquatic ecosystems for lowland freshwater in the Mary River for selected water quality parameters.

| Parameter | Unit | WQO |
|---|---|---|
| Turbidity | NTU | <50 |
| Dissolved oxygen | percent saturation | 85 – 110 |
| pH | unit | 6.5 – 8.0 |
| Electrical conductivity [a] | µS/cm | <626 |
| Suspended solids | mg/L | <6 |
| Chlorophyll a | µg/L | <5 |
| Total nitrogen | µg/L | <500 |
| Oxidised nitrogen | µg/L | <60 |
| Ammonia | µg/L | <20 |
| Organic nitrogen | µg/L | <420 |
| Total phosphorus | µg/L | <50 |
| Filterable reactive phosphorus | µg/L | <20 |

[a] based on the 75th percentile of the Sandy Coastal salinity zone in Appendix G of the Queensland Water Quality Guidelines.

## Results

Water quality in Six Mile Creek is generally good and typically achieves the WQO for the protection of aquatic ecosystems EV, although dissolved oxygen levels are often low due to decomposition of organic matter from the adjacent rainforest canopy (DNRM 2004). DNRM (2004) also report that water quality typically achieves other EVs identified for Six Mile Creek, including Primary Industry, Recreation and Drinking Water (assuming disinfection) (DNRM 2004).

Water quality data for water temperature, electrical conductivity and pH were available on the DNRME Water Monitoring Portal, with records commencing in December 1998. Results showed that both electrical conductivity and pH complied with the applicable WQO for aquatic ecosystems (there is no WQO for temperature) (Table 4.3).

Seqwater's water quality monitoring data for Lake Macdonald (Appendix D) shows that:

- total nitrogen, organic nitrogen, chlorophyll-a and dissolved aluminium were commonly higher than the applicable WQO in Lake Macdonald
- total aluminium, total zinc and total cobalt were sometimes higher than the applicable WQO in Lake Macdonald
- pH, dissolved oxygen, total suspended solids, total nitrogen, organic nitrogen, ammonia, total aluminium, total chromium, total copper, total mercury, total zinc and dissolved aluminium were non-compliant with the applicable WQO at the Lake Macdonald tailwater, and
- all other parameters (where data was available) complied with the applicable WQO in Lake Macdonald and at the Lake Macdonald tailwater.

Biogeochemical cycling of key elements, including nutrients and metals, in benthic sediments has a significant influence on water quality in reservoirs, with elevated concentrations of these parameters commonly observed in reservoirs (Grinham et al., 2018). Therefore, the above described results are likely typical of water quality conditions for reservoirs.

The *Water Monitoring Data Collection Standards* (DNRW 2007) define a reservoir as stratified if the temperature difference between surface and basement layers exceeds 5ºC. Depth profile measurements of water temperature through the depth profile in Lake Macdonald (mid-lake) were summarised on a monthly basis between November 2011 and November 2017 (i.e. 70 months), with measurements for 69 of these months indicating no stratification. Stratification was detected in only one month (January 2015). Overall, these results indicate that Lake Macdonald rarely stratifies, and when it does it is only weakly stratified.

Survey data for water quality measured in situ since 2013 was pooled based on reach (i.e. downstream of Six Mile Creek Dam, in the impounded section of Six Mile Creek Dam, or upstream of Six Mile Creek Dam). Results showed that (Table 4.4, Table 4.5, Table 4.6; Appendix E):

- electrical conductivity, pH and turbidity complied with the WQO in all reaches of Six Mile Creek, and
- the percent saturation of dissolved oxygen was below the WQO in Six Mile Creek upstream and downstream of Lake Macdonald, but complied with the WQO in Lake Macdonald.

Table 4.3 Summary of mean monthly water quality since December 1989 measured at gauging station 138107B on Six Mile Creek at Cooran.

| **Summary statistic** | **Temperature (ºC)** [a] | **Electrical conductivity (µS/cm)** | **pH (unit)** |
|---|---|---|---|
| count of mean monthly data points | 225 | 221 | 93 |
| minimum | 10.0 | 91 | 6.4 |
| 20th percentile | 15.0 | 145 | 6.6 |
| median | 19.6 | 171 | 6.8 |
| 80th percentile | 23.2 | 203 | 7.1 |
| maximum | 25.3 | 275 | 7.8 |

Grey shading indicates if a parameter exceeds the applicable WQO (note median was compared to the WQO).

[a] There is no published WQO for water temperature.

Table 4.4 Summary of water quality since from October 2013 to February 2018 measured at Six Mile Creek downstream of Lake Macdonald (i.e. sites SMC4, SMC5, SMCDS05, SMCDS04, SMCDS03, SMCDS02 and SMCDS01).

| Summary statistic | Temperature (ºC) [a] | Electrical conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 24 | 24 | 24 | 24 | 24 | 24 |
| minimum | 17.7 | 76 | 5.55 | 2.0 | 24.0 | 2.5 |
| 20th percentile | 19.0 | 114 | 6.21 | 3.0 | 33.5 | 5.2 |
| median | 20.9 | 161 | 6.78 | 4.5 | 49.1 | 7.9 |
| 80th percentile | 24.5 | 180 | 7.18 | 5.7 | 65.0 | 11.0 |
| maximum | 26.6 | 244 | 7.43 | 7.9 | 93.3 | 15.6 |

Grey shading indicates where the median value of a parameter does not comply with the WQO

Table 4.5 Summary of water quality since from October 2013 to February 2018 measured at Six Mile Creek in Lake Macdonald (i.e. sites DS Lake and US Lake).

| Summary statistic | Temperature (ºC) [a] | Electrical conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 6 | 6 | 6 | 6 | 6 | 6 |
| minimum | 22.9 | 42 | 6.69 | 4.2 | 54.8 | 3.1 |
| 20th percentile | 23.2 | 53 | 6.77 | 7.7 | 99.2 | 3.5 |
| median | 24.5 | 87 | 6.99 | 8.8 | 105.6 | 4.5 |
| 80th percentile | 28.0 | 92 | 7.31 | 9.9 | 117.1 | 5.6 |
| maximum | 28.8 | 103 | 7.46 | 10.0 | 119.8 | 5.8 |

Table 4.6 Summary of water quality since from October 2013 to February 2018 measured at Six Mile Creek upstream of Lake Macdonald (i.e. sites CU02, CU01, CU03, SMCUS02, SMCUS01, SMCUS03).

| Summary statistic | Temperature (ºC) [a] | Electrical conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 13 | 13 | 13 | 13 | 13 | 13 |
| minimum | 17.4 | 59 | 5.80 | 2.1 | 24.7 | 4.5 |
| 20th percentile | 18.9 | 89 | 6.25 | 3.1 | 34.1 | 5.8 |
| median | 21.2 | 107 | 6.67 | 4.9 | 51.1 | 7.4 |
| 80th percentile | 24.0 | 142 | 7.09 | 7.3 | 91.6 | 13.6 |
| maximum | 188.0 | 189 | 7.61 | 8.9 | 110.1 | 15.4 |

Grey shading indicates where the median value of a parameter does not comply with the WQO

## 4.3 Aquatic Plants

### Assessment Methods

Aquatic plants of Six Mile Creek were assessed through the review of:

- published literature, such as DNRM 2004 and the Mary River Aquatic Weeds Strategy 2010-2014 (Mary River Pest Management Group 2010), and
- publicly available databases, including
  - MNES and MSES search tools, to identify threatened plants species potentially occurring in Six Mile Creek
  - the Wildlife online and Atlas of Living Australia's databases.

The field survey was based on a timed meander methodology (approximately 15 minutes per site), as described in Flora Survey Guidelines for Protected Plants (EHP 2016), with both in-stream and bank habitats surveyed.

## Results

Aquatic plants are absent or rare in Six Mile Creek downstream of Lake Macdonald, although they are common in Lake Macdonald, with the noxious weed *Cabomba caroliniana* growing prolifically in the dam (DNRM 2004) and the noxious *Hygrophila costata* occurring in high cover along the lake margins. Various attempts to control Cabomba in Lake Macdonald have been made, particularly by Noosa Shire Council in the past through the use of mechanical harvesting. Eradication of Cabomba is generally considered to be unviable with current control methods and attempts to reduce cover being labour intensive. Hygrophila infestations around Lake Macdonald have been effectively controlled by local stakeholder groups and its occurrence is now sparse. A plan to eradicate remaining Hygrophila from Lake Macdonald and the upper catchment is currently being considered.

The diversity and growth forms of aquatic plants in the wider Mary River are greater than in Six Mile Creek, with the diversity of aquatic weeds also higher in the Mary River compared to Six Mile Creek (Mary River Pest Management Group 2010).

The field surveys found (Table 4.7):

- the overall diversity of aquatic plant species and growth forms was low, with Lake Macdonald having the highest diversity of aquatic plant species both in the water and on the banks, and the highest diversity of growth forms in the water
- the cover of aquatic plants was low, mostly restricted to isolated occurrences, with the exception of:
  - *Cabomba* and water snowflake in Lake Macdonald
  - *Lomandra* on banks of the downstream and upstream reaches of Six Mile Creek
- no listed threatened species were recorded, reflecting the absence of records of threatened aquatic plants in the Project area
- introduced species included *Cabomba* and cape lily, with *Cabomba* a restricted biosecurity matter.

Table 4.7 Results of aquatic plant surveys.

| Species | Common name | Growth form | Six Mile Creek DS | Lake Macdonald | Six Mile Creek US |
|---|---|---|---|---|---|
| **Plants in water (in-stream)** | | | | | |
| *Cabomba caroliniana* | Cabomba [c] | submerged | I [a] | D | S |
| *Nymphoides indica* | water snowflake | floating-attached | I [a] | S | I |
| *Ludwigia peploides* | water primrose | emergent | | I [b] | I |
| *Philydrum lanuginosum* | frog's mouth | emergent | | I [b] | |
| *Eleocharis* sp. | spike rush | emergent | | I [b] | |
| *Nymphae caerulea* | cape waterlily [c] | floating-attached | | I | |
| *Azolla* sp. | Azolla | floating | | | I |
| *Typha* sp. | bull rush | emergent | | I [b] | |
| *Potamogeton javanicus* | Javan pondweed | submerged | | I | |
| Lemnoideae | duck weed | floating | | | I |
| **Plants not in water (banks)** | | | | | |
| *Lomandra* spp. | mat rush | _ | D | I | S |
| *Carex* spp. | Sedge | _ | I | | |
| *Cyperus* spp. | flat sedge | – | I | I | I |
| *Persicaria* spp. | knot weeds | – | I | I | I |
| *Ludwigia octovalvis* | willow primrose | – | | I | |
| *Schoenoplectus mucronatus* | bog bulrush | – | I | | |

I = isolated; S = scattered; D = dense cover

[a] Cabomba was found in Six Mile Creek downstream of Lake Macdonald, but only within several hundred meters of the dam. Most of Six Mile Creek downstream was without instream aquatic plants, including Cabomba.

[b] these emergent species only occurred in shallow water along the edge of Lake Macdonald

[c] denotes pest species

### 4.4 Macroinvertebrates

#### Assessment Methods

The field survey was implemented in February 2018, following nearly two months of base-flow conditions and several brief elevated flows in October, November and early December 2017, but before a high flow event in late February 2018. Thus, conditions were typical wet season conditions at the time of sampling. Sampling used the AUSRIVAS sampling protocol (DNRM 2001), with samples were collected over a 10 m length of stream using a standard triangular-framed dip net (250 µm mesh size) and the kick-sweep method to dislodge macroinvertebrates from the substrate. At each site, one sample was collected from bed habitat and another one from edge habitat. Samples were picked in frc environmental's biological laboratory, and identified to the lowest practical taxonomic level (in most instances, family) and counted, to comply with AUSRIVAS protocols.

Standard macroinvertebrate indices were calculated (i.e. taxonomic richness, PET richness and SIGNAL-2 Scores), and were compared to the guidelines for biological indicators for South East Queensland, as reported in the Queensland Water Quality Guidelines (EHP 2013) for lowland freshwaters, as there are no biological guidelines presented in the EPP(Water) for the Mary River:

- taxonomic richness: ≥ 22
- PET richness: ≥ 4, and
- SIGNAL-2 score: ≥ 4.

#### Results

Macroinvertebrate communities are highly variable between sites in Six Mile Creek, with taxonomic diversity low at some sites due to limited microhabitat diversity (DNRM 2004).

Survey results found low taxonomic diversity of macroinvertebrates in bed and edge habitat (Table 4.8 and Table 4.9) in Six Mile Creek, ranging from only eight taxa in bed habitat at site SMCDS04 to 25 taxa in edge habitat at site SMCDS04. The diversity of sensitive taxa, indicated by both PET richness, and the overall proportion of sensitive taxa, indicated by SIGNAL-2 Scores, was similar for bed and edge habitat, and often lower than the WQO, suggesting that sensitive taxa are not a dominant feature of macroinvertebrate communities in Six Mile Creek. Whilst there is no WQO for abundance, the results indicate that macroinvertebrates are abundant in Six Mile Creek. The number of samples collected upstream of, and within, Lake Macdonald were less than the number collected downstream, but the macroinvertebrate indices collected upstream of, and within Lake Macdonald were typically in the range recorded in Six Mile Creek downstream of Lake Macdonald, except SIGNAL-2 score in edge habitat (upstream of, and within, Lake Macdonald) and PET richness in edge habitat (upstream of Lake Macdonald).

Table 4.8 Mean macroinvertebrate indices in bed habitat at each site in February 2018.

| Site | Macroinvertebrate Indices | | | |
|---|---|---|---|---|
| | Abundance | Taxonomic Richness | PET Richness | SIGNAL 2 |
| **Six Mile Creek downstream of Lake Macdonald** | | | | |
| SMCDS04 | 167 | 8 | 1 | 3.40 |
| SMCDS03 | 169 | 15 | 4 | 4.11 |
| SMCDS02 | 153 | 19 | 5 | 4.12 |
| SMCDS01 | 190 | 14 | 3 | 3.48 |
| **Lake Macdonald** | | | | |
| DS Lake | 131 | 10 | 2 | 3.83 |
| **Six Mile Creek upstream of Lake Macdonald** | | | | |
| SMCUS01 | 204 | 13 | 1 | 3.59 |

Grey shading indicates where a macroinvertebrate index does not comply with the WQO

Table 4.9 Mean macroinvertebrate indices in edge habitat at each site in February 2018.

| Site | Macroinvertebrate Indices | | | |
|---|---|---|---|---|
| | Abundance | Taxonomic Richness | PET Richness | SIGNAL 2 |
| **Six Mile Creek downstream of Lake Macdonald** | | | | |
| SMCDS04 | 177 | 25 | 4 | 4.06 |
| SMCDS03 | 125 | 14 | 4 | 3.82 |
| SMCDS02 | 123 | 16 | 5 | 3.77 |
| SMCDS01 | 232 | 19 | 3 | 3.60 |
| **Lake Macdonald** | | | | |
| DS Lake | 163 | 15 | 4 | 3.31 |
| **Six Mile Creek upstream of Lake Macdonald** | | | | |
| SMCUS01 | 126 | 17 | 1 | 3.45 |

Grey shading indicates where a macroinvertebrate index does not comply with the WQO

## 4.5 Fish

### Assessment Methods

In addition to the data and information sources described above, fish stocking data and reports for Lake Macdonald were reviewed.

The methods used to collect the fish data that was synthesised for this are presented in Appendix F, and were designed to record species diversity, abundance and life history stage (total length). The habitat preferences, reproductive ecology and migration strategies of fish species from Six Mile Creek were reviewed.

### Results

The fish fauna in Six Mile Creek downstream of Lake Macdonald is generally in good condition and the creek provides significant breeding habitat for Mary River cod (DNRM 2004). Within Lake Macdonald, the impounded water is likely to favour some species native to Six Mile Creek (e.g. bony bream) as well as the recreational species (not native to the creek) that have been stocked in the dam (e.g. Australian bass, yellow belly).

Overall, a total of 26 native species, and five pest species, are known or likely to occur in Six Mile Creek, with a number of these species having been caught in the field surveys (Table 4.10). Mary River cod and Australian lungfish are both Matters of National and State Environmental Significance (Appendix A and B), and eastern Gambusia and tilapia are restricted biosecurity matters under the Queensland *Biosecurity Act 2014*. Tilapia were only recently recorded for the first time in Six Mile Creek downstream of Lake Macdonald. It is currently unknown if tilapia occur in Lake Macdonald, or if the dam wall has prevented this species extending further upstream.

Detailed results of the fish surveys for each site are presented in Appendix G, with the key results being:

- several species, including Pacific blue eye, were only present in Six Mile Creek downstream of Lake Macdonald, suggesting that the dam prevents these species from migrating further upstream
- several diadromous species expected to be present in Six Mile Creek were absent (e.g. sea mullet, pink eye mullet, estuary glassfish, striped gudgeon, empire gudgeon), which may reflect the cumulative impacts of barriers to fish passage in the lower Mary River between the estuary and Six Mile Creek

- Mary River cod and Australian lungfish were caught in Six Mile Creek downstream of Lake Macdonald
- common gudgeons were the most abundant species, with this species also having very high abundance in Lake Macdonald
- a seasonal pattern in abundance was recorded, with abundance of most species higher in spring compared to summer
- the abundance of pest fish (eastern Gambusia and swordtails) was highest in Six Mile Creek upstream of Lake Macdonald
- most species had healthy populations comprised of juveniles, sub-adults and adults
- bony bream attained a larger size in Lake Macdonald than in Six Mile Creek, but there were no other notable size differences between waterway and reservoir sections of Six Mile Creek for any other species, and
- during periods of low flow fish may become isolated in the tailwater pool downstream of Lake Macdonald.

Review of literature describing the preferred habitat, reproductive ecology and migration pattern of fish species in Six Mile Creek (Table 4.11; Fishbase (2010), Pusey et al. (2004), DAF (2015), DoE (2015)) showed that:

- larger bodied species, such as Mary River cod and Australian lungfish, have a preference for deep pool habitats with large woody debris
- estuarine tolerant species (e.g. striped gudgeon, empire gudgeon, mullet and estuary glassfish), are predominantly distributed within lowland sections of the Mary River, including lowland tributaries
- most species prefer fine substrates (sand/gravel) with low to moderate flow
- Mary River cod spawn annually in spring, soon after the water temperature rises to 20°C. Spawning activity may be increased on a full moon.
- Australian lungfish spawn in slow-flowing shallow pools among aquatic plants between August and December, where they deposit eggs on plants or submerged matts of fine roots
- bullrout, sea mullet, Australian bass, Australian smelt, common gudgeon, and striped gudgeon spawn in winter and early spring, prior to increased water temperature and flows
- most other fish species spawn in summer with increased water temperature and water flow

- The fish species in Six Mile Creek have a range of migration and dispersal patterns, including species that must migrate to estuaries or the ocean to complete their life cycle (diadromous – including species with catadromous and amphidromous forms of diadromy), and species that migrate within freshwater reaches (potamodromous).
- Australian lungfish are generally inactive during the day, where they occupy shaded, deep-water complex habitats, although juveniles typically occupy dense submerge aquatic plant meadows (Kind 2002). Movement occurs mostly at night, with daily ranges greater in summer than in winter, with total linear ranges varying between 0.3 km and 74.9 km and mean linear home range being approximately 1.5 km (Kind 2002). Movement distances are larger in impounded reaches than in flowing reaches, as suitable spawning locations are less common in impounded waters, thus movement distances linked with the annual breeding cycle are greater
- Mary River cod have a tendency to move upstream and / or from the Mary River to tributaries during spring and summer when stream flow increases, and downstream during winter, with the distances travelled often spanning many kilometres (e.g. up to approximately 30 km; Simpson and Jackson 1996a)
- the southern shortfin eel, longfin eel, Australian bass, empire gudgeon, flathead gudgeon and mullet species are diadromous, with spawning occurring in estuarine or marine waters
- the flyspecked hardyhead, crimson-spotted rainbowfish, Agassiz's glassfish, carp gudgeon, dwarf flathead gudgeon, bony bream and Australian smelt are potamodromous, These species use various cues for migration, including increased water temperature and rise in river discharge, and
- mouth almighty, silverstreak hardyhead and eel-tailed catfish have limited migration.

The total length of each fish caught[7] for each assessment zone for each survey is shown by species in Appendix G. Results show:

- a gradual increase in fish lengths for most species in each assessment zone, indicating a healthy population with juveniles, sub-adults and adults present
- a steep increase in the length of bony bream caught in the reservoir zone, suggesting that this species can grow to a larger size in reservoir habitat and individuals of intermediate size are uncommon, and
- a trend with a strong inflection point (i.e. gradual incline that changes to a steep incline) for some species, suggesting the presence of adults of different size (i.e. some relatively very large individuals were present). For some species (e.g. bony

7 Length data was graphed only for species that were caught in sufficient numbers to assess trends.

bream), this may be related to the age of the fish or the habitat within which it was caught (see previous point), but for other species (e.g. eastern Gambusia and carp gudgeons) it may be linked to sexual dimorphism of adult fish (i.e. where adult males are larger than adult females for carp gudgeons, and adult females are larger than adult males for eastern Gambusia; (Allen et al. 2002).

Spawning Mary River cod have been recorded from Six Mile Creek downstream of Lake Macdonald (Dunlop 2016). Consequently, this reach of Six Mile Creek supports a key population of Mary River cod, although inter-annual recruitment success is likely to be variable. Reproduction by Mary River cod in and upstream of Lake Macdonald has not been assessed, although at least 112,730 Mary River cod fingerlings were released to Lake Macdonald between 1983 and 2015 (MRCCA 2016) . Reproduction by Australian lungfish in Six Mile Creek is likely to be very limited as preferred breeding habitats are absent, and it is expected that there would be no reproduction in Lake Macdonald (see Kind 2002) or in Six Mile Creek upstream of Lake Macdonald.

Table 4.10 Fish species known from, or likely to occur in Six Mile Creek.

| Species | Common Name | Caught during field surveys |
|---|---|---|
| **Native Species** | | |
| **Ambassidae** | | |
| *Ambassis agassizii* | Agassiz's glassfish | ✓ |
| *Ambassis marianus* | estuary glassfish | – |
| **Anguillidae** | | |
| *Anguilla australis* | southern shortfin eel | ✓ |
| *Anguilla reinhardtii* | longfin eel | ✓ |
| **Apogonidae** | | |
| *Glossamia aprion* | mouth almighty | ✓ |
| **Atherinidae** | | |
| *Craterocephalus marjoriae* | silverstreak hardyhead | – |
| *Craterocephalus stercusmuscarum* | flyspecked hardyhead | ✓ |
| **Eleotridae** | | |
| *Gobiomorphus australis* | striped gudgeon | – |
| *Hypseleotris* spp. | common gudgeons | ✓ |
| *Hypseleotris compressa* | empire gudgeon | – |

| Species | Common Name | Caught during field surveys |
|---|---|---|
| *Mogurnda adspersa* | purple spotted gudgeon | ✓ |
| *Philypnodon macrostomus* | dwarf flathead gudgeon | ✓ |
| *Philypnodon grandiceps* | flathead gudgeon | ✓ |
| **Melanotaeniidae** | | |
| *Melanotaenia duboulayi* | crimson-spotted rainbowfish | ✓ |
| **Percichthyidae** | | |
| *Maccullochella mariensis* | Mary River cod | ✓ |
| *Percalates novemaculeata* | Australian bass | ✓ |
| *Macquaria ambigua* | yellowbelly | ✓ |
| **Plotosidae** | | |
| *Tandanus tandanus* | eel-tailed catfish | ✓ |
| *Neosilurus hyrtlii* | Hyrtl's tandan | – |
| **Pseudomugilidae** | | |
| *Pseudomugil signifer* | Pacific blue-eye | ✓ |
| **Retropinnidae** | | |
| *Retropinna semoni* | Australian smelt | ✓ |
| **Clupeidae** | | |
| *Nematolosa erebi* | bony bream | ✓ |
| **Ceratodontidae** | | |
| *Neoceratodus forsteri* | Australian lungfish | ✓ |
| **Mugilidae** | | |
| *Trachystoma petardi* | pinkeye mullet | – |
| *Mugil cephalus* | sea mullet | – |
| **Tetrarogidae** | | |
| *Notesthes robusta* | bullrout | – |
| **Terapontidae** | | |
| *Leiopotherapon unicolor* | spangled perch | ✓ |
| **Osteoglossidae** | | |
| *Scleropages leichardti* | southern saratoga | ✓ |

| Species | Common Name | Caught during field surveys |
|---|---|---|
| **Pest Species** | | |
| *Gambusia holbrooki* | eastern Gambusia | ✓ |
| *Xiphophorus maculatus* | platy | – |
| *Xiphophorus hellerii* | swordtail | ✓ |
| *Poecilia reticulata* | guppy | – |
| *Oreochromis mossambicus* | tilapia | ✓ [a] |

[a] observed only.

Table 4.11 Summary of literature review of habitat requirements of native fish species known or likely to occur in Six Mile Creek [a].

| Species | Common Name | Catchment Position | Physical habitat | flow-habitat | Reproductive Ecology | Migration Pattern |
|---|---|---|---|---|---|---|
| *Ambassis agassizii* | Agassiz's glassfish | mid to upper catchment | submerged aquatic plants, fine substrates (sand/gravel) and open water | low gradient, slow moving, moderate depth pools | spring to autumn, triggered by rising temperatures | potamodromous |
| *Ambassis marianus* | estuary glassfish | lower catchment; brackish estuaries, tidal creeks and lower reaches | mangrove roots, woody debris and aquatic vegetation | – | – | – |
| *Anguilla australis* | southern shortfin eel | lower to mid catchment | fine substrates (sand/gravel), leaf litter, woody debris, undercut banks and submerged roots | shallow, still water pools | outward migration during summer and autumn, spawning between June and September | catadromous |
| *Anguilla reinhardtii* | longfin eel | entire catchment, commonly lower to mid | no discernible habitat preference | prefers flowing water including riffles and runs | outward migration during summer and autumn, unknown spawning time | catadromous |

| Species | Common Name | Catchment Position | Physical habitat | flow-habitat | Reproductive Ecology | Migration Pattern |
|---|---|---|---|---|---|---|
| *Glossamia aprion* | mouth almighty | lower to mid catchment | large rivers, limited riparian cover, fine substrates (sand/gravel), submerged macrophytes | deep slow-flowing pools | spring and early summer | limited migration |
| *Craterocephalus marjoriae* | silverstreak hardyhead | entire catchment, commonly mid to upper | intermediate substrates (gravel/cobble), submerged macrophytes, filamentous algae, leaf litter, undercut banks and submerged roots | moderate depth and velocity, but also occurs in shallow riffles with high velocity | late winter to summer, with increased water temperature | limited migration |
| *Craterocephalus stercusmuscarum* | flyspecked hardyhead | entire catchment | macrophyte beds and in-stream cover | no discernible flow regime, prefers moderate current velocities, seen to congregate where streams flow into still water | late winter to summer with increased water temperate | potamodromous |
| *Gobiomorphus australis* | striped gudgeon | lower to mid catchment including estuaries and dune lake systems | fine substrates (sand/gravel), leaf-litter, undercut banks and submerged roots | pools and runs with low velocity and moderate depth | autumn and winter | amphidromous |

| Species | Common Name | Catchment Position | Physical habitat | flow-habitat | Reproductive Ecology | Migration Pattern |
|---|---|---|---|---|---|---|
| *Hypseleotris* spp. | common carp gudgeons | entire catchment, commonly lower to mid | fine to intermediate substrates (sand/gravel), submerged aquatic plants, undercut banks, submerged roots | narrows streams with low flow and moderate depth (0.43 m) | late winter to early autumn, prior to high flows | potamodromous |
| *Hypseleotris compressa* | empire gudgeon | lower catchment in coastal rivers and streams | fine substrates (mud, sand, gravel), leaf litter, undercut banks and submerged roots | moderate streams (5 m wide, with low flow and moderate depth (0.35 m) | January to May with increased water temperature | amphidromous |
| *Mogurnda adspersa* | purple spotted gudgeon | entire catchment, commonly coastal uplands | fine to intermediate substrates (sand, gravel, cobble), aquatic plants, filamentous algae, leaf litter, submerged roots and undercut banks | pools with low velocity and low to moderate depth | spring to late summer | limited migration |
| *Philypnodon macrostomus* | dwarf flathead gudgeon | entire catchment, commonly lower to mid-upper catchment | intermediate substrates (gravel, cobble), submerged plants, leaf litter, undercut banks, submerged roots | low flow, moderate depth (0.31 m) but can occur in shallow, high velocity riffle habitats | spring to autumn, with increasing water temperature | amphidromous |

| Species | Common Name | Catchment Position | Physical habitat | flow-habitat | Reproductive Ecology | Migration Pattern |
|---|---|---|---|---|---|---|
| *Philypnodon grandiceps* | flathead gudgeon | entire catchment, commonly lower to mid catchment | intermediate to coarse sediment (gravel, cobbles, bedrock), aquatic plants, filamentous algae, leaf litter, submerged roots, undercut banks | low flow, moderate depth (0.4 m), but has been classified as a riffle-dwelling species | spring to autumn, with increasing water temperature | amphidromous |
| *Melanotaenia duboulayi* | crimson-spotted rainbowfish | entire catchment, commonly mid catchment | fine to intermediate substrate (sand, gravel), submerged plants, filamentous algae, leaf litter, undercut banks, submerged roots | low-moderate flow, moderate depth (0.43 m), but occasionally in shallow riffles with high water velocity | late winter to summer with increasing water temperature | potamodromous |
| *Percalates novemaculeata* | Australian bass | entire catchment, males predominantly estuarine and females in lagoons and upstream | submerged woody debris, undercut banks and overhanging vegetation | slow, deep (>2 m) pools | June to August with elevated discharge | catadromous |
| *Maccullochella mariensis* | Mary River cod | entire catchment, but now thought to be restricted to three isolated mid catchment regions | mud/clay substrate, woody debris and log jams, extensive overhanging vegetation, undercut banks, rock ledges | slow, deep pools | annually around spring when temperatures rise above 20°C | potamodromous |

| Species | Common Name | Catchment Position | Physical habitat | flow-habitat | Reproductive Ecology | Migration Pattern |
|---|---|---|---|---|---|---|
| *Tandanus tandanus* | eel-tailed catfish | entire catchment, mostly mid to upper catchment | variety of habitats but prefers intact low to moderate riparian zone, diverse substrates (sand, gravel, cobble), leaf litter, undercut banks | low flow streams with moderate depths (0.4m) | spring and summer with increasing temperature | limited migration |
| *Neosilurus hyrtlii* | Hyrtl's tandan | entire catchment | uses virtually every aquatic habitat except estuarine reaches, commonly from areas with muddy or sandy substrates, leaf litter, submerged plants and blue-green algae | slow, deep (>2m) pools | summer wet season, with increasing water levels | potamodromous |
| *Pseudomugil signifer* | Pacific blue-eye | entire catchment, commonly in the lower catchment | intermediate substrates (gravel, cobble), leaf litter, submerged roots, undercut banks, submerged plants and filamentous algae | common in streams of intermediate width (6-10m) and low to moderate flow. | late winter to late summer, with increasing water temperature | no migration pattern is known |

| Species | Common Name | Catchment Position | Physical habitat | flow-habitat | Reproductive Ecology | Migration Pattern |
|---|---|---|---|---|---|---|
| *Retropinna semoni* | Australian smelt | entire catchment, commonly lower to mid catchment | intermediate to coarse substrate (gravel, cobble), aquatic plants, filamentous algae | shallow (0.23m), high velocity riffles and runs, but is found in deeper slow flowing pools during periods of low flow | winter to summer, with low water temperatures | potamodromous |
| *Nematolosa erebi* | bony bream | lower to mid catchment, although known to survive in upper catchment conditions when translocated | no discernible habitat known, instead thought to refuge with fellow fish | most common in lowland channel lagoons, with juvenile fish common in open shallow areas (30-150cm) and adults in deeper waters | all year except June to August (the coldest months) | potamodromous |
| *Neoceratodus forsteri* | Australian lungfish | lower to mid catchment, but restricted to freshwater | mud, sand and gravel substrates, overhanging vegetation, submerged woody debris and dense macrophyte beds. Tends to avoid open water | slow-flowing rivers and still water reservoirs and deep pools | August to December with peak activity within three months of the winter solstice. | potamodromous |
| *Trachystoma petardi* | pinkeye mullet | lower catchment, predominantly in estuarine waters | – | deep pools or gently flowing sections of rivers | summer | catadromous |

| Species | Common Name | Catchment Position | Physical habitat | flow-habitat | Reproductive Ecology | Migration Pattern |
|---|---|---|---|---|---|---|
| *Mugil cephalus* | sea mullet | lower catchment, predominantly in estuarine waters | varies on life history stage, larva are initially pelagic in estuarine water, juveniles prefer shallow water with sandy substrate and adults have no discernable preference | predominantly tidally influence slow-flowing rivers, but can migrate upstream into fast-flowing tributaries | autumn to winter, stimulated by decreased water temperature | catadromous |
| *Notesthes robusta* | bullrout | lower catchment, predominantly within 50km of the river mouth | intermediate substrate (gravel/cobble) and in-stream cover | riffle/run habitats with a depth of 0.5m and flow less than 0.3 m/s | possibly winter to spring | catadromous |
| *Leiopotherapon unicolor* | spangled perch | lower to mid-upper catchment, | fine substrate (sand and gravel), predominantly near undercut banks and submerged woody debris | little to no flow at depths between 0.3 to 0.6 m | summer during the wet season with rising water temperature | potamodromous |

[a] sources of information:, Fishbase (2010), Pusey et al. (2004), DAF (2015), DoE (2015)

– denote: no known information on the species

## 4.6 Turtles

### Assessment Methods

In addition to the data and information sources described above, the turtle assessment included a review of Limpus (2008) 'Freshwater turtles in the Mary River: review of biological data for turtles in the Mary River, with emphasis on *Elusor macrurus* and *Elseya albagula*'.

The field survey methods used to collect the turtle data that was collated for this study are presented in Appendix H.

### Results

The Mary River has high diversity (six species) and endemism (two regionally endemic species) of freshwater turtles (Limpus 2008):

- Mary River turtle (*Elusor macrurus*) – endemic to the Mary River Basin
- white-throated snapping turtle (*Elseya albagula*) – endemic to the Mary, Burnett and Fitzroy River Basins
- Krefft's river turtle (*Emydura macquarii krefftii*) – widespread
- saw-shelled turtle (*Wollumbinia latisternum*) – widespread
- eastern long-necked turtle (*Chelodina longicollis*) – widespread, and
- broad-shelled river turtled (*Chelodina expansa*) – widespread.

Mary River turtle (endangered) and white-throated snapping turtle (critically endangered) are MNES, listed as threatened species under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* and also under Queensland's *Nature Conservation Act 1992*. Predation of eggs from nesting banks is the most critical threat to the survival of these two species, causing a deficiency of immature turtles and very low recruitment rates in both species, although past harvesting of eggs from Mary River turtle nests has a legacy in the continuing decline of this species (Limpus 2008).

While Six Mile Creek was not surveyed for turtles by Limpus (2008), Mary River turtle and white-throated snapping turtle are known to occur in 'permanent stream and large pool habitats' (Limpus 2008, p.17 and p. 31), whereas the Krefft's river turtle is commonly found in permanent and semi-permanent waterways and man-made waterbodies on ephemeral streams (Limpus 2008, p. 45). Mary River turtle and white-throated snapping turtle were found in several of the larger tributaries of the Mary River, including Tinana Creek, Yabba

Creek and Obi Obi Creek, although white-throated snapping turtle was also found in several additional tributaries and tended to extend further upstream in both tributary streams and the Mary River proper in comparison to Mary River turtle (Limpus 2008). It is therefore possible that both Mary River turtle and white-throated snapping turtle occur infrequently in the lower reaches of Six Mile Creek, with white throated-snapping turtle possibility occurring further upstream than Mary River turtle. All known breeding banks for Mary River turtle and white-throated snapping turtle are along two reaches of the Mary River proper (the first near Tiaro and the second between Traveston and Kenilworth), although white-throated snapping turtle also has several known breeding banks on Yabba Creek (Limpus 2008). Previous survey work for the Project in August and October 2015 found that it is unlikely that there is suitable breeding habitat for either species on Six Mile Creek.

Four of the six turtle species known from the Mary River catchment (Krefft's river turtle, saw-shelled turtle, eastern-long neck turtle and broad-shelled river turtle) were caught during the baseline surveys. Only saw-shelled turtle was recorded in Six Mile Creek downstream of Lake Macdonald, with eastern long-necked turtle and Krefft's river turtle recorded from Lake Macdonald, and all four species recorded from upstream of Lake Macdonald (Table 4.12; Appendix I). Saw-shelled turtle and Krefft's river turtle were the most abundant turtle species. Only two juvenile saw-shelled turtles were caught; all other individuals were adults (Appendix I).

Table 4.12 Results of turtle surveys.

| Species | Common name | Six Mile Creek DS | Lake Macdonald | Six Mile Creek US |
|---|---|---|---|---|
| *Emydura macquarii krefftii*) | Krefft's river turtle | | ✓ | ✓ |
| *Wollumbinia latisternum* | Saw-shelled turtle | ✓ | | ✓ |
| *Chelodina longicollis* | Eastern long-necked turtle | | ✓ | ✓ |
| *Chelodina expansa* | Broad-shelled river turtle | | | ✓ |

## 4.7 Platypus

Platypus (*Ornithorhynchus anatinus*) is a long-lived (up to 17 years), small, egg-laying, amphibious mammal that is widely distributed in eastern Australia (Grant 1989). It inhabits perennial freshwater streams and connected lentic habitats (including impounded waters), where it spends about 50% of time in water (foraging, moving) and the remaining 50% in one of several short, simple resting burrows (Grant 1989).

Platypus feeds predominantly on benthic invertebrates, with foraging typically occurring at night or dusk, with some individuals foraging during the day in winter. Foraging movements generally within a 1.5 km range, although movements of over 3 km have been recorded, and juveniles are speculated to move over larger distances such as when dispersing from natal areas (Grant 1989).

The breeding season is typically spring, with breeding occurring earlier in norther regions of the species' distribution compared to southern regions. Eggs laid, and young raised, within long (up to 30 m), complex breeding burrows that are maintained by breeding females. Young are weaned after approximately four months and emerge from the burrow in late summer (Grant 1989).

Platypus is a 'Special Least Concern' species under the *Nature Conservation Act 1992*, but is not threatened at National or State levels.

Platypus records from Six Mile Creek and Lake Macdonald were obtained from Atlas of Living Australia (viewed 9 October 2018) and from direct observations of Seqwater rangers. There are confirmed platypus records from Six Mile Creek downstream, within and upstream of Six Mile Dam, including mid-area of Lake Macdonald and within impounded sections of both the Six Mile Creek and Cooroy Creek arms of Lake Macdonald.

## 4.8 Stygofauna

Stygofauna were assessed using only a desktop approach, including review of relevant literature (e.g. Tomlinson & Boulton 2008; Glanville et al. 2016) and the groundwater study for the Six Mile Creek Upgrade Project (SLR 2018).

Stygofauna are subterranean aquatic animals that live in the pores, voids and cavities of aquifers and other groundwater ecosystems. Many species of stygofauna have specialised adaptations to underground life, including:

- small body size (e.g. many species have a total body length <1 mm)
- lack of pigmentation
- absence of eyes, and
- elongated appendages (for tactile sensing of the surrounding environment).

Crustaceans, including copepods, amphipods, isopods and syncarids, typically dominate the composition of stygofaunal communities, although oligochaetes, molluscs, mites, insects and rotifers are also common. Blind fish and eels are also known from some cave systems, such as those in Western Australia.

Stygofauna taxa are grouped into one of several classes based on the degree of their requirement for subterranean life (Tomlinson & Boulton 2008). For the purpose of this assessment, two classes of stygofauna are considered:

- stygobites: obligate groundwater aquatic fauna that have specialised adaptations to underground life and that live within groundwater systems for their entire life, and
- stygoxenes: aquatic fauna that facultatively use groundwater ecosystems, but are not dependent on groundwater to complete their life cycle.

Stygofauna have no conservation listing at the Queensland level. At the Commonwealth level, the following are listed:

- the Cape Range Remiped (*Kumonga exleyi*) in Western Australia, which is listed as Vulnerable under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and
- stygofauna communities associated with Great Artesian Springs (i.e. the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin), which is listed as Endangered under the EPBC Act.

The Project area is not within the Great Artesian Basin, and is outside the known range of the Cape Range Remiped, therefore listed species of stygofauna do not occur within the Project area.

At the family level stygofauna are widespread and many families that include stygofaunal species also include surface water and marine species (e.g. copepods, rotifers and mites). However, at the species level many taxa have a narrow distributional range (i.e. stygofauna communities contain species that occur exclusively within a small area), and thus stygofauna communities are generally thought to have high endemism (Boulton et al. 2010; Harvey et al. 2011). For example, about one quarter (i.e. 23%) of the stygofauna species that were sampled on two or more occasions in a long-term study of stygofauna in the Pilbara region were sampled from within the same sub-region, and the median area of distribution of these stygofaunal species was 683 km$^2$ (Halse et al. 2014), with almost all stygofaunal species having distributions of less than 1 000 km$^2$ (Eberhard et al. 2009). A species of Parabathynellidae was recorded from 3 bores in the Burdekin River Alluvial Aquifer in Queensland, with two of these bores located approximately 20 km apart (Cook et al. 2012), suggesting a potential distribution of approximately 400 km$^2$. Additionally, studies in both Western Australia and Queensland have found evidence that sub-catchment boundaries can demarcate locations of turn-over of stygofaunal species (Finston et al. 2007;

Little et al. 2016). Therefore, areas of approximately 400 – 600 km$^2$ within a single sub-catchment may represent reasonable estimates of distribution of most stygofaunal species, acknowledging that site-specific factors (e.g. highly confined aquifers) may impose further restrictions on distribution in some cases, or create strong population subdivision within species on smaller spatial scales (Cook et al. 2012; Little et al. 2016).

A total of 24 described families and 23 described genera have been recorded from Queensland across numerous bioregional areas (Glanville et al. 2016), with representatives of these taxa known from South East Queensland (Glanville et al. 2016; Little et al. 2016). This suggests that stygofauna are likely to be present in the Project area where the habitat of groundwater ecosystems is suitable for their occurrence. The suitability of a groundwater ecosystem to provide habitat for stygofauna is dependent on several environmental factors including:

- geology – stygofauna have the potential to occur in aquifers composed of any geological unit with sufficient pore space to complete their life cycle (Tomlinson & Boulton 2008); thus, stygofauna are most common in alluvium, granite, gravel, sand, sandstone, silt, and volcanic geological units (Glanville et al. 2016). Stygofauna are less likely in geological units with relatively small pore spaces, such as those dominated by mudstone, siltstone and clays.
- groundwater hydrology – in alluvial aquifers in eastern Australia the average number of stygofauna taxa was higher within 6 m from the water table height, and where the water table height was less than approximately 15 m below the ground (Hancock & Boulton 2008), although stygofauna have been recorded from over 60 m below ground (Glanville et al. 2016), indicating that deep groundwater ecosystems can also support stygofaunal communities.
- groundwater quality:
  - The mean electrical conductivity of water from which stygofauna have been sampled is less than 4,000 µS/cm, although they have been recorded from a broad range of electrical conductivities (i.e. 11.5 – 54,800 µS/cm) (Glanville et al. 2016), Tolerance to high electrical conductivity is likely to vary among taxa, with only crustaceans (i.e. copepods and syncarids) reported from the upper end of this range (Glanville et al. 2016)
  - The minimum concentration of dissolved oxygen needed to support stygofauna communities is unknown. Some taxonomic groups are likely to be more tolerant of very low dissolved oxygen, and others more tolerant of very high dissolved oxygen (Halse et al. 2014). However, bores with the highest diversity of stygofauna had dissolved oxygen levels ranging from approximately 20 to 60% saturation (Halse et al. 2014).

- Stygofauna have been recorded from groundwater with pH ranging from 3.5 to 10.3, with diversity highest when pH is between 6.5 and 7.5 (average of 7.0) (Hancock & Boulton 2008).
- Total dissolved solids (TDS) can strongly influence the diversity of stygofauna, with stygofauna almost always absent where TDS is higher than 15 mg/L (Halse et al. 2014).
- Other water quality parameters, such as ionic composition, may also influence the diversity and taxonomic composition of stygofauna (Halse et al. 2014).

The groundwater study for the Six Mile Creek Dam Upgrade Project (SLR 2018) indicated that the:

- Geological units underlying Lake Macdonald, include quaternary alluvium approximately 3 – 21 m deep with high clay content overlaying weathered Triassic Myrtle Creek beds composed of weathered sandstone. Outcrops of Triassic Kin Kin bedrock composed of shale and mudstone occur to the east of Six Mile Creek Dam.
- Hydrology of the underlying geological units is characterised by:
  - low hydraulic conductivity in the alluvium due to high clay content
  - higher hydraulic conductivity of underlying sandstone
- Water quality of groundwater of:
  - alluvium (SMEC 2018):
  - pH: 5.39 – 6.59
  - dissolved oxygen: 57.4 – 62.3 mg/L
  - electrical conductivity: 86 – 140 µS/cm
  - TDS: 59 – 160 mg/L
  - Kin Kin sandstone considered potable to slightly brackish (SLR 2018).

In summary, the desktop assessment indicated that the alluvium of the Project area is *unlikely to be suitable* for stygofauna due to high clay content, low hydraulic conductivity and high TDS, and the Kin Kin sandstone is *suitable* for stygofauna due to the higher hydraulic conductivity.

## 4.9 Aquatic Ecology Values Assessment

### Assessment Method

The aquatic ecological value of Six Mile Creek was assessed using the criteria in Table 4.13.

Table 4.13 Criteria used to assess environmental value of each site.

| Aquatic Ecological Value | Criteria / Description |
|---|---|
| Very High | Known occurrence and breeding of aquatic MNES and / or threatened species protected under Queensland *Nature Conservation Act 1992* |
| High | Known or likely occurrence of aquatic MNES and / or threatened species protected under Queensland *Nature Conservation Act 1992* and / or HEV Waters under the EPP(Water) |
| Moderate | Aquatic MNES, threatened species protected under Queensland *Nature Conservation Act 1992* and HEV waters unlikely to occur, but suitable habitat for non-listed aquatic species of turtles and fish is present. Regulated vegetation categories under the *Vegetation Management Act 1999* may be present in riparian areas, and watercourses may be important for fish passage under the Queensland *Fisheries Act 1994* (mapped as having higher than low risk of impact to fish passage by waterway barriers) |
| Low | Ephemeral watercourse without refugial pools; limited aquatic habitat features present; likely to provide low quality habitat for non-listed aquatic species during high flow events only |
| Negligible | Site is a drainage feature as per the definition in the *Water Act 2000* |

### Results

Aquatic MNES (i.e. Mary River cod and Australian lungfish) and platypus are known from Six Mile Creek downstream of Lake Macdonald, and it is possible that Mary River turtle and white-throated snapping turtle occur in the lower reaches of Six Mile Creek. Mary River cod are known to breed in Six Mile Creek downstream of Lake Macdonald. MSES downstream of Lake Macdonald include: waterways providing fish passage, several categories of regulated vegetation (i.e. category R vegetation and vegetation intersecting a watercourse) and HEV (watercourse) waters (4.3 and 4.4).

Within Lake Macdonald, and upstream of Lake Macdonald, platypus are known to occur and likely breed, Mary River cod and Australian lungfish may occur but are unlikely to be breeding, and it is likely that Mary River turtle or white-throated snapping turtle would be rare or absent from Lake Macdonald or upstream of Lake Macdonald.  MSES upstream of Lake Macdonald include: waterways providing fish passage, several categories of regulated vegetation (i.e. category R vegetation) and HEV (watercourse) waters (Map 4.2, 4.3 and 4.4).

Using the criteria presented in Table 4.13, the assigned ecological value of:

- Six Mile Creek downstream of Lake Macdonald is *very high*
- Lake Macdonald is *high*
- Six Mile Creek upstream of Lake Macdonald is *high*, and
- groundwater ecosystems of the Project area is *low* (i.e. no habitat for conservation significant species).

# 5 Six Mile Creek Dam Safety Upgrade Project Description

## 5.1 Project Description

The Project will incorporate the demolition of the existing spillway and embankments and the construction of a new spillway and embankments to improve the safety and performance of the dam to meet current Queensland dam safety regulations. The new spillway will be an uncontrolled dual height labyrinth weir, with the capacity, FSL and inundation area remaining the same as the existing dam following completion of the Project (Table 5.1).

Table 5.1 Design features of existing and upgraded dam.

| Design Feature | Existing Dam | Upgraded Dam |
|---|---|---|
| Spillway type | Uncontrolled fixed ogee crest | Uncontrolled dual height labyrinth |
| Spillway Description | Concrete slab broad crest weir | Mass concrete dual height, multiple cycle labyrinth weir |
| Spillway crest elevation (low level) | Notch/initial: RL 95.32 m AHD<br>Full width: RL 95.35 m AHD | Initial: RL 95.32 m AHD<br>Full width: RL 95.40 m AHD |
| Spillway crest elevation (high level) | Not applicable | RL 97.1 m AHD |
| Stilling basin floor elevation | RL 83.5 m | RL 86 m |
| Energy dissipation method | Plunge pool/stilling basin | Plunge pool/stilling basin |
| Full supply level | 8,018 ML | 8,018 ML |
| Dead storage | RL 87.7 m | RL 87.7 m |
| Historical No Failure Yield | 7,118 ML/y | 7,118 ML/y |
| Maximum depth | 10.5 m | 10.5 m |
| Area inundated a FSL | 260 ha | 260 ha |

The major phases of the Project are:

- **Drawdown**, whereby Lake Macdonald will be drawn-down in stages over a twelve-week period to RL 89 m AHD prior to construction (Figure 5.1). Water levels will be allowed to increase to 89.5 m AHD once construction of the coffer dam is completed (i.e. water levels will be maintained at 89 m AHD for approximately two months), and will be managed within the range of 89-89.5 m AHD during construction. The lake will be drawn down by large scale pumping from the reservoir using a pontoon based pump station supported by a temporary power supply on the left abutment or adjacent to the right embankment. A pipe system will transfer the water to the existing dam spillway for aeration and energy dissipation before flowing to Six Mile Creek.

- **Construction**, which will involve:

  - construction of the temporary coffer dam over approximately the first two months of the construction phase, to manage water in Lake Macdonald between 89 m AHD and 89.5 m AHD, and provide a work platform for the main construction phase. The coffer dam will comprise a single row of sheet piles driven into the upstream face of the existing spillway embankment. The design will incorporate a low flow notch no lower than 89.5 m AHD to accommodate low flows, an upper flow level no lower than 90.0 m AHD that is designed to overtop during flood events, and a no-overflow level no lower than 92 m AHD to protect embankment excavations. A width of 30 m has tentatively been adopted for the low flow notch, with position of the notch potentially to be moved during the construction phase by cutting / repairing sheet piles to allow flows to be directed appropriately for site conditions at the time.

  - demolition of the existing dam and spillway, which will be undertaken using rock breakers and excavators. Inert materials from the demolished spillway will be re-used where possible, likely as fish habitat structures to be used in the inundation area.

  - construction of the new dam over approximately 18 to 24 months, which will involve staged construction of the spillway base, spillway wing walls, left and right embankments, outlet tower and labyrinth spillways, and saddle dam

- **Refill and Operation**, whereby the dam will be allowed to be filled to FSL by natural inflows, and normal dam operations, including water supply and provision of environmental flows according to the ROP, re-commence.

The construction period is currently programmed for between August 2019 and October 2021 subject to obtaining approvals and a satisfactory water security situation. Drawdown of Lake Macdonald is currently proposed to begin in May 2019, but this timing may be subject to change. During the construction phase, recreational activities will be temporarily ceased, and the Gerry Cook Hatchery temporarily re-located although some hatchery facilities will be retained through construction and used to support management of Mary River cod and Australian lungfish during the Project.

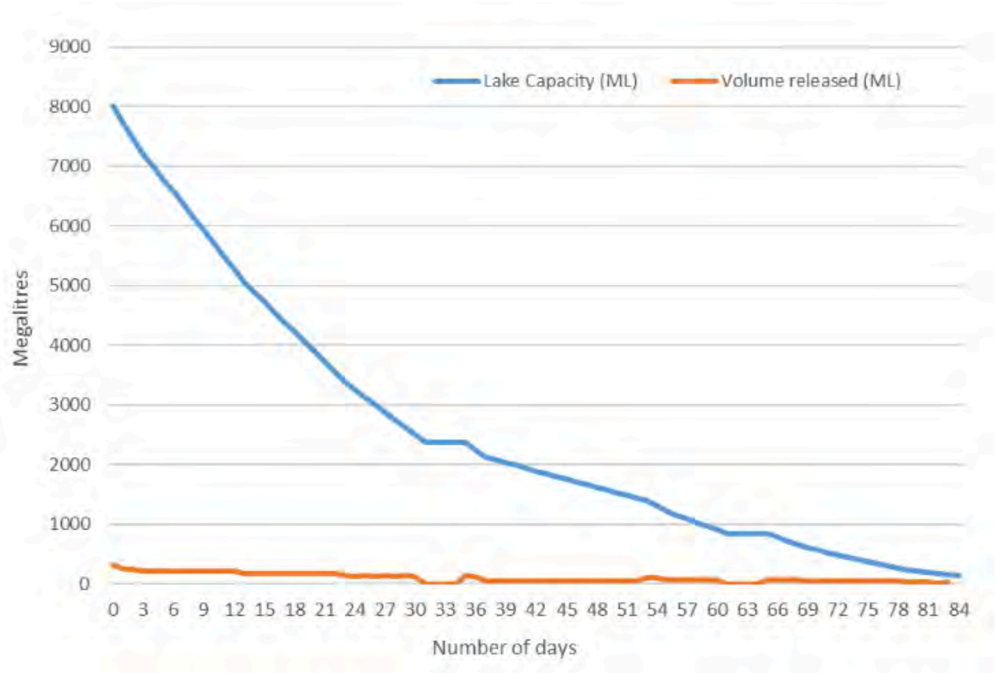


Figure 5.1 Drawdown schedule.

## 5.2 Sources of Potential Impact on Aquatic Ecological Values

Review of the Project Description has identified the following sources of potential impact to the aquatic Environmental Values of Six Mile Creek and Lack Macdonald:

- Impacts to water quality in Lake Macdonald and downstream of the lake during the drawdown, construction and refill phases
- Impacts to aquatic habitat in Lake Macdonald and downstream of the Lake during the drawdown and construction phases
- Impacts to aquatic fauna (injury, mortality or stranding) in Lake Macdonald during the drawdown and construction phases
- Impacts to aquatic flora in Lake Macdonald and downstream of the lake during the drawdown and construction phases
- Spread of biosecurity matters downstream of Lake Macdonald during the drawdown and construction phases
- Impacts to stygofauna communities in shallow groundwater systems during drawdown and construction phases, and
- Barriers to fish passage at the dam wall during the refill and operation phases.

# 6 Risk and Mitigation Assessment

## 6.1 Impact Assessment Methods

The risks of, and mitigations for, each of the identified potential sources of adverse impact of the Project on the Environmental Values of Six Mile Creek was assessed using a risk-based approach, with the risk score for a potential impact calculated by multiplying the likelihood and consequence scores for that potential impact (Table 6.1, Table 6.2, Table 6.3). The 5 x 3 risk matrix (Table 6.3) gives risk scores ranging between one and 15, with risk being:

- low, when the score is <5
- medium, when the score is >5 but <10, and
- high, when the score is >10.

Table 6.1 Ratings used to assess the likelihood of potential impacts.

| Rating | Likelihood of occurrence |
|---|---|
| Very high (5) | Almost certain to occur frequently |
| High (4) | Probably would happen sometimes to frequently |
| Moderate (3) | Could happen sometimes |
| Low (2) | Remote possibility of occurring or not expected to occur |
| Very low (1) | Definitely would not happen at all |

Table 6.2 Ratings used to assess the consequence of potential impacts.

| Rating | Consequence of occurrence |
|---|---|
| High (3) | Catastrophic short-term or significant long-term / irreversible environmental harm; significant short- or long-term harm to protected components of the environment, such as MNES. |
| Moderate (2) | Significant short-term but reversible environmental harm; minor environmental harm to protected components of the environment, such as MNES. |
| Low (1) | Unfavourable impact with no material harm to the environment; no impact to protected components of the environment. |

Table 6.3 Environmental risk matrix, showing risk score and level of risk (green = low; amber = moderate, red = high).

| | | Likelihood | | | | |
|---|---|---|---|---|---|---|
| | | **Very Low (1)** | **Low (2)** | **Moderate (3)** | **High (4)** | **Very High (5)** |
| **Consequence** | **Low (1)** | 1 | 2 | 3 | 4 | 5 |
| | **Moderate (2)** | 2 | 4 | 6 | 8 | 10 |
| | **High (3)** | 3 | 6 | 9 | 12 | 15 |

Assessment of potential impacts to Mary River cod, Mary River turtle, Australian lungfish and white-throated snapping turtle were further assessed using the MNES Significant Impact Criteria Guidelines 1.1.

## 6.2 Risk-based Impact Assessment

### Water Quality

#### *Potential Impacts*

Drawdown of waterbodies can have adverse impacts on water quality both at, and downstream of, the discharge site(s) and in the lake. Construction earthworks, and runoff from stock piles of soil, during construction can also adversely impact water quality. Submersion of decomposing organic matter can also adversely affect water quality during dam refill phases and lead to eutrophication. The potential impacts to water quality during the drawdown, construction and refill phases include:

- increasing turbidity and total suspended solids via disturbance of bed sediments and / or the erosion of bed and banks during drawdown and construction; and from disturbance of earth and runoff from soil stockpiles during construction
- reducing pH by exposing or disturbing acidic soils during drawdown and construction and / or where decomposing organic material (e.g. aquatic plants) reduces the pH of water
- reducing dissolved oxygen in the lake and in Six Mile Creek downstream if the source waterbody becomes stratified or eutrophied, such as through submersion of decomposing organic matter (e.g. decomposing Cabomba) during the refill phase

- increasing nutrient concentrations in the lake if drawdown exposes deep sediments below approximately 90 m AHD, which have higher nutrient content than sediments above 90 m AHD (Grinham et al., 2018), and in receiving waters during drawdown if the source water has high nutrient concentrations, or during refill if the lake becomes eutrophied from decomposing organic matter
- increasing dissolved metal concentrations in the lake and receiving waters during drawdown, construction and refilling phases due to mobilisation and oxidation of lake sediments, lateral transport of sediment pore water and ebullition fluxes during drawdown (Grinham, et al., 2018). Drawdown that exposes deep sediments below approximately 90 m AHD, which have higher metal content than sediments above 90 m AHD, will increase the risk of adverse water quality (Grinham et al., 2018), and
- contaminating water from spills of fuels, oils or other chemicals from pumping equipment or other machinery / vehicles during drawdown and construction.

Increased turbidity (and total suspended solids) may negatively impact fish and macroinvertebrates, because highly turbid water reduces respiratory and feeding efficiency. Increased turbidity may also adversely affect submerged aquatic plants as light penetration (required for photosynthesis) is reduced. Reduced light penetration can also lead to a reduction in temperature throughout the water column. Small and brief increases in turbidity, consistent with increases in turbidity that occur during natural flow events, would be unlikely to have a significant impact on aquatic fauna (Dunlop et al., 2005). However, significant increases in turbidity, especially turbidity caused by fine silt and clay particles, could adversely impact the health, feeding and breeding ecology of aquatic fauna species (Dunlop et al., 2005). However, significant resuspension of sediments is likely to be limited by cohesive properties of the sediment in the Six Mile Creek Dam (Grinham et al., 2018).

Reduced pH can negatively impact fish health by causing diseases (e.g. lesions and ulcers) and impacting metabolism and reproduction in fish, with very low pH (such as from acidic soil exposure) potentially causing fish kills. While many waterways of the lower Mary River Basin are naturally acidic and stained with tannins and organic compounds, Six Mile Creek is not of this acidic water type; similarly water in Lake Macdonald is tannin stained but is not naturally acidic. Some variation in pH is tolerated by aquatic biota of Six Mile Creek, although significant reductions in pH may have adverse effects on aquatic ecosystem health. The potential for acid sulfate soils in the Project area was assessed and determined to be unlikely (SMEC 2018).

Dissolved oxygen is essential for respiration and metabolism by aquatic biota. Reduced dissolved oxygen can cause stress to fish, and very low dissolved oxygen can cause mass mortality ('fish kills'). Some waterways of the region can have naturally low dissolved oxygen, especially during low flow periods, and thus much of the aquatic biota of the region can tolerate periods of low dissolved oxygen (i.e. approximately 50 percent saturation), but sustained periods of low dissolved oxygen and / or very low dissolved oxygen will cause mortality in aquatic fauna.

High nutrient concentrations can cause increased growth of phytoplankton, which in turn can deplete dissolved oxygen concentrations, particularly at night when there is no photosynthesis. Benthic algae, including filamentous algae, and aquatic plant growth may increase under high nutrient conditions, especially under high sunlight conditions. Excessive algae and aquatic plant growth can reduce in-stream habitat quality for some aquatic biota.

Fuels, oils and other chemicals (e.g. lubricants and solvents) that may be required for the operation of pumps and other machinery for lake drawdown, including vehicles, are toxic to aquatic flora and fauna at relatively low concentrations. Spilt fuel is most likely to enter watercourses via an accidental spill when activities are adjacent to waterbodies. A significant fuel spill to waterways (in the order of tens or hundreds of litres) is likely to have a locally significant impact on both flora and fauna, with the size of spill and the volume of water in the creeks being the most significant factors influencing the length of stream impacted.

### *Mitigations*

Appropriate mitigation measures should be implemented for the Project to achieve the following objective:

- prevent or reduce potential impacts to water quality.

Suggested mitigation measures are provided below, however alternative measures may also be appropriate to achieve the objective:

- Minimise exposure of deep sediments that have high metal and nutrient concentrations, for example by not lowering water in Lake Macdonald to below 89 m AHD
- Minimise disturbance of unconsolidated bed sediments, which could increase turbidity and TSS, and organic matter on the bed of Lake Macdonald, which could influence dissolved oxygen concentrations and pH (e.g. by using pontoon based pump stations)
- Reduce the likelihood of releasing poor quality water to Six Mile Creek from Lake Macdonald during the drawdown by taking water from mid-depth, or mix of depths, for example with a multi-level intake

- Avoid or manage areas of potential erosion, for example by implementing an Erosion and Sediment Control Plan (ESCP) in accordance with applicable industry standards, monitoring the efficacy of sediment and erosion control management measures, and/or releasing water to the existing concrete apron during drawdown
- Maintain dissolved oxygen concentrations in Lake Macdonald and Six Mile Creek, for example by using aeration units (potentially including the existing destratification unit) within the lake and turbulent release to the existing concrete apron.
- Remove decomposing Cabomba from exposed lake surfaces, where possible, to reduce risk of eutrophication and low dissolved oxygen during refill phase
- Implement real-time water quality monitoring for comparison against suitable objectives for key parameters (i.e. pH, dissolved oxygen, turbidity, TSS, nutrients). The objectives should be consistent with the desired outcomes and trigger corrective action, such as a review and update of existing control measures, if exceeded.
- Reduce the likelihood of chemical spills or leaks, for example through:
  - storing fuels, oils and other chemicals in bunded areas in accordance with Australian Standard 1940 (2004) – *The storage and handling of flammable and combustible liquids*
  - establishing bunded areas away from water bodies, preferable above the Q100 level
  - only refuelling in bunded areas, and
  - making spill kits available to enable a rapid response to a spill if one was to occur.

### *Risk Assessment*

The *consequence* of impacted water quality is *moderate* because large changes in some water quality parameters, such as drops in pH or the concentration of dissolved oxygen, may have adverse effects for aquatic biota.

The *likelihood* of impacts to water quality is *low* where appropriate mitigation measures such as those described above are implemented, because dissolved oxygen concentrations will be maintained, turbidity and TSS are less likely to increase, and other water quality parameters will be monitored and managed as required (see above).

The mitigated *risk* of impact to water quality is *low*.

## Aquatic Habitat

### *Potential Impacts*

Aquatic habitat in the lake will be adversely affected by lowered water levels during the drawdown phase, with the amount of aquatic habitat (i.e. volume of water) in Lake Macdonald reduced to approximately 2.8% of FSL (27 hectares) for the first two months of construction, and allowed to increase to approximately 5.1% of FSL (42 hectares) for the remainder of the construction period. This is a significant temporary reduction in aquatic habitat that will be reversed during the refill and operational phases of the Project.

There may also be potential adverse impacts to aquatic habitat downstream of the lake due to sedimentation and hydrological changes during drawdown and construction phases:

- Sedimentation – Fine sediments accumulate on the bed of reservoirs (e.g. >90% of sediment is captured in Six Mile Creek Dam, DNRM 2014), which could be mobilised during drawdown and construction phases and deposited downstream (i.e. sedimentation). Sedimentation smothers benthic habitats, including in-filling pools and interstitial spaces of coarse substrate (e.g. gravels and cobbles), causing cascading impacts to primary producers (i.e. aquatic plants and benthic algae), macroinvertebrates and fishes (Wood and Armitage 1997).
- Potential hydrological impacts – The drawdown phase will create a 'flow event' that is of similar magnitude to an ARI 2 year flow, although the duration of this flow will be significantly longer than a natural flow event of similar magnitude. The frequency and duration of low flows will likely increase from current conditions during the construction period, as the reduced dam wall height provides less capacity to reduce or buffer outflows, and thus a greater proportion of in-flows will flow downstream to Six Mile Creek downstream of Lake Macdonald. However, the magnitude, frequency, duration and timing of large flows should not change substantially from current, because the nature of Lake Macdonald and it's catchment are such that attenuation of high flows by the current dam are minimal.

### *Mitigations*

Appropriate mitigation measures should be implemented for the Project to achieve the following objective:

- prevent or reduce potential impacts to aquatic habitat.

Suggested mitigation measures for potential impacts are provided below, however alternative measures may also be appropriate to achieve the objective:

- temporary loss of aquatic habitat in Lake Macdonald
  - where possible, augment aquatic habitat within Lake Macdonald (e.g. by adding physical habitat structures; controlling aquatic weeds) during construction to improve the long-term aquatic habitat values of Lake Macdonald from current condition
- sedimentation
  - minimise disturbance and downstream transfer of unconsolidated bed sediments, for example by using a pontoon based pump station
  - stabilise exposed sediments, for example by seeding the exposed Lake Macdonald bed with non-invasive grasses following initial drawdown
  - avoid or manage areas of potential erosion, for example by implementing an ESCP in accordance with applicable industry standards, and monitoring the efficacy of management measures
  - slow flow and reduce erosion in the upper reaches of the lake, for example by using physical barriers (e.g. staggered baffles) at key upstream locations
- potential hydrological impacts:
  - avoid releases during natural low flow periods, for example undertake drawdown when flows of moderate magnitude commonly occur
  - avoid major pulse flow events, for example by using a maximum pumping / discharge rate that will not exceed the bank full width of Six Mile Creek downstream of the dam and/or pumping / discharging over an extended period (e.g. 12 weeks)
  - avoid changes to hydrology during the breeding seasons for MNES species known to be in Six Mile Creek downstream of the dam, for example undertake drawdown outside the Mary River cod and Australian lungfish breeding seasons
  - maintain the existing flow regime during the construction period, for example by allowing inflows to pass the construction area, pumping water downstream at a rate consistent with inflows, and/or using water piped from the Mary River to the water treatment plant.

### *Risk Assessment*

*Temporary loss of aquatic habitat in Lake Macdonald*

The *consequence* of temporary loss of aquatic habitat in Lake Macdonald is *moderate*, because non-breeding habitat for Mary River cod, and habitat for platypus, occurs in Lake Macdonald; however the impact on habitat is reversible, with long-term habitat values to be augmented during the project.

The *likelihood* of temporary loss of habitat is *very high* as it is certain that temporary loss of approximately 97.2% of aquatic habitat (by water volume) in Lake Macdonald will occur.

The *risk* of impact of temporary loss of habitat in Lake Macdonald is therefore *high*, and requires further mitigation measures, specifically:

- developing and implementing a comprehensive aquatic fauna salvage operation (see Aquatic Fauna below).

This additional mitigation reduces the *consequence* to *low*, giving a *residual risk* rating of *moderate*. This is an unavoidable risk given the safety requirements of the Project.

*Sedimentation*

The *consequence* of sedimentation is *moderate* because breeding habitat for Mary River cod occurs in the downstream reaches of Six Mile Creek; however, the impact is reversible, and subsequent large flows will naturally flush sediment after the construction phase is completed.

The *likelihood* of sedimentation is *low* where appropriate mitigation measures, such as those described above, are applied.

The mitigated *risk* of impact of sedimentation is *low*.

*Changes to Downstream Flows*

The *consequence* of altered *hydrology* is *low*, because the most notable change to hydrology will be a one-off, short-duration event during the drawdown phase, which is recommended to occur outside the breeding season of Mary River cod and Australian lungfish (the MNES species known to be in Six Mile Creek downstream of Six Mile Creek dam).

The *likelihood* of altered hydrology is *moderate*, because there will be a sustained 12-week release during drawdown and the frequency of flows past the construction site may increase compared to current flows past the dam, which is considered a temporary benefit to the downstream environment.

The mitigated *risk* of impact of altered hydrology is *low*.

## Aquatic Fauna

### *Potential Impacts*

Aquatic fauna may become injured in pumping equipment during the drawdown phase, which could make them susceptible to pathogens and disease, or be fatally injured, trapped and subsequently drown. Injury may also occur in the low flow notch during the construction phase, and over the spillway during the refill and operate phase.

Aquatic fauna in Lake Macdonald may become stranded in small isolated pools during the drawdown phase once water levels have lowered, and following large flow events during the construction phase (i.e. when water levels rise and then lower again following significant rainfall), which may increase predation (e.g. predation of smaller fish by larger fish and / or birds), and / or crowding. Crowding may result in reduced dissolved oxygen concentrations in water, increased competition for food and shelter, and increased stress on fauna. As small isolated pools evaporate, or in areas that are dewatered rapidly, there is a risk that aquatic fauna could become stranded on dry areas and perish. Turtles and platypus may also have difficulty moving to the nearest available water through exposed lake bed sediments (i.e. mud) and exposed aquatic vegetation.

Some turtle species have an innate biological response to ‘walk out’ of waterbodies as water levels lower; however, alternate waters may not be sufficiently proximate, and / or movement to alternate water may involve crossing roads and encountering other hazards.

During the refill and operation phase, injury or mortality to stream fauna could occur by downstream passage over the labyrinth spillway, with the vertical drop to the surface over a vertical fall spillway to the surface below being the predominant source of risk (Berghuis 2017). A vertical fall from a spillway to a deep plunge pool or stilling basin can cause significant injuries to fish when the fall higher is greater than 13 m (Berghuis 2017), with vertical falls to hard surfaces (e.g. concrete , rock) or shallow water likely to result in serious injury at much lower fall heights. The proposed dual height labyrinth spillway incorporates stepped plunge pools on the downstream face, ensuring low vertical fall heights, with plunge pools designed to be at least 30 percent of the vertical fall. Furthermore, tail water levels rise rapidly during overtopping flows, and thus it is expected that the stepped plunge pools will be drowned out in large flow events. However, entrapment of fish in the stepped plunge pools is possible as overtopping flows subside, where they may be susceptible to predation and poor tailwater quality.

### *Mitigations*

Appropriate mitigation measures should be implemented for the Project to achieve the following objective:

- prevent or reduce potential impacts to aquatic fauna, in particular listed threatened species.

Suggested mitigation measures for potential impacts are provided below, however alternative measures may also be appropriate to achieve the objective:

- Prevent aquatic fauna from being entrained and injured or trapped by pumping equipment, for example by using suitably designed screens with aperture <20 mm, and a pumping rate / in-let housing size that ensures that 'approach velocities'[8] are < 0.1 m/s (see Boys et al. 2012), and/or monitoring measures implemented to ensure they are functioning correctly
- Enable aquatic fauna to move to areas where water will persist for the duration of the Project, for example lowering water levels slowly during the initial weeks of drawdown
- Where possible, maintain suitable habitat for protected species (e.g. by maintaining refugial pools within platypus home range, or reduce the likelihood of impacts to protected species, for example by implementing a comprehensive aquatic fauna salvage operation in accordance with DAF's Fish Salvage Guidelines (DPI 2004), that includes:
  - establishing quantitative targets for recovery of large bodied fishes, turtles and, if necessary, platypus
  - undertaking salvage and relocation until such time that the quantitative salvage objectives have been achieved
  - selecting relocation sites with consideration of biosecurity management, protecting genetic integrity of populations of all turtle species, Mary cod and

[8] Approach velocity: velocity of water flowing in the vector perpendicular to, and in front of, the screen face. As velocity declines steadily with increasing distance from the screen, approach velocity is measured 8 cm in front of the screen, which is typical of screening guidelines throughout the world.

Australian lungfish, carrying capacity, and ease of re-introduction of key fauna (especially Mary cod and Australian lungfish) back to Lake Macdonald in the refill and operate phase

– basing the number of individuals released at any one location on the assessed carrying capacity to avoid over-stocking / crowding, and monitoring the success of relocation

– undertaking incidental fish salvage after large flow events during construction until the quantitative salvage objectives have been achieved

– monitoring key water quality parameters and observing fauna in Lake Macdonald during construction to trigger incidental fish salvage, or other mitigation measures, as required

- Prevent turtles dispersing over roads, for example by installing temporary fencing, similar to coarse sediment barriers, between Lake Macdonald and roads, and/or daily surveillance and salvage of turtles during the drawdown phase and weekly during the construction phase
- Restore Lake Macdonald, where possible, once water quality assessments have confirmed suitability, for example by re-stocking salvaged Mary River cod and Australian lungfish, and other species, during the refilling and operation
- Reduce the risk of injury and mortality to aquatic fauna over the spillway and stranding of fauna in plunge pools, for example by ensuring the design of the spillway includes low fall heights to sufficiently deep plunge pools and incorporating recommendations from Berghuis (2017).

### ***Preliminary Risk Assessment***

*Injury to Fauna*

The *consequence* of injury or mortality of aquatic fauna where the proposed mitigation is implemented is *moderate,* as the mitigations will prevent significant harm (e.g. mortality of large numbers) to threatened (and other) species of aquatic fauna that occur in Lake Macdonald.

The *likelihood* of injury or mortality of aquatic fauna is *low* where appropriate mitigation measure, such as those described above, are implemented, because they will prevent threatened species from becoming entrapped in equipment, reduce risks of stranding, and reduce impacts of injury or mortality to fauna over the spillway and stranding of fauna in plunge pools.

The mitigated *risk* of injury or mortality of aquatic fauna is *low*. Further risk assessment will be implemented once detailed designs of the labyrinth spillway are available.

*Stranding of Fauna*

The *consequence* of fish and turtle stranding is *moderate* because appropriate mitigations will prevent significant stranding of aquatic fauna, but also because the lake will not be completely drained and refugial habitat will persist through the construction period.

The *likelihood* of fish and turtle stranding is *low* where appropriate mitigations, such as those described above, are applied.

The mitigated *risk* of fish and turtle stranding is *moderate*.

*Road Kill of Turtles*

The *consequence* of road kill of turtles is *moderate* where appropriate mitigations, such as those described above, are applied, because threatened turtle species are unlikely to occur in the Project area and these species are not known to wander to the same extent as many common species of turtle. Appropriate mitigation measures will also reduce potentially large numbers of common species of turtles walking across nearby roads.

The *likelihood* of road kill of turtles is *low* where suitable mitigations, such as those described, are applied, because they will reduce the frequency of turtles from walking across road.

The *mitigated* risk of impact is *low*.

## Aquatic Flora

### *Potential Impacts*

Dewatering will expose aquatic plants above 89.5 m AHD, with those species dependent on standing water expected to perish in these areas.

### *Mitigations*

Water will be retained in Lake Macdonald below 89.5 m AHD, providing refugee habitat for aquatic plants.

### *Risk Assessment*

The *consequence* of impact of dewatering on aquatic plants is *low* because no threatened species of aquatic plant is known from the area, and the aquatic plant community of Lake Macdonald is dominated by *Cabomba*, a restricted biosecurity matter. Furthermore, water will be retained in Lake Macdonald below 89.5 m AHD, and aquatic plant species have effective dispersal capabilities ensuring recolonization by aquatic plants during the refill and operate phase.

The *likelihood* of impact of dewatering on aquatic plants is *moderate*, because some native plants can persist in saturated sediments, but at least some species will perish in dewatered areas, but the impact will be reversed during the refill and operate phase.

The *mitigated risk* of impact is *low*.

## Spread of Aquatic Biosecurity Matters

### *Potential Impacts*

An invasive species is a species that is found beyond its natural distribution, and which threatens valued environmental, agricultural or other societal resources. Invasive species that have, or have the potential to have, significant adverse impacts on the ecological, agricultural or economic resources of Queensland are declared under the *Biosecurity Act 2014*, as either:

- a prohibited matter, not yet present in Queensland, or
- a restricted matter, currently present in Queensland.

The damage caused by invasive species includes:

- Competitive impacts, where the invasive species can reproduce more rapidly, or otherwise out-compete native species, to the extent that a native species declines or is threatened. For example, fish such as eastern gambusia (*Gambusia holbrooki*) and tilapia (*Oreochromis mossambicus*) displace native fish, while aquatic weeds such as water hyacinth (*Eichhornia crassipes)* and Cabomba (*Cabomba caroliniana*) can displace native aquatic plants.

- Degradation of habitat, where feeding or other behaviours result in the degradation of habitat that supports native species. For example, aquatic weeds choke waterways and can reduce the concentration of dissolved oxygen in the water, making it unsuitable for native fauna; and tilapia disturb benthic habitats through their breeding behaviour.
- Predatory impacts, where an invasive species reduces the population size and / or threatens the survival of native species by predation.
- Herbivory impacts, where an invasive species consumes native plants, causing a population decline.

Operational activities of the Project have the potential to spread restricted biosecurity matters, most notably:

- upstream movement of tilapia during the construction period at times when the coffer dam is over-topped by large flows, and
- spread of aquatic plant fragments during fauna relocation during the drawdown phase.

### *Mitigations*

Appropriate mitigation measures should be implemented to achieve the following objective:

- prevent or reduce the potential impacts of the Project on the establishment and spread of aquatic biosecurity matters.

Suggested mitigation measures are provided below, however alternative measures may also be appropriate to achieve the objective:

- To the extent that is possible, reduce the opportunities for upstream movement by tilapia during the lake lowering and construction phases, for example by managing the water level in the lake to reduce the potential for drown out / overtopping (i.e. via pumping), not using or pumping water from Six Mile Creek downstream of the dam for construction or machinery purposes
- When caught, euthanise pest fish humanely in accordance with methods approved by animal ethics, for example, if possible, sort fish during any salvage effort before relocation and euthanise pest fish.

- Control potential increases in cane toad populations, for example by installing cane toad traps, as manufactured by the Mary River Catchment Coordinating Committee
- Where possible, remove Hygrophila and Cabomba from Lake Macdonald during the construction phase
- Minimise potential spread of aquatic weeds, for example by implementing pest identification training for all relevant construction personnel, only relocating aquatic fauna to waterbodies that are already infested with Cabomba, and/or requiring that vehicles, machinery, equipment and temporary infrastructure are subject to weed hygiene protocols.

### *Risk Assessment*

The *consequence* of establishment or spread of biosecurity matters is *high*, as this would represent both an environmental impact and non-compliance with the *Biosecurity Act 2014,* with establishment of invasive species generally non-reversible.

The *likelihood* of establishment or spread of biosecurity matters is *low* where appropriate mitigations, as described above, are implemented.

The *mitigated risk* of impact from spread and establishment of biosecurity matters in *low*.

## Stygofauna

### *Potential Impacts*

The Project has the potential to impact local stygofauna communities in underlying shallow alluvial aquifers through:

- Reducing the rate of aquifer recharge from direct infiltration from Lake Macdonald during dewatering and construction phases, which may result in localised reductions in groundwater levels in the order of 8 – 14 m below ground level (SLR 2018), thereby reducing habitat availability for stygofauna in shallow groundwater systems, and
- Contamination from spills of fuels and oils, which may contaminate shallow groundwater ecosystems and cause lethal or sub-lethal impacts to stygofauna.

### *Mitigations*

Appropriate mitigation measures should be implemented to achieve the following objective:

- prevent or reduce the potential impacts to stygofauna in the Project area.

Suggested mitigation measures are provided below, however alternative measures may also be appropriate to achieve the objective:

- Reduce the likelihood of chemical spills or leaks, for example through:
  - storing fuels, oils and other chemicals in bunded areas in accordance with Australian Standard 1940 (2004) – *The storage and handling of flammable and combustible liquids*
  - establishing bunded areas away from water bodies, preferable above the Q100 level
  - only refuelling in bunded areas, and
  - making spill kits available to enable a rapid response to a spill if one was to occur.

### *Risk Assessment*

The *consequence* of shallow groundwater drawdown, or contamination of shallow groundwater ecosystems, for stygofauna is *low*, because the alluvial aquifer underlying Six Mile Creek Dam is considered unlikely to be suitable habitat for stygofauna. Furthermore, if stygofauna were present in the alluvial aquifer, potential disturbances to stygofauna habitat associated with the Project would be an order of magnitude smaller than the likely distribution of stygofauna taxa (i.e. speculated to be in the order of 400 $km^2$ within a single subcatchment area (see Section 4.8).

The *likelihood* of shallow groundwater drawdown, or contamination of shallow groundwater ecosystems, for stygofauna is *low* where appropriate mitigations, as described above, are implemented.

The *mitigated risk* to stygofauna is *low*.

## Fish Passage

### *Potential Impacts*

Almost all freshwater fish species migrate at some spatial scale (Harris et al. in press), with migration being the regular cyclic alteration between different habitats used for spawning, feeding or survival (Northcote 1998).

Migration is a key ecological process that enables species to complete their life history by:

- providing access to foraging, residing and spawning / breeding habitats, which may occur in geographically distinct segments of a river system
- avoiding predation
- reducing population density and intra-specific competition, and
- enabling individuals to find refuge from seasonal or inter-annual harsh conditions, such as dry seasons and droughts.

Migration also maintains diverse and abundant fish communities, with both diversity and abundance of fish known to decrease where natural migration patterns are impacted; barriers to fish migration represent a significant threatening process for freshwater fish globally (Harris et al. in press). Maintenance of naturally diverse fish communities (via maintenance of fish passage and other factors, such as habitat quality and natural flow regime) maintains natural ecological processes at the location of the fish community (e.g. natural tropic interactions and food web structure) and contributes significantly to maintaining the EVs of the watercourse.

A permanent waterway barrier in a downstream reach may cause significant changes to fish communities along the whole river if diadromous migration is impeded. Multiple waterway barriers may cause cumulative impacts and can severely change aquatic communities. Secondary ecological impacts such increased rates of benthic algal growth, sedimentation and accumulation of organic matter may result from the exclusion of migratory fish and shrimps due to waterway barrier works.

Six Mile Creek is mapped as a ‘major risk of impact’ (purple) waterway in DAF’s waterway barrier works risk layer, indicating that permanent waterway barriers, such as dams, are likely to have a significant impact on fish passage. The absence of Pacific blue-eyes (a diadromous species) upstream of the dam indicates a likely impact to fish passage from the existing dam (frc environmental 2016). However, many species that undertake diadromous migration in Six Mile Creek are often present in relatively low abundance, and a number of diadromous species that would be expected to occur were absent from surveys (e.g. sea mullet, pink eye mullet, empire gudgeon, striped gudgeon), suggesting the possibility of cumulative impacts to fish passage between the estuary and Six Mile Creek by barriers in the lower Mary River (e.g. Gympie Weir) (see Walker 2008). Providing fish passage at barriers in the lower Mary River will therefore improve the native fish community in Six Mile Creek below the dam, as well as in other sections of the broader Mary River system.

### *Management of Fish Passage*

Fish passage is currently not provided at the Six Mile Creek dam. While investigations into fishway options have been implemented for the Six Mile Creek dam upgrade (e.g. frc environmental, 2016; Seqwater 2018), preliminary advice from DAF indicates that several factors outweigh the benefit of providing fish passage over the upgraded dam, including site constraints, the risk of aiding upstream dispersal by tilapia, and the anticipated regional benefits of the proposed offsite mitigation option (DAF 2018). Additionally, the limited options available at Six Mile Creek Dam for implementing fish passage were generally not attractive with respect to the need for a mechanical fishway and limitations on available water. Where provision of fish passage is not possible due to overriding constraints, DAF may accept fish passage mitigations. The following mitigation measures are suggested for managing fish passage issues for the Project:

- Provision of fish passage at Gympie Weir by installation of a suitable fishway, and
- Removal of the old culvert material from Six Mile Creek immediately downstream of the Six Mile Creek dam, because during low flows this barrier traps fish in the spillway pool and prevents downstream movement.

## 6.3 Impacts to Aquatic Matters of National Environmental Significance

### The Sensitivity of the Environment that will be Impacted

Six Mile Creek is a sensitive environmental receptor as threatened aquatic species inhabit this waterway, and Mary River cod breeds in Six Mile Creek downstream of Lake Macdonald.

### The Timing, Duration and Frequency of the Action and its Impacts

The major phases of the Project are:

- **Drawdown**, whereby Lake Macdonald will be drawn down in stages over a twelve-week period to RL 89 m AHD prior to construction (Figure 5.1). Water levels will be allowed to increase to 89.5 m AHD once construction of the coffer dam is completed (i.e. water levels will be maintained at 89 m AHD for approximately two months) and managed between 89 m AHD and 89.5 m AHD during construction. The lake will be drawn down by large scale pumping from the reservoir using a pontoon based pump station supported by a temporary power supply on the left abutment or adjacent to the right embankment. A pipe system will transfer the water to the existing dam spillway for aeration and energy dissipation before flowing to Six Mile Creek.
- **Construction**, which will involve:
  - construction of the temporary coffer dam over approximately the first two months of the construction phase, to contain water in Lake Macdonald between 89.0 m AHD and 89.5 m AHD, and provide a work platform for the main construction phase. The coffer dam will comprise a single row of sheet piles driven into the upstream face of the existing spillway embankment. The design will incorporate a low flow notch no lower than 89.0 m AHD to accommodate low flows, an upper flow level no lower than 90.0 m AHD that is designed to overtop during flood events, and a no-overflow level no lower than 92 m AHD to protect embankment excavations. A width of 30 m has tentatively been adopted for the low flow notch, with position of the notch potentially to be moved during the construction phase by cutting / repairing sheet piles to allow flows to be directed appropriately for site conditions at the time.
  - demolition of the existing dam and spillway, which will be undertaken using rock breakers and excavators. Inert materials from the demolished spillway will be re-used where possible, likely as fish habitat structures to be used in the inundation area.
  - construction of the new dam over approximately 18 to 24 months, which will involve staged construction of the spillway base, spillway wing walls, left and right embankments, outlet tower and labyrinth spillways, and saddle dam
- **Refill and Operation**, whereby the dam will be allowed to be filled to FSL by natural inflows, and normal dam operations, including water supply and provision of environmental flows according to the ROP, re-commence.

The construction period is currently programmed for between August 2019 and October 2021 subject to obtaining approvals and a satisfactory water security situation. Drawdown of Lake Macdonald is currently proposed to begin in May 2019, but this timing may be subject to change. During the construction phase, recreational activities will be temporarily ceased, and the Gerry Cook Hatchery temporarily re-located although some hatchery facilities will be retained through construction and used to support management of Mary River cod and Australian lungfish during the Project.

### On-site and Off-site, and Direct and Indirect Impacts

Potential direct and indirect impacts of the Project are likely to affect both Lake Macdonald and Six Mile Creek downstream. Potential sources of impact are described in Section 5.2, and the risk of adverse impact from each of these sources of potential impact has been assessed (Section 6.2). Most sources of impact were assessed as having a low risk of impact when the appropriate mitigations, such as those identified, are applied. However, the temporary loss of aquatic habitat in Lake Macdonald on aquatic fauna still had a moderate residual impact after mitigation measures were applied.

### The Total Impact that can be Attributed to the Action

The Project is replacing an existing dam wall; thus, the long-term impact will be no change from current condition, with the potential exception of improved physical habitat for Mary River cod in Lake Macdonald. Most potential impacts will be temporary (i.e. for the duration of the drawdown and construction periods, approximately 2 to 3 years in total), and where appropriate mitigations, as described above, are applied there will be no ongoing impacts to the aquatic environmental values of Lake Macdonald or Six Mile Creek.

### Existing Levels of Impact from Other Sources

Land uses in the catchment of Six Mile Creek include forestry, grazing, horticulture, rural residential and urban areas, which have relatively low levels of impact on the aquatic ecology of Lake Macdonald and Six Mile Creek. Aquatic weeds, especially Cabomba and Hygrophila, are notable existing stressors, with tilapia recently recorded from Six Mile Creek downstream of Lake Macdonald. These biosecurity matters will be managed throughout the Project via an Environmental Management Plan.

The Project will have no impact on the scope or scale of these impacts.

### The Degree of Confidence with which the Impacts of the Action are Known and Understood

It is considered that potential impacts of the Project on the aquatic ecology of Six Mile Creek have been assessed with a 'moderate to high' degree of confidence, because:

- the Environmental Values assessment was based on recent survey data supported by database and literature searches, and
- the potential impacts of the Project are generally well understood by specialist aquatic ecologists.

### Mitigation Measures

Section 6.2 specifies numerous mitigations that can be applied during one or more phases of the Project to reduce the level of risk of the identified sources of potential impact on aquatic ecological values.

### Assessment Against the Significant Impact Criteria

The assessment against the Significant Impact Criteria for critically endangered and endangered aquatic species is presented in Table 6.4. The assessment against the Significant Impact Criteria for vulnerable aquatic species is presented in Table 6.5.

The assessment indicates a significant impact to aquatic MNES species associated with the Project is unlikely.

Table 6.4 Assessment of the Project on critically endangered and endangered aquatic MNES species: Mary River cod, Mary River turtle, white-throated snapping turtle.

| Significant Impact Criteria | Will the action have a significant impact | Justification |
|---|---|---|
| Lead to a long-term decrease in the size of a population of a species | No | Mary River turtle and white-throated snapping turtle are not expected to occur in Six Mile Creek; thus it is unlikely that any population of these species will be in or near the Project area. However, the application of appropriate mitigations will protect water quality, habitat and flows that support these species, as well as ensure any individuals of these species are not injured or stranded should any be present in Lake Macdonald. There will be no long-term decrease in the size of a population of Mary River turtle or white-throated snapping turtle associated with the Project.<br><br>Mary River cod is known from Six Mile Creek downstream of Lake Macdonald, and has been stocked to Lake Macdonald. The application of appropriate mitigations will protect water quality, habitat and flows that support this species, as well as ensure any individuals of Mary River cod are not injured or stranded in Lake Macdonald. Stocking densities at the relocation sites will be carefully managed and monitored. There will be no long-term decrease in the size of a population of Mary River cod associated with the Project. |

| Significant Impact Criteria | Will the action have a significant impact | Justification |
|---|---|---|
| Reduce the area of occupancy of the species | No | The area of occupancy of Mary River turtle and white-throated snapping turtle is unlikely to be influenced by the Project, because these species are not expected to occur in Six Mile Creek. The area of Lake Macdonald will be temporarily reduced during the drawdown and construction phases of the Project, with a fauna salvage and relocation operation implemented during these phases of the Project. Should any Mary River turtle or white-throated snapping turtle be caught and relocated during the salvage operation, they will be returned to Lake Macdonald during the refill and operate phase, ensuring that the area of occupancy of these species after completion of construction is the same as current area of occupancy.<br><br>The area of Lake Macdonald will be temporarily reduced during the drawdown and construction phases of the Project, with a fauna salvage and relocation operation implemented during these phases of the Project. It is expected that Mary River cod will be the primary focus of the salvage operation, with any cod caught during the salvage operation returned to Lake Macdonald during the refill and operate phase, ensuring that the area of occupancy of this species after completion of construction is the same as current area of occupancy. |
| Fragment an existing population into two or more populations | No change from current | Mary River turtle and white-throated snapping turtle are not expected to occur in Six Mile Creek; thus it is unlikely that any population of these species will be in or near the Project area.<br><br>Mary River cod is known from Six Mile Creek downstream of Lake Macdonald, and has been stocked to Lake Macdonald. Replacement of the dam wall will not change the current level of connectivity (i.e. no connectivity) between upstream and downstream populations of Mary River cod. |

| Significant Impact Criteria | Will the action have a significant impact | Justification |
|---|---|---|
| Adversely affect habitat critical to the survival of a species | No | Mary River turtle and white-throated snapping turtle are not expected to occur in Six Mile Creek; and habitat critical for the survival of these species does not occur in Lake Macdonald or Six Mile Creek. The Project will have no impact on habitat critical to the survival of these species.<br><br>Habitat critical to the survival of Mary River cod occurs in Six Mile Creek downstream of Lake Macdonald. While Mary River cod has been stocked to Lake Macdonald, it is considered that the lake is not habitat critical to the survival of this species. Impacts to downstream habitat and water quality in Six Mile Creek will be mitigated using numerous measures such as those described in Section 6.2. It is unlikely that there will be an impact to habitat critical to the survival of Mary River cod. |
| Disrupt the breeding cycle of a population | No | Mary River turtle and white-throated snapping turtle are not expected to occur in Six Mile Creek; and breeding habitat for these species in not known from Six Mile Creek or Lake Macdonald. The Project will not adversely impact breeding by Mary River turtle or white-throated snapping turtle.<br><br>Mary River cod are known to breed in Six Mile Creek downstream of Lake Macdonald, but the population in Lake Macdonald is considered to be non-breeding. Impacts to downstream habitat and water quality in Six Mile Creek will be mitigated using numerous measures such as those described in Section 6.2, which will also function to minimise potential impacts to Mary River cod breeding in Six Mile Creek. It is proposed that the drawdown phase will occur outside the breeding season of Mary River cod; thus, this phase of the Project will have no influence on Mary River cod breeding in Six Mile Creek. |

| Significant Impact Criteria | Will the action have a significant impact | Justification |
| --- | --- | --- |
| Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline | No | Mary River turtle and white-throated snapping turtle are not expected to occur in Six Mile Creek; and suitable habitat for these species in not known from Six Mile Creek or Lake Macdonald. The Project will not modify, destroy, remove, isolate or decrease the availability or quality of habitat of this species.<br><br>Mary River cod are known to breed in Six Mile Creek downstream of Lake Macdonald, but the population in Lake Macdonald is considered to be non-breeding. Impacts to downstream habitat and water quality in Six Mile Creek will be mitigated using numerous measures described in Section 6.2, which will also function to minimise potential impacts to Mary River cod breeding in Six Mile Creek. Temporary reduction of habitat availability for stocked Mary River cod in Lake Macdonald during the drawdown and construction phases will be mitigated by a salvage, relocation and restocking program, with long-term habitat quality for Mary River cod in Lake Macdonald potentially enhanced during the construction phase. Therefore the Project will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that Mary River cod is likely to decline. . |
| Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat | No | Known biosecurity matters of the Project area (e.g. Cabomba, Hygrophila, tilapia) will be carefully managed via the Lake Lowering Plan and the Environmental Management Plan. |
| Introduce disease that may cause the species to decline | No | The Project will not introduce a disease or pathogen to the Project area as all equipment used should be clean before attending the Project area. Appropriate mitigation measures will also be implemented to minimise injury to aquatic fauna that can leave them susceptible to diseases and pathogens. |

| Significant Impact Criteria | Will the action have a significant impact | Justification |
| --- | --- | --- |
| Interfere with the recovery of the species. | No | White-throated snapping turtle<br><br>Key recovery actions for white-throated snapping turtle include: controlling predators and cattle access to nesting sites to prevent trampling and predation of nests and hatchlings to improve recruitment; managing water releases to avoid inundation of nesting banks during the incubation period while providing adequate environmental flows of good quality water to provide base flows, refugial habitat and geomorphological process to sustain nesting banks; and ensuring that dam and spillway designs minimise injury and mortality of turtles over spillways. As populations and nesting sites for white-throated snapping turtle are not known from Six Mile Creek, the Project will not interfere with recovery actions relating to recruitment, waterway barriers and environmental flows. The final design of the labyrinth spillway will have low fall heights, sufficiently deep plunge pools and adopt the recommendations of Berghuis (2017); thus, the design of the new dam will be consistent with the recovery plan for white-throated snapping turtle.<br><br>Mary River turtle<br><br>There is no recovery plan currently available for Mary River turtle, although the conservation advice statement for the species indicates threats to Mary River turtle are: predation and trampling of nests and hatchlings and lack of recruitment; unfavourable water releases from dams, clearing for agriculture, and impacts to habitat from pollution and invasive weeds. Although recovery action have not currently been developed for Mary River turtle, the Project will not contribute any of |

| Significant Impact Criteria | Will the action have a significant impact | Justification |
|---|---|---|
| | | the key threats known for the species. Furthermore, as populations and nesting sites for Mary River turtle are not known from Six Mile Creek, the Project will not interfere with the recovery of this species.<br>Mary River cod<br>Key recovery recommendations for Mary River cod include: community education and regulatory and administrative initiatives; limiting waterway barrier construction while ensuring that fishways are incorporated into the design of new barriers (and existing barriers where possible), prohibition of stocking of non-indigenous fish in the Mary River systems (especially other species of *Maccullochella*), environmental flow management, and hatchery and stocking programs. The Project will include a commitment to continue support of the Mary Cod hatchery at Lake Macdonald, with water releases to Six Mile Creek complying with the ROP during the refill and operate phase. While a fishway has been determined to be non-viable at the upgraded Six Mile Creek dam, a fishway will be provided at Gympie Weir (which has been identified as a high priority barrier for retrofitting a fishway, Stockwell et al. 2008). The Project therefore is consistent with the recovery actions for Mary River cod. |

Table 6.5 Assessment of the Project on vulnerable aquatic MNES species: Australian lungfish.

| Significant Impact Criteria | Will the action have a significant impact | Justification |
|---|---|---|
| Lead to a long-term decrease in the size of an important population of a species<br>An important population is a population that is necessary for a species' long-term survival, including source population for breeding or dispersal, necessary for maintaining genetic diversity, and / or populations near the limit of a species' range | No | Australian lungfish are occur in low numbers in Six Mile Creek (Appendix G; Atlas of Living Australia), with breeding by the species in Six Mile Creek downstream of Lake Macdonald likely to be infrequent and not critical to the species' long-term survival, as breeding habitat (i.e. submerged aquatic plant beds) for lungfish is not present in this reach of Six Mile Creek. Few Australian lungfish are expected to occur in Lake Macdonald or upstream of Lake Macdonald, and the species does not breed in Lake Macdonald. Thus, there is not an important population of Australian lungfish in Six Mile Creek or Lake Macdonald. However, the application of appropriate mitigations will protect water quality, habitat and flows that support this species, as well as ensure any individuals of this species are not injured or stranded should any be present in Lake Macdonald. There will be no long-term decrease in the size of an important population of Australian lungfish associated with the Project. |
| Reduce the area of occupancy of the species | No | The area of Lake Macdonald will be temporarily reduced during the drawdown and construction phases of the Project, with a fauna salvage and relocation operation implemented during these phases of the Project. It is expected that very few Australian lungfish occur in Lake Macdonald, and thus the temporary reduction in lake area will not be a significant impact on the species. However, any lungfish in Lake Macdonald will be salvaged during the drawdown and construction phases and returned to Lake Macdonald during the refill and operate phase, ensuring that the area of occupancy of this species after completion of construction is the same as current area of occupancy. |

| Significant Impact Criteria | Will the action have a significant impact | Justification |
|---|---|---|
| Fragment an existing population into two or more populations | No change from current | Australian lungfish are known to occur in low numbers in Six Mile Creek, and may also occur in low numbers in Lake Macdonald. Replacement of the dam wall will not change the current level of connectivity (i.e. no connectivity) between upstream and downstream populations of Australian lungfish. |
| Adversely affect habitat critical to the survival of a species | No | There is no habitat critical to the survival of Australian lungfish in Six Mile Creek or Lake Macdonald. Impacts to downstream habitat and water quality in Six Mile Creek will be mitigated using numerous measures described in Section 6.2. There will be no impact to habitat critical to the survival of Australian lungfish. |
| Disrupt the breeding cycle of a population | No | Australian lungfish are known to occur in low numbers in Six Mile Creek, with breeding by the species in Six Mile Creek likely to be infrequent. Impacts to downstream habitat and water quality in Six Mile Creek will be mitigated using numerous measures such as those described in Section 6.2, which will also function to minimise potential impacts to Australian lungfish breeding in Six Mile Creek. The drawdown phase is planned to occur outside the breeding season of Australian lungfish; thus, this phase of the Project will have no influence on any Australian lungfish breeding in Six Mile Creek. |
| Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline | No | Australian lungfish are known to occur in low numbers in Six Mile Creek, and may also occur in low numbers in Lake Macdonald. While neither Six Mile Creek or Lake Macdonald is habitat that is critical to the survival of Australian lungfish, the application of appropriate mitigations as described above will protect water quality, habitat and flows that support this species. There will be no adverse effects to the quality of habitat for Australian lungfish associated with the Project. |

| Significant Impact Criteria | Will the action have a significant impact | Justification |
|---|---|---|
| Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat | No | Known biosecurity matters of the Project area (e.g. Cabomba, Hygrophila, tilapia) will be carefully managed via the Aquatic Fauna Salvage and Relocation Plan and the Environmental Management Plan. |
| Introduce disease that may cause the species to decline | No | The Project will not introduce a disease or pathogen to the Project area. |
| Interfere with the recovery of the species. | No | There is no recovery plan currently available for Australian lungfish, although the conservation advice for the species identified the main threats as: impoundment of riverine habitat and barriers to movement by dams, reductions in water levels during spawning periods, and pest fish (especially tilapia). Although recovery action have not currently been developed for Australian lungfish, important populations of this species do not occur in Six Mile Creek or Lake Macdonald; thus, the Project will not interfere with the recovery of the species. |

# 7 Conclusions

Two threatened fish and two freshwater turtle species listed under the *Environment Protection and Biodiversity Act 1994* (i.e. aquatic Matters of National Environmental Significance) are known from the Mary River and Six Mile Creek:

- white-throated snapping turtle (*Elseya albagula*), critically endangered
- Mary River cod (*Maccullochella mariensis*), endangered
- Mary River turtle (*Elusor macrurus*), endangered, and
- Australian lungfish (*Neoceratodus forsteri*), vulnerable.

Mary River cod and Australian lungfish are known from Six Mile Creek downstream of Lake Macdonald, and it is possible that Mary River turtle and white-throated snapping turtle sometimes occur in the lower reaches of Six Mile Creek. Mary River cod are known to breed in Six Mile Creek downstream of Lake Macdonald. Within Lake Macdonald, and upstream of Lake Macdonald, platypus are known to occur, Mary River cod and Australian lungfish may occur but are unlikely to be breeding, and Mary River turtle or white-throated snapping turtle are likely to be rare or absent. Matters of State Environmental Significance downstream and upstream of Lake Macdonald include: waterways providing for fish passage, several categories of regulated vegetation and High Ecological Value (watercourse) waters.

The desktop assessment indicated that the alluvium of the Project area is *unlikely to be suitable* for stygofauna due to high clay content, low hydraulic conductivity and high total dissolved solids, and the Kin Kin sandstone is *suitable* for stygofauna due to the higher hydraulic conductivity.

The following sources of potential impact from the Project to the aquatic Environmental Values of Six Mile Creek and Lake Macdonald were identified:

- Impacts to water quality in Lake Macdonald and downstream of the lake
- Impacts to aquatic habitat in Lake Macdonald and downstream
- Impacts to aquatic fauna (injury, mortality or stranding) in Lake Macdonald
- Impacts to aquatic flora in Lake Macdonald and downstream of the lake
- Spread of biosecurity matters downstream of Lake Macdonald
- Impacts to stygofauna communities in shallow groundwater systems, and
- Barriers to fish passage at the dam wall.

The risks of, and mitigations for, each of the identified potential sources of adverse impact of the Project on the Environmental Values of Six Mile Creek were assessed using a risk-based approach.

Potential direct and indirect impacts of the Project are likely to affect both Lake Macdonald and Six Mile Creek downstream. As the Project is replacing an existing dam wall the long-term impact will be no change from current condition. Most sources of impact during the Project were assessed as having a low risk of impact when appropriate mitigations are applied. Most potential impacts will be temporary (i.e. for the duration of the drawdown and construction periods; approximately 2 to 3 years in total), and if appropriate mitigations are applied there will be no ongoing impacts to the aquatic environmental values of Lake Macdonald or Six Mile Creek.

However, the temporary loss of aquatic habitat in Lake Macdonald due to the drawdown of the lake for safety during construction still resulted in a moderate residual impact after mitigation measures were applied. There will be a temporary loss of approximately 97.2% of aquatic habitat (by water volume) in Lake Macdonald, which requires additional mitigation in the form of a comprehensive aquatic fauna salvage operation. This is an unavoidable risk given the safety requirements of the Project.

Matters of National Environmental Significance were also assessed against the Significant Impact Criteria for critically endangered, endangered and vulnerable aquatic species. The assessment indicates that, while there may be temporary impacts, a significant impact from the Project on aquatic species that are Matters of National Environmental Significance is unlikely.

Fish passage is currently not provided at the Six Mile Creek dam. While fishway options have been considered for the Six Mile Creek dam upgrade (e.g. frc environmental, 2016; Seqwater 2018), preliminary advice from DAF indicates that several factors outweigh the benefit of providing fish passage over the upgraded dam, including site constraints, the risk of aiding upstream dispersal by tilapia, and the anticipated regional benefits of the proposed offsite mitigation option (DAF 2018). Off-site mitigation measures for fish passage are therefore proposed; specifically the provision of fish passage at Gympie Weir by installation of a suitable fishway.

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# Appendix A Matters of National Environmental Significance Search Results

Australian Government

Department of the Environment and Energy

# EPBC Act Protected Matters Report

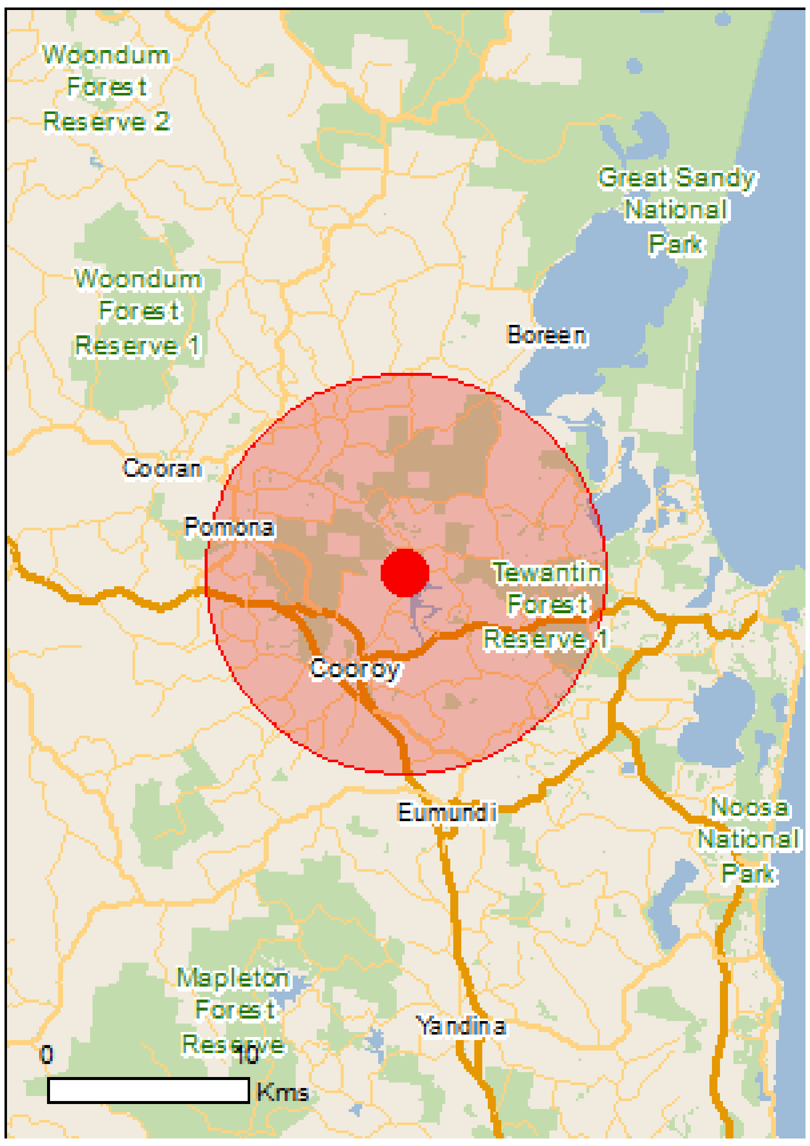
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 27/08/18 11:40:10

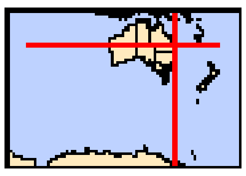

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements




Coordinates

Buffer: 10.0Km



# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

| | |
|---|---|
| World Heritage Properties: | None |
| National Heritage Places: | None |
| Wetlands of International Importance: | 1 |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Area: | None |
| Listed Threatened Ecological Communities: | 3 |
| Listed Threatened Species: | 72 |
| Listed Migratory Species: | 44 |

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

| | |
|---|---|
| Commonwealth Land: | None |
| Commonwealth Heritage Places: | 1 |
| Listed Marine Species: | 46 |
| Whales and Other Cetaceans: | 2 |
| Critical Habitats: | None |
| Commonwealth Reserves Terrestrial: | None |
| Australian Marine Parks: | None |

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

| | |
|---|---|
| State and Territory Reserves: | 17 |
| Regional Forest Agreements: | None |
| Invasive Species: | 38 |
| Nationally Important Wetlands: | 1 |
| Key Ecological Features (Marine) | None |

# Details

## Matters of National Environmental Significance

### Wetlands of International Importance (Ramsar) [ Resource Information ]

| Name | Proximity |
|---|---|
| Great sandy strait (including great sandy strait, tin can bay and tin can | 30 - 40km upstream |

### Listed Threatened Ecological Communities [ Resource Information ]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

| Name | Status | Type of Presence |
|---|---|---|
| Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community | Endangered | Community likely to occur within area |
| Lowland Rainforest of Subtropical Australia | Critically Endangered | Community likely to occur within area |
| Subtropical and Temperate Coastal Saltmarsh | Vulnerable | Community likely to occur within area |

### Listed Threatened Species [ Resource Information ]

| Name | Status | Type of Presence |
|---|---|---|
| Birds | | |
| Anthochaera phrygia | | |
| Regent Honeyeater [82338] | Critically Endangered | Species or species habitat known to occur within area |
| Botaurus poiciloptilus | | |
| Australasian Bittern [1001] | Endangered | Species or species habitat known to occur within area |
| Calidris canutus | | |
| Red Knot, Knot [855] | Endangered | Species or species habitat may occur within area |
| Calidris ferruginea | | |
| Curlew Sandpiper [856] | Critically Endangered | Species or species habitat likely to occur within area |
| Cyclopsitta diophthalma coxeni | | |
| Coxen's Fig-Parrot [59714] | Endangered | Species or species habitat likely to occur within area |
| Dasyornis brachypterus | | |
| Eastern Bristlebird [533] | Endangered | Species or species habitat may occur within area |
| Diomedea antipodensis | | |
| Antipodean Albatross [64458] | Vulnerable | Species or species habitat may occur within area |
| Diomedea antipodensis gibsoni | | |
| Gibson's Albatross [82270] | Vulnerable | Species or species habitat may occur within area |
| Diomedea exulans | | |
| Wandering Albatross [89223] | Vulnerable | Species or species habitat may occur within area |

| Name | Status | Type of Presence |
| --- | --- | --- |
| Erythrotriorchis radiatus<br>Red Goshawk [942] | Vulnerable | Species or species habitat known to occur within area |
| Geophaps scripta  scripta<br>Squatter Pigeon (southern) [64440] | Vulnerable | Species or species habitat may occur within area |
| Lathamus discolor<br>Swift Parrot [744] | Critically Endangered | Species or species habitat likely to occur within area |
| Limosa lapponica  baueri<br>Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380] | Vulnerable | Species or species habitat likely to occur within area |
| Limosa lapponica  menzbieri<br>Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432] | Critically Endangered | Species or species habitat may occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Pachyptila turtur  subantarctica<br>Fairy Prion (southern) [64445] | Vulnerable | Species or species habitat likely to occur within area |
| Poephila cincta  cincta<br>Southern Black-throated Finch [64447] | Endangered | Species or species habitat may occur within area |
| Rostratula australis<br>Australian Painted-snipe, Australian Painted Snipe [77037] | Endangered | Species or species habitat likely to occur within area |
| Thalassarche cauta  cauta<br>Shy Albatross, Tasmanian Shy Albatross [82345] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche cauta  steadi<br>White-capped Albatross [82344] | Vulnerable | Species or species habitat likely to occur within area |
| Thalassarche eremita<br>Chatham Albatross [64457] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Species or species habitat may occur within area |
| Turnix melanogaster<br>Black-breasted Button-quail [923] | Vulnerable | Species or species habitat likely to occur within area |
| Fish | | |

| Name | Status | Type of Presence |
|---|---|---|
| Epinephelus daemelii | | |
| Black Rockcod, Black Cod, Saddled Rockcod [68449] | Vulnerable | Species or species habitat may occur within area |
| Maccullochella mariensis | | |
| Mary River Cod [83806] | Endangered | Species or species habitat known to occur within area |
| Neoceratodus forsteri | | |
| Australian Lungfish, Queensland Lungfish [67620] | Vulnerable | Species or species habitat known to occur within area |
| Frogs | | |
| Litoria olongburensis | | |
| Wallum Sedge Frog [1821] | Vulnerable | Species or species habitat known to occur within area |
| Mixophyes fleayi | | |
| Fleay's Frog [25960] | Endangered | Species or species habitat likely to occur within area |
| Mixophyes iteratus | | |
| Giant Barred Frog, Southern Barred Frog [1944] | Endangered | Species or species habitat known to occur within area |
| Insects | | |
| Argynnis hyperbius  inconstans | | |
| Australian Fritillary [88056] | Critically Endangered | Species or species habitat may occur within area |
| Phyllodes imperialis  smithersi | | |
| Pink Underwing Moth [86084] | Endangered | Breeding may occur within area |
| Mammals | | |
| Chalinolobus dwyeri | | |
| Large-eared Pied Bat, Large Pied Bat [183] | Vulnerable | Species or species habitat likely to occur within area |
| Dasyurus hallucatus | | |
| Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331] | Endangered | Species or species habitat likely to occur within area |
| Dasyurus maculatus  maculatus (SE mainland population) | | |
| Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184] | Endangered | Species or species habitat likely to occur within area |
| Petauroides volans | | |
| Greater Glider [254] | Vulnerable | Species or species habitat likely to occur within area |
| Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) | | |
| Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104] | Vulnerable | Species or species habitat known to occur within area |
| Potorous tridactylus  tridactylus | | |
| Long-nosed Potoroo (SE mainland) [66645] | Vulnerable | Species or species habitat likely to occur within area |
| Pteropus poliocephalus | | |
| Grey-headed Flying-fox [186] | Vulnerable | Roosting known to occur within area |
| Xeromys myoides | | |
| Water Mouse, False Water Rat, Yirrkoo [66] | Vulnerable | Species or species habitat known to occur within area |
| Plants | | |
| Acacia attenuata | | |
| [10690] | Vulnerable | Species or species habitat likely to occur within area |
| Allocasuarina thalassoscopica | | |
| [21927] | Endangered | Species or species habitat may occur within |

| Name | Status | Type of Presence |
|---|---|---|
| | | area |
| Archidendron lovelliae<br>Bacon Wood, Tulip Siris [13451] | Vulnerable | Species or species habitat likely to occur within area |
| Arthraxon hispidus<br>Hairy-joint Grass [9338] | Vulnerable | Species or species habitat likely to occur within area |
| Baloghia marmorata<br>Marbled Balogia, Jointed Baloghia [8463] | Vulnerable | Species or species habitat likely to occur within area |
| Bosistoa transversa<br>Three-leaved Bosistoa, Yellow Satinheart [16091] | Vulnerable | Species or species habitat likely to occur within area |
| Cryptocarya foetida<br>Stinking Cryptocarya, Stinking Laurel [11976] | Vulnerable | Species or species habitat likely to occur within area |
| Cryptostylis hunteriana<br>Leafless Tongue-orchid [19533] | Vulnerable | Species or species habitat may occur within area |
| Eucalyptus conglomerata<br>Swamp Stringybark [3160] | Endangered | Species or species habitat likely to occur within area |
| Floydia praealta<br>Ball Nut, Possum Nut, Big Nut, Beefwood [15762] | Vulnerable | Species or species habitat likely to occur within area |
| Lepidium peregrinum<br>Wandering Pepper-cress [14035] | Endangered | Species or species habitat may occur within area |
| Macadamia integrifolia<br>Macadamia Nut, Queensland Nut Tree, Smooth-shelled Macadamia, Bush Nut, Nut Oak [7326] | Vulnerable | Species or species habitat known to occur within area |
| Macadamia ternifolia<br>Small-fruited Queensland Nut, Gympie Nut [7214] | Vulnerable | Species or species habitat known to occur within area |
| Phaius australis<br>Lesser Swamp-orchid [5872] | Endangered | Species or species habitat likely to occur within area |
| Prostanthera spathulata<br>[88266] | Vulnerable | Species or species habitat known to occur within area |
| Samadera bidwillii<br>Quassia [29708] | Vulnerable | Species or species habitat likely to occur within area |
| Sophora fraseri<br>[8836] | Vulnerable | Species or species habitat may occur within area |
| Triunia robusta<br>Glossy Spice Bush [14747] | Endangered | Species or species habitat known to occur within area |
| Xanthostemon oppositifolius<br>Penda, Southern Penda, Luya's Hardwood [8738] | Vulnerable | Species or species habitat likely to occur within area |
| Reptiles | | |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known |

| Name | Status | Type of Presence |
|---|---|---|
| | | to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Delma torquata<br>Adorned Delma, Collared Delma [1656] | Vulnerable | Species or species habitat may occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat known to occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Furina dunmalli<br>Dunmall's Snake [59254] | Vulnerable | Species or species habitat may occur within area |
| Lepidochelys olivacea<br>Olive Ridley Turtle, Pacific Ridley Turtle [1767] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Saiphos reticulatus<br>Three-toed Snake-tooth Skink [88328] | Vulnerable | Species or species habitat may occur within area |
| Sharks | | |
| Pristis zijsron<br>Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442] | Vulnerable | Breeding may occur within area |

## Listed Migratory Species

[ Resource Information ]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

| Name | Threatened | Type of Presence |
|---|---|---|
| Migratory Marine Birds | | |
| Anous stolidus<br>Common Noddy [825] | | Species or species habitat may occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Calonectris leucomelas<br>Streaked Shearwater [1077] | | Species or species habitat may occur within area |
| Diomedea antipodensis<br>Antipodean Albatross [64458] | Vulnerable | Species or species habitat may occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Species or species habitat may occur within area |
| Fregata ariel<br>Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat likely to occur within area |
| Fregata minor<br>Great Frigatebird, Greater Frigatebird [1013] | | Species or species habitat likely to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel | Endangered | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| [1060] | | habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche cauta<br>Tasmanian Shy Albatross [89224] | Vulnerable* | Species or species habitat may occur within area |
| Thalassarche eremita<br>Chatham Albatross [64457] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable* | Species or species habitat likely to occur within area |
| Migratory Marine Species | | |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Crocodylus porosus<br>Salt-water Crocodile, Estuarine Crocodile [1774] | | Species or species habitat likely to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat known to occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Lamna nasus<br>Porbeagle, Mackerel Shark [83288] | | Species or species habitat may occur within area |
| Lepidochelys olivacea<br>Olive Ridley Turtle, Pacific Ridley Turtle [1767] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Manta alfredi<br>Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994] | | Species or species habitat may occur within area |
| Manta birostris<br>Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995] | | Species or species habitat may occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Orcaella brevirostris<br>Irrawaddy Dolphin [45] | | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | habitat likely to occur within area |
| Pristis zijsron | | |
| Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442] | Vulnerable | Breeding may occur within area |
| Sousa chinensis | | |
| Indo-Pacific Humpback Dolphin [50] | | Species or species habitat likely to occur within area |
| **Migratory Terrestrial Species** | | |
| Cuculus optatus | | |
| Oriental Cuckoo, Horsfield's Cuckoo [86651] | | Species or species habitat known to occur within area |
| Hirundapus caudacutus | | |
| White-throated Needletail [682] | | Species or species habitat known to occur within area |
| Monarcha melanopsis | | |
| Black-faced Monarch [609] | | Species or species habitat known to occur within area |
| Monarcha trivirgatus | | |
| Spectacled Monarch [610] | | Species or species habitat known to occur within area |
| Myiagra cyanoleuca | | |
| Satin Flycatcher [612] | | Species or species habitat known to occur within area |
| Rhipidura rufifrons | | |
| Rufous Fantail [592] | | Species or species habitat known to occur within area |
| **Migratory Wetlands Species** | | |
| Actitis hypoleucos | | |
| Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Calidris acuminata | | |
| Sharp-tailed Sandpiper [874] | | Species or species habitat known to occur within area |
| Calidris canutus | | |
| Red Knot, Knot [855] | Endangered | Species or species habitat may occur within area |
| Calidris ferruginea | | |
| Curlew Sandpiper [856] | Critically Endangered | Species or species habitat likely to occur within area |
| Calidris melanotos | | |
| Pectoral Sandpiper [858] | | Species or species habitat may occur within area |
| Gallinago hardwickii | | |
| Latham's Snipe, Japanese Snipe [863] | | Species or species habitat may occur within area |
| Limosa lapponica | | |
| Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Numenius madagascariensis | | |
| Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur within area |
| Pandion haliaetus | | |
| Osprey [952] | | Breeding known to occur within area |
| Tringa nebularia | | |
| Common Greenshank, Greenshank [832] | | Species or species habitat likely to occur |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | within area |

## Other Matters Protected by the EPBC Act

### Commonwealth Heritage Places [ Resource Information ]

| Name | State | Status |
|---|---|---|
| Historic | | |
| Cooroy Post Office | QLD | Listed place |

### Listed Marine Species [ Resource Information ]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

| Name | Threatened | Type of Presence |
|---|---|---|
| Birds | | |
| Actitis hypoleucos<br>Common Sandpiper [59309] | | Species or species habitat known to occur within area |
| Anous stolidus<br>Common Noddy [825] | | Species or species habitat may occur within area |
| Anseranas semipalmata<br>Magpie Goose [978] | | Species or species habitat may occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Ardea alba<br>Great Egret, White Egret [59541] | | Species or species habitat known to occur within area |
| Ardea ibis<br>Cattle Egret [59542] | | Species or species habitat may occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Species or species habitat known to occur within area |
| Calidris canutus<br>Red Knot, Knot [855] | Endangered | Species or species habitat may occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | Critically Endangered | Species or species habitat likely to occur within area |
| Calidris melanotos<br>Pectoral Sandpiper [858] | | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | habitat may occur within area |
| Calonectris leucomelas<br>Streaked Shearwater [1077] | | Species or species habitat may occur within area |
| Diomedea antipodensis<br>Antipodean Albatross [64458] | Vulnerable | Species or species habitat may occur within area |
| Diomedea exulans<br>Wandering Albatross [89223] | Vulnerable | Species or species habitat may occur within area |
| Diomedea gibsoni<br>Gibson's Albatross [64466] | Vulnerable* | Species or species habitat may occur within area |
| Fregata ariel<br>Lesser Frigatebird, Least Frigatebird [1012] | | Species or species habitat likely to occur within area |
| Fregata minor<br>Great Frigatebird, Greater Frigatebird [1013] | | Species or species habitat likely to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | | Species or species habitat may occur within area |
| Haliaeetus leucogaster<br>White-bellied Sea-Eagle [943] | | Species or species habitat known to occur within area |
| Hirundapus caudacutus<br>White-throated Needletail [682] | | Species or species habitat known to occur within area |
| Lathamus discolor<br>Swift Parrot [744] | Critically Endangered | Species or species habitat likely to occur within area |
| Limosa lapponica<br>Bar-tailed Godwit [844] | | Species or species habitat known to occur within area |
| Macronectes giganteus<br>Southern Giant-Petrel, Southern Giant Petrel [1060] | Endangered | Species or species habitat may occur within area |
| Macronectes halli<br>Northern Giant Petrel [1061] | Vulnerable | Species or species habitat may occur within area |
| Merops ornatus<br>Rainbow Bee-eater [670] | | Species or species habitat may occur within area |
| Monarcha melanopsis<br>Black-faced Monarch [609] | | Species or species habitat known to occur within area |
| Monarcha trivirgatus<br>Spectacled Monarch [610] | | Species or species habitat known to occur within area |
| Myiagra cyanoleuca<br>Satin Flycatcher [612] | | Species or species habitat known to occur within area |
| Numenius madagascariensis<br>Eastern Curlew, Far Eastern Curlew [847] | Critically Endangered | Species or species habitat known to occur |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | within area |
| Pachyptila turtur<br>Fairy Prion [1066] | | Species or species habitat likely to occur within area |
| Pandion haliaetus<br>Osprey [952] | | Breeding known to occur within area |
| Rhipidura rufifrons<br>Rufous Fantail [592] | | Species or species habitat known to occur within area |
| Rostratula benghalensis (sensu lato)<br>Painted Snipe [889] | Endangered* | Species or species habitat likely to occur within area |
| Thalassarche cauta<br>Tasmanian Shy Albatross [89224] | Vulnerable* | Species or species habitat may occur within area |
| Thalassarche eremita<br>Chatham Albatross [64457] | Endangered | Species or species habitat may occur within area |
| Thalassarche impavida<br>Campbell Albatross, Campbell Black-browed Albatross [64459] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche melanophris<br>Black-browed Albatross [66472] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche salvini<br>Salvin's Albatross [64463] | Vulnerable | Species or species habitat may occur within area |
| Thalassarche steadi<br>White-capped Albatross [64462] | Vulnerable* | Species or species habitat likely to occur within area |
| Tringa nebularia<br>Common Greenshank, Greenshank [832] | | Species or species habitat likely to occur within area |
| Reptiles | | |
| Caretta caretta<br>Loggerhead Turtle [1763] | Endangered | Foraging, feeding or related behaviour known to occur within area |
| Chelonia mydas<br>Green Turtle [1765] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Crocodylus porosus<br>Salt-water Crocodile, Estuarine Crocodile [1774] | | Species or species habitat likely to occur within area |
| Dermochelys coriacea<br>Leatherback Turtle, Leathery Turtle, Luth [1768] | Endangered | Species or species habitat known to occur within area |
| Eretmochelys imbricata<br>Hawksbill Turtle [1766] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |
| Lepidochelys olivacea<br>Olive Ridley Turtle, Pacific Ridley Turtle [1767] | Endangered | Foraging, feeding or related behaviour likely to occur within area |
| Natator depressus<br>Flatback Turtle [59257] | Vulnerable | Foraging, feeding or related behaviour known to occur within area |

| Whales and other Cetaceans | | [ Resource Information ] |
|---|---|---|
| Name | Status | Type of Presence |
| Mammals | | |
| Orcaella brevirostris | | |
| Irrawaddy Dolphin [45] | | Species or species habitat likely to occur within area |
| Sousa chinensis | | |
| Indo-Pacific Humpback Dolphin [50] | | Species or species habitat likely to occur within area |

## Extra Information

| State and Territory Reserves | [ Resource Information ] |
|---|---|
| Name | State |
| Alyxia | QLD |
| Cooloothin | QLD |
| Cooroibah Environmental Reserve | QLD |
| Great Sandy | QLD |
| Great Sandy National Park | QLD |
| Harry Spring | QLD |
| Johns Property addition to Great Sandy National Park | QLD |
| Kingsgate Drive | QLD |
| Mount Cooroy | QLD |
| Penda Scrub | QLD |
| Six Mile Creek | QLD |
| Symplocos | QLD |
| Tewantin | QLD |
| Tuchekoi | QLD |
| Una Corbould | QLD |
| Woondum | QLD |
| Yurol | QLD |

### Invasive Species [ Resource Information ]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

| Name | Status | Type of Presence |
|---|---|---|
| Birds | | |
| Acridotheres tristis | | |
| Common Myna, Indian Myna [387] | | Species or species habitat likely to occur within area |
| Anas platyrhynchos | | |
| Mallard [974] | | Species or species habitat likely to occur within area |
| Columba livia | | |
| Rock Pigeon, Rock Dove, Domestic Pigeon [803] | | Species or species habitat likely to occur within area |
| Lonchura punctulata | | |
| Nutmeg Mannikin [399] | | Species or species habitat likely to occur within area |
| Passer domesticus | | |
| House Sparrow [405] | | Species or species habitat likely to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Streptopelia chinensis<br>Spotted Turtle-Dove [780] | | Species or species habitat likely to occur within area |
| Sturnus vulgaris<br>Common Starling [389] | | Species or species habitat likely to occur within area |
| Frogs | | |
| Rhinella marina<br>Cane Toad [83218] | | Species or species habitat known to occur within area |
| Mammals | | |
| Bos taurus<br>Domestic Cattle [16] | | Species or species habitat likely to occur within area |
| Canis lupus familiaris<br>Domestic Dog [82654] | | Species or species habitat likely to occur within area |
| Felis catus<br>Cat, House Cat, Domestic Cat [19] | | Species or species habitat likely to occur within area |
| Feral deer<br>Feral deer species in Australia [85733] | | Species or species habitat likely to occur within area |
| Lepus capensis<br>Brown Hare [127] | | Species or species habitat likely to occur within area |
| Mus musculus<br>House Mouse [120] | | Species or species habitat likely to occur within area |
| Oryctolagus cuniculus<br>Rabbit, European Rabbit [128] | | Species or species habitat likely to occur within area |
| Rattus rattus<br>Black Rat, Ship Rat [84] | | Species or species habitat likely to occur within area |
| Sus scrofa<br>Pig [6] | | Species or species habitat likely to occur within area |
| Vulpes vulpes<br>Red Fox, Fox [18] | | Species or species habitat likely to occur within area |
| Plants | | |
| Annona glabra<br>Pond Apple, Pond-apple Tree, Alligator Apple, Bullock's Heart, Cherimoya, Monkey Apple, Bobwood, Corkwood [6311] | | Species or species habitat likely to occur within area |
| Anredera cordifolia<br>Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643] | | Species or species habitat likely to occur within area |
| Asparagus aethiopicus<br>Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425] | | Species or species habitat likely to occur within area |
| Asparagus africanus<br>Climbing Asparagus, Climbing Asparagus Fern [66907] | | Species or species habitat likely to occur within area |
| Asparagus plumosus<br>Climbing Asparagus-fern [48993] | | Species or species |

| Name | Status | Type of Presence |
|---|---|---|
| | | habitat likely to occur within area |
| Cabomba caroliniana<br>Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171] | | Species or species habitat likely to occur within area |
| Chrysanthemoides monilifera<br>Bitou Bush, Boneseed [18983] | | Species or species habitat may occur within area |
| Chrysanthemoides monilifera subsp. rotundata<br>Bitou Bush [16332] | | Species or species habitat likely to occur within area |
| Dolichandra unguis-cati<br>Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119] | | Species or species habitat likely to occur within area |
| Eichhornia crassipes<br>Water Hyacinth, Water Orchid, Nile Lily [13466] | | Species or species habitat likely to occur within area |
| Hymenachne amplexicaulis<br>Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754] | | Species or species habitat likely to occur within area |
| Lantana camara<br>Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892] | | Species or species habitat likely to occur within area |
| Opuntia spp.<br>Prickly Pears [82753] | | Species or species habitat likely to occur within area |
| Parthenium hysterophorus<br>Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566] | | Species or species habitat likely to occur within area |
| Sagittaria platyphylla<br>Delta Arrowhead, Arrowhead, Slender Arrowhead [68483] | | Species or species habitat likely to occur within area |
| Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii<br>Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497] | | Species or species habitat likely to occur within area |
| Salvinia molesta<br>Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665] | | Species or species habitat likely to occur within area |
| Senecio madagascariensis<br>Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624] | | Species or species habitat likely to occur within area |
| **Reptiles** | | |
| Hemidactylus frenatus<br>Asian House Gecko [1708] | | Species or species habitat likely to occur within area |
| Ramphotyphlops braminus<br>Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258] | | Species or species habitat may occur within area |

## Nationally Important Wetlands [ Resource Information ]

| Name | State |
|---|---|
| Noosa River Wetlands | QLD |

# Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Coordinates

-26.38065 152.93177

# Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.


Please feel free to provide feedback via the Contact Us page.



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# Appendix B Detailed Description of Aquatic Matters of National Environmental Significance

# 1 Critically Endangered and Endangered Species

White-throated snapping turtle (listed as critically endangered under the EPBC Act), the Mary River cod (listed as endangered), and the Mary River turtle (listed as endangered), are the only critically endangered or endangered aquatic species that are known from the vicinity of the proposed development, and that could potentially be impacted.

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:

- lead to a long-term decrease in the size of a population
- reduce the area of occupancy of the species
- fragment an existing population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of a population
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- introduce disease that may cause the species to decline, or
- interfere with the recovery of the species.

## 1.1 White-throated snapping turtle

### Status

White-throated snapping turtle (*Elseya albagula*) is listed as critically endangered under the EPBC and endangered under the NC Act.

### Population

The population of white-throated snapping turtles is dominated by adults, because predation of eggs and hatchlings, and trampling of nests by cattle, have greatly reduced recruitment and the juvenile proportion of the population (Hamann et al. 2007; Limpus 2008;

Limpus et al. 2011; DotEE 2017). This likely represents a significant reduction in population size, because an unimpacted population of freshwater turtles would be expected to have a high proportion of juveniles (Thompson 1983). While population size is responsive to adult survivorship due to relatively high life-time fecundity of long-lived adults (Heppell et al. 1996), and thus population size would likely increase if recruitment rates increase, population size will decline further if recruitment rates continue to be low (Threatened Species Scientific Committee 2014a).

Population genetic analyses indicate that the population of white-throated snapping turtle in the Fitzroy River Basin is highly divergent at both mitochondrial and nuclear genetic markers from southern populations in the Burnett, Mary and Kolan Rivers (Todd et al. 2013; Todd 2013). However, populations from the Burnett, Mary and Kolan Rivers are highly differentiated from each other at nuclear genetic markers; hence, each river contains a genetically distinct population (Todd et al., 2013; Todd 2013). There is little genetic differentiation between populations within basins (Todd et al. 2013; Todd 2013), suggesting that significant barriers would fragment populations of this species.

As shown for other aquatic species in the Mary River (e.g. Mary River cod, lungfish and Mary River turtle), the estuarine reach that separates Tiana Creek from the remainder of the Mary River is likely a significant natural long-term barrier to connectivity, and thus the population of white-throated snapping turtles in Tiana Creek is likely differentiated from the population in the main Mary River basin (noting this precautionary population assessment requires validating with samples from Tiana Creek).

## Area of Occupancy

The white-throated snapping turtle is restricted to the Fitzroy, Mary and Burnett River basins, and adjacent small, coastal systems, including the Kolan and Burrum Rivers (Hamann et al., 2007). White-throated snapping turtle is widely distributed in the main stem and major tributaries of the Fitzroy, Burnett and Mary Rivers (Todd 2013). The tributaries of the Mary River from which white-throated snapping turtle have been reported are Tinana, Wide Bay, Obi Obi and Yabba creeks (Limpus 2008). There are no records of white-throated snapping turtle from Six Mile Creek.

## Habitat

White-throated snapping turtles are habitat specialists that prefer permanent, clear, well oxygenated water that is flowing and contains shelter (e.g. large woody debris and undercut banks) (Todd 2013). The species has also been recorded in non-flowing waters, such as impoundments (e.g. Borumba Dam, Imbil Weir, Mary River Barrage) but only in low numbers (Threatened Species Scientific Committee 2014a). Within the greater Fitzroy, Burnett and Mary River basins, this species has been recorded almost exclusively in close association with permanent flowing stream reaches that are typically characterised by a sand-gravel substrate with submerged rock crevices, undercut banks and / or submerged logs and fallen trees, and are rarely found in reaches without such refuge. (Hamann et al. 2007; Limpus et al. 2007; Limpus et al. 2011). Across its distribution, individuals have been recorded from both shallow and deep, slow flowing pools (Hamann et al. 2007).

White-throated snapping turtles are rarely present in water bodies that are isolated from flowing streams, such as farm dams or sewage treatment ponds, suggesting that the species does not move extended distances over dry land (Hamann et al. 2007). However, white-throated snapping turtles have been observed walking short distances from drying waterholes to nearby water bodies (Limpus et al. 2007).

### *Water Quality*

There are no published water quality tolerances for white-throated snapping turtle, although they are known from flowing streams with generally clear, well-oxygenated water (i.e. low turbidity and high dissolved oxygen). The species is one of several turtle species that can absorb oxygen from water via cloacal respiration, which reduces energy expenditure and reduce exposure to threats, especially for juveniles (DotEE 2017a). Thus high dissolved oxygen concentrations is a key water quality characteristic for this species. It is also suggested that high suspended sediment concentrations and high water temperatures (the latter of which limits dissolved oxygen concentrations) likely decrease diving duration, which may increase exposure to predation, especially juveniles (DotEE 2017a)

### *Flow Requirements*

White-throated snapping turtle generally prefer flowing waterways with clear water of variable depth (i.e. shallow riffles, shallow runs and deep pools). The species is uncommon in non-flowing waters and isolated waterbodies that are not connected to flowing water habitats. As the species is a cloacal ventilating species, it is thought that it would not function well in deeper habitats of impounded waters where dissolved oxygen concentrations are likely low (Limpus 2008), although could occur in shallow upper reaches of impoundments where there are inflows.

### *Foraging and Movement*

White-throated snapping turtles feed primarily on aquatic plants, and fruits and leaves from overhanging riparian vegetation (Limpus et al. 2007; DotEE 2017a). They may also eat periphyton, freshwater bivalves and insects, particularly when plant food resources are limited (Limpus et al. 2007). The diet of juveniles is dominated by invertebrates, whereas the diet of larger individuals (i.e. standard carapace length < 6 cm) is dominated by plant material (Limpus 2008).

The species generally has small home ranges of less than 1 km with some individuals recorded as moving up to 10 km (DotEE 2017a), although population genetic analyses indicate high rates of gene flow within basins (Todd 2013), indicating that at least some individuals move larger distances within basins. There longer-range dispersal events often exceed the distance of flowing riverine habitat between dams and weirs, indicating that barriers to long-range movement is a significant impact on the species (DotEE 2017a).

The estuarine reach that separates Tiana Creek from the remainder of the Mary River is a significant natural long-term barrier to connectivity for Mary River cod, lungfish and Mary River turtle, and thus movement between Tiana Creek and the Mary River is also unlikely for white-throated snapping turtles, but to date has not been confirmed for this species.

### Habitat Critical to Survival

Habitat critical to the survival of natural populations of white-throated snapping turtle includes (DotEE 2017a):

- Riverine systems with permanent generally clear, well-oxygenated flowing water, and deeper waterholes, in the Fitzroy, Burnett, Kolan, Burrum and Mary River Basins
- all currently known and potential nesting sites (i.e. sandy banks within 50 m of the channel)

### Breeding Cycle

The life history of white-throated snapping turtles is characterised by a long life span and slow growth to maturity (Threatened Species Scientific Committee 2014a). The age at first breeding is approximately 15 to 20 years (Limpus et al. 2011; DotEE 2017a). Breeding occurs once per year, mostly during autumn and winter, with adult females breeding in each successive year unless the turtle has been injured or debilitated, or riverine habitat has been altered (e.g. water extraction, drought or weeds) (Threatened Species Scientific Committee 2014a). Females generally nest on sandy or loam alluvial banks over an extended breeding season of some 7 months from autumn to spring (DotEE 2017a). Females lay a single clutch of eggs during the breeding season, with an average of 14 eggs per clutch (Hamann et al. 2007; Limpus et al. 2011). Nests are generally laid in areas of low canopy cover and in areas of dense grass cover; however, dense weeds at the water's edge may limit suitability of potential nesting banks (Hamann et al. 2007; Limpus et al. 2011). Nests are an average of 16.6 m from the water's edge, with eggs laid in deep chambers (greater than 20 cm in depth) and on banks with a slope of up to 26.5º (Hamann et al. 2007; Limpus et al. 2011). However, nests have been recorded up to 60 m from the water (Hamann et al. 2007). White-throated snapping turtles will repeatedly use specific areas of banks over multiple years (Limpus et al. 2007).

There is no parental care, and egg and small juvenile survival is typically low (Heppell et al. 1996; Hamann et al. 2007). There is abundant evidence of nesting in all three river basins (i.e. Fitzroy, Burnett and Mary River Basins), but most eggs are lost to predation or trampling by stock (Hamann et al. 2007; Limpus et al. 2011).

## Threats

The principal threat to white-throated snapping turtles is the excessive loss of eggs and hatchlings due to predation (Threatened Species Scientific Committee 2014a; DotEE 2017a). Primary predators include feral (e.g. foxes, dogs, pigs and cats) and native (e.g. water rats and goannas) animals. Trampling of nests by cattle is also a major threat.

Suitable habitat for white-throated snapping turtle is often limited, has often become fragmented by dams and weirs, and reduced in quality by inappropriate water allocation. Mortality of turtles in dam outlet works and over dam spillways is also a threat to this species (Hamann et al. 2007).

Other threats to this species are:

- stocking of fish into dam impoundments for recreational fishing
- recreational fishing resulting in hook injuries
- boat strike
- loss of nesting habitat to weed infestation in the riparian zone
- dense aquatic weeds in the waterways, and
- water extraction for agriculture and irrigation (Limpus et al. 2011).

No introduced diseases have been recorded as a threat to this species (DotEE 2017a).

### Summary of Draft Recovery Plan

The objectives of the draft recovery plan (DotEE 2017a) are to:

- ensure a self-sustaining healthy population structure in all catchments in which the white-throated snapping turtle occurs; and
- ensure an ecologically functional wild population of white-throated snapping turtle that, with limited species-specific management, has a high likelihood of persistence in nature.

The strategies to achieve the plan's objectives are to:

- Substantially improve the recruitment of hatchlings into the population;
- Reduce the incidence of adult mortality and injury;
- Maintain and/or improve stream flow and habitat quality throughout the species' distribution;
- Maintain and/or improve the connectivity within populations throughout each catchment; and
- Increase public awareness and participation in conservation of the species and its habitat.

## 1.2 Mary River Cod

### Status

The Mary River cod (*Maccullochella mariensis*) is listed as endangered under the EPBC Act. It is also listed as a 'no take' species under the Queensland *Fisheries Act 1994,* with the exception of specific impoundments nominated by DAF where it has been stocked.

### Population

The species is restricted to the Mary River basin, where fewer than 600 individuals may occur, primarily in three main tributaries of the Mary River (i.e. Tiana-Coondoo, Obi Obi and Six Mile Creeks (Simpson & Jackson 1996; Threatened Species Scientific Committee 2016), although recent survey work suggests that the main stem of the Mary River, and potentially other significant tributaries, contains a larger population of cod than previously recognised (SKM 2007 and references therein). Nonetheless, the population size appears to be decreasing ((Simpson & Jackson 1996), with effective population size estimates being very low (18 – 56), suggesting the breeding population of Mary River cod is very small (Huey et al. 2013).

Population genetic analyses indicate two genetically distinct populations of Mary River cod – main Mary River system and Tiana-Coondoo Creek, which are separated by estuarine waters (Huey et al., 2013). While past stocking from Tiana Creek to the Mary River has not appeared to influence population genetic structure, the genetic results indicate that stocking programs should keep populations from the Mary River (including Six Mile Creek) totally separate from those of Tiana Creek (Huey et al., 2013).

### Area of Occupancy

The Mary River cod is endemic to the Mary River system. While of low abundance in most reaches, Mary River cod is reported to occur in the main stem of the Mary River (SKM 2007 and references therein) and several tributaries, with Six Mile Creek, Obi Obi Creek and Tiana Creek likely having larger numbers of cod than Yabba Creek, Munna Creek and Booloumba Creek (Simpson & Jackson 1996; Threatened Species Scientific Committee 2016). The population in Six Mile Creek is distributed from the confluence with the Mary River to well upstream of Lake Macdonald, and has historically considered to be in a stable condition (Simpson & Jackson 1996). In Tinana-Coondoo Creek, Mary River cod occur up to seventy kilometres upstream of the confluence with the Mary river, of which only 25-30% is considered suitable habitat. In Obi Obi creek, the species range extends approximately 10 km upstream from the confluence with the Mary River (Simpson & Jackson 1996). A number of impoundments in South East Queensland have been stocked with Mary River cod for recreational fishing (Huey et al. 2013).

### Habitat

The pool habitats within Obi Obi, Six Mile and Tinana-Coondoo Creeks are known strong-holds for Mary River cod, although pools along the main Mary River, and other significant tributaries of the Mary River, may contain more cod than previously recognised (SKM 2007 and references therein). Suitable pools are of variable depth (up to 3 m) and usually occur along pool and shallow riffle or run sequences (Simpson & Jackson 1996). The in-stream habitat features used for foraging and nesting by Mary River cod include submerged large woody debris, undercut banks, rock ledges and boulders (DoE 2014b). Reaches of creek with intact riparian vegetation are also favoured by the species as it provides shade and a supply of woody debris (Hydrobiology 2008a; Threatened Species Scientific Committee 2016).) Larval and juvenile fish habitat preferences are variable between the tributaries of its distribution in the Mary River, with no single habitat type (small wood debris, large woody debris, marginal vegetation, leaf litter) or substrate type (sand or mud) dominant (Dunlop 2016).

### *Water Quality*

The reported water quality ranges for sites where Mary River cod have been caught are:

- pH = 6.0 – 7.3
- conductivity (µS/cm) = 100 – 800
- temperature (°C) = 15.7 – 29.0, and
- dissolved oxygen (mg/L) = 3.9 – 9.7 (Hydrobiology 2008a).

Of the listed water quality parameters, temperature and dissolved oxygen are the most important, as high temperatures and low dissolved oxygen levels can be lethal to the species (DNRM, pers. Com.).

### *Flow Requirements*

Adults of the species typically prefer low flowing water of suitable depth (i.e. 1 – 3 m) (Hydrobiology 2008a, 2008b), and generally avoid shallow (<1 m) areas. During periods of high flow, they shelter amongst woody debris and undercut banks, although movement may be triggered by moderate flows (Hydrobiology 2008b). Stable base flows maintain shallow riffles, which also maintain dissolved oxygen levels (Hydrobiology 2008b). Mary River cod have been observed dispersing from 10 km to 70 km over several months following high flows (Simpson & Jackson 1996). Spawning is triggered by light episodic rainfall (up to 20 mm) and associated flows, when it coincides with a water temperature of at least 19 ºC and the full moon phase (R Manning 2014, pers. comm.).

### *Foraging and Movement*

Mary River cod typically have relatively narrow home ranges, occupying a particular pool for extended periods (Simpson & Jackson 1996). Within their ranges, movement tends to be upstream during the summer months when rainfall and flows are higher, connecting pools, and downstream or into larger tributaries during the winter months (Threatened Species Scientific Committee 2016). Population genetic analyses indicate some level of connectivity throughout the main Mary River (Huey et al. 2013), suggesting at least some individuals move larger distances from home ranges, although it is not known if longer-range dispersal is by juveniles or adults (or both).

Mary River cod are predatory and generally feed on smaller fish and crustaceans, most commonly during dawn and dusk; but the species is also known to occasionally consume waterbirds and other fauna (Threatened Species Scientific Committee 2016). The species often forages on prey immediately downstream of riffles, presumably due to a constriction of the watercourse and the concentration of prey items (SKM 2007 and references therein) This suggests that shallower riffle habitats is important habitats for Mary River cod, although this habitat may not be commonly occupied by the species.

### Habitat Critical to Survival

Habitat critical to the survival of natural populations of Mary Cod includes the following features in streams and waterways within the Mary River:

- Deep, slow-flowing, clay-lined pools with submerged large woody debris and other complex submerged habitat features (e.g. boulders, undercut banks) along the Mary River and major tributaries, especially Six Mile Creek, Obi Obi Creek and Tiana Creek
- Shallow flowing riffle habitats connecting the pool habitats, to maintain dissolved oxygen concentrations
- For breeding: water temperature of at least 19ºC coinciding with a rise (e.g. approximately 30cm) in discharge from early spring to early summer

### Breeding Cycle

Mary River cod mature at approximately 38 cm and are considered to be a large, slow growing, long-lived fish with relatively low fecundity (Threatened Species Scientific Committee 2016). ). The cod is presumed to spawn more than once a year, during spring and into early summer (Simpson & Jackson 1996). Spawning is triggered by light episodic rainfall (up to 20 mm) and associated increases in flows, when it coincides with a water temperature of at least 19 ºC (Hydrobiology 2008b).

Eggs are typically deposited in a nest formed by a hollow log or similar habitat features (e.g. submerged open pipe) (Simpson & Jackson 1996). The male will subsequently guard the eggs until they begin to hatch towards the end of the fourth day at 20°C. The male will continue to guard the brood until they are ready to search for food between seven and nine days after hatching (Simpson & Jackson 1996). In the event that conditions do not coincide i.e. water temperature of at least 19ºC, and light episodic rainfall up to 20 mm, female Mary

River cod will reabsorb their eggs and will not spawn (Threatened Species Scientific Committee 2016).

## Threats

Threats to Mary River cod, include:

- Overfishing - overfishing during the late 1800's and early 1900's saw the removal of large numbers of fish (Simpson & Jackson 1996). Currently, fishing for Mary River cod is prohibited in the Mary River, however there is evidence that illegal capture of the Mary River cod still occurs (Simpson & Jackson 1996).
- Habitat degradation – specifically clearing of riparian zones, which exposes bank soil to erosion and leads to sedimentation of pool habitats (Simpson and Jackson 1996). Loss of riparian vegetation also reduces the input of branches and other habitat elements that are preferred by Mary River cod
- Dams and weirs – impose barriers to movement; while long-range dispersal by cod is not frequent as they generally have relatively small home ranges, periodic movement over longer distances is likely to be important for the long-term survival of the species (Simpson & Jackson 1996). Cold-water releases from dams and altered flows downstream of dams may also impact breeding and / or survival of larvae (DoE SPRAT Profile)
- Pollution – various sources of pollution may impact the suitability of water quality for Mary River cod, with increased nutrients and reduced dissolved oxygen known water quality issued for Mary River cod (Simpson & Jackson 1996), and
- Introduced and invasive species – may increase competition for food or habitat resources, or may prey on larval and juvenile cod (Simpson & Jackson 1996).

No introduced diseases have been recorded as a threat to this species (Simpson & Jackson 1996).

## Summary of Recovery Plan

- 1. Establish a program of community involvement and education.
- 2. Review and develop regulations and administrative procedures to ensure protection of the Mary River cod and its habitats, including:
  - develop a translocation strategy to minimise impacts of non-endemic fish introductions.

  - maintain and restore fish passage past weirs/dams
  - develop and implement environmental flow guidelines.
- 3. Develop a plan to improve hatchery production of the Mary River cod, and restock throughout the former range.
- 4. Undertake research on key aspects of Mary River cod ecology and captive-breeding techniques.
- 5. Restore degraded Mary River cod habitats:
  - 5.1. Develop a strategic plan for restoration of cod habitats.
  - 5.2. Implement pilot habitat rehabilitation programs in key areas of the Mary River.

## 1.3 Mary River Turtle

### Status

The Mary River turtle (*Elusor macrurus*) is listed as endangered under the EPBC Act, and endangered under the NC Act.

### Population

There is limited data available on the population size of the Mary River Turtle (Limpus 2008), although effective population size estimates for the species in the wild were between 136 and 158 (Schmidt et al., 2017), suggesting that the breeding population of this species is very small. This is consistent with estimates that the nesting population has declined by 95% since 1974 (Flakus 2002). The current population is dominated by aging adults, but studies suggest that the proportion of immature turtles may be increasing (Limpus 2008).

Population genetic analyses indicate that most of the Mary River contains a genetically connected population of Mary River turtle, with the exception of Tinana Creek, which is a genetically unique population (Schmidt et al., 2017).

### Area of Occupancy

The Mary River turtle has been recorded in the Mary River and several of its tributaries (e.g. Yabba Creek and Tiana Creek) between Kenilworth (260 km from the river mouth) and the

Mary River tidal barrage at Tiaro (Flakus 2002; Limpus 2008); Threatened Species Scientific Committee 2008, although has not been recorded from Six Mile Creek.

## Habitat

The species is regularly associated with areas of submerged habitat, including sparse to dense aquatic plant coverage, woody debris and rock crevices (SKM 2007 and references cited therein). Similar to other reptiles, the Mary River turtle often basks on emerging rock and logs within the waterbody and along its banks (Cann & Legler 1994).

Much of the Mary River turtle habitat is surrounded by cleared grazing and agricultural land, although in such reaches the species has been caught in areas where the river is wide and there is trailing vegetation and in-stream habitat (Cann & Legler 1994). Some areas of Mary River turtle habitat retain some riparian and catchment vegetation, especially in upper catchment areas and along several tributaries.

### *Water Quality*

There are no specific water quality tolerances that have been published for Mary River turtle; but like other turtles with aquatic cloacal respiration, Mary River turtle requires flowing, well-oxygenated sections of streams (Threatened Species Scientific Committee 2008). Declines in water quality may reduce the efficiency of cloacal respiration by Mary River turtle, which can reduce foraging efficiency and more frequently expose juveniles to predators at the water surface.

### *Flow Requirements*

The Mary River turtle prefers habitats characterised by shallow, flowing streams with riffle zones and well-oxygenated water with connecting shallow runs and deep pools (depth ranging from approximately 1 m – 5 m) (Flakus & Connell 2008; Threatened Species Scientific Committee 2008). During flooding, the Mary River turtle takes refuge in backwaters until flow decreases to pre-flood levels (Sadlier et al. 2004). They are also known to swim upstream during moderate to high flow events, returning to the same pool once water levels recede (Flakus & Connell 2008).

### *Foraging and Movement*

The Mary River turtle is omnivorous and feeds on aquatic plants (including algae) and invertebrates (including bivalves) (Cann & Legler 1994). Juvenile Mary River turtles eat aquatic insect larvae, supplemented by freshwater sponges, aquatic plants including green algae, and fruits of some terrestrial trees (Flakus 2002; Micheli-Campbell et al. 2013).

Individuals of the species have well defined home ranges and many show strong site fidelity (Limpus 2008; Micheli-Campbell et al. 2013), although low spatial genetic variability through the main Mary River (excluding Tiana Creek) (Schmidt et al., 2017) suggest that at least some individuals undertake longer-range movement. Movement may be seasonal, with limited movement in winter but up to 2 km in search of breeding sand banks have been recorded during the early summer months (Sadlier et al. 2004).

### Habitat Critical to Survival

Habitat critical to the survival of natural populations of Mary River turtle includes the following features in streams and waterways within their range:

- wide sections of the river with trailing vegetation and in-stream habitat
- flowing streams with riffle zones and well-oxygenated water, and reaches with deep connected pools
- aquatic plants (including algae) and invertebrates (including bivalves)
- sparsely vegetated sandy river banks in close proximity to riffles and pools.

### Breeding Cycle

Mary River turtles live for between 30 and 80 years and do not breed until between 15 and 25 years of age (Limpus 2008). Sparsely vegetated sandy river banks in close proximity to riffles and pools are preferred nesting habitats, with these sites revisited across decades by the same individual (Flakus 2002; Limpus 2008). Breeding occurs only once every year with a clutch size of approximately 13 eggs. Successful hatching is dependent on 50 consecutive days of non-inundation after nesting (Cann & Legler 1994; Flakus 2002). For this reason, nests are typically located 5 m above the water level and up to 30 m inland from the watercourse. Nesting occurs in late October to December after the first significant summer rain (Cann & Legler 1994; Flakus 2002). Eggs have an incubation period of 50 – 56 days, depending on sand temperature (Cann & Legler 1994).

### Threats

Major threats to the Mary River turtle include:

- Nest predation and reduced success of recruitment - for twelve years during the 1960's and 1970's large numbers of Mary River turtle eggs were collected for commercial purposes (Flakus 2002; Limpus 2008; Schmidt et al., 2017). As a result, little to no recruitment occurred during this time and this resulted in poor breeding success of Mary River turtle for four decades (Flakus 2002; Schmidt et al., 2017). Furthermore, pressure from predation in nesting areas by foxes, goannas and wild dogs has continued to cause low hatching success of the Mary River (Flakus 2002; Limpus 2008).
- Dams - impoundments do not provide suitable habitat for the Mary River turtle, having typically still water with low levels of dissolved oxygen that reduces the efficiency of cloacal respiration (Threatened Species Scientific Committee 2008). Dam also do not provide favourable conditions for food resources of Mary River turtles, not suitable nesting habitats.
- Habitat degradation - including clearing of the riparian zone, weed invasion and trampling of nest sites by cattle (Threatened Species Scientific Committee 2008).

## Summary of Recovery Plan

As there is no recovery plan for the Mary River turtle. The priority actions outlined in the Approved Conservation Advice (Threatened Species Scientific Committee 2008) have been listed below.

Habitat Loss, Disturbance and Modification

- Monitor known populations to identify key threats.
- Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.
- Identify and protect areas critical to the survival of the species, such as nesting sites.
- Involve sand mining lessees in protection of critical habitat.
- Ensure road widening and maintenance activities (or other infrastructure or development activities as appropriate) in areas where the Mary River Turtle occurs do not adversely impact on known populations.
- Manage any disruptions to water flows.
- Suitably control access to areas of critical habitat to minimise impacts on habitat and nesting.
- Continue protection of Mary River Turtle eggs from illegal collection.

- Investigate formal conservation arrangements such as the use of covenants, conservation agreements or inclusion in reserve tenure.

Trampling, Browsing or Grazing

- Continue protection of Mary River Turtle eggs from trampling.

Animal Predation

- Undertake predator control in nesting areas of the Mary River Turtle.

Conservation Information

- Raise awareness of the Mary River Turtle within the local community.

Enable Recovery of Additional Sites and/or Populations

- Develop a headstart program to increase hatchling survival and allow recruitment into the population, including moving clutches to safe incubation sites, creating new sandbanks for nesting, re-planting macrophytes after flood scouring, and introducing snags to pools.

# 2 Vulnerable Species

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

- lead to a long-term decrease in the size of an important population of a species
- reduce the area of occupancy of an important population
- fragment an existing important population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of an important population
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- introduce disease that may cause the species to decline, or
- interfere substantially with the recovery of the species.

## 2.1 Australian Lungfish

### Status

Australian lungfish (*Neoceratodus forsteri*) is listed as vulnerable under the EPBC Act. It is also listed as a 'no take' species under the Queensland *Fisheries Act 1994*.

### Population

As a result of significant changes to core lungfish habitat recruitment to the adult breeding population is considered to be unsustainable low, and thus population reductions over the next few generations are likely (Threatened Species Scientific Committee 2014b; DotEE 2017b).

Population genetic analyses indicate three natural and genetically discrete populations of Australian lungfish: Burnett River, main Mary River and Tiana Creek in the lower Mary River (Hughes et al. 2015). Genetic analyses confirm populations in the Brisbane River and Pine River have been translocated from the main Mary River population (Hughes et al. 2015).

## Area of Occupancy

The main stem and major tributaries of the Burnett and Mary Rivers comprise the natural distribution of Australian lungfish (Hughes et al. 2015; DotEE 2017b), although translocated populations also occur in the Brisbane, Pine, Albert and Coomera Rivers (Threatened Species Scientific Committee 2014b). Australian lungfish have been periodically recorded in low abundance from Six Mile Creek.

## Habitat

Australian lungfish are generally found in wide, slow-flowing reaches with deep pools (i.e. 2 – 3 m) and shallower sections (i.e. 1m deep) with abundant aquatic plant cover and overhaning riparian vegetation (Threatened Species Scientific Committee 2014b; DotEE 2017b). Riffles and runs may also be present among deeper pool habitats (Arthington 2009). Australian lungfish tend to inhabit reaches with structurally complex submerged habitat, including submerged logs, high aquatic plant cover and underwater crevices formed by rock scouring and / or undercut banks (Arthington 2009). Open water with an absence of complex in-stream structures, such as impounded waters, is not preferred habitat of the species, although the species is known from shallow, headwater areas of impoundments where more complex habitats are available (Arthington 2009).

### *Water Quality*

The water quality ranges of sites where Australian lungfish have been caught are:

- pH = 7.0 – 9.1
- conductivity (µS/cm) = 421 – 1165
- temperature (°C) = 10 – 30, and
- dissolved Oxygen (mg/L) = 6.9 – 15.6 (Hydrobiology 2008a).

Australian lungfish are not tolerant of, and will not disperse through, saline water (Pusey et al. 2004); hence, the genetic distinctness of the population in Tiana Creek, which is separated from the main Mary River by estuarine waters.

### *Flow Requirements*

The specific flow requirements for lungfish are only partly understood. Adults of the species are found mostly in permanent still or slow flowing deep pools, or in shallow pools with high cover of submerged aquatic plants. Breeding and recruitment occurs under low flow conditions (i.e. water levels between 10 and 30 cm above cease to flow levels) (Hydrobiology 2008b).

### *Foraging and Movement*

Lungfish are largely sedentary, having home ranges of less than 2 km, although long-term recoding of movement patterns shows that some individuals may move up to 5 km over a number of years (Kind 2002; Threatened Species Scientific Committee 2014b). Genetic connectivity in the Burnett and Mary Rivers, respectively, suggests that at least some individuals undertake longer-range movements (Hughes et al. 2015). Most movement is reported to occur during the summer months (Kind 2002), with individuals in upper reaches of impounded waters known to move larger distances to find suitable habitat than individuals from non-impounded waters (Kind 2002; Threatened Species Scientific Committee 2014b; DotEE 2017b).

Lungfish feed mostly at night on benthic invertebrates, amphibian larvae and aquatic plants, with juveniles consuming mostly benthic invertebrates (Threatened Species Scientific Committee 2014b). There are also reports of lungfish ingesting terrestrial plant leaves and fruits (DotEE 2017b).

## Habitat Critical to Survival

Habitat critical to the survival of natural populations of Australian Lungfish includes the following features main stem rivers and significant tributaries of the Burnett and Mary Rivers:

- wide, slow-flowing or still permanent reaches with deep pools and shallower sections with abundant aquatic plant cover and structurally complex submerged habitat in the Burnett and Mary River basins, but also any breeding or foraging habitat in areas to which it has been translocated (e.g. Brisbane and North Pine Rivers)

## Breeding Cycle

Male Australian lungfish begin breeding at approximately 15 years of age while females first breed at approximately 20 years of age (Threatened Species Scientific Committee 2014b). Most spawning occurs at night in flowing streams between August and December, before summer rains commence, and when water temperatures are higher than 20ºC (Threatened Species Scientific Committee 2014b; DotEE 2017b). Spawning habitat is primarily dense aquatic plant meadows in shallow water with high dissolved oxygen (Threatened Species Scientific Committee 2014b; DotEE 2017b), although trailing roots and other habitats are occasionally used for spawning. Hatching of eggs occurs approximately one month after fertilisation (McGrouther 2013), with larval lungfish thought to have poor swimming abilities, and thus take refuge in aquatic plant meadows where water velocity is low and dissolved oxygen is high. Growth rates are typically slow, attaining 40 cm in length over approximately five years, although under optimal conditions growth rates are much faster (Arthington 2009).

## Threats

The main threats to Australian lungfish are (Threatened Species Scientific Committee 2014b; DotEE 2017b):

- Dams and weirs – which modify core habitat (i.e. convert flowing river habitats to impounded waters) and impact migration, including breeding migrations in search of suitable breeding locations. Stranding of lungfish below tidal barrages is reported, as is crowing in impoundments at times of very low water
- Altered Hydrology – water extraction and water reductions during spawning times can expose shallow aquatic plant beds resulting of death of fertilised eggs, but similarly large water releases at the times may also have adverse impacts in recruitment
- Habitat degradation and impacted water quality – such as through clearing of riparian zones, which exposes bank soil to erosion and leads to sedimentation of pool habitats, and invasive aquatic plants can reduce spawning habitat quality.
- Invasive species – including stocked and pest fish which may compete with, and prey on eggs of , lungfish, with tilapia impacting the quality of spawning habitats by disturbing aquatic plants; invasive aquatic plants also impact the quality of lungfish spawning habitat.
- Fishing - recreational fishers are known to unintentionally catch the Australian lungfish

## Summary of Draft Recovery Plan

### *Draft Recovery Plan objectives:*

Enhance Australian lungfish populations throughout their range (particularly populations within the Burnett, Mary, Brisbane and North Pine River catchments) to a point where there can be assurance that the species no longer meets the criteria for listing and can be delisted from the national threatened species list under the EPBC Act.

### *Recovery strategies:*

The strategies to achieve the plans' objectives are to:

- Reduce the impacts of, and remove any redundant, artificial barriers
- Manage waterways to optimise breeding and recruitment opportunities
- Limit habitat degradation and maintain or enhance water quality
- Reduce the impacts of introduced pest and weed species
- Manage the impacts of water-based recreational activities
- Address key knowledge gaps to improve Australian lungfish management
- Facilitate high levels of community participation and support in the implementation of Australian lungfish management strategies

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# Appendix C Detailed Habitat Results

## Six Mile Creek – Downstream of Lake Macdonald

| Site: SMC4 | Years surveyed | | | | |
|---|---|---|---|---|---|
| | October 2013 | November 2014 | November 2015 | October 2016 | November 2017 |
| **Photograph (upstream view)** |  |  |  |  |  |
| **Habitat features** | | | | | |
| **Adjacent land use** | native forest, road | native forest | native forest, grazing | native forest, railroad, rural residential | native forest, grazing |
| **Riparian vegetation cover** | moderate | extensive | extensive | moderate | low to moderate |
| **Dominant type of riparian vegetation** | grass, shrubs, trees | shrubs, trees | grass, shrubs, trees | grass and trees | grass and trees |
| **Mean wetted width (m)** | 6 m | 8 m | 9 m | 12 m | 9 m |
| **Flow habitats** | – | connected pool, run | connected pool, riffle, run | connected pool | connected pool, riffle, run |
| **Mean water velocity (m/s)** | no flow | 0.01 m/s | 0.12 m/s | 0.015 m/s | 0.155 m/s |
| **Water level** | low | at watermark | low | low | at watermark |
| **Bed substrate composition** | sand (60%), silt/clay (40%) | bedrock (5%), sand (85%), silt/clay (5%) | bedrock (5%), sand (80%), silt/clay (15%) | sand (90%), silt/clay (10%) | sand (90%), silt/clay (10%) |
| **Stream bed stability** | stable | stable | stable | stable | moderate erosion |
| **Bank material** | sand | sand, silt/clay | sand, silt/clay | sand, silt/clay | sand, silt, bedrock |
| **Bank slope** | steep to vertical | steep | moderate to steep | steep | flat and steep |
| **Bank shape** | convex and undercut | convex and concave | stepped and convex | convex and concave | convex |
| **Extent of bank erosion** | moderate | low to high | none to low | low | low |
| **Aquatic Plant cover in water** | none | none | none | none | none |
| **Aquatic plant cover on banks** | – | none | low | low | low to moderate |
| **Physical in-stream habitat features** | individual logs and log jams, 5% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 5% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 5% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 5% cover trailing bank vegetation | individual branches and branch piles, individual logs, terrestrial leaves and twigs, 5% cover trailing bank vegetation |
| **In-stream barriers to aquatic fauna passage** | bridge | bridge | bridge | bridge | bridge |
| **Other disturbances** | erosion, roads | erosion, roads | erosion, roads | erosion, roads | weeds, erosion, roads |

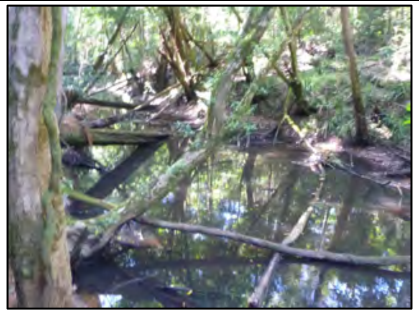
– no data

| Site: SMC5 | Years surveyed | | | | |
|---|---|---|---|---|---|
| | **October 2013** | **November 2014** | **November 2015** | **October 2016** | **November 2017** |
| **Photograph (upstream view)** |  |  |  |  |  |
| **Habitat features** | | | | | |
| **Adjacent land use** | native forest | native forest, grazing | native forest, grazing | native forest, rural residential | native forest, grazing |
| **Riparian vegetation cover** | moderate | low to moderate | extensive | moderate | moderate |
| **Dominant type of riparian vegetation** | shrubs, trees | shrubs, trees | shrubs, trees | grass and trees | grass, shrubs, trees |
| **Mean wetted width (m)** | 7 m | 10 m | 8 m | 10 m | 10 m |
| **Flow habitats** | – | connected pool, riffle, run | connected pool, riffle, run | connected pool, riffle, run | connected pool, riffle, run |
| **Mean water velocity (m/s)** | slow | 0.05 m/s | 0.45 m/s | 0.034 m/s | 0.35 m/s |
| **Water level** | low | low | low | low | at watermark |
| **Bed substrate composition** | boulder (2%), cobble (5%), pebble (3%), gravel (20%), sand (70%) | pebble (5%), gravel (25%), sand (50%), silt/clay (20%) | boulder (7%), cobble (5%), pebble (5%), gravel (5%), sand (60%), silt/clay (18%) | boulder (2%), cobble (3%), pebble (5%), gravel (5%), sand (75%), silt/clay (10%) | bedrock (5%), boulder (15%), cobble (10%), pebble (5%), sand (50%), silt/clay (5%) |
| **Stream bed stability** | stable | stable | stable | stable | moderate erosion |
| **Bank material** | boulder, cobble, sand | pebbles, gravel, sand, silt | sand, boulder (deposited by trucks) | sand, silt/clay | gravel, sand, clay |
| **Bank slope** | steep | moderate to steep | moderate to steep | steep | steep to vertical |
| **Bank shape** | convex | stepped | convex and concave | convex and concave | concave |
| **Extent of bank erosion** | low | none to low | low | low | low |
| **Aquatic Plant cover in water** | none | none | none | none | low |
| **Aquatic plant cover on banks** | – | none | low | low | low |
| **Physical in-stream habitat features** | large woody debris, terrestrial leaves and twigs, 5% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 5% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 50% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 5% cover trailing bank vegetation | branch piles, individual logs and log jams, terrestrial leaves and twigs, 15% cover trailing bank vegetation |
| **In-stream barriers to aquatic fauna passage** | bridge, build up of rocks and logs at the base of the bridge | bridge | bridge | bridge | bridge |
| **Other disturbances** | erosion, roads | erosion, roads, access tracks | erosion, roads, weeds, cleared vegetation | erosion, weeds, roads | weeds, roads |

– no data

| Site: SMCDS05 | Years surveyed |
|---|---|
| | August 2015 |
| Photograph (upstream view) |  |
| Habitat features | |
| Adjacent land use | industrial, native forest, camping |
| Riparian vegetation cover | low |
| Dominant type of riparian vegetation | grass, shrubs, trees |
| Mean wetted width (m) | 4 m |
| Flow habitats | connected pool, riffle, run |
| Mean water velocity (m/s) | 2.0 m/s |
| Water level | low |
| Bed substrate composition | boulder (5%), cobble (10%), pebble (15%), gravel (15%), sand (45%), silt/clay (10%) |
| Stream bed stability | moderate erosion |
| Bank material | cobble, pebble, gravel, sand, silt/clay |
| Bank slope | steep |
| Bank shape | concave |
| Extent of bank erosion | moderate |
| Aquatic Plant cover in water | none |
| Aquatic plant cover on banks | low |
| Physical in-stream habitat features | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 5% cover trailing bank vegetation |
| In-stream barriers to aquatic fauna passage | nil |
| Other disturbances | erosion, roads, weeds |

| Site: SMCDS04 | Years surveyed | | |
|---|---|---|---|
| | August 2015 | October 2015 | February 2018 |
| Photograph (upstream view |  |  |  |
| Habitat features | | | |
| Adjacent land use | native forest | native forest | native forest, road |
| Riparian vegetation cover | moderate | moderate | moderate |
| Dominant type of riparian vegetation | shrubs, ferns, trees | trees | grass, trees, shrubs |
| Mean wetted width (m) | 15 m | 15 m | 10 m |
| Flow habitats | connected pool, run | connected pool | connected pool |
| Mean water velocity (m/s) | 0.1 m/s | 0.01 m/s | 0.05 m/s |
| Water level | low | at watermark | at watermark |
| Bed substrate composition | sand (20%), silt/clay (80%) | sand (10%), silt/clay (90%) | artificial boulder (5%), cobble (5%), pebble (5%), gravel (5%), sand (15%), silt/clay (65%) |
| Stream bed stability | moderate aggradation | moderate aggradation | stable |
| Bank material | silt | silt | clay/silt |
| Bank slope | steep | vertical | moderate to steep |
| Bank shape | convex | wide lower bench, undercut 20–30% | convex |
| Extent of bank erosion | low | moderate | some |
| Aquatic Plant cover in water | none | none | none |
| Aquatic plant cover on banks | low | low | low to moderate |
| Physical in-stream habitat features | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 15% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 10% cover trailing bank vegetation | individual branches and branch piles, dense terrestrial leaves and twigs, individual logs and log jams, 10% trailing bank vegetation, turtle basking spots present |
| In-stream barriers to aquatic fauna passage | nil | nil | nil |
| Other disturbances | roads | roads | roads, erosion |

| Site: SMCDS03 | Years surveyed | | |
|---|---|---|---|
| | **August 2015** | **October 2015** | **February 2018** |
| **Photograph (upstream view)** |  |  |  |
| **Habitat features** | | | |
| **Adjacent land use** | native forest | native forest | native forest |
| **Riparian vegetation cover** | extensive | extensive | extensive |
| **Dominant type of riparian vegetation** | shrubs, trees | trees | shrubs, trees |
| **Mean wetted width (m)** | 6 m | 3 m | 8 m |
| **Flow habitats** | connected pool, run | connected pool, riffle, run | connected pool, riffle, run |
| **Mean water velocity (m/s)** | 0.2 m/s | 0.2 m/s | 0.02 m/s |
| **Water level** | low | at watermark | at watermark |
| **Bed substrate composition** | boulder, cobble, pebble, gravel, sand, silt/clay | boulder (3%), cobble (6%), pebble (5%), gravel (5%), sand (50%), silt/clay (31%) | gravel (5%), sand (15%), silt/clay (80%) |
| **Stream bed stability** | stable to moderate aggradation | moderate aggradation | moderate aggradation |
| **Bank material** | gravel, sand, silt/clay | sand, silt | silt/clay |
| **Bank slope** | steep | steep | steep to vertical |
| **Bank shape** | concave | concave | concave |
| **Extent of bank erosion** | low | moderate | moderate |
| **Aquatic Plant cover in water** | none | none | none |
| **Aquatic plant cover on banks** | low | low | low |
| **Physical in-stream habitat features** | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 10% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 10% cover trailing bank vegetation | individual branches and branch piles, sparce terrestrial leaves and twigs, individual logs and log jams, 5% cover trailing vegetation, turtle basking spots present |
| **In-stream barriers to aquatic fauna passage** | bridge | bridge | bridge |
| **Other disturbances** | access tracks | erosion, roads | erosion |

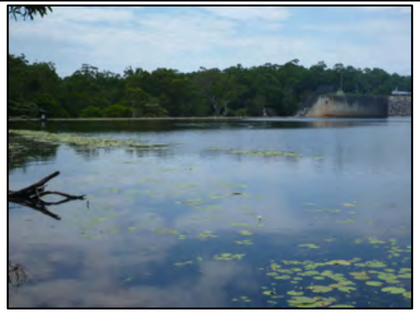
| Site: SMCDS02 | Years surveyed | | |
|---|---|---|---|
| | **August 2015** | **October 2015** | **February 2018** |
| **Photograph (upstream view)** |  |  |  |
| **Habitat features** | | | |
| **Adjacent land use** | native forest | native forest, residential | native forest |
| **Riparian vegetation cover** | low | moderate | mocerate |
| **Dominant type of riparian vegetation** | shrubs, trees | shrubs, trees | shrubs, trees |
| **Mean wetted width (m)** | 4 m | 4 m | 4 m |
| **Flow habitats** | connected pool, riffle, run | connected pool, riffle, run | connected in-channel pool, riffle, run |
| **Mean water velocity (m/s)** | 0.5 m/s | 0.01 m/s | 0.05 m/s |
| **Water level** | low | at watermark | at watermark |
| **Bed substrate composition** | boulder (10%), cobble (10%), pebble (10%), gravel (15%), sand (50%), silt/clay (5%) | cobble (5%), pebble (2%), gravel (10%), sand (77%), silt/clay (10%) | cobble (5%), pebble (20%), gravel (25%), sand (25%), silt/clay (25%) |
| **Stream bed stability** | moderate erosion | moderate aggradation | stable |
| **Bank material** | sand, silt | cobble, sand, silt | clay/silt |
| **Bank slope** | moderate to steep | moderate | moderate |
| **Bank shape** | convex | concave and undercut 20–25% | uncercut 10%, wide lower brank, convex and concave on the left bank; convex and concave on the right bank |
| **Extent of bank erosion** | low | moderate | – |
| **Aquatic Plant cover in water** | none | none | low |
| **Aquatic plant cover on banks** | low | low | low to moderate |
| **Physical in-stream habitat features** | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 10% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 15% cover trailing bank vegetation | individual branches and branch piles, individual ogs and log jams, 10% cover trailing bank vegetation |
| **In-stream barriers to aquatic fauna passage** | nil | nil | nil |
| **Other disturbances** | erosion, roads | cleared vegetation, roads | tyre debris, roads |

– no data

| Site: SMCDS01 | Years surveyed | | | |
|---|---|---|---|---|
| | August 2015 | October 2015 | February 2018 | February 2018 |
| Photograph (upstream view) |  |  |  |  |
| Habitat features | | | | |
| Adjacent land use | native forest, rural | native forest, recreation, SEQ Water | dam, native forest | native forest, national park |
| Riparian vegetation cover | moderate | moderate | little upstream, extensive downstream | extensive |
| Dominant type of riparian vegetation | grass, shrubs, trees | shrubs, trees | grasses and trees upstream, trees and others downstream | trees, shrubs |
| Mean wetted width (m) | 6 m | 5 m | 17 m | 12 m |
| Flow habitats | connected pool, run | connected pool, riffle, run | connected pool, riffle | isolated in-channel pool |
| Mean water velocity (m/s) | 0.5 m/s | 0.15 m/s | 0.01 m/s | 0.01 m/s |
| Water level | low | at watermark | at watermark | – |
| Bed substrate composition | boulder (5%), cobble (5%), pebble (10%), gravel (10%), sand (30%), silt/clay (4%) | boulder (2%), pebble (3%), gravel (10%), sand (70%), silt/clay (15%) | boulder (15%), cobble (10%), pebble (15%), gravel (25%), sand (10%) silt/clay (25%) | gravel (10%), sand (10%), silt/clay (80%) |
| Stream bed stability | stable | moderate aggradation | stable | high |
| Bank material | pebble, gravel, sand, silt | gravel, sand, silt | clay, silt, pebble, cobble, concrete boulder | silt/clay |
| Bank slope | steep | moderate | steep, vertical | moderate to steep |
| Bank shape | convex | concave and undercut 20–25% | convex | – |
| Extent of bank erosion | none | low | moderate | – |
| Aquatic Plant cover in water | low | moderate | low | moderate |
| Aquatic plant cover on banks | low | high | low to moderate | moderate |
| Physical in-stream habitat features | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 15% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 25% cover trailing bank vegetation | individual branches, terrestrial leaves and twigs, 5% cover trailing bank vegetation | large woody debris, 50% cover trailing bank vegetation |
| In-stream barriers to aquatic fauna passage | dam wall upstream of site | dam wall upstream of site | dam wall upstream of site | old culvert upstream |
| Other disturbances | weeds | cleared vegetation, roads | roads | culvert |

– no data

## Six Mile Creek – In Lake Macdonald

| Site: DS Lake | Years surveyed | | | |
|---|---|---|---|---|
| | August 2015 | October 2015 | February 2018 | February 2018 |
| Photograph (upstream view) |  |  |  |  |
| Habitat features | | | | |
| Adjacent land use | residential | native forest, residential | recreation, water treatment | recreation, water treatment |
| Riparian vegetation cover | extensive | extensive | little | some |
| Dominant type of riparian vegetation | grass, shrubs, trees | grass, trees | grass, trees, shrubs | grass, trees, shrubs |
| Mean wetted width (m) | 100 m | 300 m | >100 m | >100 m |
| Flow habitats | connected pool | connected pool | connected in-channel pool | connected pool |
| Mean water velocity (m/s) | <0.1 m/s | 0.01 m/s | <0.1 m/s | <0.1 m/s |
| Water level | low | at watermark | at watermark | at watermark |
| Bed substrate composition | gravel (5%), sand (15%), silt/clay (80%) | gravel (3%), sand (90%), silt/clay (7%) | boulder (5%), cobble (10%), pebble (10%), gravel (10%), sand (55%), silt/clay (10%) | pebble (5%), gravel (10%), sand (75%), silt/clay ( 10%) |
| Stream bed stability | stable | moderate aggradation | moderate aggradation | moderate aggradation |
| Bank material | sand, silt/clay | sand, silt | clay/silt | clay/silt and sand |
| Bank slope | low | low | low to moderate | low |
| Bank shape | concave | concave and undercut 2% | concave | concave |
| Extent of bank erosion | none | none to low | moderate | low |
| Aquatic Plant cover in water | low | moderate | high | high |
| Aquatic plant cover on banks | low | low | low | low |
| Physical in-stream habitat features | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 5–25% cover trailing bank vegetation | individual branches, individual logs and log jams, terrestrial leaves and twigs, 5% cover trailing bank vegetation | individual branches, sparce terrestrial leaves and twigs, individual logs, 25% cover trailing vegetation | individual branches, sparce terrestrial leaves and twigs, individual logs, 50% cover trailing vegetation, |
| In-stream barriers to aquatic fauna passage | dam wall downstream of site | dam wall downstream of site | dam wall downstream of site | dam wall downstream of site |
| Other disturbances | weeds, cleared vegetation | weeds, cleared vegetation | cleared vegetation, roads, weeds, cleared vegetation | weeds, cleared vegetation, access tracks |

| Site: US Lake | Years surveyed | |
|---|---|---|
| | August 2015 | October 2015 |
| **Photograph (upstream view)** |  |  |
| **Habitat features** | | |
| **Adjacent land use** | native forest, rural residential | native forest, residential |
| **Riparian vegetation cover** | low | low to moderate |
| **Dominant type of riparian vegetation** | grass, trees | grass, trees |
| **Mean wetted width (m)** | >30 m | 120 m |
| **Flow habitats** | connected pool | connected pool |
| **Mean water velocity (m/s)** | <0.1 m/s | 0.02 m/s |
| **Water level** | low | at watermark |
| **Bed substrate composition** | cobble (5%), pebble (5%), gravel (5%), sand (15%), silt/clay (70%) | sand (90%), silt/clay (10%) |
| **Stream bed stability** | stable | moderate aggradation |
| **Bank material** | sand, silt/clay | sand, silt |
| **Bank slope** | low to moderate | low |
| **Bank shape** | convex | concave |
| **Extent of bank erosion** | none to low | none |
| **Aquatic Plant cover in water** | low | moderate |
| **Aquatic plant cover on banks** | low | low |
| **Physical in-stream habitat features** | individual branches and logs, terrestrial leaves and twigs, 5–25% cover trailing bank vegetation | individual branches and logs, terrestrial leaves and twigs, 10–15% cover trailing bank vegetation |
| **In-stream barriers to aquatic fauna passage** | dam wall downstream of site | dam wall downstream of site |
| **Other disturbances** | cleared vegetation, weeds | cleared vegetation, weeds |

## Six Mile Creek – Upstream of Lake Macdonald

| Site: CU02 | Years surveyed | |
|---|---|---|
| | August 2015 | October 2015 |
| Photograph (upstream view) |  |  |
| Habitat features | | |
| Adjacent land use | native forest | native forest |
| Riparian vegetation cover | extensive | moderate to extensive |
| Dominant type of riparian vegetation | grass, trees | grass, trees |
| Mean wetted width (m) | 19 m | 13 m |
| Flow habitats | connected pool | connected pool |
| Mean water velocity (m/s) | <0.1 m/s | 0.01 m/s |
| Water level | low | at watermark |
| Bed substrate composition | gravel (5%), sand (10%), silt/clay (85%) | sand (20%), silt/clay (80%) |
| Stream bed stability | stable | moderate erosion |
| Bank material | silt | silt |
| Bank slope | low | low and steep |
| Bank shape | convex | concave, wide lower bench, undercut 20% |
| Extent of bank erosion | low | low |
| Aquatic Plant cover in water | low | moderate |
| Aquatic plant cover on banks | low | low |
| Physical in-stream habitat features | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 25–75% cover trailing bank vegetation | individual logs, terrestrial leaves and twigs, 25–50% cover trailing bank vegetation |
| In-stream barriers to aquatic fauna passage | nil | nil |
| Other disturbances | weeds | cleared vegetation, weeds |

| Site: CU01 | Years surveyed | |
|---|---|---|
| | August 2015 | October 2015 |
| Photograph (upstream view |  |  |
| Habitat features | | |
| Adjacent land use | native forest | native forest |
| Riparian vegetation cover | extensive | moderate |
| Dominant type of riparian vegetation | grass, trees | grass, trees |
| Mean wetted width (m) | 13 m | 13 m |
| Flow habitats | connected pool | connected pool |
| Mean water velocity (m/s) | <0.1 m/s | 0.01 m/s |
| Water level | low | at watermark |
| Bed substrate composition | pebble (5%), gravel (5%), sand (10%), silt/clay (80%) | sand (30%), silt/clay (70%) |
| Stream bed stability | moderate erosion | moderate erosion |
| Bank material | silt | silt |
| Bank slope | moderate | steep to vertical |
| Bank shape | convex, concave and undercut 60% | wide lower bench, undercut 60% |
| Extent of bank erosion | low | moderate |
| Aquatic Plant cover in water | low | moderate |
| Aquatic plant cover on banks | low | low |
| Physical in-stream habitat features | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 75% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 15–25% cover trailing bank vegetation |
| In-stream barriers to aquatic fauna passage | nil | nil |
| Other disturbances | weeds, access tracks, erosion | cleared vegetation, access tracks, weeds |

| Site: CU03 | Years surveyed | |
|---|---|---|
| | August 2015 | October 2015 |
| **Photograph (upstream view)** |  |  |
| **Habitat features** | | |
| **Adjacent land use** | native forest, rural | native forest, residential, recreational park |
| **Riparian vegetation cover** | moderate to extensive | extensive |
| **Dominant type of riparian vegetation** | grass, shrubs, trees | shrubs, trees |
| **Mean wetted width (m)** | 9 m | 10 m |
| **Flow habitats** | connected pool | connected pool |
| **Mean water velocity (m/s)** | 0.1 m/s | 0.01 m/s |
| **Water level** | low | at watermark |
| **Bed substrate composition** | pebble (5%), gravel (10%), sand (25%), silt/clay (60%) | sand (30%), silt/clay (70%) |
| **Stream bed stability** | moderate aggradation | moderate aggradation |
| **Bank material** | sand, silt | sand, silt |
| **Bank slope** | low to moderate | low and steep |
| **Bank shape** | convex | concave and undercut 10–30% |
| **Extent of bank erosion** | moderate | low |
| **Aquatic Plant cover in water** | high | moderate |
| **Aquatic plant cover on banks** | high | moderate |
| **Physical in-stream habitat features** | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 25% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 25% cover trailing bank vegetation |
| **In-stream barriers to aquatic fauna passage** | nil | nil |
| **Other disturbances** | weeds, roads | cleared vegetation, roads |

– no data

| Site: SMCUS02 | Years surveyed | |
|---|---|---|
| | August 2015 | October 2015 |
| **Photograph (upstream view** |  |  |
| **Habitat features** | | |
| **Adjacent land use** | rural residential | native forest, park, recreation |
| **Riparian vegetation cover** | extensive | low to moderate |
| **Dominant type of riparian vegetation** | grass, shrubs, trees | grass, trees |
| **Mean wetted width (m)** | 24 m | 12 m |
| **Flow habitats** | connected pool | connected pool |
| **Mean water velocity (m/s)** | 0.1 m/s | – |
| **Water level** | low | at watermark |
| **Bed substrate composition** | gravel (5%, sand (15%), silt/clay (80%) | sand (20%), silt/clay (80%) |
| **Stream bed stability** | stable | moderate aggradation |
| **Bank material** | sand, silt/clay | silt |
| **Bank slope** | low | low |
| **Bank shape** | convex | concave |
| **Extent of bank erosion** | none | none |
| **Aquatic Plant cover in water** | high | moderate |
| **Aquatic plant cover on banks** | high | low |
| **Physical in-stream habitat features** | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 5–15% cover trailing bank vegetation | individual branches and logs, terrestrial leaves and twigs, 5–10% cover trailing bank vegetation |
| **In-stream barriers to aquatic fauna passage** | bridge | bridge |
| **Other disturbances** | cleared vegetation, weeds, roads | cleared vegetation, roads |

| Site: SMCUS01 | Years surveyed | | |
|---|---|---|---|
| | August 2015 | October 2015 | February 2018 |
| Photograph (upstream view) |  |  |  |
| **Habitat features** | | | |
| **Adjacent land use** | native forest | native forest, conservation | native vegetation, rainforest |
| **Riparian vegetation cover** | extensive | moderate | extensive |
| **Dominant type of riparian vegetation** | grass, shrubs, trees | shrubs, trees | shrubs, trees |
| **Mean wetted width (m)** | 7 m | 5 m | 8 m |
| **Flow habitats** | connected pool | connected pool | connected pool, riffle |
| **Mean water velocity (m/s)** | <0.1 m/s | 0.01 m/s | no flow |
| **Water level** | low | at watermark | high |
| **Bed substrate composition** | gravel (5%), sand (25%), silt/clay (70%) | sand (40%), silt/clay (60%) | gravel (5%), sand (75%), silt/clay (20%) |
| **Stream bed stability** | stable | moderate aggradation | stable |
| **Bank material** | sand, silt | sand, silt | sand, silt/clay |
| **Bank slope** | moderate | vertical | moderate to vertical |
| **Bank shape** | convex and undercut 30% | undercut 60–70% | 25% undercut, convex to concave |
| **Extent of bank erosion** | low | moderate | some |
| **Aquatic Plant cover in water** | none | moderate | none |
| **Aquatic plant cover on banks** | low | low | low |
| **Physical in-stream habitat features** | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 50% cover trailing bank vegetation | individual branches and branch piles, individual logs and log jams, terrestrial leaves and twigs, 15% cover trailing bank vegetation | individual branches and branch piles, sparce terrestrial leaves and twigs, individual logs and log jams, 90% cover trailing bank vegetation, limited basking spots and nesting habitat for turtles |
| **In-stream barriers to aquatic fauna passage** | nil | nil | pipe culvert upstream |
| **Other disturbances** | weeds | nil | access tracks and roads |

| Site: SMCUS03 | Years surveyed | |
|---|---|---|
| | August 2015 | October 2015 |
| Photograph (upstream view |  |  |
| Habitat features | | |
| Adjacent land use | rural residential | native forest, residential |
| Riparian vegetation cover | extensive | moderate |
| Dominant type of riparian vegetation | shrubs, trees, ferns | shrubs, trees |
| Mean wetted width (m) | 10 m | 8 m |
| Flow habitats | connected pool | connected pool, riffle, run |
| Mean water velocity (m/s) | <0.1 m/s | 0.05 m/s |
| Water level | low | at watermark |
| Bed substrate composition | boulder (2%), cobble (3%), pebble (10%), gravel (15%), sand (50%), silt/clay (20%) | pebble (20%), gravel (50%), sand (20%), silt/clay (10%) |
| Stream bed stability | stable | moderate erosion |
| Bank material | sand, silt/clay | sand, silt |
| Bank slope | moderate to steep | vertical |
| Bank shape | convex | undercut 90% |
| Extent of bank erosion | low | moderate |
| Aquatic Plant cover in water | none | none |
| Aquatic plant cover on banks | low | low |
| Physical in-stream habitat features | individual branches and logs, terrestrial leaves and twigs, 10% cover trailing bank vegetation | individual branches and logs, terrestrial leaves and twigs, 25–50% cover trailing bank vegetation |
| In-stream barriers to aquatic fauna passage | culvert | culvert |
| Other disturbances | cleared vegetation, roads | nil |

# Appendix D Summary of Seqwater Water Quality Monitoring Data for Lake Macdonald

Water quality monitoring data collected by Seqwater was collated and summarised for:

- Lake Macdonald at the dam wall
- Lake Macdonald, mid lake
- Lake Macdonald, Six Mile Creek Arm
- Cooroy Creek at Cooroy-Noosa Road, and
- Lake Macdonald tailwater.

## Lake Macdonald – Dam Wall

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| **Physico-Chemical** | | | | | | | | | | | | | | | | |
| Temperature - Field | °C | – | 121 | 14.9 | 20.1 | 23.3 | 26.5 | 29 | 31.9 | 6 | 18.5 | 19.4 | 25.15 | 27.3 | 27.75 | 27.9 |
| pH - Field | pH unit | 6.5-8.0 | 32 | 6.4 | 6.7 | 7.07 | 7.512 | 7.972 | 9.28 | 6 | 6.5 | 6.6 | 6.6 | 6.7 | 6.85 | 6.9 |
| pH - Lab | ph Unit | 6.5-8.0 | 129 | 6.2 | 6.7 | 6.8 | 6.9 | 7.1 | 8.9 | 1 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 |
| Conductivity - Field | µS/cm | 626 | 28 | 69 | 106.2 | 117 | 131 | 137.3 | 143 | 2 | 57 | 61 | 67 | 73 | 76 | 77 |
| Conductivity | µS/cm | 626 | 133 | 33 | 82 | 100 | 124.6 | 140 | 178 | 5 | 29 | 45.8 | 57 | 72 | 111 | 124 |
| Dissolved Oxygen - Field | mg/L | – | 121 | 3.4 | 4.5 | 5.8 | 7.4 | 8.19 | 8.9 | 6 | 1.8 | 2.8 | 4.3 | 5.2 | 5.65 | 5.8 |
| Dissolved Oxygen - Field | % Saturation | 85-110 | 26 | 60.3 | 77.2 | 85.3 | 93 | 98.675 | 108.5 | 0 | – | – | – | – | – | – |
| Turbidity - Field | NTU | 50 | 26 | 1.2 | 2.76 | 3.6 | 4.3 | 7.15 | 10 | 0 | – | – | – | – | – | – |
| Turbidity - Lab | NTU | 50 | 130 | 1.6 | 2.6 | 3.35 | 4.4 | 7.865 | 14 | 7 | 2.9 | 4.12 | 4.6 | 9.8 | 12.4 | 13 |
| Suspended Solids | mg/L | 6 | 160 | 1 | 2.5 | 4 | 5 | 10.05 | 40 | 81 | 1 | 4 | 5 | 6 | 8 | 17 |
| Total Dissolved Solids | mg/L | – | 0 | – | – | – | – | – | – | 2 | 70 | 73.6 | 79 | 84.4 | 87.1 | 88 |
| Alkalinity - Total | mg/L | – | 0 | – | – | – | – | – | – | 1 | 9 | 9 | 9 | 9 | 9 | 9 |
| BGA - Field | cells/mL | – | 1 | 279384 | 279384 | 279384 | 279384 | 279384 | 279384 | 0 | – | – | – | – | – | – |
| BGA - Field | RFU | – | 1 | 132.8 | 132.8 | 132.8 | 132.8 | 132.8 | 132.8 | 0 | – | – | – | – | – | – |
| Eutrophic Depth | mg/L | – | 5 | 0.6 | 0.84 | 1 | 1 | 1 | 1 | 0 | – | – | – | – | – | – |
| Redox Potential | MV | – | 6 | 54.6 | 57.7 | 131.9 | 153.3 | 160.65 | 163.1 | 0 | – | – | – | – | – | – |
| SUVA | L/mg-M | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| **Nutrients** | | | | | | | | | | | | | | | | |
| Total Nitrogen as N | mg/L | 0.5 | 162 | 0 | 0.41 | 0.52 | 0.82 | 1.1 | 2.43 | 88 | 0.09 | 0.39 | 0.48 | 0.59 | 0.8165 | 1.08 |
| Total Dissolved Nitrogen | mg/L | – | 1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 67 | 0.09 | 0.3 | 0.39 | 0.46 | 0.709 | 0.8 |
| Kjeldahl Nitrogen as N | mg/L | – | 83 | 0 | 0.4 | 0.51 | 0.8 | 1.1 | 2.4 | 1 | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 |
| Total Oxidised N | mg/L | 0.06 | 135 | 0 | 0.0029 | 0.027 | 0.05 | 0.122 | 0.986 | 81 | 0.001 | 0.001 | 0.002 | 0.011 | 0.043 | 0.2 |
| Nitrate as N | mg/L | 0.7 | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 43 | 0.001 | 0.001 | 0.001 | 0.0106 | 0.0523 | 0.19 |
| Nitrite as N | mg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 43 | 0.001 | 0.001 | 0.001 | 0.004 | 0.0109 | 0.011 |
| Organic Nitrogen | mg/L | 0.42 | 120 | 0 | 0.388 | 0.57 | 0.832 | 1.07 | 2.33 | 0 | – | – | – | – | – | – |
| Ammonia - Total as N | mg/L | 0.02 | 135 | 0 | 0.0025 | 0.02 | 0.05 | 0.09 | 0.181 | 81 | 0.0025 | 0.007 | 0.023 | 0.07 | 0.1 | 0.795 |
| Total Phosphorus | mg/L | 0.05 | 161 | 0 | 0.014 | 0.02 | 0.04 | 0.057 | 0.27 | 87 | 0.0025 | 0.017 | 0.022 | 0.0328 | 0.0444 | 0.079 |
| Total Dissolved Phosphorus | mg/L | – | 1 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 67 | 0.0025 | 0.006 | 0.01 | 0.015 | 0.025 | 0.049 |
| Filterable Reactive Phosphorus | mg/L | 0.02 | 129 | 0 | 0.0016 | 0.004 | 0.01 | 0.029 | 0.18 | 75 | 0.0005 | 0.0005 | 0.002 | 0.0052 | 0.008 | 0.011 |
| Phosphate | mg/L | – | 5 | 0.0025 | 0.0025 | 0.0025 | 0.0038 | 0.0077 | 0.009 | 5 | 0.0025 | 0.0025 | 0.0025 | 0.0036 | 0.0069 | 0.008 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| **Other Organics** | | | | | | | | | | | | | | | | |
| DOC | mg/L | – | 0 | – | – | – | – | – | – | 74 | 3.8 | 5.6 | 6.3 | 8.24 | 10 | 11.1 |
| TOC | mg/L | – | 0 | – | – | – | – | – | – | 74 | 3.8 | 6 | 6.8 | 8.34 | 10.07 | 13.1 |
| **Major Cations & Anions** | | | | | | | | | | | | | | | | |
| Fluoride - Total | mg/L | – | 0 | – | – | – | – | – | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Chloride | mg/L | – | 0 | – | – | – | – | – | – | 1 | 21 | 21 | 21 | 21 | 21 | 21 |
| Magnesium - Total | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Silica - Reactive as SiO3 | mg/L | – | 0 | – | – | – | – | – | – | 53 | 0.34 | 1.592 | 3.54 | 5.844 | 7.464 | 8.49 |
| Sulphide | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Sulphur-Total | mg/L | – | 0 | – | – | – | – | – | – | 6 | 2 | 3 | 3.5 | 4 | 6.25 | 7 |
| **Total Metals** | | | | | | | | | | | | | | | | |
| Aluminium | µg/L | 55 | 1 | 41 | 41 | 41 | 41 | 41 | 41 | 13 | 7 | 19 | 31 | 176.6 | 431.2 | 676 |
| Antimony | µg/L | – | 0 | – | – | – | – | – | – | 14 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Arsenic | µg/L | 13 | 0 | – | – | – | – | – | – | 13 | 0.25 | 0.25 | 0.5 | 0.6 | 0.78 | 0.9 |
| Barium | µg/L | – | 0 | – | – | – | – | – | – | 13 | 6 | 7 | 9 | 12.4 | 20.94 | 24 |
| Beryllium | µg/L | – | 0 | – | – | – | – | – | – | 13 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Boron | µg/L | 370 | 0 | – | – | – | – | – | – | 13 | 15 | 15 | 15 | 15 | 15 | 15 |
| Cadmium | µg/L | 0.2 | 0 | – | – | – | – | – | – | 13 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Chromium | µg/L | 1 | 0 | – | – | – | – | – | – | 13 | 0.5 | 0.5 | 0.5 | 0.5 | 0.7 | 1 |
| Cobalt | µg/L | – | 0 | – | – | – | – | – | – | 12 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Copper | µg/L | 1.4 | 0 | – | – | – | – | – | – | 13 | 0.5 | 0.5 | 0.5 | 1 | 1.4 | 2 |
| Iron | µg/L | – | 15 | 359 | 543 | 1100 | 1440 | 1857 | 2025 | 78 | 189 | 622.4 | 1000 | 1568 | 2151.5 | 7670 |
| Lead | µg/L | 3.4 | 0 | – | – | – | – | – | – | 13 | 0.5 | 0.5 | 0.5 | 0.5 | 1.9 | 4 |
| Lithium | µg/L | – | 0 | – | – | – | – | – | – | 12 | 0.5 | 0.5 | 0.5 | 0.9 | 1 | 1 |
| Manganese | µg/L | 1900 | 81 | 9 | 16 | 52 | 130 | 174 | 209 | 78 | 43 | 90.34 | 137.5 | 209.6 | 326.2 | 1750 |
| Mercury | µg/L | 0.06 | 0 | – | – | – | – | – | – | 14 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Molybdenum | µg/L | 11 | 0 | – | – | – | – | – | – | 13 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Nickel | µg/L | – | 0 | – | – | – | – | – | – | 13 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Selenium | µg/L | 5 | 0 | – | – | – | – | – | – | 14 | 1 | 1 | 1 | 1 | 1 | 1 |
| Silver | µg/L | 0.05 | 0 | – | – | – | – | – | – | 13 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Strontium | µg/L | – | 0 | – | – | – | – | – | – | 12 | 12 | 18 | 19.5 | 22 | 24.35 | 26 |
| Thorium | µg/L | – | 0 | – | – | – | – | – | – | 12 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Tin | µg/L | – | 0 | – | – | – | – | – | – | 12 | 0.5 | 0.5 | 0.5 | 0.5 | 3.875 | 8 |
| Uranium | µg/L | – | 0 | – | – | – | – | – | – | 13 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Vanadium | µg/L | – | 0 | – | – | – | – | – | – | 12 | 5 | 5 | 5 | 5 | 5 | 5 |
| Zinc | µg/L | 8 | 0 | – | – | – | – | – | – | 13 | 2.5 | 2.5 | 2.5 | 7.8 | 24.2 | 38 |
| **Soluble Metals** | | | | | | | | | | | | | | | | |
| Aluminium | µg/L | 55 | 7 | 2.5 | 7 | 11 | 42.6 | 56.2 | 61 | 6 | 2.5 | 2.5 | 12 | 40 | 91 | 108 |
| Arsenic | µg/L | 13 | 0 | – | – | – | – | – | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Barium | µg/L | – | 0 | – | – | – | – | – | – | 1 | 5.8 | 5.8 | 5.8 | 5.8 | 5.8 | 5.8 |
| Beryllium | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Boron | µg/L | 370 | 0 | – | – | – | – | – | – | 1 | 15 | 15 | 15 | 15 | 15 | 15 |
| Cadmium | µg/L | 0.2 | 0 | – | – | – | – | – | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Chromium | µg/L | 1 | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Cobalt | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Copper | µg/L | 1.4 | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Iron | µg/L | – | 16 | 52 | 147 | 354 | 566 | 765 | 930 | 80 | 55 | 199 | 432 | 771.4 | 1321 | 6410 |
| Lead | µg/L | 3.4 | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Lithium | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Manganese | µg/L | 1900 | 81 | 0 | 5 | 10 | 25 | 81 | 104 | 80 | 1 | 6 | 18.6 | 60.6 | 153.4 | 1740 |
| Molybdenum | µg/L | 11 | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Nickel | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Silver | µg/L | 0.05 | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Strontium | µg/L | – | 0 | – | – | – | – | – | – | 1 | 19 | 19 | 19 | 19 | 19 | 19 |
| Thorium | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Tin | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Uranium | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Vanadium | µg/L | – | 0 | – | – | – | – | – | – | 1 | 5 | 5 | 5 | 5 | 5 | 5 |
| Zinc | µg/L | 8 | 0 | – | – | – | – | – | – | 1 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| **Algae** | | | | | | | | | | | | | | | | |
| Chlorophyll a - Field | µg/L | 5 | 1 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 10.8 | 0 | – | – | – | – | – | – |
| Chlorophyll a | µg/L | 5 | 132 | 0 | 6 | 10 | 14 | 20 | 37 | 6 | 9.1 | 11 | 16 | 18 | 20.25 | 21 |
| **Microbiological** | | | | | | | | | | | | | | | | |
| Cryptosporidium - Corrected | MPN/100mL | – | 5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | – | – | – | – | – | – |
| Cryptosporidium - Detected | MPN/100mL | – | 18 | 0.5 | 0.5 | 0.5 | 0.5 | 1.0375 | 1.25 | 0 | – | – | – | – | – | – |
| E.coli - Colilert | MPN/100mL | – | 77 | 0.5 | 1.2 | 3 | 9 | 16.2 | 170 | 0 | – | – | – | – | – | – |
| E.coli - MF | MPN/100mL | – | 2 | 8 | 17.8 | 32.5 | 47.2 | 54.55 | 57 | 0 | – | – | – | – | – | – |
| Enterococci - MF | MPN/100mL | – | 79 | 0.5 | 0.5 | 2 | 4 | 23.5 | 440 | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Giardia - Corrected | MPN/100mL | – | 5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | – | – | – | – | – | – |
| Giardia - Detected | MPN/100mL | – | 19 | 0.5 | 0.5 | 0.5 | 0.7 | 3.625 | 25 | 0 | – | – | – | – | – | – |
| Total Coliforms - Colilert | MPN/100mL | – | 74 | 140 | 452 | 690 | 1600 | 2335 | 3100 | 0 | – | – | – | – | – | – |
| **Pesticide** | | | | | | | | | | | | | | | | |
| 2.4-D | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4-DB | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4-DP | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4.5-T | µg/L | 36 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4.6-T | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 2.6-D | µg/L | 280 | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 3-Hydroxy Carbofuran | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| 4-Chlorophenoxy acetic acid | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 4.4-DDD (pp-DDD) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 4.4-DDE (pp-DDE) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 4.4-DDT (pp-DDT) | µg/L | 0.006 | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Acrolein | µg/L | – | 0 | – | – | – | – | – | – | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Aldicarb | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Aldrin (Eldrin) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| alpha-BHC (lindane) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Ametryn | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Amitrole | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| AMPA | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Asulam | µg/L | – | 0 | – | – | – | – | – | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Atrazine | µg/L | 13 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Azinphos methyl | µg/L | 0.01 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Azinphos-ethyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Bendiocarb | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Benomyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.006 | 0.0075 | 0.009 | 0.00975 | 0.01 |
| beta-BHC (lindane) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Bioresmethrin | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Brodifacoum | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Bromacil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Bromophos-ethyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Bromoxynil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Carbaryl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Carbofuran | µg/L | 0.06 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Carbophenothion | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chlordane - Total | µg/L | 0.03 | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Chlorfenvinphos - Total | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chlorothalonil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Chlorpyrifos | µg/L | 0.01 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chlorpyrifos-methyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Chlorsulfuron | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| cis-Chlordane | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Clopyralid | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Coumaphos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Cyanazine | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Cyproconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Cyprodinil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Cyromazine | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| delta-BHC | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Demeton-O & Demeton-S | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Demeton-S methyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Diazinon | µg/L | 0.01 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Dicamba | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Dichlorvos (DDVP) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Diclofop-methyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Dieldrin | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Difenoconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Diflufenican | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Dimethoate | µg/L | 0.15 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Diquat | µg/L | 1.4 | 0 | – | – | – | – | – | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Disulfoton | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Diuron | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Endosulfan - Total | µg/L | 0.03 | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan I (alpha isomer) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan II (beta isomer) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan sulfate | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Endrin | µg/L | 0.01 | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endrin aldehyde | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endrin ketone | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| EPN | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Ethion | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Ethoprophos (Prophos) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fenamiphos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fenarimol | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fenchlorphos (Ronnel) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 5 | 5 | 5 | 5 | 5 | 5 |
| Fenitrothion | µg/L | 0.2 | 0 | – | – | – | – | – | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Fensulphothion | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fenthion | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Fenvalerate & Esfenvalerate | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Fipronil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fluometuron | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fluroxypyr | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Flusilazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Glyphosate | µg/L | 370 | 0 | – | – | – | – | – | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Heptachlor | µg/L | 0.01 | 0 | – | – | – | – | – | – | 2 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 |
| Heptachlor epoxide | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Hexachlorobenzene (HCB) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Hexazinone | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Iprodione | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Irgarol | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Lindane (gamma-BHC) | µg/L | 0.2 | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Malathion (Maldison) | µg/L | 0.05 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| MCPA | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| MCPB | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Mecoprop | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Methiocarb | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Methomyl | µg/L | 3.5 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Methoxychlor | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Metolachlor | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Metribuzin | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Metsulfuron-methyl | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Mevinphos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Molinate | µg/L | 3.4 | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Monocrotophos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Omethoate | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Oryzalin | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Oxamyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Oxychlordane | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Oxyfluorfen | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Paclobutrazol | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Paraquat | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Parathion | µg/L | 0.004 | 0 | – | – | – | – | – | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Parathion-methyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Penconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Pendimethalin | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Permethrin | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Phorate | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Picloram | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Piperonyl Butoxide | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Pirimiphos-ethyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Pirimiphos-methyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Profenofos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Prometryn | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Propazine | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Propiconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Prothiophos (Tokuthion) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Pyrimethanil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Silvex (2,4,5-TP/Fenoprop) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Simazine | µg/L | 3.2 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Sulprofos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Sum of DDD + DDE + DDT | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Tebuconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Tebuthiuron | µg/L | 2.2 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Temephos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Terbufos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Terbuthylazine | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Terbutryn | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Tetrachlorvinphos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Tetraethyl dithiopyrophos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Thiamethoxam | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Thiobencarb | µg/L | 2.8 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Thiodicarb | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| trans-Chlordane | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Triazophos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Trichlorfon | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Trichloronate (Trichloronat) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Triclopyr | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Trifluralin | µg/L | 2.6 | 0 | – | – | – | – | – | – | 2 | 5 | 5 | 5 | 5 | 5 | 5 |
| **Polyaromatic Hydrocarbon** | | | | | | | | | | | | | | | | |
| 2-Chloronaphthalene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 2-Methylnapthalene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Acenaphthene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Acenapthylene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Anthracene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[a]anthracene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[a]pyrene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Benzo[b+j]fluoranthene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[e]pyrene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Benzo[ghi]perylene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[k]fluoranthene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chrysene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Dibenzo[ah]anthracene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fluoranthene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fluorene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Indeno(1.2.3-cd)pyrene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Napthalene | µg/L | 16 | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Perylene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Phenanthrene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Pyrene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Total PAH | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| **Taste and Colour** | | | | | | | | | | | | | | | | |
| 2-Methylisoborneol | ng/L | – | 0 | – | – | – | – | – | – | 66 | 1 | 3.1 | 11.7 | 20.3 | 24.325 | 33.4 |
| 2-methylisoborneol + Geosmin | ng/L | – | 0 | – | – | – | – | – | – | 28 | 2.1 | 4.68 | 12.05 | 15.68 | 22.64 | 24.2 |
| Geosmin | ng/L | – | 0 | – | – | – | – | – | – | 66 | 1 | 1 | 2.1 | 4.2 | 7.6 | 19.1 |
| **Volatile Organic Compound** | | | | | | | | | | | | | | | | |
| Benzene | µg/L | 950 | 0 | – | – | – | – | – | – | 3 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Toluene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Ethylbenzene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| meta & para-Xylene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ortho-Xylene | µg/L | 350 | 0 | – | – | – | – | – | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Total Xylenes | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Hexaconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

Grey shading denotes parameters that exceed the water quality object / trigger value

Gold shading denotes parameters that have an LOR higher than the water quality objective / trigger value

## Lake Macdonald Mid Lake

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| **Physico-Chemical** | | | | | | | | | | | | | | | | |
| Temperature - Field | °C | – | 40 | 16.37 | 19.752 | 23.985 | 27.32 | 28.905 | 30 | 0 | – | – | – | – | – | – |
| pH - Field | pH unit | 6.5-8.0 | 32 | 6.43 | 6.7 | 7 | 7.332 | 7.79 | 7.9 | 0 | – | – | – | – | – | – |
| pH - Lab | ph Unit | 6.5-8.0 | 128 | 6.4 | 6.7 | 6.8 | 6.9 | 7.165 | 8.9 | 0 | – | – | – | – | – | – |
| Conductivity - Field | µS/cm | 626 | 28 | 63 | 106 | 116.5 | 128.6 | 137.3 | 143 | 0 | – | – | – | – | – | – |
| Conductivity | µS/cm | 626 | 132 | 35 | 81 | 100 | 124 | 143.6 | 192 | 0 | – | – | – | – | – | – |
| Dissolved Oxygen - Field | mg/L | – | 40 | 4.9 | 6.34 | 7.64 | 8.46 | 9.14 | 9.28 | 0 | – | – | – | – | – | – |
| Dissolved Oxygen - Field | % Saturation | 85-110 | 26 | 71.1 | 88.2 | 93.3 | 99.3 | 103.8 | 107.1 | 0 | – | – | – | – | – | – |
| Turbidity - Field | NTU | 50 | 26 | 1.6 | 2.3 | 3.05 | 4 | 7.375 | 10.4 | 0 | – | – | – | – | – | – |
| Turbidity - Lab | NTU | 50 | 129 | 1.3 | 2.5 | 3.4 | 4.24 | 7.9 | 20.4 | 0 | – | – | – | – | – | – |
| Suspended Solids | mg/L | 6 | 135 | 0 | 2 | 3 | 4 | 8 | 13 | 67 | 1 | 3.2 | 5 | 6.8 | 8.7 | 20 |
| Total Dissolved Solids | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Alkalinity - Total | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| BGA - Field | cells/mL | – | 1 | 279400 | 279400 | 279400 | 279400 | 279400 | 279400 | 0 | – | – | – | – | – | – |
| BGA - Field | RFU | – | 1 | 132.8 | 132.8 | 132.8 | 132.8 | 132.8 | 132.8 | 0 | – | – | – | – | – | – |
| Eutrophic Depth | mg/L | – | 5 | 0.6 | 0.84 | 1.1 | 1.12 | 1.18 | 1.2 | 0 | – | – | – | – | – | – |
| Redox Potential | MV | – | 6 | 45.1 | 49.5 | 76.65 | 135.9 | 150.975 | 156 | 0 | – | – | – | – | – | – |
| SUVA | L/mg-M | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| **Nutrients** | | | | | | | | | | | | | | | | |
| Total Nitrogen as N | mg/L | 0.5 | 137 | 0 | 0.412 | 0.6 | 0.868 | 1.2 | 2.11 | 76 | 0.09 | 0.37 | 0.475 | 0.58 | 0.7625 | 0.91 |
| Total Dissolved Nitrogen | mg/L | – | 3 | 0.3 | 0.336 | 0.39 | 0.42 | 0.435 | 0.44 | 64 | 0.07 | 0.29 | 0.4 | 0.46 | 0.62 | 0.76 |
| Kjeldahl Nitrogen as N | mg/L | – | 81 | 0 | 0.4 | 0.6 | 0.8 | 1.2 | 2.1 | 1 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| Total Oxidised N | mg/L | 0.06 | 136 | 0 | 0.0025 | 0.021 | 0.047 | 0.13475 | 0.945 | 70 | 0.001 | 0.001 | 0.001 | 0.01 | 0.03875 | 0.066 |
| Nitrate as N | mg/L | 0.7 | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 41 | 0.001 | 0.001 | 0.001 | 0.007 | 0.039 | 0.061 |
| Nitrite as N | mg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 41 | 0.001 | 0.001 | 0.001 | 0.004 | 0.008 | 0.011 |
| Organic Nitrogen | mg/L | 0.42 | 119 | 0 | 0.39 | 0.6 | 0.82 | 1.068 | 2.06 | 0 | – | – | – | – | – | – |
| Ammonia - Total as N | mg/L | 0.02 | 136 | 0 | 0.0025 | 0.0125 | 0.03 | 0.07 | 0.091 | 70 | 0.0025 | 0.0025 | 0.0155 | 0.0504 | 0.0762 | 0.12 |
| Total Phosphorus | mg/L | 0.05 | 136 | 0 | 0.01 | 0.02 | 0.04 | 0.06325 | 0.2 | 76 | 0.0025 | 0.017 | 0.022 | 0.034 | 0.054 | 0.262 |
| Total Dissolved Phosphorus | mg/L | – | 3 | 0.006 | 0.0076 | 0.01 | 0.0124 | 0.0136 | 0.014 | 63 | 0.0025 | 0.006 | 0.01 | 0.0156 | 0.0227 | 0.043 |
| Filterable Reactive Phosphorus | mg/L | 0.02 | 130 | 0 | 0.001 | 0.005 | 0.008 | 0.0231 | 0.09 | 70 | 0.0005 | 0.0005 | 0.002 | 0.005 | 0.0101 | 0.017 |
| Phosphate | mg/L | – | 5 | 0.0025 | 0.0025 | 0.0025 | 0.0038 | 0.0077 | 0.009 | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| **Other Organics** | | | | | | | | | | | | | | | | |
| DOC | mg/L | – | 2 | 5.4 | 5.54 | 5.75 | 5.96 | 6.065 | 6.1 | 69 | 3.9 | 5.5 | 6.3 | 8.54 | 9.64 | 10 |
| TOC | mg/L | – | 2 | 5.4 | 5.72 | 6.2 | 6.68 | 6.92 | 7 | 69 | 3.9 | 5.9 | 6.8 | 8.7 | 10 | 10.5 |
| **Major Cations & Anions** | | | | | | | | | | | | | | | | |
| Fluoride - Total | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chloride | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Magnesium - Total | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Silica - Reactive as SiO3 | mg/L | – | 2 | 4.24 | 4.632 | 5.22 | 5.808 | 6.102 | 6.2 | 47 | 0.45 | 2.554 | 3.67 | 5.488 | 7.777 | 9.59 |
| Sulphide | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Sulphur-Total | mg/L | – | 0 | – | – | – | – | – | – | 4 | 2 | 2.6 | 3 | 3.4 | 3.85 | 4 |
| **Total Metals** | | | | | | | | | | | | | | | | |
| Aluminium | µg/L | 55 | 0 | – | – | – | – | – | – | 11 | 7 | 12 | 29 | 99 | 741.5 | 996 |
| Antimony | µg/L | – | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Arsenic | µg/L | 13 | 0 | – | – | – | – | – | – | 11 | 0.25 | 0.25 | 0.6 | 0.6 | 0.7 | 0.8 |
| Barium | µg/L | – | 0 | – | – | – | – | – | – | 11 | 4 | 6 | 7.2 | 10.9 | 48.05 | 75 |
| Beryllium | µg/L | – | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Boron | µg/L | 370 | 0 | – | – | – | – | – | – | 11 | 15 | 15 | 15 | 15 | 15 | 15 |
| Cadmium | µg/L | 0.2 | 0 | – | – | – | – | – | – | 11 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Chromium | µg/L | 1 | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 1.25 | 2 |
| Cobalt | µg/L | – | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Copper | µg/L | 1.4 | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 1 | 1.5 | 2 |
| Iron | µg/L | – | 3 | 247 | 509 | 902 | 966.8 | 999.2 | 1010 | 67 | 340 | 754 | 1100 | 1628 | 2267 | 2930 |
| Lead | µg/L | 3.4 | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Lithium | µg/L | – | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 1 | 1.05 | 1.1 |
| Manganese | µg/L | 1900 | 5 | 45 | 52.2 | 100 | 108.4 | 115.6 | 118 | 67 | 41 | 88.48 | 130 | 230.6 | 341.5 | 642 |
| Mercury | µg/L | 0.06 | 0 | – | – | – | – | – | – | 11 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Molybdenum | µg/L | 11 | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Nickel | µg/L | – | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Selenium | µg/L | 5 | 0 | – | – | – | – | – | – | 11 | 1 | 1 | 1 | 1 | 1 | 1 |
| Silver | µg/L | 0.05 | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Strontium | µg/L | – | 0 | – | – | – | – | – | – | 11 | 13 | 18 | 19 | 21 | 33 | 44 |
| Thorium | µg/L | – | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Tin | µg/L | – | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Uranium | µg/L | – | 0 | – | – | – | – | – | – | 11 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Vanadium | µg/L | – | 0 | – | – | – | – | – | – | 11 | 5 | 5 | 5 | 5 | 5 | 5 |
| Zinc | µg/L | 8 | 0 | – | – | – | – | – | – | 11 | 2.5 | 2.5 | 2.5 | 2.5 | 6.25 | 10 |
| **Soluble Metals** | | | | | | | | | | | | | | | | |
| Aluminium | µg/L | 55 | 0 | – | – | – | – | – | – | 5 | 2.5 | 2.5 | 2.5 | 30.2 | 113.3 | 141 |
| Arsenic | µg/L | 13 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Barium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Beryllium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Boron | µg/L | 370 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Cadmium | µg/L | 0.2 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chromium | µg/L | 1 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Cobalt | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Copper | µg/L | 1.4 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Iron | µg/L | – | 3 | 59 | 192.6 | 393 | 691.2 | 840.3 | 890 | 67 | 60 | 225.4 | 450 | 842.8 | 1249 | 1840 |
| Lead | µg/L | 3.4 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Lithium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Manganese | µg/L | 1900 | 5 | 2.1 | 2.9 | 5 | 44.4 | 48.6 | 50 | 67 | 0.5 | 7.52 | 25 | 75.56 | 233.4 | 582 |
| Molybdenum | µg/L | 11 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Nickel | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Silver | µg/L | 0.05 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Strontium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Thorium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Tin | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Uranium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Vanadium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Zinc | µg/L | 8 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| **Algae** | | | | | | | | | | | | | | | | |
| Chlorophyll a - Field | µg/L | 5 | 1 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 | 0 | – | – | – | – | – | – |
| Chlorophyll a | µg/L | 5 | 134 | 0 | 6 | 9 | 12 | 18 | 36 | 0 | – | – | – | – | – | – |
| **Microbiological** | | | | | | | | | | | | | | | | |
| Cryptosporidium - Corrected | MPN/100mL | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Cryptosporidium - Detected | MPN/100mL | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| E.coli - Colilert | MPN/100mL | – | 78 | 0.5 | 1 | 3 | 7.6 | 16.6 | 550 | 0 | – | – | – | – | – | – |
| E.coli - MF | MPN/100mL | – | 2 | 6 | 8 | 11 | 14 | 15.5 | 16 | 0 | – | – | – | – | – | – |
| Enterococci - MF | MPN/100mL | – | 80 | 0.5 | 0.5 | 1 | 3 | 10 | 320 | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Giardia - Corrected | MPN/100mL | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Giardia - Detected | MPN/100mL | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Total Coliforms - Colilert | MPN/100mL | – | 73 | 99 | 390 | 730 | 1360 | 1940 | 2400 | 0 | – | – | – | – | – | – |
| **Pesticide** | | | | | | | | | | | | | | | | |
| 2.4-D | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4-DB | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4-DP | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4.5-T | µg/L | 36 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4.6-T | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 2.6-D | µg/L | 280 | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 3-Hydroxy Carbofuran | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| 4-Chlorophenoxy acetic acid | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 4.4-DDD (pp-DDD) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 4.4-DDE (pp-DDE) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 4.4-DDT (pp-DDT) | µg/L | 0.006 | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Acrolein | µg/L | – | 0 | – | – | – | – | – | – | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Aldicarb | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Aldrin (Eldrin) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| alpha-BHC (lindane) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Ametryn | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Amitrole | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| AMPA | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Asulam | µg/L | – | 0 | – | – | – | – | – | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Atrazine | µg/L | 13 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Azinphos methyl | µg/L | 0.01 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Azinphos-ethyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Bendiocarb | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Benomyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.006 | 0.0075 | 0.009 | 0.00975 | 0.01 |
| beta-BHC (lindane) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Bioresmethrin | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Brodifacoum | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Bromacil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Bromophos-ethyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Bromoxynil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Carbaryl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Carbofuran | µg/L | 0.06 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Carbophenothion | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chlordane - Total | µg/L | 0.03 | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Chlorfenvinphos - Total | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chlorothalonil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Chlorpyrifos | µg/L | 0.01 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chlorpyrifos-methyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Chlorsulfuron | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| cis-Chlordane | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Clopyralid | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Coumaphos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Cyanazine | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Cyproconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Cyprodinil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Cyromazine | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| delta-BHC | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Demeton-O & Demeton-S | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Demeton-S methyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Diazinon | µg/L | 0.01 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Dicamba | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Dichlorvos (DDVP) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Diclofop-methyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Dieldrin | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Difenoconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Diflufenican | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Dimethoate | µg/L | 0.15 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Diquat | µg/L | 1.4 | 0 | – | – | – | – | – | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Disulfoton | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Diuron | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Endosulfan - Total | µg/L | 0.03 | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan I (alpha isomer) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan II (beta isomer) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan sulfate | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Endrin | µg/L | 0.01 | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endrin aldehyde | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endrin ketone | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| EPN | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Ethion | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Ethoprophos (Prophos) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fenamiphos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fenarimol | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fenchlorphos (Ronnel) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 5 | 5 | 5 | 5 | 5 | 5 |
| Fenitrothion | µg/L | 0.2 | 0 | – | – | – | – | – | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Fensulphothion | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fenthion | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Fenvalerate & Esfenvalerate | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Fipronil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fluometuron | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fluroxypyr | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Flusilazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Glyphosate | µg/L | 370 | 0 | – | – | – | – | – | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Heptachlor | µg/L | 0.01 | 0 | – | – | – | – | – | – | 2 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 |
| Heptachlor epoxide | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Hexachlorobenzene (HCB) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Hexazinone | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Iprodione | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Irgarol | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Lindane (gamma-BHC) | µg/L | 0.2 | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Malathion (Maldison) | µg/L | 0.05 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| MCPA | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| MCPB | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Mecoprop | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Methiocarb | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Methomyl | µg/L | 3.5 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Methoxychlor | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Metolachlor | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Metribuzin | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Metsulfuron-methyl | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Mevinphos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Molinate | µg/L | 3.4 | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Monocrotophos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Omethoate | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Oryzalin | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Oxamyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Oxychlordane | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Oxyfluorfen | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Paclobutrazol | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Paraquat | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Parathion | µg/L | 0.004 | 0 | – | – | – | – | – | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Parathion-methyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Penconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Pendimethalin | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Permethrin | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Phorate | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Picloram | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Piperonyl Butoxide | µg/L | – | 0 | – | – | – | – | – | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Pirimiphos-ethyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Pirimiphos-methyl | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Profenofos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Prometryn | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Propazine | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Propiconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Prothiophos (Tokuthion) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Pyrimethanil | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Silvex (2,4,5-TP/Fenoprop) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Simazine | µg/L | 3.2 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Sulprofos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Sum of DDD + DDE + DDT | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Tebuconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Tebuthiuron | µg/L | 2.2 | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Temephos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Terbufos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Terbuthylazine | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Terbutryn | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Tetrachlorvinphos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Tetraethyl dithiopyrophos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Thiamethoxam | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Thiobencarb | µg/L | 2.8 | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Thiodicarb | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| trans-Chlordane | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Triazophos | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Trichlorfon | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Trichloronate (Trichloronat) | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Triclopyr | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Trifluralin | µg/L | 2.6 | 0 | – | – | – | – | – | – | 2 | 5 | 5 | 5 | 5 | 5 | 5 |
| **Polyaromatic Hydrocarbon** | | | | | | | | | | | | | | | | |
| 2-Chloronaphthalene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 2-Methylnapthalene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Acenaphthene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Acenapthylene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Anthracene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[a]anthracene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[a]pyrene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Benzo[b+j]fluoranthene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[e]pyrene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Benzo[ghi]perylene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[k]fluoranthene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chrysene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Dibenzo[ah]anthracene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fluoranthene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fluorene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Indeno(1.2.3-cd)pyrene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Napthalene | µg/L | 16 | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Perylene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Phenanthrene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Pyrene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Total PAH | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| **Taste and Colour** | | | | | | | | | | | | | | | | |
| 2-Methylisoborneol | ng/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 2-methylisoborneol + Geosmin | ng/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Geosmin | ng/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| **Volatile Organic Compound** | | | | | | | | | | | | | | | | |
| Benzene | µg/L | 950 | 0 | – | – | – | – | – | – | 3 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Toluene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Ethylbenzene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| meta & para-Xylene | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ortho-Xylene | µg/L | 350 | 0 | – | – | – | – | – | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Total Xylenes | µg/L | – | 0 | – | – | – | – | – | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Hexaconazole | µg/L | – | 0 | – | – | – | – | – | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

Grey shading denotes parameters that exceed the water quality object / trigger value

Gold shading denotes parameters that have an LOR higher than the water quality objective / trigger value

## Six Mile Creek Arm

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| **Physico-Chemical** | | | | | | | | | | | | | | | | |
| Temperature - Field | °C | – | 24 | 14.3 | 17.8584 | 21.295 | 25.008 | 26.565 | 27.3 | 0 | – | – | – | – | – | – |
| pH - Field | pH unit | 6.5-8.0 | 24 | 6.07 | 6.5 | 6.88 | 7.278 | 7.7575 | 8 | 0 | – | – | – | – | – | – |
| pH - Lab | ph Unit | 6.5-8.0 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Conductivity - Field | µS/cm | 626 | 24 | 108 | 116.6 | 123 | 136.4 | 166.35 | 187 | 0 | – | – | – | – | – | – |
| Conductivity | µS/cm | 626 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Dissolved Oxygen - Field | mg/L | – | 24 | 2.17 | 4.728 | 5.815 | 7.212 | 8.2905 | 8.87 | 0 | – | – | – | – | – | – |
| Dissolved Oxygen - Field | % Saturation | 85-110 | 24 | 0.209 | 51.16 | 67.4 | 80.46 | 97.91 | 102.1 | 0 | – | – | – | – | – | – |
| Turbidity - Field | NTU | 50 | 24 | 1.2 | 2.16 | 3.75 | 6.168 | 16.51 | 25.2 | 0 | – | – | – | – | – | – |
| Turbidity - Lab | NTU | 50 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Suspended Solids | mg/L | 6 | 30 | 0.5 | 3 | 4 | 6 | 8 | 10 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |
| Total Dissolved Solids | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Alkalinity - Total | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| BGA - Field | cells/mL | – | 1 | 279400 | 279400 | 279400 | 279400 | 279400 | 279400 | 0 | – | – | – | – | – | – |
| BGA - Field | RFU | – | 1 | 132.8 | 132.8 | 132.8 | 132.8 | 132.8 | 132.8 | 0 | – | – | – | – | – | – |
| Eutrophic Depth | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Redox Potential | MV | – | 5 | 68.7 | 78.86 | 97.8 | 127.14 | 127.56 | 127.7 | 0 | – | – | – | – | – | – |
| SUVA | L/mg-M | – | 2 | 3.8 | 3.9 | 4.05 | 4.2 | 4.275 | 4.3 | 0 | – | – | – | – | – | – |
| **Nutrients** | | | | | | | | | | | | | | | | |
| Total Nitrogen as N | mg/L | 0.5 | 33 | 0.09 | 0.47 | 0.61 | 0.878 | 0.974 | 1.1 | 1 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 |
| Total Dissolved Nitrogen | mg/L | – | 27 | 0.07 | 0.412 | 0.5 | 0.646 | 0.741 | 1 | 1 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| Kjeldahl Nitrogen as N | mg/L | – | 1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 1 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 |
| Total Oxidised N | mg/L | 0.06 | 29 | 0.001 | 0.001 | 0.001 | 0.0054 | 0.0498 | 0.202 | 1 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| Nitrate as N | mg/L | 0.7 | 24 | 0.001 | 0.001 | 0.001 | 0.0024 | 0.019 | 0.053 | 1 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| Nitrite as N | mg/L | – | 25 | 0.001 | 0.001 | 0.001 | 0.0034 | 0.0148 | 0.196 | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Organic Nitrogen | mg/L | 0.42 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Ammonia - Total as N | mg/L | 0.02 | 31 | 0.0025 | 0.0025 | 0.008 | 0.019 | 0.0725 | 0.105 | 1 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Total Phosphorus | mg/L | 0.05 | 33 | 0.006 | 0.0208 | 0.031 | 0.052 | 0.0832 | 0.175 | 1 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Total Dissolved Phosphorus | mg/L | – | 27 | 0.0025 | 0.0072 | 0.011 | 0.0176 | 0.0321 | 0.067 | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Filterable Reactive Phosphorus | mg/L | 0.02 | 31 | 0.0005 | 0.002 | 0.003 | 0.005 | 0.012 | 0.027 | 1 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 |
| Phosphate | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| **Other Organics** | | | | | | | | | | | | | | | | |
| DOC | mg/L | – | 30 | 5.3 | 6.6 | 7.9 | 10 | 15.2 | 25 | 0 | – | – | – | – | – | – |
| TOC | mg/L | – | 30 | 5.3 | 6.84 | 8.3 | 10.52 | 14.2 | 23 | 0 | – | – | – | – | – | – |
| Major Cations & Anions | | | | | | | | | | | | | | | | |
| Fluoride - Total | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chloride | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Magnesium - Total | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Silica - Reactive as SiO3 | mg/L | – | 16 | 1.26 | 2.75 | 4.91 | 7.51 | 8.0525 | 9.26 | 0 | – | – | – | – | – | – |
| Sulphide | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Sulphur-Total | mg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| **Total Metals** | | | | | | | | | | | | | | | | |
| Aluminium | µg/L | 55 | 4 | 2.5 | 14.2 | 26.5 | 86.6 | 149.15 | 170 | 6 | 11 | 40 | 120.5 | 509 | 765.5 | 851 |
| Antimony | µg/L | – | 4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Arsenic | µg/L | 13 | 4 | 0.6 | 0.66 | 0.8 | 1.1 | 1.325 | 1.4 | 6 | 0.8 | 0.8 | 1.2 | 1.5 | 1.575 | 1.6 |
| Barium | µg/L | – | 4 | 2.3 | 2.72 | 5 | 10.6 | 14.65 | 16 | 6 | 6 | 9 | 14.15 | 17.9 | 22.7 | 24.3 |
| Beryllium | µg/L | – | 4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Boron | µg/L | 370 | 4 | 15 | 15 | 15 | 15 | 15 | 15 | 6 | 15 | 15 | 15 | 15 | 15 | 15 |
| Cadmium | µg/L | 0.2 | 4 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 6 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Chromium | µg/L | 1 | 4 | 0.5 | 0.5 | 0.5 | 0.7 | 0.925 | 1 | 6 | 0.5 | 0.5 | 0.75 | 1.2 | 1.35 | 1.4 |
| Cobalt | µg/L | – | 4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Copper | µg/L | 1.4 | 4 | 0.5 | 0.5 | 0.5 | 1.1 | 1.775 | 2 | 6 | 0.5 | 0.5 | 0.5 | 1 | 1.75 | 2 |
| Iron | µg/L | – | 28 | 460 | 632.4 | 1120 | 1700 | 1972.5 | 2600 | 21 | 577 | 1160 | 1500 | 3610 | 4700 | 5580 |
| Lead | µg/L | 3.4 | 4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Lithium | µg/L | – | 4 | 0.5 | 0.5 | 0.5 | 1.1 | 1.775 | 2 | 6 | 1 | 1 | 1.25 | 2 | 2 | 2 |
| Manganese | µg/L | 1900 | 28 | 10 | 28.16 | 55.5 | 84.54 | 125.1 | 160 | 21 | 22.3 | 36 | 95 | 256 | 581 | 620 |
| Mercury | µg/L | 0.06 | 4 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 6 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Molybdenum | µg/L | 11 | 4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Nickel | µg/L | – | 4 | 0.5 | 0.5 | 0.5 | 1.1 | 1.775 | 2 | 6 | 0.5 | 0.5 | 0.5 | 0.5 | 1.625 | 2 |
| Selenium | µg/L | 5 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 6 | 1 | 1 | 1 | 1 | 1 | 1 |
| Silver | µg/L | 0.05 | 4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Strontium | µg/L | – | 4 | 16 | 16.6 | 17.5 | 21.2 | 24.8 | 26 | 6 | 17 | 19 | 20 | 27 | 27 | 27 |
| Thorium | µg/L | – | 4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Tin | µg/L | – | 4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Uranium | µg/L | – | 4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Vanadium | µg/L | – | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Zinc | µg/L | 8 | 4 | 2.5 | 2.5 | 4.75 | 7.4 | 7.85 | 8 | 6 | 2.5 | 2.5 | 2.5 | 7 | 10 | 11 |
| **Soluble Metals** | | | | | | | | | | | | | | | | |
| Aluminium | µg/L | 55 | 1 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 1 | 8 | 8 | 8 | 8 | 8 | 8 |
| Arsenic | µg/L | 13 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Barium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Beryllium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Boron | µg/L | 370 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Cadmium | µg/L | 0.2 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chromium | µg/L | 1 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Cobalt | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Copper | µg/L | 1.4 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Iron | µg/L | – | 29 | 162 | 306.8 | 633 | 993 | 1276 | 1320 | 22 | 239 | 430 | 1120 | 1850 | 3877.5 | 4100 |
| Lead | µg/L | 3.4 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Lithium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Manganese | µg/L | 1900 | 29 | 1.3 | 4 | 8.5 | 14.88 | 26.8 | 130 | 22 | 4.2 | 21.46 | 37 | 247.2 | 535.7 | 550 |
| Molybdenum | µg/L | 11 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Nickel | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Silver | µg/L | 0.05 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Strontium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Thorium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Tin | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Uranium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Vanadium | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Zinc | µg/L | 8 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| **Algae** | | | | | | | | | | | | | | | | |
| Chlorophyll a - Field | µg/L | 5 | 1 | 5.7 | 5.7 | 5.7 | 5.7 | 5.7 | 5.7 | 0 | – | – | – | – | – | – |
| Chlorophyll a | µg/L | 5 | 7 | 4 | 7.2 | 11 | 18.2 | 22.1 | 23 | 0 | – | – | – | – | – | – |
| **Microbiological** | | | | | | | | | | | | | | | | |
| Cryptosporidium - Corrected | MPN/100mL | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Cryptosporidium - Detected | MPN/100mL | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| E.coli - Colilert | MPN/100mL | – | 70 | 1 | 16 | 32 | 96.8 | 300.5 | 520 | 0 | – | – | – | – | – | – |
| E.coli - MF | MPN/100mL | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Enterococci - MF | MPN/100mL | – | 70 | 0.5 | 2.8 | 11 | 24 | 130 | 340 | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Giardia - Corrected | MPN/100mL | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Giardia - Detected | MPN/100mL | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Total Coliforms - Colilert | MPN/100mL | – | 70 | 280 | 1600 | 2400 | 2400 | 4565 | 12000 | 0 | – | – | – | – | – | – |
| **Pesticide** | | | | | | | | | | | | | | | | |
| 2.4-D | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 2.4-DB | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 2.4-DP | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 2.4.5-T | µg/L | 36 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 2.4.6-T | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 2.6-D | µg/L | 280 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 3-Hydroxy Carbofuran | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 4-Chlorophenoxy acetic acid | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 4.4-DDD (pp-DDD) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 4.4-DDE (pp-DDE) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 4.4-DDT (pp-DDT) | µg/L | 0.006 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Acrolein | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Aldicarb | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Aldrin (Eldrin) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| alpha-BHC (lindane) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Ametryn | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Amitrole | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| AMPA | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Asulam | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Atrazine | µg/L | 13 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Azinphos methyl | µg/L | 0.01 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Azinphos-ethyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Bendiocarb | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Benomyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| beta-BHC (lindane) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Bioresmethrin | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Brodifacoum | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Bromacil | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Bromophos-ethyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Bromoxynil | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Carbaryl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Carbofuran | µg/L | 0.06 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Carbophenothion | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chlordane - Total | µg/L | 0.03 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chlorfenvinphos - Total | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chlorothalonil | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chlorpyrifos | µg/L | 0.01 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chlorpyrifos-methyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chlorsulfuron | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| cis-Chlordane | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Clopyralid | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Coumaphos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Cyanazine | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Cyproconazole | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Cyprodinil | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Cyromazine | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| delta-BHC | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Demeton-O & Demeton-S | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Demeton-S methyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Diazinon | µg/L | 0.01 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Dicamba | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Dichlorvos (DDVP) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Diclofop-methyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Dieldrin | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Difenoconazole | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Diflufenican | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Dimethoate | µg/L | 0.15 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Diquat | µg/L | 1.4 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Disulfoton | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Diuron | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Endosulfan - Total | µg/L | 0.03 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Endosulfan I (alpha isomer) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Endosulfan II (beta isomer) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Endosulfan sulfate | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Endrin | µg/L | 0.01 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Endrin aldehyde | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Endrin ketone | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| EPN | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Ethion | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Ethoprophos (Prophos) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fenamiphos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fenarimol | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fenchlorphos (Ronnel) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fenitrothion | µg/L | 0.2 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fensulphothion | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fenthion | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fenvalerate & Esfenvalerate | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fipronil | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fluometuron | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fluroxypyr | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Flusilazole | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Glyphosate | µg/L | 370 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Heptachlor | µg/L | 0.01 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Heptachlor epoxide | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Hexachlorobenzene (HCB) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Hexazinone | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Iprodione | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Irgarol | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Lindane (gamma-BHC) | µg/L | 0.2 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Malathion (Maldison) | µg/L | 0.05 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| MCPA | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| MCPB | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Mecoprop | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Methiocarb | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Methomyl | µg/L | 3.5 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Methoxychlor | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Metolachlor | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Metribuzin | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Metsulfuron-methyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Mevinphos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Molinate | µg/L | 3.4 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Monocrotophos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Omethoate | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Oryzalin | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Oxamyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Oxychlordane | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Oxyfluorfen | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Paclobutrazol | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Paraquat | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Parathion | µg/L | 0.004 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Parathion-methyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Penconazole | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Pendimethalin | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Permethrin | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Phorate | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Picloram | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Piperonyl Butoxide | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Pirimiphos-ethyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Pirimiphos-methyl | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Profenofos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Prometryn | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Propazine | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Propiconazole | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Prothiophos (Tokuthion) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Pyrimethanil | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Silvex (2,4,5-TP/Fenoprop) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Simazine | µg/L | 3.2 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Sulprofos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Sum of DDD + DDE + DDT | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Tebuconazole | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Tebuthiuron | µg/L | 2.2 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Temephos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Terbufos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Terbuthylazine | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Terbutryn | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Tetrachlorvinphos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Tetraethyl dithiopyrophos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Thiamethoxam | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Thiobencarb | µg/L | 2.8 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Thiodicarb | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| trans-Chlordane | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Triazophos | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Trichlorfon | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Trichloronate (Trichloronat) | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Triclopyr | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Trifluralin | µg/L | 2.6 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| **Polyaromatic Hydrocarbon** | | | | | | | | | | | | | | | | |
| 2-Chloronaphthalene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 2-Methylnapthalene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Acenaphthene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Acenapthylene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Anthracene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Benzo[a]anthracene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Benzo[a]pyrene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Benzo[b+j]fluoranthene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Benzo[e]pyrene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Benzo[ghi]perylene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Benzo[k]fluoranthene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Chrysene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Dibenzo[ah]anthracene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fluoranthene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Fluorene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Indeno(1.2.3-cd)pyrene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Napthalene | µg/L | 16 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Perylene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Phenanthrene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | | Deep | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Pyrene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Total PAH | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| **Taste and Colour** | | | | | | | | | | | | | | | | |
| 2-Methylisoborneol | ng/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| 2-methylisoborneol + Geosmin | ng/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Geosmin | ng/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| **Volatile Organic Compound** | | | | | | | | | | | | | | | | |
| Benzene | µg/L | 950 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Toluene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Ethylbenzene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| meta & para-Xylene | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| ortho-Xylene | µg/L | 350 | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Total Xylenes | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |
| Hexaconazole | µg/L | – | 0 | – | – | – | – | – | – | 0 | – | – | – | – | – | – |

Grey shading denotes parameters that exceed the water quality object / trigger value

Gold shading denotes parameters that have an LOR higher than the water quality objective / trigger value

## Cooroy Creek at Cooroy-Noosa Road

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| **Physico-Chemical** | | | | | | | | | |
| Temperature - Field | °C | – | 22 | 14.8 | 17.43 | 21.82 | 25.35 | 28.17 | 29.8 |
| pH - Field | pH unit | 6.5-8.0 | 22 | 6.2 | 6.59 | 6.7 | 6.9 | 7.02 | 7.1 |
| pH - Lab | ph Unit | 6.5-8.0 | 0 | – | – | – | – | – | – |
| Conductivity - Field | µS/cm | 626 | 22 | 80 | 106.13 | 127 | 139.6 | 147.65 | 197 |
| Conductivity | µS/cm | 626 | 0 | – | – | – | – | – | – |
| Dissolved Oxygen - Field | mg/L | – | 22 | 3.94 | 5.66 | 7.12 | 8.27 | 9.06 | 9.42 |
| Dissolved Oxygen - Field | % Saturation | 85-110 | 22 | 44.4 | 64.8 | 82.49 | 94.88 | 96.30 | 98.2 |
| Turbidity - Field | NTU | 50 | 22 | 2.1 | 3.04 | 3.915 | 6.63 | 19.51 | 114.1 |
| Turbidity - Lab | NTU | 50 | 0 | – | – | – | – | – | – |
| Suspended Solids | mg/L | 6 | 69 | 0.5 | 3 | 4 | 6 | 8.6 | 20 |
| Total Dissolved Solids | mg/L | – | 0 | – | – | – | – | – | – |
| Alkalinity - Total | mg/L | – | 0 | – | – | – | – | – | – |
| BGA - Field | cells/mL | – | 0 | – | – | – | – | – | – |
| BGA - Field | RFU | – | 0 | – | – | – | – | – | – |
| Eutrophic Depth | mg/L | – | 0 | – | – | – | – | – | – |
| Redox Potential | MV | – | 3 | 68.1 | 72.8 | 79.8 | 89.1 | 93.8 | 95.3 |
| SUVA | L/mg-M | – | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| **Nutrients** | | | | | | | | | |
| Total Nitrogen as N | mg/L | 0.5 | 78 | 0.18 | 0.414 | 0.51 | 0.616 | 0.84 | 1.08 |
| Total Dissolved Nitrogen | mg/L | – | 64 | 0.15 | 0.366 | 0.44 | 0.52 | 0.67 | 0.91 |
| Kjeldahl Nitrogen as N | mg/L | – | 0 | – | – | – | – | – | – |
| Total Oxidised N | mg/L | 0.06 | 70 | 0.001 | 0.0058 | 0.0205 | 0.0558 | 0.1422 | 0.21 |
| Nitrate as N | mg/L | 0.7 | 39 | 0.001 | 0.0056 | 0.035 | 0.0882 | 0.1439 | 0.2 |
| Nitrite as N | mg/L | – | 40 | 0.001 | 0.001 | 0.003 | 0.005 | 0.0081 | 0.017 |
| Organic Nitrogen | mg/L | 0.42 | 0 | – | – | – | – | – | – |
| Ammonia - Total as N | mg/L | 0.02 | 67 | 0.0025 | 0.0232 | 0.044 | 0.083 | 0.15 | 0.316 |
| Total Phosphorus | mg/L | 0.05 | 78 | 0.0025 | 0.018 | 0.024 | 0.0316 | 0.04175 | 0.075 |
| Total Dissolved Phosphorus | mg/L | – | 64 | 0.0025 | 0.008 | 0.012 | 0.018 | 0.024 | 0.034 |
| Filterable Reactive Phosphorus | mg/L | 0.02 | 66 | 0.0005 | 0.0005 | 0.003 | 0.006 | 0.007 | 0.01 |
| Phosphate | mg/L | – | 0 | – | – | – | – | – | – |
| **Other Organics** | | | | | | | | | |
| DOC | mg/L | – | 67 | 3.1 | 5.4 | 6 | 7.58 | 9.49 | 11 |
| TOC | mg/L | – | 67 | 3.8 | 5.7 | 6.2 | 7.78 | 9.56 | 11.2 |
| **Major Cations & Anions** | | | | | | | | | |
| Fluoride - Total | mg/L | – | 0 | – | – | – | – | – | – |
| Chloride | mg/L | – | 0 | – | – | – | – | – | – |
| Magnesium - Total | mg/L | – | 2 | 1 | 1.2 | 1.5 | 1.8 | 1.95 | 2 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Silica - Reactive as SiO3 | mg/L | – | 0 | – | – | – | – | – | – |
| Sulphide | mg/L | – | 41 | 0.013 | 0.025 | 0.025 | 0.025 | 0.025 | 0.06 |
| Sulphur-Total | mg/L | – | 0 | – | – | – | – | – | – |
| **Total Metals** | | | | | | | | | |
| Aluminium | µg/L | 55 | 2 | 503 | 516.8 | 537.5 | 558.2 | 568.55 | 572 |
| Antimony | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Arsenic | µg/L | 13 | 2 | 0.6 | 0.64 | 0.7 | 0.76 | 0.79 | 0.8 |
| Barium | µg/L | – | 2 | 9 | 9.8 | 11 | 12.2 | 12.8 | 13 |
| Beryllium | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Boron | µg/L | 370 | 2 | 15 | 15 | 15 | 15 | 15 | 15 |
| Cadmium | µg/L | 0.2 | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Chromium | µg/L | 1 | 2 | 0.5 | 0.6 | 0.75 | 0.9 | 0.975 | 1 |
| Cobalt | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Copper | µg/L | 1.4 | 2 | 0.5 | 0.6 | 0.75 | 0.9 | 0.975 | 1 |
| Iron | µg/L | – | 66 | 370 | 734 | 1050 | 1690 | 2330 | 2800 |
| Lead | µg/L | 3.4 | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Lithium | µg/L | – | 2 | 0.5 | 0.8 | 1.25 | 1.7 | 1.925 | 2 |
| Manganese | µg/L | 1900 | 66 | 41 | 92 | 154.5 | 211 | 362.5 | 699 |
| Mercury | µg/L | 0.06 | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Molybdenum | µg/L | 11 | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Nickel | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Selenium | µg/L | 5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Silver | µg/L | 0.05 | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Strontium | µg/L | – | 2 | 16 | 18.4 | 22 | 25.6 | 27.4 | 28 |
| Thorium | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Tin | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Uranium | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Vanadium | µg/L | – | 2 | 5 | 5 | 5 | 5 | 5 | 5 |
| Zinc | µg/L | 8 | 2 | 2.5 | 6 | 11.25 | 16.5 | 19.125 | 20 |
| **Soluble Metals** | | | | | | | | | |
| Aluminium | µg/L | 55 | 2 | 87 | 88.4 | 90.5 | 92.6 | 93.65 | 94 |
| Arsenic | µg/L | 13 | 0 | – | – | – | – | – | – |
| Barium | µg/L | – | 0 | – | – | – | – | – | – |
| Beryllium | µg/L | – | 0 | – | – | – | – | – | – |
| Boron | µg/L | 370 | 0 | – | – | – | – | – | – |
| Cadmium | µg/L | 0.2 | 0 | – | – | – | – | – | – |
| Chromium | µg/L | 1 | 0 | – | – | – | – | – | – |
| Cobalt | µg/L | – | 0 | – | – | – | – | – | – |
| Copper | µg/L | 1.4 | 0 | – | – | – | – | – | – |
| Iron | µg/L | – | 67 | 70 | 277.2 | 434 | 834.4 | 1162 | 1560 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Lead | µg/L | 3.4 | 0 | – | – | – | – | – | – |
| Lithium | µg/L | – | 0 | – | – | – | – | – | – |
| Manganese | µg/L | 1900 | 67 | 11.3 | 38.64 | 100 | 178.4 | 305 | 591 |
| Molybdenum | µg/L | 11 | 0 | – | – | – | – | – | – |
| Nickel | µg/L | – | 0 | – | – | – | – | – | – |
| Silver | µg/L | 0.05 | 0 | – | – | – | – | – | – |
| Strontium | µg/L | – | 0 | – | – | – | – | – | – |
| Thorium | µg/L | – | 0 | – | – | – | – | – | – |
| Tin | µg/L | – | 0 | – | – | – | – | – | – |
| Uranium | µg/L | – | 0 | – | – | – | – | – | – |
| Vanadium | µg/L | – | 0 | – | – | – | – | – | – |
| Zinc | µg/L | 8 | 0 | – | – | – | – | – | – |
| **Algae** | | | | | | | | | |
| Chlorophyll a - Field | µg/L | 5 | 0 | – | – | – | – | – | – |
| Chlorophyll a | µg/L | 5 | 0 | – | – | – | – | – | – |
| **Microbiological** | | | | | | | | | |
| Cryptosporidium - Corrected | MPN/100mL | – | 0 | – | – | – | – | – | – |
| Cryptosporidium - Detected | MPN/100mL | – | 0 | – | – | – | – | – | – |
| E.coli - Colilert | MPN/100mL | – | 67 | 0.5 | 4.2 | 12 | 56.6 | 233 | 2400 |
| E.coli - MF | MPN/100mL | – | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Enterococci - MF | MPN/100mL | – | 67 | 0.5 | 5.2 | 17 | 49.6 | 297 | 2100 |
| Giardia - Corrected | MPN/100mL | – | 0 | – | – | – | – | – | – |
| Giardia - Detected | MPN/100mL | – | 0 | – | – | – | – | – | – |
| Total Coliforms - Colilert | MPN/100mL | – | 67 | 680 | 2400 | 2400 | 2400 | 9070 | 14000 |
| **Pesticide** | | | | | | | | | |
| 2.4-D | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4-DB | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4-DP | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4.5-T | µg/L | 36 | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4.6-T | µg/L | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 2.6-D | µg/L | 280 | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 3-Hydroxy Carbofuran | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| 4-Chlorophenoxy acetic acid | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 4.4-DDD (pp-DDD) | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 4.4-DDE (pp-DDE) | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 4.4-DDT (pp-DDT) | µg/L | 0.006 | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Acrolein | µg/L | – | 0 | – | – | – | – | – | – |
| Aldicarb | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Aldrin (Eldrin) | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| alpha-BHC (lindane) | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Ametryn | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Amitrole | µg/L | – | 0 | – | – | – | – | – | – |
| AMPA | µg/L | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Asulam | µg/L | – | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Atrazine | µg/L | 13 | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Azinphos methyl | µg/L | 0.01 | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Azinphos-ethyl | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Bendiocarb | µg/L | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Benomyl | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| beta-BHC (lindane) | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Bioresmethrin | µg/L | – | 0 | – | – | – | – | – | – |
| Brodifacoum | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Bromacil | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Bromophos-ethyl | µg/L | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Bromoxynil | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Carbaryl | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Carbofuran | µg/L | 0.06 | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Carbophenothion | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chlordane - Total | µg/L | 0.03 | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Chlorfenvinphos - Total | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Chlorothalonil | µg/L | – | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Chlorpyrifos | µg/L | 0.01 | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chlorpyrifos-methyl | µg/L | – | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Chlorsulfuron | µg/L | – | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| cis-Chlordane | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Clopyralid | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Coumaphos | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Cyanazine | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Cyproconazole | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Cyprodinil | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Cyromazine | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| delta-BHC | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Demeton-O & Demeton-S | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Demeton-S methyl | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Diazinon | µg/L | 0.01 | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Dicamba | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Dichlorvos (DDVP) | µg/L | – | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Diclofop-methyl | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Dieldrin | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Difenoconazole | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Diflufenican | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Dimethoate | µg/L | 0.15 | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Diquat | µg/L | 1.4 | 0 | – | – | – | – | – | – |
| Disulfoton | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Diuron | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Endosulfan - Total | µg/L | 0.03 | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan I (alpha isomer) | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan II (beta isomer) | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan sulfate | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endrin | µg/L | 0.01 | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endrin aldehyde | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endrin ketone | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| EPN | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Ethion | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Ethoprophos (Prophos) | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fenamiphos | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fenarimol | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fenchlorphos (Ronnel) | µg/L | – | 1 | 5 | 5 | 5 | 5 | 5 | 5 |
| Fenitrothion | µg/L | 0.2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Fensulphothion | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Fenthion | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Fenvalerate & Esfenvalerate | µg/L | – | 0 | – | – | – | – | – | – |
| Fipronil | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fluometuron | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fluroxypyr | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Flusilazole | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Glyphosate | µg/L | 370 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Heptachlor | µg/L | 0.01 | 1 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 |
| Heptachlor epoxide | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Hexachlorobenzene (HCB) | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Hexazinone | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Iprodione | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Irgarol | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Lindane (gamma-BHC) | µg/L | 0.2 | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Malathion (Maldison) | µg/L | 0.05 | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| MCPA | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| MCPB | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Mecoprop | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Methiocarb | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Methomyl | µg/L | 3.5 | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Methoxychlor | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Metolachlor | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Metribuzin | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Metsulfuron-methyl | µg/L | – | 0 | – | – | – | – | – | – |
| Mevinphos | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Molinate | µg/L | 3.4 | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Monocrotophos | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Omethoate | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Oryzalin | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Oxamyl | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Oxychlordane | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Oxyfluorfen | µg/L | – | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Paclobutrazol | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Paraquat | µg/L | – | 0 | – | – | – | – | – | – |
| Parathion | µg/L | 0.004 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Parathion-methyl | µg/L | – | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Penconazole | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Pendimethalin | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Permethrin | µg/L | – | 0 | – | – | – | – | – | – |
| Phorate | µg/L | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Picloram | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Piperonyl Butoxide | µg/L | – | 0 | – | – | – | – | – | – |
| Pirimiphos-ethyl | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Pirimiphos-methyl | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Profenofos | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Prometryn | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Propazine | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Propiconazole | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Prothiophos (Tokuthion) | µg/L | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Pyrimethanil | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Silvex (2,4,5-TP/Fenoprop) | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Simazine | µg/L | 3.2 | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Sulprofos | µg/L | – | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Sum of DDD + DDE + DDT | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Tebuconazole | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Tebuthiuron | µg/L | 2.2 | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Temephos | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Terbufos | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Terbuthylazine | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Terbutryn | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Tetrachlorvinphos | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Tetraethyl dithiopyrophos | µg/L | – | 1 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Thiamethoxam | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Thiobencarb | µg/L | 2.8 | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Thiodicarb | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| trans-Chlordane | µg/L | – | 1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Triazophos | µg/L | – | 1 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Trichlorfon | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Trichloronate (Trichloronat) | µg/L | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Triclopyr | µg/L | – | 1 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Trifluralin | µg/L | 2.6 | 1 | 5 | 5 | 5 | 5 | 5 | 5 |
| **Polyaromatic Hydrocarbon** | | | | | | | | | |
| 2-Chloronaphthalene | µg/L | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 2-Methylnapthalene | µg/L | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Acenaphthene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Acenapthylene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Anthracene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[a]anthracene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[a]pyrene | µg/L | – | 2 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Benzo[b+j]fluoranthene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Benzo[e]pyrene | µg/L | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Benzo[ghi]perylene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[k]fluoranthene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chrysene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Dibenzo[ah]anthracene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fluoranthene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fluorene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Indeno(1.2.3-cd)pyrene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Napthalene | µg/L | 16 | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Perylene | µg/L | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Phenanthrene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Pyrene | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Total PAH | µg/L | – | 2 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| **Taste and Colour** | | | | | | | | | |
| 2-Methylisoborneol | ng/L | – | 0 | – | – | – | – | – | – |
| 2-methylisoborneol + Geosmin | ng/L | – | 0 | – | – | – | – | – | – |
| Geosmin | ng/L | – | 0 | – | – | – | – | – | – |
| **Volatile Organic Compound** | | | | | | | | | |
| Benzene | µg/L | 950 | 2 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Toluene | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Ethylbenzene | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| meta & para-Xylene | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ortho-Xylene | µg/L | 350 | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Total Xylenes | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Hexaconazole | µg/L | – | 1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

Grey shading denotes parameters that exceed the water quality object / trigger value

Gold shading denotes parameters that have an LOR higher than the water quality objective / trigger value

## Lake Macdonald Tailwater Below Dam Wall

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| **Physico-Chemical** | | | | | | | | | |
| Temperature - Field | °C | – | 23 | 11.69 | 13.744 | 16.2 | 20.64 | 24.91 | 25.9 |
| pH - Field | pH unit | 6.5-8.0 | 25 | 5.1 | 6 | 6.4 | 6.64 | 7.02 | 7.5 |
| pH - Lab | ph Unit | 6.5-8.0 | 114 | 5.7 | 6.3 | 6.5 | 6.7 | 7 | 7.8 |
| Conductivity - Field | µS/cm | 626 | 21 | 61 | 79 | 90 | 96 | 99 | 100.4 |
| Conductivity | µS/cm | 626 | 118 | 51 | 112.4 | 131.5 | 147.2 | 174.2 | 220 |
| Dissolved Oxygen - Field | mg/L | – | 21 | 0.24 | 0.69 | 1.16 | 2.4 | 3.6 | 3.74 |
| Dissolved Oxygen - Field | % Saturation | 85-110 | 20 | 2.5 | 6.9 | 11.78 | 21.74 | 34.48 | 36.03 |
| Turbidity - Field | NTU | 50 | 19 | 7.07 | 11.20 | 17.9 | 30.31 | 60.50 | 70.43 |
| Turbidity - Lab | NTU | 50 | 7 | 7.4 | 9.52 | 12 | 32.28 | 96.08 | 122 |
| Suspended Solids | mg/L | 6 | 185 | 2 | 4 | 7 | 13 | 23 | 65 |
| Total Dissolved Solids | mg/L | – | 11 | 44 | 56 | 73 | 85 | 102.5 | 120 |
| Alkalinity - Total | mg/L | – | 0 | – | – | – | – | – | – |
| BGA - Field | cells/mL | – | 0 | – | – | – | – | – | – |
| BGA - Field | RFU | – | 0 | – | – | – | – | – | – |
| Eutrophic Depth | mg/L | – | 0 | – | – | – | – | – | – |
| Redox Potential | MV | – | 6 | 62.1 | 63.7 | 76 | 141 | 141.05625 | 141.075 |
| SUVA | L/mg-M | – | 2 | 3.9 | 4.04 | 4.25 | 4.46 | 4.565 | 4.6 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| **Nutrients** | | | | | | | | | |
| Total Nitrogen as N | mg/L | 0.5 | 189 | 0.09 | 0.366 | 0.55 | 0.974 | 1.46 | 4.5 |
| Total Dissolved Nitrogen | mg/L | – | 57 | 0.04 | 0.342 | 0.45 | 0.646 | 0.812 | 0.95 |
| Kjeldahl Nitrogen as N | mg/L | – | 69 | 0 | 0.396 | 0.6 | 1.04 | 1.72 | 4.4 |
| Total Oxidised N | mg/L | 0.06 | 130 | 0 | 0.001 | 0.01 | 0.0892 | 0.1865 | 0.464 |
| Nitrate as N | mg/L | 0.7 | 36 | 0.001 | 0.001 | 0.001 | 0.005 | 0.00625 | 0.077 |
| Nitrite as N | mg/L | – | 37 | 0.001 | 0.001 | 0.003 | 0.0078 | 0.009 | 0.02 |
| Organic Nitrogen | mg/L | 0.42 | 12 | 0.47 | 0.58 | 0.705 | 1.008 | 1.5495 | 2.16 |
| Ammonia - Total as N | mg/L | 0.02 | 77 | 0.0025 | 0.016 | 0.035 | 0.0934 | 0.1746 | 0.487 |
| Total Phosphorus | mg/L | 0.05 | 192 | 0 | 0.0222 | 0.0405 | 0.07 | 0.1245 | 0.89 |
| Total Dissolved Phosphorus | mg/L | – | 58 | 0.0025 | 0.016 | 0.022 | 0.029 | 0.037 | 0.043 |
| Filterable Reactive Phosphorus | mg/L | 0.02 | 76 | 0 | 0.0005 | 0.002 | 0.008 | 0.0155 | 0.03 |
| Phosphate | mg/L | – | 1 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| **Other Organics** | | | | | | | | | |
| DOC | mg/L | – | 65 | 4.7 | 6.96 | 10.8 | 14 | 21 | 24 |
| TOC | mg/L | – | 65 | 4.7 | 7.38 | 11.6 | 15.32 | 23.4 | 25 |
| **Major Cations & Anions** | | | | | | | | | |
| Fluoride - Total | mg/L | – | 0 | – | – | – | – | – | – |
| Chloride | mg/L | – | 0 | – | – | – | – | – | – |
| Magnesium - Total | mg/L | – | 3 | 0.5 | 0.7 | 1 | 1.6 | 1.9 | 2 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Silica - Reactive as SiO3 | mg/L | – | 0 | – | – | – | – | – | – |
| Sulphide | mg/L | – | 0 | – | – | – | – | – | – |
| Sulphur-Total | mg/L | – | 0 | – | – | – | – | – | – |
| **Total Metals** | | | | | | | | | |
| Aluminium | µg/L | 55 | 3 | 84 | 105.2 | 137 | 1128.8 | 1624.7 | 1790 |
| Antimony | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Arsenic | µg/L | 13 | 3 | 0.8 | 0.8 | 0.8 | 0.92 | 0.98 | 1 |
| Barium | µg/L | – | 3 | 7 | 7.8 | 9 | 9.6 | 9.9 | 10 |
| Beryllium | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Boron | µg/L | 370 | 3 | 15 | 15 | 15 | 15 | 15 | 15 |
| Cadmium | µg/L | 0.2 | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Chromium | µg/L | 1 | 3 | 0.5 | 0.5 | 0.5 | 1.4 | 1.85 | 2 |
| Cobalt | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Copper | µg/L | 1.4 | 3 | 0.5 | 1.1 | 2 | 2 | 2 | 2 |
| Iron | µg/L | – | 62 | 1490 | 2292 | 3150 | 4200 | 5591.5 | 7640 |
| Lead | µg/L | 3.4 | 4 | 0.5 | 0.5 | 0.5 | 0.7 | 0.925 | 1 |
| Lithium | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Manganese | µg/L | 1900 | 62 | 49.8 | 132.2 | 229.5 | 330.8 | 469.85 | 1300 |
| Mercury | µg/L | 0.06 | 3 | 0.05 | 0.05 | 0.05 | 0.32 | 0.455 | 0.5 |
| Molybdenum | µg/L | 11 | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Nickel | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.8 | 0.95 | 1 |
| Selenium | µg/L | 5 | 3 | 1 | 1 | 1 | 1 | 1 | 1 |
| Silver | µg/L | 0.05 | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Strontium | µg/L | – | 3 | 10 | 12.8 | 17 | 20.6 | 22.4 | 23 |
| Thorium | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Tin | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Uranium | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Vanadium | µg/L | – | 3 | 5 | 5 | 5 | 5 | 5 | 5 |
| Zinc | µg/L | 8 | 3 | 6 | 6 | 6 | 9.6 | 11.4 | 12 |
| **Soluble Metals** | | | | | | | | | |
| Aluminium | µg/L | 55 | 3 | 47 | 48.6 | 51 | 177 | 240 | 261 |
| Arsenic | µg/L | 13 | 0 | – | – | – | – | – | – |
| Barium | µg/L | – | 0 | – | – | – | – | – | – |
| Beryllium | µg/L | – | 0 | – | – | – | – | – | – |
| Boron | µg/L | 370 | 0 | – | – | – | – | – | – |
| Cadmium | µg/L | 0.2 | 0 | – | – | – | – | – | – |
| Chromium | µg/L | 1 | 0 | – | – | – | – | – | – |
| Cobalt | µg/L | – | 0 | – | – | – | – | – | – |
| Copper | µg/L | 1.4 | 0 | – | – | – | – | – | – |
| Iron | µg/L | – | 64 | 650 | 1120 | 1605 | 2116 | 2579 | 3440 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Lead | µg/L | 3.4 | 0 | – | – | – | – | – | – |
| Lithium | µg/L | – | 0 | – | – | – | – | – | – |
| Manganese | µg/L | 1900 | 64 | 14.5 | 92.88 | 162 | 277.6 | 320 | 366 |
| Molybdenum | µg/L | 11 | 0 | – | – | – | – | – | – |
| Nickel | µg/L | – | 0 | – | – | – | – | – | – |
| Silver | µg/L | 0.05 | 0 | – | – | – | – | – | – |
| Strontium | µg/L | – | 0 | – | – | – | – | – | – |
| Thorium | µg/L | – | 0 | – | – | – | – | – | – |
| Tin | µg/L | – | 0 | – | – | – | – | – | – |
| Uranium | µg/L | – | 0 | – | – | – | – | – | – |
| Vanadium | µg/L | – | 0 | – | – | – | – | – | – |
| Zinc | µg/L | 8 | 0 | – | – | – | – | – | – |
| **Algae** | | | | | | | | | |
| Chlorophyll a - Field | µg/L | 5 | 0 | – | – | – | – | – | – |
| Chlorophyll a | µg/L | 5 | 0 | – | – | – | – | – | – |
| **Microbiological** | | | | | | | | | |
| Cryptosporidium - Corrected | MPN/100mL | – | 0 | – | – | – | – | – | – |
| Cryptosporidium - Detected | MPN/100mL | – | 1 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| E.coli - Colilert | MPN/100mL | – | 66 | 4 | 24 | 77 | 240 | 595 | 1700 |
| E.coli - MF | MPN/100mL | – | 0 | – | – | – | – | – | – |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Enterococci - MF | MPN/100mL | – | 66 | 2 | 13 | 37 | 100 | 322.5 | 880 |
| Giardia - Corrected | MPN/100mL | – | 0 | – | – | – | – | – | – |
| Giardia - Detected | MPN/100mL | – | 2 | 0.7 | 1.06 | 1.6 | 2.14 | 2.41 | 2.5 |
| Total Coliforms - Colilert | MPN/100mL | – | 66 | 180 | 1400 | 2400 | 2400 | 5150 | 7400 |
| **Pesticide** | | | | | | | | | |
| 2.4-D | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4-DB | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4-DP | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4.5-T | µg/L | 36 | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 2.4.6-T | µg/L | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 2.6-D | µg/L | 280 | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 3-Hydroxy Carbofuran | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| 4-Chlorophenoxy acetic acid | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| 4.4-DDD (pp-DDD) | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 4.4-DDE (pp-DDE) | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 4.4-DDT (pp-DDT) | µg/L | 0.006 | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Acrolein | µg/L | – | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Aldicarb | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Aldrin (Eldrin) | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| alpha-BHC (lindane) | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Ametryn | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Amitrole | µg/L | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| AMPA | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Asulam | µg/L | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Atrazine | µg/L | 13 | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Azinphos methyl | µg/L | 0.01 | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Azinphos-ethyl | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Bendiocarb | µg/L | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Benomyl | µg/L | – | 2 | 0.005 | 0.006 | 0.0075 | 0.009 | 0.00975 | 0.01 |
| beta-BHC (lindane) | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Bioresmethrin | µg/L | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Brodifacoum | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Bromacil | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Bromophos-ethyl | µg/L | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Bromoxynil | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Carbaryl | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Carbofuran | µg/L | 0.06 | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Carbophenothion | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chlordane - Total | µg/L | 0.03 | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Chlorfenvinphos - Total | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Chlorothalonil | µg/L | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Chlorpyrifos | µg/L | 0.01 | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chlorpyrifos-methyl | µg/L | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Chlorsulfuron | µg/L | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| cis-Chlordane | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Clopyralid | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Coumaphos | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Cyanazine | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Cyproconazole | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Cyprodinil | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Cyromazine | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| delta-BHC | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Demeton-O & Demeton-S | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Demeton-S methyl | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Diazinon | µg/L | 0.01 | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Dicamba | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Dichlorvos (DDVP) | µg/L | – | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Diclofop-methyl | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Dieldrin | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Difenoconazole | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Diflufenican | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Dimethoate | µg/L | 0.15 | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Diquat | µg/L | 1.4 | 1 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Disulfoton | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Diuron | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Endosulfan - Total | µg/L | 0.03 | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan I (alpha isomer) | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan II (beta isomer) | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endosulfan sulfate | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endrin | µg/L | 0.01 | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endrin aldehyde | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Endrin ketone | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| EPN | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Ethion | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Ethoprophos (Prophos) | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fenamiphos | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fenarimol | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fenchlorphos (Ronnel) | µg/L | – | 2 | 5 | 5 | 5 | 5 | 5 | 5 |
| Fenitrothion | µg/L | 0.2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Fensulphothion | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Fenthion | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Fenvalerate & Esfenvalerate | µg/L | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Fipronil | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fluometuron | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Fluroxypyr | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Flusilazole | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Glyphosate | µg/L | 370 | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Heptachlor | µg/L | 0.01 | 2 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 |
| Heptachlor epoxide | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Hexachlorobenzene (HCB) | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Hexazinone | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Iprodione | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Irgarol | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Lindane (gamma-BHC) | µg/L | 0.2 | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Malathion (Maldison) | µg/L | 0.05 | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| MCPA | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| MCPB | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Mecoprop | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Methiocarb | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Methomyl | µg/L | 3.5 | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Methoxychlor | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Metolachlor | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Metribuzin | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Metsulfuron-methyl | µg/L | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Mevinphos | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Molinate | µg/L | 3.4 | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Monocrotophos | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Omethoate | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Oryzalin | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Oxamyl | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Oxychlordane | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Oxyfluorfen | µg/L | – | 2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Paclobutrazol | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Paraquat | µg/L | – | 1 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Parathion | µg/L | 0.004 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Parathion-methyl | µg/L | – | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| Penconazole | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Pendimethalin | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Permethrin | µg/L | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Phorate | µg/L | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Picloram | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Piperonyl Butoxide | µg/L | – | 1 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Pirimiphos-ethyl | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Pirimiphos-methyl | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Profenofos | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Prometryn | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Propazine | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Propiconazole | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Prothiophos (Tokuthion) | µg/L | – | 2 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Pyrimethanil | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Silvex (2,4,5-TP/Fenoprop) | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Simazine | µg/L | 3.2 | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Sulprofos | µg/L | – | 2 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Sum of DDD + DDE + DDT | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Tebuconazole | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Tebuthiuron | µg/L | 2.2 | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Temephos | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Terbufos | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Terbuthylazine | µg/L | – | 2 | 0.005 | 0.008 | 0.0125 | 0.017 | 0.01925 | 0.02 |
| Terbutryn | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Tetrachlorvinphos | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Tetraethyl dithiopyrophos | µg/L | – | 2 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Thiamethoxam | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Thiobencarb | µg/L | 2.8 | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Thiodicarb | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| trans-Chlordane | µg/L | – | 2 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Triazophos | µg/L | – | 2 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Trichlorfon | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Trichloronate (Trichloronat) | µg/L | – | 2 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Triclopyr | µg/L | – | 2 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Trifluralin | µg/L | 2.6 | 2 | 5 | 5 | 5 | 5 | 5 | 5 |
| **Polyaromatic Hydrocarbon** | | | | | | | | | |
| 2-Chloronaphthalene | µg/L | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 2-Methylnapthalene | µg/L | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Acenaphthene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Acenapthylene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Anthracene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[a]anthracene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[a]pyrene | µg/L | – | 3 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Benzo[b+j]fluoranthene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Benzo[e]pyrene | µg/L | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Benzo[ghi]perylene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Benzo[k]fluoranthene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Chrysene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Dibenzo[ah]anthracene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fluoranthene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Fluorene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Indeno(1.2.3-cd)pyrene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Napthalene | µg/L | 16 | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Perylene | µg/L | – | 3 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Phenanthrene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Pyrene | µg/L | – | 3 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Total PAH | µg/L | – | 3 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| **Taste and Colour** | | | | | | | | | |
| 2-Methylisoborneol | ng/L | – | 0 | – | – | – | – | – | – |
| 2-methylisoborneol + Geosmin | ng/L | – | 0 | – | – | – | – | – | – |
| Geosmin | ng/L | – | 0 | – | – | – | – | – | – |
| **Volatile Organic Compound** | | | | | | | | | |
| Benzene | µg/L | 950 | 3 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Toluene | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

| Parameter | Units | WQO | Surface | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Count | minimum | 20th percentile | median | 80th percentile | 95th percentile | maximum |
| Ethylbenzene | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| meta & para-Xylene | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| ortho-Xylene | µg/L | 350 | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Total Xylenes | µg/L | – | 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Hexaconazole | µg/L | – | 2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

Grey shading denotes parameters that exceed the water quality object / trigger value

Gold shading denotes parameters that have an LOR higher than the water quality objective / trigger value

# Appendix E Summary of frc environmental Water Quality Monitoring Data for Lake Macdonald and Six Mile Creek

## Six Mile Creek – Downstream

### *SMC4*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 5 | 5 | 5 | 5 | 5 | 5 |
| minimum | 19.3 | 135 | 6.24 | 2.8 | 33.8 | 4.8 |
| 20$^{th}$ percentile | 20.5 | 146 | 6.75 | 4.1 | 46.0 | 6.3 |
| median | 20.9 | 159 | 7.08 | 4.5 | 49.1 | 11.4 |
| 80$^{th}$ percentile | 23.4 | 175 | 7.21 | 5.7 | 64.7 | 12.4 |
| maximum | 25.5 | 197 | 7.30 | 5.9 | 65.8 | 13.9 |

### *SMC5*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 5 | 5 | 5 | 5 | 5 | 5 |
| minimum | 17.7 | 160 | 5.82 | 2.0 | 24.0 | 5.4 |
| 20$^{th}$ percentile | 19.3 | 173 | 6.36 | 2.6 | 29.9 | 7.9 |
| median | 21.0 | 189 | 7.14 | 4.1 | 41.7 | 9.3 |
| 80$^{th}$ percentile | 23.4 | 239 | 7.34 | 5.5 | 63.4 | 11.2 |
| maximum | 24.6 | 244 | 7.43 | 6.1 | 68.8 | 15.6 |

### *SMCDS05*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 1 | 1 | 1 | 1 | 1 | 1 |
| minimum | 18.3 | 185 | 7.16 | 7.6 | 80.4 | 10.8 |
| 20th percentile | 18.3 | 185 | 7.16 | 7.6 | 80.4 | 10.8 |
| median | 18.3 | 185 | 7.16 | 7.6 | 80.4 | 10.8 |
| 80th percentile | 18.3 | 185 | 7.16 | 7.6 | 80.4 | 10.8 |
| maximum | 18.3 | 185 | 7.16 | 7.6 | 80.4 | 10.8 |

### *SMCDS04*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 3 | 3 | 3 | 3 | 3 | 3 |
| minimum | 18.8 | 110 | 6.16 | 2.2 | 26.7 | 7.8 |
| 20th percentile | 18.9 | 133 | 6.32 | 2.5 | 26.8 | 8.6 |
| median | 19.1 | 167 | 6.56 | 3.0 | 26.9 | 9.8 |
| 80th percentile | 22.4 | 173 | 6.73 | 4.4 | 30.6 | 12.0 |
| maximum | 24.5 | 177 | 6.85 | 5.3 | 33.0 | 13.5 |

### *SMCDS03*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 3 | 3 | 3 | 3 | 3 | 3 |
| minimum | 18.3 | 117 | 5.55 | 3.3 | 39.7 | 7.3 |
| 20th percentile | 18.5 | 135 | 6.01 | 3.5 | 40.3 | 7.6 |
| median | 18.9 | 162 | 6.70 | 3.8 | 41.2 | 7.9 |
| 80th percentile | 22.2 | 168 | 6.81 | 4.8 | 51.6 | 9.3 |
| maximum | 24.4 | 172 | 6.89 | 5.5 | 58.6 | 10.3 |

### *SMCDS02*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 3 | 3 | 3 | 3 | 3 | 3 |
| minimum | 20.3 | 89 | 5.72 | 3.0 | 37.8 | 2.5 |
| 20th percentile | 20.4 | 113 | 6.07 | 3.9 | 46.4 | 2.6 |
| median | 20.5 | 148 | 6.60 | 5.3 | 59.2 | 2.9 |
| 80th percentile | 23.8 | 159 | 6.95 | 5.4 | 60.3 | 2.9 |
| maximum | 26.0 | 166 | 7.18 | 5.4 | 61.0 | 3.0 |

### *SMCDS01*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 4 | 4 | 4 | 4 | 4 | 4 |
| minimum | 20.0 | 76 | 5.94 | 3.2 | 39.9 | 5.1 |
| 20th percentile | 22.4 | 85 | 6.26 | 3.9 | 48.2 | 5.2 |
| median | 24.8 | 98 | 6.49 | 5.8 | 67.3 | 5.4 |
| 80th percentile | 26.0 | 112 | 6.82 | 7.6 | 85.8 | 5.9 |
| maximum | 26.6 | 122 | 7.31 | 7.9 | 93.3 | 6.4 |

## Six Mile Creek – In Lake Macdonald

### *DS Lake*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 4 | 4 | 4 | 4 | 4 | 4 |
| minimum | 23.2 | 42 | 6.69 | 4.2 | 54.8 | 3.5 |
| 20th percentile | 24.1 | 69 | 6.78 | 6.3 | 82.2 | 3.5 |
| median | 26.4 | 89 | 6.99 | 8.8 | 108.8 | 4.6 |
| 80th percentile | 28.3 | 96 | 7.26 | 9.9 | 118.2 | 5.7 |
| maximum | 28.8 | 103 | 7.46 | 10.0 | 119.8 | 5.8 |

### *US Lake*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 2 | 2 | 2 | 2 | 2 | 2 |
| minimum | 22.9 | 53 | 6.77 | 8.2 | 99.2 | 3.1 |
| 20th percentile | 23.2 | 60 | 6.88 | 8.5 | 101.5 | 3.6 |
| median | 23.6 | 70 | 7.04 | 8.8 | 105.0 | 4.3 |
| 80th percentile | 24.0 | 80 | 7.20 | 9.2 | 108.4 | 4.9 |
| maximum | 24.3 | 87 | 7.31 | 9.4 | 110.7 | 5.4 |

## Six Mile Creek – Upstream of Lake Macdonald

### *CU02*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 2 | 2 | 2 | 2 | 2 | 2 |
| minimum | 21.6 | 59 | 6.31 | 6.4 | 72.9 | 5.7 |
| 20th percentile | 22.4 | 66 | 6.45 | 6.7 | 77.5 | 6.1 |
| median | 23.6 | 77 | 6.67 | 7.1 | 84.5 | 6.6 |
| 80th percentile | 24.9 | 88 | 6.88 | 7.5 | 91.5 | 7.0 |
| maximum | 25.7 | 95 | 7.02 | 7.8 | 96.1 | 7.4 |

### *CU01*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 2 | 2 | 2 | 2 | 2 | 2 |
| minimum | 17.4 | 82 | 6.16 | 4.9 | 51.1 | 4.5 |
| 20th percentile | 17.8 | 93 | 6.38 | 5.7 | 62.9 | 6.0 |
| median | 18.6 | 109 | 6.72 | 6.9 | 80.6 | 8.3 |
| 80th percentile | 19.3 | 126 | 7.06 | 8.1 | 98.3 | 10.7 |
| maximum | 19.8 | 137 | 7.28 | 8.9 | 110.1 | 12.2 |

### *CU03*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 2 | 2 | 2 | 2 | 2 | 2 |
| minimum | 21.2 | 92 | 6.27 | 4.1 | 46.2 | 12.2 |
| 20th percentile | 54.6 | 103 | 6.44 | 4.8 | 56.0 | 12.8 |
| median | 104.6 | 119 | 6.71 | 5.8 | 70.7 | 13.8 |
| 80th percentile | 154.6 | 135 | 6.97 | 6.8 | 85.4 | 14.8 |
| maximum | 188.0 | 146 | 7.14 | 7.4 | 95.2 | 15.4 |

### *SMCUS02*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 2 | 2 | 2 | 2 | 2 | 2 |
| minimum | 19.3 | 92 | 6.53 | 3.4 | 35.6 | 4.7 |
| 20th percentile | 20.1 | 111 | 6.56 | 4.2 | 45.7 | 6.6 |
| median | 21.3 | 141 | 6.61 | 5.3 | 61.0 | 9.6 |
| 80th percentile | 22.4 | 170 | 6.65 | 6.4 | 76.2 | 12.5 |
| maximum | 23.2 | 189 | 6.68 | 7.2 | 86.3 | 14.5 |

### *SMCUS01*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 3 | 3 | 3 | 3 | 3 | 3 |
| minimum | 18.7 | 107 | 6.24 | 2.1 | 24.7 | 5.9 |
| 20th percentile | 18.9 | 121 | 6.41 | 2.2 | 25.9 | 7.8 |
| median | 19.1 | 141 | 6.67 | 2.3 | 27.7 | 10.8 |
| 80th percentile | 22.4 | 142 | 7.23 | 3.7 | 41.1 | 13.0 |
| maximum | 24.5 | 142 | 7.61 | 4.6 | 50.1 | 14.5 |

### *SMCUS03*

| Summary statistic | Temperature (ºC) | Electrical Conductivity (µS/cm) | pH (unit) | Dissolved Oxygen (mg/L) | Dissolved Oxygen (% saturation) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| count | 2 | 2 | 2 | 2 | 2 | 2 |
| minimum | 18.7 | 87 | 5.80 | 2.8 | 33.1 | 6.2 |
| 20th percentile | 19.4 | 97 | 6.04 | 3.4 | 38.4 | 6.5 |
| median | 20.6 | 112 | 6.41 | 4.2 | 46.3 | 6.8 |
| 80th percentile | 21.7 | 127 | 6.77 | 5.0 | 54.2 | 7.1 |
| maximum | 22.5 | 137 | 7.01 | 5.5 | 59.5 | 7.3 |

# Appendix F Detailed Fish and Turtle Survey Methods

The survey methods were consistent with methods for the survey of large freshwater perches and lungfish presented in the *Survey Guidelines for Australia's Threatened Fish* (SEWPAC 2011a) and the *Survey Guidelines for Australia's Threatened Reptiles* (SEWPAC 2011b), and included use of:

- Active fishing methods:
  - Underwater camera with live viewing. Where turbidity and light conditions allowed, an underwater camera with live viewing was used to actively search for the MNES species at each site. For watercourse sites, the full length of the site was walked on the bank (where possible) so as not to disturb fish and turtles, with the camera mounted on a pole to provide live footage of underwater life in deep pools, under logs, in undercut banks and amongst other habitat features. For reservoir sites, the camera was mounted on a pole and operated from the boat prior to electrofishing;
  - Electrofishing. Experienced and certified operators electrofished in accordance with the Australian Code of Electrofishing Practice; boat units were used at the two sites in the reservoir zone; backpack units were used in the watercourse sites in the upstream and downstream zones[9];
  - Angling. Two set lines using baited barbless hooks were set at each site for one hour at dusk on each survey;
- Passive fishing methods:
  - Fyke nets. Two fyke nets were set overnight with appropriate floating devices to ensure that air breathing species had access to the surface at all times. For watercourse sites in the upstream and downstream zones deep pools were targeted, with one fyke was oriented in the upstream direction and the other in the downstream direction. At the reservoir sites, fyke nets were set at sites where water depth allowed (i.e. if water was too deep, i.e. > 3 m, then fyke nets could not be set);

[9] Electrofishing was not used in the downstream zone during the August survey, so as not to interfere with a research project that is assessing Mary River cod recruitment and larval ecology. However, electrofishing was used as site SMCDS05 during this survey to provide additional fish data, noting that fish caught at this site could be vagrants from the main stem of the Mary River.

- Baited box traps / bait fish traps. Five box traps were set overnight to sample small / juvenile fish. These traps were placed in appropriate habitat, such as shallow water amongst aquatic plants or other habitat features;
- Baited cathedral traps. Three cathedral traps, baited with ox heart meat, were set overnight to capture turtles at sites that had suitable characteristics for setting cathedral traps.

The sampling effort used at each site on each survey is presented in Tables C1 and C2.

All fish and turtle species were identified to species in the field. Identification of some turtle species was confirmed in the office by review of photographs taken during the field surveys.

The total length of all fish was measured in the field, and the life history stage (juvenile, intermediate, adult) of turtles was recorded.

Fish and turtle surveys were conducted under ethics (CA 2015/08/893) and fisheries (181742) permits held by frc environmental, and all specimens of native fish and turtle were released unharmed at the location of capture. Pest species of fish were euthanised in accordance with methods approved under the ethics permit.

The Department of Natural Resources and Mines provided fish data for a survey (November 2015) of large bodied fish (boat electrofishing) at the Lake Macdonald tail water, which included records for Mary River cod and Australian lungfish at this site.

Table F.1 Fishing effort for the August 2015 survey.

| Site | Method | Habitat | Date | Time In | Time Out | Settings | Effort [a] |
|---|---|---|---|---|---|---|---|
| **Downstream Zone** | | | | | | | |
| SMCDS05 | backpack electrofishing | pool | 2015-08-28 | 1400 | 1510 | 225 V | 1208 s |
| | | | | | | 30 Hz | |
| SMCDS04 | small bait traps (5) | pool | 2015-08-28 | 1200 | 0915 | | 106.25 h |
| | fyke nets (2) | | | | | | 42.5 h |
| | cathedral trap (3) | | | | | | 63.75 |
| | line fishing (2) | | | 1640 | 1740 | | 2 h |
| SMCDS03 | small bait traps (5) | pool | 2015-08-28 | 1115 | 0845 | | 107.5 h |
| | fyke nets (2) | | | | | | 43 h |
| | cathedral trap (3) | | | | | | 64.5 h |

| Site | Method | Habitat | Date | Time In | Time Out | Settings | Effort [a] |
|---|---|---|---|---|---|---|---|
| | line fishing (2) | | | 1630 | 1730 | | 2 h |
| SMCDS02 | small bait traps (5) | pool | 2015-08-27 | 1430 | 0930 | | 95 h |
| | fyke nets (2) | | | | | | 38 h |
| | cathedral trap (3) | | | | | | 57 h |
| | line fishing (2) | | | 1000 | 1045 | | 1.5 h |
| SMCDS01 | small bait traps (5) | pool | 2015-08-27 | 1330 | 0900 | | 97.5 h |
| | fyke nets (2) | | | | | | 39 h |
| | cathedral trap (3) | | | | | | 58.5 h |
| | line fishing (2) | | | 1715 | 1830 | | 2.5 h |
| **Reservoir Zone** | | | | | | | |
| DS Lake | small bait traps (5) | pool | 2015-08-26 | 1630 | 1000 | | 87.5 h |
| | fyke nets (2) | | | | | | 35 h |
| | cathedral trap (3) | | | | | | 52.5 h |
| | line fishing (2) | | 2015-08-26 | 1645 | 1730 | | 1.5 h |
| | boat electrofishing | | | 1645 | 1730 | 50–1000 V<br>4 amps<br>100% | 2000 s |
| US Lake | small bait traps (5) | pool | 2015-08-26 | 1600 | 1015 | | 91.25 h |
| | fyke nets (2) | | | | | | 36.5 h |
| | cathedral trap (3) | | | | | | 54.75 h |
| | line fishing (2) | | 2015-08-25 | 1800 | 1845 | | 1.5 h |
| | boat electrofishing | | | 1445 | 1555 | 50–1000 V<br>4 amps<br>100% | 2000 s |
| **Upstream Zone** | | | | | | | |
| CU02 | small bait traps (5) | pool | 2015-08-25 | 1130 | 900 | | 107.5 h |
| | fyke nets (2) | | | | | | 43 h |
| | cathedral traps (3) | | | | | | 64.5 h |
| | boat electrofishing | | | 1245 | 1345 | 50–1000 V<br>4 amps<br>100% | 2000 s |
| | line fishing (2) | | 2015-08-25 | 1630 | 1730 | | 2 h |

| Site | Method | Habitat | Date | Time In | Time Out | Settings | Effort [a] |
|---|---|---|---|---|---|---|---|
| CU01 | fyke nets (2) | pool | 2015-08-24 | 1445 | 1200 | | 42.5 h |
| | small bait traps (5) | | | | | | 106.25 h |
| | cathedral traps (3) | | | | | | 63.75 h |
| | boat electrofishing | | | 1245 | 1430 | 50–1000 V | 2000 s |
| | | | | | | 4 amps | |
| | | | | | | 80% | |
| CU03 | fyke nets (2) | pool | 2015-08-25 | 1245 | 1000 | | 42.5 h |
| | small bait traps (5) | | | | | | 106.25 h |
| | cathedral traps (3) | | | | | | 63.75 h |
| | line fishing (2) | | 2015-08-26 | 1745 | 1845 | | 2 h |
| | boat electrofishing | | | 1145 | 1230 | 50–1000 V | 2000 s |
| | | | | | | 4 amps | |
| | | | | | | 80% | |
| SMCUS02 | small bait traps (5) | pool | 2015-08-29 | 1200 | 0800 | | 100 h |
| | fyke nets (2) | | | | | | 40 h |
| | cathedral trap (3) | | | | | | 60 h |
| | line fishing (2) | | | 1645 | 1745 | | 2 h |
| SMCUS01 | small bait traps (5) | pool | 2015-08-24 | 1700 | 0900 | | 80 h |
| | fyke nets (2) | | | 1700 | 0915 | | 32.5 h |
| | cathedral trap (3) | | | | | | 48.75 h |
| | line fishing (2) | | | 1730 | 1830 | | 2 h |
| SMCUS03 | small bait traps (5) | pool | 2015-08-29 | 1045 | 730 | | 103.75 h |
| | fyke nets (2) | | | | | | 41.5 h |
| | cathedral trap (3) | | | | | | 62.25 |
| | line fishing (2) | | | 1530 | 1630 | | 2 h |

[a] s – seconds; h – hours

Table F.2 Fishing effort for the October 2015 survey.

| Site | Method | Habitat | Date | Time In | Time Out | Settings | Effort [a] |
|---|---|---|---|---|---|---|---|
| **Downstream Zone** | | | | | | | |
| SMCDS04 | small bait traps (5) | pool | 2015-10-20 | 1745 | 0730 | – | 68.75 h |
| | fyke nets (2) | | | | | | 27.5 h |
| | cathedral trap (3) | | | | | | 41.25 h |
| | line fishing (2) | | | 1745 | 1815 | | 1 h |
| | backpack electrofishing | | | 1630 | 1730 | 270 V | 2001 s |
| | | | | | | 40 Hz | |
| SMCDS03 | small bait traps (5) | pool | 2015-10-20 | 1530 | 900 | – | 87.5 h |
| | fyke nets (2) | | | | | | 35 h |
| | cathedral trap (3) | | | | | | 52.5 h |
| | backpack electrofishing | | | 1245 | 1500 | 265 V | 2012 s |
| | | | | | | 40 Hz | |
| | line fishing (2) | | 2015-10-21 | 720 | 840 | | 2.67 h |
| SMCDS02 | small bait traps (5) | pool | 2015-10-18 | 1735 | 715 | – | 68.33 h |
| | fyke nets (2) | | | | | | 27.33 h |
| | cathedral trap (3) | | | | | | 41 h |
| | line fishing (2) | | | 1755 | 1850 | | 1.83 h |
| | backpack electrofishing | | | 1515 | 1715 | 275 V | 2007 s |
| | | | | | | 40 Hz | |
| SMCDS01 | small bait traps (5) | pool | 2015-10-18 | 1400 | 900 | | 95 h |
| | fyke nets (2) | | | | | | 38 h |
| | cathedral trap (3) | | | | | | 57 h |
| | line fishing (2) | | | 1820 | 1900 | | 1.33 h |
| | backpack electrofishing | | | 1045 | 1300 | 240 V | 2004 s |
| | | | | | | 40 Hz | |
| **Reservoir Zone** | | | | | | | |
| DS Lake | small bait traps (5) | pool | 2015-10-19 | 1630 | 1015 | | 88.75 h |
| | fyke nets (2) | | | | | | 35.5 h |

| Site | Method | Habitat | Date | Time In | Time Out | Settings | Effort [a] |
|---|---|---|---|---|---|---|---|
| | cathedral trap (3) | | | | | | 53.25 h |
| | line fishing (2) | | | 1800 | 1830 | | 1 h |
| | boat electrofishing | | | 1400 | 1500 | 50–1000 V | 2004 s |
| | | | | | | 4–7 amps | |
| | | | | | | 100% | |
| US Lake | small bait traps (5) | pool | 2015-10-19 | 1700 | 930 | | 82.5 h |
| | fyke nets (2) | | | | | | 33 h |
| | cathedral trap (3) | | | | | | 49.5 h |
| | line fishing (2) | | | 1730 | 1750 | | 0.67 h |
| | boat electrofishing | | | 1115 | 1245 | 50–1000 V | 2000 s |
| | | | | | | 4–7 amps | |
| | | | | | | 100% | |
| **Upstream Zone** | | | | | | | |
| CU02 | small bait traps (4) | pool | 2015-10-22 | 1445 | 1030 | | 79 h |
| | fyke nets (2) | | | | | | 39.5 h |
| | cathedral trap (2) | | | | | | 39.5 h |
| | line fishing (2) | | 2015-10-23 | 1830 | 1900 | | 1 h |
| | boat electrofishing | | | 1515 | 1630 | 50–1000 V | 2002 s |
| | | | | | | 4–7 amps | |
| | | | | | | 100% | |
| CU01 | small bait traps (4) | pool | 2015-10-22 | 1530 | 0915 | | 71 h |
| | fyke nets (2) | | | | | | 35.5 h |
| | cathedral trap (3) | | | | | | 53.25 h |
| | boat electrofishing | | 2015-10-23 | 1330 | 1500 | 50–1000 V | 2004 s |
| | | | | | | 4–7 amps | |
| | | | | | | 100% | |
| CU03 | small bait traps (4) | pool | 2015-10-22 | 1245 | 0830 | | 79 h |
| | fyke nets (2) | | | | | | 39.5 h |
| | cathedral trap (3) | | | | | | 59.25 h |
| | boat electrofishing | | 2015-10-23 | 1500 | 1645 | 50–1000 V | 2018 s |
| | | | | | | 4–7 amps | |
| | | | | | | 100% | |

| Site | Method | Habitat | Date | Time In | Time Out | Settings | Effort [a] |
|---|---|---|---|---|---|---|---|
| SMCUS02 | small bait traps (5) | pool | 2015-10-21 | 1700 | 1000 | | 85 h |
| | fyke nets (2) | | | | | | 34 h |
| | cathedral trap (3) | | | | | | 51 h |
| | line fishing (2) | | | 1745 | 1820 | | 1.17 h |
| | boat electrofishing | | | 1500 | 1645 | 50–1000 V | 2000 s |
| | | | | | | 4–7 amps | |
| | | | | | | 100% | |
| SMCUS01 | small bait traps (5) | pool | 2015-10-21 | 1215 | 0820 | | 100.42 h |
| | fyke nets (2) | | | | | | 40.17 h |
| | cathedral trap (3) | | | | | | 60.3 h |
| | line fishing (2) | | | 1830 | 1850 | | 0.67 h |
| | backpack electrofishing | | | 1230 | 1400 | 240 V | 2018 s |
| | | | | | | 40 Hz | |
| SMCUS03 | backpack electrofishing | pool | 2015-10-22 | 1615 | 1745 | 275 V | 2008 s |
| | | | | | | 40 Hz | |
| | line fishing (2) | | | 1745 | 1815 | | 1 h |
| | small bait traps (5) | | 2015-10-23 | 1730 | 0720 | | 69.17 h |
| | fyke nets (2) | | | | | | 27.67 h |
| | cathedral trap (3) | | | | | | 41.5 h |

[a] s – seconds; h – hours

# Appendix G Detailed Fish Survey Results

Table G.1 Summary of fish survey counts.

| Species | Common Name | Caught August 2015 Survey | Caught October 2015 Survey |
|---|---|---|---|
| **Native Species** | | | |
| **Ambassidae** | | | |
| *Ambassis agassizii* | Agassiz's glassfish | 112 | 188 |
| *Ambassis marianus* | estuary glassfish | 0 | 0 |
| **Anguillidae** | | | |
| *Anguilla australis* | southern shortfin eel | 2 | 0 |
| *Anguilla reinhardtii* | longfin eel | 11 | 38 |
| **Apogonidae** | | | |
| *Glossamia aprion* | mouth almighty | 0 | 1 |
| **Atherinidae** | | | |
| *Craterocephalus marjoriae* | silverstreak hardyhead | 0 | 0 |
| *Craterocephalus stercusmuscarum* | flyspecked hardyhead | 60 | 347 |
| **Eleotridae** | | | |
| *Gobiomorphus australis* | striped gudgeon | 0 | 0 |
| *Hypseleotris* spp. | common carp gudgeons | 1106 | 3099 |
| *Hypseleotris compressa* | empire gudgeon | 0 | 0 |
| *Mogurnda adspersa* | purple spotted gudgeon | 0 | 13 |
| *Philypnodon macrostomus* | dwarf flathead gudgeon | 5 | 26 |
| *Philypnodon grandiceps* | flathead gudgeon | 34 | 20 |
| **Melanotaeniidae** | | | |
| *Melanotaenia duboulayi* | crimson-spotted rainbowfish | 83 | 581 |
| **Percichthyidae** | | | |
| *Maccullochella mariensis* | Mary River cod | 0 | 0 (3) |
| *Percalates novemaculeata* | Australian bass | 2 | 15 (75) |
| *Macquaria ambigua* | yellowbelly | 0 | 0 (2) |

| Species | Common Name | Caught August 2015 Survey | Caught October 2015 Survey |
|---|---|---|---|
| **Plotosidae** | | | |
| *Tandanus tandanus* | eel-tailed catfish | 14 | 23 (5) |
| *Neosilurus hyrtlii* | Hyrtl's tandan | 0 | 0 |
| **Pseudomugilidae** | | | |
| *Pseudomugil signifer* | Pacific blue-eye | 1 | 27 |
| **Retropinnidae** | | | |
| *Retropinna semoni* | Australian smelt | 25 | 104 |
| **Clupeidae** | | | |
| *Nematolosa erebi* | bony bream | 31 | 112 (16) |
| **Ceratodontidae** | | | |
| *Neoceratodus forsteri* | Australian lungfish | 0 | 0 (1) |
| **Mugilidae** | | | |
| *Trachystoma petardi* | pinkeye mullet | 0 | 0 |
| *Mugil cephalus* | sea mullet | 0 | 0 |
| **Tetrarogidae** | | | |
| *Notesthes robusta* | bullrout | 0 | 0 |
| **Terapontidae** | | | |
| *Leiopotherapon unicolor* | spangled perch | 0 | 0 (20) |
| **Osteoglossidae** | | | |
| *Scleropages leichardti* | southern saratoga | 0 | 0 (3) |
| **Pest Species** | | | |
| *Gambusia holbrooki* | eastern Gambusia | 55 | 62 |
| *Xiphophorus maculatus* | platy | 0 | 0 |
| *Xiphophorus hellerii* | swordtail | 0 | 2 |
| *Poecilia reticulata* | guppy | 0 | 0 |

Bracketed numbers were provided by DNRM during the expert consultation process and were the result of a survey completed by DNRM in November 2015 at the Six Mile Creek Dam tailwater.

Table G.2 Catch Per Unit Effort (CPUE) of native fish species caught at each site during the August 2015 survey.

| Site | Common Name | Scientific Name | Method | Catch | CPUE (catch per hour) |
|---|---|---|---|---|---|
| **Downstream zone** | | | | | |
| SMCDS05 | carp gudgeon | *Hypseleotris* spp. | BPEF | 1 | 0.05 |
| | flathead gudgeon | *Philypnodon grandiceps* | BPEF | 1 | 0.05 |
| | freshwater catfish | *Tandanus tandanus* | BPEF | 1 | 0.05 |
| | longfin eel | *Anguilla reinhardtii* | BPEF | 6 | 0.30 |
| *SMCDS05 Total* | | | | 9 | 0.45 |
| SMCDS04 | Australian smelt | *Retropinna semoni* | Fyke | 1 | 0.01 |
| | carp gudgeon | *Hypseleotris* spp. | Fyke | 8 | 0.05 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | Fyke | 9 | 0.06 |
| | Pacific blue eye | *Pseudomugil signifer* | Fyke | 1 | 0.01 |
| *SMCDS04 Total* | | | | 19 | 0.13 |
| SMCDS03 | Australian smelt | *Retropinna semoni* | Fyke | 18 | 0.12 |
| | carp gudgeon | *Hypseleotris* spp. | Fyke | 4 | 0.03 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | Fyke | 6 | 0.04 |
| | longfin eel | *Anguilla reinhardtii* | Fyke | 1 | 0.02 |
| *SMCDS03 Total* | | | | 29 | 0.19 |
| SMCDS02 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 18 | 0.14 |
| | carp gudgeon | *Hypseleotris* spp. | Fyke | 50 | 0.38 |

| Site | Common Name | Scientific Name | Method | Catch | CPUE (catch per hour) |
|---|---|---|---|---|---|
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | Fyke | 9 | 0.07 |
| | flathead gudgeon | *Philypnodon grandiceps* | Fyke | 2 | 0.02 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | Fyke | 1 | 0.01 |
| | freshwater catfish | *Tandanus tandanus* | Fyke | 2 | 0.05 |
| *SMCDS02 Total* | | | | 82 | 0.61 |
| SMCDS01 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 16 | 0.12 |
| | carp gudgeon | *Hypseleotris* spp. | Bait, Fyke | 45 | 0.33 |
| | freshwater catfish | *Tandanus tandanus* | Fyke | 2 | 0.05 |
| *SMCDS01 Total* | | | | 63 | 0.45 |
| **Reservoir zone** | | | | | |
| DS Lake | Agassiz's glassfish | *Ambassis agassizii* | BPE, Fyke | 35 | 0.22 |
| | bony bream | *Nematalosa erebi* | BPE | 9 | 0.13 |
| | carp gudgeon | *Hypseleotris* spp. | BPE, Fyke | 270 | 1.73 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | Fyke | 2 | 0.01 |
| | flathead gudgeon | *Philypnodon grandiceps* | Fyke | 3 | 0.02 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | BPE, Fyke | 35 | 0.22 |
| | freshwater catfish | *Tandanus tandanus* | Fyke | 3 | 0.04 |
| *DS Lake Total* | | | | 357 | 2.27 |
| US Lake | Agassiz's glassfish | *Ambassis agassizii* | BPE, Fyke | 9 | 0.06 |
| | Australian bass | *Percalates novemaculeata* | BPE | 1 | 0.01 |

| Site | Common Name | Scientific Name | Method | Catch | CPUE (catch per hour) |
|---|---|---|---|---|---|
| | Australian smelt | *Retropinna semoni* | BPE | 1 | 0.01 |
| | bony bream | *Nematalosa erebi* | BPE | 2 | 0.03 |
| | carp gudgeon | *Hypseleotris* spp. | BPE, Fyke | 195 | 1.21 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | Fyke | 4 | 0.02 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | BPE, Fyke | 18 | 0.11 |
| US Lake Total | | | | 230 | 1.41 |
| **Upstream zone** | | | | | |
| CU02 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 15 | 0.08 |
| | bony bream | *Nematalosa erebi* | BEF, Fyke | 13 | 0.17 |
| | carp gudgeon | *Hypseleotris* spp. | BEF, Bait, Fyke | 60 | 0.33 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | BEF, Fyke | 5 | 0.03 |
| | freshwater catfish | *Tandanus tandanus* | Fyke | 1 | 0.01 |
| | longfin eel | *Anguilla reinhardtii* | Fyke | 2 | 0.03 |
| *CU02 Total* | | | | 96 | 0.52 |
| CU01 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 3 | 0.02 |
| | Australian bass | *Percalates novemaculeata* | BEF | 1 | 0.01 |
| | carp gudgeon | *Hypseleotris* spp. | BEF, Bait, Fyke | 128 | 0.70 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BEF, Fyke | 13 | 0.07 |
| | flathead gudgeon | *Philypnodon grandiceps* | Fyke | 4 | 0.02 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | Fyke | 1 | 0.01 |

| Site | Common Name | Scientific Name | Method | Catch | CPUE (catch per hour) |
|---|---|---|---|---|---|
| | southern shortfin eel | *Anguilla australis* | Line | 2 | 0.03 |
| *CU01 Total* | | | | 152 | 0.83 |
| CU03 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 5 | 0.03 |
| | bony bream | *Nematalosa erebi* | BEF, Fyke | 3 | 0.04 |
| | carp gudgeon | *Hypseleotris* spp. | BEF, Bait, Fyke | 155 | 0.85 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BEF | 4 | 0.02 |
| | flathead gudgeon | *Philypnodon grandiceps* | BEF, Fyke | 15 | 0.08 |
| | freshwater catfish | *Tandanus tandanus* | Fyke | 2 | 0.03 |
| | longfin eel | *Anguilla reinhardtii* | Line | 1 | 0.01 |
| *CU03 Total* | | | | 185 | 1.00 |
| SMCUS02 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 10 | 0.07 |
| | carp gudgeon | *Hypseleotris* spp. | Fyke | 50 | 0.36 |
| | dwarf flathead gudgeon | *Philypnodon macrostomus* | Fyke | 5 | 0.04 |
| | flathead gudgeon | *Philypnodon grandiceps* | Fyke | 5 | 0.04 |
| *SMCUS02 Total* | | | | 70 | 0.49 |
| SMCUS01 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 1 | 0.01 |
| | Australian smelt | *Retropinna semoni* | Fyke | 5 | 0.04 |
| | bony bream | *Nematalosa erebi* | Fyke | 4 | 0.12 |
| | carp gudgeon | *Hypseleotris* spp. | Bait | 80 | 0.71 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | Fyke | 1 | 0.01 |

| Site | Common Name | Scientific Name | Method | Catch | CPUE (catch per hour) |
|---|---|---|---|---|---|
| | freshwater catfish | *Tandanus tandanus* | Fyke | 2 | 0.06 |
| *SMCUS01 Total* | | | | 93 | 0.81 |
| SMCUS03 | carp gudgeon | *Hypseleotris* spp. | Line | 60 | 0.41 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | Line | 35 | 0.24 |
| | flathead gudgeon | *Philypnodon grandiceps* | Line | 4 | 0.03 |
| | freshwater catfish | *Tandanus tandanus* | Line | 1 | 0.02 |
| | longfin eel | *Anguilla reinhardtii* | Line | 1 | 0.02 |
| *SMCUS03 Total* | | | | 101 | 0.69 |

Table G.3 Catch Per Unit Effort (CPUE) for native fish species caught at each site during the October 2015 survey.

| Site | Common Name | Scientific Name | Method | Catch | CPUE (hr) |
|---|---|---|---|---|---|
| **Downstream zone** | | | | | |
| SMCDS04 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 1 | 0.01 |
| | Australian smelt | *Retropinna semoni* | Fyke | 2 | 0.03 |
| | carp gudgeon | *Hypseleotris* spp. | BPEF, Box, Fyke | 78 | 0.60 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BPEF, Box, Fyke | 60 | 0.46 |
| | dwarf flathead gudgeon | *Philypnodon macrostomus* | BPEF | 2 | 0.02 |
| | flathead gudgeon | *Philypnodon grandiceps* | BPEF | 3 | 0.02 |
| | freshwater catfish | *Tandanus tandanus* | Fyke | 1 | 0.02 |
| | Pacific blue eye | *Pseudomugil signifer* | Fyke | 1 | 0.01 |
| | purple-spotted gudgeon | *Mogurnda adspersa* | BPEF | 5 | 0.04 |
| *SMCDS04 Total* | | | | 153 | 1.17 |
| SMCDS03 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 4 | 0.03 |
| | Australian smelt | *Retropinna semoni* | Fyke | 4 | 0.06 |
| | carp gudgeon | *Hypseleotris* spp. | BPEF, Fyke | 147 | 0.94 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BPEF, Box, Fyke | 102 | 0.65 |
| | dwarf flathead gudgeon | *Philypnodon macrostomus* | BPEF, Fyke | 2 | 0.01 |
| | flathead gudgeon | *Philypnodon grandiceps* | BPEF | 2 | 0.01 |
| | freshwater catfish | *Tandanus tandanus* | BPEF | 1 | 0.01 |
| | longfin eel | *Anguilla reinhardtii* | BPEF | 4 | 0.06 |
| | Pacific blue eye | *Pseudomugil signifer* | BPEF, Fyke | 20 | 0.13 |

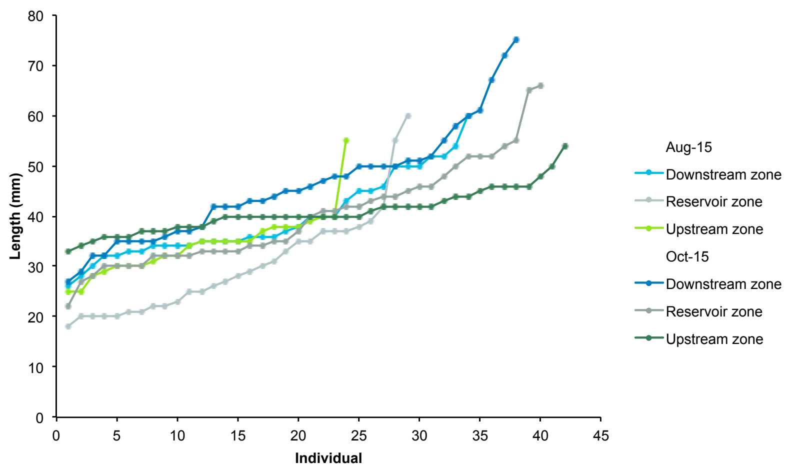
| Site | Common Name | Scientific Name | Method | Catch | CPUE (hr) |
|---|---|---|---|---|---|
| | purple-spotted gudgeon | *Mogurnda adspersa* | BPEF | 2 | 0.01 |
| *SMCDS03 Total* | | | | 288 | 1.81 |
| SMCDS02 | Agassiz's glassfish | *Ambassis agassizii* | BPEF, Fyke | 18 | 0.14 |
| | carp gudgeon | *Hypseleotris* spp. | BPEF, Fyke | 61 | 0.47 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BPEF, Box, Fyke | 124 | 0.96 |
| | flathead gudgeon | *Philypnodon grandiceps* | BPEF | 1 | 0.01 |
| | freshwater catfish | *Tandanus tandanus* | BPEF, Line | 5 | 0.08 |
| | longfin eel | *Anguilla reinhardtii* | BPEF, Fyke | 11 | 0.18 |
| | Pacific blue eye | *Pseudomugil signifer* | Fyke | 6 | 0.05 |
| *SMCDS02 Total* | | | | 226 | 1.73 |
| SMCDS01 | Agassiz's glassfish | *Ambassis agassizii* | BPEF, Fyke | 15 | 0.09 |
| | Australian bass | *Percalates novemaculeata* | BPEF, Fyke | 2 | 0.03 |
| | carp gudgeon | *Hypseleotris* spp. | BPEF, Fyke | 278 | 1.67 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BPEF, Fyke | 170 | 1.02 |
| | dwarf flathead gudgeon | *Philypnodon macrostomus* | BPEF | 2 | 0.01 |
| | flathead gudgeon | *Philypnodon grandiceps* | BPEF | 2 | 0.01 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | Fyke | 3 | 0.02 |
| | freshwater catfish | *Tandanus tandanus* | BPEF, Line, Fyke | 4 | 0.05 |
| | longfin eel | *Anguilla reinhardtii* | BPEF | 6 | 0.08 |
| | mouth almighty | *Glossamia aprion* | Fyke | 1 | 0.01 |
| *SMCDS01 Total* | | | | 483 | 2.88 |

| Site | Common Name | Scientific Name | Method | Catch | CPUE (hr) |
|---|---|---|---|---|---|
| **Reservoir zone** | | | | | |
| DS Lake | Agassiz's glassfish | *Ambassis agassizii* | BEF, Fyke | 50 | 0.32 |
| | Australian bass | *Percalates novemaculeata* | BEF | 1 | 0.01 |
| | Australian smelt | *Retropinna semoni* | BEF | 4 | 0.06 |
| | bony bream | *Nematalosa erebi* | BEF | 5 | 0.07 |
| | carp gudgeon | *Hypseleotris* spp. | BEF, Fyke | 515 | 3.27 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BEF, Fyke | 32 | 0.20 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | BEF, Fyke | 194 | 1.23 |
| | freshwater catfish | *Tandanus tandanus* | BEF | 5 | 0.07 |
| *DS Lake Total* | | | | 806 | 5.08 |
| US Lake | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 55 | 0.37 |
| | bony bream | *Nematalosa erebi* | BEF | 23 | 0.34 |
| | carp gudgeon | *Hypseleotris* spp. | BEF, Box, Fyke | 543 | 3.65 |
| | dwarf flathead gudgeon | *Philypnodon macrostomus* | BEF | 1 | 0.01 |
| | flathead gudgeon | *Philypnodon grandiceps* | Fyke | 1 | 0.01 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | BEF, Fyke | 66 | 0.44 |
| | longfin eel | *Anguilla reinhardtii* | Fyke | 1 | 0.01 |
| *US Lake Total* | | | | 690 | 4.62 |
| Upstream zone | | | | | |
| CU02 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 2 | 0.01 |
| | Australian smelt | *Retropinna semoni* | BEF | 2 | 0.03 |

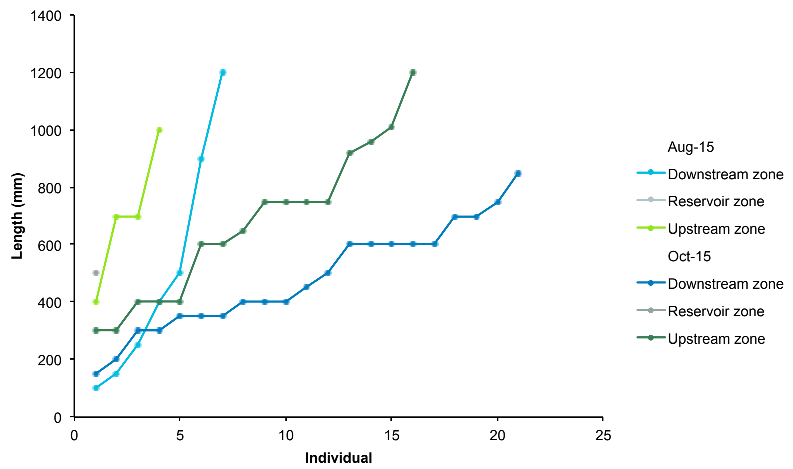
| Site | Common Name | Scientific Name | Method | Catch | CPUE (hr) |
|---|---|---|---|---|---|
| | bony bream | *Nematalosa erebi* | BEF | 1 | 0.01 |
| | carp gudgeon | *Hypseleotris* spp. | BEF, Box, Fyke | 659 | 4.34 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BEF, Fyke | 12 | 0.08 |
| | dwarf flathead gudgeon | *Philypnodon macrostomus* | BEF, Fyke | 6 | 0.04 |
| | flathead gudgeon | *Philypnodon grandiceps* | Fyke | 1 | 0.01 |
| | freshwater catfish | *Tandanus tandanus* | BEF | 1 | 0.01 |
| | longfin eel | *Anguilla reinhardtii* | BEF, Fyke | 11 | 0.15 |
| | purple-spotted gudgeon | *Mogurnda adspersa* | BEF, Fyke | 2 | 0.01 |
| *CU02 Total* | | | | 697 | 4.56 |
| CU01 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 11 | 0.08 |
| | Australian bass | *Pervalates novemaculeata* | BEF | 3 | 0.04 |
| | bony bream | *Nematalosa erebi* | BEF | 14 | 0.20 |
| | carp gudgeon | *Hypseleotris* spp. | BEF, Box, Fyke | 227 | 1.62 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BEF, Fyke | 15 | 0.11 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | Fyke | 8 | 0.06 |
| | longfin eel | *Anguilla reinhardtii* | BEF | 1 | 0.01 |
| *CU01 Total* | | | | 279 | 1.99 |
| CU03 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 7 | 0.05 |
| | Australian bass | *Percalates novemaculeata* | BEF | 6 | 0.08 |
| | bony bream | *Nematalosa erebi* | BEF | 38 | 0.52 |
| | carp gudgeon | *Hypseleotris* spp. | BEF, Box, Fyke | 104 | 0.68 |

| Site | Common Name | Scientific Name | Method | Catch | CPUE (hr) |
|---|---|---|---|---|---|
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BEF | 16 | 0.11 |
| | flathead gudgeon | *Philypnodon grandiceps* | Fyke | 2 | 0.01 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | BEF, Fyke | 44 | 0.29 |
| | freshwater catfish | *Tandanus tandanus* | Fyke | 3 | 0.04 |
| | longfin eel | *Anguilla reinhardtii* | BEF, Fyke | 2 | 0.03 |
| | purple-spotted gudgeon | *Mogurnda adspersa* | BEF | 1 | 0.01 |
| *CU03 Total* | | | | 223 | 1.47 |
| SMCUS02 | Agassiz's glassfish | *Ambassis agassizii* | BEF, Fyke | 23 | 0.15 |
| | Australian bass | *Percalates novemaculeata* | BEF | 1 | 0.01 |
| | Australian smelt | *Retropinna semoni* | BEF | 66 | 0.96 |
| | bony bream | *Nematalosa erebi* | BEF | 31 | 0.45 |
| | carp gudgeon | *Hypseleotris* spp. | BEF, Box, Fyke | 97 | 0.64 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BEF | 4 | 0.03 |
| | dwarf flathead gudgeon | *Philypnodon macrostomus* | Fyke | 9 | 0.06 |
| | flyspecked hardyhead | *Craterocephalus stercusmuscarum* | BEF | 32 | 0.21 |
| | freshwater catfish | *Tandanus tandanus* | BEF | 1 | 0.01 |
| | longfin eel | *Anguilla reinhardtii* | BEF | 1 | 0.01 |
| | purple-spotted gudgeon | *Mogurnda adspersa* | Fyke | 1 | 0.01 |
| *SMCUS02 Total* | | | | 266 | 1.73 |
| SMCUS01 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 1 | 0.01 |
| | Australian smelt | *Retropinna semoni* | Fyke | 7 | 0.09 |

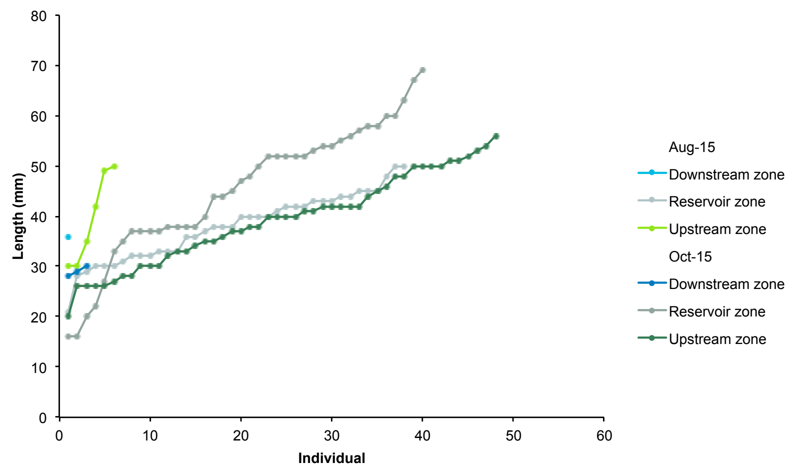
| Site | Common Name | Scientific Name | Method | Catch | CPUE (hr) |
|---|---|---|---|---|---|
| | carp gudgeon | *Hypseleotris* spp. | BPEF, Box, Fyke | 310 | 1.78 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | Fyke | 7 | 0.04 |
| | dwarf flathead gudgeon | *Philypnodon macrostomus* | BPEF, Fyke | 3 | 0.02 |
| | flathead gudgeon | *Philypnodon grandiceps* | BPEF, Fyke | 7 | 0.04 |
| | freshwater catfish | *Tandanus tandanus* | Fyke | 2 | 0.03 |
| | longfin eel | *Anguilla reinhardtii* | Fyke | 1 | 0.01 |
| | purple-spotted gudgeon | *Mogurnda adspersa* | BPEF, Fyke | 2 | 0.01 |
| *SMCUS01 Total* | | | | 340 | 1.94 |
| SMCUS03 | Agassiz's glassfish | *Ambassis agassizii* | Fyke | 1 | 0.01 |
| | Australian bass | *Percalates novemaculeata* | BPEF | 2 | 0.03 |
| | Australian smelt | *Retropinna semoni* | Fyke | 19 | 0.31 |
| | carp gudgeon | *Hypseleotris* spp. | BPEF, Fyke | 80 | 0.61 |
| | crimson-spotted rainbowfish | *Melanotaenia duboulayi* | BPEF, Fyke | 39 | 0.30 |
| | dwarf flathead gudgeon | *Philypnodon macrostomus* | Fyke | 1 | 0.01 |
| | flathead gudgeon | *Philypnodon grandiceps* | Fyke | 1 | 0.01 |
| *SMCUS03 Total* | | | | 143 | 1.09 |



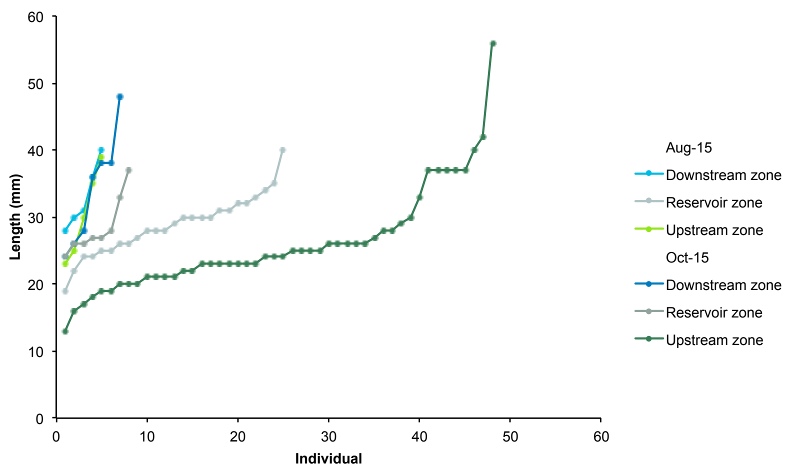

*Ambassis agassizii* (Agassiz's glassfish)



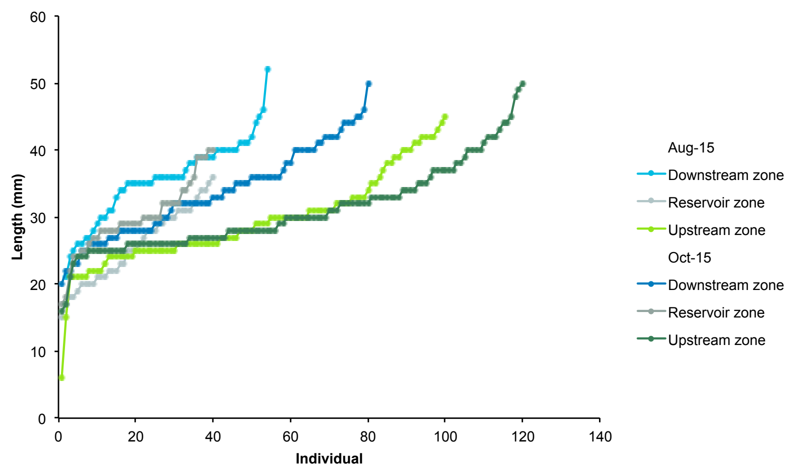

*Anguilla reinhardtii* (longfin eel)



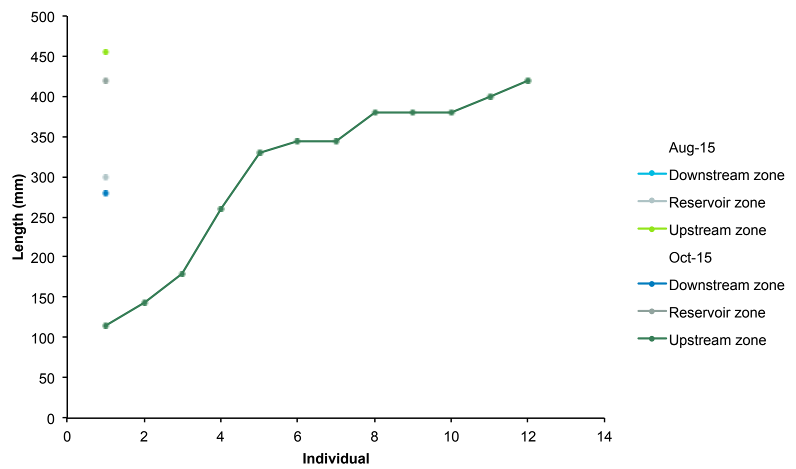

*Craterocephalus stercusmuscarum* (flyspecked hardyhead)



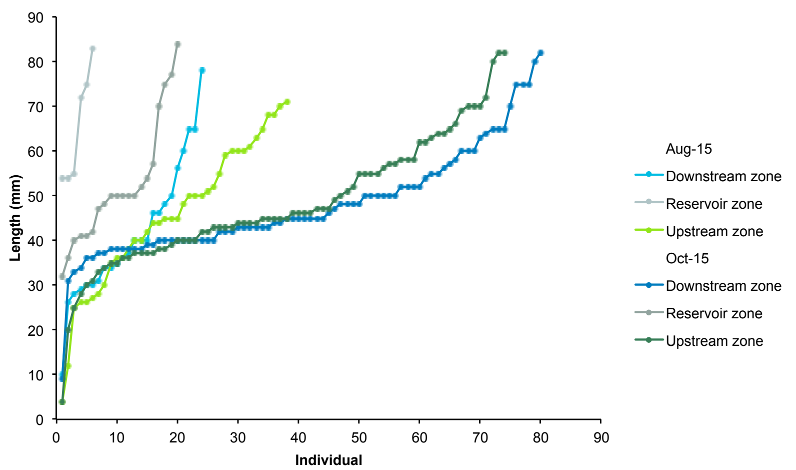

*Gambusia holbrooki* (eastern Gambisua)



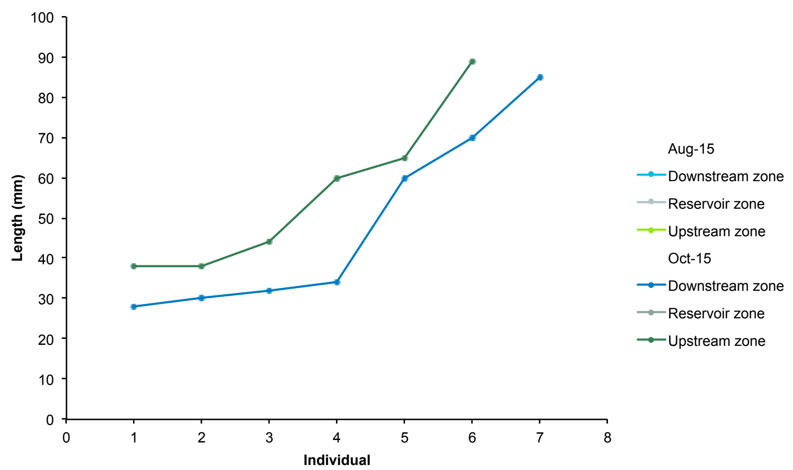

*Hypseleotris spp.* (carp gudgeon)



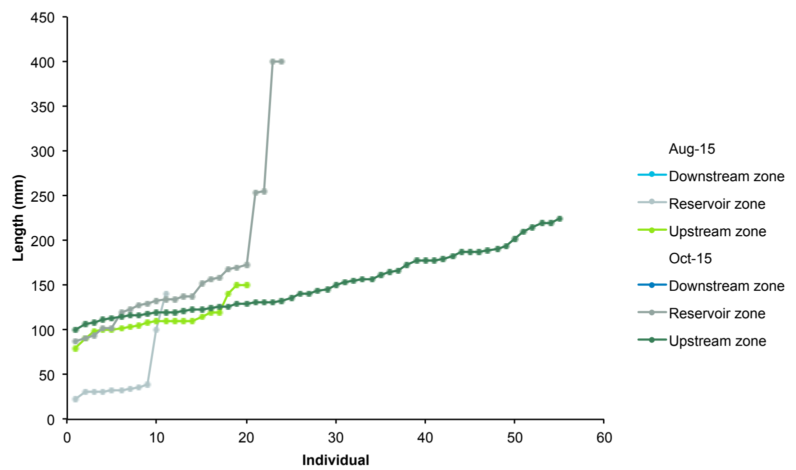

*Percalates novemaculeata* (Australian bass)



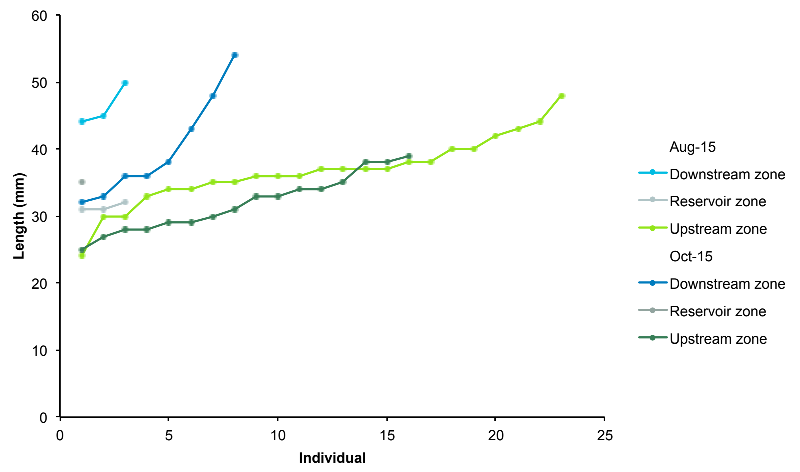

*Melanotaenia duboulayi* (crimson-spotted rainbowfish)



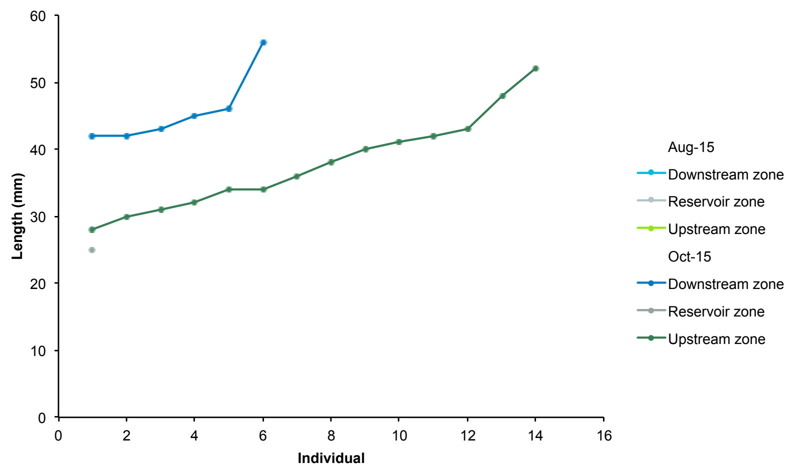

*Mogurnda adspersa* (purple-spotted gudgeon)



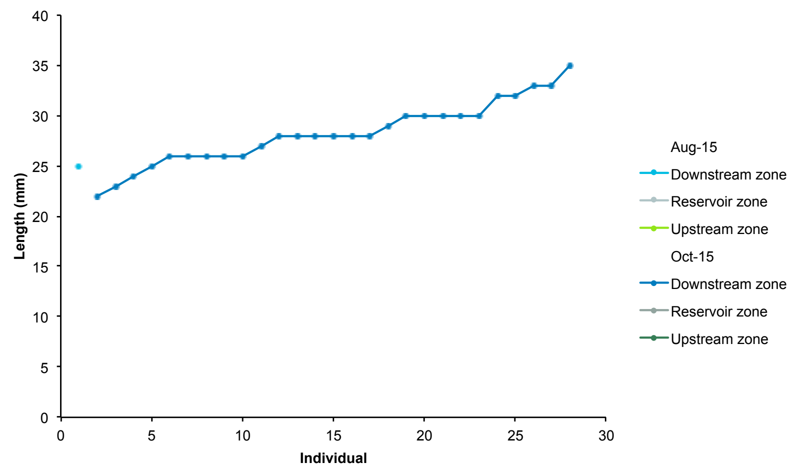

*Nematalosa erebi* (bony bream)



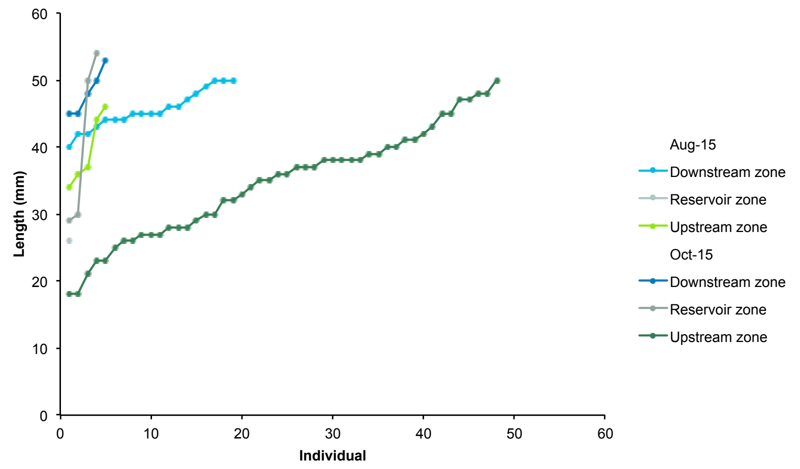

*Philypnodon grandiceps* (flathead gudgeon)



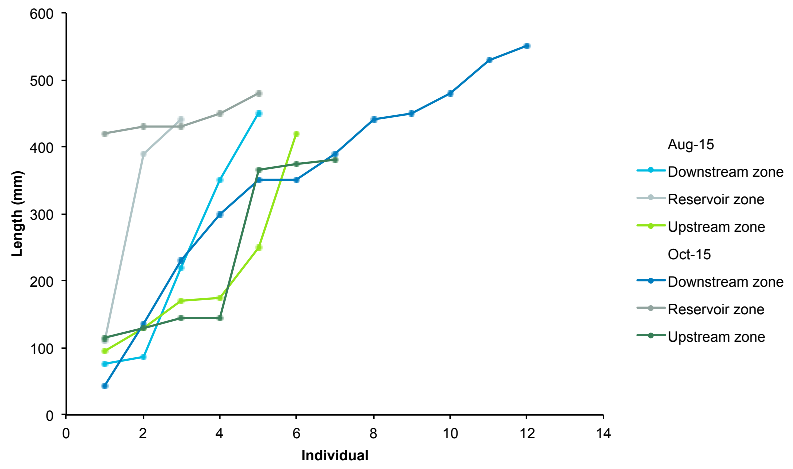

*Philypnodon macrostomus* (dwarf flathead gudgeon)




*Pseudomugil signifer* (Pacific blue-eye)




*Retropinna semoni* (Australian smelt)




*Tandanus tandanus* (eel-tailed catfish)

Figure G.1 Total length of each fish caught from each assessment zone for each survey, by species.

# Appendix H Detailed Turtle Survey Results

Table H.1 Raw turtle survey data.

| Species | Site | August 2015 | | October 2015 | |
|---|---|---|---|---|---|
| | | Juvenile | Adult | Juvenile | Adult |
| *Wollumbinia latisternum* | CU01 | – | 1 | – | – |
| | CU02 | – | 1 | – | 4 |
| | SMCUS01 | – | 2 | – | 3 |
| | SMCUS02 | – | 1 | – | – |
| | SMCUS03 | – | 3 | – | 1 |
| | SMCDS02 | – | – | – | 1 |
| | SMCDS04 | – | 3 | 2 | – |
| *Emydura macquarii krefftii* | CU02 | – | 2 | – | – |
| | SMCUS02 | – | 4 | – | 3 |
| | SMCUS03 | – | – | – | 1 |
| | US Lake | – | 1 | – | – |
| | DS Lake | – | 2 | – | 2 |
| *Chelodina longicolis* | CU03 | – | 1 | – | 1 |
| | DS Lake | – | 1 | – | – |
| *Chelodina expansa* | CU01 | – | – | – | 1 |

# Appendix I Summary of critical flows for MNES species in Six Mile Creek at Cooran

Table I.1 Summary of critical flows for MNES species in Six Mile Creek at Cooran (gauging station 138107B).

| Critical flow | Description | Discharge required to achieve critical flow (ML/day) | When required for MNES species | Percentage of time exceeded | | | |
|---|---|---|---|---|---|---|---|
| | | | | Aug – Nov | Dec – Feb | Mar – Apr | May – Jun |
| 10 cm above cease to flow | Stable base flow; maintain shallow riffles; maintain water levels in deep pools; maintain dissolved oxygen | 0.02 – 1.0 | constant | >90 | – | – | – |
| 30 cm above cease to flow | Maintain riffle-run habitats, connect habitats | 0.9 – 20.0 | Constant, but especially in spring and early summer for all species | 42 – 64 | – | – | >90 |
| 2 m above cease to flow | Stimulate dispersal in Mary cod and probably other MNES species; maintain breeding habits for MNES species | 676 | Twice per year, preferably not between December and January in areas where Mary River turtles nest, or between August – February for lungfish; **Needed May to June, and September to February for Mary River cod** | 4.5 (spring) – 8.5 (late winter) | 13.5 | 20.5 | 13 |
| 5 year ARI event | Geomorphic maintenance of habitats via scouring | 12,729 | Once every 5 years | 0 | 0 | 4 | 3 |

Adapted from Hydrobiology (2007)