# Appendix H BOOBOOK 2021. Habitat Survey and Impact Assessment for White-throated snapping turtle and Fitzroy River turtle

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# Dawson River Proposed Action Area Habitat Survey and Impact Assessment for White-throated Snapping Turtle and Fitzroy River Turtle

Compiled by BOOBOOK for Santos

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# Executive Summary

BOOBOOK was engaged by Santos (the Client) to conduct a literature review and field survey of aspects of the distribution and ecology for two freshwater turtle species, the White-throated Snapping Turtle (*Elseya albagula*) and Fitzroy River Turtle (*Rheodytes leukops*), within a section of the Dawson River and associated watercourses, described as the proposed action area. Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), *Elseya albagula* is listed as Critically Endangered, while *Rheodytes leukops* is listed as Vulnerable. The subsequent report was to provide additional information for use in assessment by the Commonwealth Department of Agriculture, Water and the Environment (DAWE), now known as the Department of Climate Change, Energy, the Environment and Water (DCCEEW), of the Fairview Water Release Scheme (EPBC 2021/8914) with regard to impacts on the two turtle species. In accord with the requirements detailed in the DAWE request for additional information, this report will synthesize desktop and field results and provide a discussion of:

- The known historical distribution (i.e. location records) of the two turtle species within their broad range;
- The occurrence of the two species within the proposed action area, including mapped locations;
- The terrestrial and aquatic environment suitable to support habitat requirements, including estimated areal extent and mapping of suitable foraging, shelter and breeding habitat within the proposed action area;
- Aspects of water quality suitable to support habitat requirements;
- The potential impacts on the habitat of the proposed action, including hydrology (flow rates, water levels, bank stability), sediment and contaminant effects. Avoidance and mitigation measures appropriate to any impacts will be discussed.

The proposed action is the release of up to 18 ML/day of desalinated produced water to the Dawson River via a drainage feature, waterhole and outlet watercourse to the Dawson River. There is no proposed increase in the existing approved maximum daily release rate (18 ML/day) or total annual volume of 6,570 ML/year (limited by the State EA). Proposed releases of Gas Field Development (GFD) Project water will substitute Gladstone Liquefied Natural Gas (GLNG) Project water currently released, and other water management and beneficial use options such as irrigation will remain in place. Water management and treatment prior to the proposed action will use existing water management and water treatment infrastructure at HCS04, including the ROP, water storage ponds and desalinated water release pipe from HCS04 to the drainage feature.

Initial release of treated water as part of the Dawson River Release Scheme (DRRS) began in July 2015 (frc environmental 2019a, Santos 2012). The water is piped from a reverse osmosis water treatment facility (ROP2) to the release outfall at the head of a first order stream drainage feature (the drainage feature). Discharged water flows approximately 2.9 km along the Drainage Feature to a large lagoon (the waterhole). Overflow from the waterhole enters a second order stream watercourse (the watercourse), flowing 1.8 km to enter the Dawson River at a point approximately midway between Dawson's Bend and the Baroondah (Yebna) Crossing (Appendix A). Thus, the drainage feature, waterhole, watercourse and the Dawson River below the confluence with the watercourse to Baroondah Crossing form the receiving environment for the desalinated water release.

The turtles *E. albagula* and *Rheodytes leukops* are confirmed as being present within the proposed action area, having been recorded at several locations. It is considered highly likely that both turtle species will occur throughout the Dawson River within the proposed action area. Critical habitat for *E. albagula* and suitable habitat for *R. leukops* was available within the Dawson River but no significant habitat for the two species was present in either the drainage feature, waterhole or the watercourse. The Dawson River within the proposed action area provided a continuous length (8.1 km) of suitable riverine habitat for the two turtle species. This habitat was consistent with the definition of 'critical habitat' given in the National Recovery Plan for *E. albagula* (Commonwealth of Australia 2020); and consistent with the description of *R. leukops* habitat provided by TSSC (2008). It was found in the field that under the flow regime operating during the survey period the average bed width was estimated at 15 m. Aquatic shelter and foraging habitat for the two species within the Dawson River was estimated at 12.12 ha.

The stretch of the Dawson River within the proposed action area was found to provide a variety of riverine landforms suitable for the location of nests by the two turtle species. Three predated and one intact turtle nests were detected during the field survey: three of these were thought to be *E. albagula* nests. Using the high banks of the river as limits of nesting habitat we calculated that 88.17 ha of potential nesting habitat was available to the two species. In line with published accounts (see section 4.1.3) it is expected that most nesting within this area would occur close to the water's edge. That is to say, preferred nesting habitat would be a small subset of the potential habitat.

The Dawson River within the proposed action area is a perennial stream with variable flows, typically at low levels but periodically experiencing high-energy flood events. Based on a series of assessments covering a range of flow levels from low to flood, frc environmental (2019b) concluded that bank stability was moderate, with some unstable and eroding sections and areas of cattle disturbance to banks. Bed stability was low, with significant scouring and deposition of sand following very high flow events. These data indicate that the riverbank environment is reasonably resilient to flood-induced erosion events.

Measured water depth changes at Baroondah Crossing during desalinated water release events on base flow levels showed that for a release of 18 ML/d (the maximum allowable daily release) the water level increases by approximately 0.05 m. Such a rise would still be contained below the first bench in the banks. Measured water level data at Baroondah Crossing also shows that increases in water depth at S4 following the start of a desalinated water release occurs slowly over a number of days as the upstream waterhole gradually fills and starts to spill. Initial water level increases in the Dawson River at S4 are not observable for between two to three days after the start of a desalinated water release, then the water level at S4 slowly increases to the measured maximum of 0.05 m above pre-release levels over a duration of between nine to ten days. By comparison, water depth change in response to rainfall events are rapid and occur within a day.Consequently, the effects of water release would be confined to the bed and banks below the first bench for most of the time, that is within a pre-existing high disturbance zone unlikely to be used as nesting habitat. The higher banks are apparently relatively resilient to flood erosion. The contribution of released water flows to floods is insignificant in terms of the erosional impact of those floods so loss of nesting habitat over and above natural levels is unlikely. The released water would not inundate nesting habitat for the turtles during their winter-spring nesting seasons and would at worst only minimally impact on the effects of floods in summer when most hatching would have occurred.

For both *E. albagula* and *R. leukops* the most significant identified threat is a near-total failure of recruitment of juveniles into their populations as a result of predation or trampling of nests (Limpus *et al.* 2011, TSSC 2008, TSSC 2014). Known predators include both native and non-native species. Feral pigs were commonly detected during the field survey, by their distinctive diggings or sightings of pigs. Field-based evidence indicates that nest predation is occurring within the proposed action area and more generally in suitable habitat throughout the upper Dawson catchment, and that Feral Pigs are likely to be a significant nest predator.

Trampling of nests by livestock, principally cattle, also results in loss of eggs (Limpus *et al.* 2011, TSSC 2008, TSSC 2014). Domestic cattle were commonly encountered throughout the proposed action area, and feral cattle and horses are known to be present in the adjacent Expedition Resources Reserve, which has frontage on the Dawson River upstream of the proposed action area (BOOBOOK 2020). Deep pugging, bank slumping and incised tracks on banks were frequently seen. It is very likely that trampling contributes to nest loss within and upstream of the proposed action area, as it does elsewhere.

Water quality monitoring has occurred at sites above and below the desalinated water release point into the Dawson River, both prior to commencement and subsequent to release of desalinated water. All measured parameters for riverine physico-chemical water quality are within the identified limits described in Environmental Authority No. EPPG00928713. Riverine water quality within the proposed action area, both upstream and downstream of the discharge point to the river, is satisfactory. This also implies that water quality thresholds are within limits for water travelling from the discharge point to the waterhole and thence to the river discharge point.

Receiving environment monitoring program (REMP) data indicates that flows, water quality and riverine hydrology and geomorphology have been unaffected or only minimally affected by release of desalinated water to the proposed action area. These minor changes are unlikely to impact on the environmental values of the Dawson River. There will be no significant residual impact to the White throated Snapping Turtle (*E. albagula*) nor on the Fitzroy River Turtle (*R. leukops*) as a result of the proposed action.

There is potential for development of a nesting habitat protection project for the Dawson River within the proposed area. Such a project would seek to address both nest predation due to feral animals and trampling of nests by domestic and feral livestock. It would necessarily require the cooperation of all landholders upstream and within the proposed action area to be effective.

# Abbreviations and Definitions

| Abbreviation | Description |
|---|---|
| ANZECC | Australia and New Zealand Environment and Conservation Council |
| AoO | Area of Occupancy |
| ARI | Average recurrence interval |
| cm | centimetre(s) |
| CSG | coal seam gas |
| DAWE | Department of Agriculture, Water and the Environment |
| DCCEEW | Department of Climate Change, Energy, the Environment and Water |
| DES | Department of Environment and Science |
| DO | dissolved oxygen |
| DRRS | Dawson River Release Scheme |
| EA | Environmental Authority |
| e.g. | for example |
| EoO | Extent of Occupancy |
| EPBC Act | *Environment Protection and Biodiversity Conservation Act 1999* |
| GPS | Global Positioning System |
| ha | hectare(s) |
| i.e. | that is |
| km | kilometre(s) |
| m | metre(s) |
| mm | millimetres(s) |
| m/s | metres/second |
| $m^3/s$ | cubic metres/second |
| ML/d | Megalitres/day |
| MNES | Matter(s) of National Environmental Significance |
| No. | Number |
| PAH | Polycyclic aromatic hydrocarbon |
| PCB | Polychlorinated biphenyl |
| Proposed Action | The release of up to 18 ML/d of desalinated water produced from gas extraction in the Fairview gas field. |
| Proposed action area | The receiving environment for treated (desalinated) produced water including the drainage feature, the waterhole, the watercourse and the bed and banks of the Dawson River downstream to Baroondah (Yebna) Crossing. |
| ROP2 | Reverse Osmosis Plant 2 |
| SF | State Forest |
| spp. | species (plural) |
| SRI | Significant Residual Impact |
| The drainage feature | The first order stream that carries desalinated water 2.9 km from the ROP2 discharge pipe to the waterhole. |
| The watercourse | The second order stream that carries overflow from the waterhole 1.8 km to the Dawson River. |
| The waterhole | A large lagoon (the waterhole) that receives desalinated water via the drainage feature. The waterhole also receives water from rainfall and occasionally receives floodwater from the Dawson River. |

# 1. Introduction

## 1.1. Purpose and Scope

BOOBOOK was engaged by Santos (the Client) to conduct a literature review and field survey of aspects of the distribution and ecology for two freshwater turtle species, the White-throated Snapping Turtle (*Elseya albagula*) and Fitzroy River Turtle (*Rheodytes leukops*), within a section of the Dawson River and associated watercourses, described as the proposed action area. Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), *Elseya albagula* is listed as Critically Endangered, while *Rheodytes leukops* is listed as Vulnerable. The subsequent report was to provide additional information for use in assessment by the Commonwealth Department of Agriculture, Water and the Environment (DAWE), now known as the Department of Climate Change, Energy, the Environment and Water (DCCEEW), of the Fairview Water Release Scheme (EPBC 2021/8914) with regard to impacts on the two turtle species.

The proposed action area to be surveyed was identified in a map provided by the Client. Subsequently, in October 2022 the proposed action was modified to exclude event-based releases of water. Appendix A shows the location and extent of the proposed action area.

In accord with the requirements detailed in the DAWE request for additional information, the report is to synthesize desktop and field results and provide a discussion of:

- The known historical distribution (i.e. location records) of the two turtle species within their broad range;
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- The terrestrial and aquatic environment suitable to support habitat requirements, including estimated areal extent and mapping of suitable foraging, shelter and breeding habitat within the proposed action area;
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- The potential impacts on the habitat of the proposed action, including hydrology (flow rates, water levels, bank stability), sediment and contaminant effects. Avoidance and mitigation measures appropriate to any impacts will be discussed.

## 1.2. Survey and Reporting Team

The field survey was undertaken on 14-19th July 2021 by Richard Johnson (BOOBOOK, Senior Ecologist) and Eamon Amsters (BOOBOOK, Graduate Ecologist). The report was compiled by Richard Johnson and Lynda Hardwick (BOOBOOK, GIS Officer). All aspects of the project including field survey and reporting were conducted under the supervision of Craig Eddie (BOOBOOK, Principal Ecologist).

The project supervisor (Craig Eddie) was approved by the Department of Agriculture, Water and the Environment (DAWE), formerly the Commonwealth Department of Sustainability, Environment, Water, Population and Communities, in writing on the 28th of January 2011 for the purpose of undertaking ecological assessment works for the Gladstone Liquefied Natural Gas (GLNG) project.

## 1.3. Site Description

The proposed action area consists of the bed and banks of a section of the Dawson River (and tributary), its upstream limit being the desalinated water release and includes a first order stream drainage feature ("the Drainage Feature") which discharges into a large, isolated ox-bow lake or billabong referred to as the "waterhole" and ultimately drains to the Dawson River via a second order watercourse. These features carry releases of desalinated water of varying volumes and duration. The proposed action area extends downstream to Baroondah Crossing (also known as Yebna Crossing) on the Injune-Taroom Road, a distance of approximately 8 km.

The proposed action area is located approximately 55 km east-northeast of Injune, south central Queensland. It is located entirely within Subregion 24 (Carnarvon Ranges) of the Brigalow Belt bioregion (Sattler and Williams 1999) and is located in the mid- to upper reaches of the Dawson River, a major tributary of the Fitzroy drainage basin. The river here features a perennial, spring-fed flow derived from the upstream Hutton Creek (entering the river about 14 km above the upstream limit of the proposed action area) and greatly augmented by numerous spring discharges associated with the incised Precipice Sandstone. Within this section of the river the bed is largely confined within steeply sloping banks delineated by outcropping hills and rises, with only limited floodplain development. The area of the Dawson River within the proposed action area features greater development of a floodplain.

Deep sandy to silty loam alluvium associated with the banks and channel of the Dawson River supports riparian open forest of Queensland Blue Gum (*E. tereticornis*), River Oak (*Casuarina cunninghamiana*), Rough-barked Apple (*Angophora floribunda*) and Weeping Bottlebrush (*Melaleuca viminalis*).

Land use within the proposed action area includes coal seam gas (CSG) production activities on the properties "Fairview" and "Yebna", associated with the Fairview Gas Field. Yebna is an extensive pastoral (beef cattle) property with some areas of cropping, particularly around the waterhole. The upper part of the river, upstream of the proposed action area, is bordered to the north by Crown land, this being the Expedition Resources Reserve. Within the proposed action area, Yebna has a double frontage on the river, this extending downstream almost to Baroondah Crossing. The last (downstream) 1.5 km of the proposed action area is bounded by State Forest (SF) but this land has been largely cleared for pastoral purposes.

## *1.4. Details of the Proposed Action*

The proposed action is the release of up to 18 ML/day of desalinated produced water via a drainage feature, waterhole and outlet watercourse to the Dawson River. There will be no increase in the existing approved maximum daily release rate (18 ML/day) or total annual volume of 6,570 ML/year (limited by the State EA). Proposed releases of Gas Field Development (GFD) Project water will substitute Gladstone Liquefied Natural Gas (GLNG) Project water currently released, and other water management and beneficial use options such as irrigation will remain in place. Initial release of desalinated water as part of the Dawson River Release Scheme (DRRS) began in July 2015 (frc environmental 2019a, Santos 2012).

Water management and treatment prior to the proposed action will use existing water management and water treatment infrastructure at the Hub Compressor Station 04 (HCS04), including the reverse osmosis plant (ROP), water storage ponds and desalinated water release pipe that transports desalinated water from HCS04 to the top of the drainage feature. Released desalinated water flows approximately 2.9 km along the drainage feature to the waterhole. Overflow from the waterhole enters a second order stream watercourse downstream, flowing 1.8 km to enter the Dawson River at a point approximately midway between Dawson's Bend and Baroondah Crossing (Appendix A).

Thus, the drainage feature, waterhole, watercourse and the Dawson River below the confluence with the watercourse form the receiving environment for the treated CSG produced water. Maximum designed output of treated water under the proposed action is 18 megalitres per day (ML/d) as limited by the existing Environmental Authority (EA) EPPG00928713. The frequency of desalinated water releases have varied between 87 days per year and 156 days per year between 2016 and 2022. Revised water management prioritising more water use for beneficial uses such as irrigation has been recently introduced that has resulted in a reduction from 156 desalinated water release days in 2020 to 95 desalinated water release days in 2021.

# 2. Methodology

## *2.1. Desktop Assessment*

A literature review was undertaken of the known distribution, ecology, habitat use and known or potential threatening processes affecting the two turtle species, *Elseya albagula* and *Rheodytes leukops.* Sources included published books and research papers, government departmental reports, conservation advices and action plans, and published and unpublished consultancy reports. Publicly accessible databases were searched for occurrence records – these included Wildlife Online (DES 2021) and Atlas of Living Australia (ALA 2021). These sources were augmented by BOOBOOK field experience in the area.

Findings of the desktop assessment were used in summarising the known or potential occurrence, habitat use and breeding ecology of the species within the proposed action area. Results of this assessment were also collated to inform the definition of turtle aquatic and nesting habitat used during field survey within the proposed action area, as discussed below.

## 2.2. Field Assessment

No published guidelines are available for habitat mapping for the turtles. However, the habitat requirements of the two species are relatively well understood (as discussed in Section 4.1.2). Published information thus informed habitat mapping decisions. Potential foraging and shelter habitat for *Elseya albagula* and *Rheodytes leukops* was defined as the entirety of stream beds containing a permanent, albeit variable, flow and featuring riffles joining deeper pools.

Based on published accounts of nest habitat preferences (Hamann *et al*. 2004, Limpus *et al*. 2011) we defined the area most likely to include nest habitat as being that part of the river from the first bench or bank above the low or base flow level landward to the high bank. Most *Rheodytes leukops* nests would be encountered within this region, though a small number of *Elseya albagula* nests may be located further away from the water (Limpus *et al.* 2011). Because some areas of particularly preferred nesting habitat may occur within the low banks of the watercourses (e.g. sandbars) it was proposed to spatially define such features (point location or region as required) where possible, using GPS and tablet data capture.

A two-person team of ecologists walked traverses on successive sections of the Dawson River and other watercourses within the proposed action area. One team member walked the high bank defining the outer limit of likely nest habitat while the other walked the lower banks to identify any preferred nesting habitat. Representative examples of in-stream foraging and intra-bank nesting habitat were documented (GPS waypoints, photographs) and site characteristics were recorded, including bank profiles and substrates. Height of these features above the low flow level were captured photographically at selected representative sites.

Searches were conducted for evidence of nesting by turtles (tracks of turtles, broken egg shells from predated nests). Observations of evidence of threatening processes operating locally (i.e. in the proposed action area) were recorded.

Incidental observations were made of turtles, evidence of turtle nesting, and the presence of other obligate aquatic vertebrates (e.g. platypus, other turtle species, water rat, fishes) with records captured on tablet using a Santos data capture schema.

## 2.3. Survey Limitations

The field survey was aimed at identifying the potential of the proposed action area to provide shelter, foraging and breeding (nesting) habitat for *Elseya albagula* and *Rheodytes leukops*, and characterization of any habitat present, as well as assessment of any threatening processes present. In particular, the potential for habitat loss as a result of inundation from increased flows was a priority. No assessment was made of water quality parameters or water chemistry, for which pre-existing data is available (e.g. frc environmental 2019b).

No observational or trapping surveys of the two turtle species were conducted. This was not the primary focus as both species were already known to occur in the area. Further, species-appropriate surveys, such as extended-time pool-watches for *Elseya albagula* and seine netting or night spotlighting for *Rheodytes leukops* (Eyre *et al.* 2018, Limpus *et al.* 2011), were not feasible within the project time-frame. Encounters were limited to incidental observations only.

Discharge of treated water was ceased at 0600 hrs on 13 June 2021 i.e. approximately 24 hrs prior to commencement of the field survey. When inspected on 14 June 2021, no flow was apparent in the drainage feature above the waterhole. However, below the waterhole the watercourse was still discharging water to the Dawson River: that is, some flow from the waterhole to the river was still occurring.

# 3. Results & Discussion

## 3.1. Review of known distribution, nesting ecology and threats

### 3.1.1. Distribution

Both turtles are endemic to Queensland. *Elseya albagula* is found only in permanent waters of the Burnett, Mary and Fitzroy Rivers and their associated tributaries.

In the Mary River *E. albagula* is known from the freshwater limits near Tiaro, upstream to the Kenilworth area. It also occurs in major tributaries including Wide Bay Creek, Yabba Creek and Obi Obi Creek (Limpus 2008).

*E. albagula* is known in the Burnett River from locations throughout the freshwater reaches upstream to Gayndah and Mundubbera, and in Three Moon Creek near Monto. It has also been recorded in the Burrum River from Lenthalls Dam and Howard (ALA 2020, Limpus 2008).

*E. albagula* is known to occur throughout the Fitzroy catchment from the Fitzroy Barrage upstream to the highest spring-fed pools in the Mackenzie and Dawson Rivers. The western-most records of the species are in the Nogoa River at Emerald and at Carnarvon Creek, a tributary of the Comet River (ALA 2021). Limpus *et al.* (2011) reported that within the Dawson catchment animals were recorded from permanent waters as far upstream as the properties “Warndoo” on Hutton Creek and “Korcha” on the Dawson River, well upstream of the action area. The species was reported (DES 2021, ALA 2020) from Baroondah Crossing on the Dawson River (the downstream limit of the proposed action area) in 1979 and frc environmental (2010) recorded the species in the Nathan Gorge during surveys in 2010. It has more recently been detected at several locations on the upper Dawson River and associated tributaries, including some that are within or near the action area. In a rapid survey of *ca.* 45 km of potentially suitable habitat on Eurombah Creek (a major southern tributary of the upper Dawson River), the species was detected in seventeen of 45 waterholes and it was was assessed as likely to be present in all suitable habitat (BOOBOOK 2017). During assessments associated with a proposed water release into the Dawson River within the proposed action area, characteristics of the riverine environment indicated that potentially suitable habitat was present (AECOM 2016a).

*E. albagula* is confirmed as being present within the proposed action area (Figure 1). Baseline surveys in 2013-2015 and subsequent monitoring surveys for turtles in 2017-2019 (frc environmental 2018, 2019a) detected *E. albagula* on multiple occasions at a site in the Dawson River (and once at the waterhole) within the proposed action area and at sites upstream of the proposed action area, including one site in Hutton Creek. Incidental observations at pools in the river during ecological surveys in 2019-2020 (BOOBOOK 2020) detected *E. albagula* at four locations at and below the junction of Hutton Creek and the river. During the present survey, turtles were seen at a further two locations within the proposed action area. While a comprehensive survey for the species within the proposed action area has not been carried out, the multiple records to date from incidental encounters and limited site-specific trapping indicate that the species will be present throughout the proposed action area. The broader distribution of *E. albagula* and its known occurrence within/near the proposed action area are shown inAppendices B and C.

*R. leukops* is found only in the Fitzroy River and its associated tributaries. Previously known sites include the Fitzroy River near Duaringa, Boolburra, Glenroy Crossing and Gogango; Marlborough Creek; Moura, Baralaba, Gainsford and Theodore on the Dawson River; the Mackenzie River near Comet; and the Connors River near Lotus Creek (ALA, 2020, Limpus *et al.* 2011). The proposed construction of the Rookwood and Eden Bann weirs on the Fitzroy River have been a significant driver of research into the distribution of this turtle (e.g. GHD 2015, 2016). Until recently the records from Theodore represented the upstream limit of this turtle’s known occurrence in the Dawson River. This may be due to lack of surveys using species-appropriate techniques (frc environmental 2010, C. Limpus pers. comm. 2018), though some netting surveys have been conducted (frc environmental 2010).

In 2017-19 *R. leukops* (Figure 2) was recorded at three survey locations on the upper Dawson River, one of which (site DRMP1) is within the proposed action area, with other sites immediately upstream (site DRR1) and downstream (site S4) of the proposed action area (frc environmental 2018, 2019a). These records are approximately 260 km upstream of the Theodore records. Suitable riverine habitat recorded near this location (AECOM 2016a, this report) is present upstream to at least the confluence of the Dawson River with Hutton Creek (BOOBOOK 2019). It is therefore considered highly likely that this turtle will occur throughout the Dawson River within the proposed action area. The broader distribution of *R. leukops* and its known occurrence within/near the proposed action area are shown at Appendices B and C.

Four other turtle species are present within the proposed action area (frc environmental 2019, BOOBOOK 2020): these are the Saw-shelled Turtle (*Wollumbinia latisternum*), Krefft’s River Turtle (*Emydura krefftii*), Eastern Long-necked Turtle (*Chelodina longicollis*) and Broad-shelled River Turtle (*C. expansa*). None of these are currently listed as conservation-dependent species.

**Figures 1, 2**: Threatened freshwater turtle species present in the Dawson River proposed action area - White-throated Snapping Turtle (*Elseya albagula*) (left: image BOOBOOK) and Fitzroy River Turtle (*Rheodytes leukops*) (right: image frc environmental). Both individuals shown were detected within the proposed action area.

### 3.1.2. Aquatic (Shelter and Foraging) Habitat

*Elseya albagula* and *Rheodytes leukops* inhabit the permanent waters of rivers and streams with deep pools permanently or periodically inter-connected by shallow riffles (Hamann *et al*. 2004, Limpus *et al*. 2011). *R. leukops* is found in rivers with rocky, gravelly or sandy substrates: *E. albagula* uses similar habitat but is also known to be present in slow-flowing or still pools with silty substrate. Preferred areas have high water clarity, and are often associated with beds of aquatic plants (TSSC 2008, Hamann *et al*. 2004, Limpus *et al*. 2011). Both *E. albagula* and *R. leukops* are notable for their possession of highly-developed cloacal respiration capacity. This physiological adaptation allows them to remain submerged for prolonged periods in well-oxygenated waters, and both species are known to exploit resource-rich riffle sections of streams (Limpus *et al*. 2011). Limpus *et al.* (2011) emphasize the importance of riffles as preferred foraging habitat for both species at least when these are seasonally available. Turtles preferentially feed in these resource-rich zones, allowing build-up of body condition and reproductive fitness. When riffles reduce or dry up with decreasing flows, turtle retreat to deeper pools which can be viewed as refugia. Both species are able to use deeper pools but these may be of lower productivity than riffle zones, and it is suggested that access to riffles allows populations of the turtles to exist at higher densities than they might if restricted to permanent deep pools (Limpus *et al*. 2011).

In a telemetric study conducted on the Mary River, Micheli-Campbell *et al*. (2017) found that *E. albagula* foraged at the margins of slow-flowing deep pools and rarely moved through or occupied stretches of fast-flowing water. This suggests that the species is not dependent on fast-flowing and well-oxygenated water, a finding at odds with the reported decline in turtle species diversity in long-established impoundments, with cloacal-breathing species being most negatively impacted (Tucker 2001, Limpus *et al*. 2011). However, the subjects of their study were adult animals: smaller (juvenile or sub-adult) *E. albagula* are dependent on cloacal respiration to provide sufficient oxygen to support prolonged dives (Mathie and Franklin 2006). Micheli-Campbell *et al*. (2017) also showed that *E. albagula* and the sympatric Mary River Turtle *Elusor macrurus* (another cloacal-respiring species) partitioned their environment: the latter species foraged within riffles, while *E. albagula* foraged on the margins of deeper pools. Further, they fed on differing resources: *E. albagula* fed on filamentous algae and crustaceans, while *E. macrurus* fed on bivalve and gastropod molluscs and aquatic insects.

To date, there is limited evidence available that similar spatial habitat partitioning may exist between *E. albagula* and *R. leukops*. However, dietary studies suggest that *Rheodytes* is carnivorous, feeding on sessile or slow-moving invertebrates, while *E. albagula*, at least as adults, is primarily herbivorous (Limpus *et al.* 2011). The assumption that *R. leukops* is a riffle zone specialist has been questioned on the grounds of possible sampling bias (Limpus *et al*. 2011) and revised survey technique – spotlighting – has shown extensive nocturnal foraging on submerged timber in deep pools by this species.

Though both species are apparently capable of moving across relatively short distances of dry riverine habitat at least in seasonally favourable conditions (e.g. during rainy weather), neither species is known to use ephemeral, non-flowing lacustrine habitat such as swamps and billabongs, or farm dams (Hamann *et al.* 2007, Limpus *et al*. 2011, Commonwealth of Australia 2020).

### 3.1.3. Breeding Ecology and Nesting Habitat

*E. albagula* lays a single clutch of eggs (mean clutch size = 14) annually, primarily in autumn-winter though some lay as late as spring, with hatching occurring in December-January (Limpus *et* al. 2011, Commonwealth of Australia 2020). Published data for *E. albagula* nesting sites in the Mary, Burnett and Fitzroy Rivers (Hamann *et al.* 2004, Limpus *et al.* 2011) indicate that a variety of nesting locations may be used. These include in-stream and on-bank flood-deposited sandbanks as well as sandy to loamy soils on riverbanks. Both bare and vegetated substrate may be used. Summary data for the Fitzroy catchment in Limpus *et al.* (2011) indicate that *E. albagula* nests were located a mean distance of 16.6m from the water's edge (range 1-86m) and 2m above the water level (range 1.2-2.5m). Hamann *et* al. (2007) reported nests at a mean of 4.8m from the water's edge (range 1-10m) and 2.7m above the water, generally at the top of steep slopes. The variations in data for the two catchments may reflect sample sizes or variation in river topography between the sampled sites, but do suggest that this species is able to nest on banks featuring a variety of substrates and slope angles. Both scattered individual nests and localised aggregations of nests, and both migrations to favoured nest sites and nesting close to home pools have been reported in *E. albagula* populations in the Mary, Burnett and Fitzroy Rivers (Hamann *et al*. 2004, Limpus *et al.* 2011, Micheli-Campbell *et al.* 2017).

Less data on breeding habitat requirements is available for *R. leukops*, and are more localised, being largely confined to studies at nesting aggregations on the lower Fitzroy River (Limpus *et al.* 2011). The species may lay two or more clutches of eggs (mean clutch size = 18) in spring, with hatching occurring in December-January (Limpus *et al.* 2011). Limited data on nest site preferences indicate location of the nest a mean distance of 5.6m from the water's edge (range 1-22m) at a height of 1m above water level. Available data suggest a preference for females to congregate at favoured nest sites on flood-deposited sand-loam banks, though isolated nests have been recorded (Limpus *et al.* 2011). For both species egg incubation takes place when river flows are likely to be low or falling in a summer-dominant rainfall regime. This strategy would protect nests from inundation by floods.

### 3.1.4. Threats

Known threats to the two species are similar (TSSC 2008, 2014). For both species the most significant identified threat is a near-total failure of recruitment of juveniles into their population, which is now composed almost entirely of adults. Even though nesting is still commonly occurring there is a loss of almost all eggs as a result of predation or trampling of nests (Limpus *et al.* 2011; TSSC 2008, 2014). Predators include both native species (water rat, goannas) and non-native feral species (pig, fox, dog/dingo, cat) (Limpus *et al.* 2011, DEWHA 2008, Commonwealth of Australia 2017). Trampling of nests by livestock, principally cattle, also results in loss of eggs. Although other threatening processes are known, the failure to recruit juveniles into the population is considered to be the highest-priority management issue for the two species (Limpus *et al*. 2011).

The construction of dams and weirs impacts on both species through several mechanisms including loss of preferred habitat with replacement of original hydrological conditions by permanent, deep, anoxic water bodies with attendant loss of aquatic macrophytes and other food resources; obstruction of migration within rivers; fatalities associated with over-topping of dam walls, water releases and drowning on screens; flooding of traditional breeding habitat; reduction or prevention of replenishment of sand banks used for nesting; and loss of riparian vegetation which may provide food resources (fallen fruit) (TSSC 2008, 2014).

Reductions in water quality due to pollution and siltation arising from adjacent land uses (agriculture, mining) are also implicated. Increased sedimentation has been reported to reduce the efficiency of cloacal respiration in *Elseya irwini,* a species closely related to *E. albagula* (Schaffer *et al.* 2015). Aquatic macrophyte growth is also reduced or prevented under such conditions, particularly when suspended sediments loads are persistent for extended periods.

Both species, but particularly *E. albagula*, are known to be occasionally killed by fishing activities e.g. drowned in traps, killed when captured on fishing lines.

## 3.2. Ecotoxicology of Freshwater Turtles

Limpus *et al.* (2011) suggested that cloacal-respiring turtles were more likely to take up dissolved chemical contaminants than were species with more reliance on lung respiration. Jeffree and Jones (1992) showed that cloacal radiocalcium uptake in three Australian species (*Elseya dentata*, *Chelodina longicollis* and *Emydura signata*) was at least four times more important than uptake via the bucco-pharyngeal route. They attributed this to the structure of the cloaca, with its development of epithelial folds and abundant villi. The high degree of development of respiratory structures in the cloaca of *E. albagula* and *R. leukops* would suggest the potential for an efficient uptake of dissolved contaminants.

Freshwater turtles have attracted attention as potential bio-indicator or sentinel species for aquatic chemical contaminants due to their trophic level, longevity and site fidelity (e.g. Browne 2009, Adams *et al.* 2016). Internationally, and particularly in the United States where freshwater turtles are widely distributed, numerous studies have shown bioaccumulation of contaminants such as radionuclides, heavy metals, organochlorine pesticides, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) entering the aquatic environment via industrial, mining and agricultural land use (USGS undated, Yu *et al.* 2011, Zychowski and Godard-Codding 2017). Some studies have linked the presence (or elevated levels) of contaminants to various pathologies in the affected turtles, though variation in responses between turtle species, variation in toxicity of members within chemical classes, the complexity of the physical and chemical environment in which some studies were carried out, and the lack of controlled (e.g. experimental) studies to assess the impact of chemical contaminants, has sometimes made definitive cause-and-effect relationships difficult to define (e.g. Brown 2009, Yu *et al.* 2011). A summary of responses to contaminants by the widespread and well-studied Common Snapping Turtle (*Chelydra serpentina*) in the United States (USGS, undated) indicated occurrence of abnormal development and deformity of embryos and poor hatching rates due to exposure to PCBs and PAHs; and depression of heme-building enzyme activity due to high lead (Pb) levels.

In Australia, ecotoxicological studies of freshwater turtle are rare and generally have not conclusively established links between contaminant concentrations in tissues and subsequent pathologies (e.g. Browne 2009). This paucity of data is reflected in the aquatic toxicology summaries for toxicants (e.g. metals and metalloids, organic compounds) and derived guidelines in the ANZECC Guidelines (ANZECC/ARMCANZ 2000a, b). These data address macroinvertebrates, fishes and birds but do not discuss freshwater turtles (or any other reptiles). Though they do not directly address the impact of toxicants upon turtles they are nevertheless relevant, as they relate to a diversity of freshwater aquatic taxa important in the productivity of the environment that turtles inhabit.

Thus, though extrapolations can be made from overseas studies and involving other species, threshold values for contaminants, either in turtle tissues or in the surrounding aquatic environment, are not available for the target species.

## 3.3. Field Survey Findings and Discussion

### 3.3.1. Aquatic habitat within the proposed action area

The stream order 1 drainage feature that carries released desalinated water from the pipeline outlet to the waterhole was found to be an essentially terrestrial drainage line (Fig. 3) with no development of aquatic habitat except for its lower end, near its discharge point to the waterhole. Here (Fig. 4), some pooling associated with minor channel formation occurred but this showed limited presence of hydrophytes or other habitat features. It was not considered suitable habitat for either *E. albagula* or *R. leukops*, and is not discussed further in relation to potential impacts on the two species.


**Figure 3** (left): The drainage feature receiving produced water follows the narrow valley that descends from center-left of the image. The tree-line in center mid-distance indicates the position of the waterhole. **Figure 4** (right): Drainage Feature shortly above discharge into the waterhole, about 24 hours after flow shut-down. Though the water level has dropped it can be seen that very limited development of aquatic habitat has taken place during the discharge period.

The waterhole, though it is a continuous waterbody when full or near-full, can be considered in two parts. Upstream of the point of entry of the drainage feature (site WLMP1 of frc environmental (2019a): see Appendix A) the waterhole is shallow, and at the time of survey was largely covered by submerged and emergent macrophyte beds (Fig. 5, 6). Analysis of historical imagery shows that this section of the waterhole is most prone to dry out in low-rainfall periods.

Downstream of this point the waterhole is deeper, with macrophyte beds confined to the margins (Fig. 7). During the survey, numerous fish-eating birds (Australian Pelican, Great and Little Black Cormorants, Australasian Darter) were present on this part of the waterhole, indicating a population of forage fish was available. Maintenance of deep pool conditions may enhance the habitat value of the waterhole to *E. albagula.* No data is available to compare conditions here prior to the start of desalinated water releases in 2015 but it is likely that at least intermittent connectivity with the Dawson River via the stream order 2 watercourse was present during periods of heavy rainfall and flooding in the river. For much of the time, though, this watercourse would have been dry. Connectivity between the waterhole and the river has been augmented by the influx, and subsequent discharge, of desalinated water. Fig. 8 shows the watercourse below the waterhole: though the image was captured after the discharge was stopped, a pool and flowing water is present. This is likely to facilitate the movement of aquatic fauna between the waterhole and the river, including turtles.


**Figure 5** (left): Shallow upstream (western) end of waterhole with extensive macrophyte beds. **Figure 6** (right): waterhole where Drainage Feature enters – a shallow delta has formed.

**Figure 7** (left): Deep section of the waterhole downstream of drainage feature entry, with macrophyte beds extending shortly from water's edge. **Figure 8** (right): shallow glide below a pool in the watercourse below the waterhole. Water was still discharging 24 hours after the release was ceased. This water may facilitate movement of turtles between the waterhole and the Dawson River.

During 13 surveys from August 2013 to April 2019 (frc environmental 2019a), trapping effort at three locations within the waterhole captured one *E. albagula* at one location on a single occasion. Neither *E. albagula* nor *R. leukops* were encountered in ongoing regular REMP surveys of the waterhole, through to 2022 (frc environmental, 2022). Over the course of the surveys, four other species were captured, the most numerous of which was Krefft's River Turtle (*Emydura krefftii*), as well as Eastern Long-necked Turtle (*Chelodina longicollis*) and Broad-shelled River Turtle (*C. expansa*). These three species are commonly found in off-stream lagoons (Cann and Sadlier 2017, Limpus *et al.* 2011). *E. albagula* appears to be rare in the waterhole, a finding consistent with comments in Limpus *et al*. (2011). The single capture of this species in the waterhole occurred in 2017, i.e. subsequent to the water release project commencement, but it is not possible to say whether this represented a movement into the waterhole facilitated by the water release or a movement during a flood event, nor can there be any certainty about when the turtle entered the waterhole. Though individual animals may enter the waterhole and possibly stay for prolonged periods, it is unlikely that these animals would be present in sufficient numbers to contribute significantly to the population within the proposed action area. Further, given that the water release project has a finite life (EA No. EPPG00928713), any augmentation of habitat value of the waterhole for *E. albagula*, and perhaps *R. leukops*, will be temporary. For these reasons, the waterhole is not considered to be critical habitat for *E. albagula*, nor is it suitable habitat for *R. leukops.*

The Dawson River in the vicinity of the proposed action area has been characterised as relatively narrow with moderate to steep banks and featuring very variable annual flows, with intermittent high flow floods separated by periods (up to several years) of low flow (AECOM 2016a, b). As noted earlier, the river has a perennial base flow derived from spring discharges from an upstream tributary, Hutton Creek, and augmented by numerous springs discharging into the river upstream of the proposed action area, where the Precipice Sandstone is exposed.

The river upstream of the proposed action area features a sandy bed with flow dominated by very shallow riffles with intermittent deeper pools, which are generally very small (Figures 9, 10). These are commonly associated with outcropping boulder rock and spring discharge may be maintaining these small pools. Flows increase downstream, associated with significant spring inputs. Pool length, width and depth increase, with some pools being several hundred metres in length. Pools are connected by continuous flow in shallow runs, glides and riffles, with pools being present to the downstream limit of the proposed action area at Baroondah Crossing.

Pools were generally estimated to be 1.0-2.0 m in depth and contained low to moderate amounts of large woody debris (logs, fallen trees) and often featured undercut banks (Figures 11- 16). Small areas of macrophyte beds (e.g. *Vallisneria* sp., *Potamogeton crispus*) were common where areas of silty sand substrate provided suitable conditions (Figures 17, 18). Bed substrate was typically sandy, especially in runs, riffles and glides with only limited presence of rocky substrates other than outcropping rock which confines some pools. frc environmental (2019) noted that sandy sediments mobilized in flood events were likely to cover cobble substrates, at least temporarily. Deeper pools are likely to have silty to silty sand substrate as flow slows. Rocky riffles were only rarely identified during this survey (Figures 19, 20). Woody debris was moderately common within riffles.

In the upper perennial reach of the Dawson River and the proposed action area the available habitat can be viewed as a continuum of shelter and feeding habitat. Pools are small and shallow when compared to those in the lower reaches of the Dawson River and glides, riffles and runs connect them continuously. Deeper pools are available as shelter for both turtles and provide preferred feeding habitat for *E. albagula* (Micheli-Campbell *et al.* 2017). Faster-moving water in runs, glides and riffles is readily available to *R. leukops*. Tucker *et al*. (2001), working in the much more expansive lower Fitzroy River, noted that *R. leukops* preferred riffle habitat; mean distance of tracked individuals from a riffle (depths <1.1 m) was 310 m. In the riverine environment of the proposed action area at the time of this field survey, it would not be possible for a turtle to be as far from shallow water as this – indeed, all but the deepest pools would be no more than 1 m deep.

All BOOBOOK-attributed records for *E. albagula* within the riverine part of the proposed action area, were of animals seen within pools, including two records during the field survey. While it is unclear what habitat types was present at sites where frc environmental (2019a) trapped this species and *R. leukops* in the river, their methods – cathedral traps and fyke nets – suggest pools and/or deeper runs or glides. In any case it seems likely that the two species may be encountered throughout the riverine habitat, with the only restriction being very shallow riffles during low flow periods. Records for the two species within the proposed action area (BOOBOOK 2020 and this survey; frc environmental 2019a) are shown at Appendix C.

In summary, it was found that the Dawson River within the proposed action area provided a continuous length (*ca.* 8.1 km) of suitable riverine habitat for the two turtle species. This habitat was consistent with the definition of 'critical habitat' given in the National Recovery Plan for *E. albagula* (Commonwealth of Australia 2020); and consistent with the description of *R. leukops* habitat provided by TSSC (2008). It was found in the field that under the flow regime operating during the survey period the width of water within the bed varied from *ca.* 4 m in the narrowest shallow riffles to a maximum of 25 m in the widest pool. The average bed width was estimated at 15 m. Foraging habitat for both species was defined as all aquatic habitat within the bed of the Dawson River, derived as the mid-line of the river bed buffered to a total width of 15 m.

Field data and image interpretation were used to produce GIS-based mapping. Note that this includes parts of the bed not covered by water at low flow periods; and, as it is based on a mean bed width, will also likely include some non-aquatic habitat areas, thus potentially over-estimating the total area. During flood events this area would be increased considerably but since floods recede quickly here, the mapped aquatic habitat can be considered a minimum available during extended periods of flow at or near base levels. Aquatic habitat for the two species within the Dawson River within the proposed action area was thus estimated at 12.12 ha. Additionally, ca. 18 ha of habitat for these species, contiguous with that in the proposed action area, occurs in the perennial reaches of the Dawson River, upstream of the proposed action area. Additional habitat for these species occurs further upstream, around permanent waterholes in the intermittent section of the Dawson River and tributaries.

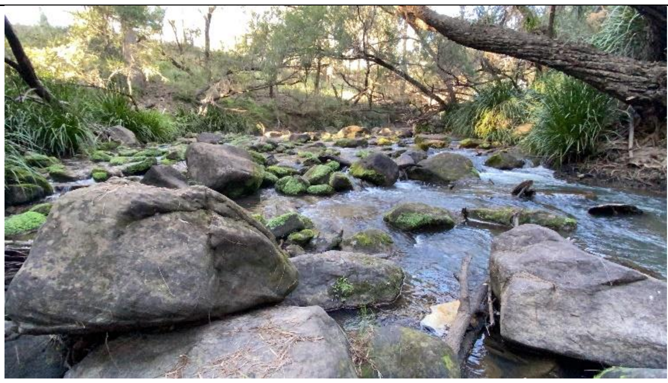

**Figures 9, 10**: The perennial reaches of the Dawson River, upstream of the proposed action area, was characterised by shallow riffles over a sandy bed, with occasional small pools. Steep confining sandy to loam banks are visible in these images.


**Figure 11** (left): Further downstream, within the proposed action area, riffles and runs become deeper. Riparian vegetation often crowds in on water's edge. **Figure 12** (right): Deeper pools show undercut banks and large woody debris that provide shelter and foraging habitat for turtles.


**Figure 13** (left): Some pools in the upper half of the river reach featured sections of bank formed from bedrock sandstone or siltstone. **Figure 14** (right): A turtle apparently sunning in shallow water at a pool edge, protected by the overhanging bank. This is the adult female *E. albagula* shown in Fig. 1.


**Figures 15, 16**: Pools were sometimes separated by relatively long shallow, sandy riffles (left) but more commonly, glides at the tail of pools were separated from the downstream run by short sections of shallow riffle (right).


**Figure 17, 18**: Macrophyte beds (*Vallisneria* sp., *Potamogeton crispus*) were present in runs and glides as well as the margins of less shaded pools. These would be a food resource for adult *E. albagula* and possibly refuge areas for young turtles.

**Figures 19, 20**: Rocky sections of riverbed were uncommon. This shallow run at a pool head has a bed of scattered cobbles **(**left): One well-established rocky riffle with cobbles and larger rocks was seen (right). These may be foraging habitat for *R. leukops.*

### 3.3.2. Nesting habitat within the proposed action area

The high banks of the river within the proposed action area averaged *ca.* 124 m apart. Where the river cut against steep hillsides – more common upstream of the proposed action area - the distance between the bed and the high bank was reduced. A typical profile of the river, based on LiDAR imaging, is shown in Figure 21.

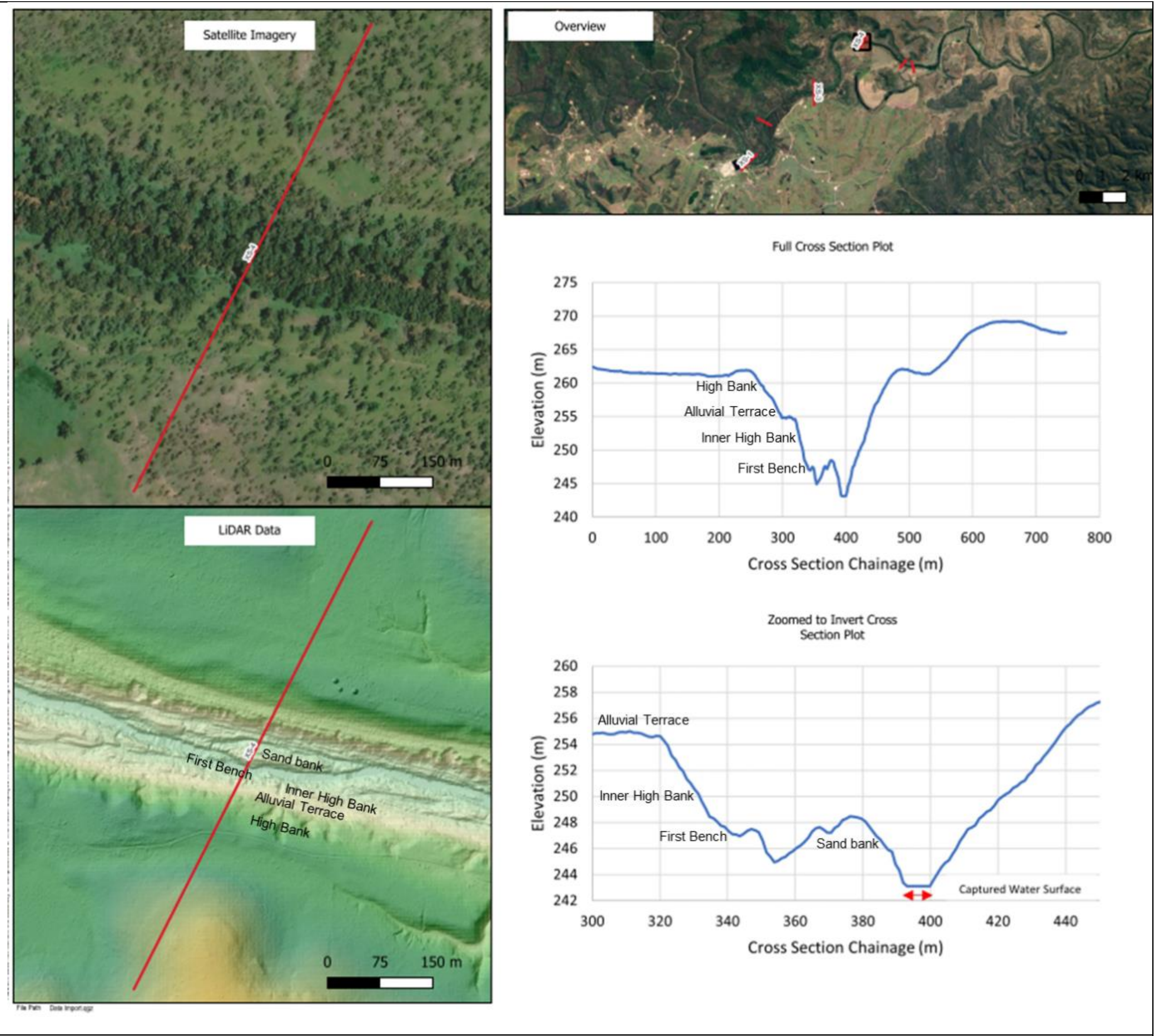



**Figure 21**: Profile of the Dawson River at site XS-4, approximately 2.5 km upstream of the watercourse and waterhole discharge point. Clockwise from lower left: a representation of bank topography based on LiDAR imaging; satellite imagery around this transect, an overview indicating the location of the cross-sectional transect; a graph of elevation across this transect; and a larger scale graph of the cross-section between the high banks (Figure provided by AECOM).

Below the outer high banks an alluvial terrace extended inward to the crest of the inner high bank. The terrace was variable in width and slope, with the wider and level to gently sloping terraces associated with accreting inner bends of the river (Figures 22, 23). Soils were loamy to sandy loam. Based on reported nest occurrences (Limpus *et al.* 2011), a precautionary approach would be to assume that these terraces may be used as nest sites, even though nesting is more likely to occur closer to the channel. The confining inner high banks were comprised of stable sandy loam to silty clay loam of varying slope up to 50° and to a height of 6m above the bed. Exceptions to this occurred where the bed was confined on one bank, or rarely both banks, by vertical outcropping sandstone or siltstone. This was present within the upper part of the proposed action area where the river incised the underlying Precipice Sandstone Formation.

Short channel cut-offs were present but rare. They formed "islands" that can be considered similar to the inner high banks (Figures 24-27).

A first bench was generally present, particularly above riffles, at a height of at least 0.3m above bed level. This bench varied in width from <1 m to several metres, the larger benches forming sand-banks with or without a low grass cover. Some of these banks were 1.5-2.0 m above water level. These sand banks and the slopes and crests of the inner high banks are most likely sites for nest location (Figures 26-29).

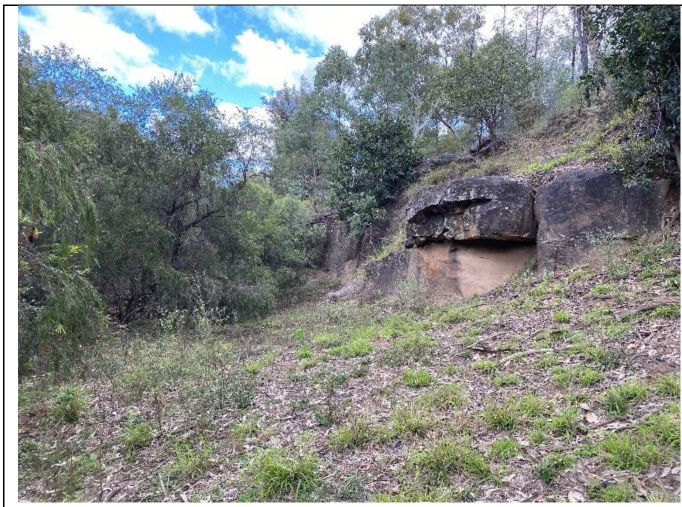
Four nests detected during the field survey were positioned at heights ranging from 0.6 m to 5 m above the water level at the time. Very large, steep-sided sand banks, as described for the lower Fitzroy River (e.g. Limpus *et al.* 2011) were not present within the proposed action area.

Low sandbanks were commonly present within the channel of riffle zones, glides and runs. The height of the majority of these was less than that the first bench (where present) (Figure 30). Sediment within the bed of the river is highly mobile (Santos 2012, AECOM 2016a, b) and it is likely that many or all sand deposits are re-positioned after every flood. These in-channel deposits are unlikely to be used as nest sites as they would be vulnerable to small rises in water level e.g. local storm run-off.

In summary, the stretch of the Dawson River within the proposed action area was found to provide a variety of riverine landforms suitable for the location of nests by the two turtle species. Three predated and one intact nest were detected during the field survey: based on measurements of shell fragments, and the timing of the fresh nest attempt, all but one of these were thought to be *E. albagula* nests. All four turtle nests were located on the slopes or crest of the inner high bank, or on sand to sandy-loam banks below the slope of the high bank (Figure 31).

Some locations within the proposed action area (e.g. broad alluvial terraces on accreting banks) may provide areas suitable for more concentrated nesting densities, but the hydrological conditions of the river at the proposed action area seem to prevent formation of large, discrete locations for large nesting aggregations of *E. albagula* and *R. leukops*, such as are described in the literature (e.g. Limpus *et al.* 2011, TSSC 2008, Commonwealth of Australia 2020). More survey effort would be required to determine if aggregated nesting occurs within the proposed action area but it seems likely that nests may be more isolated here. It is also possible that some turtles may travel downstream of the proposed action area to nest at favoured locations.

Using the high banks of the river as limits of nesting habitat we calculated that 88 ha of potential nesting habitat was available to the two species within the proposed action area, with a further *ca.* 138 ha within the contiguous perennial section of the Dawson River upstream. In line with published accounts (see section 4.1.3) it is expected that most nesting within this area would occur close to the water's edge. That is to say, preferred nesting habitat would be a small subset of the potential habitat.



**Figures 22, 23**: Outer high banks of the Dawson River within the proposed action area. Where steep hillsides constrain the river the distance from the channel to the outer bank is small (left). A narrow alluvial terrace is present between rocky hillside and the inner high bank. Elsewhere, the outer high bank is further from the channel (right), with formation of a broad terrace. These terraces may be used as nesting habitat.


**Figures 24, 25**: Inner bank morphology was variable, with a discontinuous low first bench topped by sandy to silt loam high banks of varying slope. Riparian vegetation was generally intact on these banks.


**Figure 26** (left): Some areas of bank supported few trees; this appeared to be natural, with tree establishment hindered by scouring and mobilization of sediment during flood events. **Figure 27** (right): An island formed by a channel cut-out. This provides potential nesting habitat. Note steep loam banks above this feature, also potential nesting habitat.


**Figures 28, 29**: Two examples of raised sandbanks deposited above the first bench, up to 2 m in height. Grass cover suggests that the banks may persist at least until a major flood event. They would offer nest habitat during that time. Disturbance by cattle and feral pigs is evident at both of these sandbanks.

**Figure 30** (left): Bed-level sand deposits were sometimes present in runs, glides and riffles. These would be vulnerable to even low-level floods and are unlikely to be used as nesting habitat. **Figure 31** (right): A recently constructed nest on a sand deposit. A shallow depression can be seen (beside the ballpoint pen) with slide down to water also visible. The timing of the nesting indicates that it is of *E. albagula.* Note the lack of any other animal tracks here.

### 3.3.3. Assessment of potential threats within the proposed action area

#### 3.3.3.1. Erosion or inundation of nesting habitat

An increase in flow rate and water level rise within the Dawson River associated with anthropogenic inflows such as release of desalinated water, if large, could potentially erode banks (nesting habitat) and inundate breeding habitat, at least temporarily and so drown incubating nests.

The Dawson River within the proposed action area experiences highly variable flows. Spring-fed low flows within this reach range from 15 ML/d at the end of the dry season to 18 ML/d during the wet season (Santos 2012), as measured at Baroondah Crossing, the downstream limit of the proposed action area. Low stream flows may persist for several years and are present for approximately 67% of the time (AECOM 2016a). There is a high-flow season from November to March, driven by summer rainfall, though volumes are variable to a recorded maximum of 126,800 ML/d. The main river channel is capable of carrying a flow of 16,000 ML/d and floods of this size (i.e. that fill the channel) occur every 2.33 years on average (Santos 2012, AECOM 2016a). These floods are characterized by rapid water level rises and high velocity current. In summary, the Dawson River within the proposed action area is a perennial stream with variable flows, typically at low levels but periodically experiencing high-energy flood events.

Based on a series of assessments covering a range of flow levels from low to flood, frc environmental (2019b) concluded that bank stability was moderate, with some unstable and eroding sections and areas of cattle disturbance to banks. Bed stability was low, with significant scouring and deposition of sand following very high flow events. These data indicate that the riverbank environment is reasonably resilient to flood-induced erosion events.

Measured water depth changes at Baroondah Crossing during a desalinated water release event indicates that for a release of 18 ML/d (the maximum allowable daily release) the water level increases by approximately 0.05 m on base flow levels. Such a rise would be contained below the first bench in the banks.

Measured water level data at Baroondah Crossing also shows that increases in water depth at S4 following the start of a desalinated water release occurs slowly over a number of days as the upstream waterhole gradually fills and starts to spill. Initial water level increases in the Dawson River at S4 are not observable for between two to three days after the start of a desalinated water release, then water level at Baroondah Crossing slowly increases to the measured maximum of 0.05 m above pre-release levels over a duration of between nine to ten days. By comparison, water depth change responses to rainfall events are rapid and occur within a day.

Measured effects on flow depth and rate of change in flow depth indicate that desalinated water releases are not likely to significantly alter the naturally variable stream hydraulics or hydrology when compared to natural variability. *E. albagula* nests over an extended period with a peak in autumn-winter and *R. leukops* nests in spring. These are times when river flows are likely to be falling to seasonal low levels. Thus, based on measured flow data, even at maximum release volume for the desalinated water discharge during these periods of 18 ML/day, the water depth increase of 0.05 m will be still confined within the first benches above bed level and nests placed on the slope or crest of lower banks (heights 1-2.7 m above the water: Limpus et al. 2011, Hamann et al. 2007) would be above the combined water level. Location of nests at these heights indicates that the turtles rarely if ever nest on low sandbanks within the channel to first bench height, where their nests would be more at risk of inundation by small rises in water level. It seems likely that the turtles are pre-adapted to this situation, having evolved a strategy that minimises the risk of egg loss due to flooding. By laying above the first bench level at a time when water levels are low (i.e. contained below and within the first bench of the channel) and with an incubation period extending over a period with continuing low flows (winter to spring), the risk of inundation by unpredictably high floods in summer is reduced.

The effects of desalinated water release would therefore be confined to the bed and banks below the first bench for most of the time, that is within a pre-existing high disturbance zone unlikely to be used as nesting habitat. The higher banks are apparently relatively resilient to flood erosion. The contribution of released desalinated water flows to floods is insignificant in terms of the erosional impact of those floods so loss of nesting habitat over and above natural levels is unlikely. The desalinated water released during low flow periods would not inundate nesting habitat for the turtles during their nesting seasons, and desalinated water releases would at worst only minimally impact on the effects of floods in summer when most hatching would have occurred.

#### 3.3.3.2. Predation of nests

For both *E. albagula* and *R. leukops* the most significant identified threat is a near-total failure of recruitment of juveniles into their populations as a result of predation or trampling of nests (Limpus *et al.* 2011, TSSC 2008, TSSC 2014). Known predators include both native and non-native species. Though turtles, including *E. albagula* and *R. leukops*, would have historically faced nest predation by native species (e.g. Water Rat *Hydromys leucogaster*, goannas *Varanus* spp.), rates of nest predation have increased in the presence of feral species such as Pig *Sus scrofa*, Fox *Vulpes vulpes*, Dog/Dingo *Canis* sp., and Cat *Felis catus*. Spencer and Thompson (2004) demonstrated a decline in nest predation rates in the Murray Short-necked Turtle *Emydura macquarii* following Fox control.

Three predated nests were found during the field survey, detected by the presence of scattered eggshell fragments. For two of these nests, partial shell lengths of 41.3 mm and 44.8 mm (Figures 32, 33) indicate that these were eggs of *E. albagula*, which are significantly larger than those of the other five turtle species known to be present within the proposed action area (Limpus *et al*. 2011). The third clutch was of smaller eggs consistent in size with those of *Emydura krefftii*. One recently-laid (i.e. since the last rain event a few days earlier) and undisturbed nest was seen on a sand deposit between large boulders. The lack of animal tracks at this site suggested that it was not visited by feral pigs or other potential feral predators (Fig 30).

Feral pigs were commonly detected during the field survey. Their distinctive diggings – both deep and shallow excavations - were widespread and abundant on the banks of the river (Figures 34-37), and two groups of several pigs were seen. The tracks of dogs/dingoes were also detected, as were those of Water Rats. Tracks or other signs of foxes were not detected. It is possible that competitive interactions between dingoes and foxes suppress the latter (Glen *et al.* 2007, DEWHA 2008) in this area, where dingoes are common but foxes are rarely recorded (e.g. DES 2021).

Field survey timing (winter) precluded detection of varanids, but the large species *Varanus varius*, *V. panoptes* and *V. gouldii* are all known to be present in or near the proposed action area (DES 2021) and all are potential nest predators.

Field-based evidence indicates that nest predation is occurring within the proposed action area and that feral pigs are likely to be a significant nest predator.

#### 3.3.3.3. Trampling of nests

Trampling of nests by livestock, principally cattle, also results in loss of eggs (Limpus *et al.* 2011, TSSC 2008, TSSC 2014). Tracks of cattle were seen throughout the river: domestic cattle were commonly encountered throughout the proposed action area, and feral cattle and horses are known to be present in the adjacent Expedition Resources Reserve, which has frontage on the river upstream of the proposed action area (BOOBOOK 2020). Deep pugging, bank slumping and incised tracks on banks were frequently seen (Figures 38, 39). It is very likely that trampling contributes to nest loss within the proposed action area, as it does elsewhere.

**Figure 32** (left): Remains of a predated turtle nest – scattered egg fragments. **Figure 33** (right): Closer view of egg fragments: size of these partial shells indicate that they are of *E. albagula*.

**Figure 34** (left): Tracks of a Feral Pig. **Figure 35** (right): Deep digging on a sandbank by a Feral Pig.

**Figure 36** (left): Deep digging in loam bank by a Feral Pig. Ballpoint pen provides scale. **Figure 37** (right): Shallow digging on a loam bank by a Feral Pig(s). Deep digging may represent excavation of a turtle nest, while shallow diggings are likely to be directed at earthworms or other invertebrates.

**Figure 38** (left): Incised tracks, bank erosion and trampling of water's edge at a point accessed by cattle and horses. **Figure 39** (right): Cattle tracks and trampling of banks and bed of river. Evidence of impacts by domestic and feral cattle, and feral horses, were apparent on the river throughout the proposed action area.

#### 3.3.3.4. Water Quality

The discharge of desalinated water into the proposed action area (i.e. the receiving environment) is subject to the conditions of the Queensland Government Environmental Authority (EA) No. EPPG00928713, as revised and effective from 03 November 2022. Conditions B15-B25 of the EA, which apply to the release of contaminants in coal seam gas water, are pertinent to the release of desalinated water. In particular, Table 4 – Contaminant Limits and Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water specify limits for a wide range of physico-chemical attributes, metals and metalloids, and other inorganic and organic contaminants. Similarly, Conditions 26-35 of the EA, including Tables 8 and 9, apply to untreated CSG water. The relevant conditions are shown in Appendix D. The limits used in the Tables are derived from the Dawson River Sub-basin Water Quality Objectives (DEHP 2011) and/or the ANZECC/ARMCANZ Guidelines (2000a[1]).

No measures of riverine water quality were undertaken during this survey. Under the conditions of EA EPPG00928713, the proponent is required to develop and conduct a receiving environment monitoring program (REMP). Summary results of REMP water quality monitoring from January 2015 to April 2022 for a range of parameters are shown in Table 1. Note that assessments were made at two sites on the river: site DRR1 is a control site located approximately 550 m upstream of the waterhole outlet watercourse and Dawson River confluence; and site DRMP1 is located 200 m downstream of this confluence (see Appendix A). Assessments were made biannually at times that should reflect differing river flow regimes, with high flows in the post-wet season and lowest flow in pre-wet season surveys.

*Table 1: Water quality results for selected parameters 2015-2022, Dawson River (source: Santos GLNG REMP monitoring data).*

| | | | DRR1 | | DRMP1 | |
|---|---|---|---|---|---|---|
| **Parameter** | **unit** | **Water Quality Objective (WQO) [a]** | **Data points** | **Median [b] or 95th Percentile [c] (minimum – maximum)** | **Data points** | **Median (Range)** |
| Dissolved oxygen [b] | mg/L | 7.0 – 9.0 | 25 | 6.3 [b] (3.6 – 7.8) | 58 | 7.1 (3.4 – 11.6) |
| Electrical conductivity [b] | µS/cm | 370 (Base Flow)<br>210 (High Flow) | 25 | 273 [b] (82 – 309) | 58 | 275 (102 – 602) |
| pH [b] | unit | 6.5-8.5 | 25 | 7.4 [b] (6.7 – 7.9) | 56 | 7.4 (5.9 – 8.1) |
| Suspended solids [b] | mg/L | 30 | 26 | 12 [b] (5 – 711) | 25 | 12 (5 – 174) |
| Turbidity [b] | NTU | 50 | 11 | 20 [b] (11 – 1,000) | 10 | 17 (12 – 39) |
| Ammonia (as N) [c] | mg/L | 0.02 | 26 | 0.10 [c] (0.01 – 0.15) | 25 | 0.08 [c] (0.01 – 0.13) |
| Total Nitrogen [c] | mg/L | 0.62 | 26 | 2.0 [c] (0.1 – 2.10) | 25 | 1.7 [c] (0.1 – 1.8) |
| Boron (dissolved) [c] | mg/L | 2.9 | 26 | < 0.05 [d] | 60 | 0.11 [c] (< 0.05 – 0.28) |
| Zinc (dissolved) [c] | mg/L | 0.008 | 26 | < 0.005 [d] | 60 | < 0.005 [d] |

[a] from Environment Protection (Water) Policy 2009 Dawson River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130; [b] median measures are compared with objectives for physico-chemical parameters; [c] 95th percentile measures are compared with water quality objectives for nutrients, toxicants and metals; [d] no detections or insufficient detections above limit of reporting to calculate median value.

*R. leukops* is said to be reliant on well-oxygenated water to allow foraging and resting in fast-running water (Limpus *et al.* 2011). *E. albagula* obtained *ca.* 74% of its oxygen requirement from water (FitzGibbon 1998, cited in Limpus *et al.* 2011), while Mathie and Franklin (2006) demonstrated experimentally that smaller *E. albagula* depended on cloacal respiration to provide sufficient oxygen to support prolonged dives, which may allow avoidance of predators. Thus, both *E. albagula* and *R. leukops* can be characterized as being dependent on well-oxygenated water.

Measurements of dissolved oxygen (DO) in the Dawson River were often below the identified water quality objective at both the upstream control site (DRR1) and the downstream monitoring site (DRMP1), below the confluence of the waterhole and Dawson River (Table 1). However, in baseline (i.e. pre-release of produced water) studies of water quality, site DRR1 was sampled on seven occasions between August 2013 and January 2015 and met or exceeded the DO threshold only twice (frc environmental (2016): Figure 4.4). Similarly, site DRMP1 was sampled four times between April 2014 and January 2015, meeting the DO threshold only once.

Low levels in DO pre-date the release of CSG produced water into the riverine environment and may reflect the influence of sampling periods of low flow, as prevailed during much of the baseline study (frc environmental 2016): accumulation of dead plant material under such conditions, with resultant increases in oxygen consumption during

[1] Now the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018) - https://www.waterquality.gov.au/anz-guidelines

bacterial decomposition of this material, may account for low DO levels (ANZECC/ARMCANZ 2000b). Nevertheless, DO within the Dawson River appears to be generally suitable for maintenance of aquatic communities, as evidenced for example by the presence of the two turtles, and an assemblage of up to fourteen species of native fishes both upstream and downstream of the discharge site (frc environmental 2016).

Schaffer *et al.* (2015) reported that elevated suspended solids concentrations adversely affected dive times in *Elseya irwini*, a close relative of *E. albagula*, even under conditions of high dissolved oxygen levels. This was attributed to decreased efficiency in cloacal respiration. Sediment loads are likely to similarly reduce dive times, and thus foraging efficiency, in *E. albagula* and *R. leukops*. AECOM (2016a) noted that the Dawson River within the proposed action area can carry very high sediment loads during flood events, but that fine sediments are generally lost with re-establishment of sandy bed substrate as the river returns to low flow levels with flushing by spring flow contributions. This is supported by the data shown in Table 1, with occasional very high values of suspended solids measured at both DRR1 and DRMP1 but with median concentrations well below the identified water quality objective at each monitoring site. At the time of the field survey, a low flow regime prevailed, with water clarity being good. No appreciable difference in turbidity was apparent between locations along the Dawson River upstream and downstream of the watercourse discharge point. It seems unlikely that either turtle was affected by impact on cloacal respiration efficiency due to the levels of suspended solids within the riverine portion of the proposed action area at the time of survey.

With the exception of dissolved oxygen (discussed above) median values of riverine water quality measures were within the identified water quality objective limits at both the control site (DRR) and the downstream post-discharge site (DRMP1) (Table 1). Measures of nitrogenous nutrients (Ammonia as N, and total Nitrogen) occasionally exceeded the water quality objective limits (see $95^{th}$ percentile values in Table 1). However, these outlier values were similar at both upstream (DRR1) and downstream (DRMP1) sites.

Therefore, it appears that riverine water quality within the proposed action area, both upstream and downstream of the confluence of the watercourse and Dawson River, is satisfactory following the discharge of desalinated water. This also implies that water quality thresholds are within limits for water travelling from the release point to the waterhole and thence to the river confluence. Santos (2012) noted that cooling and oxygenation of discharged water was expected to occur as it travelled down the drainage feature to the waterhole.

### 3.3.4. Significant Residual Impact Assessment of water discharge

The release of coal seam gas water into the Dawson River has the potential to create a Significant Residual Impact (SRI) on Matters of National Environmental Significance (MNES) within the proposed action area. Such potential impacts are assessed following the EPBC guidelines for Significant Impacts on MNES (DoE 2013). The assessment criteria are applicable to Critically Endangered and Vulnerable fauna species. Table 2 shows the results of this assessment for the two threatened turtle species *E. albagula* and *R. leukops*, confirmed as being present in the proposed action area.

*Table 1: Assessment of potential Significant Residual Impacts on two turtle species of release of coal seam gas water into the proposed action area.*

| Species | Significant Impact Criteria (DoE 2013; DEHP 2014) | | | | | | | Significant Residual Impact |
|---|---|---|---|---|---|---|---|---|
| | **Lead to a long-term decrease in the size of a population (including declines due to loss or modification of habitat).** | **Reduce the Area of Occupancy (AoO), or the Extent of Occurrence (EoO) of the species.** | **Fragment an existing population into two or more populations; or, result in genetically distinct populations forming.** | **Adversely affect habitat critical to the survival of a species (including disruption to breeding, feeding, nesting, migration or resting sites).** | **Result in invasive species that are harmful to a threatened species becoming established in the threatened species' habitat.** | **Introduce disease that may cause the population to decline.** | **Interfere with the recovery of the species.** | |
| *Elseya albagula*<br><br>White-throated Snapping Turtle | **No**:<br><br>The Dawson River is subject to a highly variable flow regime, including sometimes extreme flow events, yet it provides suitable aquatic (foraging and sheltering) and terrestrial (nesting) habitat. Minimal or no changes to water quality and flows, and no change to river geomorphology of the Dawson River are expected as a result of water releases into this environment, based on pre- and post-release studies. There is only very low risk of impact on the aquatic ecology of the Dawson River, including its suitability as habitat for *E. albagula*. | **No**:<br><br>Within the proposed action area the species is near its western limits in the headwaters of the Dawson River. The species occurs throughout the Dawson River within the proposed action area, though the size of the population here is not known.<br><br>No changes to the riverine environment are expected as a result of the proposed action and no reduction in AoO or EoO is likely to occur. | **No**:<br><br>Perennial flows are present within the proposed action area but cease shortly upstream, at the junction of the Dawson River with Hutton Creek. Above this the species is only recorded in relatively few permanent, spring-fed pools (Limpus *et al.* 2011, BOOBOOK unpubl. data). The proposed action will not impact the connectivity of flows upstream or downstream of the release point, nor will it form a barrier to aquatic fauna passage. No changes are expected in the species' population within the proposed action area. The proposed action will not fragment the population of the species. | **No**:<br><br>The Dawson River is subject to a highly variable flow regime, including sometimes extreme flow events, yet it provides suitable aquatic (foraging and sheltering) and terrestrial (nesting) habitat. Minimal or no changes to water quality and flows, and no change to river geomorphology of the Dawson River are expected as a result of desalinated water releases into this environment, based on pre- and post-release data. There is only very low risk of impact on the aquatic ecology of the Dawson River, including its suitability as habitat for *E. albagula*. Minimal changes in flow heights and velocity will not impact on the suitability of the proposed action area as foraging and shelter habitat (e.g. no alteration of abundance of aquatic macrophytes or riparian vegetation) or breeding habitat (e.g. no increase in frequency or duration of inundation of nesting banks). | **No**:<br><br>Minimal or no changes to water quality and flows, and no change to river geomorphology of the Dawson River are expected as a result of desalinated water releases into this environment, based on pre- and post-release studies. As a result, no changes that may favour either aquatic or terrestrial invasive species are likely to occur within the proposed action area.<br><br>Note that several plant and animal species known or potentially adversely impacting on the species are present already, including feral pigs and horses, dingoes, livestock (cattle); two species of non-native fish; and non-native pasture grasses that may dominate terrestrial nesting areas in some places. No material change in abundance or distribution of these species is expected as a result of the proposed action. Therefore, no exacerbation of any pre-existing impact is expected. | **No**:<br><br>The proposed action is very unlikely to introduce a disease that will cause the population to decline.<br><br>The desalinated water releases to be discharged is very unlikely to produce an ecotoxic impact on either the turtle or on other species within the aquatic environment. It is very unlikely to be a source of pathogens. No external inputs likely to transmit disease are involved in the proposed action. Minimal or nil impacts on flows and hydrology are unlikely to produce change affecting the incidence or severity of any disease already present (none are known). | **No**:<br><br>Minimal or no changes to water quality and flows, and no change to river geomorphology of the Dawson River are expected as a result of water releases into this environment, based on pre- and post-release studies. Thus, changes in the aquatic and terrestrial environment here are expected to be negligible or non-existent.<br><br>The proposed action is unlikely to impact on the extent and quality of foraging, shelter and nesting habitat for the species. It will not affect the existing known extent of the species, nor interfere with movement by the species within the proposed action area or movement of the species upstream or downstream from the proposed action area. It will not allow the introduction of, or exacerbate the existing impact of, invasive species or diseases.<br><br>The recovery of the species will not be adversely affected by the proposed action. | **NIL**<br><br>The proposed action will not create a Significant Residual Impact on the population of *Elseya albagula* |

| Species | Significant Impact Criteria (DoE 2013; DEHP 2014) | | | | | | | Significant Residual Impact |
|---|---|---|---|---|---|---|---|---|
| | **Lead to a long-term decrease in the size of a population (including declines due to loss or modification of habitat).** | **Reduce the Area of Occupancy (AoO), or the Extent of Occurrence (EoO) of the species.** | **Fragment an existing population into two or more populations; or, result in genetically distinct populations forming.** | **Adversely affect habitat critical to the survival of a species (including disruption to breeding, feeding, nesting, migration or resting sites).** | **Result in invasive species that are harmful to a threatened species becoming established in the threatened species' habitat.** | **Introduce disease that may cause the population to decline.** | **Interfere with the recovery of the species.** | |
| *Rheodytes leukops*<br>Fitzroy River Turtle | **No**:<br>The Dawson River is subject to a highly variable flow regime, including sometimes extreme flow events, yet it provides suitable aquatic (foraging and sheltering) and terrestrial (nesting) habitat. Minimal or no changes to water quality and flows, and no change to river geomorphology of the Dawson River are expected as a result of desalinated water releases into this environment, based on pre- and post-release studies. There is only very low risk of impact on the aquatic ecology of the Dawson River, including its suitability as habitat for *R. leukops*. | **No**:<br>Recent records (frc environmental 2019a) of this species within the proposed action area represent the furthest upstream records in the Dawson River. Though survey effort has been limited, the lack of records between the proposed action area and Theodore (a distance of approximately 260 km) suggests that the species may be rare or absent from much of the intervening river. The species is only likely to be present throughout the Dawson River within the proposed action area, though the size of the population here is not known. The upstream limit is probably the Hutton Creek junction as the Dawson River above this point consists of widely scattered perennial pools only linked during flood events. Thus, the species is probably at its western range limit in the proposed action area.<br>No changes to the riverine environment are expected as a result of the proposed action and no reduction in AoO or EoO is likely to occur. | **No**:<br>The species is at its uppermost known distributional limit in the Dawson River within the proposed action area.<br>The proposed action will not impact the connectivity of flows upstream or downstream of the release point, nor will it form a barrier to aquatic fauna passage. No changes are expected in the species' population within the proposed action area. The proposed action will not fragment the population of the species. | **No**:<br>The Dawson River is subject to a highly variable flow regime, including sometimes extreme flow events, yet it provides suitable aquatic (foraging and sheltering) and terrestrial (nesting) habitat. Minimal or no changes to water quality and flows, and no change to river geomorphology of the Dawson River are expected as a result of desalinated water releases into this environment, based on pre- and post-release studies. There is only very low risk of impact on the aquatic ecology of the Dawson River, including its suitability as habitat for *R. leukops*. Minimal changes in flow heights and velocity will not impact on the suitability of the proposed action area as foraging and shelter habitat (e.g. no alteration of abundance of submerged woody debris). Breeding by the species within the proposed action area has not been confirmed to date, but no significant impact to nesting habitat (e.g. no increase in frequency or duration of inundation of potential nesting banks) is expected to occur. | **No**:<br>Minimal or no changes to water quality and flows, and no change to river geomorphology of the Dawson River are expected as a result of desalinated water releases into this environment, based on pre- and post-release studies. As a result, no changes that may favour either aquatic or terrestrial invasive species are likely to occur within the proposed action area.<br>Note that several plant and animal species known or potentially adversely impacting on the species are present already, including feral pigs and horses, dingoes, livestock (cattle); two species of non-native fish; and non-native pasture grasses that may dominate terrestrial areas in some places. No material change in abundance or distribution of these species is expected as a result of the proposed action. Therefore, no exacerbation of any pre-existing impact is expected. | **No**:<br>The proposed action is very unlikely to introduce a disease that will cause the population to decline.<br>The desalinated water release is very unlikely to produce an ecotoxic impact on either the turtle or on other species within the aquatic environment. It is very unlikely to be a source of pathogens. No external inputs likely to transmit disease are involved in the proposed action. Minimal or nil impacts on flows and hydrology are unlikely to produce change affecting the incidence or severity of any disease already present (none are known). | **No**:<br>Minimal or no changes to water quality and flows, and no change to river geomorphology of the Dawson River are expected as a result of desalinated water releases into this environment, based on pre- and post-release studies. Thus, changes in the aquatic and terrestrial environment here are expected to be negligible or non-existent.<br>The proposed action is unlikely to impact on the extent and quality of foraging, shelter and nesting habitat for the species. It will not affect the existing known extent of the species, nor interfere with movement by the species within the proposed action area or movement of the species upstream or downstream from the proposed action area. It will not allow the introduction of, or exacerbate the existing impact of, invasive species or diseases.<br>The recovery of the species will not be adversely affected by the proposed action. | **NIL**<br>The proposed action will not create a Significant residual Impact on the population of *Rheodytes leukops* |

# 4. Conclusions

Several studies have confirmed the presence of the White-throated Snapping Turtle (*Elseya albagula*) and Fitzroy River Turtle (*Rheodytes leukops*) within the proposed action area (the Dawson River and in the case of *E. albagula* at least occasionally in the waterhole). A field survey found approximately 12.12 ha of suitable aquatic (foraging and shelter) habitat for the two species within the Dawson River in the proposed action area. Potential breeding habitat, i.e. nesting areas within the high banks of the river, occupy about 88 ha within the proposed action area but it is expected that most nest activity will be confined to a smaller area, closer to the water's edge and on or near the crest of the first high bank. Some evidence of breeding by *E. albagula* was discovered – one intact and two predated nests - and it is likely the species nests in suitable locations along the entirety of the 8.1 km of river within the proposed action area. Breeding by *R. leukops* was not confirmed but is likely.

REMP monitoring indicates that flows, water quality and riverine hydrology and geomorphology have been unaffected or only minimally affected by release of desalinated water to the proposed action area. These minor changes are unlikely to impact on the environmental values of the Dawson River. There will be no significant residual impact on the White throated Snapping Turtle (*E. albagula*) nor on the Fitzroy River Turtle (*R. leukops*).

No mitigation measures are required with respect to the proposed release of desalinated water to the receiving environment. However, ongoing monitoring of water quality, flow characteristics and abiotic and biotic parameters of riverine ecosystem health will be conducted at suitable frequency during the life of the release project under the ongoing REMP program.

The most significant threat identified for both turtle species is the very low recruitment into the population due to predation, and trampling, of eggs. Though both species would have co-evolved with native nest predators, novel predators such as the introduced pig and Red Fox have elevated losses to an unsustainable level. Additionally, access to riverbanks by livestock (especially cattle) results in trampling of relatively shallow nests. Field survey confirmed that pigs were common and that they dug up extensive areas of riverbank within and upstream of the proposed action area. Three predated nests, identified by broken eggshells, were detected but the predator involved could not be determined. Cattle and feral horses accessed the banks, with trampling, track formation and bank erosion being commonly observed. The major identified threats to these turtle species appeared to be operating within the proposed action area.

There is potential for development of a nesting habitat protection project for the Dawson River within the proposed action area. Such a project would seek to address both nest predation due to feral animals and trampling of nests by domestic and feral livestock. It would necessarily require the cooperation of all landholders within the proposed action area to be effective.

Field survey indicated that the feral pig was a common, and potentially the most destructive, nest predator in the proposed action area. Its digging activities were also likely to be a cause of riverine bank habitat degradation. A program of coordinated trapping and/or poison baiting would be most likely to achieve control of feral pigs within the proposed action area (Commonwealth of Australia 2017).

This and earlier field surveys have shown that both domestic cattle and feral horses and cattle have access to much of the Dawson River within and in the vicinity of the proposed action area, which they use as a water source as well as grazing on the riverbanks. Strategic fencing to either restrict or exclude access to the river may be feasible. This need not be a permanent exclusion – which is likely to be an unattractive option for pastoral landowners – as timed access to the river, e.g. allowing livestock access for a period in the late summer to early autumn, would allow exploitation of spring-summer grasses while avoiding disturbance during turtle nesting and incubation. A fencing project would ideally be combined with removal of feral cattle and horses.

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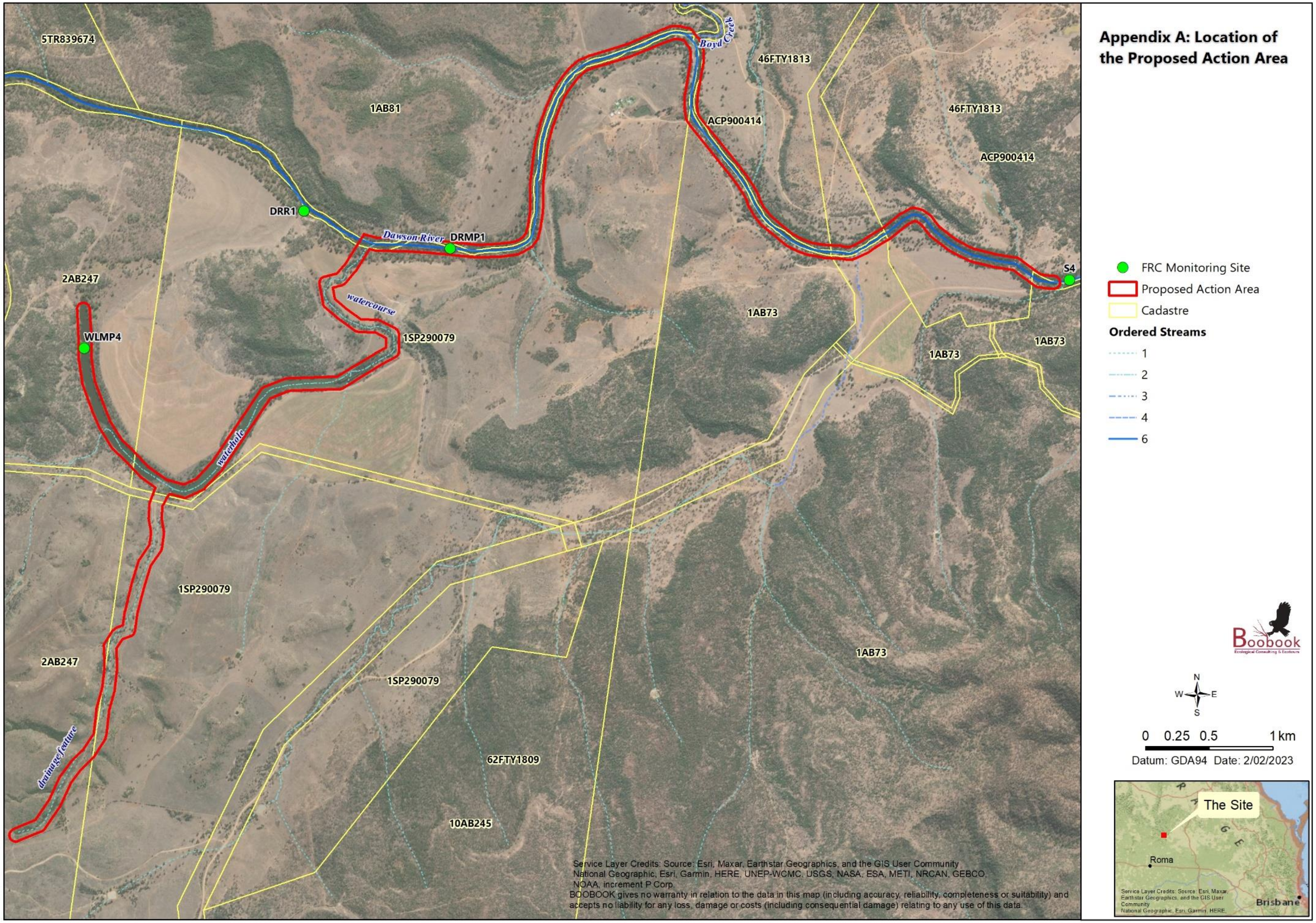
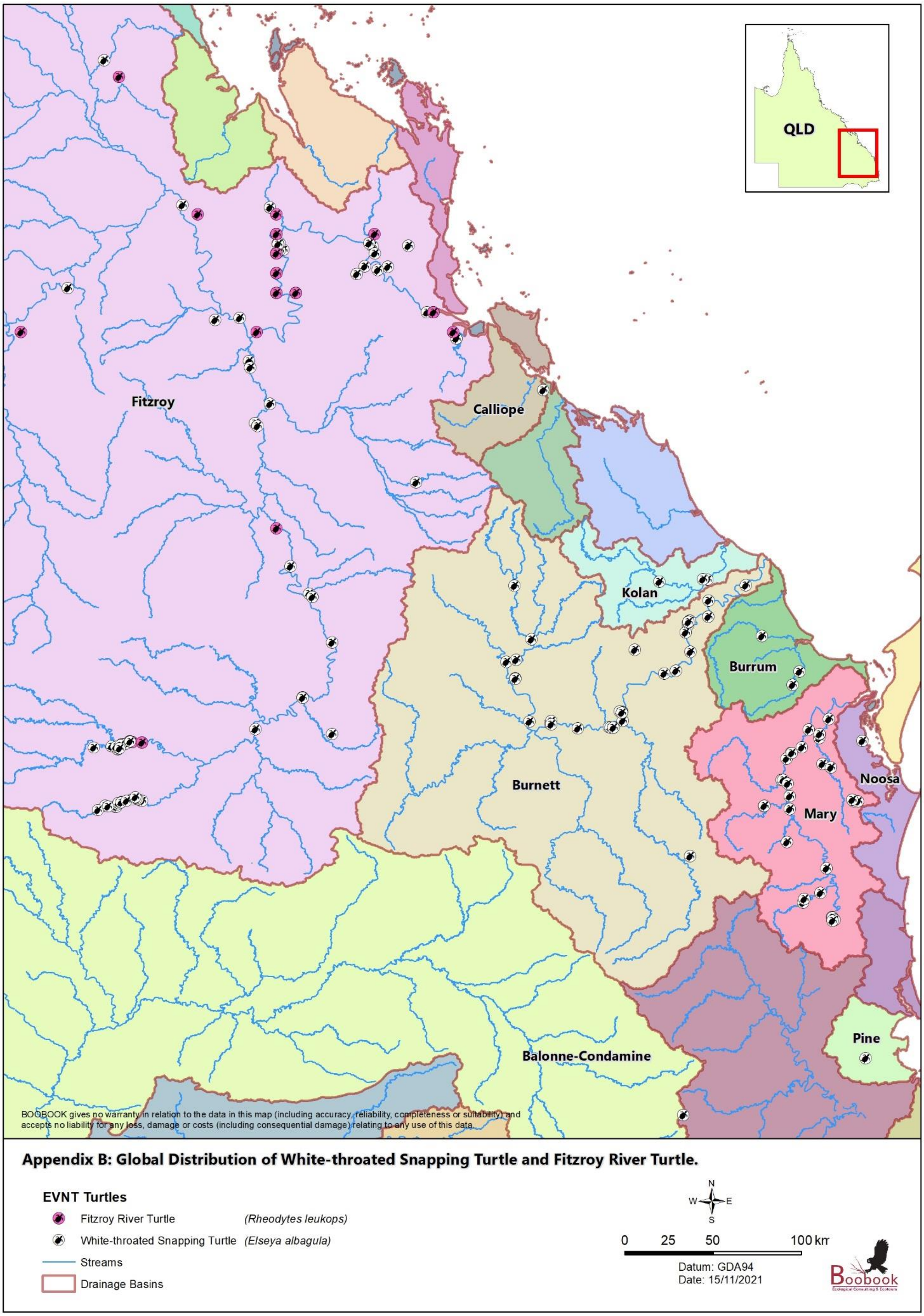
# Appendix A. Map of Dawson River Proposed Action Area, including pre-existing monitoring sites.

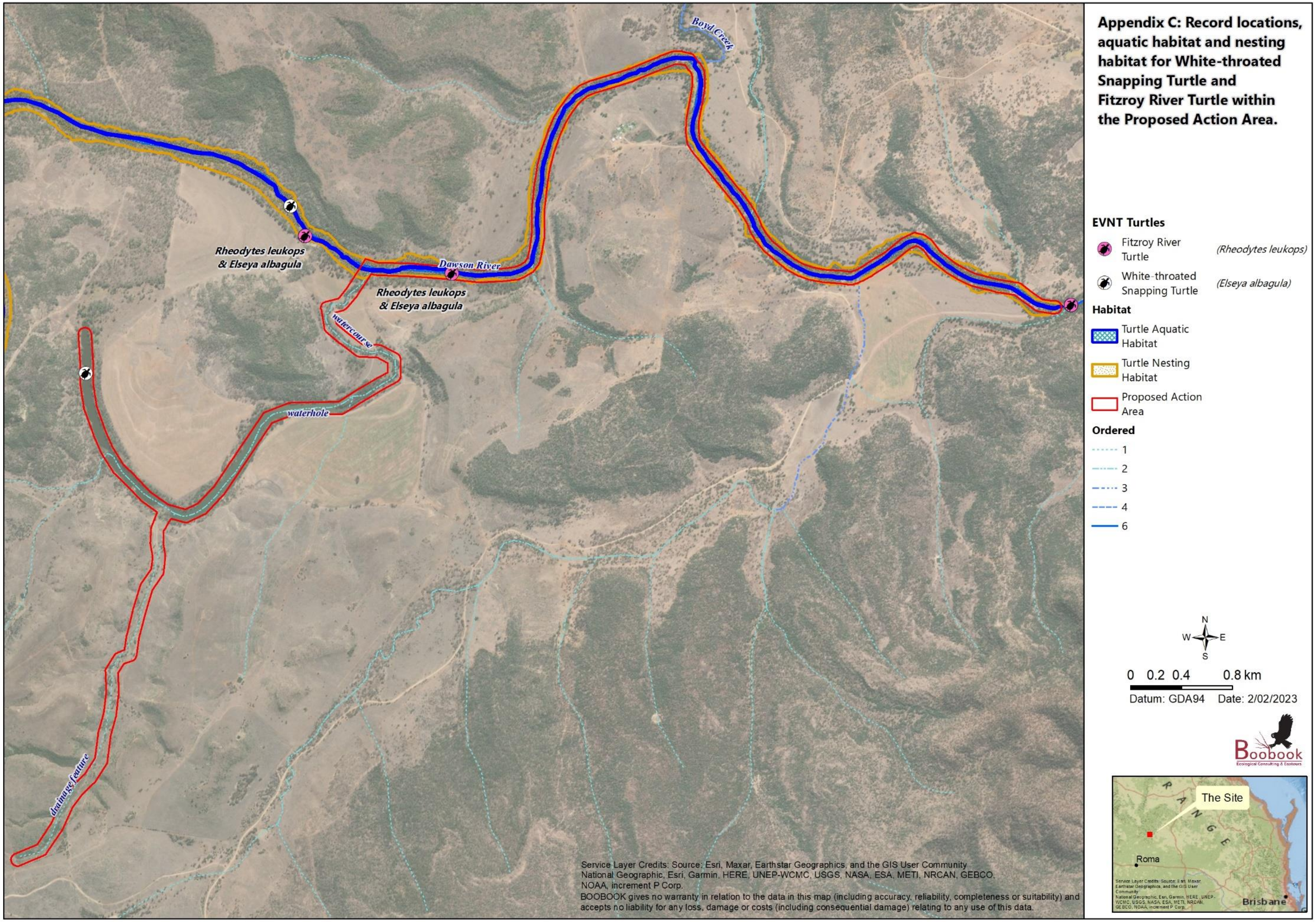

Appendix A: Location of the Proposed Action Area
FRC Monitoring Site
Proposed Action Area
Cadastre
Ordered Streams
1
2
3
4
6
5TR839674
1AB81
46FTY1813
ACP900414
DRR1
Dawson River
DRMP1
Boyd Creek
S4
2AB247
WLMP4
watercourse
1SP290079
1AB73
waterhole
62FTY1809
10AB245
drainage feature
N
W
E
S
0 0.25 0.5 1 km
Datum: GDA94 Date: 2/02/2023
The Site
Roma
Brisbane
Boobook
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO,
NOAA, increment P Corp.
BOOBOOK gives no warranty in relation to the data in this map (including accuracy, reliability, completeness or suitability) and accepts no liability for any loss, damage or costs (including consequential damage) relating to any use of this data.

# Appendix B. Global Distribution of White-throated Snapping Turtle and Fitzroy River Turtle




**Appendix B: Global Distribution of White-throated Snapping Turtle and Fitzroy River Turtle.**

# Appendix C. Record locations, aquatic habitat and breeding habitat for White-throated Snapping Turtle and Fitzroy River Turtle within the Proposed Action Area


Appendix C: Record locations, aquatic habitat and nesting habitat for White-throated Snapping Turtle and Fitzroy River Turtle within the Proposed Action Area.
Boyd Creek
Dawson River
Rheodytes leukops & Elseya albagula
Rheodytes leukops & Elseya albagula
watercourse
waterhole
drainage feature
EVNT Turtles
Fitzroy River Turtle (Rheodytes leukops)
White-throated Snapping Turtle (Elseya albagula)
Habitat
Turtle Aquatic Habitat
Turtle Nesting Habitat
Proposed Action Area
Ordered
1
2
3
4
6
N
W
E
S
0 0.2 0.4 0.8 km
Datum: GDA94 Date: 2/02/2023
Boobook
The Site
RANGE
Roma
Brisbane
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
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# Appendix D. Extract from Environmental Authority No. EPPG00928713: Conditions relating to contaminant limits in released coal seam gas water

# Permit

**B12** The construction and/or maintenance of linear infrastructure in any general ecologically significant wetland must not:

(a) prohibit the flow of surface water in or out of the wetland;
(b) impact surface water quality in the wetland unless specifically authorised by this environmental authority;
(c) drain the wetland;
(d) fill the wetland;
(e) impact bank stability; or
(f) result in the clearing of riparian vegetation outside of the required footprint.

**Floodplains**

**B13** Where the petroleum activity is carried out on floodplains the petroleum activity must be carried out in a way that does not:

(a) concentrate flood flows in a way that will or may cause or threaten an adverse environmental impact; or
(b) divert flood flows from natural drainage paths and alter flow distribution; or
(c) increase the local duration of floods; or
(d) increase the risk of detaining flood flows.

**Erosion and Sediment Control**

**B14** For activities involving significant disturbance to land, control measures that are commensurate to the site-specific risk of erosion, and risk of sediment release to waters must be implemented to:

(a) preferentially divert stormwater around significantly disturbed land, or allow stormwater to pass through the site in a controlled manner and at non-erosive flow velocities;
(b) minimise soil erosion resulting from wind, rain, and flowing water;
(c) minimise the duration that disturbed soils are exposed to the erosive forces of wind, rain, and flowing water;
(d) minimise work-related soil erosion and sediment runoff; and
(e) minimise negative impacts to land or properties adjacent to the activities (including roads).

**Contaminant Release – Coal Seam Gas Water**

**B15** Subject to condition (B16), the release of contaminants to waters must only occur from the release points specified in *Schedule B, Table 3 – Contaminant Release Points.*

**Schedule B, Table 3 – Contaminant Release Points**

| Description | Latitude (Decimal degrees GDA94) | Longitude (Decimal degrees GDA94) | Contaminant | Description of Receiving Waters |
|---|---|---|---|---|
| Reverse Osmosis Plant 1 "Pony Hills Water Treatment Plant" (ROP1) | -25.76870484 | 149.030008341 | Treated coal seam gas water | Tributary of Hutton Creek |

# Permit

| | | | | |
|---|---|---|---|---|
| Reverse Osmosis Plant 2 (ROP2) | -25.73 | 149.14 | Treated coal seam gas water | Tributary of the Dawson River |

**B16** The release of contaminants to waters from ROP2 in accordance with condition (B15) must cease on or before 23 July 2026.

**B17** The release of contaminants to waters from ROP2 in accordance with condition (B15) must not cause an adverse impact on the species richness or species abundance of aquatic fauna.

**B18** The maximum volume of contaminants released to waters under condition (B15) must not exceed:

(a) 5.1 ML per day for ROP1;
(b) 18 ML per day for ROP2.

**Receiving Environment Monitoring**

**B19** The release of contaminants to waters authorised by condition (B15) must not exceed the limits specified in *Schedule B, Table 4 – Contaminant Limits* and drinking water limits specified in *Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water*.

**B20** The release of contaminants to waters authorised by condition (B15) must be monitored at the locationsand for each quality characteristic and at the frequency specified in *Schedule B, Table 4 – Contaminant Limits* and *Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of DrinkingWater*.

**Schedule B, Table 4 – Contaminant Limits**

| Quality Characteristic | Monitoring Point (MP) | Latitude (Decimal degrees GDA94) | Longitude (Decimal degrees GDA94) | Limit Type | Limit | Monitoring Frequency |
|---|---|---|---|---|---|---|
| Temperature | HCS04DWB1 | -25.730 | 149.090 | Monitor only | Monitor only | Daily during release from ROP2 |
| pH | HCS04DWB1 | -25.730 | 149.090 | Range | 6.5-8.5 | |
| Electrical Conductivity | HCS04DWB1 | -25.730 | 149.090 | 75th %ile | 370 µS/cm | |
| | ROP1 end of pipe | -25.76870484 | 149.030008341 | Maximum | 500 µS/cm | Daily during release from ROP1 |
| Turbidity | HCS04DWB1 | -25.730 | 149.090 | Maximum | 50 (NTU) | Daily during release from ROP2 |

# Permit

| | | | | | | |
|---|---|---|---|---|---|---|
| Dissolved Oxygen (85-110% Saturation) | HCS04DWB1 | --25.730 | 149.090 | Range | 6.4-16.1 mg/L | Daily during release from ROP2 |
| Total nitrogen | HCS04DWB1 | -25.730 | 149.090 | Maximum | 620 µg/L | Weekly during release from ROP2 |
| Ammonia | HCS04DWB1 | -25.730 | 149.090 | Maximum | 0.9 mg/L | |
| Calcium | HCS04DWB1 | -25.730 | 149.090 | Minimum | 1 mg/L | |
| Chloride | HCS04DWB1 | -25.730 | 149.090 | Maximum | 175 mg/L | |
| Fluoride | HCS04DWB1 | -25.730 | 149.090 | Maximum | 1 mg/L | |
| Magnesium | HCS04DWB1 | -25.730 | 149.090 | Monitor only | mg/L | Weekly during release from ROP2 |
| Potassium | HCS04DWB1 | -25.730 | 149.090 | Monitor only | mg/L | |
| Sodium | HCS04DWB1 | -25.730 | 149.090 | Maximum | 115 mg/L | |
| Sulphate | HCS04DWB1 | -25.730 | 149.090 | Maximum | 5 mg/L | |
| Aluminium | HCS04DWB1 | -25.730 | 149.090 | Maximum | 55 µg/L | |
| Total Arsenic | HCS04DWB1 | -25.730 | 149.090 | Maximum | 13 µg/L | |
| Boron | HCS04DWB1 | -25.730 | 149.090 | Maximum | 2.9mg/L ≤ 13.5ML/Day OR 2.5mg/L ≤18.0 ML/day | Weekly during release from ROP2 |
| | Dawson River MP1 | -25.690 | 149.163 | Maximum | 2.9 mg/L | Weekly during release from ROP1 |
| Cadmium | HCS04DWB1 | -25.730 | 149.090 | Maximum | 0.2 µg/L | |
| Chromium (VI) | HCS04DWB1 | -25.730 | 149.090 | Maximum | 1 µg/L | Weekly during release from ROP2 |
| Copper | HCS04DWB1 | -25.730 | 149.090 | Maximum | 1.4 µg/L | |
| Iron | HCS04DWB1 | -25.730 | 149.090 | Maximum | 300 µg/L | |
| Lead | HCS04DWB1 | -25.730 | 149.090 | Maximum | 3.4 µg/L | |
| Manganese | HCS04DWB1 | -25.730 | 149.090 | Maximum | 1,900 µg/L | |
| Mercury | HCS04DWB1 | -25.730 | 149.090 | Maximum | 0.6 µg/L | |
| Nickel | HCS04DWB1 | -25.730 | 149.090 | Maximum | 11 µg/L | |
| Selenium | HCS04DWB1 | -25.730 | 149.090 | Maximum | 11 µg/L | |
| Zinc | HCS04DWB1 | -25.730 | 149.090 | Maximum | 8 µg/L | |
| | Dawson River MP1 | -25.690 | 149.163 | Maximum | 8 µg/L | Weekly during release from ROP1 |
| Hardness (mg/L) | HCS04DWB1 | -25.730 | 149.090 | Monitor only | Monitor only | Weekly during release from ROP2 |

*Note: All metals and metalloids must be measured as dissolved (filtered in the field).*
*Note: HCS04DWB1 refers to the inlet to release pipe of the dam identified as HCS04DWB1.*

# Permit

**Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water**

| Quality Characteristic | Monitoring Point | Limit Type | Drinking Water Limit | Release Point | Monitoring Frequency |
|---|---|---|---|---|---|
| Alpha Activity | Dawson River S4 (coordinates: -25.6920, 149.2160) | Maximum | 0.5 Bq/L | ROP1 and ROP2 | First release day of each quarter |
| Aluminium | | | 200 µg/L | | |
| Ammonia | | | 500 µg/L | | |
| Antimony | | | 3 µg/L | | |
| Arsenic | | | 10 µg/L | | |
| Barium | | | 2000 µg/L | | |
| Benzene | | | 1 µg/L | | |
| Beta Activity | | | 0.5 Bq/L | | |
| Bisphenol A | | | 200 µg/L | | |
| Boron | | | 4000 µg/L | | |
| Bromide | | | 7000 µg/L | | |
| Cadmium | | | 2 µg/L | | |
| Chromium | | | 50 µg/L | | |
| Copper | | | 2000 µg/L | | |
| Cyanide | | | 80 µg/L | | |
| Ethylbenzene | | | 300 µg/L | | |
| Fluoride | | | 1500 µg/L | | |
| Iodide | | | 500 µg/L | | |
| Lead | | | 10 µg/L | | |
| Manganese | | | 500 µg/L | | |
| Mercury | | | 1 µg/L | | |
| Molybdenum | | | 50 µg/L | | |
| Nickel | | | 20 µg/L | | |
| Nonylphenol | | | 500 µg/L | | |
| PAH (as B(a)P TEF) TEF:<br>Benz[a]anthracene 0.1<br>Benzo[b+j]fluoranthene 0.1<br>Benzo[k]fluoranthene 0.1<br>Benzo[a]pyrene 1.0<br>Chrysene 0.01<br>Dibenz[a,h]anthracene 5<br>Indeno[1,2,3-cd]pyrene 0.1 | | | 0.01 µg/L | | |
| Selenium | | | 10 µg/L | | |
| Silver | | | 100 µg/L | | |
| Strontium | | | 4000 µg/L | | |
| Toluene | | | 800 µg/L | | |
| TPH | | | 200 µg/L | | |
| Vanadium | | | 50 µg/L | | |
| Xylenes | | | 600 µg/L | | |
| Zinc | | | 3000 µg/L | | |
| <u>Disinfection by-products:</u> | | | | | |
| Bromochloroacetonitrile | | Monitor only | Monitor only | | |

# Permit

| Quality Characteristic | Monitoring Point | Limit Type | Drinking Water Limit | Release Point | Monitoring Frequency |
|---|---|---|---|---|---|
| Dichloroacetonitrile | Dawson River S4 (coordinates: -25.6920, 149.2160) | Monitor only | Monitor only | ROP1 and ROP2 | First release day of each quarter |
| N-Nitrosodimethylamine | | Maximum | 0.1 µg/L | | |
| Trihalomethanes (THM): Bromodichloromethane Bromoform Chloroform (Trichloromethane) Dibromochloromethane | | Maximum | 250 µg/L | | |

**B21** Weekly monitoring for the quality characteristic of boron must be undertaken at S4 (Dawson River, coordinates: -25.6920, 149.2160) when the boron concentration of the release exceeds 2.0 mg/L at HSC04DWB1.

**B22** If the quality characteristic of Boron at S4 is between 1.2 mg/L and 1.5 mg/L, all third parties that undertake irrigation using water from the Dawson River, up to a distance of 20km downstream of S4, must be notified.

**B23** If the quality characteristic of Boron at S4 exceeds 1.5mg/L, all third parties downstream of S4 that undertake irrigation using water from the Dawson River upstream of the Glebe Weir (coordinates: -25.4647, 150.0349), must be notified.

**B24** Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters, or cause a material build-up of sediment in such waters.

**B25** Notwithstanding any other condition of this environmental authority, there must be no release of any toxic substance in any amount or concentration, either alone or in combination with substances already in the receiving water or release, that cause acute toxicological effects to aquatic organisms in the receiving environment, with the exception of the release authorised in *Schedule B, Table 6 – Event-based Release Point* within the receiving environment mixing zone presented in the Dawson River Event Release Technical Impact Assessment Report 2016 (AECOM).

**Contaminant Release – Event-based release of Coal Seam Gas Water**

**B26** Subject to conditions (B26) to (B35), the release of contaminants to waters must only occur from the release point specified in *Schedule B, Table 6 – Event-based Contaminant Release Point.*

**Schedule B, Table 6 – Event-based Contaminant Release Point**

| Description | Latitude (Decimal degrees GDA94) | Longitude (Decimal degrees GDA94) | Contaminant | Description of Receiving Waters |
|---|---|---|---|---|
| Event-based release | -25.728583 | 149.093207 | Coal seam gas water | Dawson River |

# Permit

**B27** The release of contaminants to waters authorised by condition (B26) must only occur as a contingency measure to support the beneficial use of coal seam water during rainfall events.

**B28** A diffuser outlet must be used at the contaminant release location specified in *Schedule B, Table 6 – Event-based Contaminant Release Point.*

**B29** The release of contaminants must only occur during periods of natural flow events when the limits in *Schedule B, Table 7 – Event-based release – Limits for release* are met.

**Schedule B, Table 7 – Event-based release – Limits for release**

| Quality Characteristic | Monitoring Point (MP) | Latitude (Decimal degrees GDA94) | Longitude (Decimal degrees GDA94) | Limit Type | Limit | Monitoring Frequency |
|---|---|---|---|---|---|---|
| Receiving environment stream flow ($m^3$/sec) | Upstream Dawson River gauging station (S3A) | -25.7237 | 149.0915 | Minimum | >1.16$m^3$/sec | Prior to release and continuous (15min intervals) during release |
| Electrical Conductivity | Upstream Dawson River gauging station (S3A) | -25.7237 | 149.0915 | Monitor only | Monitor only | Prior to release and continuous (15min intervals) during release |
| Electrical Conductivity | Release location (i.e. at pumping source or inlet to pipe) | -25.728583 | 149.093207 | Maximum | 10,000 µS/cm | Prior to release and continuous (15min intervals) during release |

**B30** The release of contaminants to waters authorised by condition (B26) must not exceed the limits specified in *Schedule B, Table 8 – Event-based release – Contaminant monitoring* or *Schedule B, Table 9 – Event-based Release - Contaminant Limits for Protecting the Environmental Value of Drinking Water.*

**B31** The release of contaminants to waters authorised by condition (B26) must be monitored at the locations and for each quality characteristic and at the frequency specified in S*chedule B, Table 8– Event-based release – Contaminant* Limits and Schedule *B, Table 9 – Event based release - Contaminant Limits for Protecting the Environmental Value of Drinking Water.*

**Schedule B, Table 8 – Event-based release – Contaminant monitoring**

| Quality Characteristic | Monitoring Point (MP) | Latitude (Decimal degrees GDA94) | Longitude (Decimal degrees GDA94) | Limit Type | Limit | Monitoring Frequency |
|---|---|---|---|---|---|---|
| Volume of untreated CSG water | Release location (end of pipe) | -25.728583 | 149.093207 | Monitor | ML | Continuous (15min intervals) during release |

# Permit

| | | | | | | |
|---|---|---|---|---|---|---|
| pH | Release location (end of pipe) | -25.728583 | 149.093207 | Range | 6.5 - 8.5 | Within 2 hours of commencement of release, and daily during release thereafter |
| Temperature | Release location (end of pipe) | -25.728583 | 149.093207 | Monitor | °C | |
| Turbidity | Release location (end of pipe) | -25.68836 | 149.15716 | Monitor | Monitor (NTU) | Within 2 hours of commencement of release, and weekly during release thereafter |
| Total Nitrogen | Downstream monitoring point S1a | -25.72464 | 149.10405 | Monitor | μg/L | |
| Ammonia | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 0.9 mg/L | |
| Chloride | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 175 mg/L | |
| Fluoride | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 2 mg/L | |
| Magnesium | Downstream monitoring point S1a | -25.72464 | 149.10405 | Monitor | mg/L | |
| Potassium | Downstream monitoring point S1a | -25.72464 | 149.10405 | Monitor | mg/L | Within 2 hours of commencement of release, and weekly during release thereafter |
| Sodium | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 115 mg/L | |
| Sulfate | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 5 mg/L | |
| Aluminium | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 150 μg/L* | |
| Arsenic (Total) | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 13 μg/L | |
| Boron | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 1.2 mg/L | |
| Cadmium | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 0.2 μg/L | |

# Permit

| Quality Characteristic | Monitoring Point (MP) | Latitude (Decimal degrees GDA94) | Longitude (Decimal degrees GDA94) | Limit Type | Limit | Monitoring Frequency |
|---|---|---|---|---|---|---|
| Chromium (VI) | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 1 µg/L | |
| Copper | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 2.5 µg/L* | |
| Iron | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 350 µg/L | |
| Lead | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 3.4 µg/L | |
| Manganese | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 1,900 µg/L | |
| Mercury | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 0.6 µg/L | |
| Nickel | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 11 µg/L | |
| Selenium | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 11 µg/L | |
| Zinc | Downstream monitoring point S1a | -25.72464 | 149.10405 | Maximum | 15 µg/L^ | |
| Hardness as CaCO3 | Downstream monitoring point S1a | -25.72464 | 149.10405 | Monitor | mg/L | |
| Receiving environment stream flow ($m^3$/sec) | Downstream monitoring point S1a | -25.72464 | 149.10405 | Monitor ($m^3$/sec) | Monitor | Continuous (15min intervals) during release |
| Electrical Conductivity | Downstream monitoring point S1a | -25.72464 | 149.10405 | 95th Percentile | 370 µS/cm | Continuous (15min intervals) during release |

Note: all metals and metalloids must be measured as dissolved unless otherwise specified.
* Limit based on the protection of 80% of species (ANZECC, 2000)
^ Limit based on the protection of 90% of species (ANZECC, 2000)

# Permit

**Schedule B, Table 9 – Event based release- Contaminant Limits for Protecting the Environmental Value of Drinking Water**

| Quality Characteristic | Monitoring Point | Limit Type | Drinking Water Limit | Release Point | Monitoring Frequency |
|---|---|---|---|---|---|
| Alpha Activity | Dawson River S1a (coordinates -25.72464, 149.10405) | Maximum | 0.5 Bq/L | Schedule B, Table 6 Event-based Contaminant Release Point. | Following release on the first release day of each quarter |
| Aluminium | | | 200 µg/L | | |
| Ammonia | | | 500 µg/L | | |
| Antimony | | | 3 µg/L | | |
| Arsenic | | | 10 µg/L | | |
| Barium | | | 2000 µg/L | | |
| Benzene | | | 1 µg/L | | |
| Beta Activity | | | 0.5 Bq/L | | |
| Bisphenol A | | | 200 µg/L | | |
| Boron | | | 4000 µg/L | | |
| Bromide | | | 7000 µg/L | | |
| Cadmium | | | 2 µg/L | | |
| Chromium | | | 50 µg/L | | |
| Copper | | | 2000 µg/L | | |
| Cyanide | | | 80 µg/L | | |
| Ethylbenzene | | | 300 µg/L | | |
| Fluoride | | | 1500 µg/L | | |
| Iodide | | | 500 µg/L | | |
| Lead | | | 10 µg/L | | |
| Manganese | | | 500 µg/L | | |
| Mercury | | | 1 µg/L | | |
| Molybdenum | | | 50 µg/L | | |
| Nickel | | | 20 µg/L | | |
| Nonylphenol | | | 500 µg/L | | |
| PAH (as B(a)P TEF) TEF:<br>Benz[a]anthracene 0.1<br>Benzo[b+j]fluoranthene 0.1<br>Benzo[k]fluoranthene 0.1<br>Benzo[a]pyrene 1.0<br>Chrysene 0.01<br>Dibenz[a,h]anthracene 5<br>Indeno[1,2,3-cd]pyrene 0.1 | | | 0.01 µg/L | | |
| Selenium | | | 10 µg/L | | |
| Silver | | | 100 µg/L | | |
| Strontium | | | 4000 µg/L | | |
| Toluene | | | 800 µg/L | | |
| TPH | | | 200 µg/L | | |
| Vanadium | | | 50 µg/L | | |
| Xylenes | | | 600 µg/L | | |
| Zinc | | | 3000 µg/L | | |

**B32** The environmental authority holder must take all reasonable and practicable measures to maintain safe and practical access to monitoring locations specified in *Schedule B, Table 4 – Contaminant Limits,*

# Permit

*Schedule B, Table 5 – Contaminant Limits for Protecting the Environmental Value of Drinking Water*, *Schedule B, Table 8 – Event-based release – Contaminant monitoring* and *Schedule B, Table 9 – Event based releases - Contaminant Limits for Protecting the Environmental Value of Drinking Water.*

**B33** If the release limits defined in *Schedule B, Table 9 – Event based releases - Contaminant Limits for Protecting the Environmental Value of Drinking Water-* or *Schedule B, Table 8 – Event-based release - Contaminant monitoring* are exceeded, the following events must occur:

(a) the release of contaminants to waters authorised by condition (B26) must cease within 24 hours of becoming aware of any exceedance: and

(b) the holder of the environmental authority must demonstrate to the administering authority a strategy for managing future releases without exceedances before undertaking further releases.

**B34** If the quality characteristic of Boron of the release exceeds the release limit of 1.2 mg/L specified in and *Schedule B, Table 8 – Event- based release - Contaminant monitoring*, all third parties that undertake irrigation using water from the receiving waters up to a distance of 300km downstream must be notified.

**B35** Releases to waters must be undertaken so as not to cause erosion of the bed and banks of the receiving waters or cause a material build-up of sediment in such waters.

**Receiving Environment Monitoring Program**

**B36** For the release authorised in *Schedule B, Table 3 – Contaminant Release Points*, a REMP must be developed to monitor, identify and describe any adverse impacts to surface water environmental values, quality and flows due to the authorised activity(ies) by 1 February 2014. The REMP must include periodic monitoring for the effects of the discharge on the receiving environment (under natural flow conditions) as a result of contaminant releases to waters from the site.

**B37** For the release authorised in *Schedule B, Table 3 – Contaminant Release Points,* for the purposes of the REMP, the receiving environment is the waters of the Dawson River and connected or surrounding waterways (including the receiving wetland) up to Yebna Crossing, located 8.5 km downstream of the receiving wetland.

**B38** For the release authorised in *Schedule B, Table 6 – Event Based Contaminant Release Point*, a Receiving Environment Monitoring Program (REMP) Design Document that addresses each criterion presented in condition (B41), except criteria (B41)(m), must be prepared and submitted to the administering authority for approval prior to any release occurring under condition (B29). Due consideration must be given to any comments made by the administering authority on the REMP Design Document and subsequent implementation of implemented for the duration of the program.

**B39** Conditions (B40) and (B41) apply to the releases authorised in *Schedule B, Table 3 – Contaminant Release Points* and *Schedule B, Table 6 – Event-based Contaminant Release Point.*

**B40** The REMP must be reviewed and certified by a suitably qualified person.

**B41** The REMP must address but not be limited to the following:

a) description of potentially affected receiving waters including key communities and background water quality characteristics based on accurate and reliable monitoring data that takes into