Baralaba South Project

Environmental Impact Statement

CHAPTER 9

Matters of National Environmental Significance

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9 Matters of National Environmental Significance

9.1 Introduction

The Baralaba South Project (the Project) is a 'controlled action' under the EPBC Act (Reference: EPBC 2012/6547). The EIS has been prepared pursuant to the bilateral agreement between the Commonwealth and Queensland Governments' assessment under Part 8 of the EPBC Act.

The controlling provisions of the Project are:

- listed threatened species and communities (sections 18 and 18A);
- listed migratory species (sections 20 and 20A); and
- a water resource in relation to coal seam gas development and large coal mining development (sections 24D and 24E).

The purpose of this chapter of the EIS is to address potential impacts of the action on MNES, inclusive of any avoidance, mitigation, and offset measures. In doing so, this chapter demonstrates how the EIS has addressed the requirements of the EPBC Act.

9.1.1. Proponent

The Proponent for the Project is Baralaba South Pty Ltd (ACN 603 037 065) (formerly Mount Ramsay Coal Company Pty Ltd and Wonbindi TLO Holdings Pty Limited). The registered address and postal address for Baralaba South Pty Ltd (the Proponent) is:

Level 20
10 Eagle Street
BRISBANE CITY, QLD 4000

The Proponent is a privately owned Australian metallurgical coal company; and a wholly owned subsidiary of Baralaba Coal Pty Ltd (Baralaba Coal Company). Baralaba Coal Pty Ltd is majority owned by the AMCI Group.

9.1.1.1 Environmental record of the Proponent

The Proponent has adhered to all environmental regulatory responsibilities in association with its activities and has not been subject to any environmental related legal proceedings, penalty infringement notices, or other environmental related compliance actions.

9.1.1.2 Environmental policy and planning framework

Baralaba Coal Company has policies in place that form the foundation of its broader planning framework. These are its:

- Environmental Policy;
- Health and Safety Policy; and
- Community Policy.

The abovementioned policies are provided in Figure 9.1, Figure 9.2 and Figure 9.3.

The Proponent's overarching planning framework will be guided by their environmental management system, which will be developed prior to construction and during the detailed design phase of the Project. The environmental management system will be developed to achieve a series of key framework components, including:

- performance targets and objectives;
- key roles and responsibilities that will ensure satisfactory environmental outcomes;
- operational procedures and protocols:
    - communication;
    - emergency response; and
    - educational staff training and induction requirements;
- monitoring/reporting obligations, including incident and compliance reviews;
- environmental management activities/mitigation controls; and
- periodic management review.

BARALABA
COAL COMPANY

Environmental Policy

Baralaba Coal Company is committed to being an environmentally responsible coal company by avoiding, minimising or mitigating environmental impacts.

We will:

- Display visible leadership by considering environmental aspects throughout all phases of project development;
- Comply with all relevant legislation, regulations and approval conditions;
- Plan, implement, monitor and review appropriate environmental management systems and processes;
- Identify and control hazards and impacts resulting from Baralaba Coal Company's operations that may affect the natural environment;
- Promote the efficient use of natural resources;
- Consider and actively manage our impacts on the communities in which we operate throughout all phases of our projects; and
- Engage with stakeholders and consider their views in project planning and operations.

Baralaba Coal Company's commitment to the environment extends to our employees, contractors and the communities in which we operate.

Andrew Boyd
Chief Executive Officer

1 January 2022

ABN 42 096 969 634 | Level 20, 15 Eagle Street, Brisbane QLD 4000 | www.baralabacoal.com.au

Figure 9.1: Baralaba Coal Company Environmental Policy

BARALABA
COAL COMPANY

Community Policy

Baralaba Coal Company seeks to contribute positively to the communities in which we operate.

We will:

- Behave with integrity;
- Treat people with dignity and respect;
- Provide accurate and timely information to the community and all stakeholders;
- Actively listen and acknowledge other points of view in project planning and operations;
- Respect individual and cultural differences at all times;
- Support local employment and businesses.

All Baralaba Coal Company employees and contractors are responsible for applying this policy at all times.

Andrew Boyd
Chief Executive Officer

1 January 2022

Figure 9.2: Baralaba Coal Company Community Policy

BARALABA
COAL COMPANY

Health & Safety Policy

Baralaba Coal Company is committed to creating a workplace, free from injury and harm.

We will:

- Display leadership and commitment;
- Comply with all relevant legislation, regulations, codes of practice and standards;
- Monitor and review the risk management approach and safety performance of our major service providers;
- Provide a safe and healthy workplace and working conditions for all, including employees, contractors and visitors;
- Provide training and support to enable all employees to work safely;
- Conduct investigations into all applicable incidents and ensure corrective actions are implemented;
- Consult with employees and major service providers to ensure understanding of the Health and Safety Management System and enhance effectiveness of policies & procedures;
- Regularly communicate and provide feedback to ensure high standards of health & safety, and a culture of continuous improvement.

Andrew Boyd
Chief Executive Officer

1 January 2022

ABN [illegible] | Level 35, 10 Eagle Street, Brisbane QLD 4000 | www.baralabacoal.com.au

Figure 9.3 Baralaba Coal Company Health and Safety Policy

9.1.2. Environmental impact assessment process

On 10 August 2011 Wonbindi Coal applied to the now DES under sections 70 and 71 of the EP Act for approval to voluntarily prepare an EIS. Under section 72 of the EP Act, DES approved the application on 16 August 2011. An Initial Advice Statement was subsequently submitted to DES in September 2012 outlining the resource, operations and infrastructure of the proposed Project. In October 2012, Wonbindi Coal also applied to the now DoR for a mining lease (ML) over the Project area.

On 18 October 2012, the now Commonwealth DCCEEW determined the proposed Project to be a controlled action under the EPBC Act, with the controlling provisions being sections 18 and 18A (listed threatened species and communities) and 20 and 20A (listed migratory species). At this time, the DCCEEW also established that the Project assessment could proceed under the bilateral assessment agreement process. To support this, the DCCEEW provided specific requirements that were included within the final TOR established by the DES. On 22 October 2013, DCCEEW decided under item 23 of Schedule 1 of the *Environment Protection and Biodiversity Conservation Amendment Act 2013* that sections 24D and 24E of the EPBC Act, regarding impacts to water resources related to a large coal mining development, would also be controlling provisions for the Project.

The TOR for the BSP were finalised on 2 April 2013, however, ceased to have effect on 2 April 2015. An updated IAS was submitted in 2017, commencing a new TOR application process for the Project. The TOR for the BSP were finalised on 19 July 2017. An extension to the submission period for the EIS was granted to 19 January 2020.

The Proponent at this time, Mount Ramsay Coal, prepared a draft EIS that described a proposed 5 million tonne per annum (Mtpa) run of mine (ROM) coal project. Before final submission, the Proponent changed from Mount Ramsay coal to Baralaba South Pty Ltd

Baralaba South Pty Ltd was granted an extension by the department to 19 December 2023 to revise the mine plan to reduce the proposed Project's output to approximately 2.5 Mtpa of ROM Coal. This was primarily to mitigate potential flooding impacts of activities on the Dawson River floodplain.

9.1.2.1 Terms of reference

The Terms of Reference (TOR) for the Project were finalised on 2 April 2013, however, ceased to have effect on 2 April 2015. A revised TOR was finalised for the Proponent on 19 July 2017. A six-month extension to the submission period for the EIS was granted before the expiry of the initial two-year period. As discussed in section 9.1.1, Baralaba South Pty Ltd is now the Proponent for the Project.

The TOR is provided in Attachment 1. Section 8.3.9 of the TOR (note typographical error in TOR refers to 8.3.6) requires the EIS to address the IESC's information guidelines 'Information guidelines for proponents preparing coal seam gas and large coal mining development proposals' (Commonwealth of Australia, 2018). A detailed reconciliation table indicating where the IESC guidelines are addressed in this chapter is provided in Attachment 4.

Appendix 2 of the TOR details the MNES assessment requirements that must be addressed by the EIS. A detailed reconciliation table indicating where the TOR Appendix 2 are addressed in the EIS is provided in Attachment 5.

9.1.2.2 EIS preparation

This EIS has been prepared to ensure that sufficient information is provided to the Department of Environment and Science Queensland (DES); the DAFF; and the DCCEEW); to identify and assess any potential adverse and beneficial environmental, economic and social impacts of the Project. This EIS also provides a detailed description of the actions undertaken by the Proponent to avoid, mitigate and minimise adverse impacts.

Baseline scientific and technical investigations have been undertaken across a range of impact areas, consistent with the requirements of the TOR. While the key outcome of the EIS process is to obtain an EA for the Project and an EPBC decision, the information provided throughout these investigations will be utilised to support secondary approvals, such as water licences or offsets agreements.

A flow chart of the EIS process (and linkages to the parallel ML application process) is provided in Figure 9.4.

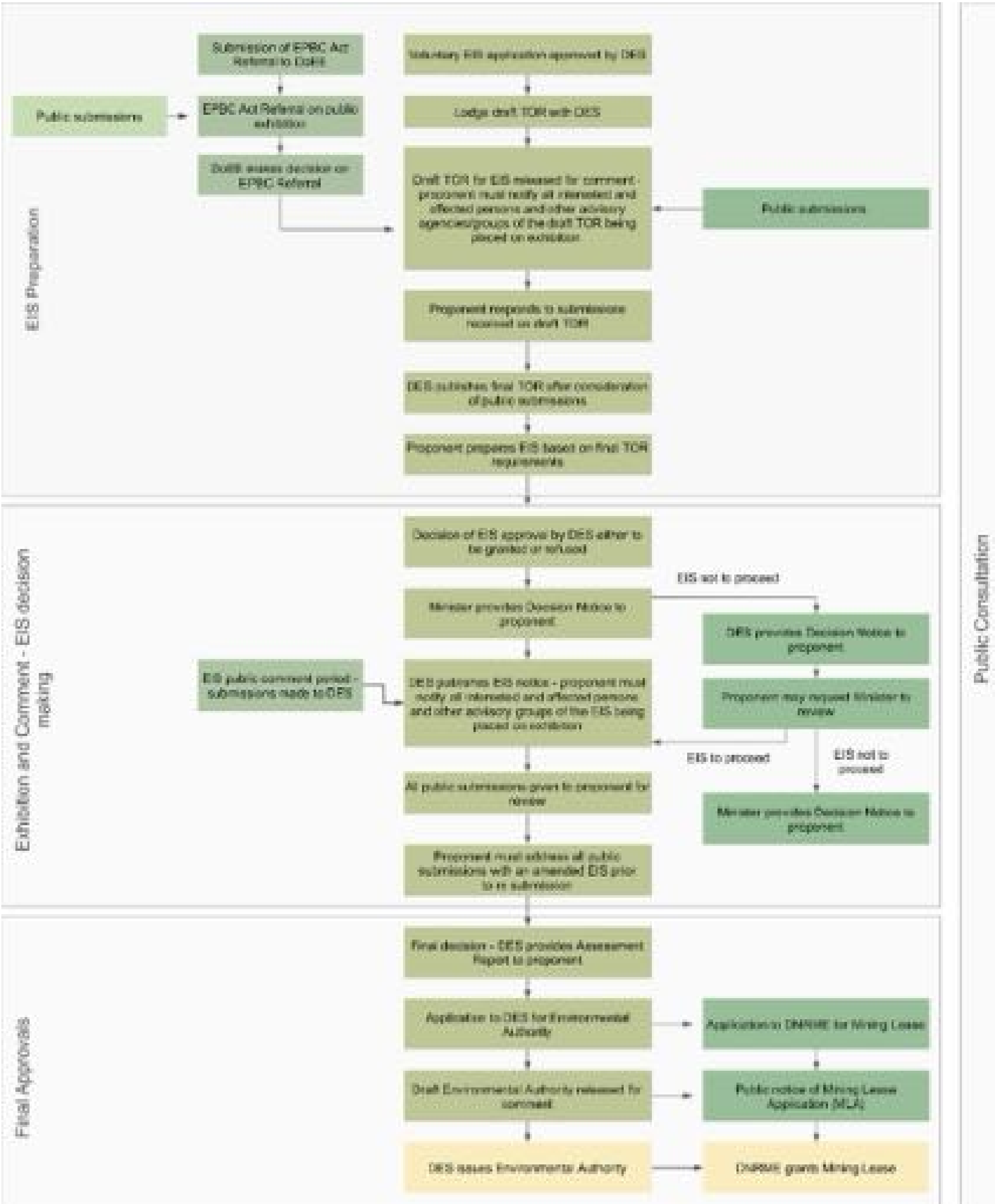

Figure 9.4: EIS process for Baralaba South Project

9.1.2.3 Public consultation process

Extensive public consultation has been undertaken in accordance with the TOR and in consideration of the guideline, 'Preparing an environmental impact statement: Guideline for proponents' (DSDILGP, 2020) and is described in section 9.15.

9.1.2.4 Public submissions

In accordance with section 52 of the EP Act, the Proponent will issue a public EIS notice for the Project, which will:

1) provide a description of the Project and operational land;
2) state where the submitted EIS may be inspected and where copies or extracts can be obtained;
3) state that anyone may make a submission to the chief executive of the DES regarding the EIS;
4) clearly define the time period in which submissions may be made;
5) state how to make a properly made submission;
6) state the Project's title, location and the name of the Proponent; and
7) state any protected matter for the Project.

Under section 51 of the EP Act, this EIS notice must be:

- provided to each affected person for the Project and interested party and any other person decided by the chief executive prior the notice being published elsewhere;
- published in at least one newspaper circulating the local region; and
- made available online through a website.

Any party may elect to make a submission on the EIS prepared for the Project. A properly made submission is one that:

- is written;
- is signed by each person who made the submission;
- states the name and address of each signatory;
- is received on or before the last day of the submission period; and
- is made to the chief executive of the DES.

9.1.2.5 Approvals and conditions sought

The primary environmental, planning and mining approvals required for the Project include:

1) approval as a 'controlled action' under the EPBC Act;
2) approval of a site-specific EA authorising applicable environmentally relevant activities (ERAs) under the *Environmental Protection Act 1994* (EP Act);
3) approval of a Progressive Rehabilitation and Closure Plan (PRC Plan) under the EP Act;
4) grant of a ML for the Project under the *Mineral Resources Act 1989*; and
5) development approval under the *Regional Planning Interests Act 2014* (RPI Act) for potential impacts on the strategic cropping area.

Other off-lease infrastructure developments associated with the Project include:

- the proposed realignment of the Moura-Baralaba Road to the east of and adjacent to the Mining Lease Application (MLA) area;
- the provision of a 132/22 kV transformer to be constructed on land, owned by a related entity to the Proponent, adjacent to the existing Baralaba Substation;
- a 22 kV electricity transmission line (ETL) and associated infrastructure, approximately 8 km in length and 20 m wide, to supply power from the 132/22 kV transformer to the mine site. Two ETL alignment options contained within a wider ETL assessment zone have been assessed;
- expansion of the existing Baralaba accommodation camp owned and operated by the Baralaba Coal Company.

The final alignments and approvals of third-party infrastructure will be subject to separate permitting processes under the Queensland *Planning Act 2016*.

While the key outcome of the EIS process is to obtain an EA for the Project, the information provided throughout these investigations will be utilised to support secondary approvals.

9.2 Objective of the action

The steel production industry continues to demand high quality metallurgical coal. To meet this demand, the Proponent is seeking approval to develop the Baralaba South Project. The Project objective is to develop an open cut, metallurgical coal resource able to export a low volatile pulverised coal injection (PCI) product for use by the steel production industry. The Proponent) is proposing to develop a greenfield, metallurgical coal mine of medium scale, having contemporary environmental management systems and plans in place sufficient to address all identified environmental impacts.

The Project will utilise existing coal transport infrastructure and port facilities to capitalise on increases in global demand for metallurgical coal. Australian metallurgical coal holds a very strong position in the traditionally important markets of India, China, Japan, Korea and Taiwan, attributed to its higher quality (particularly for coal from the Bowen Basin which is generally considered one of the best metallurgical coals in the world), proximity to key Asian markets, and Australia's geopolitical stability (Commodity Insights, 2018).

9.3 Location of the action

9.3.1. Regional context

The Project is located approximately 8 km south of the township of Baralaba and 115 km west of Rockhampton in the lower Bowen Basin region of central Queensland within the Banana Shire local government area (Figure 9.5 and Figure 9.6).

The Project is located:

- Within the Gaangalu Nation People (QC2012/009) native title application area (Figure 9.12).
- Within the north-eastern portion of the Brigalow Belt South Bioregion (Figure 9.7), as defined by the Interim Biogeographic Regionalisation for Australia (DoEE, 2012).
- In the Lower Dawson Sub-catchment Area of the Fitzroy Basin (Figure 9.8), as defined by the Water Resource (Fitzroy Basin) Plan 2011 (DES, 2011).
- Outside of the Great Artesian Basin and Other Regional Aquifers Water Plan and outside of any declared Groundwater Management Areas (Figure 9.9).
- In the rural zone in the Banana Town Planning Scheme (2021), which allows for mining where the specific outcomes of the zone are met; the specific outcomes include environmental considerations, amenity, and separation distances. The Banana Town Planning Scheme's Mining Resources Overlay is also relevant in assessing mining developments and has the outcomes of protecting mineral resources of major economic significance, and compatibility with nearby uses and works.
- Outside of zones mapped as Priority Living Areas (PLA) and Priority Agricultural Areas (PAA) under the *Regional Planning Interests Act 2014* (Figure 9.10). The Project contains some strategic cropping land trigger area (Figure 9.11).
- Within the area covered by the Inland Fitzroy and Southern Burdekin Suitability Framework (DNRM and DSITIA, 2013a).

9.3.2. Local context

The main activity associated with the Project involves developing a greenfield open cut coal mine within MLA 700057 (Figure 9.6). Off-lease infrastructure associated with the Project is described in Section 9.4.

The local region is primarily grazing land with areas of cropping, particularly along the floodplains of the Dawson River and larger watercourses. Mount Ramsay is located to the east of the Project, providing a topographic landmark for the area.

Access to the Project site is from the Moura-Baralaba Road, which intersects the MLA in its current location. The road connects the towns of Moura and Baralaba and provides access to several local properties in between. The Moura-Baralaba Road is also the main haul road used by the existing Baralaba North Mine to transport product coal to the Train Load Out (TLO) facility, approximately 4 km east of Moura (Figure 9.6). The road has undergone substantial upgrades and maintenance to facilitate the haulage of coal for the Baralaba North Mine. A 4.5 km section of the Moura-Baralaba Road will require realigning to facilitate the mining activity.

9.3.3. Topography and watercourses overview

9.3.3.1 Topography

The topography of the Project area is dominated by the Dawson River floodplain and Mount Ramsay, located approximately 400 m to the east (Figure 9.13). The land within the MLA is slightly undulating. Ground elevations range between 75 m and 110 m Australian Height Datum (mAHD), generally rising towards the east. Mount Ramsay, which lies to the east of the MLA is the most significant topographical feature near the Project, occurring as a single sharp rise to 430 mAHD.

9.3.3.2 Local and regional catchments

The Project is located in central Queensland within the Fitzroy Basin, a sub-basin of the greater North-East Coast Basin. The Fitzroy Basin has a total catchment area of 142,900 km^2 with the main tributary rivers being the Mackenzie River, Isaac River, Dawson River and Comet River. The Fitzroy River is located within the Great Barrier Reef catchment and flows north-east, discharging into the Coral Sea, south-east of Rockhampton.

The Great Barrier Reef World Heritage Area is approximately 386 km downstream from the Project. It is the largest tributary to the Fitzroy River System, with a catchment of 50,760 km^2, representing 35% of the Fitzroy River basin.

The Dawson River valley is typified by a landscape of wide, flat floodplains of tertiary sediments with average grades of less than 5%. Evaporation rates throughout the Dawson River valley typically exceed rainfall by two to three times. Average daily evaporation is 5.3 mm and varies between 2.9mm and 7.5mm, depending on the season.

The Dawson River has a catchment of approximately 40,500 km^2 at the Baralaba township. It is a perennial watercourse subject to seasonal flooding. Directly west of the Project, the Dawson River has a main channel approximately 150 m wide, bordered by a floodplain extending 1.5–3 km on either side. It exhibits several anabranch channels, both upstream and downstream from the Project. The river experiences consistent flows throughout the year, supported by inflows from groundwater sources along its length. Water resources are managed in the lower Dawson River through several water supply storages.

9.3.4. Geological overview

The Project lies within the Permo-Triassic aged Bowen Basin. In the southern part of the Bowen Basin, the two significant basin structures are the Comet Ridge Anticline in the west and the Mimosa Syncline in the east, which formed during the early Permian extensional tectonic phase of the basin. The Project is situated in a structurally complex zone on the eastern limb of the Mimosa Syncline.

The economic coal seams lie in the Permian-age Baralaba Coal Measures that are the stratigraphic equivalent to the Rangal Coal Measures of the Blackwater Group in other parts of the Bowen Basin. The coal measures are overlain by the Triassic-age Rewan Formation that is comprised of massive sandstone strata that are interbedded with successions of laminated mudstone, siltstone and sandstone. The Rewan Formation is barren of coal bearing sequences, and its base marks the end of coal accumulation in the Bowen Basin. The Kaloola Member and Gyranda Formation conformably underlie the coal measures and comprise interbedded thin coal bands and sandstone units.

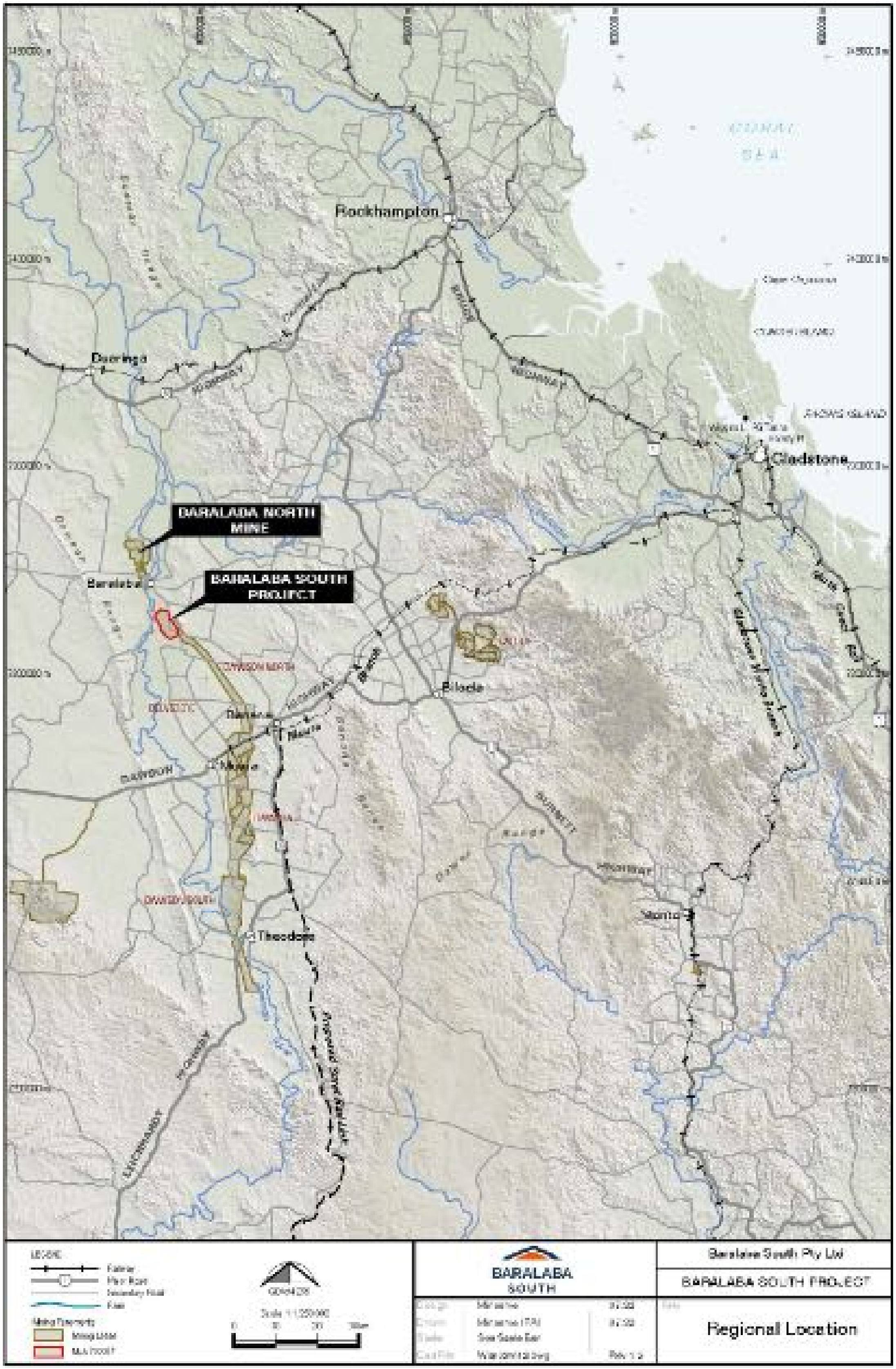

Figure 9.5: *Regional Project location*

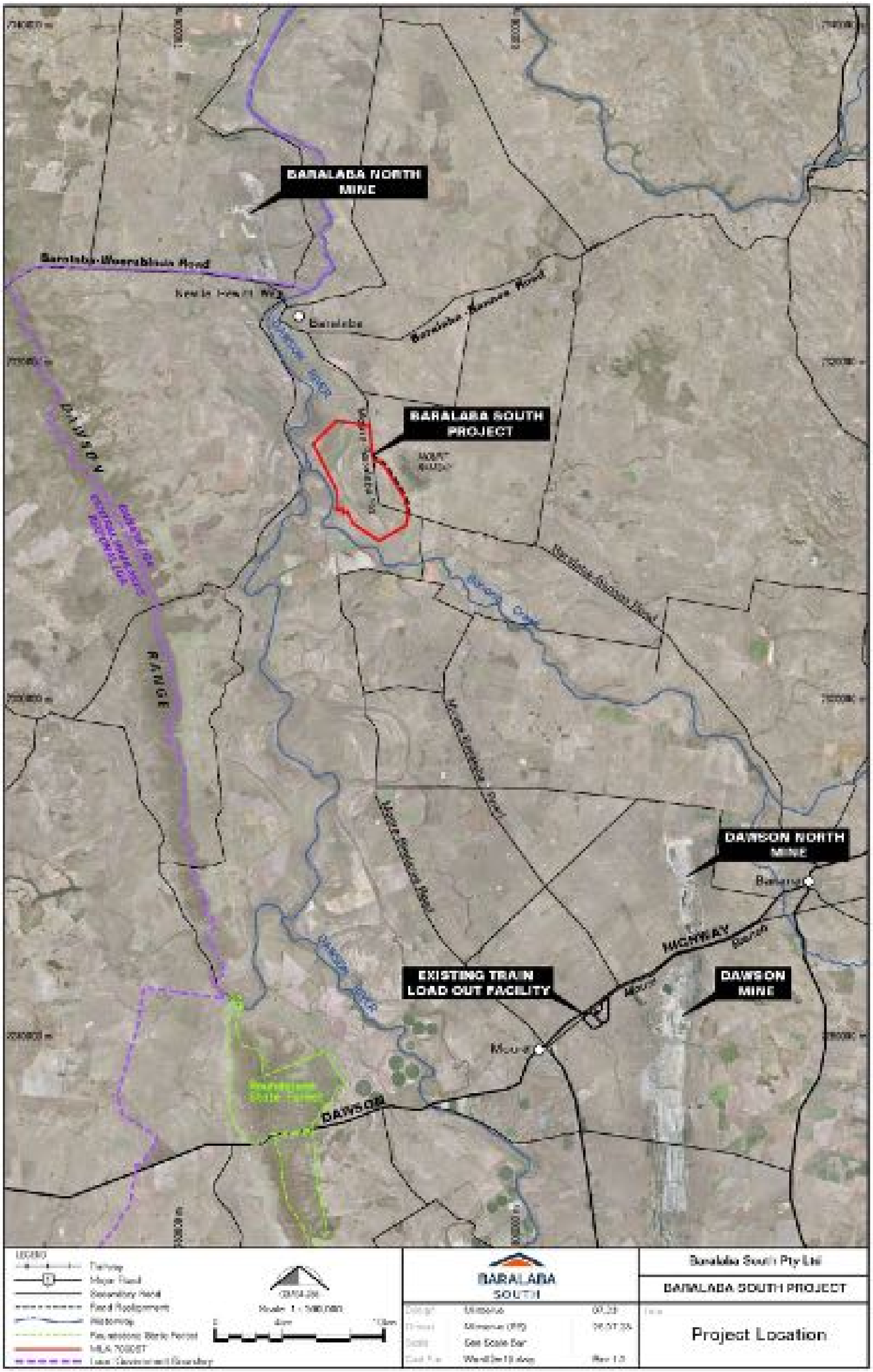

Figure 9.6: *Project locality*

Figure 9.7: Brigalow Belt South Bioregion

Figure 9.8: *Regional water catchments*

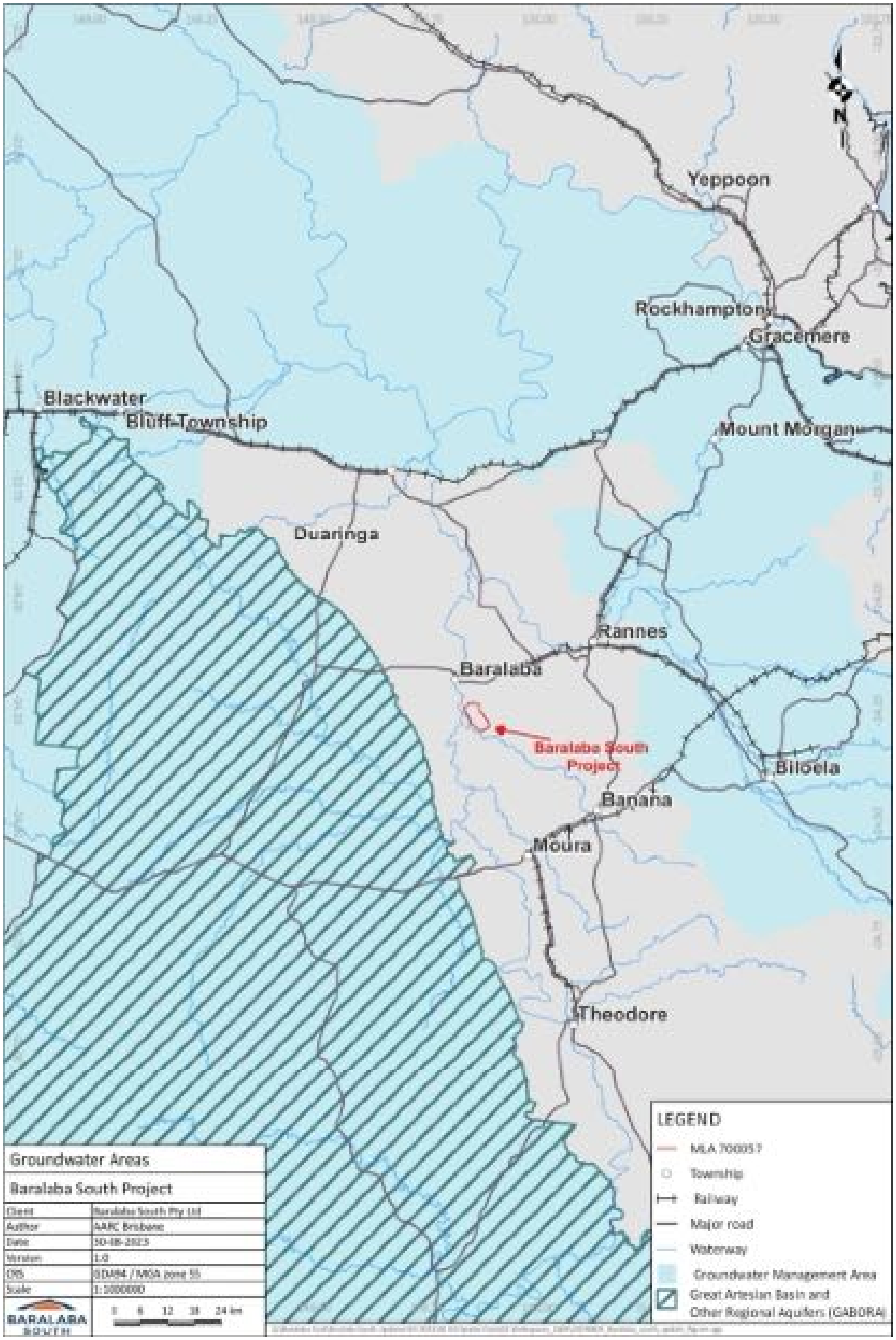

Figure 9.9: Groundwater areas

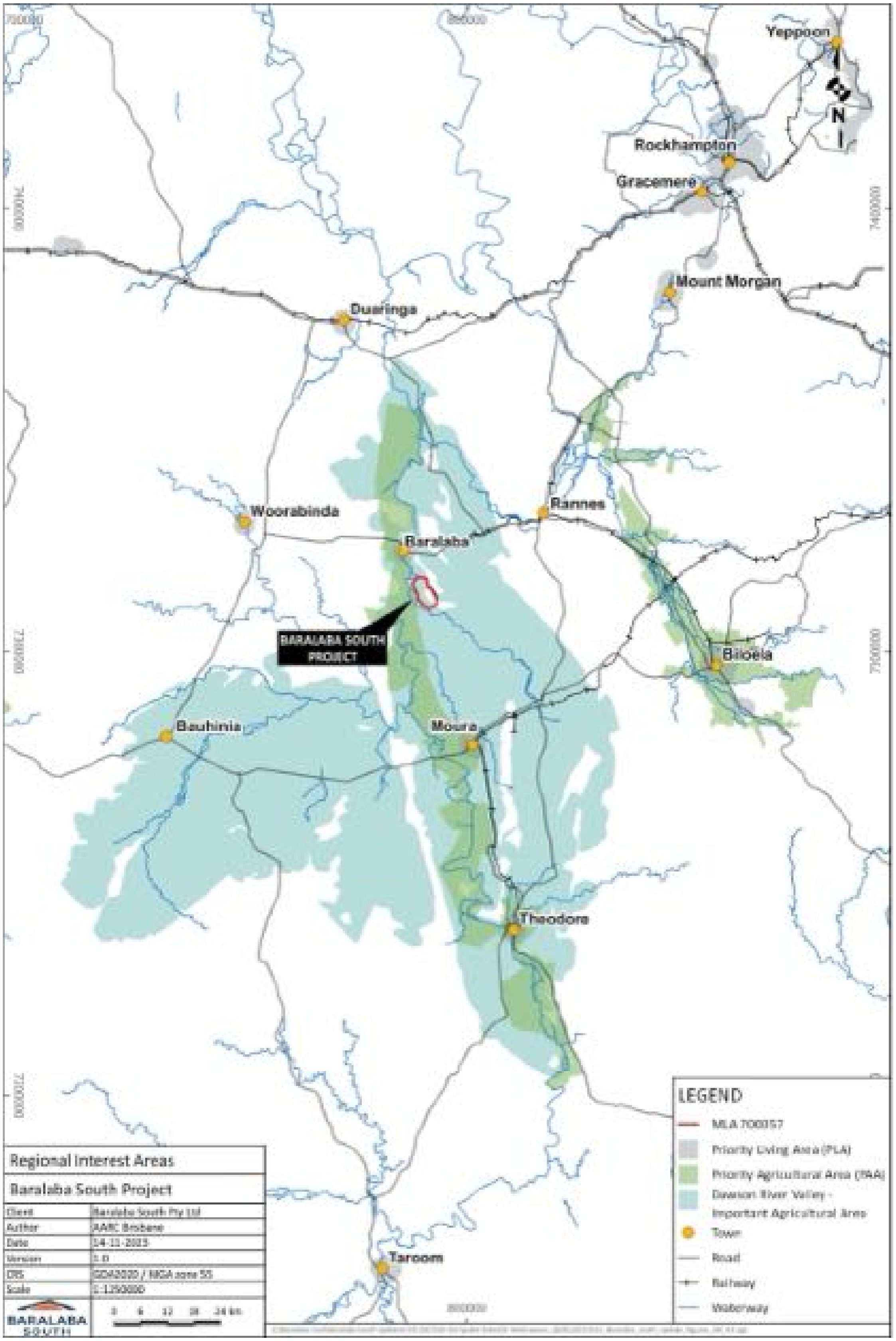

Figure 9.10: Regional interest areas

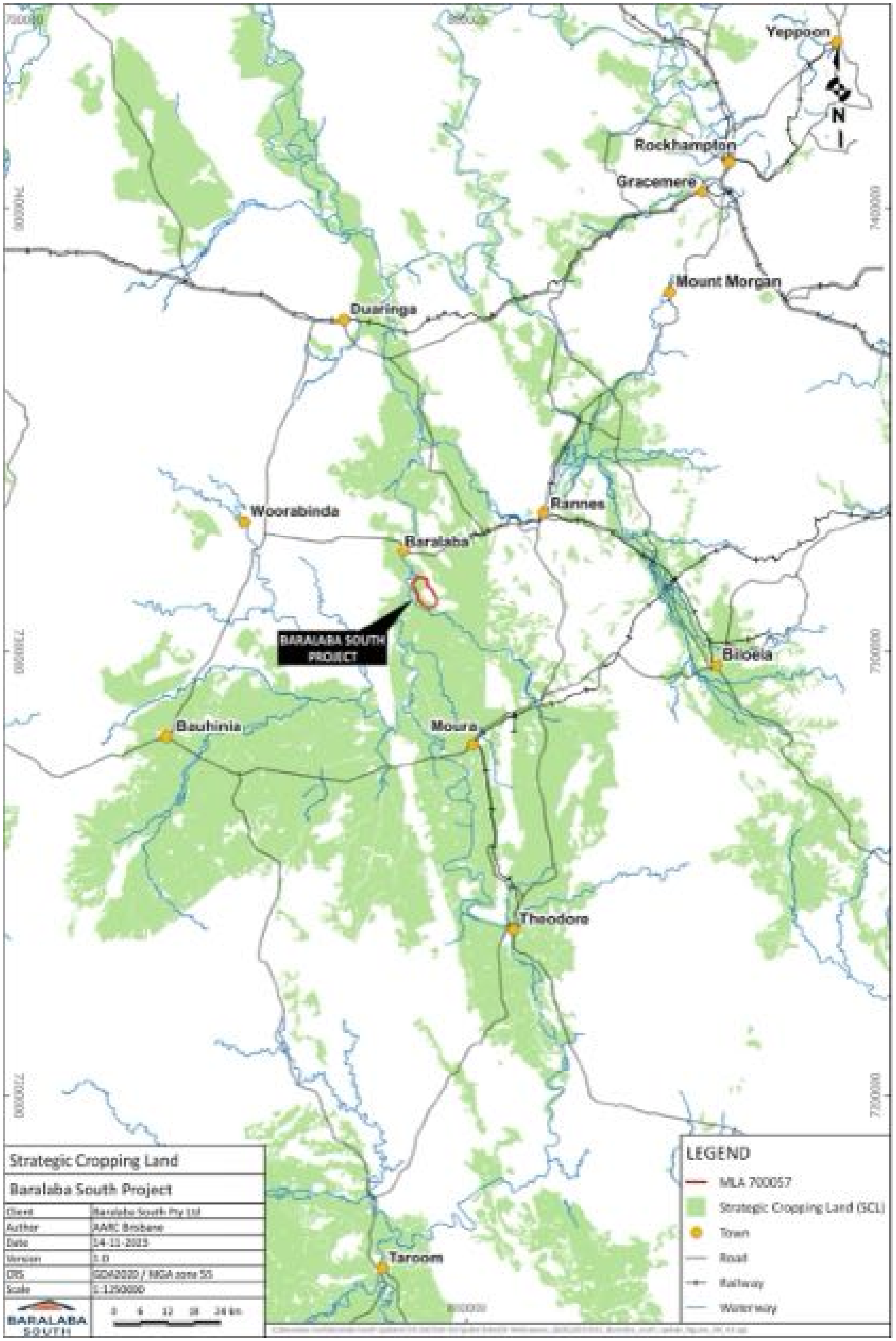

Figure 9.11: Strategic cropping land trigger area

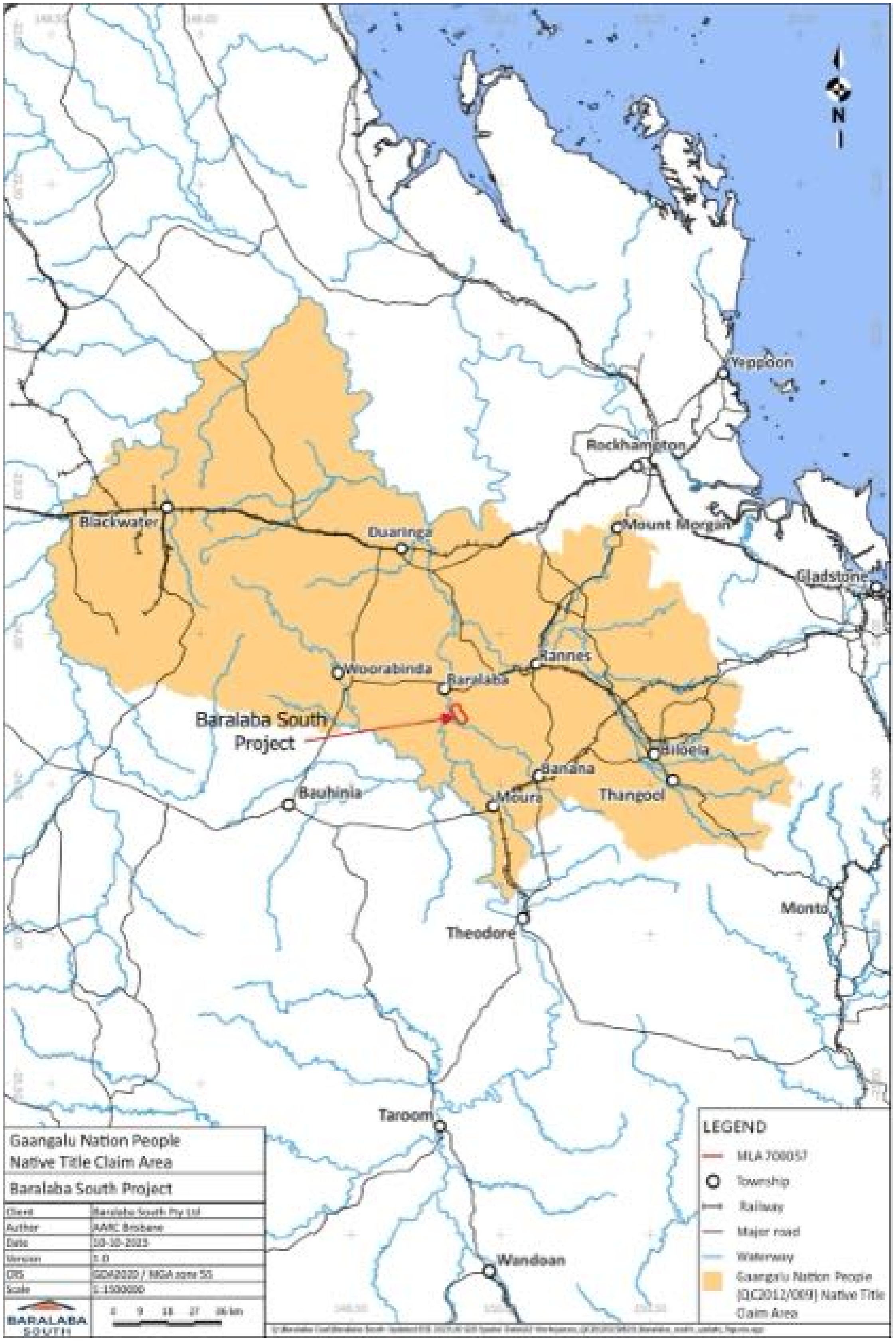

Figure 9.12: Gaangalu Nation People native title claim area

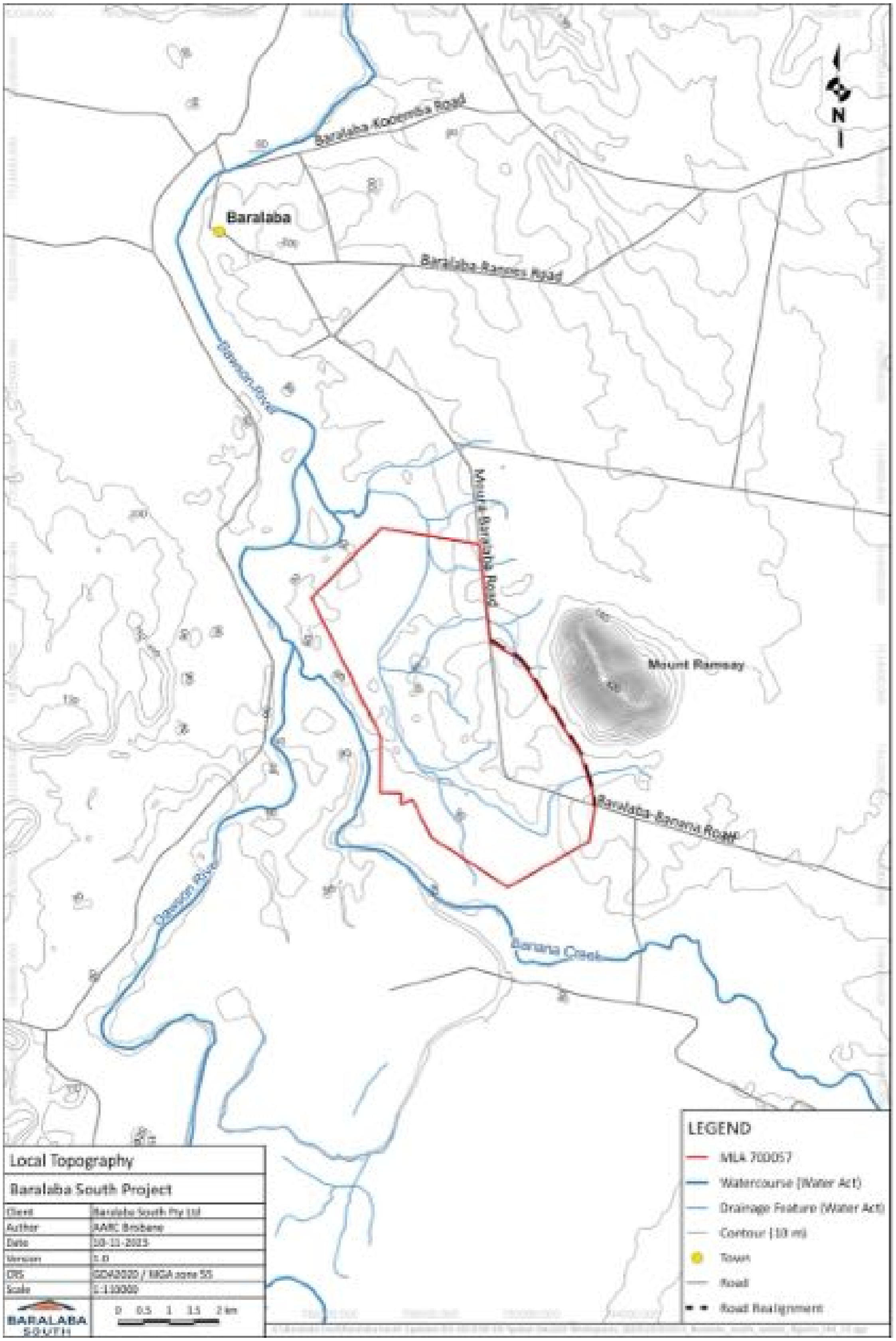

Figure 9.13: Local topography

9.4 Description of the action

9.4.1. Project overview

The Project is a proposed greenfield, metallurgical coal mine development located approximately 8 km south of Baralaba and 115 km west of Rockhampton in the lower Bowen Basin region of central Queensland. Approximately 49 Mt of ROM coal is estimated to be mined to produce approximately 36 Mt of product coal over the life of the Project. A detailed Project overview describing the nature and scale of the Project is provided in Chapter 2, Project Description.

The maximum area proposed to be disturbed within the MLA footprint is 1,211 ha. Disturbance associated with required supporting infrastructure located outside of the MLA includes the ETL (approximately 16 ha disturbance, refer section 2.6.1), the access easement for the pump station and water release/extraction pipeline (approximately 1 ha disturbance, refer section 2.6.5.5) and the Moura-Baralaba Road realignment of approximately 4.5 km (approximately 14 ha disturbance, refer section 2.4.2).

Product coal will be transported via road trains 40 km south along the existing Baralaba North Mine haul route (a public road) to the existing TLO facility east of Moura for export by transport service providers *via* rail to the Port of Gladstone and then to international markets. The Proponent has a current Road Use Agreement for up to 3.5 Mtpa, which is sufficient for the proposed Project.

Project development requires the provision of power *via* an ETL from the Baralaba Substation to the north and the realignment of a 4.5 km section of Moura-Baralaba Road; part of the Banana Shire Council rural road network – from within the MLA area. The preferred route for the road is directly east of the MLA boundary, which has been selected to minimise impacts to landholders, road users and the environment. The final alignments and approvals of third-party infrastructure will be subject to separate permitting processes under the Queensland *Planning Act 2016*. Road impacts of the Project will be subject to agreements with Banana Shire Council. A pipeline and access track extend approximately 670 m off-lease from the north-western corner of the lease to the Dawson River, just downstream of its confluence with Banana Creek, for water extraction and release infrastructure.

All land disturbed by mining activities will be rehabilitated to achieve a post-mining land use. Rehabilitation will occur progressively during the mine life in accordance with the PRC Plan for the Project, which will be submitted to DES for approval prior to commencement. Queensland's 'Mined Land Rehabilitation Policy' and associated legislative amendments to the EP Act have been considered in the design of all phases of the Project, and rehabilitation of the Project will occur accordingly.

Construction expenditure for developing the Project is estimated at approximately $157.0 million. The Project will contribute to economic growth through increased industry output and GRP during construction and operation, as well as decommissioning and rehabilitation, flowing from both direct and indirect impacts. The Project is estimated to support an additional:

- $13.5 million in GRP per annum in the regional catchment during construction;
- $170 million GRP per annum in the regional catchment during operations; and
- $1.6 million GRP per annum in the regional catchment during post-mine decommissioning and rehabilitation.

At its peak, the Project is estimated to result in an increase in GRP of 2.5% compared to what would be expected to occur without the Project.

9.4.2. Project description

9.4.2.1 Construction

Construction and mine development activities required to enable the commencement of the open cut mining operation are planned to occur over a period of approximately 24 months anticipated to commence within 12 to 24 months of approval and grant of the ML, EA and all other permit requirements for the Project. For consistency throughout the EIS, Year 0 is forecast to occur in 2029 with coal production to commence in 'Year 1' (currently forecast for 2030). In chronological order:

- construction commencement will occur in 'Year 0' and 'Year 1';
- the peak construction period will occur in 'Year 0'; and
- coal production will commence in 'Year 1'.

Construction activities will generally be undertaken during the day, seven days per week. The construction will involve a civil and earthworks phase which will include the following activities within the ML:

- Clearing the vegetation from the areas where infrastructure is to be constructed including:
  - MIA;
  - CHPP;
  - ROM and product stockpile pads;
  - dams, pipelines, pumps and other water management infrastructure;
  - the WREs; and
  - road and other infrastructure;
- grubbing, with the grubbed material disposed of by mulching as required;
- stripping and stockpiling of topsoil for later use in rehabilitation;
- levelling the disturbance footprint if required to create a suitable landscape to construct infrastructure;
- excavating footings of infrastructure areas and laying concrete footings;
- constructing the mine water management system, including:
  - mine water dam;
  - sediment dams;
  - raw water dams;
  - runoff and stormwater channels; and
  - associated drainage structures; and
- constructing main access roads, site roads and the haul road.

Other off-lease development, such as the Moura-Baralaba Road realignment, will also commence during the construction stage. However, the exact timing of the infrastructure development will be dependent on agreements with third-party participants.

Construction of the Moura-Baralaba Road realignment; a 4.5 km section of the public road bisects the ML will be moved to a new location immediately to the east. The road will include an intersection to maintain access to and from the MLA. Details of the road relocation will be subject to approval from the Banana Shire Council

To enable power supply to the mine, construction of a 132/22 kV transformer on land owned by a related entity to the Proponent, adjacent to the Baralaba Substation, located on Baralaba-Rannes Road, is proposed.

Connection to the local Ergon grid will consist of an upgrade and/or construction of a 22 kV ETL and associated substation.

Given the specialised nature of the work to be completed during the construction phase and its temporary nature, it has been assumed that Rockhampton and Gladstone will provide 95% of the workforce due to being major centres near to the Project. The remaining 5% will be sourced from towns within the study area. The accommodation camp will be expanded to cater specifically for the Project construction and operations workforce. The accommodation camp expansion requirements are anticipated to be up to 255 rooms prior to construction to provide for the maximum combined Baralaba North and South total workforce requiring temporary (on shift) accommodation.

Construction materials, plant and equipment

The estimated quarry material of 56,160 m^3 is required for the Project. If suitable material is identified on-site for road construction, the material will be won from borrow pits within the Project disturbance footprint. Suitable clay and rock materials (for embankments, bunds etc.) will predominantly be sourced from the box cut spoil.

If required, existing hard rock quarries located within the region may be used to meet Project construction requirements. Other anticipated construction materials include:

- bitumen;
- cement;
- pre-cast concrete structures;
- miscellaneous items;
- prefabricated buildings;
- structural steel and steel reinforcing; as well as
- oversized special items.

Equipment used during construction will include excavators, haul trucks, dozers, graders, front-end loaders and water trucks. The start-up mining fleet will also be delivered to the Project during the construction stage. Some equipment models and numbers may change due to contractor and equipment availability.

The majority of infrastructure components (e.g. CHPP, buildings, pipelines, etc.) will be manufactured off-site and transported to the site for assembly and installation.

9.4.2.2 Operations—mine life, sequence and staging

The resource area supports a mine production life of up to 23 years. Further details of the Project mine life is provided in Chapter 2, section 2.2.5. An indicative schedule for the maximum production case is presented in Table 9.1 which shows the total ROM coal produced and overburden and spoil (ROM waste), CHPP rejects material and product coal tonnes. Figure 9.14 depicts the sequential location of mining for each year of mine life.

The staged progression of mining operations at the Project is shown in conceptual plans at various stages of the mine life (Figure 9.15, Figure 9.16, Figure 9.17, Figure 9.18, Figure 9.19, Figure 9.20 and Figure 9.21), for the 2.5 Mtpa of ROM coal production rate over the life of the mine.

Table 9.1: Mining schedule

Year	ROM coal (t)	ROM waste (bcm)	Product (t)	CHPP rejects (t)
1	1,251,073	29,917,134	947,374	329,444
2	2,141,756	36,470,360	1,578,896	605,767
3	2,030,053	37,146,816	1,469,714	600,280
4	2,100,000	35,182,411	1,548,821	593,269
5	2,200,000	37,018,878	1,608,699	635,019
6	2,300,000	36,725,699	1,694,116	651,923
7	2,400,000	26,950,122	1,769,800	678,296
8	2,500,000	26,894,981	1,789,793	758,846
9	2,500,000	26,880,500	1,806,014	743,065
10	2,317,103	27,095,057	1,666,441	695,949
11	2,250,000	27,048,859	1,662,594	632,588
12	2,250,000	27,061,516	1,618,978	675,019
13	2,250,000	27,071,849	1,620,640	673,402
14	2,189,267	27,150,196	1,595,225	637,394
15	2,416,509	26,948,916	1,750,293	713,781
16	2,500,000	26,877,465	1,833,437	716,388
17	2,500,000	26,877,027	1,848,062	702,160
18	2,182,084	27,179,947	1,613,811	612,130
19	2,100,000	27,178,118	1,528,349	613,185
20	2,019,095	27,229,113	1,489,877	569,707
21	2,142,522	24,557,634	1,579,192	606,245
22	1,309,976	15,258,017	942,255	393,327
23	750,948	5,662,948	563,484	202,777

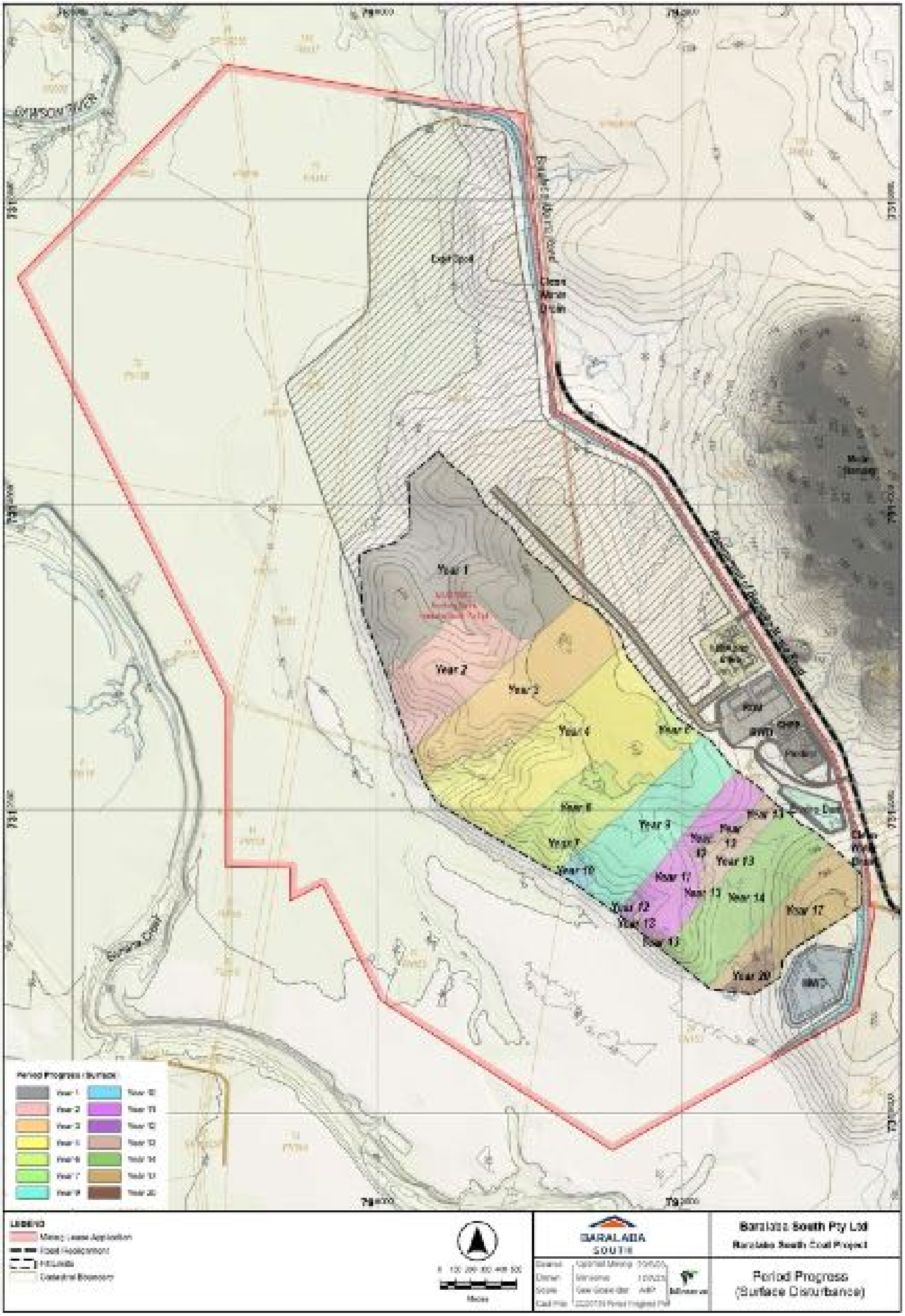

Figure 9.14: Indicative life of mine period progress plot

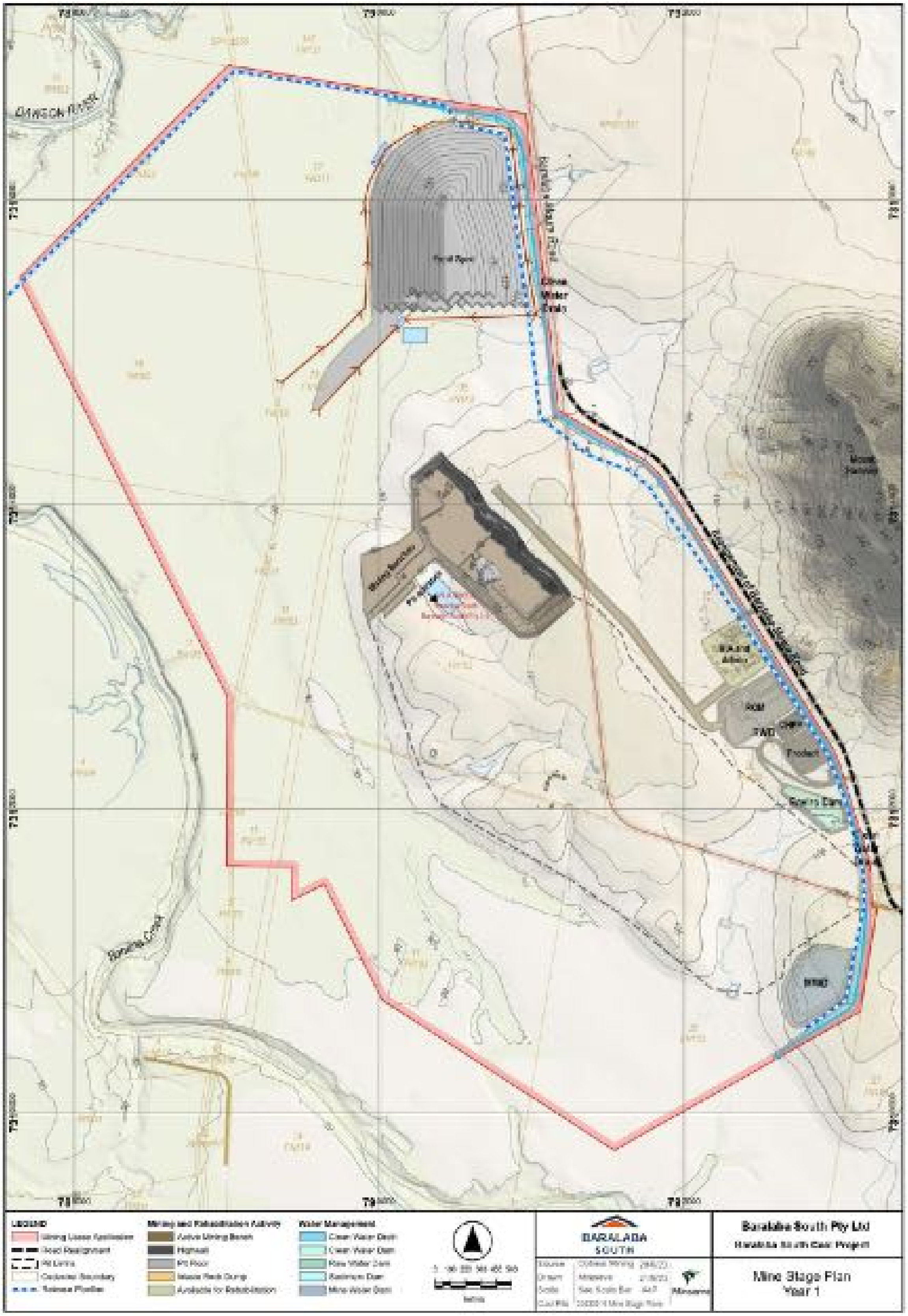

Figure 9.15: *Mine stage plan—Year 1*

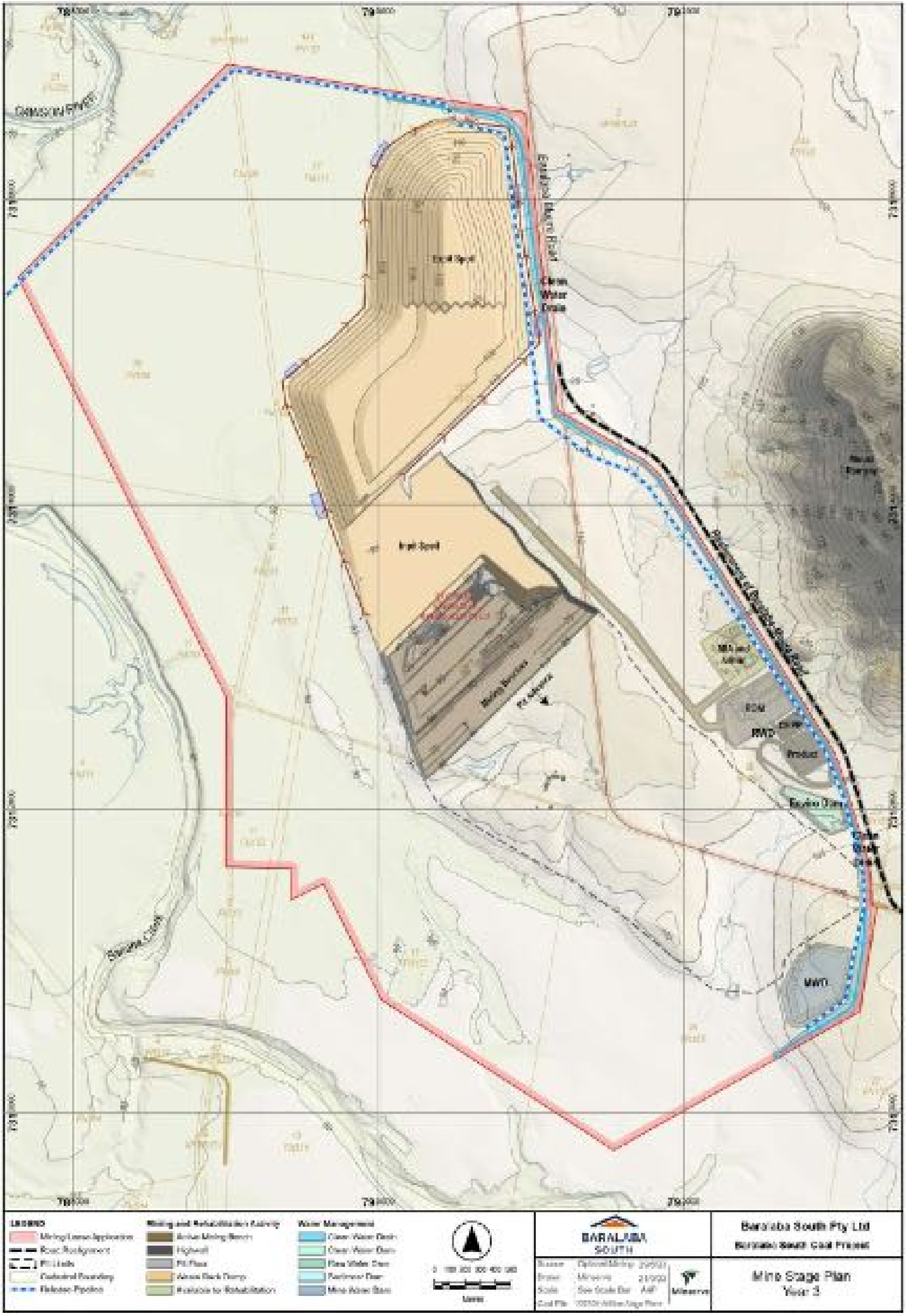

Figure 9.16: Mine stage plan—Year 3

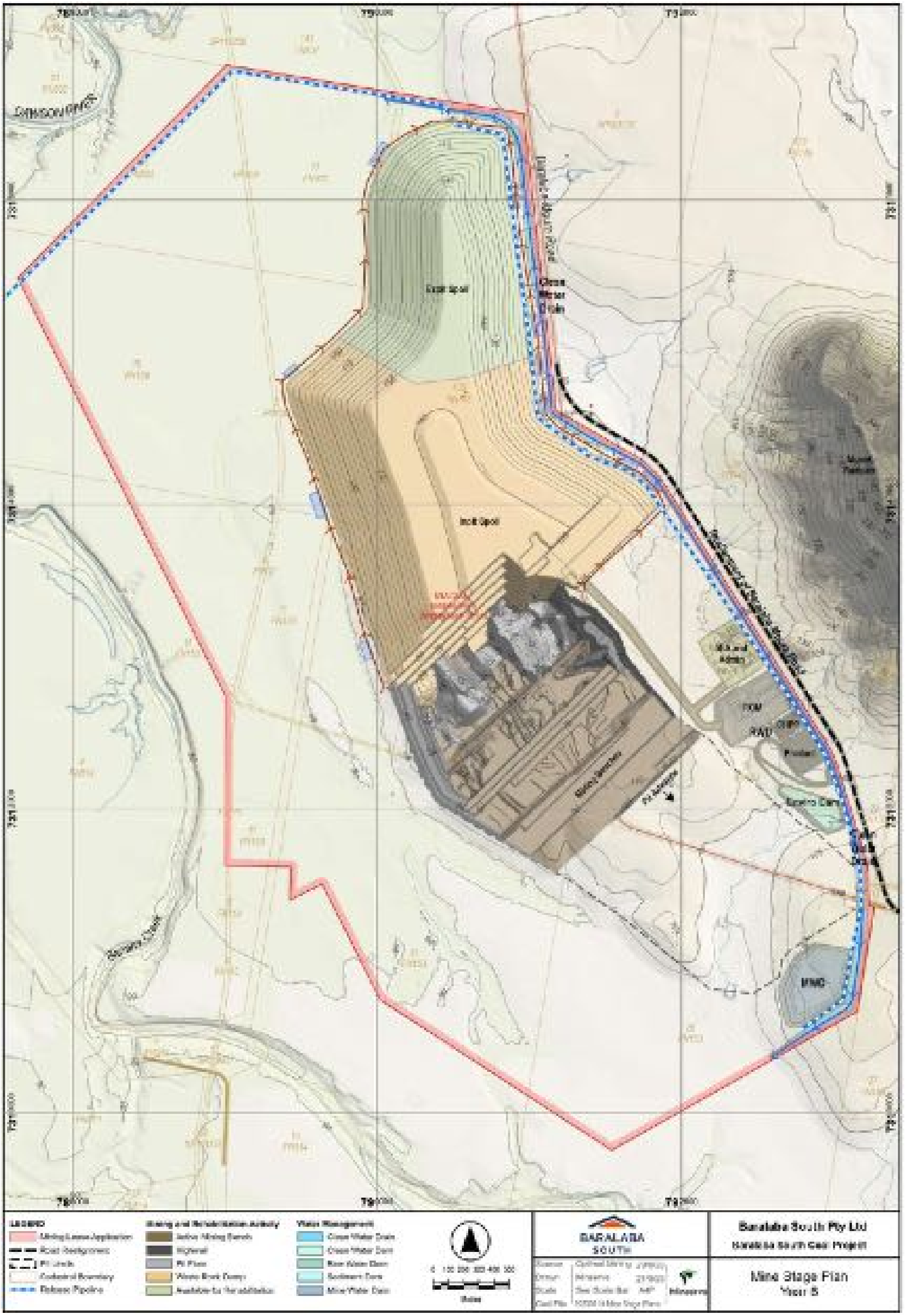

Figure 9.17: Mine stage plan – Year 6

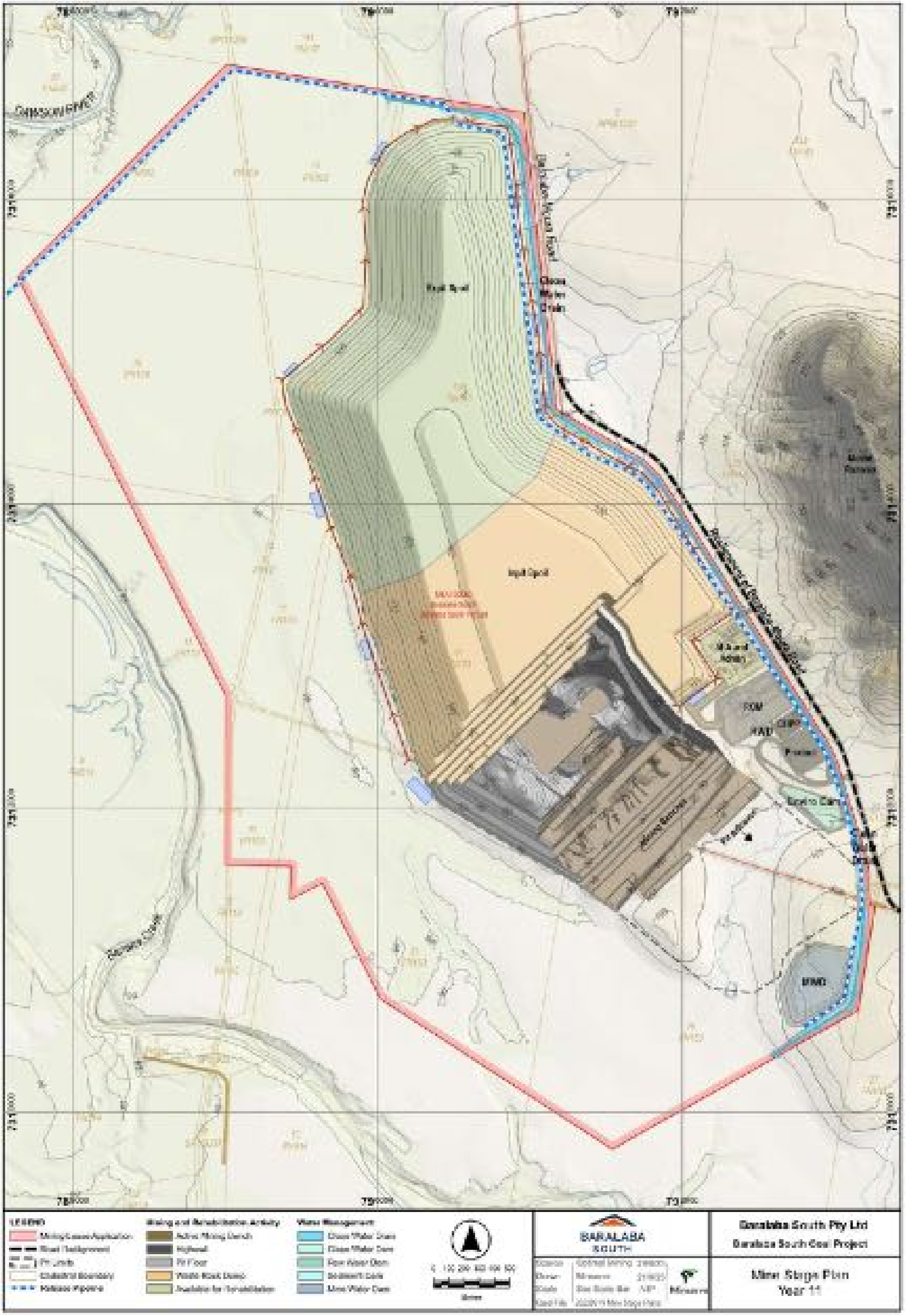

Figure 9.18: Mine stage plan—Year 11

Figure 9.19: Mine stage plan—Year 14

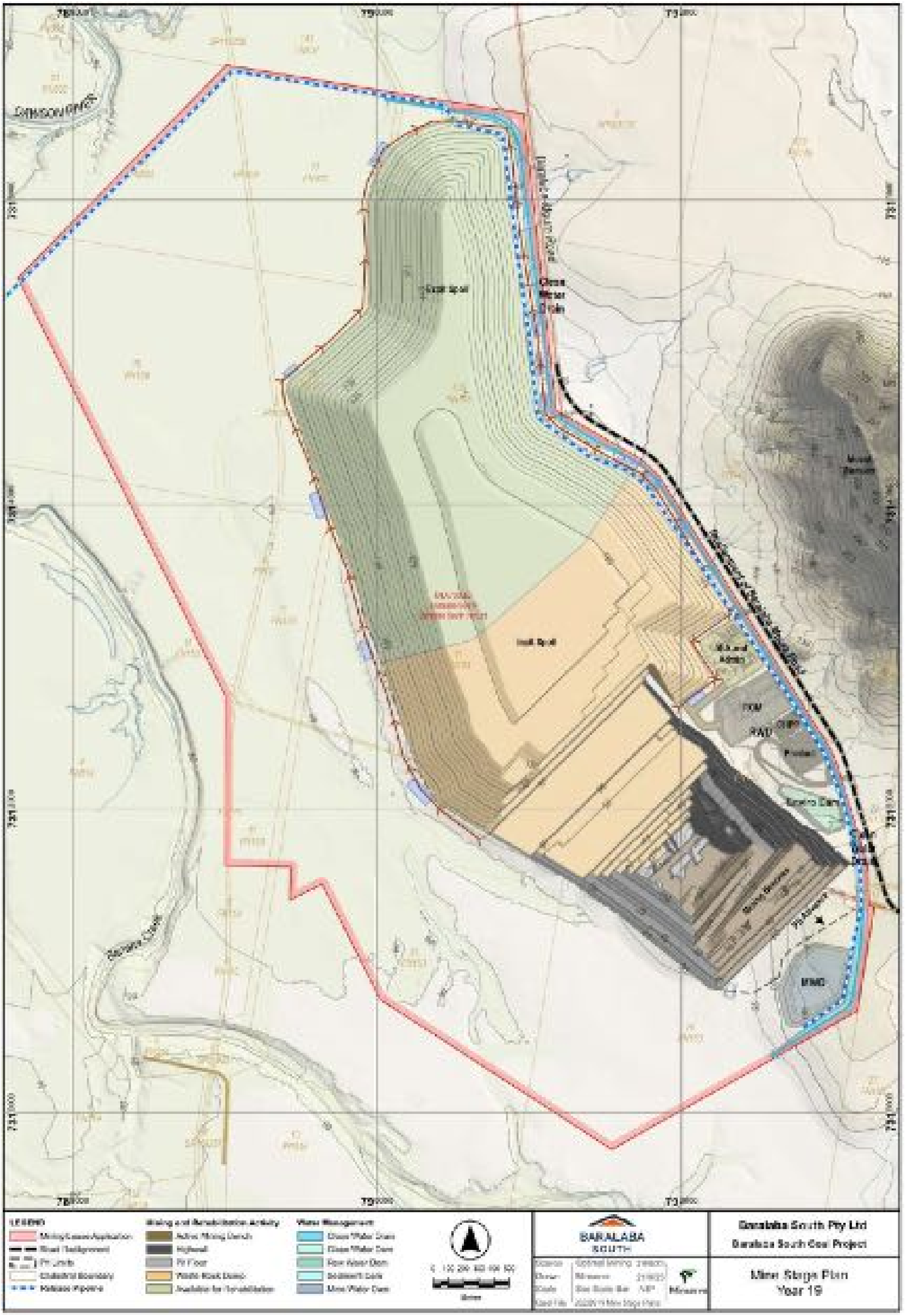

Figure 9.20: Mine stage plan—Year 19

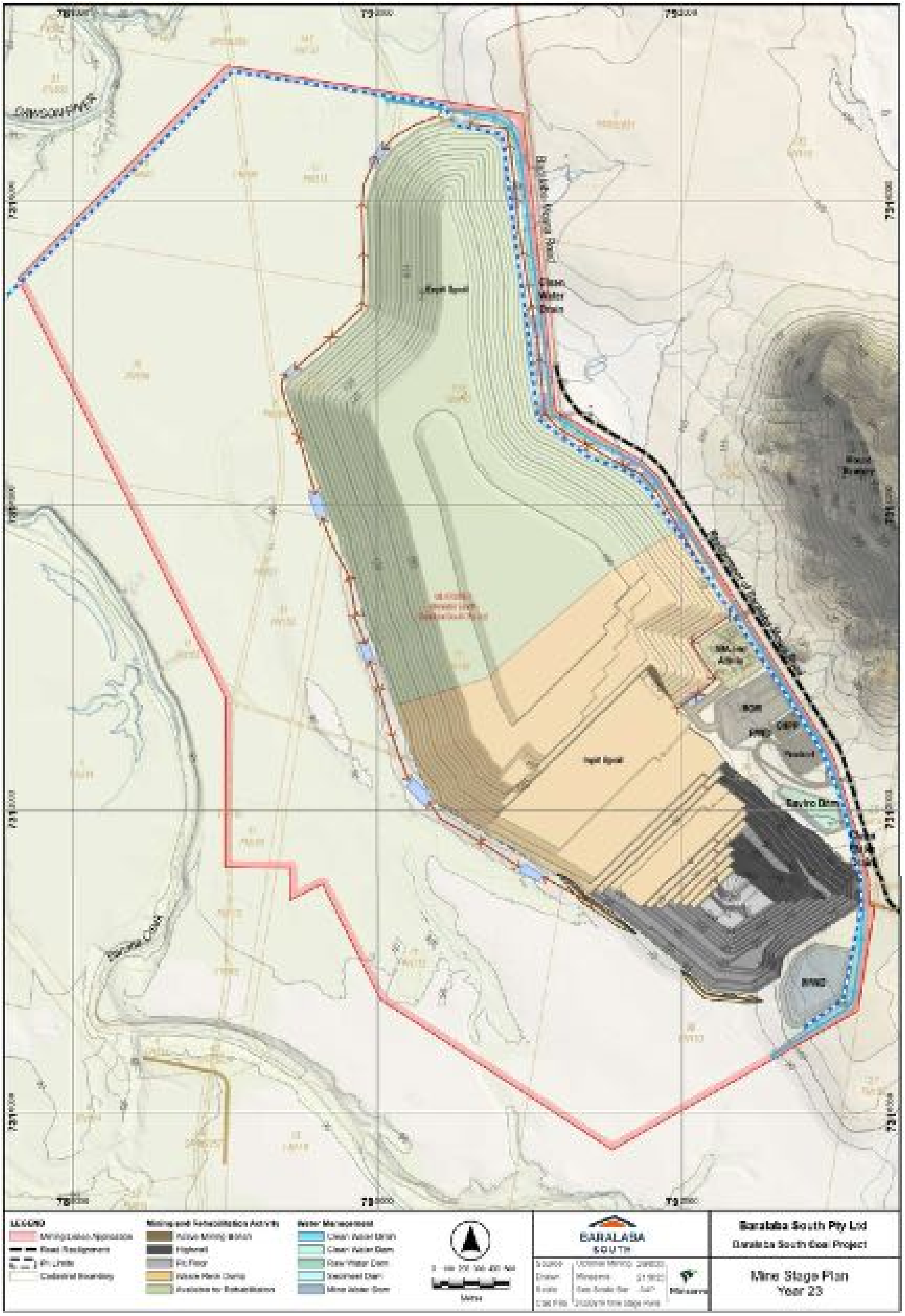

Figure 9.21: Mine stage plan – Year 23

9.4.2.3 Operations - mining and waste rock disposal

Mining operations will advance from north to south along the strike using a terrace mining method, with the advancing in-pit WRE including mine flitches (benches) that are expected to be between 3 to 5 m deep. In the steeper areas, extra equipment, typically D10 sized dozers or small backhoes, will move material onto the floor to allow efficient excavation of the waste/coal interface while minimising coal loss.

The width of the proposed pit is up to approximately 1,600 m. Working benches 200 m wide will provide room across the pit width to have multiple coal mining faces exposed at any one time. Two main 50 m wide end wall haul-back roads are proposed to be placed in the western wall at RL35 and RL-55. The mining flitches are expected to be between 3 to 5 m deep. In the steeper areas, extra equipment, such D10 sized dozers or small backhoes, will move material onto the floor to allow efficient excavating of the waste/coal interface and minimise coal loss.

Waste will be hauled to the WRE while coal will be hauled to the ROM. The Project haulage routes will be positioned to minimise dust generation and haul distance. As space becomes available, waste will be returned to in-pit WREs within the mined-out void. Further details of mine operations are described in Chapter 2, section 2.5.

A summary of the typical open cut mining activities and sequence is provided below.

- Vegetation clearing: vegetation will be progressively cleared over the life of the Project ahead of the active mining and waste rock emplacement areas. Specific vegetation clearance procedures will be developed for the Project.
- Topsoil stripping and handling: where stripped topsoils cannot be used directly for progressive rehabilitation, the topsoil will be stockpiled separately. Specific soil management, stockpiling and re-application procedures will be developed for the Project.
- Overburden removal: overburden will primarily be removed by excavators and haul trucks along with supporting dozers and used for backfilling the void behind the advancing operations or placed in out-of-pit mine waste rock emplacements or noise attenuation bunds. Conventional drill and blast techniques, using standard rotary drills, will be used for the removal of competent overburden and interburden material. Small quantities of underburden may also be drilled and blasted as required for geotechnical stability. Standard commercial products will be used, with the principal blasting agent being ANFO.
- Coal mining and ROM coal handling: coal mining will involve excavators loading ROM coal into haul trucks for haulage to the ROM pad. It is proposed to establish a CHPP at the Project. On-site ROM coal handling and crushing facilities will be established and used at the ROM pad.
- A single out-of-pit waste rock emplacement adjacent to the mining pit will be required to provide sufficient working space for operations to proceed. The WRE will have elevations approximately 60 m to 70 m above the existing surface. As operations progress, spoil will be able to be placed in-pit, commencing from the northern end of the pit and progressing southward.
- Rehabilitated landforms are proposed to have elevations of approximately 160 mAHD, with a typical slope of equal to or less than 9^{o} and maximum overall slope lengths of approximately 470 m. The in-pit waste rock emplacement will have a maximum elevation of 110 mAHD and a maximum slope of 10^{o}. Where appropriate, contour banks will be utilised along slopes, resulting in maximum slope lengths of approximately 235 m when measured between contour banks

9.4.2.4 Operation—coal processing

A single 360 t/hr modularised process plant is proposed for the Project. The CHPP will be completed and commissioned by the end of the second construction year. The CHPP is planned for development in a single stage and will be ramped up to maximum production by year 3 of operations.

The CHPP will comprise the following elements:

- a ROM stockpile area;

- crushing circuit;
- wet coal processing plant;
- washed product coal stockpile and loading areas for road trains;
- coarse rejects bin and/or hardstand for coarse rejects; and
- rejects holding, filtration, drying and transfer system.

The CHPP is a conventional Bowen Basin design (dense medium cyclones, spirals and flotation) with a nominal 360 t/hr capacity, which is planned to process up to 2.5 Mtpa of ROM coal. The CHPP processing specifications over the life of the mine are shown in Table 9.2.

Table 9.2: CHPP processing specifications

Description		Value/statement
Target annual CHPP product		2.5 Mtpa
ROM tonnes	Minimum	0.75 Mtpa (year 23)
	Maximum	2.5 Mtpa (year 8,9,16,17)
Product tonnes	Minimum	0.57 Mtpa (year 23)
	Maximum	1.9 Mtpa (year 8,9,16,17)
CHPP operation/shift roster		24 hrs a day, 7 days per week
Product coal handling		Fixed stacker with dual discharges to two conical stockpiles. Product stockpile 100,000 t capacity.

The Proponent intends to use dry tailings disposal. The CHPP will utilise a belt filter press to dewater the CHPP waste material to enable disposal of the majority of the CHPP waste materials in-pit mixed with the overburden spoil material. The dry reject material from the CHPP will be stacked in a stockpile on the ROM pad. The front-end loader responsible for loading raw coal into the ROM hopper will also load dry reject into empty haul trucks for disposal in spoil.

A small proportion of the CHPP waste material with either a high ash content that will not be suitable for the belt filter press; or waste that will be collected when the belt filter press system is offline; will be deposited into drying cells within the MIA. Once the tailings material has sufficiently dried, it will be excavated and trucked for final disposal within final spoil in the WRE areas.

9.4.2.5 Infrastructure

A conceptual infrastructure layout of the Project is in Figure 9.22. Infrastructure associated with the Project includes:

- energy infrastructure;
- lighting;
- telecommunications;
- sewage treatment plant (STP); and
- water management infrastructure.

Figure 9.22: Conceptual mine layout

Energy infrastructure

Modifications to existing energy infrastructure are required to provide power to the Project. The peak permanent power demand during the operational period will be approximately 8,200 kW, with an average permanent power demand of 6,000 kW.

Power supply to the mine will be via a connection to the local grid. Powerlink's Baralaba Substation is located on Baralaba-Rannes Road, approximately 6 km east of Baralaba and 10 km north of the Project. A 132/22 kV transformer is proposed to be constructed on land, owned by a related entity to the Proponent, adjacent to the Baralaba Substation. Associated upgrades to the Baralaba Substation infrastructure will be subject to approval from Powerlink as owner of the infrastructure.

A substation is proposed to be constructed to the east of the MLA 700057, from which the ETL would extend into the MLA to supply power to the mine.

A 22 kV ETL, approximately 8 km in length and 20 m wide, is required to supply power from the 132/22 kV transformer to the mine site. Two ETL alignment options contained within a wider ETL assessment zone have been assessed. The ETL alignment options include:

- **ETL option 1:** a preliminary assessment by Ergon and Powerlink in 2012 of power supply options for the Project identified ETL option 1 as a potential alignment route (Figure 9.23). This alignment is generally parallel to the existing 12.7 kV power line, which currently supplies properties to the south of the Baralaba Substation including those underlying the MLA.
- **ETL option 2:** comprising an upgrade of Ergon's existing 12.7 kV powerline to a 22 kV ETL along the existing alignment to the north of the MLA, at which point the alignment would be modified to connect with the proposed substation to be situated to the east of the MLA (Figure 9.23).

The electricity network infrastructure upgrades and/or construction will be subject to agreement with Ergon as owner of the infrastructure and will be subject to separate approvals, for which the necessary permitting will be undertaken by Ergon. The wider ETL assessment zone has been assessed to inform final placement of the ETL and substation infrastructure.

It is anticipated that development of the required electricity infrastructure will commence during the construction stage. However, the exact timing of infrastructure development will be dependent on agreements with third-party participants. Temporary generators may be utilised to secure reliable power prior to the Ergon supply being available. These generators will comprise modular units and associated switchgear that can be progressively added as the Project develops and the power demand changes.

Lighting components

Artificial lighting will be designed, installed, operated and maintained in accordance with 'AS 4282:1997 Control of the obtrusive effects of outdoor lighting' (Standards Australia, 1997a) to minimise the amount of light spill.

Controls stipulated in this standard include consideration of the location and orientation of lighting with respect to surrounding sensitive receivers and environmental values, as well as the selection and maintenance of luminaries. Any further mitigation (e.g. shielding, further restriction on use of lighting) will be implemented on an as-needed basis. Lighting impacts and mitigation are discussed further in Chapter 10, Land and Visual Amenity.

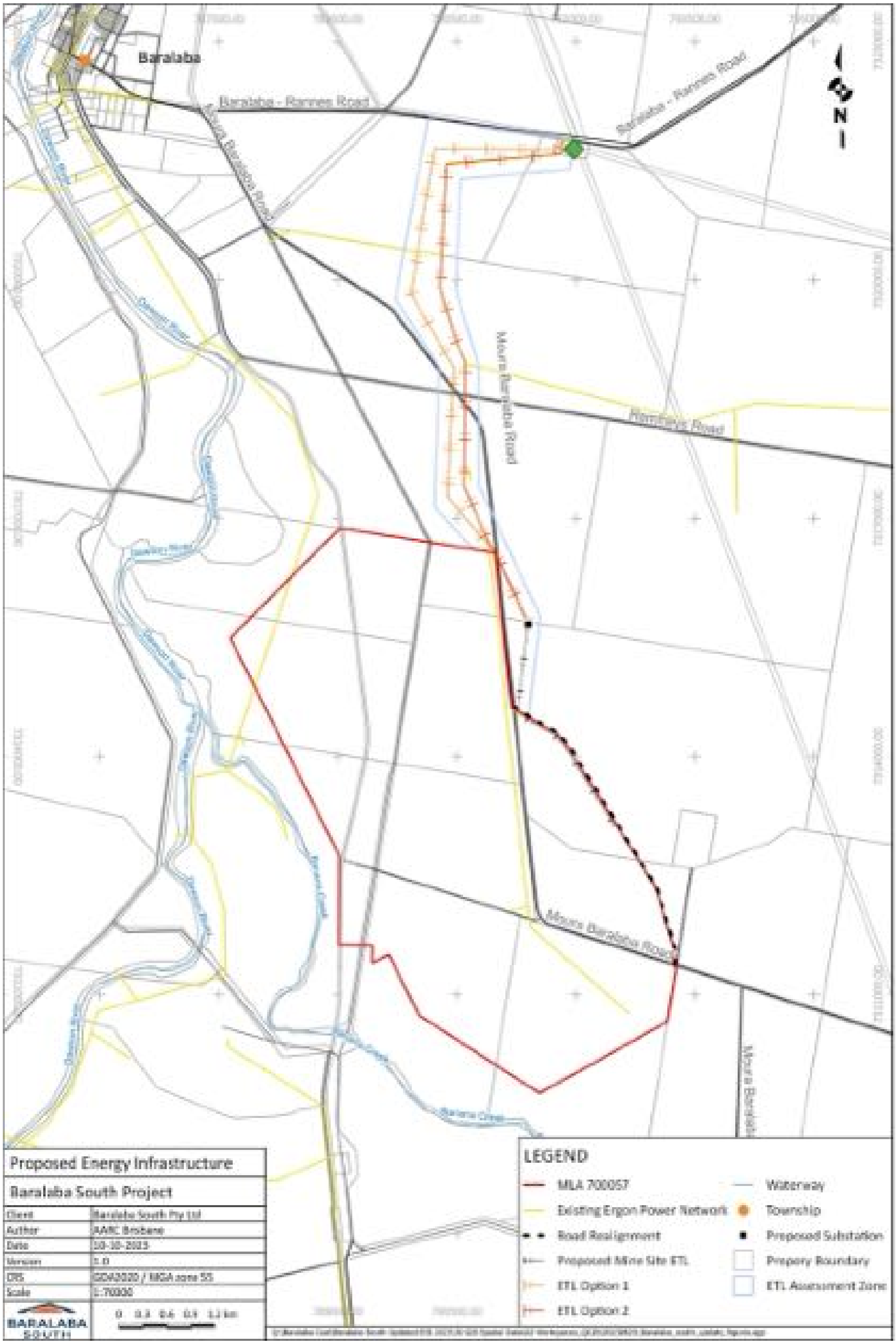

Figure 9.23: Proposed energy infrastructure

Telecommunications

The communications strategy at the Project is to have both comprehensive on-site and off-site communications established in time for the beginning of the construction phase. The underlying basis for having a pre-established network is to ensure that good telecommunications are available for managing the Project health and safety aspects, incident management, reporting, and effective construction and operational information flow from the outset.

Baralaba Coal Company currently operates a data centre located at the Baralaba Town Caravan Park. The Proponent proposes to expand the existing communications systems to provide shared access to the Project.

Moura-Baralaba Road diversion

The 4.5 km section of the Moura-Baralaba Road that is located within the MLA is proposed to be replaced by a newly constructed section of road immediately to the east along the MLA boundary. The design of the new section of public road will be consistent with the upgraded sections of the Moura-Baralaba Road to the north and south of the MLA. The sealed carriageway will be a minimum of 10 m wide, with two 3.5 m wide lanes, a 1m wide median strip and two 1 m wide shoulders.

Access to the Project site is from the Moura-Baralaba Road, which intersects the MLA in its current location. This access will be used by personnel, equipment, material deliveries and mine haulage vehicles. Intersection designs will be incorporated into the road diversion and completed as part of the detailed Project design. A concept design cross-section of the new section of the Moura-Baralaba Road is provided in Figure 9.24. Modifications may be incorporated into the detailed design phase.

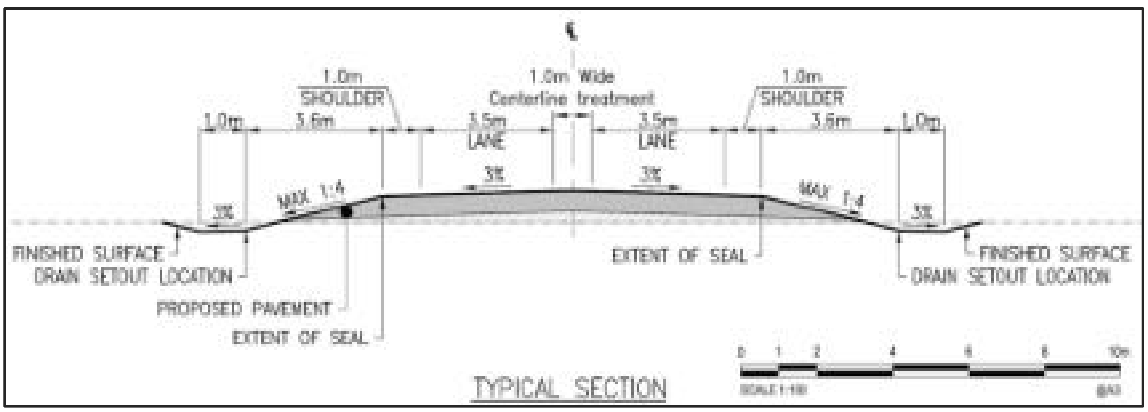

Figure 9.24: Moura-Baralaba Road—concept design of diverted section

The Project access design will meet rural condition road criteria for the greater of current and projected future traffic volumes.

Approach sight distance and safe intersection sight distance are to be designed in accordance with ‘Austroads Guide to Road Design 4A: Unsignalised and Signalised Intersections’ (Austroads, 2010a).

Left and right turn treatments at the intersection are to be in accordance with sections 7 and 8 of ‘Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections’ (Austroads, 2010a).

A Traffic Management Plan will be adopted for the construction stage. Appropriate signage will be installed in accordance with Council requirements and guidelines. Construction of intersections will be staged to allow for a majority of the construction work to be undertaken offline of the operating road network. This methodology is designed to minimise disruption impacts on the road network.

Other permanent or temporary road closures within the MLA, will be coordinated with Banana Shire Council. These roads are either unformed or are not required for access to properties—other than within the MLA. Proposed public road closures and new road sections are in Figure 9.25.

Sewage treatment plant and wastewater disposal

Existing sewage treatment facilities are located in Biloela. During the construction phase, a primary sewage treatment process will be installed. Septic tanks will collect liquid and sludge waste products, which will be routinely transported off-site to Biloela for further processing and disposal.

During operations, either the primary sewage treatment process will continue to be utilised (for transport off-site for processing and disposal) or a package STP will be constructed within the MIA.

Should the second option be adopted, sewage generated at the MIA and CHPP will be pumped to a package STP by way of underground sewage pump stations and underground rising mains. The STP would be designed to treat 100% of the potable water (200 L per person per day), assumed to become wastewater requiring treatment in the plant.

Modelling utilising the ‘Model for Effluent Disposal Using Land Irrigation’ (MEDLI) software has been undertaken to assess the adequacy of a proposed irrigation area located to the west of the Moura-Baralaba Road in the southern half of the MLA. The modelling assessed treatment volumes for both the construction and operational phases to ensure the highest volume of effluent could be treated. Modelling results determined that an area of 1.5 ha would be sufficient for irrigation, given the soils and vegetation of the area assessed. The area nominated is suitable to ensure that drainage controls can be implemented. The waste sludge is expected to be removed every 12–18 months by a regulated waste contractor for disposal at a licensed facility.

The STP design recommended as an outcome of the MEDLI modelling is a low maintenance system with secondary treatment capability and the ability to produce at least Class C effluent. The collection system would utilise an appropriately sized pump station to minimise the retention of raw sewage and mitigate the potential for production of odour and volatile organic compounds. All equipment and control panels would be in a control room at the MIA. Wet weather storage would be located adjacent to the plant with a capacity determined by modelling to ensure irrigation of saturated soil is avoided during wet weather periods.

If an STP was installed, treated wastewater from the STP would be disposed of using low height sprays in the designated irrigation area. The effluent disposal system would incorporate a buffer of at least 50 m to comply with guideline requirements, and warning signs complying with Australian Standard AS 1319 would be installed. System operation will ensure no runoff from the disposal area occurs.

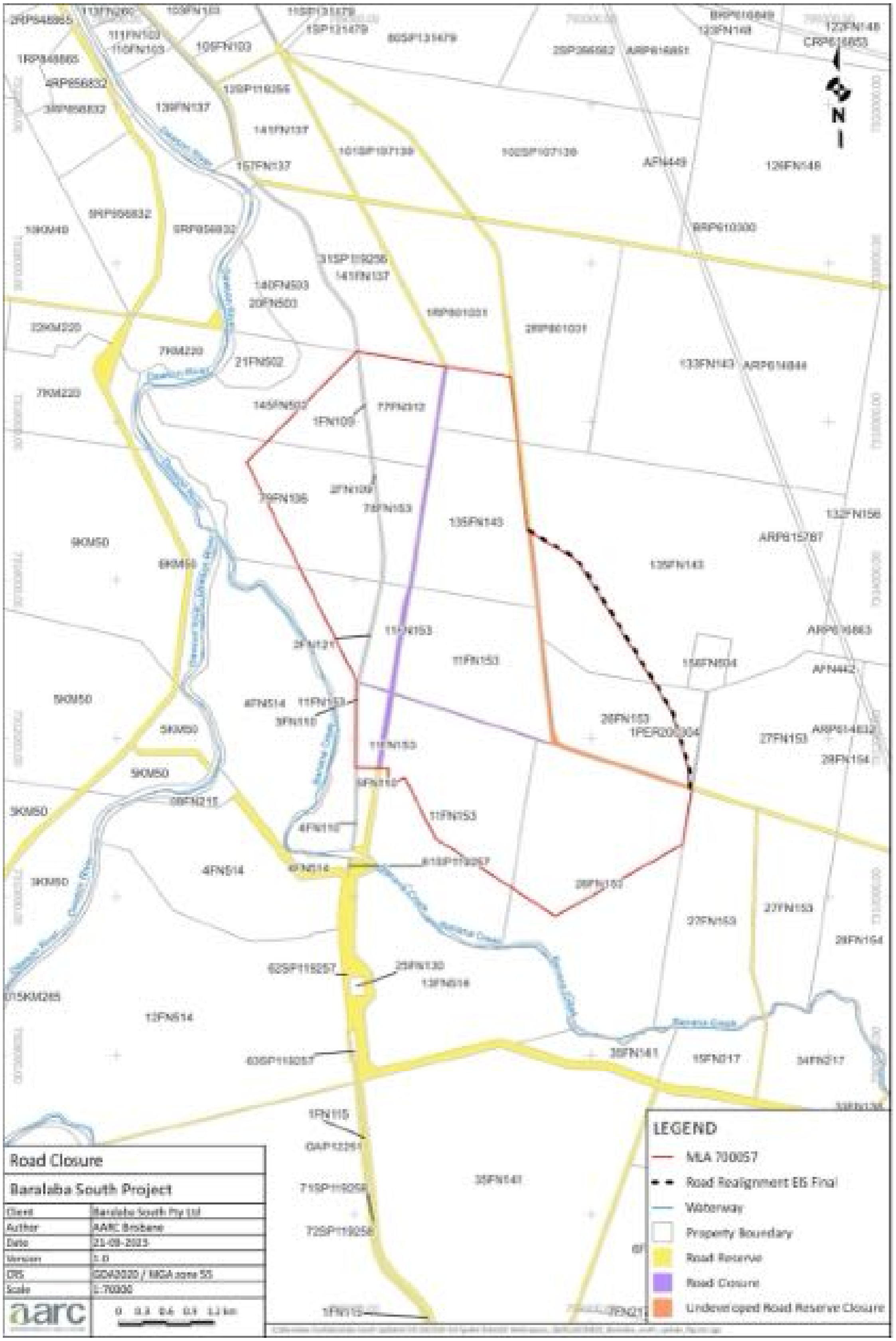

Figure 9.25: Map of road closures and realignments

Water release infrastructure

The water management system for the Project will include infrastructure for the controlled release of excess water off-site. A high-capacity pump and pipe system will be used to release water from MWD directly to the Dawson River. The pipeline will be buried beneath the access roads to the MIA and product coal stockpile, and thereafter will be above ground to the Dawson River. Ground supports will be used to raise the pipeline above the natural surface level on the floodplain so that overland flow is not obstructed. The outlet pipe will extend over, and beyond the bank, of the Dawson River to minimise the risk of erosion. The location of the pipeline and release point are shown on Figure 9.26 and have been located to minimise potential impacts to environmental values. The pipeline will be located within a 10 m easement that will also be used for maintenance and access.

The pipeline and its associated infrastructure will be inspected following flood events that result in inundation of the pipeline or its easement.

The controlled release strategy is described in section 9.8.1.8.

Water supply infrastructure

Water demands for the Project will be supplied according to the following priority order (excluding potable water supplies):

1) Mine water supplied from pit dewatering (including groundwater inflows).
2) Recycled process water recovered from the CHPP tailings thickener and belt press filters.
3) Surface runoff water captured and stored within the Project water dams.
4) Water supply ‘make-up’ sourced from water allocations from the Dawson Valley Water Supply Scheme. Related entities of the Proponent currently hold over 1,418 ML of water allocation from the Fitzroy Basin, Dawson River Zones C/D and 315ML of water licences from the Broadmeadow properties.

The Project will capture water from rainfall runoff from disturbed areas as well as groundwater. These water supplies will interact with mining operations or waste rock and will therefore be considered mine-affected water. The proposed water management strategy seeks to divert as much clean catchment water away from the operation as possible. Remaining catchment, and groundwater, will be captured and pumped to key water supply dams on site, which will then be preferentially utilised for dust suppression and process demands. Water supply infrastructure will include a pump and above ground poly pipe to extract and transfer water from the Dawson River to MWD. The water supply pipeline is proposed to be located within the easement of, and adjacent to, the water extraction pipeline (Figure 9.26).

External supply of water to the mine is expected only in extended dry periods when demand of the net site water balance exceeds inputs from rainfall runoff and groundwater. The Project accessing this allocation will not impact other existing licence holders as water allocations are existing entitlements (i.e. no new water entitlements are being sought for the Project).

Water management infrastructure

A detailed water management system for the Project is described in Chapter 6, Water Resources, and Appendix A, Surface Water Impact Assessment. The water management system for the Project has been designed to: minimise environmental impacts on the receiving environment, provide runoff containment; and supply water demands for the Project.

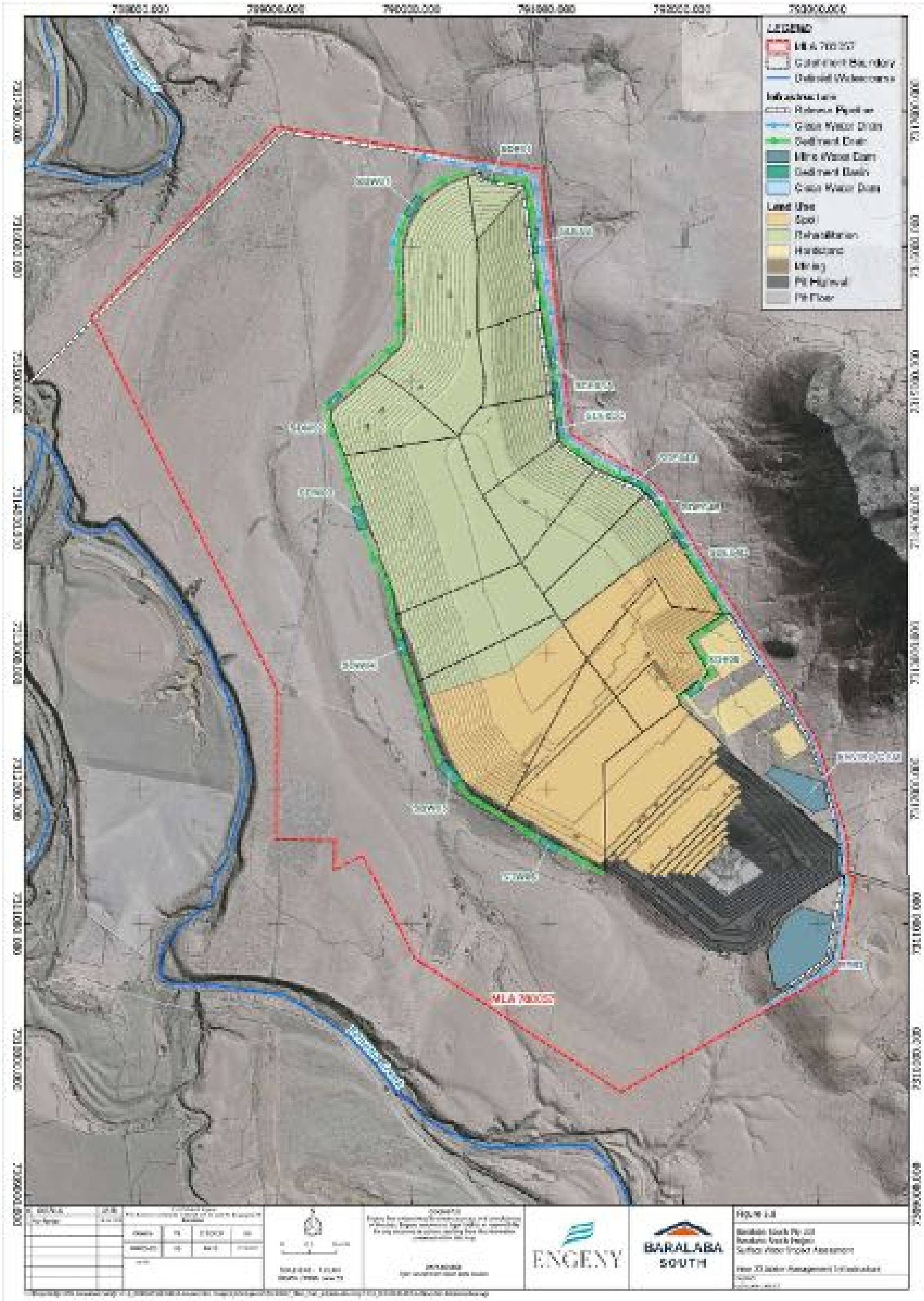

Figure 9.26: Water Management Infrastructure

The water management system can be summarised by the following objectives:

- minimising capture of clean surface water from external catchments via catchment diversion;
- initially maximising recycling and reusing mine-affected water, and then other collected runoff water for site demands including processing and dust suppression;
- preferentially supplying water from site water storages before external supply and surface water harvesting; and
- minimising and managing releases of water to receiving waterways.

Water management infrastructure has been proposed to achieve separation of water types by:

- drainage diversions for clean catchment runoff around mine infrastructure and other disturbed land;
- capturing and treating disturbed runoff in sediment basins and other sediment control infrastructure;
- containing mine-affected water in dedicated storages; and
- protecting and mitigating flood flows by relocating mine infrastructure predominantly above the 0.1% AEP flood extent.

Mine water dams

Mine water storages will be used to contain surface water runoff and groundwater collected in the mining pit, recycled water from the CHPP, runoff from the MIA area and excess water in the tailings drying cells.

Site storages to manage mine-affected water are summarised in Table 9.3. The mine-affected water storages have been conservatively designed to provide 95th percentile wet season containment despite the 'low' consequence outcome of the preliminary consequence category assessment (Appendix A, Surface Water Impact Assessment). Mine water storages are not located in the 0.1% AEP flood extent.

Water collected within the pits from rainfall events and groundwater ingress will be dewatered to the MWD and transferred to the environmental water dam (Enviro Dam) to supply the CHPP and dust suppression demands. During dry conditions MWD will be maintained empty with site inventory consolidated in the Environmental Dam to reduce evaporation losses. When required, there is the opportunity to supplement demands using site water allocations from the Dawson River Scheme.

Embankment heights will be reviewed as part of the future detailed design for each dam.

Table 9.3: Mine water dams

Identification Name	Description	Catchment Area	Full Supply Volume	Estimated Embankment Height
Mine Water Dam (MWD)	Embankment dam sized to maximum capacity allowing storage of dewatered inventory from Pit and sediment dams. Dam used as intermediary storage for CHPP process water. Allowing to capture recycled water from coal wash plant and mechanical dewatering.	29 ha	1,220 ML	~ 14 m
Environmental Water Dam (Enviro Dam)	Storage to capture runoff from MIA area, ROM and rejects stockpile.	79 ha	410 ML	~ 8 m

Sediment dams

Sediment dams are required to ensure runoff from overburden and disturbed areas, which may contain elevated concentrations of solids, is contained prior to overflows being directed to the receiving environment during rainfall events. Sediment dams form a key part of the erosion and sediment control management practices and will be managed in accordance with a site wide environment and sediment control plan. The principles to be implemented for the Project in managing erosion and sediment control include:

- minimising surface disturbance;
- progressively rehabilitating the WRE and disturbed areas to prevent sediment generation;
- separating runoff from disturbed and undisturbed areas using drainage controls; and
- constructing sediment dams to contain sediment-laden runoff.

Site storages to manage sediment-affected water are summarised in Table 9.4. Sediment dams are required around the out-of-pit spoil dump to treat runoff containing sediments before discharging off-site. The location of sediment dams was determined based on topographical low points and where water would naturally accumulate and discharge from site. The sediment dams have also been placed at regular frequencies to reduce the dam sizes and allow simpler access for desilting and maintenance activities.

All sediment dams have been sized as per 'International Erosion Control Association Guidelines' methodology for 'Type D' sediment basins (IECA, 2018) to allow for a settling zone volume to contain a 5-day, 85th percentile rainfall event and a storage zone volume equal to 50% of the settling volume.

The sediment dams will dewater to the mine water system in the event the stored water quality cannot meet water quality objectives and cannot be released to the receiving environment. Sediment dams have been designed to have pumping infrastructure to ensure a maximum 5-day dewatering period after rainfall, allowing their continued effectiveness and availability to treat sediment-affected runoff.

Table 9.4: Sediment dams

Identification Name	Function	Catchment Area	Full Supply Volume	Estimated Maximum Embankment Height	Associated Mine Stages
Western Sedimentation Dam 1 (SDW01)	Manages sediment runoff generated from north-western section of the northern spoil dump.	92.4 ha	26.3 ML	~1 m	Year 1 – 23
Western Sedimentation Dam 2 (SDW02)	Manages sediment runoff generated from western section of the northern spoil dump	32.8 ha	9.3 ML	~1 m	Year 3 – 23
Western Sedimentation Dam 3 (SDW03)	Manages sediment runoff generated from western section of the spoil dump	100.4 ha	28.6 ML	~1 m	Year 3 – 23
Western Sedimentation Dam 4 (SDW04)	Manages sediment runoff generated from south-western section of the spoil dump	51.6 ha	14.7 ML	~1 m	Year 6 – 23
Western Sedimentation Dam 5 (SDW05)	Manages sediment runoff generated from south-western section of the spoil dump	98.2 ha	27.9 ML	~1 m	Year 11 – 23
Western Sedimentation Dam 6 (SDW06)	Manages sediment runoff generated from southern section of the northern spoil dump.	72.6 ha	20.7 ML	~1 m	Year 23

Identification Name	Function	Catchment Area	Full Supply Volume	Estimated Maximum Embankment Height	Associated Mine Stages
Eastern Sedimentation Dam 1 (SDE01)	Manages sediment runoff generated from northern section of the northern spoil dump.	10.0 ha	2.8 ML	~1 m	Year 1 – 23
Eastern Sedimentation Dam 2 (SDE02)	Manages sediment runoff generated from north-eastern section of the northern spoil dump.	33.7 ha	9.6 ML	~1 m	Year 1 – 23
Eastern Sedimentation Dam 3A (SDE03A)	Manages sediment runoff generated from north-eastern section of the spoil dump.	29.8 ha	8.5 ML	~1 m	Year 3 – 23
Eastern Sedimentation Dam 3B (SDE03B)	Manages sediment runoff generated from north-eastern section of the spoil dump.	34.0 ha	9.7 ML	~1 m	Year 6 – 23
Eastern Sedimentation Dam 3C (SDE03C)	Manages sediment runoff generated from eastern section of the spoil dump.	34.4 ha	9.8 ML	~1 m	Year 6 – 23
Eastern Sedimentation Dam 4A (SDE04A)	Manages sediment runoff generated from eastern section of the spoil dump.	33.1 ha	9.4 ML	~1 m	Year 6 – 23
Eastern Sedimentation Dam 4B (SDE04B)	Manages sediment runoff generated from eastern section of the spoil dump.	32.9 ha	9.4 ML	~1 m	Year 6 – 23
Eastern Sedimentation Dam 4C (SDE04C)	Manages sediment runoff generated from eastern section of the spoil dump.	34.3 ha	9.8 ML	~1 m	Year 11 – 23
Eastern Sedimentation Dam 5 (SDE05)	Manages sediment runoff generated from southern section of the spoil dump.	55.8 ha	15.9 ML	~1 m	Year 11 – 23
Year 1 Sedimentation Dam 1 (SDY01_01)	Manages sediment runoff generated from eastern section of the initial northern spoil dump.	17.1 ha	4.9 ML	~1 m	Year 1 – 3

Clean water structures

Diversion of the clean catchment has been maximised to reduce harvesting clean catchment into the mine water system. Where topography allows, the clean catchment will be diverted via drainage features that connect the upstream clean catchment with the receiving waterways.

Clean water dams located within the MLA are listed in Table 9.5. The clean water dams will be used to intercept the natural catchment upstream of the mining pit highwall prevent unnecessary accumulation of mine-affected water. They are not planned for water offtake. Clean water dams have been designed to contain a nominal 2-year, 24-hour runoff volume. Pump rates have been proposed to enable 20-day dewatering.

There are two clean catchment diversions on the eastern side of the MLA that will redirect runoff from Mount Ramsay around the Project. A third clean water drain will divert a stream order 3 waterway (Tributary 8) around the proposed out-of-pit WRE to ensure the drainage path is unaffected from the Project.

The clean water storages used to divert clean catchments are proposed to be mostly excavated storages and will not have permanent water retaining embankments.

Table 9.5: Clean water structures

Feature/ structure identification	Description	Catchment area	Full supply volume	Associated mine stages
Northern clean water drain	Diverts clean catchment runoff east of MLA from mining activities, diverting it south into the Dawson River	470 ha	4.3 km drainage channel	Year 1-23
Southern clean water drain	Diverts clean catchment runoff east of MLA from mining activities, diverting it south into Banana Creek.	586 ha	3.7 km drainage channel	Year 1-23
Tributary 8 Diversion drain	Minor diversion of Tributary 8 around the proposed spoil dump toe and sediment collection drain at the northern extent of the MLA	3,180ha	0.39 km drainage channel	Year 1-23
Clean Water Dam 1 (CWD1)	Captures clean catchment runoff from south of the northern spoil dump.	181 ha	88 ML	Year 1-3
Clean Water Dam 2 (CWD2)	Captures clean catchment runoff from south of mining pit.	66 ha	32 ML	Year 1-3

9.4.2.6 Mine rehabilitation and closure

Progressive rehabilitation will be a statutory requirement, with binding rehabilitation milestones imposed on the Project in accordance with a PRC Plan schedule approved by the DES.

The overarching objective of mined land rehabilitation for the Project is to conform to the Queensland State Government's policy of returning disturbed lands to a safe and stable landform that does not cause environmental harm and is able to sustain an approved post-mining land use (PMLU).

In accordance with the Queensland Government's policy objectives defined in the 'Mined land rehabilitation policy' (DEHP *et al*., n.d.), the general rehabilitation goals for the Project are to leave an area that is:

- safe;
- stable;
- does not cause environmental harm; and
- is able to sustain an agreed PMLU.

These goals align with the relevant performance outcomes for land rehabilitation in the EP Regulation. In addition to the general rehabilitation goals listed above, the site-specific goals for the Project include:

- minimising the loss of pre-existing agricultural land value by reinstating, where possible, grazing lands at a similar suitability to that existing prior to mining;
- where this cannot be achieved, identifying alternative uses that provide a similar value to the value able to be generated from the land prior to mining or an alternative land use, or uses, able to provide long-term ecological value to the region; and
- minimising or avoiding the potential for post-mining lands having no or little value to the area or region.

The identification of preferred PMLU options must consider all of the key influencing ecosystem processes and functions summarised in Chapter 3, Rehabilitation, as well as government planning constraints and a number of critical site-specific aspects—most importantly the proposed post-mining landform which introduces physical aspects that may be better or less suited to particular land uses. The final landform includes the following discrete rehabilitation areas:

- an in-pit WRE with an elevation up to approximately 60 m above natural landform, grading to the south and contiguous with the out-of-pit WRE;
- one residual void located at the southernmost extent of the pit; and
- mine infrastructure areas, including water infrastructure areas consisting primarily of water storage features.

Project specific objectives aim to minimise the loss of pre-existing agricultural land value by reinstating, where possible, grazing lands that are of a similar suitability to that existing prior to mining. Where this cannot be achieved, alternative land use(s), able to provide long-term ecological value to the region will be established.

The natural landscape in the Project area will be altered by forming both in-pit and out-of-pit waste rock emplacements, and a final void. The disturbance to land during mining operations will be managed with progressive rehabilitation. Grazing will form the primary expected PMLU, capable of sustaining improved and native pastures. Where the final landforms represent a relatively flat landscape (e.g. slopes less than 5°), it is envisaged that the post-mining land suitability for cattle grazing will likely reflect that of the pre-mining landscape.

At closure, it is anticipated that most of the mine infrastructure (including sediment dams, tailings storage facilities, mine-affected water dams, clean water dams and supporting pipelines and pumps) will be decommissioned, unless otherwise agreed with the underlying landholder and Ministerial consent is obtained under the MR Act. Decommissioning of mining areas and access roads would occur progressively throughout the mining operations, as they are no longer needed. It is anticipated that final decommissioning and rehabilitation activities will be achieved within three years of the cessation of mining activities.

Focus areas of rehabilitation in the final landform include an out-of-pit waste rock dump, an in-pit waste rock emplacement, a single residual void, and mine infrastructure areas. For most of the Project area, the Proponent's lowest hierarchical objective is to reinstate the land to the previous land use, in this case, to a predominantly improved pasture grazing land use. This PMLU was indicated in Appendix S, Social Impact Assessment, as having long-term and substantial value to the local community.

Alternative PMLUs need to be identified for the residual void highwalls and pit lake features that will not be able to sustain a grazing land use. A number of alternative PMLUs have been identified and assessed with the following PMLU options being subjected to initial feasibility assessments:

- reinstatement of improved pasture grazing activities (i.e. rehabilitation hierarchy level 4), with the residual void highwalls and pit lakes rehabilitated to become natural, novel native ecosystems providing habitat and ecosystem services to local flora and fauna (i.e. rehabilitation hierarchy level 2);
- complete backfilling of the pit void and reinstatement of improved pasture grazing activities (i.e. rehabilitation hierarchy level 4) across the Project site; and
- development of a solar photovoltaic farm and pumped-storage hydro-electric scheme (i.e. rehabilitation hierarchy level 3); complementary to an improved pasture grazing use, and retention of the final void.

As the EA application for the Project was made prior to the commencement of the PRC Plan provisions of the EP Act, neither the EA application, nor this EIS, is required to be accompanied by a draft PRC Plan. Instead, the Proponent has agreed to separately prepare a draft PRC Plan for the Project to facilitate the approvals process.

9.4.2.7 Workforce

Construction workforce

The peak construction workforce of 268 personnel for the Project is estimated to occur within the first 12 months; then gradually reduce to 40 in the second year of construction. The main workforce categories include:

1) civil works;
2) CHPP construction;
3) site buildings and Infrastructure construction;
4) equipment assembly; and
5) accommodation camp management.

Occupations represented in the construction workforce are likely to include:

- earthmoving plant operators;
- structural steel and welding trades workers;
- professionals including geologists, managers, safety officers, engineers and environmental scientists;
- painting, plumbing and electrical trades workers;
- concreters; and
- construction and mining labourers.

Given the specialised nature of the work to be completed during the construction phase and its temporary nature, it has been assumed that Rockhampton and Gladstone will provide 95% of the workforce due to being major centres near the Project. The remaining 5% will be sourced from towns within the study area. The accommodation camp will be expanded to cater specifically for the Project construction and operations workforce. The accommodation camp expansion requirements are anticipated to be up to 255 rooms prior to construction to provide for the maximum combined Baralaba North and South total workforce requiring temporary (on shift) accommodation.

Operational workforce

The peak operational workforce for the Project is estimated to be 521 workers. This number will only be reached during peak production periods during the mine life. Workforce numbers will decrease relative to actual mining and production rates over the Project life.

Occupations required by the Project during operations are anticipated to include:

- machinery operators;
- truck operators;
- tradespeople including diesel fitters, boiler makers, electricians, plumbers, gasfitters and painters;
- engineers, surveyors, geologists;
- health, safety, environment, human resources, and mine management professionals;
- TLO operators; and
- administrative staff.

The workforce is forecast to be categorised into three groups:

1) mining staff and crew (89%);
2) processing plant staff and crew (5%); and
3) other staff and crew (6%).

It is expected that:

- approximately 5% of the staff will FIFO;
- approximately 70% will DIDO; and
- approximately 25% will be local and will drive in and out from the mine on a daily basis, with approximately 60% anticipated to travel to and from the mine from the south (e.g. Banana and Moura) and 40% anticipated to travel to and from the mine from the north (e.g. Baralaba).

Workforce management

Project workforce management practices will include:

- prioritising recruitment of workers from local and regional communities and workers who will live in regional communities;
- reducing the proportion of workers engaged in FIFO arrangements; and
- supporting the health and wellbeing of the Project workforce.

Local industry service providers and jobseekers will be provided with timely notification regarding potential Project employment opportunities. Employment opportunities will be promoted widely, which may include community and stakeholder engagements, major contractors' websites, employment agency listings and local/regional papers.

The Gaangalu Nation People, Gangalu Endorsed Parties, Woorabinda Aboriginal Shire Council, Department of Seniors, Disability Services and Aboriginal and Torres Strait Islander Partnerships–Central Region (Rockhampton office) and Queensland South Native Title Services (Rockhampton office) will be consulted in relation to employment and training opportunities for Indigenous people.

The Project will provide equal opportunities for employment and will recruit based on candidates' skills, skills requirements and job suitability without regard to gender, age, race or disability status.

As a component of its recruitment strategy, the Project's equal employment opportunity and local employment focus will be promoted in surrounding communities, including under-represented groups, to encourage local participation in the Project.

Training opportunities will be provided at the Project to attract unskilled and semi-skilled, local employees and may include traineeships, apprenticeships and/or general on-the-job training.

Rostering

The operational hours of the Project will be 24 hours a day, seven days a week. Operational employees will work industry standard 12-hour or 12.5-hour shifts (depending on shift change requirements), working seven days on and seven days off. Senior management will work on a five-day on (Monday to Friday), two-day off roster.

Accommodation

Baralaba Coal Company owns and operates an accommodation camp in Baralaba, approximately 8 km north of the Project. The camp currently has 156 single accommodation units, and recreation and dining facilities on-site for guests. The accommodation camp is fully utilised for the Baralaba North Mine.

Baralaba Coal Company has a current approval from the Banana Shire Council to construct an additional 32 rooms at the accommodation camp to accommodate the Baralaba North Mine workforce, with only eight of these rooms currently constructed. Consultation with the Banana Shire Council indicated the accommodation camp in Baralaba is the preferred location to accommodate the Project’s non-resident workforce. The accommodation camp will be expanded to cater specifically for the Project construction and operations workforce. The accommodation camp expansion requirements are anticipated to be up to 255 rooms prior to construction to provide for the peak for the maximum combined Baralaba North and South total workforce requiring temporary (on shift) accommodation.

Temporary accommodation is also available in Baralaba and surrounding towns.

9.5 Relationships to other Projects

The following other coordinated or major resource projects are publicly known in the region:

- The **Baralaba North Mine** (refer to Figure 9.6), a metallurgical coal mine with tenements held by Baralaba Coal Pty Ltd and Wonbindi Coal Pty Limited located approximately 12 km to the north of the Project. The Project will share use of off-lease infrastructure, including a 40 km stretch of the public road that has been upgraded for transport of product coal and the existing TLO facility located east of Moura, which is permitted for 50,000 t of coal stockpiling.
- The **Dawson Mine** (refer to Figure 9.6), with tenements held by Anglo Coal (Dawson) Limited and located between Moura and Baralaba, approximately 25 km south-east of the Project. ML 5656 extends from the northern open cut pit at Dawson approximately 23 km to the north, ending at the south-eastern boundary of the Project MLA. The unmined portion of ML 5656 represents possible future mining potential; however, the intentions of the holder with regards to this tenement are not known.
- The **Meridian Coal Seam Gas project** located approximately 28 km south of the Project, near Moura and the Dawson Mine. The gas field started production in 1999 and has been operated by Westside since its acquisition in 2010. The project owns gas compression and pipeline infrastructure which is connected to Queensland's commercial gas network and a trunk line of the GLNG Project. The Project includes Petroleum Lease 94 and gas rights in MLs.
- The **Mungi North proposed gas field** comprises a Petroleum Lease application to the north of the Meridian Coal Seam Gas Project. The proposed project, which extends to within 5 km of the Project but does not overlap it in any way, was approved in 2020.

9.6 Project alternatives and consequence of not proceeding

A 5 Mtpa ROM mine operation was previously proposed and a corresponding EIS submitted to the regulator on 20 January 2020. Government adequacy reviews identified that additional information was required to meet the ‘properly made’ application requirements. An amended EIS was due to be submitted in April 2021 but did not proceed. Following a change in ownership, an extension request by Baralaba Coal Company was approved, with an EIS submission due 30 December 2022. Following further stakeholder consultation and with consideration of social and environmental impacts, opportunities were identified and assessed with the objective of achieving a material reduction in environmental impacts.

Two Project alternatives, and a ‘do nothing’ alternative were evaluated; resulting in the currently proposed 2.5 Mtpa ROM coal production Project. For each alternative, several key strategic decisions were evaluated, based on previous Project plans, feedback from regulators and responsible economic and resource stewardship options. The evaluation of alternative options is described in the following sections.

The evaluated Project alternatives, as depicted in Figure 9.27 and Figure 9.28, are;

Alternative 1 – Maximise resource: for this alternative, the highest priority is to extract all economically viable product within the ML.

Alternative 2 – Balanced moderate production: for this alternative, incorporating key stakeholder concerns regarding flood and environmental impacts are given equal priority to maximising resource extraction.

A number of strategic decisions were also evaluated for the alternatives to further optimise the proposed Project. The key decisions evaluated for each alternative were:

- What is the resulting impact on floodplain encroachment?
- What is the resulting scale of production?
- Where is the optimal location for the MIA?
- What processing method is to be used?
- How is product to be transported?

The outcomes of this evaluation are summarised in Table 9.6 and detailed in the following sections.

Table 9.6: Project alternatives assessment summary

	Alternative 1	**Alternative 2**	**Alternative 3**
Strategic decision	**Maximise resource**	**Balanced moderate production**	**Do nothing**
Flood plain encroachment	Build a levee	All disturbance outside flood area	n/a
Scale of operation	Mine all available resource in the MLA 5 Mtpa	Mine available resource off the flood plan 2.5 Mtpa	0 Mtpa
MIA location	Anywhere it fits (within flood levee)	Above 0.1% AEP	n/a
Processing method	Novel dry separation plant	Existing process (dense medium cyclones)	n/a
Product transport	New rail link or road corridor	Use existing haul road plus 4.5 km road realignment	No product haulage

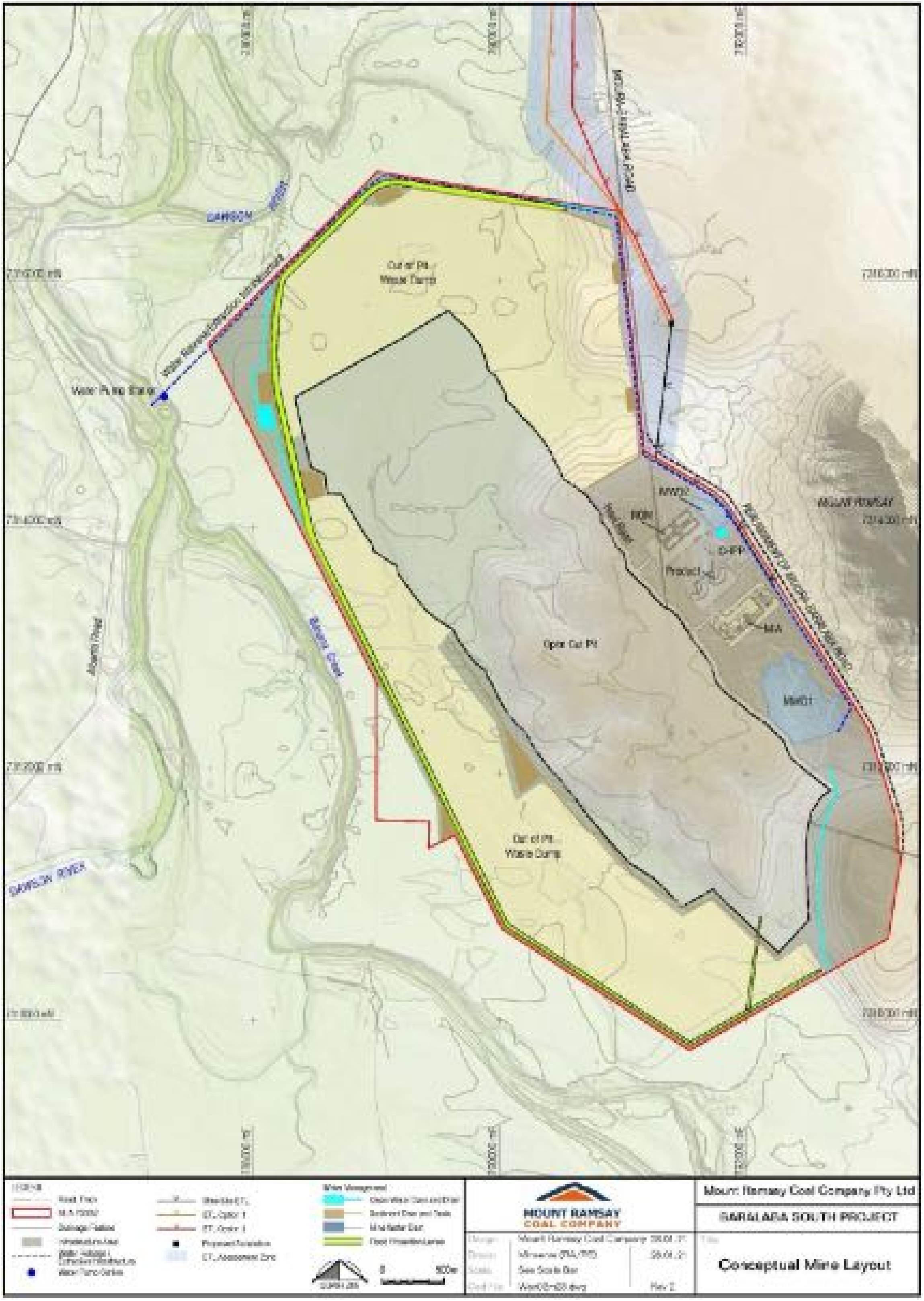

Figure 9.27: Alternative 1 - Conceptual mine layout 5 Mtpa mine operation

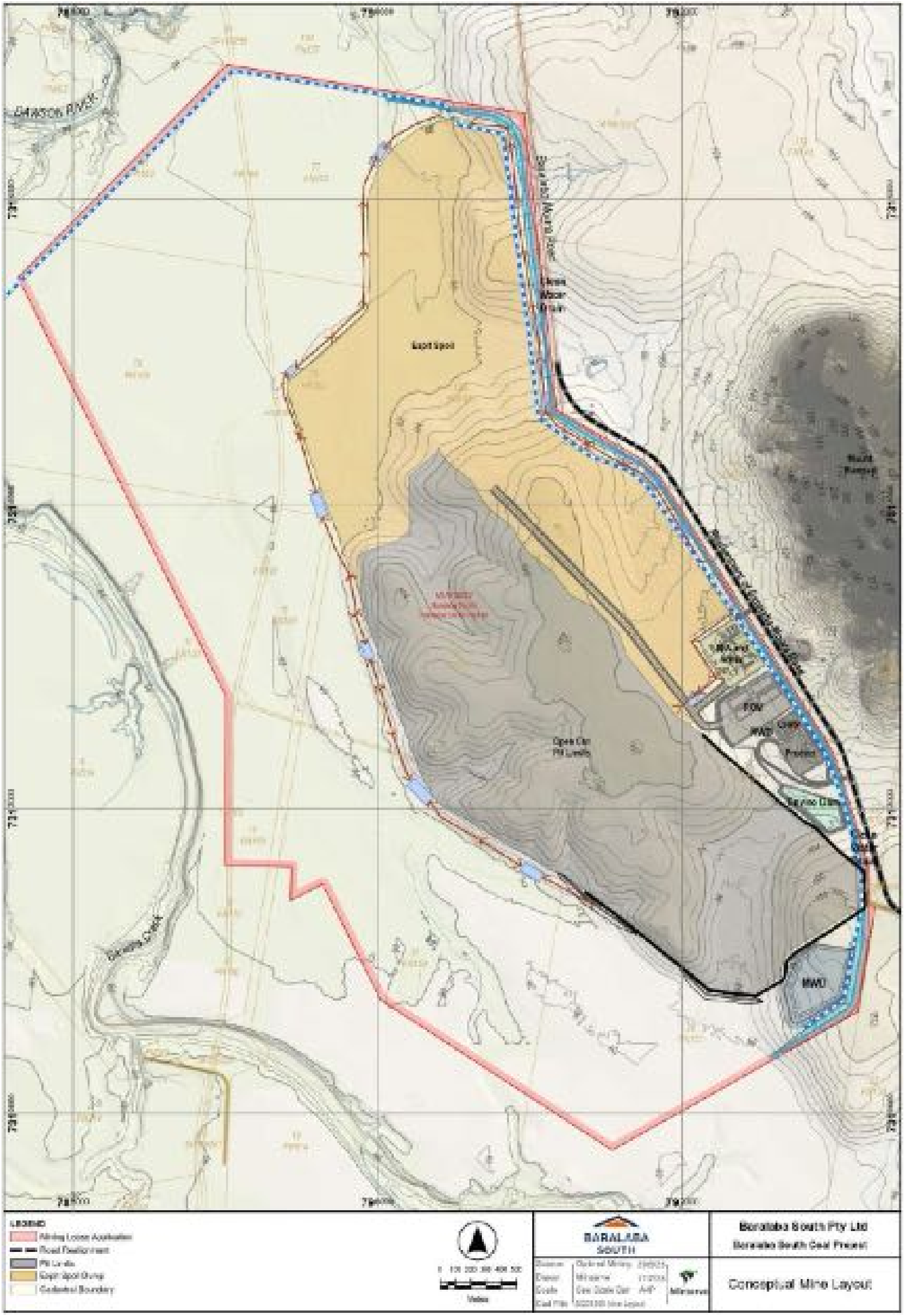

Figure 9.28: Alternative 2 - Conceptual mine layout 2.5 Mtpa mine operation

9.6.1. Flood plain encroachment

The footprint of Alternative 1 (5 Mtpa operation) covers the entire MLA area including sections of the Dawson River floodplain. Mine operations are to be protected from flooding by an operational flood levee along the western boundary. Encroachment on the floodplain would result in changes to flood behaviour and potential impact on neighbouring properties. These potential changes to flood regime were raised as an important concern by the community and regulators.

Alternative 2 (2.5 Mtpa operation) utilises only the eastern portion of the MLA with mine operations commencing in the north, progressing south; and located predominantly outside the 0.1% floodplain. The rehabilitated WRE is located predominantly outside the floodplain extents.

9.6.2. Scale of operation

As indicated in section 9.6.1, regulator feedback and stakeholder consultation identified concerns relating to environmental and social impacts arising from the changed flood behaviour associated with Alternative 1. Effectively addressing the identified concerns necessitated a reduction in the scale of operations. Alternative 1 also seeks to maximise production with both Baralaba North and Baralaba South mines to operate in parallel.

A small, additional mining lease application area located adjacent north - east of the MLA was considered as an option for Alternative 2 for spoil placement, to further reduce impacts within the 0.1% AEP floodplain. The area had been identified because it:

- does not directly impact any additional underlying properties;
- was not expected to increase impacts for any sensitive receptor;
- was not expected to increase adverse environmental impacts; and
- was expected to result in a significant reduction in the potential for surface water impacts within the 0.1% AEP floodplain.

The option to progress the additional mining lease for Alternative 2 was dismissed because it did not sufficiently reduce flooding and added complexities and time to the Project for little benefit.

Alternative 2 is a smaller scale of operation of up to approximately 2.5 Mtpa within the current MLA 700057, with a footprint limited to areas outside the 0.1% AEP floodplain extents; effectively minimising any potential changes to the flood regime. Alternative 2 also considers the operation being sequenced as a transition from Baralaba North Mine as it reaches its end of mine life. Alternative 2 is proposed to commence operations as Baralaba North production ramps down.

Alternative 2 was determined to be the preferred alternative by providing better environmental outcomes, as well as still providing ongoing social benefits to the local and regional community.

9.6.3. Mine infrastructure location

Alternative 2 (2.5Mtpa plan) was further optimised through an assessment of the location of infrastructure, including the CHPP, MIA, administration buildings and workshops. Possible infrastructure locations assessed included;

1) An area to the south-west of the mining void, between the flood levee and the pit highwall; and
2) An area to the north-east of the mining void.

The second location, north-east of the mining void was assessed to be the optimal infrastructure location in view of operational, economic and environmental factors. Other benefits identified were that:

- Infrastructure is positioned well outside the economic mining footprint and will not result in sterilisation of resource.
- The location is on high ground within the MLA and outside of the existing floodplain.
- The preferred route for the Moura-Baralaba Road realignment is directly to the east of the MLA boundary. The mine infrastructure is located between the mining void and the product haul route, minimising equipment travel distances during operations. This subsequently reduces noise and air emissions, fuel usage and water use for dust suppression.
- The location of infrastructure to the north-east of the pit enables the development of a permanent landform for long-term flood protection. The rehabilitated structure will remain in the post-mining landform.

This preferred location was therefore proposed for Alternative 2.

9.6.4. Processing method

Two processing options have been examined in detail to ±10% accuracy. These include:

1) a novel dry separation plant; and
2) a conventional wet CHPP.

Dry separation plant test work was undertaken in Germany but failed to replicate the data presented in research papers. Further to this, it was found that when simulated against a conventional wet CHPP, a total yield loss of 8.1% at a higher product ash was recorded against the dry separation plant. It was, therefore, considered inappropriate to examine dry coal separation further.

Wet jigs have been eliminated from process selection through the same process.

The preferred CHPP option utilises dense medium cyclones, spirals and flotation, and has formed the basis of the front-end engineering and design of the CHPP, as described in section 9.4.2.4.

This process was therefore proposed for Alternative 2.

9.6.5. Product transport

Alternatives to public road haulage include the development of a new private infrastructure corridor, such as a private haul road or rail link. The existing public haul route used by the Baralaba North Mine has already been upgraded to provide for the haulage of product coal via road trains. As described in Chapter 13, Transport, this road has available capacity to support coal transport from the Project.

The use of an existing public road for coal transport is the preferred option as:

- alternative transport options would require the construction of new infrastructure, potentially sterilising surrounding agricultural land and dividing properties; and
- alternative infrastructure options would result in additional land clearing and environmental impacts to soil, ecology and water.

Impacts of additional road traffic on the public road have been assessed in this EIS and are subject to separate Council approval and conditions.

9.6.6. Alternative evaluation summary and preferred alternative

Alternative 2, being the 2.5 Mtpa operation with a footprint restricted to being above the 0.1% AEP presents significantly reduced impacts to environmental values while still providing transitional benefits to the community.

The preferred alternative proposed in this EIS is based on Alternative 2, i.e. a 2.5 Mtpa ROM coal operation with infrastructure and footprint located predominantly above the 0.1% AEP extent.

Further details on the comparable benefits of the proposed alternative are presented in the following sections.

Flooding

Alternative 1, the 5 Mtpa plan, requires a flood protection levee with 0.1% AEP design event flood protection to be constructed around the northern, western and southern perimeters of the mine. Post-mining, the flood protection levee is to be incorporated into the final landform design as a permanent feature of the landscape, providing Probable Maximum Flood (PMF) protection to the final landform. The placement of the flood levee would have significantly increased flood impacts to the community, with an increase in the number of landholders predicted to be impacted.

Flood flows were predicted to break out of the Dawson River and Banana Creek channel in events greater than the 10% AEP flood event and flow across the eastern floodplain at the Project site. The Project MLA area is partially inundated during a 2% AEP flood event but is not inundated in a 10% AEP flood event. The Dawson River floodplain has a flow width of approximately 5.5 km in flood events greater than 10% AEP adjacent to the Project. Flooding of the Dawson River at the Baralaba township is largely confined to the main river channel although minor flooding of the town results from a 1% AEP flood event.

For flood events rarer than the 10% AEP, Alternative 1 was predicted to reduce the extent of flooding on the eastern Dawson River floodplain and direct slightly more flood waters to the western floodplain and the Dawson River Anabranch which flows between the Baralaba Central and Baralaba North mining operations. In flood events up to and including the 10% AEP, some properties neighbouring the Project were anticipated to experience an increase in flood depth of up a maximum 0.5 m in the 1% AEP event.

An assessment of nine different levee locations for Alternative 1 was undertaken for the Project. Flood modelling was undertaken to assess the change in flood impacts at nearby dwellings (Engeny, 2020). The results of this analysis led to a review of mine plans and the option of a smaller mine plan to the east of the 0.1% AEP floodplain to mitigate resultant flood impacts (Alternative 2).

Subsequent mine planning confirmed that mining activities could be undertaken within the current MLA boundaries, with a significant reduction of the footprint on the 0.1% AEP floodplain. The Alternative 2 revised mine plan is smaller in scale and has been relocated predominantly outside the 0.1 % AEP flood extent. As such it does not require an operational flood levee and has a much smaller impact on flooding.

Terrestrial ecology and Matters of National Environmental Significance

The impact on terrestrial ecology is significantly reduced for Alternative 2 compared with Alternative 1, resulting from the reduced footprint, and being a greater distance from the Dawson River floodplain. Terrestrial ecology field surveys indicated the Project area has previously been largely cleared of native vegetation through historic and ongoing agricultural practices. Larger continuous patches of remnant vegetation occur, both along the Dawson River, Banana Creek and Mount Ramsay.

Fauna habitats throughout the Project area were noted as typically being of poor to moderate condition, with poorer quality habitat associated with areas of historic clearing, cultivation and cattle grazing, resulting in limited habitat connectivity value.

Disturbance to terrestrial ecological values as a result of clearing activities are significantly increased under Alternative 1. Alternative 2 was assessed to have the following comparable impacts:

- Approximately 10 ha of remnant vegetation will potentially be cleared or disturbed by the Project for either Alternative 1 or 2. Approximately 51.6 ha of high value regrowth vegetation would potentially be cleared or disturbed for the Project for Alternative 1. Alternative 2, the 2.5Mtpa plan potentially clears or disturbs 5.5 h of high value regrowth vegetation, some of which provides suitable habitat for threatened species.
- Approximately 0.03% for Alternative 1 and 0.01% for Alternative 2 of Brigalow TEC would be cleared for Project operations.
- Approximately 55.8 ha for Alternative 1 Coolibah – Black box Woodlands TEC would be cleared for Project operations. For Alternative 2, all areas of Coolibah – Blackbox Woodlands TEC occur outside both the proposed disturbance footprint of the Project and ETL.
- Compared to Alternative 2, Alternative 1 results in an increase in clearing potential habitat for the Squatter Pigeon, Ornamental Snake, Australian Painted Snipe, Koala, Latham's Snipe and Glossy Ibis.
- Alternative 1 when compared with Alternative 2 results in:
  - up to 60% more clearing of habitat identified as potential habitat for the Ornamental Snake;
  - up to 60% more clearing of non-critical Koala habitat to 94.6 ha;
  - up to 60% more clearing of Squatter Pigeon (Southern) habitat to 68.3 ha; and
  - up to 50% more clearing of potential Australian Painted Snipe habitat to 97.6 ha.

Aquatic ecology

Aquatic values of waterways within the Project area are typical of ephemeral areas, being highly disturbed by activities associated with the adjacent land use. The waterways within the Project area have poor habitat conditions, being ephemeral drainage lines having minimal in-stream habitat features.

The waterways within the MLA do not connect to any important breeding, feeding or refuge areas and fish passage is very limited due to their ephemeral nature.

One lacustrine (artificial) wetland and two palustrine wetlands occur within the MLA. Alternative 1 would result in the clearing of up to 10 ha of these wetlands while Alternative 2 would result in no clearing of the wetlands. However, these wetlands are poorly connected, with poor to fair habitat conditions based on diversity of in-stream features and disturbance levels. Dry wetlands provide minimal habitat, except for aquatic flora.

A Groundwater Dependent Ecosystem Assessment was undertaken for both alternatives to survey and assess potential GDEs within the study area in accordance with GDE guidelines. Under Alternative 1, vegetation clearing within the MLA will result in a direct impact of 7.2 ha to groundwater dependent vegetation (RE 11.3.3a), while under Alternative 2, no GDEs would be disturbed. Groundwater drawdown associated with the Project was not predicted to impact the ecological function of GDEs outside the MLA for either alternative.

Surface water

Both alternatives were predicted to result in a reduction of the Dawson River catchment. The maximum catchment reduction for Alternative 1 equates to approximately 2,100 ha or approximately 0.05% of the contributing catchment of the Dawson River at Beckers (130322A) gauging station and 0.01% of the catchment at the Fitzroy River at Riverslea. Alternative 1 was also predicted to result in a 13% reduction in catchment to the HES wetland situated along the western MLA boundary. The reduction in HES wetland catchment would result in a maximum modelled decrease in water level of 0.05 m, with a reduction in water level at the wetland predicted on 5% of days.

The maximum catchment area captured by site storage for Alternative 2 is approximately 966 ha (9.66 km^2) which accounts for a reduction in streamflow less than 0.045% mean annual flow) at the Project location which is not expected to impact the existing Dawson River riparian vegetation or channel morphology approximately

0.024% of contributing catchment at the Dawson River at Beckers gauging station. Alternative 2 was predicted to have no catchment impacts to HES wetlands.

Groundwater

Both alternatives result in some impact on groundwater.

Predictions of groundwater drawdown for both alternatives show similar changes to groundwater systems over time. Impacts associated with Alternative 1 result from groundwater to be taken or interfered with from the exercise of underground water rights across Years 1 to 19, with drawdown largely contained within the Permian coal measures extending from the open cut pit extents to approximately 1.2–1.3 km to the north and north-west, 400–900 m to the south and south-west and 500–800 m to the east and south-east.

Alternative 2 results in a maximum drawdown of approximately 1 m within mapped alluvium, mainly within the reach of Banana Creek where it flows to the Dawson River Alluvium as well as a small cone of depression (approximately 1 m drawdown) to the north-west.

Geomorphology

The footprint of Alternative 1 is located adjacent to the Dawson River and Banana Creek and extends into their respective floodplains; but is only expected to result in negligible changes to the geomorphic behaviour of the waterways and floodplain.

Alternative 2 will not result in any material geomorphological impacts to the Dawson River and Banana Creek channels and floodplains.

Land and visual amenity

The Project area is partially overlayed by trigger-mapped strategic cropping land (SCL) for both alternatives however, for Alternative 2 the disturbance footprint is reduced. An assessment of SCL criteria verified a total of 1,102 ha of land within the MLA as SCL that would be disturbed under Alternative 1. Given the smaller footprint of Alternative 2 only 495 ha of trigger-mapped SCL is disturbed.

Air quality

Dust emissions from the covered road haul trucks over sealed roads will be unsubstantial for either alternative. The closest residence to the haul route is approximately 100 m away, and the likelihood of impacts at sensitive receptors 100 m or more from the route has been assessed to be negligible.

The air quality assessment for Alternative 1 indicated a relatively moderate chance of exceedances of the 24-hour PM_{10} criterion, particularly at year 2. Modelling results predicted one exceedance at one receptor and two at another, both located outside the MLA boundary.

The air quality assessment for Alternative 2 indicated a low to negligible chance of exceedances of all indicators (dust deposition, annual average TSP, 24-hour average PM_{10}, annual average PM_{10}, 24-hour average $PM_{2.5}$ and annual average $PM_{2.5}$) at receptors outside the MLA boundary.

Noise and vibration

For either alternative the Project will result in an increased amount of coal transported via the rail load out, and therefore an increased number of trains will use the facility. However, there is not proposed to be any significant changes to the operational hours, train types, mobile equipment or fixed equipment at the TLO. The proposed increase in train numbers will result in additional periods of noise emissions, however, based on worst-case 1-hour noise levels the level of noise occurring during these additional periods is not predicted to increase above current noise emission levels.

A noise and vibration assessment for Alternative 1 was conducted to identify key sources of noise and vibration emissions from the construction and operational activities associated with the Project by Ask Acoustics and Air Quality now Trinity Consultants Aus. Potential noise impacts were assessed for Years 2, 11 and 18. These scenarios were selected to represent the range of mine noise levels associated with operations over the entire mine life. Modelling indicated that no exceedances were predicted for sensitive receivers outside of the MLA.

The blasting assessment for Alternative 1 predicted that ground vibration would not exceed the objective of 5 mm/s at distances greater than 1 km. The air blast overpressure assessment predicted that air blast levels will meet the Project objective at distances greater than 3 km. Impacts from blasting are not anticipated to impact surrounding infrastructure such as that associated with the Benleith Water Scheme.

The noise assessment for Alternative 2 determined that cumulative noise was not expected to exceed compliance levels and was therefore considered acceptable (Appendix N, Noise and Vibration Assessment). Noting that some receptors are located on or would need to be acquired by the mine.

The changes in noise levels due to haulage operations associated with the Baralaba North Mine and the Project under peak operating conditions are predicted to comply with the objective of less than a 3 dB noise increase at all sensitive receivers. Noise modelling scenarios captured the worse-case traffic scenario, which includes both Baralaba North Mine and Baralaba South Mine simultaneously operating at peak production.

Transport

A Traffic Impact Assessment of Alternative 1 and Alternative 2 concluded that, with respect to road capacity, it is expected that the level of service for key roads will remain classified as 'A' under all modelled future scenarios and therefore, no additional overtaking lanes will be required. No intersection upgrades or additional mitigation measures are considered necessary for the Project.

The realignment of Moura-Baralaba Road is subject to separate approval from the Banana Shire Council.

The Project will have a minor increased demand on rail, air and sea transport. The Project will utilise the Moura Rail System and port infrastructure at the Port of Gladstone for the transportation of product coal.

Waste

The potential impacts identified that may arise from the inappropriate management of waste are applicable to both Alternative 1 and Alternative 2. Alternative 2, having a lower production rate, will produce less waste than Alternative 1. Potential impacts identified include:

- Increased pressure on local and regional commercial waste collection, treatment and disposal facilities.
- Land, surface water and groundwater contamination from:
  - leachate or runoff originating from unsealed waste collection and storage areas;
  - seepage from waste rock emplacements and coal rejects stockpiles; and
  - inappropriate and/or inadequate treatment and management of sewage effluent.
- Risks to workplace health and safety resulting from unsafe or inadequate storage, containment and/or handling of hazardous wastes.
- Health and hygiene issues resulting from the inadequate management of putrescible wastes.
- Litter in and around the Project site impacting local visual amenity, creating a fauna entrapment hazard, increasing fire risk or creating a health risk by providing a mosquito breeding habitat.
- Attraction of pest fauna species (e.g., feral pigs, black rats, feral cats, native rodents and scavenging bird species) arising from an inadequately managed waste collection area.
- Impacts to visual amenity due to the planned WREs of excavated waste.
- Resource inefficiencies arising from inadequate recycling and/or reuse of waste materials.

Cultural heritage

The non-indigenous cultural heritage assessment undertaken for Alternative 1 and Alternative 2 did not identify any significant differences. An assessment of non-indigenous cultural heritage (NICH) identified three potential NICH sites considered to have low local heritage significance (Dawson Valley Railway, Dovedale Homestead Complex, and a survey tree) and one site that is considered to have moderate local heritage significance (telephone line). No sites identified were considered to meet the threshold for state heritage listing. The recording of these sites was undertaken by the cultural heritage experts.

Social values

The potential impacts of both Project alternatives on the social values of local and regional communities were identified through direct engagement with potentially affected stakeholders and an analysis of potential impacts against the attributes of the existing social environment. Stakeholder engagement and community consultation undertaken included both targeted consultation for the SIA, as well as extensive public consultation for the EIS by the Mount Ramsay Coal Company (Baralaba South Pty Ltd) for Alternative 1 and Baralaba Coal for Alternative 2.

The potential social impacts and benefits of the Project as identified by the community included:

- Population growth during construction and operation, with the potential to benefit community vitality and:
    - an increase in demand for social services (e.g. emergency services, health services, education, childcare and community services) and infrastructure (e.g. roads);
    - an increase in demand for rental properties;
    - an increase in property prices; and
    - an increase in the non-resident proportion of the population, i.e. the capacity of the region to meet the accommodation needs of the non-resident workforce is considered to be high.
- The creation of employment and training opportunities in the construction, operations and post-mining phases of the Project, including for Indigenous people.
- The potential for workplace health and safety incidents.
- The creation of opportunities for local and regional businesses and services through supply opportunities and expenditure.
- Potential impacts on the community's surroundings, health and wellbeing, such as potential Project impacts on water resources and flooding, agricultural land, amenity (e.g., dust, noise, blasting and lighting), road safety and the proposed PMLU.

The revised mine plan of 2.5 Mtpa and the associated reduction in potential impacts on the environment and flooding regime were generally well received. Engagement outcomes indicated a preference for Alternative 2.

Hazards and safety

A preliminary risk assessment workshop was undertaken to analyse and evaluate the risks and hazards identified for Alternative 1. Of the 48 risks identified and assessed, no Class IV (very high) risks were identified while two Class III (high) risks were identified. Identified Class III risks related to occupational health and safety hazards associated with a mine workplace and particulate matter impacts to neighbouring properties.

The revised risk assessment for Alternative 2 identified that many of these risks would be avoided or mitigated given the lower production rate, smaller footprint and footprint location outside the 0.1% AEP extent. Of the 48 risks identified and assessed, no Class IV (very high) risks were identified while three Class III (high) risks were identified. Identified Class III risks related to occupational health and safety hazards associated with a mine workplace and particulate matter impacts to neighbouring properties.

Mining methodology

Options for mining the Project are limited by the steeply dipping, multiple coal seam formation. Two options were considered in the planning phase included:

1) underground mining; and
2) open cut mining via strip or terrace methods.

The possibility of underground mining was discounted early in the planning and development phases of the Project. The complex nature of the faulted, steeply dipping seams at shallow depth within the MLA are not conducive for underground mining techniques. Such mining methods are more suited to thick and contiguous coal seams.

Open cut terrace mining has proven to be the optimal mining technique for the Baralaba South deposit. Strip mining using draglines or similar equipment is not practicable with the multiple steep dipping and faulted seams. Production rates between 1.5 Mtpa and 5 Mtpa have been considered. Terrace mining from the north of the sequence and a mining rate of 2.5 Mtpa is considered optimal within the context of Project viability, environmental impacts, impacts on stakeholders and the reinstatement of a safe and stable post-mining landform and land use.

This assessment is supported by:

- The defined coal resource has relatively low stripping ratios across the entire sequence.
- There is no known economic underground coal resource that will be sterilised by the development of the open cut mine.
- The mining method minimises potential for flooding of the void during operations and post-closure. This is achieved through the development of permanent landforms providing flood protection.
- The mining sequence has enabled the design of a final landform that supports a number of beneficial post-mining land uses for the site.

The selected mine plan also retains the ability to access coal seam gas which may be available downdip of open cut mining or in coal seams much deeper in the sequence than the seams which will be targeted by open cut mining.

9.6.7. Alternative 3 - Project not proceeding

Were the Project not to proceed, the following consequences are inferred:

- There will be a loss of employment opportunity including up to 521 jobs for a minimum of 23 years.
- Approximately 49 Mt of ROM coal will not be mined resulting in loss of mining royalties.
- There will be a loss of Federal tax revenue. The Project is estimated to increase the Australian Government aggregated tax revenue by a total of $512.4 million.
- There will be a loss of state tax revenue. The Project is estimated to provide additional tax revenues of approximately $62.6 million per annum to the Queensland Government.

9.7 Environment and water management policies and regulations

9.7.1. *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

The EPBC Act defines a legal framework to protect and manage nationally and internationally important flora, fauna ecological places defined as MNES. The TOR for the Project EIS (DEHP, 2017b) have identified water resources as a controlling provision for the Project.

9.7.2. *Environmental Protection Act 1994* (EP Act)

The EP Act defines environmental value as:

- A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or
- Another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.

9.7.3. Environmental Protection Regulation (EP Regulation) 2019

The Environmental Protection Regulation (EP Regulation) 2019 further defines specified environmental objectives and performance outcomes for key environmental aspects.

9.7.4. Environmental Protection (Water and Wetland Biodiversity) 2019

The purpose of the EPP (Water and Wetland Biodiversity) is to identify environmental values and associated water quality objectives for Queensland waters. That is, protecting Queensland's water environment while allowing for development that is ecologically sustainable. The Project is located within the Dawson River Sub-basin of the greater Fitzroy Basin.

Section 6 of the 'Environmental Protection (Water and Wetland Biodiversity) Policy 2019' (EPP [Water and Wetland Biodiversity]) states environmental values for waters to be enhanced or protected relevantly are:

- for high ecological value waters—the biological integrity of an aquatic ecosystem that is effectively unmodified or highly valued;

  Example of a highly valued aquatic ecosystem—an aquatic ecosystem used for drinking water

- for slightly disturbed waters—the biological integrity of an aquatic ecosystem that has effectively unmodified biological indicators, but slightly modified physical, chemical or other indicators;
- for moderately disturbed waters—the biological integrity of an aquatic ecosystem that is adversely affected by human activity to a relatively small but measurable degree;
- for highly disturbed waters—the biological integrity of an aquatic ecosystem that is measurably degraded and of lower ecological value than waters mentioned in the above bullet points;
- for waters from which aquatic foods intended for human consumption are taken—the suitability of the water for producing the foods for human consumption;
- for waters that may be used for aquaculture—the suitability of the water for aquacultural use;
- for waters that may be used for agricultural purposes—the suitability of the water for agricultural purposes;
- for waters that may be used for recreation or aesthetic purposes—the suitability of the water for:
  - primary recreational use;
  - secondary recreational use; or

  - visual recreational use;
- for waters that may be used for drinking water—the suitability of the water for supply as drinking water having regard to the level of treatment of the water;
- for waters that may be used for industrial purposes—the suitability of the water for industrial use; or
- the cultural and spiritual values of the water.

The Project has the potential to impact on the surrounding wetlands and water quality. The Project's water values, as well as the potential impacts to these values, are described in sections 9.8 to 9.14.

9.7.5. *Water Act 2000*

The *Water Act 2000* (Water Act) provides the framework for the sustainable management of Queensland's water resources and quarry material, through establishing a system for the planning, allocation and use of water; and the allocation of quarry material and riverine protection. The Water Act also has the purpose of securing water supply and demand management for the south-east Queensland region and other designated regions and the management of impacts on underground water cause by the exercise of underground water rights by the resource section.

Under the Water Act, a person must not take or interfere with water unless authorised under the Water Act, or another Act.

There are unnamed waterways of first-, second- and third-stream order within the boundaries of the MLA. These waterways are mapped as drainage features under the Water Act.

For the Project, groundwater ingress to the mining pit is considered a take (or interference) of water (associated water). However, section 334ZP of the MR Act confers underground water rights to the holder of a MDL or ML to take or interfere with underground water where this occurs during the course of, or as a result of, carrying out of an authorised activity for the licence or lease. In such circumstances, section 334ZP (5) of the MR Act also requires the holder to measure and report the volume of associated water taken, as well as imparting certain notification requirements.

Under the Water Act, a riverine protection permit may also be required to enable the placement of any fill, or for the undertaking of any excavation within a watercourse. This may be relevant in relation to potential vehicle crossings required for the Project outside the MLA.

The Project will also involve the construction of water storages, sediment dams and drains, to support the efficient management of water resources.

Section 1250U of the Water Act also provides that the holder of the mining tenure must enter into an agreement with the owner of a water bore if that bore is affected (or likely to be affected) by the proposed mining activities. The potential for the Project to affect registered bores is discussed in section 9.10.4.4.

9.7.6. Water Plan (Fitzroy Basin) 2011

Water resources within the Fitzroy are managed under the Water Plan (Fitzroy Basin) 2011. The purposes of the plan are defined as:

- to define availability of water in the plan area;
- to provide a framework for sustainably managing water and the taking of water;
- to identify priorities and mechanisms for dealing with future water requirements;
- to provide a framework for establishing water allocations;
- to provide a framework for reversing, where practicable, degradation of natural ecosystems;
- to regulate the taking of overland flow water; and

- to regulate the taking of groundwater.

The plan defines the following surface water performance indicators and objectives:

- Environmental flow objectives (EFOs); which define the flow conditions which must be maintained at defined management nodes in the Fitzroy Basin. Environmental flow objectives are defined for a range of conditions including flow volume, flow duration, seasonal base flow, medium to high flow and first post-winter flow events.
- Water allocation security objectives (WASOs): which define the minimum-security requirements for both supplemented and un-supplemented water allocations for each of the water supply schemes within the basin.

The identified location nearest to the Project is the Water Plan (Fitzroy Basin) 2011 management node 2 which is the Dawson River at Beckers monitoring station. Node 2 is located on the Dawson River 16 km downstream from the MLA.

The Water Plan (Fitzroy Basin) 2011 also contributes to regulation of the taking of overland flow water and groundwater within the region. Under this Water Plan (Fitzroy Basin) 2011, the Proponent is required to take into consideration the groundwater and surface water available for extraction and usage by the Project, as well as ensuring any works/drainage features (that capture overland flow) meet the requirements of the plan.

9.7.7. Fitzroy Basin Resource Operations Plan 2014

The Fitzroy Basin Resource Operations Plan (ROP) 2014 (DNRM, 2015) is a document prepared to outline strategies for the implementation of the Water Plan (Fitzroy Basin) 2011. The Fitzroy Basin ROP regulates water allocations and licensing within the Fitzroy Basin. The ROP sub-divides the Fitzroy Basin into water management zones. The Project is located within the Dawson Valley Water Management Area.

9.7.8. Dawson Valley Water Supply Scheme

The Dawson Valley Water Supply Scheme (WSS) is the infrastructure operations required to enable the Water Plan (Fitzroy Basin) 2011. Bulk water storages and supplemented allocations are managed by SunWater and the irrigation channels are managed by Theodore Water. The Dawson Valley WSS supplies the following:

- Irrigation water for agriculture including cotton, fodder, cereal and horticultural crops.
- Urban water supply for:
    - Theodore;
    - Moura;
    - Baralaba;
    - Duaringa; and
    - Woorabinda.
- Industrial water supply primarily for mining.

9.7.9. *Fisheries Act 1994*

The main purpose of the *Fisheries Act 1994* is to provide for the use, conservation and enhancement of the community's fisheries resources and fish habitats in a way that seeks to apply and balance and the principles of ESD and promote ESD. The *Fisheries Act 1994* provides for:

- the management and protection of fish habitats;
- the management of commercial, recreational and Indigenous fishing; and

- the management of aquaculture.

Fisheries resources, including declared fish habitat areas which are MSES, contribute to the environmental values of waterways and wetlands.

The Project has the potential to impact on fisheries resources and habitats. Several minor waterways and drainage lines are present and flow through the Project area, as tributaries of one main unnamed waterway. The waterways within MLA 700057 do not connect to any important breading, feeding or refuge areas and fish passage is currently very limited due to their ephemeral nature.

9.8 Surface water

The Project is subject to the controlling provision 'a water resource, in relation to coal seam gas development and large coal mining development'. This section assesses Project impacts to water resources according to the 'Significant Impact Guidelines 1.3' (DoE 2013).

9.8.1. Water management system

A water management system will be implemented to manage water for the Project. This section outlines the water types, objectives of the system, the proposed infrastructure to manage water, the water balance, site water requirements, water supply, and the controlled release strategy.

9.8.1.1 Water management system objectives

The proposed water management system will manage separation of the following water types:

- Mine-affected water—defined as water that has interacted with mining activities and is consistent with the mine-affected water definition from the 'Queensland Model Mining Conditions' (DES, 2017). This includes water runoff and groundwater collected within the mining pit, recycled water from the coal wash plant, runoff from the mine infrastructure area (MIA) and excess water in the tailings drying cells.
- Sediment Water—rainfall and runoff generated by disturbed landforms including the WRE, pre-cleared areas and rehabilitation that is not yet established. This water does not contain elevated water quality parameters other than suspended solids and must be treated through the erosion and sediment control system.
- Clean Water—runoff from undisturbed or established rehabilitation areas that has not come into contact with disturbed land or active mining areas.
- Raw Water—untreated water supplied from an external water supply.
- Potable Water—treated water suitable for human consumption.

The water management system for the Project has been designed to minimise environmental impacts on the receiving environment, as well as provide runoff containment and supply to water demands of the Project.

The objectives of the Water Management System are to:

- minimise capture of clean surface water from external catchments via catchment diversion;
- prioritise recycling and reuse of mine-affected water first, ahead of other water sources for site demands including processing and dust suppression;
- preferential supply from site water storages over external supply and surface water harvesting;
- minimise and manage releases of water to receiving waterways; and
- prevent uncontrolled release of mine-affected water to receiving waterways in > 95% of years.

9.8.1.2 Strategy

The proposed water management strategy is to:

- divert clean catchment around mine infrastructure and disturbed land through the use of diversion drains and pumping from upstream clean storages;
- contain mine-affected runoff in dedicated storages for reuse in the Project;
- capture and treat disturbed runoff in sediment basins and other sediment control infrastructure before it leaves the site;
- minimise external catchment runoff reporting to the mining pit;
- preferentially reuse mine-affected water and sediment runoff captured within the ML to supply operational water demands (dust suppression and CHPP demands); and
- progressively rehabilitate/stabilise WREs and mine infrastructure areas to reduce the generation of sediment runoff.

9.8.1.3 Water management infrastructure

The Water Management System will use water management infrastructure to separate water types using mine-affected water dams, sediment dams, clean water dams and diversion drains.

Mine water dams

Mine water dams will be used to manage ‘mine-affected water’. Mine water storages will be used to contain surface water runoff and groundwater collected within the mining pit, recycled water from the CHPP, runoff from the MIA area and excess water in the tailings drying cells.

Mine-affected water storages have been designed to provide 95th percentile wet season containment as per the outcome of the preliminary consequence category assessment, ‘Significant’ (Appendix A, Surface Water Impact Assessment). Mine water storages are not located within the 0.1% AEP flood extent.

Water collected in the pits from rainfall events and groundwater ingress will be dewatered to the MWD. The MWD will be preferentially utilised to supply the CHPP and dust suppression demands. The water management strategy includes controlled releases of excess water. Controlled releases will occur from the MWD only when streamflow conditions in the receiving waterways conforms to nominated thresholds and site water inventories require reduction to maintain safe levels.

The environmental water dam (Enviro Dam) has been designed to provide wet weather containment for runoff from the MIA. Water will be transferred between the Enviro Dam and the MWD to maintain containment capacity and to provide additional supply storage for the CHPP.

Overflow pathways for dams are shown on Figure 9.29.

Sediment dams

Sediment dams will be used to collect ‘sediment water’, that is rainfall and runoff generated by disturbed landforms including: waste rock; pre-cleared areas; and rehabilitated areas, that are not yet established. Sediment dams are required to ensure runoff from overburden and disturbed areas containing elevated concentrations of solids, is contained prior to overflows entering the receiving environment during rainfall events. Sediment dams form a key part of the erosion and sediment control management practices for the Project and will be managed to ensure settling volumes are reinstated prior to the next rainfall event.

Sediment dams are proposed to capture runoff from disturbed areas including access roads, unrehabilitated spoil and cleared land. Sediment dams for the Project are sized in accordance with the International Erosion Control Association Guidelines methodology for “Type D” sediment basins (IECA,2018). “Type D” sediment basins were selected as the high maintenance requirements of “Type A” and “Type B” (flow through chemical flocculation basins) are not practical in a mining operation and “Type C” basins are not suitable for dispersive or clayey soil types. The “Type D” sediment basins are designed to operate on a 5-day cycle, that being filling from a storm event and then dewatering prior to the next storm event within a 5-day period. The basins are designed to contain a nominated 5-day storm rainfall depth based on the catchment conditions (soil types) and the receiving environment. High flows are directed through the basins allowing coarse sediments to settle out in high flow events. The basins can also treat small to medium flow events at a very high efficiency.

The sediment basin’s total volume was sized to allow for a settling zone volume to contain a five-day, 85th percentile rainfall event and a sediment storage zone volume equal to 50% of the settling volume. The 85th percentile standard was adopted, which is required for a sediment basin with a design life greater than six months and for discharging to sensitive receiving waters. Volumetric runoff coefficients adopted for the basin sizing were based on expected soil types encountered at the site (clay materials). The inputs used in the sizing of the sediment dams for the Project are summarised in Appendix A, Surface Water Impact Assessment.

The sediment dams have been placed at regular frequencies to reduce the dam sizes and allow simpler access for desilting and maintenance activities (compared to a single consolidated storage). Sediment dam locations are based on topographical low points. Sediment dams are generally required around the out-of-pit spoil dump to treat sediment-laden runoff before discharging off-site.

Sediment dams will include pumping infrastructure to dewater the settling zone storage volume within a maximum 5 day period. Dewatering will allow their continued effectiveness and availability to treat sediment-affected runoff in successive storm events. Sediment dam water will be transferred to the mine water system to maximise water reuse in the Project area for water demands and minimise using raw water. This will provide additional water supply for processing and dust suppression demands, hence reducing reliance on the water allocations.

The design of sediment dams is based on the expected geochemistry of waste material. Ongoing water quality monitoring during operations will be required to confirm contained runoff does not include other contaminants and require alternative management strategies.

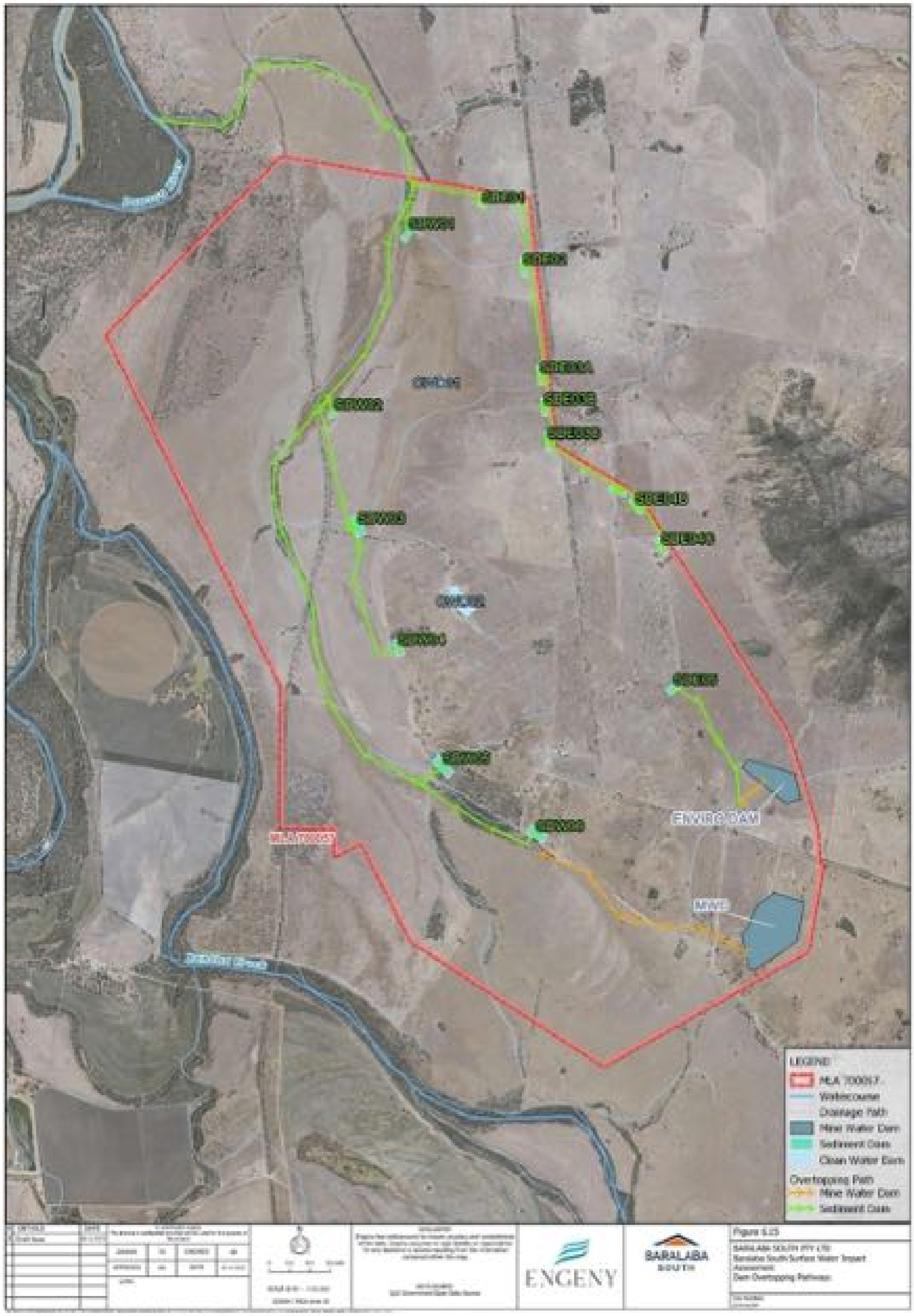

Figure 9.29: Overflow pathways for water management infrastructure

Clean water management

Clean water dams will be utilised to manage 'clean water', that is natural rainfall and runoff from undisturbed or established rehabilitation. Clean water is water that has not come into contact with disturbed land or active mining areas. Clean water dams have been designed to contain a nominal 2-year, 24-hour runoff volume. Pump rates have been proposed to enable 20-day dewatering.

Diversion of clean catchment has been maximised to reduce the harvesting of clean catchment into the mine water system. Where topography allows, clean water will be diverted via drainage features connecting the upstream clean catchment with the receiving waterways. Where a diversion drain is not feasible, the clean catchment will be diverted using clean water dams equipped with a pumped release to the Dawson River. Water quality in the clean water dams is expected to meet water quality objectives allowing for release into the Dawson River.

There are two clean catchment diversions proposed on the eastern side of the Project area, which will redirect runoff from Mount Ramsay around the Project. A third clean water drain will divert a stream order 3 waterway (Tributary 8) around the proposed out-of-pit dump to ensure the drainage path is not impacted by the Project.

Clean water storages are proposed to be mostly excavated storages and will not have permanent water retaining embankments.

Water release/extraction infrastructure

A high-capacity pump and pipeline will be used to release water from the MWD to the Dawson River. The outlet pipe will extend over and beyond the bank of the Dawson River to minimise the risk of erosion. The position of the pipeline and release point have been located to minimise potential impacts to environmental values and are shown on Figure 9.30. The pipeline will be located within a 10 m corridor that will also be used for maintenance and access.

The pipeline will be predominantly above ground to the Dawson River. Ground supports will be used to raise the pipeline above the natural surface level on the floodplain so that overland flow is not obstructed.

Water extraction infrastructure will include a pump and above ground poly pipe to extract and transfer water from the Dawson River to the MWD. The water supply pipeline is proposed to be located adjacent to the water release pipeline shown on Figure 9.30.

9.8.1.4 Surface water modelling

To assess surface water impacts, an operational water balance model was developed by Engeny Water Management (Appendix A, Surface Water Impact Assessment) using GoldSim modelling software. The model represents the proposed Project water management system and surrounding waterways and has been used to assess the performance of the following water management system elements:

- containment performance of key water storages;
- pit inundation frequency, volume and period;
- supply demands and shortfalls;
- external supply requirements;
- mine water releases; and
- changes to streamflow regime in surrounding waterways.

A schematic of the water management system is provided in Figure 9.31. The water balance model incorporates the transfer rates and destinations of the schematic. The water management system operation is outlined in Table 9.7.

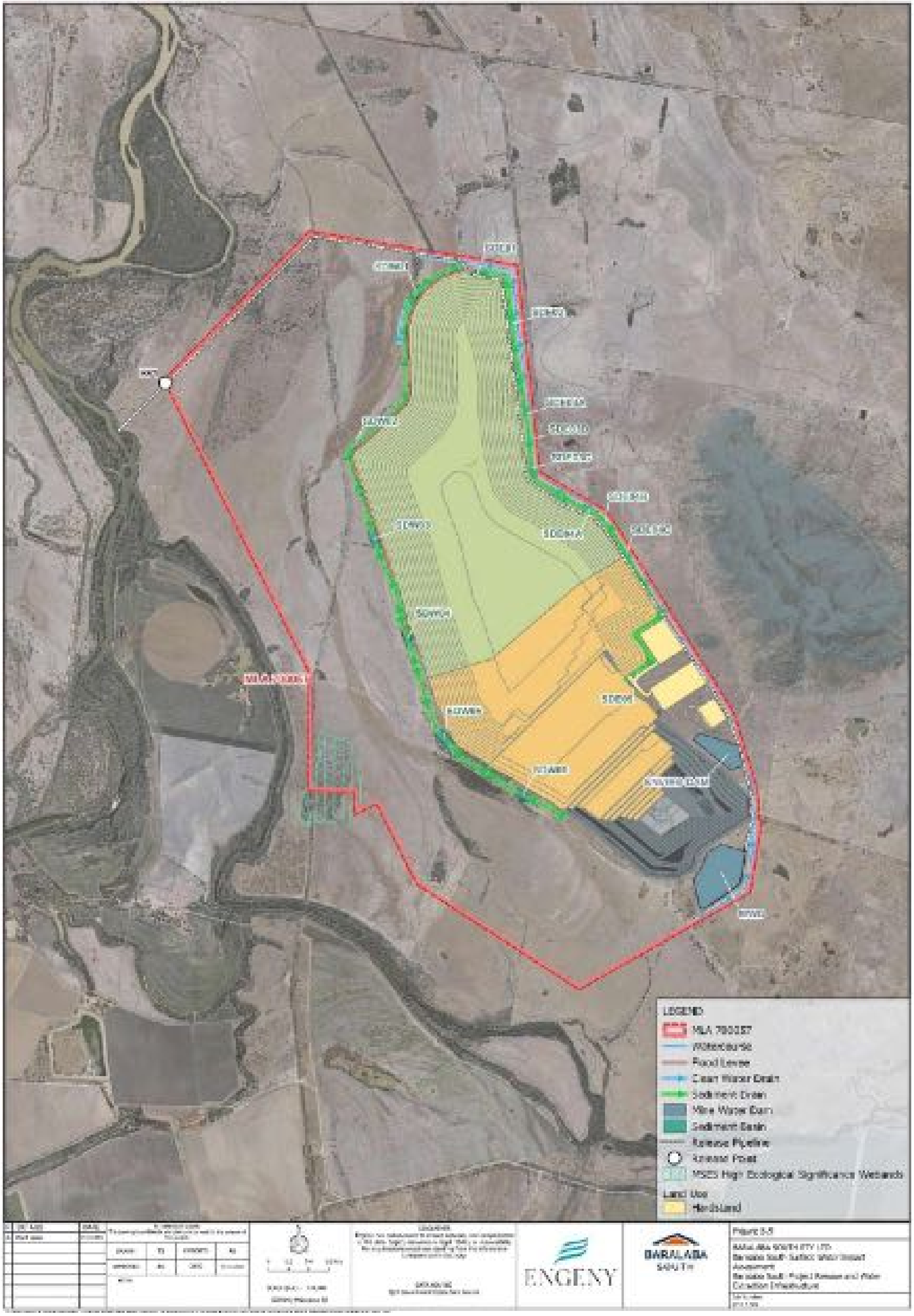

Figure 9.30: Proposed release and extraction pipeline

Table 9.7: Water management system operation of storages

Storage	Full Supply Volume (ML)	Maximum operating volume (ML)	Pump rate (L/S)	Pump destination	Years active
Pit	173,000 [1]		400	MWD	1-23
MWD	1,220	1,000	500	Release	1-23
			150	Enviro Dam	
ENVIRO DAM	420	350	153	CHPP	1-23
SDW01	26.3	25	40	MWD	1-23
SDW02	9.3	9	14	MWD	3-23
SDW03	28.6	27	44	MWD	3-23
SDW04	14.7	14	23	MWD	6-23
SDW05	27.9	27	43	MWD	11-23
SDW06	20.7	20	32	MWD	23
SDE01	2.8	2.7	4	MWD	1-23
SDE02	9.6	9	15	MWD	1-23
SDE03A	8.5	8	13	MWD	3-23
SDE03B	9.7	9	15	MWD	6-23
SDE03C	9.8	9	15	MWD	6-23
SDE04A	9.4	9	15	MWD	6-23
SDE04B	9.4	9	14	MWD	6-23
SDE04C	9.8	9	15	MWD	6-23
SDE05	15.9	15	25	MWD	11-23
SDY01_01	4.9	4.6	8	MWD	1-3
CWD1	88	84	193	Dawson River	1-3
CWD2	32	31	71	Dawson River	1-3

[1] Pit storage volume varies.
[2] Sediment Dam volume includes sediment storage volume and settling zone volume.

The various model input parameters (e.g. climate inputs, catchment conditions, groundwater ingress and quality) are detailed below and in Appendix A (Surface Water Impact Assessment). The model was run with a daily timestep for a period of 23 years, representing the operational life of the mine. The model stepped through 111 realisations of 23-year sequences of the 111 years of available climate data for the mine site thereby providing a probabilistic simulation of Water Management System performance.

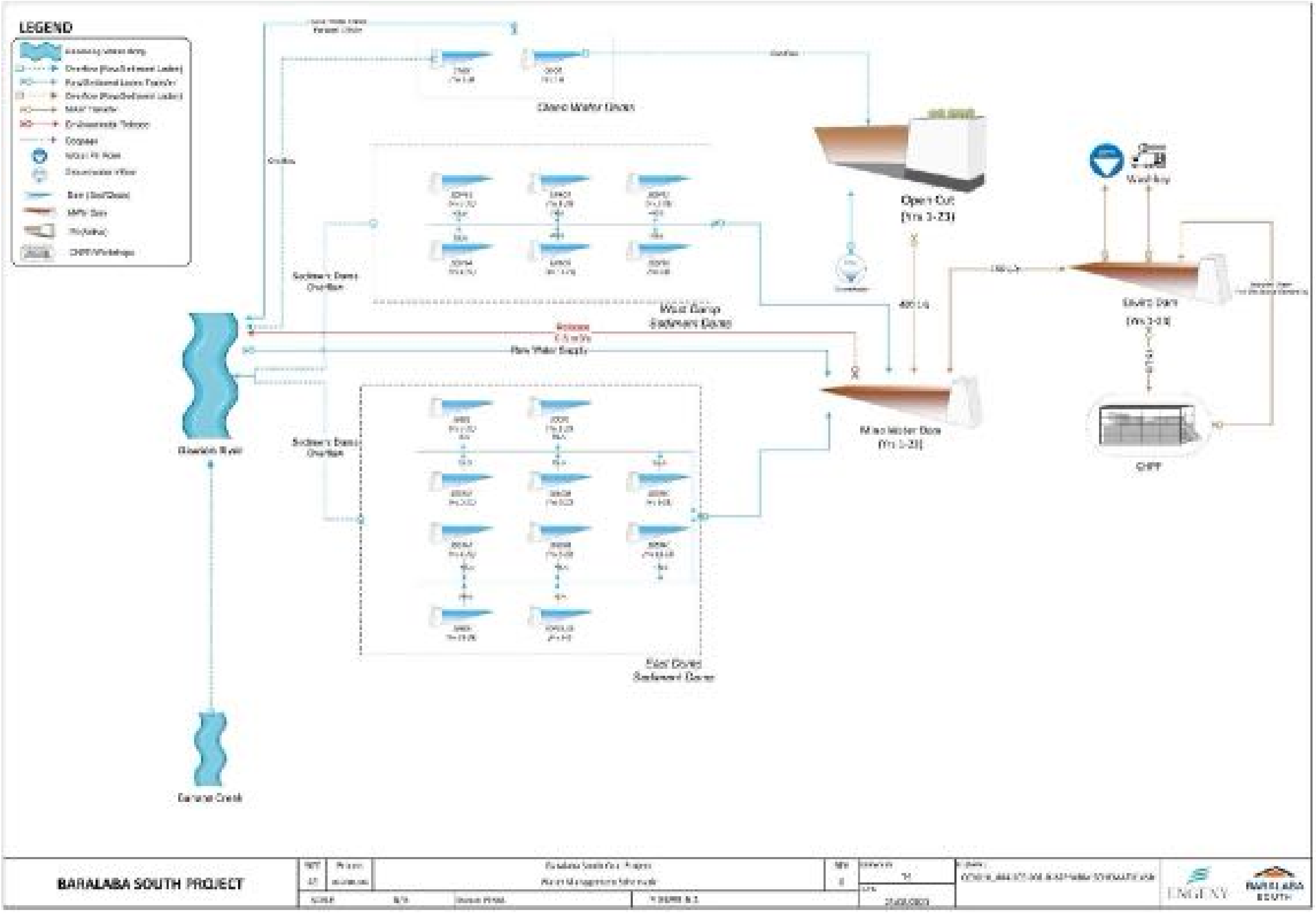

Figure 9.31: *Water management schematic*

Climate inputs

Climate data inputs of rainfall and evaporation for the water balance model were sourced from both BOM rainfall stations and SILO Data Drill. A 129-year data set was used to allow continuous simulation of scenarios. Monthly average rainfall, lake evaporation and evapotranspiration for the Project are summarised in Table 9.8.

Table 9.8: Monthly average climate data

Month	Rainfall (mm)	Lake evaporation (mm)	Evapotranspiration (mm)
January	103	204	200
February	108	171	168
March	75	168	166
April	41	131	130
May	36	98	98
June	37	76	76
July	29	85	85
August	22	113	112
September	27	146	144
October	52	184	180
November	71	197	192
December	99	212	207
Total	**700**	**1,785**	**1,758**

Catchment runoff

The GoldSim model uses the Australian Water Balance Model to simulate catchment runoff for the Project. The Australian Water Balance Model uses three surface stores to simulate partial areas of runoff in the catchment. The water balance of each surface store is calculated independently of each other at daily time steps. At each time step, rainfall is added to each of the three surface stores and evapotranspiration is subtracted from each store. If the value of water in the store exceeds the capacity of the store, the excess water becomes runoff. The model has a base flow component where part of this runoff becomes recharge of the base flow store (if there is a base flow component to the stream flow).

The adopted Australian Water Balance Model parameters were sourced from the Baralaba Central Mine water balance model calibrated in 2013 and have been continually validated as part of the Baralaba North Mine Water Management Plan annual updates.

The Baralaba South water balance model includes a contaminant transport model to simulate water quality (salinity) in site storages. Salinity generation rates for the assigned land use types were adopted from modelling of the Baralaba North Mine (WRM, 2013). These rates were validated using recorded water quality in existing storages at the Baralaba North Mine. The adopted salinity for the WRE land use (1,000 mg/L) is higher than the expected salinity of 338 mg/L determined from geochemical analysis of potential waste rock materials, which provides a conservative approach to estimating mine water storage salinity and impacts from releases.

A salinity of 3 mg/L was adopted for direct rainfall to storages (DERM, 1997). A varying streamflow and electrical conductivity relationship have been developed for the Dawson River for the purpose of estimating release opportunity.

Catchments

Catchment boundaries were defined for all storages across the life of mine using mine and dump planning GIS layers and the results from the LiDAR survey of existing topography undertaken on the 25 March 2011. Assumptions to model catchment areas included:

- finalised WRE areas are rehabilitated within three years of being completed;
- rehabilitation has a five-year establishment period; and
- rehabilitated catchments will require erosion and sediment control until rehabilitation is established.

A summary of adopted catchment areas and land use for each modelled stage is provided in Appendix A, Surface Water Impact Assessment.

Groundwater

Groundwater ingress to the open cut pit was modelled and provided as an input to the water balance model (Appendix B, Groundwater Modelling and Assessment). Groundwater ingress is variable, based on the location and geometry of the pit, and was input into the water balance model as a time series (to align with the mine plan). The groundwater ingress rates provided by Watershed HydroGeo were reduced by 10% to account for evaporation losses of the pit walls. The average pumpable groundwater ingress for the operational period of the mine plan is 0.37 ML/day (0.41ML/day total ingress).

The total groundwater ingress is attributed to several sources including:

- waste rock seepage (20%);
- weathered and interburden (45%);
- coal measures (28%); and
- alluvium (colluvium) (8%).

Groundwater inflow electrical conductivity was informed from the measured groundwater inflows from alluvium, coal measures, weathered and interburden reported in Appendix B, Groundwater Modelling and Assessment and the results from the geochemical assessment of waste rock (Appendix E, Geochemical Assessment). The following water quality parameters were adopted for the water balance model:

- average 16,750 mg/L TDS for groundwater inflow from the alluvium, coal measures and weathered and interburden inflows; and
- average 338 mg/L TDS for inflow from waste rock seepage.

Dawson River flow

The Dawson River streamflow used to assess mine water release opportunity and impact has been adopted from the Dawson Callide Sub-catchment Integrated Quantity and Quality Model (IQQM) developed for the Water Plan (Fitzroy Basin) 2011. The streamflow series from the Dawson River IQQM was available at the Dawson River at Beckers (130322A) gauging station location for the period 1889 to 2007. The streamflow series was extended to 2019 using data from the streamflow gauging station to match the adopted climate data period.

Dawson River water quality

A varying flow and electrical conductivity relationship for the Dawson River was used to model mine water release opportunity and impacts in accordance with the proposed mine water release conditions. The flow: EC relationship was developed by fitting an average relationship to the continuous monitoring data from the Dawson River at Beckers gauging station (130322A).

Mine water releases

To prevent mine water accumulating on site and minimise the risk of uncontrolled mine water releases to the receiving environment, mine water is proposed to be released at appropriate conditions and rates.

Mine water releases have been modelled to occur from the MWD. Mine water will be released via a pumped transfer arrangement at a maximum rate of up to 500 L/s, around the northern extent of the MLA area directly to the Dawson River. Mine water releases were modelled in accordance with the approach outlined in condition F11 of the 'Guideline: model mining conditions' (DES, 2017a) and 'Guideline: Model Water Conditions for Coal Mines in the Fitzroy Basin' (DES, 2013). The model uses IQQM streamflow data for the Dawson River and water quality streamflow relationships developed from the Becker's Streamflow gauge to determine the release opportunity and potential release volume. The predicted model water quality for the release dam is used to assess the release potential.

Streamflow assessment

The approved IQQM developed hydrology model for the Water Plan (Fitzroy Basin) 2011 was updated to include:

- The Project's catchment reduction of 966 ha (0.024% of catchment reporting to Beckers gauging station).
- Groundwater drawdown reduction to Dawson River baseflow of 0.1 ML/day (<0.01% of flow).

The IQQM model was then used to assess a reduction in Dawson River streamflow volumes and flow duration at the Project location and at the Beckers gauging station, and compliance against the EFOs and WASOs in the Water Plan (Fitzroy Basin) 2011. The IQQM includes the proposed Nathan Dam project, and all assessments represent cumulative impacts including this project.

Final void assessment

The mine plan for the Project will result in the south-eastern mining pit remaining as a residual void. The final void model hydrology was modified from the water balance model to address final void inflows (catchment runoff, direct rainfall and groundwater inflows) and final void outflows (evaporation) described as follows:

- Catchment runoff inflows to the final void waterbody are estimated from 103 ha of rehabilitation land use and 118 ha of final void land use areas, based on the associated Australian Water Balance Model parameters. Adopted TDS generation rate for rehabilitation and final void catchment runoff is 230 mg/L and 1,000 mg/L, respectively.
- Direct rainfall on the final void surface area is calculated from daily rainfall applied to the surface area of the final void which is dynamically calculated each daily timestep using the stage storage relationship described in section 9.8.1.4
- Groundwater inflows calculated based on the final void level groundwater inflow relationship described in section 9.8.1.4.
- Evaporation from the final void waterbody surface area is calculated from daily Moreton's Lake Evaporation time series extracted from the SILO Data Drill at the Project location. An evaporation reduction factor of 20% was applied to account for shading and reduced windspeed from the pit walls.

The Project final void arrangement is shown on Figure 9.32.

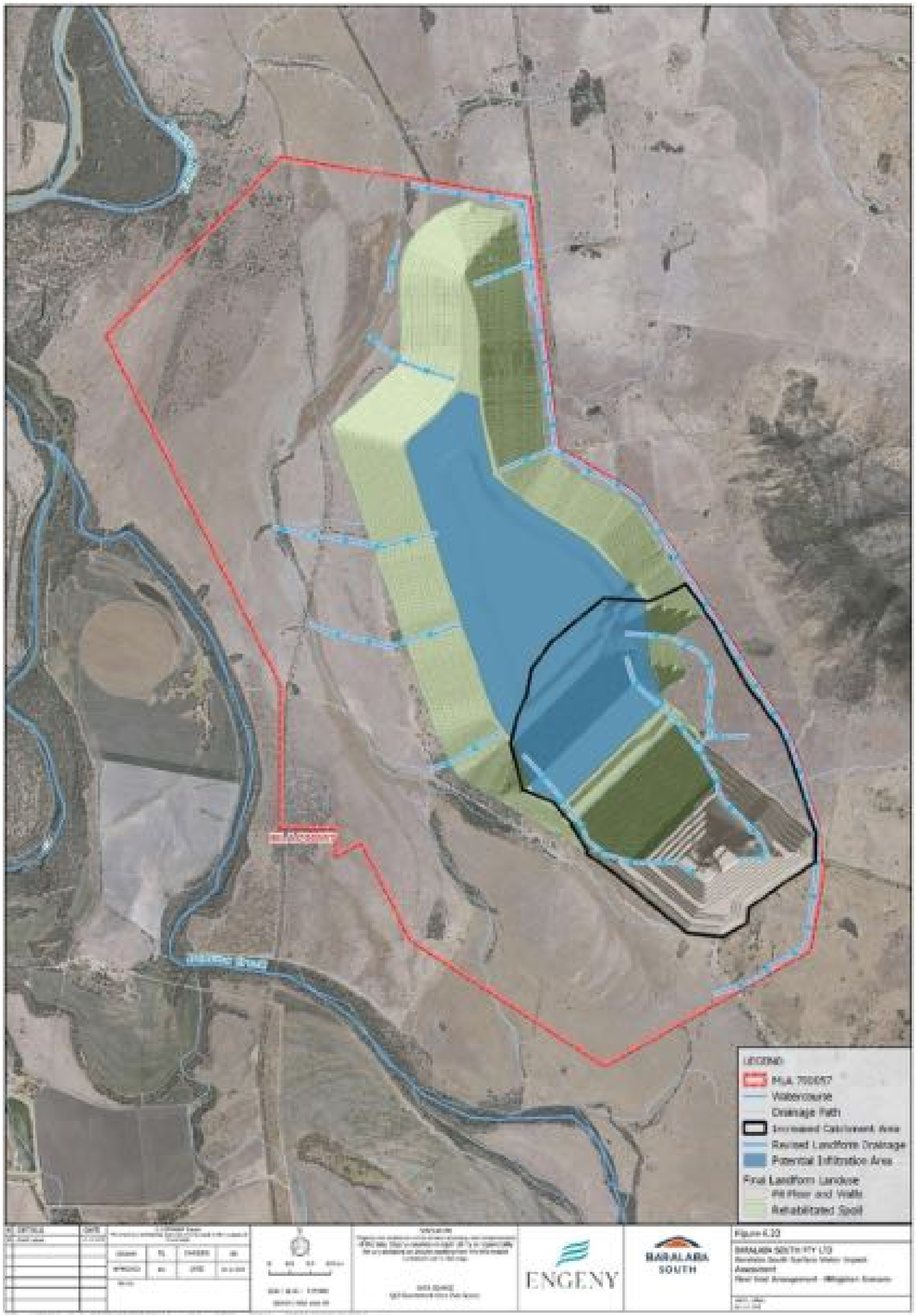

Figure 9.32: *Final void arrangement*

Improved catchment inflow measures

Diverting clean catchment into the final void will dilute groundwater inflows and slow the evapo-concentration process of the final void. It is proposed as an option to improve the water quality of the final void. The proposed measures include:

- Redirecting an additional 200 ha of rehabilitation to the pit lake to increase clean runoff volumes; and
- Modifying surface drainage on the final landform in-pit dump to increase rainfall infiltration and seepage through the backfilled spoil to the pit lake.

Groundwater inflow

A groundwater recovery curve for the final void waterbody was developed by Watershed HydroGeo using the regional groundwater model (Appendix B, Groundwater Modelling and Assessment). Groundwater inflow to the final void will consist of flows from the remaining coal measures, weathered and interburden material, alluvium, and waste rock seepage from the backfilled pit. Figure 9.39 shows the relationship between final void water level and groundwater inflow for the final void and the contribution breakdown of the multiple inflow sources. The groundwater recovery to the final void steadily decreases as the pit lake rises in level. The groundwater inflow relationship breakdown shows that at lower lake elevations (below -150m AHD), spoil seepage makes up less than 20% of the groundwater inflow, however, at higher lake elevations (above -25 mAHD) spoil seepage makes up over 70%, and the remainder is sourced from true groundwater.

An average TDS concentration of 16,750 mg/L has been adopted for the alluvium, coal measures and weathered and interburden inflows and a TDS concentration of 338 mg/L for the spoil seepage inflows.

A summary of the groundwater recovery inflows for varying final void water levels, percentage inflow contribution and TDS adopted for the final void hydrology model is presented in Table 6.11 of Appendix A, Surface Water Impact Assessment.

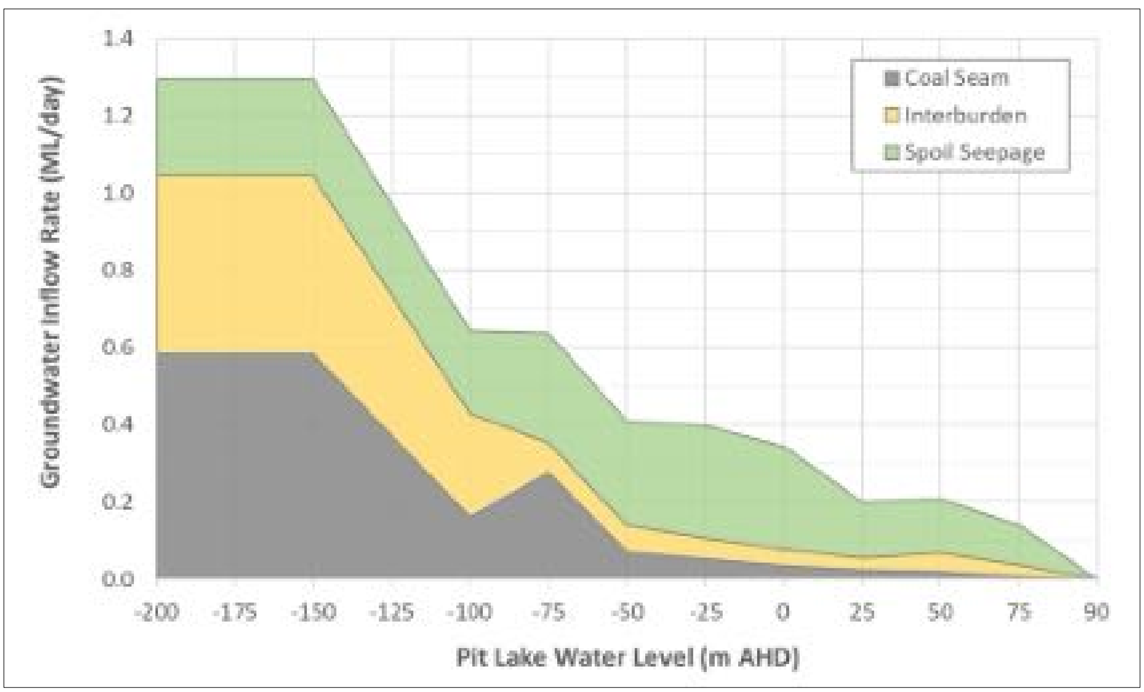

Figure 9.33: Final void groundwater recovery relationship

Climate change sensitivity assessment

A climate change sensitivity assessment was undertaken to determine the impact of climate change on the predicted impacts. The model climate data inputs were adjusted using the methodologies outlined in 'Climate Change in Australia Technical Report' (CSIRO, 2015) to undertake the sensitivity assessment. Climate projections for 'Best' and 'Worst' case scenarios and 'Maximum Consensus' were used to assess climate change scenarios on the water balance model and final void outcomes, where:

- Best Case scenario— has lower rainfall and higher evaporation, reducing rainfall runoff resulting in reduced spills from storages and reduced mine water release.
- Worst Case scenario— has higher rainfall and lower evaporation, increasing rainfall runoff resulting in increased spills from storages and increased mine water releases.
- Maximum Consensus— is the climate future projected by at least 33% of climate models and comprises at least 10% more models than any other scenario and is considered the most representative forecast of all the climate models.

9.8.1.5 Water management system performance

The average annual water balance indicates the interaction between the mine plan and the water demands and supply. The key outcomes from the average annual water balance include the following:

- Rainfall and runoff are highest during Years 11-19 when the total site catchment is at its largest.
- Runoff and groundwater account for on average 60% and 13%, respectively, of total water inflows to the system.
- Mine water releases increase slightly during the later years of the mine life due to lower water demands and increased groundwater inflows.
- Raw water extracted between mine Years 1 to 19 accounts for on average 31% of the total water inflows to the system.
- Dust suppression demand is the largest outflow from the system, accounting for an average 41% of total outflows.
- Dust suppression remains constant until year 14, reaching its peak in year 6.
- Lower CHPP demands are observed in year 1 and year 23. The mine years in between remain constant over the Project duration.
- Mine water releases account for an average 14% of the total water outflows from the system.

The Project average annual water balance (inflows and outflows) for the modelled mine plan stages have been summarised in Table 9.9.

Table 9.9: Average annual water balance (ML/year)

Inflow/Outflow	Year 1	Year 3	Year 6	Year 11	Year 14	Year 19	Year 23
Rainfall	66	59	82	95	112	104	131
Rainfall runoff to mine water and sediment dams	306	359	598	706	750	689	575
Groundwater inflow to mining pit	105	53	174	112	161	102	246
Clean Water Dam Overflow to Mine Water System	8	1	0	0	0	0	0
Raw Water Intake	312	559	388	282	203	247	4
Total Inflows	**797**	**1,031**	**1,243**	**1,195**	**1,226**	**1,143**	**955**
Evaporation	153	138	181	203	229	210	282
Dust Suppression	572	567	607	496	434	378	100
CHPP Water Use	186	315	347	338	336	324	118
Mine-affected water release (via release structure)	20	15	60	98	135	90	122
Sediment Dam Overflow	2	2	30	77	96	118	129
Total Outflows	**933**	**1,037**	**1,225**	**1,213**	**1,231**	**1,119**	**751**
Change	**-136**	**-6**	**17**	**-18**	**-4**	**24**	**205**

9.8.1.6 Water demand

Site water demands have been calculated for processing coal, dust suppression, potable water and sewage treatment. They have been incorporated into the operational water balance model. Annual water demands are provided in detail Appendix A, Surface Water Impact Assessment and are summarised as:

- The CHPP will require a reliable supply of water ranging between 107 ML/yr (year 23) to 381 ML/yr (Year 8).
- Dust suppression is required on all trafficked, unsealed roads in the absence of adequate rainfall. Dust suppression demands for trafficked, unsealed roads for the Project are estimated between 111 ML/yr (Years 23) to 669 ML/yr (Year 6).
- Other water demands anticipated for the Project include potable water (70kL/week), water for wash downs 30 kL/day.

The external raw water supply requirement to meet Project water demands in 95% of years is typically 600 to 700 ML/year, with a peak requirement of 881 ML in Year 3. Median annual raw water supply volumes are significantly smaller than the maximum requirement (typically less than 300 ML/year after Year 7).

9.8.1.7 Water supply

Water demands for the Project will be supplied according to the following priority (excluding potable water supplies):

1) Mine water supplied from pit dewatering (including groundwater inflows).
2) Recycled process water recovered from the CHPP tailings thickener and belt press filters.
3) Surface runoff water captured and stored in the Project water dams.
4) Water supply 'make-up' sourced from water allocations from the Dawson Valley WSS. Related entities of the Proponent currently hold over 1,418 ML water allocation from the Fitzroy Basin, Dawson River Zones C/D, and 315ML of water licences from the Broadmeadow properties.

Mine-affected water will be captured within the Water Management System and pumped to key water supply dams on site, which will then be preferentially utilised for dust suppression and process demands. Captured water will be used in preference to any external allocation.

External supply of water to the mine is expected where demand of the net site water balance exceeds inputs from rainfall runoff and groundwater. Medium reliability water allocations in the Dawson Valley WSS have a monthly supplemented water sharing index of at least 82%. Water allocations can be assumed to be fully supplied in 82% of months (Water Plan (Fitzroy Basin) 2011). Accessing the Project water allocation will not impact other existing licence holders as water allocations are existing entitlements (i.e. no new water entitlements are being sought for the Project).

9.8.1.8 Controlled release

Controlled releases of mine-affected water will be used in the water management system to manage stored site inventories. Mine-affected water releases from the Project will be pumped releases from storages used to contain water that has come into contact with mining or processing activities (MWD or Enviro Dam).

Mine-affected water release opportunities have been assessed in accordance with the 'Model Mining Conditions' (DES, 2017a) and the 'Model Water Conditions for Coal Mines in the Fitzroy Basin' (DES, 2013) (Appendix A, Surface Water Impact Assessment). The proposed mine water release conditions dictate natural flow conditions when releases can occur and the allowable maximum release rates and water quality. The release conditions have been designed to ensure release flows are significantly diluted with natural flows in the Dawson River to ensure downstream water quality will not exceed the receiving waterway water quality limits. The proposed release conditions are governed by salinity (measured as EC), which is the key of concern surface water quality parameter associated with the Project.

The proposed release opportunities are governed by the following conditions:

- High flow conditions in the Dawson River—high flow conditions River (measured at the confluence of Dawson River and Banana Creek) occurs when discharge is greater than 100 m^3/s.
- Maximum allowable release rate—maximum release rate of 0.5 m^3/s to provide a minimum 1:200 dilution with natural flows (for a natural flow condition in the Dawson River of 100 m^3/s).
- End-of-pipe water quality is lower than the defined end-of-pipe limit—the end of pipe limit is defined as 10,000 µS/cm.
- EC at the downstream monitoring locations is maintained at lower than 500 µS/cm and between pH 6.5 and pH 9.0.

Mine water release can occur at a maximum rate of 0.5 m^3/s when flow in the Dawson River is above the minimum flow threshold of 100 m^3/s, and the release storage water quality characteristics are less than the end of pipe limits of 10,000 µS/cm. End of pipe water quality is defined as the quality of the water being released at the point of discharge into the Dawson River. The maximum release rate and end of pipe limits provide a minimum 1:200 dilution ratio ensuring the water quality characteristics at the downstream monitoring point do not exceed the receiving waterway release limits.

The receiving waterway release limits have considered the Baralaba North Mine EA, the water quality objectives for the receiving waters and historical Dawson River water quality.

The mine water release strategy is summarised Table 9.10, Table 9.11 and Table 9.12. The release point will be the release pipeline, where it intersects the MLA boundary, presented in Figure 9.30. Details of the expected volume, duration and impact of controlled water releases is discussed in section 9.8.4.1.

Table 9.10: End-of-pipe mine-affected water release limits

Quality characteristic	End-of-pipe release limits	Monitoring frequency
Electrical Conductivity (µS/cm)	10,0000 µS/cm	Daily during release (the first sample must be taken within two hours of commencement of release)
pH (pH units)	6.5 (min)–9.0 (max)	

Table 9.11: Release point conditions

Receiving water description	Release point	Gauging station	Easting (GDA94)	Northing (GDA94)	Minimum flow in receiving water way for release event	Maximum release rate	Flow recording frequency
Dawson River	RP1	Dawson River at Banana Creek Confluence	149.822	–24.0873	100 m^3/s	0.5 m^3/s	Daily

Table 9.12: Receiving waterway release limits

Quality characteristic	Release limits	Monitoring frequency
Electrical Conductivity (µS/cm)	500 µS/cm	Daily during release (the first sample must be taken within two hours of commencement of release)
pH (pH units)	6.5 (min)–9.0 (max)	

9.8.2. Surface water environment

9.8.2.1 Local surface water values

The Project is located within the Lower Dawson River Sub-basin—WQ1309 (Lower Dawson Main Channel—Regulated Reaches). Environmental values for these areas are nominated broadly in the ‘Environmental Protection (Water and Wetland Biodiversity) Policy 2019’, ‘Dawson River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Dawson River Sub-basin except the Callide Creek Catchment’ (DEHP, 2011).

A summary of the relevant environmental values is presented in Table 9.13 and the environmental values are discussed further in Appendix A, Surface Water Impact Assessment.

Environmental flow objectives for the Project are provided in section 9.8.2.2.

Table 9.13: Environmental values—surface waters relevant to the Project

Environment value	**EPP Water and Wetlands [Schedule 1]**
	Surface waters
	Lower Dawson River Sub-Basin—WQ1309
	Lower Dawson Main Channel—regulated reaches
Aquatic ecosystem	✓
Irrigation	✓
Farm supply	✓
Stock water	✓
Aquaculture	✓
Human consumer	✓
Primary recreation	✓
Secondary recreation	✓
Visual recreation	✓
Drinking water	✓
Industrial use	✓
Cultural and Spiritual Values	✓

9.8.2.2 Environmental flow objectives

The Water Plan (Fitzroy Basin) 2011 outlines the minimum EFOs for various flow regimes in each season for the Dawson River. EFOs which define the flow durations and mean flows for a range of conditions, including seasonal base flow, medium to high flow and first post-winter flow events, are developed to sustain the natural ecosystem within the watercourse. The EFOs for the Dawson River at Beckers gauging station (Node 2) outlined in the Water Plan (Fitzroy Basin) 2011 are summarised in Table 9.14 to Table 9.17. The percentage of the total number of days in a water flow season in the simulation period that the base flow is equalled or exceeded should be between 0.8 and 1.2 times the percentage stated for the water flow season.

Table 9.14: Base flow environmental flow objectives identified for the Project

Base flow (ML/d)	**January–April water flow season**	**May–August water flow season**	**September–December water flow season**
86	64%	27%	35%

Table 9.15: Annual medium to high environmental flow objectives identified for the Project

Environmental flow objective	Description	Value
Mean annual flow	Minimum simulation mean annual flow as a percentage of pre-development flow pattern.	> 65%
Median annual flow ratio	Minimum simulation median annual flow as a percentage of pre-development flow pattern.	>48%
Annual proportional flow deviation	Maximum annual proportional flow deviation.	<3.1
Mean wet season flow	Minimum simulation mean wet season flow as a percentage of pre-development flow pattern.	N/A

Table 9.16: Daily medium to high flow environmental flow objectives identified for the Project

	10% daily exceedance duration flow	4% daily exceedance duration flow	2-year daily flow volume	5-year daily flow volume	20-year daily flow volume
Simulation period minimum % of pre-development	>45%	>53%	>55%	>69%	>80%

Table 9.17: First post-winter flow environmental flow objectives identified for the Project

Environmental flow objective	Description	Value
Number of first post-winter flows	The number of first post-winter flow events in the simulation period, expressed as a percentage of the number of post-winter flow years in the period	>80%
Number of flows within five weeks of the pre-development	The number of five-week lag events in the simulation period, expressed as a percentage of the number of post-winter flow years in the period	>60%
Number of flows within two weeks of the pre-development	The number of two-week lag events in the simulation period, expressed as a percentage of the number of post-winter flow years in the period	>70%
Average flow volume	The average of the volume ratios for the post-winter flow years in the simulation period	N/A
Average peak flow	The average of the peak flow ratios for the post-winter flow years in the simulation period	>60%
Flow duration (2-times base flow)	The number of 2-times base flow events in the simulation period, expressed as a percentage of the number of post-winter flow years in the period	>60%
Flow duration (5-times base flow)	The number of 5-times base flow events in the simulation period, expressed as a percentage of the number of post-winter flow years in the period	>60%

9.8.2.3 Water quality objectives

Environmental values and WQOs for Queensland waters are prescribed in Schedule 1 of the 'Environmental Protection (Water and Wetland Biodiversity) Policy 2019'. WQOs are long-term goals for water quality management that protect environmental values.

WQOs for the receiving environment are shown in Table 9.18. Where multiple relevant environmental values specify different WQOs for the same parameter, the most conservative value has been adopted. The receiving environment water quality criteria approved under the Baralaba North Mine EA and the Dawson Mine EA are also shown in Table 9.18, providing a comparison of the identified regional WQOs against local approved water quality limits.

9.8.2.4 Regional hydrology

The Project is located in central Queensland within the Fitzroy Basin, a sub-basin of the greater North-East Coast Basin (Figure 9.8). The Fitzroy Basin has a total catchment area of 142,900 km^2 with the main tributary rivers being the Mackenzie River, Isaac River, Dawson River, and Comet River. The Fitzroy River is located within the Great Barrier Reef catchment and flows north-east, discharging into the Coral Sea, south-east of Rockhampton.

The Project is located near the confluence of Banana Creek and the Dawson River (Figure 9.13). The Dawson River is one of the major tributaries to the Fitzroy River and with a sub-basin catchment area of 50,800 km^2, it makes up 35% of the Fitzroy Basin catchment. The Dawson River headwaters rise within the Carnarvon Range and generally flow towards the north-east to the Fitzroy River before discharging into the Coral Sea near Rockhampton (approximately 380 km downstream of the Project area). Approximately 35 km downstream of the Project, the Dawson River confluences with the Don River, which has a catchment size equivalent to 25% of the Dawson River catchment area at the confluence.

Banana Creek is a 5th order watercourse that flows in a north-westerly direction from south of the Banana township towards the Project. Banana Creek flows into the Dawson River to the west of the MLA. The western and northern MLA boundaries lie roughly parallel to Banana Creek and the Dawson River respectively.

9.8.2.5 Local hydrology

Dawson River

The Dawson River is the most significant watercourse near to the Project, with a catchment of approximately 40,500 km^2 at the Baralaba township.

The Dawson River is a perennial watercourse that experiences consistent flows throughout the year due to inflow from groundwater sources along its length and is subject to seasonal flooding. Mean daily and annual flows in the Dawson River are approximately 2,790 ML and 1,020 GL respectively. The Dawson River typically experiences significant seasonal variations in high flows with flooding typically occurring during the wet season (October to April).

Table 9.18: Receiving environment WQOs and other local criteria for the Dawson River

Indicator	Environmental Value	Approved EA Receiving Water Criteria		EPP (water and wetland biodiversity) WQOs				
		Baralaba North	Dawson Mine	Aquatic ecosystems	Drinking water	Irrigation (long-term)	Irrigation (short-term)	Stock watering
pH	Drinking water	6.5–8.5	6.5–9	6.5–8.5	6.5–8.5	—	—	—
Conductivity (base flow)	Aquatic ecosystems	500 µS/cm	1,000 µS/cm	340 µS/cm	400 µS/cm	Variable based on soil type and crop. Minimum of 1,000 µS/cm.		Cattle: 2,500 µS/cm Sheep: 5,000 µS/cm
Conductivity (high flow)	Aquatic ecosystems			210 µS/cm				
Ammonia N	Aquatic ecosystems	900 µg/L		20 µg/L	—	—	—	—
Oxidised N	Aquatic ecosystems	—	—	60 µg/L	—	—	—	—
Organic N	Aquatic ecosystems	—	—	420 µg/L	—	—	—	—
Total nitrogen	Aquatic ecosystems	—	—	500 µg/L	—	—	—	—
Filterable reactive phosphorus	Aquatic ecosystems	—	—	20 µg/L	—	—	—	—
Total phosphorus	Aquatic ecosystems	—	—	50 µg/L	—	—	—	—
Chlorophyll	Aquatic ecosystems	—	—	5 µg/L	—	—	—	—
Dissolved oxygen	Aquatic ecosystems	—	—	85%–110% saturation	< 4 mg/L at surface	—	—	—
	Drinking water							
Turbidity	Aquatic ecosystems	—	—	50 NTU	—	—	—	—
Suspended solids	Aquatic ecosystem	350 mg/L	500 mg/L	10 mg/L	—	—	—	

Indicator	Environmental Value	Approved EA Receiving Water Criteria		EPP (water and wetland biodiversity) WQOs				
		Baralaba North	Dawson Mine	Aquatic ecosystems	Drinking water	Irrigation (long-term)	Irrigation (short-term)	Stock watering
Sulphate	Aquatic ecosystem	250 mg/L	250 mg/L	25 mg/L	—	—	—	—
Cryptosporidium	Drinking water	—	—	—	0 cysts	—	—	—
Blue-green algae	Drinking water	—	—	—	5,000 cells/mg	—	—	—
Algal toxin	Drinking water	—	—	—	Level 1: > 1 µg/L	—	—	—
				—	Level 1: > 10 µg/L	—	—	—
Colour	Drinking water	—	—	—	50 hazen units	—	—	—
Total hardness	Drinking water	—	—	—	Level 1: > 150 mg/L	—	—	—
				—	Level 1: > 200 mg/L	—	—	—
Sodium	Drinking water	—	—		30 mg/L	—	—	—
Aluminium	Aquatic ecosystems	0.055 mg/L	0.055 mg/L	0.055 mg/L	—	5 mg/L	20 mg/L	5 mg/L
Arsenic	Aquatic ecosystems	0.013 mg/L	0.013 mg/L	0.013 mg/L	—	0.1 mg/L	2 mg/L	0.5-2 mg/L
Beryllium	Irrigation	—	—	—	—	0.1 mg/L	0.5 mg/L	ND
Boron	Aquatic ecosystems	0.37 mg/L	0.37 mg/L	0.37 mg/L1	—	0.5 mg/L	0.5 mg/L2	5 mg/L

Indicator	Environmental Value	Approved EA Receiving Water Criteria		EPP (water and wetland biodiversity) WQOs				
		Baralaba North	Dawson Mine	Aquatic ecosystems	Drinking water	Irrigation (long-term)	Irrigation (short-term)	Stock watering
Cadmium	Aquatic ecosystems	0.2 µg/L	0.2 µg/L	0.2 µg/L1	—	10 µg/L	50 µg/L	10 µg/L
Chromium	Aquatic ecosystems	0.001 mg/L	0.001 mg/L	0.001 mg/L1	—	0.1 mg/L	1 mg/L	1 mg/L
Cobalt	Irrigation	1.4 µg/L	90 µg/L	—	—	50 µg /L	100 µg /L	1,000 µg /L
Copper	Aquatic ecosystems	2 µg/L	2 µg/L	1.4 µg/L1	—	200 µg /L	5,000 µg /L	400 µg/L (sheep), 1,000 µg/L (cattle)
Fluoride	Stock watering	2 mg/L	2 mg/L	—	—	1 mg/L	2 mg/L	2 mg/L
Iron	Aquatic ecosystems	0.3 mg/L	0.3 mg/L	—	—	0.2 mg/L	10 mg/L	Not sufficiently toxic
Lead	Aquatic ecosystems	4 µg/L	4 µg/L	3.4 µg/L1	—	2000 µg/L	5,000 µg/L	100 µg/L
Lithium	Irrigation	—	—	—	—	2.5 mg/L	2.5 mg/L	—
Manganese	Aquatic ecosystems	1.9 mg/L	1.9 mg/L	1.9 mg/L1	—	0.2 mg/L	10 mg/L	—
Mercury	Aquatic ecosystems	0.2 µg/L	0.2 µg/L	—	—	2 µg/L	2 µg/L	2 µg/L
Molybdenum	Irrigation	34 µg/L	34 µg/L	—	—	20 µg/L	50 µg/L	—
Nickel	Aquatic ecosystems	0.011 mg/L	0.011 mg/L	0.011 mg/L1	—	—	—	1 mg/L
Selenium	Aquatic ecosystems	10 µg/L	10 µg/L	11 µg/L1	—	10 µg/L	50 µg/L	20 µg/L

Indicator	Environmental Value	Approved EA Receiving Water Criteria		EPP (water and wetland biodiversity) WQOs				
		Baralaba North	Dawson Mine	Aquatic ecosystems	Drinking water	Irrigation (long-term)	Irrigation (short-term)	Stock watering
Uranium	Irrigation	1 µg/L	1 µg/L	—	—	10 µg/L	100 µg/L	—
Vanadium	Irrigation	10 µg/L	10 µg/L	—	—	100 µg/L	500 µg/L	—
Zinc	Aquatic ecosystems	8 µg/L	8 µg/L	8 µg/L1	—	2000 µg/L	5,000 µg/L	—

Adjacent to the Project, the Dawson River has a main channel approximately 150 m wide and 10 m deep, bordered by a lower floodplain extending 1.5-3 km on either side. It is laterally an active river, with several anabranch channels both upstream and downstream of the Project (AECOM, 2016). At the closest point, the Dawson River is located approximately 700 m west of the Project and an anabranch of the Dawson River (the Dawson River Anabranch) flows approximately 400 m to the north-east of the Project boundary.

Water resources are managed in the lower Dawson River with water supply storages. The nearest upstream and downstream storages are Moura Weir (40 km to the south) and Neville Hewitt Weir near Baralaba (8 km to the north) respectively. Supplemented water entitlements for water extraction from the Dawson River are managed through the Dawson Valley WSS and the Water Plan (Fitzroy Basin) 2011.

Stream flow characteristics of the Dawson River are detailed below in section 9.8.3.2.

Banana Creek

Banana Creek is defined as a watercourse under the Water Act. Banana Creek is an ephemeral, fifth order tributary to the Dawson River with a catchment area of approximately 1,000 km^2 at its confluence with the Dawson River (approximately 1 km west of the Project). Banana Creek flows in a north-westerly direction from the south of the Banana township towards the Project within 500 m of the Project boundary, at the closest point. The south-western Project boundary closely follows Banana Creek, less than 2 km away.

There are no gauging stations monitoring flow in Banana Creek, however, Banana Creek only flows in response to large rainfall events typically during the wet season (October to April). Near the Project, Banana Creek has a main channel approximately 120 m wide 10 m deep, bordered by a lower floodplain extending approximately 1 km on either side. Streamflow in Banana Creek adjacent the Project, is heavily influenced by flooding and associated flows in the Dawson River.

9.8.2.6 Minor waterways and drainage lines

Adjacent to, and downstream of the Project area is Shirley's Gully, the reach of the main unnamed waterway closest to the confluence with the Dawson River Anabranch, which is mapped as a third order stream (DNRME, 2019). Shirley's Gully is not mapped under the Water Act.

A number of ephemeral, unnamed minor waterways (mapped as first and second stream orders) flow through the Project area, as tributaries of one unnamed waterway (Figure 9.34) (DNRME, 2019). The unnamed waterway catchment extends from Mount Ramsay to the east and to the Dawson River to the west. The 1st order streams flowing through the MLA area have catchment areas ranging from < 100 ha to as large as 1,300 ha. Flow paths are not well defined with no obvious bed or banks and channel widths are generally less than 20 m. The largest unnamed waterway that intersects the MLA has a catchment area of approximately 5,000 ha and a channel width of approximately 30 m at its confluence with the Dawson River.

All the minor waterways in the vicinity of the MLA area are ephemeral and experience flows only in response to rainfall.

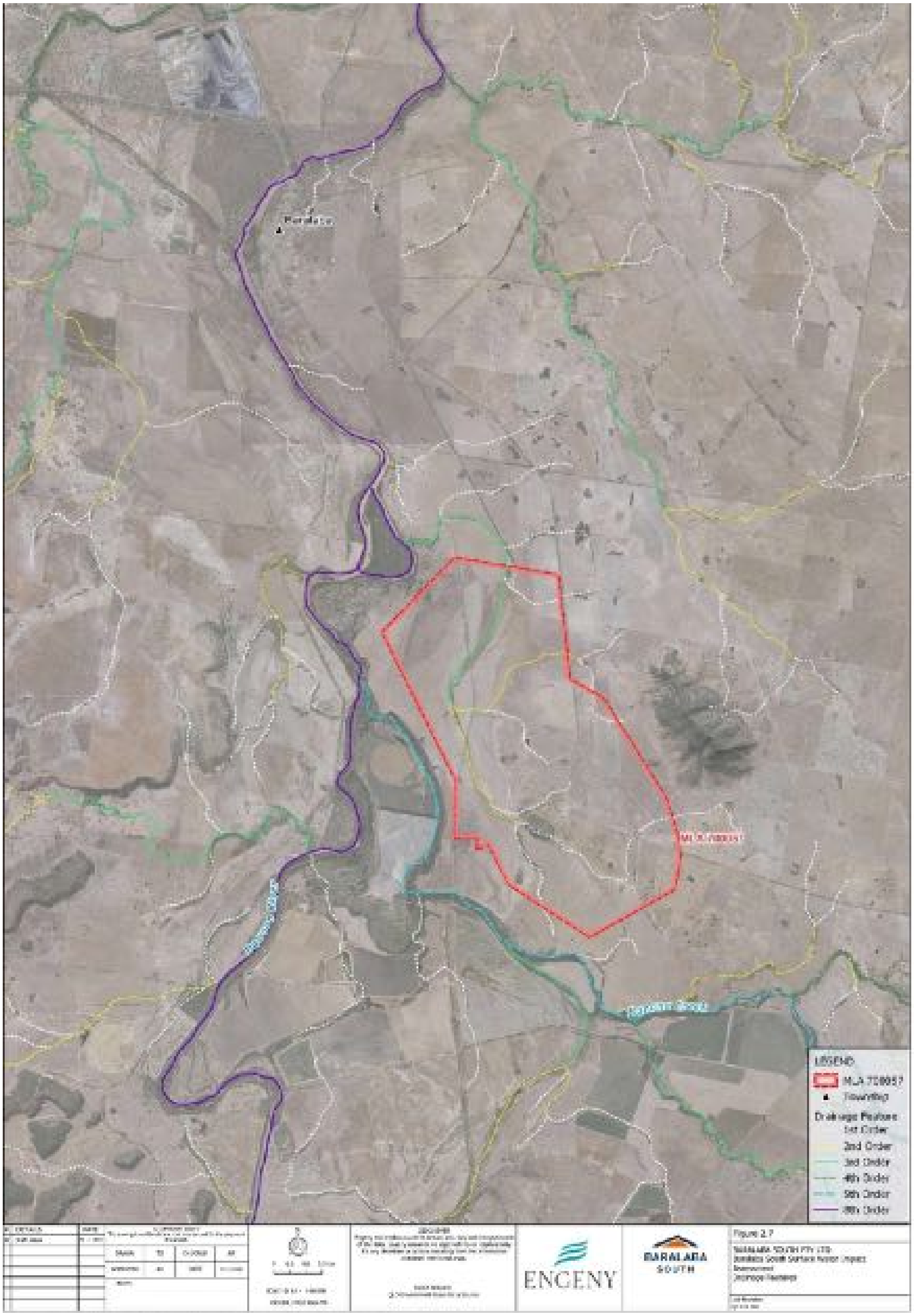

Figure 9.34: *Waterways with the MLA and surrounds*

9.8.3. Description of baseline surface water values

A Surface Water Monitoring Program has been developed and established in accordance with the Queensland Water Quality Guidelines (DEHP, 2009) and the National Water Quality Management Strategy Guideline (ANZG, 2018), with the intent of collecting baseline water quality data representative of the local receiving environment. Surface water monitoring has been undertaken at sites listed in Table 9.19 and are shown on Figure 9.35 between June 2019 and August 2023.

Table 9.19: Surface water quality monitoring locations

Monitoring location (ID)	Easting (GDA94)	Northing (GDA94)
U/S Banana Creek	149.897	–24.3091
U/S Dawson River	149.794	–24.3254
MP1 Banana Creek	149.844	–24.2763
D/S Dawson River	149.819	–24.2081
Dawson River at Baralaba DR1 (Baralaba North Mine SWMP)	149.805	–24.1825
Dawson River at Beckers (130322A)	149.822	–24.0873

9.8.3.1 Water quality

Water quality data from several sources have been analysed to characterise baseline conditions of the Project and its receiving environment, including:

- surface water quality data from existing and previous sampling programs on the Dawson River and the Dawson River Anabranch for Baralaba North Mine;
- ongoing, automated, in situ monitoring (telemetric monitoring) of EC at Beckers gauging station (130322A) since 1993, and sampling of a wider range of water quality parameters at the gauging station since 1964 by the DoR;
- surface water quality data (Appendix G, Aquatic Ecology Assessment) collected by Ecological Service Professionals (2023) from:
    - the Dawson River;
    - the Dawson River Anabranch;
    - Shirley’s Gully;
    - the unnamed tributary of the Dawson River situated within the Project area;
    - Banana Creek;
    - two wetlands located within the MLA (HES wetland and a Palustrine wetland); and
- surface water quality data collected from the Project surface water quality monitoring program.

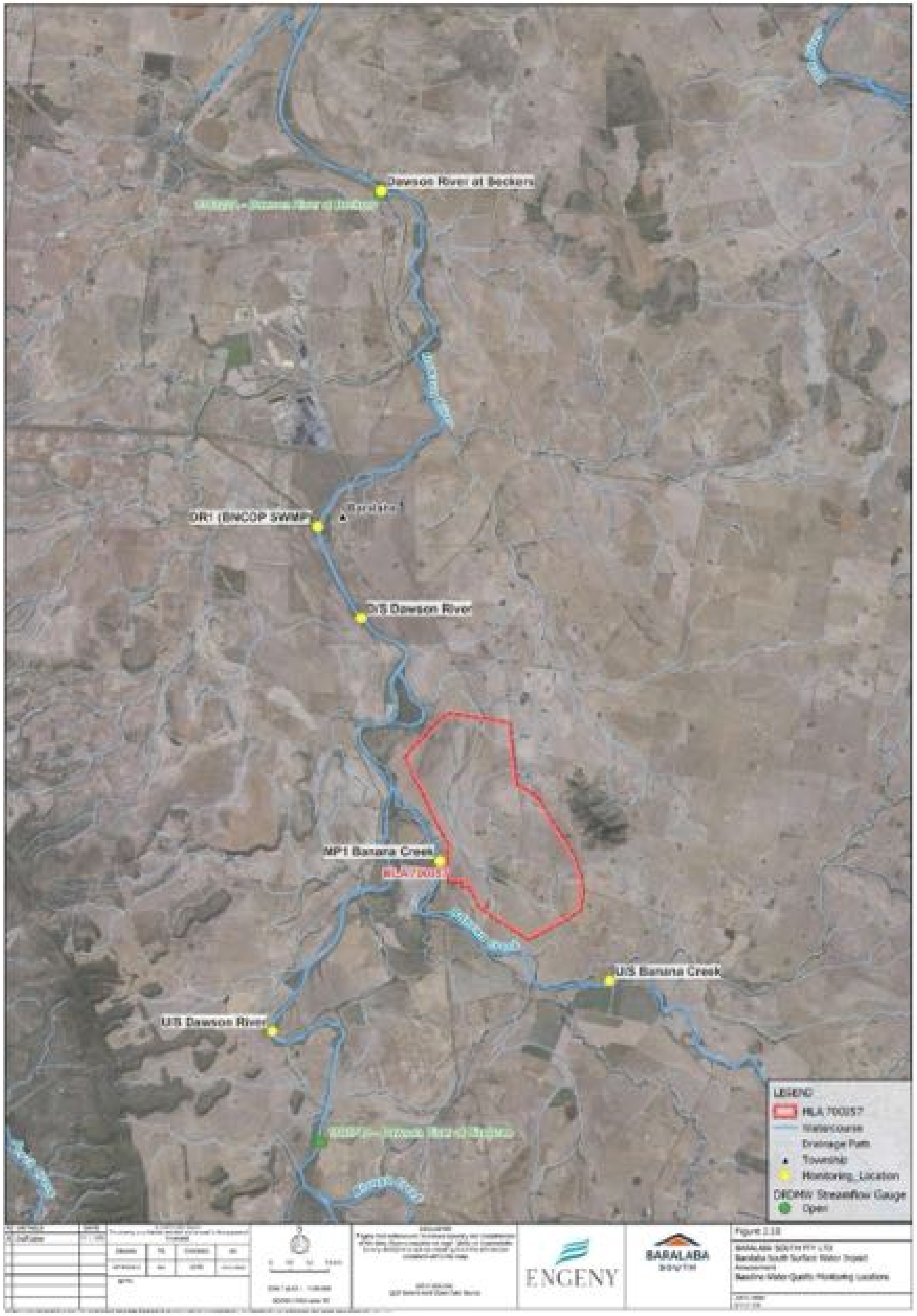

Figure 9.35: Water quality monitoring locations

Baralaba North Mine water quality

A baseline water quality monitoring program was undertaken as part of the EIS process for the Baralaba North Continued Operations Project, located approximately 11 km north of the Project. Most data was collected between 2011 and 2013, with some sampling back to 2009 (WRM, 2014).

Detailed summaries of water quality data for Dawson River (upstream and downstream of Baralaba North Mine), Dawson River Anabranch (upstream and downstream of Baralaba North Mine) and Saline Creek are provided in Appendix A, Surface Water Impact Assessment. Data from the Baralaba North Mine water quality monitoring program has been considered when defining the WQO for the Project.

Water quality monitoring at Beckers gauging station

Water quality of the Dawson River has been monitored at streamflow gauging station 130322A (Dawson River at Beckers) since 1993 (DNRME, 2019). Telemetric monitoring of EC and streamflow produces daily readings, indicated in Figure 9.36. The data shows EC is fairly constant during medium flows (150 µS/cm to 250 µS/cm); however, increases following large stream flow events are evident in 1998, 2011 and 2013 (Appendix A, Surface Water Impact Assessment). Analysis of a wider range of water quality indicators has been undertaken since 1964 through a water quality sampling program at Beckers gauging station on the Dawson River (DNRME, 2019). A statistical summary of the water quality data for each water quality parameter collected as part of this program is provided in Appendix A, Surface Water Impact Assessment.

Table 9.20 provides a statistical summary of the key water quality parameters including pH, EC, turbidity, total suspended solids, total nitrogen and total phosphorous. The water quality of the Dawson River at the Beckers gauging station (130322A) has exceeded several WQOs in the monitoring undertaken between 1964 and 2018 (DNRME, 2019). For example:

- EC exceeded low and high flow WQOs for aquatic ecosystems in the 95th percentile;
- turbidity and total suspended solids exceeded aquatic ecosystem WQOs in greater than median and 20th percentiles respectively; and
- median total phosphorus and total nitrogen measurements exceeded the WQOs for aquatic ecosystems.

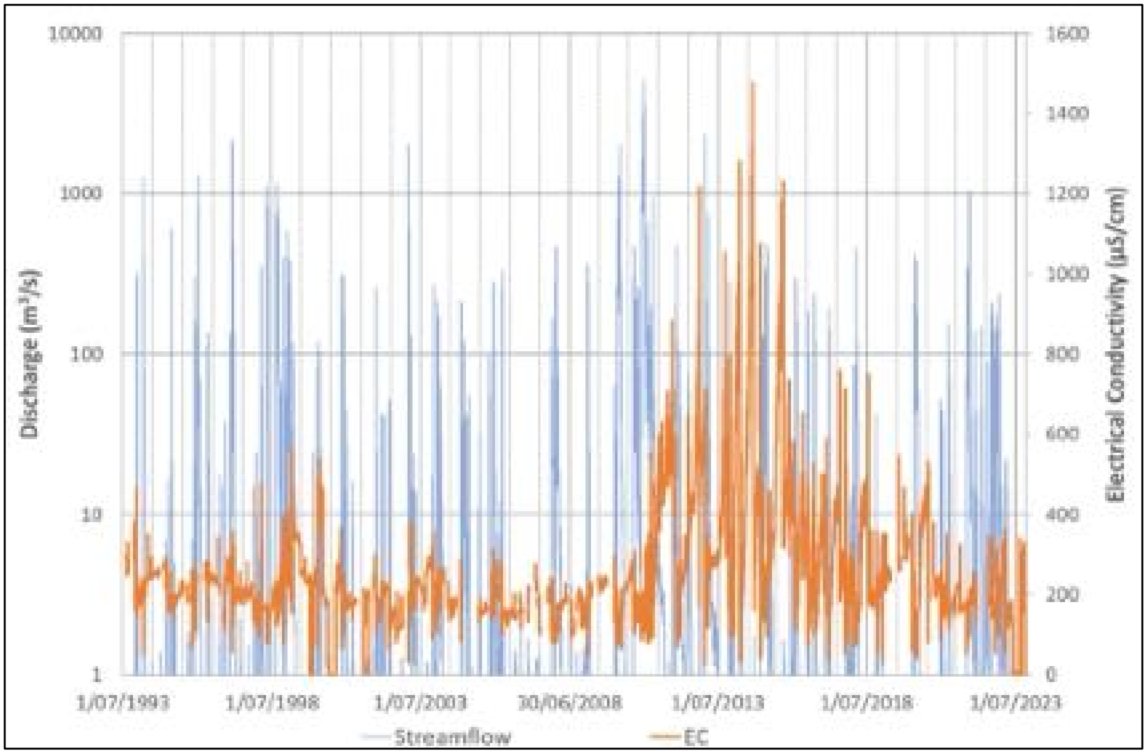

Figure 9.36: Gauging Station 130322A (Dawson R. Beckers) streamflow and water quality

Table 9.20: Water quality data (Gauging station 130322A—Dawson River at Beckers)

	Electrical conductivity (µS/cm)	pH (pH units)	Turbidity (NTU)	Total suspended solids (mg/L)	Total phosphorus (mg/L)	Total nitrogen (mg/L)
WQO	340/210 (baseflow/high flow)[1]	6.5–8.5 [1,2]	50[1]	10[1]	0.05[1]	0.5[1]
Minimum	70	6.8	1	5	0.04	0.3
5th percentile	114	6.9	5	10	0.06	0.4
20th percentile	150	7.2	27	20	0.09	0.5
Median	204	7.6	100	50	0.20	0.8
80th percentile	266	7.8	240	117	0.39	1.1
95th percentile	413	8.0	600	459	0.55	1.3
Maximum	790	8.3	1,120	682	0.72	2.0

[1] Aquatic Ecosystems, [2] Drinking Water

Baralaba South Coal Project Aquatic Ecology Assessment

As a component of the Aquatic Ecology Assessment (Appendix G), local water quality data have been collected in June 2017 and/or March 2018 and August 2023 by Ecological Service Professionals (2023) from sites located within and adjacent to the MLA. The local water quality sampling sites are shown in Chapter 7, Flora and Fauna, and the data is summarised in Table 4.9. Water quality has been generally characterised as having:

- neutral to alkaline pH, except for the lacustrine wetland (dam) site which exhibited a consistent but slightly alkaline pH;
- low EC, with one Banana Creek site above the relevant objective in the June 2017 and August 2023 surveys, and the lacustrine wetland (dam) site above the relevant objective in the March 2018 and August 2023 surveys;
- low dissolved oxygen typically below the WQO range for aquatic ecosystems, except for the lacustrine wetland (dam) site which exhibited dissolved oxygen above the WQO in the August 2023 survey;
- high turbidity and concentrations of suspended solids typically above the WQOs for aquatic ecosystems;
- low concentrations of ions, with one Banana Creek site above the relevant objective for sulphate in the June 2017 survey;
- high concentrations of nutrients (nitrogen and phosphorous) with the bioavailable fractions of nutrients also generally higher than relevant WQOs; and
- various metals and metalloids, dissolved concentrations of most metals and metalloids were low at most sites, except for aluminium, copper, and iron.

Baralaba South Coal Project Surface Water Monitoring Program

A Surface Water Monitoring Program has been developed to supplement the existing available data for the Project in accordance with the 'Queensland Water Quality Guidelines' (DEHP, 2009) and the 'National Water Quality Management Strategy' (ANZG, 2018).

Surface water quality sampling has been undertaken at sampling sites on the Dawson River and Banana Creek between June 2019 and July 2023. The results of the sampling are provided in Table 9.22 - Table 9.26 and are consistent with the findings of sampling conducted by the aquatic ecology surveys.

The water quality results are relatively typical of the region and indicate that the waterways and wetlands of the Project area are moderately disturbed and influenced by surrounding land uses, particularly agriculture.

The water quality results are considered representative of the broader region and indicate that the waterways and wetlands of the Project area are moderately disturbed and influenced by surrounding land uses, particularly agriculture.

The baseline water quality monitoring program for the Project has shown exceedances of WQOs for the following parameters:

- The pH was slightly exceeded at the downstream Dawson River monitoring location in the October, November and December 2020 samples.
- Electrical conductivities at all sites were recorded to be below 500 µS/cm for all samples, however, all monitoring locations at times have exceeded the high flow WQO for aquatic ecosystems and 40% of monitoring events exceeded the low flow WQO for aquatic ecosystems.
- Laboratory readings of turbidity showed consistent exceedances compared with the WQO for aquatic ecosystems at all sites.
- Sampling in all locations at all sampling dates showed consistent exceedance compared to the aquatic ecosystems WQOs for aluminium, ammonia, and iron.

Table 9.21: Project surface water quality data collected by Aquatic Ecology Surveys

Parameter	Units	June 2017 sampling site								March 2018 sampling site							August 2023 sampling site			
		BC1	BC2	UW1T	LW1	PW2	SG1	DA1	DR1	BC1	BC2	LW1	PW2	SG1	DA1	DR1	BC1	LW1	DA1	DR1
Physical																				
Temperature	ºC	10.9	12.6	14	15.9	9.6	13.3	17.3	19	25.7	23.8	27.6	25.4	27.3	27.6	26.4	16.8	20.5	16.7	19.4
Electrical Conductivity (EC)	µS/cm	506	144	88.1	158.9	136.8	98.7	93	93.4	193.3	156.2	294.4	236.3	157.1	143.5	145.7	466.9	437.7	275.7	272.7
pH	pH units	7.52	7.45	7.15	8.49	7.01	7.26	6.67	6.92	7.34	6.85	8.47	7.01	7.26	7.42	7.41	7.59	8.61	7.43	7.9
Dissolved Oxygen (DO)	% sat.	63.7	91.1	69.7	104	55.4	85.4	42	35.3	64	6	100	46	46	74	67	85.9	121.1	71.1	94.3
Turbidity	NTU	6	14	123	22	62	40	83	91	95.9	71.3	20.3	110	417.8	165.7	172.8	15.8	15.5	63.5	20.8
Total suspended solids	mg/L	8	32	54	26	280	14	16	14	56	42	16	20	84	48	44				
Ions																				
Total hardness	mg/L	224	89	54	86	80	41	35	41	53	44	79	69	41	35	35				
Sulphate	mg/L	35	3	< LOR	< LOR	< LOR	5	4	4	< LOR	< LOR	< LOR	< LOR	2	2	2				
Fluoride	mg/L	0.3	0.2	< LOR	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	< LOR	0.1	0.1	0.1				
Calcium	mg/L	55	21	15	23	24	10	9	10	13	11	20	21	10	9	9				
Magnesium	mg/L	21	9	4	7	5	4	3	4	5	4	7	4	4	3	3				
Sodium	mg/L	101	18	8	10	19	20	20	17	11	10	10	14	12	12	12				
Nutrients																				
Ammonia	µg/L	20	60	70	160	60	20	20	20	40	60	80	40	30	40	30				
Nitrite	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	20	< LOR	< LOR	< LOR	< LOR				
Nitrate	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	160	170	< LOR	< LOR	< LOR	< LOR	90	250	250				
Nitrite + Nitrate	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	160	170	< LOR	< LOR	20	< LOR	90	250	250				
Total organic nitrogen	µg/L	980	1,140	1,880	2040	2,540	780	480	480	1960	1,740	2,120	1,260	1,230	860	770				
Total nitrogen	µg/L	1,000	1,200	1950	2,200	2,600	800	700	700	2000	1,800	2,200	1,300	1,400	1,200	1,000				
Reactive phosphorus	µg/L	< LOR	20	125	70	260	30	70	50	140	180	100	420	170	200	200				
Total phosphorus	µg/L	50	130	390	200	620	180	150	150	570	530	270	510	450	350	370				
Total metals																				
Aluminium	µg/L	250	620	3,060	660	7,500	2,350	3,510	3,560	8,120	2,080	140	1,160	4,340	4,410	5,130				
Arsenic	µg/L	3	2	2	5	4	2	2	1g	10	8	6	4	4	2	3				
Boron	µg/L	60	< LOR	60	80	60	< LOR	< LOR	60	< LOR	< LOR	80	70	< LOR	< LOR	< LOR				
Cadmium	µg/L	0.1	< LOR	0.1	0.1	0.1	0.1	< LOR	0.1	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				

Parameter	Units	June 2017 sampling site								March 2018 sampling site							August 2023 sampling site			
		BC1	BC2	UW1T	LW1	PW2	SG1	DA1	DR1	BC1	BC2	LW1	PW2	SG1	DA1	DR1	BC1	LW1	DA1	DR1
Chromium	µg/L	< LOR	< LOR	2	< LOR	5	6	4	< LOR	7	2	< LOR	< LOR	3	3	3				
Cobalt	µg/L	< LOR	< LOR	1	2	8	<LOR	1	< LOR	4	3	1	< LOR	2	1	2				
Copper	µg/L	2	2	4	1	11	3	4	2	8	4	<LOR	3	6	6	8				
Iron	µg/L	270	1,320	3,080	820	6,520	2,810	3,970	2,350	9,100	3,580	330	1,030	5,060	4,240	5,140				
Lead	µg/L	< LOR	< LOR	2	< LOR	5	< LOR	1	< LOR	3	1	< LOR	< LOR	3	2	2				
Manganese	µg/L	92	47	44.5	222	665	52	70	17g	562	521	177	72	220	68	88				
Mercury	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Molybdenum	µg/L	4	< LOR	< LOR	1	1	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	2	< LOR	< LOR	1				
Nickel	µg/L	3	3	4	2	8	4	4	2	8	5	2	4	5	4	4				
Selenium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Silver	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	0.02	0.01	< LOR	< LOR	0.02	0.01	0.01				
Uranium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Vanadium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	20	< LOR	< LOR	< LOR	10	10	20				
Zinc	µg/L	< LOR	< LOR	9	< LOR	18	< LOR	6	< LOR	14	7	< LOR	< LOR	11	11	15				
Dissolved metals																				
Aluminium	µg/L	< LOR	< LOR	80	< LOR	< LOR	80	60	80	560	510	< LOR	80	420	280	290				
Arsenic	µg/L	2	1	2	4	2	1	1	2	6	5	5	4	2	2	2				
Boron	µg/L	70	80	80	90	80	60	80	< LOR	< LOR	< LOR	70	70	< LOR	< LOR	< LOR				
Cadmium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Chromium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	3	<LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Cobalt	µg/L	< LOR	< LOR	< LOR	1	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Copper	µg/L	< LOR	< LOR	1	< LOR	2	< LOR	< LOR	2	2	2	< LOR	2	2	2	3				
Iron	µg/L	< LOR	110	115	< LOR	< LOR	150	180	150	570	660	< LOR	70	350	240	240				
Lead	µg/L	< LOR	<LOR	<LOR	< LOR	< LOR	< LOR	< LOR	1g	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Manganese	µg/L	9	38	23	62	28	13	16	72g	6	5	< LOR	7	2	1	1				
Mercury	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Molybdenum	µg/L	3	< LOR	< LOR	1	1	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Nickel	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	<LOR	3	3	2	3	3	2	2				
Selenium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Silver	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				

Parameter	Units	June 2017 sampling site								March 2018 sampling site							August 2023 sampling site			
		BC1	BC2	UW1T	LW1	PW2	SG1	DA1	DR1	BC1	BC2	LW1	PW2	SG1	DA1	DR1	BC1	LW1	DA1	DR1
Uranium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Vanadium	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	10	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Zinc	µg/L	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
Total petroleum hydrocarbons																				
C6–C9 Fraction	µg/L	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
C10–C14 Fraction	µg/L	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
C15–C28 Fraction	µg/L	< 100	160	155	< 100	120	< 100	< 100	< 100	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
C29–C36 Fraction	µg/L	< 50	60	70	< 50	60	< 50	< 50	< 50	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				
C10–C36 Fraction (sum)	µg/L	< 50	220	225	< 50	180	< 50	< 50	< 50	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR	< LOR				

Table 9.22: Project surface water quality data June 2019–July 2023 DR1

Parameter	Units	DR1																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Mar-22	Aug-22	Oct-22	Jan-23	Apr-23	Jul-23
pH value (lab)	pH Unit	7.78	7.74	8.22	8.10	8.09	7.68	7.64	7.73	7.84	7.83	7.82	7.8	7.65	7.78	7.93	7.67	7.72
Electrical conductivity (lab)	µS/cm	254	178	187	184	200	220	147	146	158	144	150	280	183	188	307	211	275
Total suspended solids	mg/L	12	44	62	34	24	93	155	32	123	56	46	41	64	76	19	16	18
Turbidity	NTU	11.8	215.0	185.0	77.1	40.1	268	304	216	319	249	253	104	218	292	11.8	54.2	34.3
Sulphate as SO4	mg/L	3	4	3	3	3	7	2	3	3	4	4	8	5	5	8	4	6
Dissolved major cations																		
Calcium	mg/L	14	14	14	13	14	13	10	11	11	10	11	18	10	11	20	11	17
Magnesium	mg/L	6	4	5	4	5	4	3	4	4	3	3	7	4	3	8	6	7
Sodium	mg/L	26	15	16	18	18	28	13	14	17	11	14	27	22	26	32	25	28
Potassium	mg/L	7	6	7	8	7	6	6	6	6	6	7	6	6	7	7	6	6
Dissolved metals																		
Aluminium	mg/L	0.02	0.07	0.07	0.04	0.07	0.06	0.12	0.21	0.12	0.02	<0.01	0.02	0.06	<0.01	0.07	0.19	0.02
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001	0.001	0.002	0.002	0.002	0.001	<0.001	0.001	0.002	<0.001	0.001	0.003	0.003	0.001
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	<0.001	0.001	0.003	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.004	0.003	0.002	0.002
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.027	0.002	0.004	0.010	0.004	0.03	0.006	0.008	0.004	0.012	0.005	0.007	0.004	<0.001	0.002	0.067	0.002
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.001	0.003	0.002	0.002	0.004	0.002	0.003	0.002	0.002	0.001	0.002	0.002	0.001	0.004	0.027	0.003	0.004
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	0.05	0.07	<0.05	<0.05	0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	0.05	0.06
Iron	mg/L	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	0.08	0.16	0.12	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	0.18	<0.05
Total metals																		
Aluminium	mg/L	0.41	7.06	7.91	3.79	1.84	10.2	10.2	7.89	11.4	6.11	6.54	9.18	13	15.7	0.85	1.39	1.08

Parameter	Units	DR1																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Mar-22	Aug-22	Oct-22	Jan-23	Apr-23	Jul-23
Arsenic	mg/L	0.002	0.002	0.001	0.002	0.001	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.004	0.003	0.002
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	0.005	0.006	0.003	0.002	0.007	0.009	0.007	0.006	0.004	0.005	0.007	0.008	0.008	0.003	0.002	0.002
Copper	mg/L	0.001	0.007	0.009	0.005	0.005	0.011	0.01	0.008	0.012	0.007	0.011	0.007	0.012	0.014	0.005	0.003	0.008
Lead	mg/L	<0.001	0.003	<0.001	0.002	<0.001	0.003	0.003	0.002	0.004	0.003	0.004	0.002	0.003	0.005	<0.001	<0.001	<0.001
Manganese	mg/L	0.100	0.103	0.123	0.111	0.055	0.161	0.127	0.104	0.115	0.104	0.1	0.082	0.084	0.118	0.079	0.137	0.070
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.003	<0.001	<0.001
Nickel	mg/L	0.002	0.008	0.008	0.006	0.006	0.008	0.008	0.008	0.006	0.005	0.006	0.007	0.007	0.011	0.039	0.004	0.011
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	0.02	<0.01	0.01	<0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	0.016	0.02	0.010	<0.005	0.019	0.02	0.006	0.022	0.016	0.022	0.011	0.027	0.039	0.017	<0.005	0.009
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	0.05	<0.05	<0.05
Iron	mg/L	0.45	6.76	7.02	3.52	1.66	8.27	11	7.67	11.1	5.34	7.75	5.06	9.09	10.4	0.87	1.75	2.03
Other																		
Mercury (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Fluoride	mg/L	0.2	0.1	0.1	0.2	0.1	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.1	<0.1	0.2	0.1	0.2
Ammonia as N	mg/L	0.07	<0.01	0.05	0.12	0.03	0.23	0.2	0.15	0.31	0.1	0.16	0.44	0.32	0.43	<0.01	0.13	0.01
Nitrite as N	mg/L	<0.01	<0.01	0.15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1
Nitrate as N	mg/L	0.02	0.32	0.15	<0.01	<0.01	0.12	0.14	<0.01	0.43	0.31	0.46	0.03	0.2	0.24	<0.01	0.01	0.02
Nitrite + Nitrate	mg/L	0.02	0.32	0.01	<0.01	<0.01	0.12	0.14	<0.01	0.43	0.31	0.46	0.03	0.2	0.24	<0.01	0.01	0.02
Total petroleum hydrocarbons																		
C6 - C9 Fraction	µg/L	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	<50	70	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	<50	70	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50

(-) site dry, not sampled.

Table 9.23: Project surface water quality data June 2019—July 2023 D/S DR

Parameter	Units	D/S DR																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Mar-22	Aug-22	Oct-22	Jan-23	Apr-23	Jul-23
pH value (lab)	pH Unit	7.71	7.86	8.60	8.06	8.22	7.74	7.57	7.63	7.82	7.82	8	7.67	7.64	7.91	7.83	8.01	7.61
Electrical conductivity (lab)	µS/cm	253	174	184	187	200	221	146	148	157	144	222	281	183	168	341	470	255
Total suspended solids	mg/L	< 5	162	78	27	26	102	150	36	108	52	80	42	84	79	20	17	10
Turbidity	NTU	10.6	312.0	112.0	74.8	35.6	270	313	210	335	260	248	100	218	301	10.6	12.1	31.7
Sulphate as SO4	mg/L	3	3	8	3	3	8	2	3	4	4	4	8	5	5	10	9	6
Dissolved major cations																		
Calcium	mg/L	14	14	15	12	14	13	10	12	11	10	20	18	9	10	21	23	15
Magnesium	mg/L	6	4	5	4	5	4	3	4	3	3	8	7	3	3	8	12	7
Sodium	mg/L	25	14	16	18	19	28	13	14	17	12	16	28	21	24	37	61	28
Potassium	mg/L	7	6	7	8	7	5	6	6	6	6	6	6	6	7	7	8	7
Dissolved metals																		
Aluminium	mg/L	0.02	0.09	0.1	0.03	0.06	0.05	0.12	0.15	0.1	<0.01	0.07	0.02	0.03	<0.01	0.05	<0.01	0.04
Arsenic	mg/L	0.001	<0.001	0.001	<0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.001	0.002	0.001	0.001	0.003	0.002	0.002
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	<0.001	0.002	0.003	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.009	0.002	0.004	0.003	0.003	0.002	<0.001
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.008	0.057	0.003	0.003	0.003	0.007	0.017	0.029	0.007	0.005	0.088	0.019	<0.001	<0.001	0.002	0.018	0.005
Molybdenum	mg/L	<0.001	<0.001	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001	<0.001
Nickel	mg/L	0.001	0.002	0.003	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.003	0.011	0.01	0.002
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	<0.005	<0.005	0.006	0.009	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.06
Iron	mg/L	<0.05	0.07	0.06	<0.05	<0.05	<0.05	0.09	0.13	0.11	<0.05	0.08	<0.05	0.11	<0.05	0.05	<0.05	<0.05
Total metals																		
Aluminium	mg/L	0.41	10.20	5.00	2.93	1.51	10.6	10.8	8.59	11.5	5.82	6.17	10.9	12.2	15	0.49	0.61	1.77

Parameter	Units	D/S DR																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Mar-22	Aug-22	Oct-22	Jan-23	Apr-23	Jul-23
Arsenic	mg/L	0.002	0.003	0.002	0.002	0.001	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.002	0.003	0.004	0.003	0.002
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	0.008	0.004	0.003	0.001	0.008	0.01	0.007	0.006	0.003	0.009	0.008	0.007	0.007	0.002	0.002	0.002
Copper	mg/L	0.001	0.011	0.007	0.005	0.004	0.011	0.011	0.009	0.011	0.007	0.026	0.008	0.011	0.01	0.008	0.004	0.002
Lead	mg/L	<0.001	0.005	0.002	0.001	<0.001	0.004	0.003	0.002	0.004	0.003	0.005	0.002	0.004	0.004	<0.001	<0.001	<0.001
Manganese	mg/L	0.060	0.223	0.069	0.060	0.050	0.132	0.144	0.132	0.118	0.089	0.173	0.092	0.088	0.115	0.039	0.095	0.064
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002	<0.001
Nickel	mg/L	0.002	0.010	0.007	0.005	0.004	0.01	0.009	0.008	0.007	0.005	0.01	0.007	0.006	0.008	0.02	0.012	0.006
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	0.02	0.01	<0.01	<0.01	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	0.026	0.01	0.016	<0.005	0.022	0.036	0.011	0.022	0.016	0.021	0.013	0.025	0.029	0.018	0.007	<0.005
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	0.07	0.05
Iron	mg/L	0.41	10.20	4.37	2.77	1.40	8.50	11.8	8.12	10.9	5.16	8.73	5.45	8.75	9.18	0.54	0.66	1.82
Other																		
Mercury (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	8.03	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.004	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Fluoride	mg/L	0.2	0.1	0.1	0.2	0.2	<0.0001	0.2	0.2	0.1	0.1	0.2	0.2	0.1	<0.1	0.2	0.2	0.1
Ammonia as N	mg/L	0.06	0.05	<0.01	<0.01	0.01	0.005	0.03	0.06	0.19	0.02	0.06	0.06	<0.01	0.08	0.02	0.16	0.02
Nitrite as N	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	0.009	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1
Nitrate as N	mg/L	0.04	0.28	<0.01	0.01	<0.01	0.003	0.15	0.02	0.43	0.27	0.03	0.04	0.14	0.26	<0.01	<0.01	0.05
Nitrite + Nitrate	mg/L	0.04	0.28	<0.01	0.01	<0.01	0.141	0.15	0.02	0.43	0.27	0.03	0.04	0.14	0.26	<0.01	<0.01	0.05
Total petroleum hydrocarbons																		
C6 - C9 Fraction	µg/L	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50

Table 9.24: Project surface water quality data June 2019—July 2023 U/S DR

Parameter	Units	U/S DR																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Mar-22	Aug-22	Oct-22	Jan-23	Apr-23	Jul-23
pH value (lab)	pH Unit	7.79	8.05	8.22	7.92	8.03	7.83	7.58	7.63	7.86	7.82	7.94	7.54	—	7.79	7.78	7.8	7.81
Electrical conductivity (lab)	µS/cm	306	282	383	379	445	267	148	148	147	146	156	194	—	238	189	254	495
Total suspended solids	mg/L	32	19	31	22	14	79	131	36	108	44	41	84	—	81	25	14	9
Turbidity	NTU	205	100.0	44.3	33.2	12.9	195	347	210	329	253	245	248	—	298	88	57.5	6.6
Sulphate as SO_4	mg/L	5	4	5	5	6	6	2	3	4	3	3	3	—	7	4	5	8
Dissolved major cations																		
Calcium	mg/L	14	18	23	20	21	17	9	12	10	10	10	14	—	14	12	13	24
Magnesium	mg/L	6	6	8	8	10	5	4	4	3	3	3	5	—	5	5	7	11
Sodium	mg/L	36	29	47	44	53	30	13	14	17	13	15	20	—	30	24	30	62
Potassium	mg/L	5	6	7	9	8	6	6	6	6	6	6	6	—	7	6	6	8
Dissolved total metals																		
Aluminium	mg/L	0.04	0.05	0.02	0.01	0.02	0.04	0.13	0.15	0.12	<0.01	<0.01	0.01	—	<0.01	0.44	0.1	<0.01
Arsenic	mg/L	<0.001	< 0.001	<0.001	0.001	0.002	0.002	0.001	0.002	0.001	0.001	0.001	0.001	—	0.001	0.002	0.002	0.001
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.001	0.001	0.002	0.002	0.002	0.005	0.003	0.003	0.004	0.003	0.003	—	0.005	0.003	0.002	<0.001
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.002	0.002	0.008	0.006	0.003	0.007	0.024	0.029	0.003	0.016	0.013	0.012	—	0.001	0.009	0.083	0.001
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	0.001
Nickel	mg/L	0.002	0.002	0.002	0.003	0.004	0.003	0.004	0.002	0.002	0.003	0.002	0.002	—	0.025	0.006	0.004	0.004
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	—	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	—	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	—	<0.005	<0.005	<0.005	<0.005
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	—	<0.05	<0.05	0.05	0.06
Iron	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.14	0.13	0.11	<0.05	<0.05	<0.05	—	<0.05	0.33	0.1	<0.05
Total metals																		
Aluminium	mg/L	7.15	3.56	1.60	0.84	0.54	8.03	10.1	8.59	9.74	5.54	6.47	5.82	—	17.2	4.06	2.77	0.29

Parameter	Units	U/S DR																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Mar-22	Aug-22	Oct-22	Jan-23	Apr-23	Jul-23
Arsenic	mg/L	0.002	0.002	0.002	0.001	0.002	0.004	0.003	0.003	0.002	0.002	0.002	0.002	—	0.002	0.003	0.004	0.001
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.006	0.002	0.001	<0.001	<0.001	0.005	0.012	0.007	0.004	0.003	0.006	0.007	—	0.008	0.005	0.004	<0.001
Copper	mg/L	0.006	0.004	0.005	0.005	0.006	0.009	0.015	0.009	0.009	0.008	0.009	0.008	—	0.017	0.007	0.004	<0.001
Lead	mg/L	0.002	0.001	0.003	<0.001	<0.001	0.003	0.003	0.002	0.004	0.003	0.004	0.002	—	0.004	0.001	0.001	<0.001
Manganese	mg/L	0.083	0.040	0.077	0.103	0.090	0.141	0.152	0.132	0.104	0.088	0.091	0.12	—	0.127	0.062	0.159	0.037
Molybdenum	mg/L	<0.001	<0.001	0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	0.001	0.001
Nickel	mg/L	0.006	0.005	0.004	0.005	0.004	0.007	0.015	0.008	0.005	0.006	0.007	0.009	—	0.04	0.009	0.006	0.003
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	—	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.02	<0.01	0.02	<0.01	<0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.02	—	0.02	0.02	<0.01	<0.01
Zinc	mg/L	0.012	0.015	0.006	<0.005	<0.005	0.016	0.026	0.011	0.02	0.015	0.022	0.014	—	0.032	0.019	0.009	<0.005
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	0.06	0.06	0.05	<0.05	<0.05	<0.05	<0.05	0.06	—	<0.05	<0.05	<0.05	0.05
Iron	mg/L	6.50	3.33	1.47	1.12	0.54	6.30	12.9	8.12	8.74	4.97	7.76	5.84	—	10.4	4.08	2.9	0.30
Other																		
Mercury (dissolved)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (total)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0014	<0.0001	0.0007	<0.0001	0.0016	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001
Fluoride	mg/L	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	—	<0.1	0.1	0.1	0.2
Ammonia as N	mg/L	0.11	<0.01	0.03	0.06	0.08	0.15	0.13	0.06	0.15	0.05	0.3	0.02	—	<0.01	<0.01	0.04	0.01
Nitrite as N	mg/L	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	—	<0.01	<0.01	<0.01	<0.1
Nitrate as N	mg/L	0.46	0.29	0.01	0.01	<0.01	0.24	0.19	0.02	0.41	0.28	0.36	0.12	—	0.24	<0.01	0.01	<0.1
Nitrite + Nitrate	mg/L	0.46	0.29	0.15	<0.01	<0.01	<0.01	0.19	0.02	0.41	0.28	0.36	0.12	—	0.24	<0.01	0.01	<0.1
Total petroleum hydrocarbons																		
C6 - C9 Fraction	µg/L	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	—	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	—	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	—	<100	120	<100	120
C29 - C36 Fraction	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	—	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	—	<50	120	<50	120

(-) site dry; not sampled

Table 9.25: Project surface water quality data June 2019 - July 2023 MP1 BC

Parameter	Units	MP1 BC																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Mar-22	Aug-22	Oct-22	Jan-23	Apr-23	Jul-23
pH value (lab)	pH Unit	7.69	—	—	7.27	7.61	I	7.53	7.63	7.86	7.77	8	7.17	7.76	7.8	7.84	8.01	7.85
Electrical conductivity (lab)	µS/cm	245	—	—	168	257	I	188	182	193	210	222	200	197	229	263	448	390
Total suspended solids	mg/L	40	—	—	6	12	I	6	13	47	18	80	41	54	82	22	14	11
Turbidity	NTU	49.3	—	—	132.0	13.7	I	8.8	17.1	280	203	248	348	179	187	58.1	10.2	10.9
Sulphate as SO4	mg/L	2	—	—	5	<1	I	<1	<1	3	5	4	5	6	5	8	8	7
Dissolved major cations																		
Calcium	mg/L	18	—	—	13	22	I	18	18	16	18	20	17	13	18	19	22	21
Magnesium	mg/L	7	—	—	5	10	I	6	6	6	6	8	6	5	7	6	10	10
Sodium	mg/L	21	—	—	12	15	I	11	12	15	14	16	15	25	20	29	54	46
Potassium	mg/L	7	—	—	8	8	I	8	6	6	6	6	7	7	7	7	8	8
Dissolved metals																		
Aluminium	mg/L	0.06	—	—	0.54	0.03	I	0.14	0.15	0.21	<0.01	0.07	<0.01	0.92	<0.01	0.09	<0.01	<0.01
Arsenic	mg/L	0.001	—	—	0.003	0.005	I	0.008	0.007	0.003	0.001	0.001	0.003	0.001	0.004	0.003	0.002	0.001
Cadmium	mg/L	<0.0001	—	—	<0.0001	<0.0001	I	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.002	—	—	0.004	<0.001	I	0.005	0.003	0.011	0.01	0.009	0.005	0.005	0.003	0.002	0.001	0.002
Lead	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.045	—	—	0.134	0.270	I	0.058	0.112	0.124	0.14	0.088	0.152	0.043	<0.001	0.077	0.046	0.005
Molybdenum	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001
Nickel	mg/L	0.002	—	—	0.005	0.004	I	0.005	0.004	0.004	0.003	0.003	0.003	0.002	0.005	0.004	0.023	0.005
Selenium	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	<0.005	—	—	0.005	<0.005	I	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.008	<0.005	<0.005
Boron	mg/L	<0.05	—	—	0.05	0.09	I	<0.05	<0.05	0.07	<0.05	<0.05	0.06	<0.05	0.06	0.06	0.06	<0.05
Iron	mg/L	0.06	—	—	0.43	1.29	I	0.49	0.39	0.18	<0.05	0.08	<0.05	0.76	<0.05	0.13	<0.05	<0.05
Total metals																		
Aluminium	mg/L	1.74	—	—	4.94	0.28	I	0.35	0.76	9.96	6.54	6.17	38.9	11.3	11.2	3.62	0.5	0.35

Parameter	Units	MP1 BC																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Mar-22	Aug-22	Oct-22	Jan-23	Apr-23	Jul-23
Arsenic	mg/L	0.002	—	—	0.005	0.007	I	0.008	0.008	0.004	0.004	0.004	0.01	0.002	0.006	0.005	0.003	<0.001
Cadmium	mg/L	<0.0001	—	—	<0.0001	<0.0001	I	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.002	—	—	0.004	<0.001	I	<0.001	<0.001	0.008	0.007	0.009	0.03	0.008	0.01	0.003	<0.001	<0.001
Copper	mg/L	0.004	—	—	0.009	0.002	I	0.006	0.004	0.025	0.021	0.026	0.022	0.009	0.009	0.005	0.003	0.003
Lead	mg/L	<0.001	—	—	0.002	<0.001	I	<0.001	<0.001	0.002	0.002	0.005	0.005	0.003	0.003	0.001	<0.001	<0.001
Manganese	mg/L	0.086	—	—	0.194	0.332	I	0.149	0.17	0.299	0.273	0.173	0.389	0.072	0.297	0.191	0.132	0.062
Molybdenum	mg/L	0.001	—	—	<0.001	<0.001	I	0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	mg/L	0.004	—	—	0.009	0.004	I	0.005	0.004	0.01	0.01	0.01	0.02	0.007	0.012	0.008	0.03	0.005
Selenium	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	mg/L	<0.001	—	—	<0.001	<0.001	I	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	—	—	0.01	<0.01	I	<0.01	<0.01	0.02	0.02	0.02	0.07	0.02	0.02	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	—	—	0.019	<0.005	I	0.007	<0.005	0.02	0.016	0.021	0.036	0.022	0.019	0.015	0.008	<0.005
Boron	mg/L	<0.05	—	—	0.05	0.10	I	0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	0.07	0.07	0.06
Iron	mg/L	1.91	—	—	5.02	2.89	I	1.08	1.36	9.58	6.47	8.73	19.4	7.83	8	3.44	0.59	0.34
Other																		
Mercury (dissolved)	mg/L	<0.0001	—	—	<0.0001	<0.0001	I	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury (total)	mg/L	<0.0001	—	—	<0.0001	<0.0001	I	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Fluoride	mg/L	0.2	—	—	0.2	0.2	I	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2
Ammonia as N	mg/L	0.15	—	—	0.14	0.05	I	0.05	0.02	0.09	0.15	0.06	0.11	0.05	<0.01	0.06	0.03	<0.1
Nitrite as N	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	0.15	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.1
Nitrate as N	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	<0.01	0.03	0.05	0.08	<0.01	0.08	<0.01	<0.1
Nitrite + Nitrate	mg/L	<0.01	—	—	<0.01	<0.01	I	<0.01	<0.01	<0.01	<0.01	0.03	0.05	0.08	<0.01	0.09	<0.01	<0.1
Total petroleum hydrocarbons																		
C6 - C9 Fraction	µg/L	<20	—	—	<20	<20	I	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	<50	—	—	<50	<50	I	<50	<50	<50	<50	<50	<50	<50	<50	<50	110	<50
C15 - C28 Fraction	µg/L	<100	—	—	<100	<100	I	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	<50	—	—	<50	<50	I	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	<50	—	—	<50	<50	I	<50	<50	<50	<50	<50	<50	<50	<50	<50	110	<50

(-) site dry; not sampled

Table 9.26: Project surface water quality data June 2019—July 2023

Parameter	Units	U/S BC																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Mar-22	Aug-22	Oct-22	Jan-23	Apr-23	Jul-23
pH value (lab)	pH Unit	—	—	—	7.17	—	7.80	7.58	7.56	7.86	8.01	8.23	7.26	7.45	7.94	D	7.99	7.81
Electrical conductivity (lab)	µS/cm	—	—	—	193	—	248	237	237	214	232	252	222	194	225	D	278	495
Total suspended solids	mg/L	—	—	—	37	—	19	8	15	142	14	14	76	35	31	D	9	9
Turbidity	NTU	—	—	—	146	—	13.1	10.6	11.3	313	67.8	33.8	305	247	121	D	6.4	6.6
Sulphate as SO_4	mg/L	—	—	—	2	—	2	1	1	4	6	6	5	4	4	D	4	8
Dissolved major cations																		
Calcium	mg/L	—	—	—	17	—	25	26	28	22	23	25	19	14	18	D	23	24
Magnesium	mg/L	—	—	—	6	—	10	8	8	8	7	8	7	5	7	D	9	11
Sodium	mg/L	—	—	—	13	—	14	13	15	15	16	18	18	15	24	D	30	62
Potassium	mg/L	—	—	—	7	—	6	6	5	6	5	6	7	6	7	D	8	8
Dissolved metals																		
Aluminium	mg/L	—	—	—	0.18	—	0.08	0.02	0.01	0.13	0.01	0.02	<0.01	0.22	0.33	D	0.01	<0.01
Arsenic	mg/L	—	—	—	0.007	—	0.006	0.004	0.005	0.004	0.001	0.001	0.004	0.003	0.003	D	0.004	0.001
Cadmium	mg/L	—	—	—	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	D	<0.0001	<0.0001
Chromium	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Copper	mg/L	—	—	—	0.002	—	0.002	0.003	0.002	0.003	0.004	0.003	0.003	0.005	0.003	D	0.002	<0.001
Lead	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Manganese	mg/L	—	—	—	1.46	—	0.343	0.036	0.177	0.437	0.017	0.012	0.011	0.002	0.111	D	0.05	0.001
Molybdenum	mg/L	—	—	—	0.001	—	0.002	0.002	0.001	0.001	0.001	<0.001	<0.001	0.001	<0.001	D	0.001	0.001
Nickel	mg/L	—	—	—	0.006	—	0.006	0.004	0.003	0.004	0.003	0.003	0.003	0.003	0.009	D	0.006	0.004
Selenium	mg/L	—	—	—	<0.01	—	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	D	<0.01	<0.01
Silver	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Uranium	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Vanadium	mg/L	—	—	—	<0.01	—	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	D	<0.01	<0.01
Zinc	mg/L	—	—	—	0.012	—	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	D	<0.005	<0.005
Boron	mg/L	—	—	—	<0.05	—	0.07	<0.05	<0.05	0.06	<0.05	<0.05	0.07	<0.05	0.09	D	0.07	0.06
Iron	mg/L	—	—	—	0.38	—	0.26	0.07	0.08	0.16	<0.05	<0.05	<0.05	0.21	0.28	D	<0.05	<0.05
Total metals																		
Aluminium	mg/L	—	—	—	4.36	—	0.84	0.31	0.37	11	3.39	1.32	8.78	14.4	7.22	D	0.35	0.29

Parameter	Units	U/S BC																
		Jun 19	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Mar-22	Aug-22	Oct-22	Jan-23	Apr-23	Jul-23
Arsenic	mg/L	—	—	—	0.010	—	0.007	0.005	0.005	0.006	0.003	0.001	0.006	0.004	0.005	D	0.004	0.001
Cadmium	mg/L	—	—	—	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	D	<0.0001	<0.0001
Chromium	mg/L	—	—	—	0.004	—	<0.001	<0.001	<0.001	0.008	0.003	0.001	0.008	0.015	0.006	D	<0.001	<0.001
Copper	mg/L	—	—	—	0.006	—	0.004	0.004	0.002	0.013	0.007	0.005	0.013	0.013	0.007	D	0.003	<0.001
Lead	mg/L	—	—	—	0.002	—	<0.001	<0.001	<0.001	0.003	0.001	<0.001	0.003	0.004	0.002	D	<0.001	<0.001
Manganese	mg/L	—	—	—	1.72	—	0.528	0.167	0.307	0.601	0.104	0.066	0.537	0.13	0.192	D	0.122	0.037
Molybdenum	mg/L	—	—	—	0.001	—	0.002	0.002	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	0.001	0.001
Nickel	mg/L	—	—	—	0.010	—	0.006	0.004	0.004	0.01	0.006	0.004	0.012	0.012	0.014	D	0.007	0.003
Selenium	mg/L	—	—	—	<0.01	—	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	D	<0.01	<0.01
Silver	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Uranium	mg/L	—	—	—	<0.001	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	D	<0.001	<0.001
Vanadium	mg/L	—	—	—	0.01	—	<0.01	<0.01	<0.01	0.02	0.01	<0.01	0.02	0.03	0.02	D	<0.01	<0.01
Zinc	mg/L	—	—	—	0.016	—	0.008	<0.005	<0.005	0.018	0.017	<0.005	0.022	0.026	0.014	D	0.005	<0.005
Boron	mg/L	—	—	—	<0.05	—	0.06	<0.05	0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	D	0.07	0.05
Iron	mg/L	—	—	—	5.97	—	1.6	0.47	0.52	11.2	2.92	1.18	8.51	10.9	5.86	D	0.41	0.30
Other																		
Mercury (dissolved)	mg/L	—	—	—	<0.0001	—	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0004	<0.0001	<0.0001	<0.0001	D	<0.0001	<0.0001
Mercury (total)	mg/L	—	—	—	<0.0001	—	<0.0001	0.0002	<0.0001	0.0003	<0.0001	0.001	<0.0001	<0.0001	<0.0001	D	<0.0001	<0.0001
Fluoride	mg/L	—	—	—	0.2	—	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	D	0.2	0.2
Ammonia as N	mg/L	—	—	—	0.32	—	0.16	0.15	<0.01	0.22	0.07	0.06	0.12	0.04	0.02	D	<0.01	0.01
Nitrite as N	mg/L	—	—	—	<0.01	—	<0.01	<0.01	<0.01	<0.01	0.07	<0.01	<0.01	<0.01	<0.01	D	<0.01	<0.1
Nitrate as N	mg/L	—	—	—	<0.01	—	<0.01	0.02	<0.01	0.08	<0.01	0.03	0.03	0.28	<0.01	D	<0.01	<0.1
Nitrite + Nitrate	mg/L	—	—	—	<0.01	—	<0.01	0.02	<0.01	0.08	<0.01	0.03	0.03	0.28	<0.01	D	<0.01	<0.1
Total petroleum hydrocarbons																		
C6 - C9 Fraction	µg/L	—	—	—	<20	—	<20	<20	<20	<20	<20	<20	<20	<20	<20	D	<20	<20
C10 - C14 Fraction	µg/L	—	—	—	<50	—	<50	<50	<50	<50	<50	<50	<50	<50	<50	D	<50	<50
C15 - C28 Fraction	µg/L	—	—	—	<100	—	<100	<100	<100	<100	<100	<100	<100	<100	120	D	<100	120
C29 - C36 Fraction	µg/L	—	—	—	<50	—	<50	<50	<50	<50	<50	<50	<50	<50	<50	D	<50	<50
C10 - C36 Fraction (sum)	µg/L	—	—	—	<50	—	<50	<50	<50	<50	<50	<50	<50	<50	120	D	<50	120

(-) site dry; not sampled

9.8.3.2 Streamflow

A number of gauging stations exist on the Dawson River to monitor streamflow. The closest DoR Dawson River streamflow gauging stations are at Bindaree (130374A) upstream south of the Project and the Beckers gauging station (130322A) downstream, north of the Project. Historical streamflow data has been recorded at Beckers gauging station since 1964 and at the Bindaree gauging station since 2005. Streamflow duration characteristics are similar between the Bindaree gauging station and the Beckers gauging station, as shown in Figure 9.37.

There are no streamflow gauging stations located along Banana Creek.

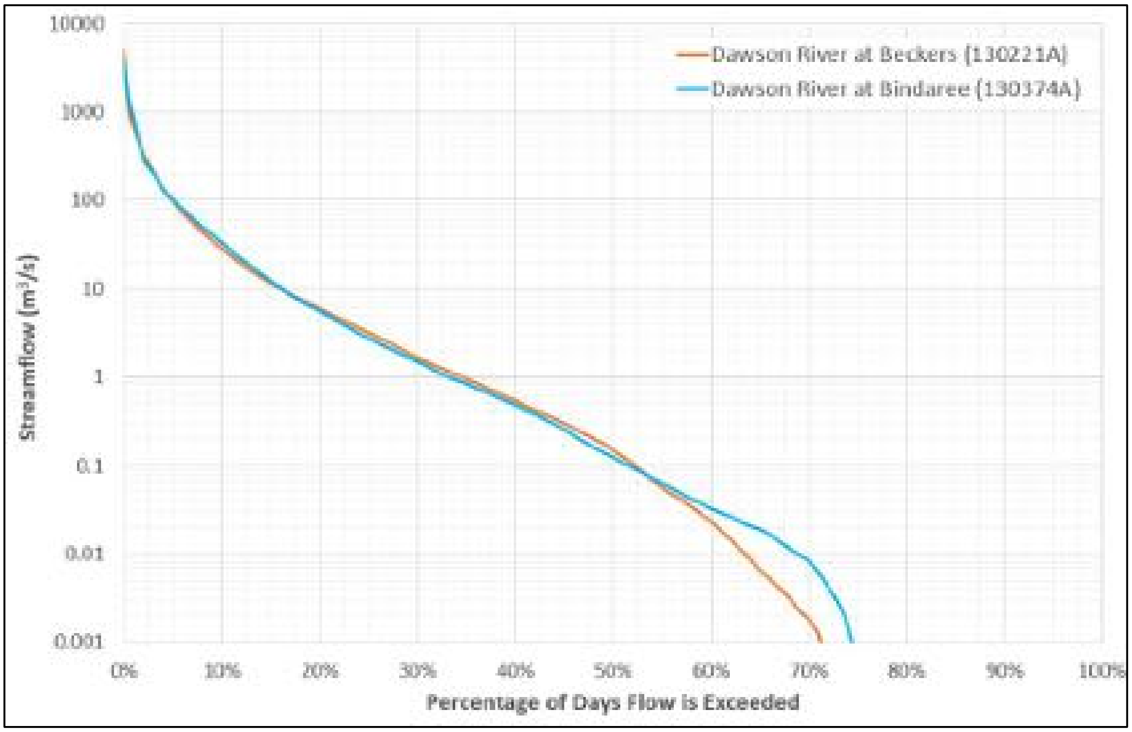

Figure 9.37: Dawson R. Beckers (130322A) and Dawson R. Bindaree (130374A): flow duration curves

9.8.3.3 Water dependent assets

Municipal use

The Banana Shire Council provides water supply services to the townships local to the Project. Banana Shire Council supplies potable water from several sources including Callide Dam and the Dawson River. Banana Shire Council provides potable water to Baralaba township from the Dawson River at Neville Hewitt Weir, approximately 8 km downstream of the Project (Banana Shire Council, 2018). The Woorabinda Aboriginal Shire Council also sources water from the Neville Hewitt Weir.

Agricultural use

Agriculture is the dominant industry using the land surrounding the Project. Agricultural users hold water allocations for the Dawson River under the Water Plan (Fitzroy Basin) 2011. A summary of un-supplemented entitlements, excluding entitlement holder names, is provided in Appendix A, Surface Water Impact Assessment.

The Project is located in Zone D of the Dawson Valley Water Management Area, as well as the Dawson Valley WSS, which supports irrigation, urban and industrial customers. Supplemented entitlements are administered under the Dawson Valley WSS, and summarised in Appendix A, Surface Water Impact Assessment.

Industrial use

The Project is located approximately 11 km south of Baralaba North Mine and approximately 27 km north of Dawson Mine. Both the Baralaba North Mine and Dawson Mine undertake controlled releases to the Dawson River. Mine-affected water release limits are defined in the EA for each mine. Monitoring of releases from both mines occurs in the Dawson River, upstream and downstream of the Project.

The Baralaba North Mine has an annual water entitlement of 500 ML/year under the *Water Act*, as administered by the Water Plan (Fitzroy Basin) 2011. Dawson Mine is located in the Dawson River catchment upstream of the Project and other nearby mine sites are located in different catchment areas.

Recreational use

The lower Dawson River’s main channel and its tributaries are used for both primary and secondary recreational purposes. These uses have been identified as environmental values for the Dawson River.

Baralaba Golf Course is located on the western bank of the Dawson River, approximately 1 km upstream of Baralaba township. On the eastern bank upstream of Baralaba township is the Neville Hewitt Weir campground and picnic area. Neville Hewitt Weir is recognised as a popular local fishing destination.

Aquatic ecosystems

The Dawson River and Banana Creek provide value as important aquatic ecosystem habitat in the region. Smaller drainage features in the Project area provide limited aquatic ecosystem value due to their highly ephemeral nature and disturbed condition.

A HES wetland (approximately 35 ha in area) is located within the MLA, between proposed operational activities and the Dawson River (refer Figure 9.38). The wetland is considered to exist due to the presence of clays in the shallow subsurface, which allows surface waters to persist after rain or flood events (Appendix B, Groundwater Modelling and Assessment). The aquatic ecosystem value of this wetland is considered moderate, and similar to other wetlands in the region (Ecological Service Professionals, 2023).

Two small wetlands of general ecological significance were also identified within the MLA boundary, shown on Figure 9.38. The wetlands are associated with drainage features within the Project area. These wetlands lie outside of the active mine disturbance footprint.

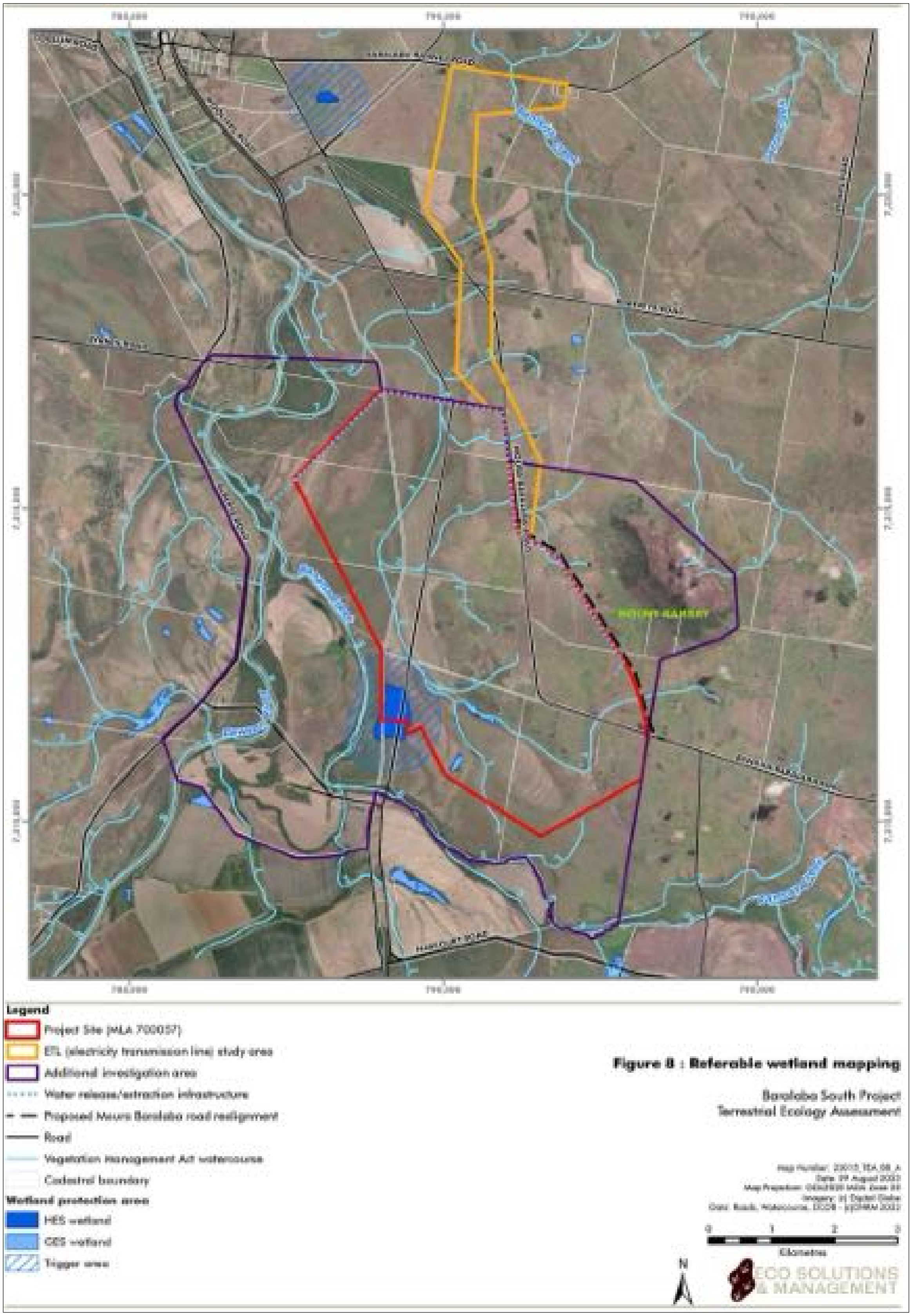

*Figure 9.38:	HES and GES wetland locations*

9.8.4. Potential impacts

9.8.4.1 Controlled mine water release impacts

Controlled releases from site will only occur where the storage capacity of the site water management system is exceeded—and then only in accordance with Fitzroy model release conditions of the EA. Mine-affected water releases from the Project are defined as pumped releases through a release point from storages used to contain water that has come into contact with mining or processing activities. These storages may contain water with elevated contaminant levels. Release from mine-affected water storages are proposed to coincide with medium to high flow events in the Dawson River.

Controlled mine water releases were modelled in accordance with the mine water release strategy. Mine water releases occur from MWD at a maximum rate of 43.2 ML/day (500 L/s pumping system) with a release efficiency factor of 90%.

Releases only occur when the modelled flow at the Dawson River is greater than 100 m^3/s in accordance with the release conditions. Therefore, all release events coincide with medium-high streamflow conditions in the Dawson River. The Dawson River flows above 100 m^3/s for approximately 5% of the time or 18 days per year on average.

Estimated annual release volumes over the Project duration for a range of probabilities are summarised in Figure 9.39. The results illustrate that releases typically occur in less than 25% of years. In a prolonged wet climate conditions (95th percentile), the annual release volume varies from 100 ML to 850 ML.

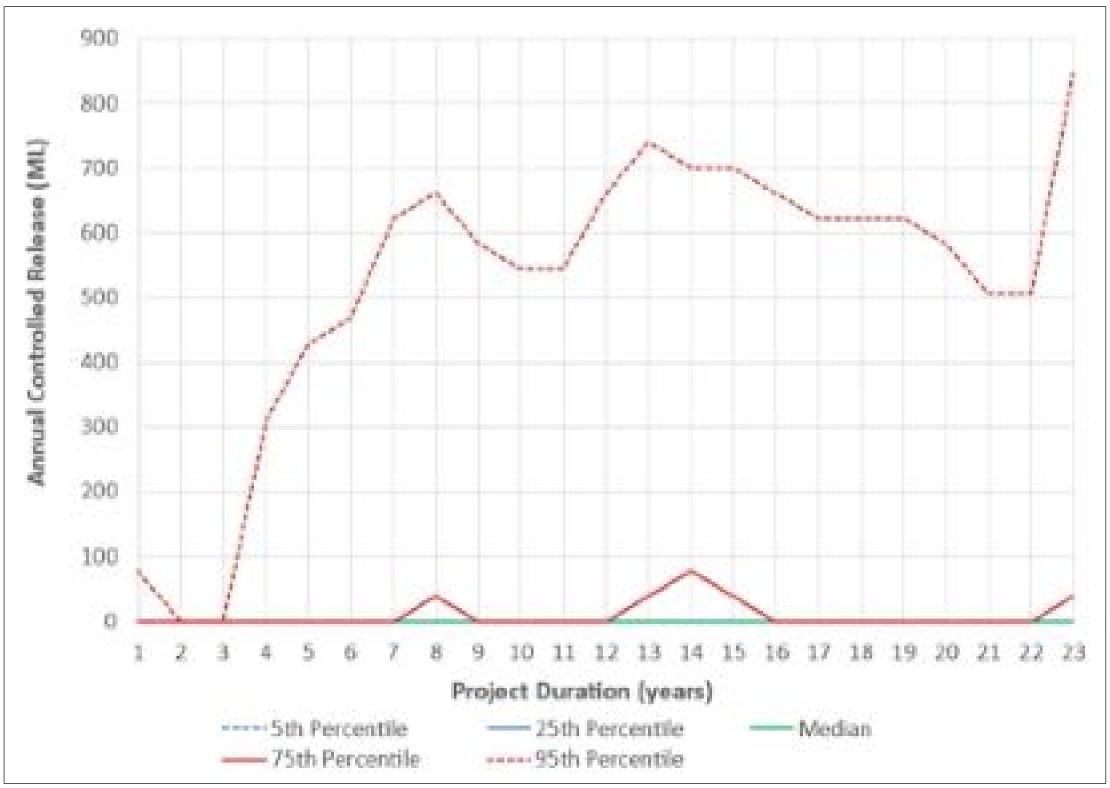

Figure 9.39: Annual controlled release volumes

An exceedance plot of annualised release event frequency is in Figure 9.40, and an exceedance plot of release event duration for all release events simulated in the model is in Figure 9.41. These plots show that:

- there are no controlled releases events in 75% of years;

- the Project is expected to have at least one controlled release event in less than 25% of years and at least two release events in 5% of years; and
- the duration of controlled release events is expected to range from 1 to 20 days (5th percentile and 95th percentile) with the median controlled release event duration being 5 days.

Controlled releases would occur over time, consistent with the existing duration of medium-high flows in the Dawson River, and would not impact the duration of flow events.

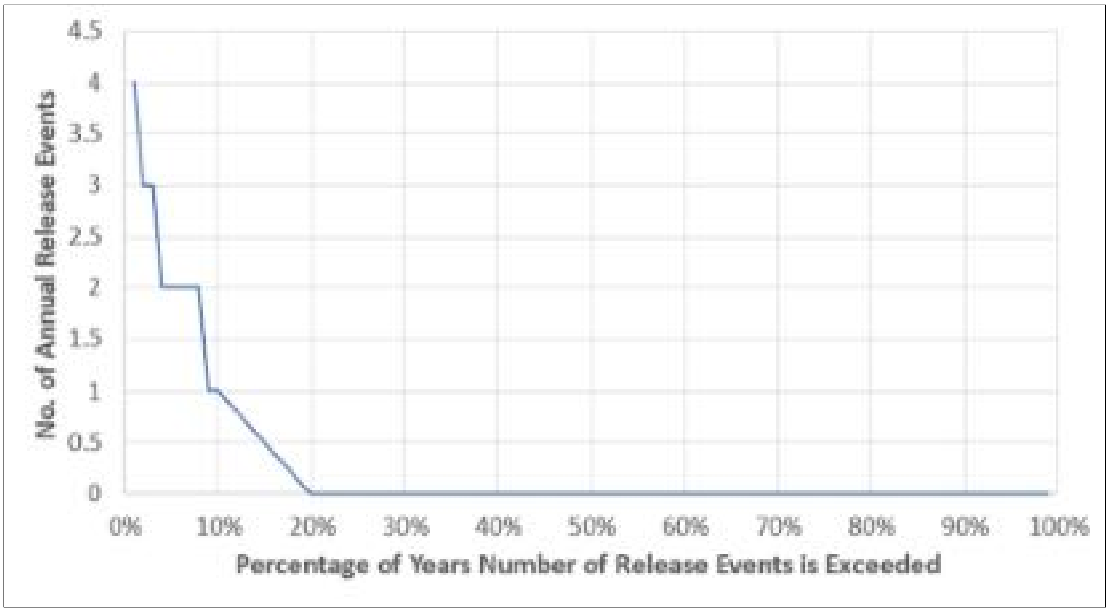

Figure 9.40: Number of release events per year

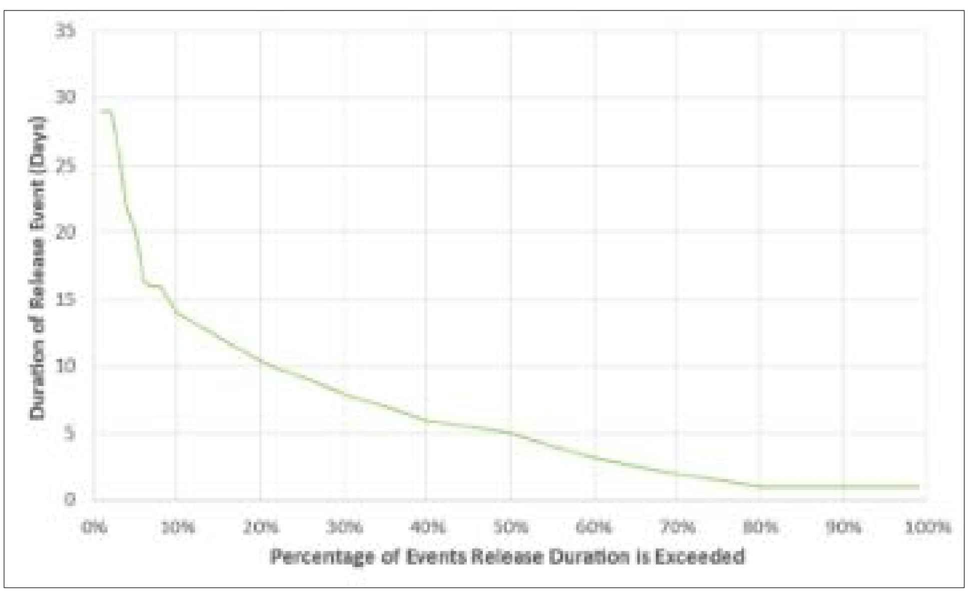

Figure 9.41: Duration of release events per year

Release mixing zone

The mixing zone is defined as the area downstream of the release location where release waters mix rapidly with the receiving waters due to momentum, buoyancy and turbulence of the surface water (DES, 2016). Within the initial mixing zone, dilution of release waters takes place and water quality objectives may not be met. Controlled releases from the Project will be discharged directly to the Dawson River main channel from MWD via a pipeline. Controlled releases will mix directly with Dawson River flows providing the required dilution to achieve the receiving water quality release limits. As described previously, the controlled release strategy has been developed so the release rate does not exceed 0.5% of the Dawson River streamflow, providing a minimum 1:200 dilution.

Small areas of elevated EC concentrations are expected in the localised vicinity of the controlled release discharge location, however, the average salinity in the river immediately downstream of the discharge location will remain below the receiving waterway water quality limit of 500 µS/cm. This is due to the high dilution rate from the proposed release conditions and mixing of the release waters from high velocity and turbulence at the discharge point location as well as mixing with the natural turbulence of flow in the river.

9.8.4.2 Mine water dam overflow

The site water balance model was also used to determine the overflow frequency of the proposed MWDs. The MWD and Enviro Dam both had no overflows during any of the model simulations, demonstrating a greater than 99th percentile annual containment performance standard.

In an overflow event, the Environment Dam and Mine Water Dam would overtop to clean water tributaries of the Dawson River. These dams have been designed to contain greater than the 95th percentile wet season inflow (overflow in less than 5% of years). The water balance assessment identifies no uncontrolled overflows from the mine water system in any simulated scenarios, demonstrating the mine water system exceeds the design containment standard.

The design containment standard for the mine water dams, and the water balance modelling results, ensure that there would be minimal actual or potential uncontrolled discharge of contaminants to waters that may or have the potential to cause an adverse effect on identified environmental values.

9.8.4.3 Sediment dam overflows

Sediment dams have been designed in accordance with the International Erosion Control Association Guidelines methodology for “Type D” sediment basins. Design selection was based on the soil types and to protect sensitive receiving waters. The sediment dams will continually be dewatered to the mine water system to improve containment to what is required. The catchments reporting to the sediment dams will progressively be rehabilitated over the Project life reducing sediment runoff being generated, improving the performance of the sediment dams.

The operational water balance model indicates that sediment dams will overtop in approximately 30% of years, which is higher than the containment standard adopted for the 85th percentile, five-day rainfall event. The annual overflow frequency of each sediment dams and the year which this occurs is provided in Appendix A, Surface Water Impacts.

The sediment dams have been designed to provide sufficient storage for settlement of suspended solids so that water quality during overtopping events has negligible impact on the water quality in the receiving waterway. During overtopping events, coarse sediments will continue to settle out as flow attenuates through the dam reservoirs. Sediment dams will be designed such that overtopping velocities are managed so they do not cause scour on the overtopping flow paths (as shown in Figure 9.29). Spillway control structures may include a combination of rock chutes, rock aprons and level spreaders.

Monitoring overtopping events will be undertaken to assess the performance of the sediment dams and ensure downstream environmental values are maintained and validate the design assumptions. Overtopping flows from sediment dams are not expected to have impacts on water quality affecting vegetation within the overflow pathways between the Project area and the Dawson River. Settlement dams will also include overflow control structures with scour protection (rock chutes, rock aprons and/or level spreaders) to ensure non-erosive discharges.

9.8.4.4 Clean water releases

Clean water releases from the Project are defined as releases from storages capturing only clean catchment runoff. These storages contain water that exhibits the same water quality characteristics as the receiving environment and does not come into contact with areas disturbed by mining activities. The release of clean water from site will not impact water quality or environmental values in the receiving waterways. Clean water release is required where a gravity diversion drain is not possible, to maximise clean and mine-affected waters separation.

9.8.4.5 Stream flow impacts

Catchment reduction

Potential impacts on streamflow in the Dawson River from the Project include:

- Decreased flow due to capture of rainfall runoff within the Project disturbance area; and
- Reduced flow as a result of predicted groundwater drawdown from the Dawson River (Watershed HydroGeo, 2023).

Impacts to the Dawson River streamflow were assessed using the Dawson River IQQM that was developed by the State Government to inform water resource planning aspects of the Water Plan (Fitzroy Basin) 2011.

The model results indicate the Project is expected to have only minor reductions to the Dawson River streamflow volume and duration. The Project is expected to reduce streamflow less than 0.045% (mean annual flow) at the Project location, which is not expected to impact the existing Dawson River riparian vegetation or channel morphology. Modelled changes to Dawson River stream flows at the Dawson River at Beckers gauging station are summarised in Table 9.27.

Table 9.27: Dawson River streamflow impact summary (Beckers Gauging Station)

Flow condition	Event basis	Stream flow characteristics before Project	Stream flow characteristics after Project	Change (%)
Base flows	Percentage of time Base flow is exceeded (86ML/day)	30.5%	30.3%	-0.66
Medium Flows	Annual mean	693,050 ML/year	692,769 ML/year	-0.04
	Median ratio of annual flows	52.4%	52.0%	-0.76
High Flows	2 year ARI peak	26,002 ML/day	25,968 ML/day	-0.13
	5 year ARI peak	100,026 ML/day	99,956 ML/day	-0.07
	20 year ARI peak	209,777 ML/day	209,628 ML/day	-0.07
	4 percentile flow	7,669 ML/day	7,664 ML/day	-0.07
	10 percentile flow	1,524 ML/day	1,520 ML/day	-0.26

In summary:

- The Project will result in only minor reductions in the Dawson River mean annual streamflow volume (0.08% at the Project location and 0.04% at the Dawson River at Beckers gauging station).
- The Project will have only minor impacts to flow duration with negligible impacts to the Dawson River low, medium and high flow regimes.
- The Project achieves all EFOs specified in the Water Plan (Fitzroy Basin) 2011.
- The Project has negligible impact on existing water licences and allocations from the Dawson River and achieves the WASOs in the Water Plan (Fitzroy Basin).

The minor reduction in streamflow as a result of the Project is not predicted to impact the existing Dawson River riparian vegetation or channel morphology.

There are also number of small, unnamed tributaries that flow through the Project area. The catchments of waterways flowing through the MLA are expected to be reduced by the open cut pit and water containment storages. The total catchment of the main waterway draining through the MLA to the Dawson River is expected to have a maximum reduction of ~33% in year 23 of the Project. This is expected to have a moderate impact to stream flows in the waterway during operations, however, at closure with the rehabilitated mine landforms draining from site, the catchment is reduced to 13% (up to 420 ha draining to the final void).

Where possible, undisturbed catchments have been diverted with clean water drains and dams to reduce mine-affected water accumulating and potential impacts to water resources. The reduction in streamflow in small ephemeral waterways within the Project area is not expected to result in significant impacts to water values.

Groundwater baseflow/leakage

The drawdown effects on the baseflow/leakage at the watercourses and drainage features defined near the Project have been assessed in Appendix B, Groundwater Modelling and Assessment, and the analysis presented in section 9.10.4.

While the predicted groundwater drawdown in the Permian strata, as a result of the Project, would be limited in the shallow groundwater systems, it would incidentally transfer directly to some, albeit immeasurable, leakage from the Dawson River (upstream of Neville Hewitt Weir) to the surficial geology. The estimated volume transferred is likely to be approximately 0.16 ML/d but may be up to 0.2 ML/day. When compared to the average surface water flows in the Dawson River, this equates to a 0.01% reduction in flow. Similarly, the modelled leakage predicted from Banana Creek is considered negligible, as it only flows on occasions following rainfall events.

9.8.4.6 Sodicity of soils

Soils of the Project are dominated by non-sodic topsoils and non-sodic and sodic subsoils. The sodic nature of subsoils indicates that they may become dispersive if exposed to surface water runoff for prolonged periods post topsoil stripping, resulting in increased sediment loads in runoff.

Stripping depths for topsoil resources have considered the sodicity of soils and are not considered to be sodic and dispersive. A significant majority of topsoil reclaimed will originate from the Langley SMU, which is characterised by non-sodic soil with negligible dispersibility (see Appendix K). Rehabilitated landforms are at low risk of the dispersive impacts associated with sodic soils.

9.8.4.7 Waste rock emplacement seepage

A geochemical assessment of potential waste rock and coal reject materials has been conducted by Terrenus Earth Sciences (Appendix E, Geochemical Assessment) to inform the potential water contaminants generated by water infiltration through the waste rock emplacements. The assessment concluded that the waste rock is expected to be overwhelmingly non-acid forming (NAF), with excess acid neutralising capacity, and have a negligible risk of developing acid conditions. Furthermore, waste rock is expected to generate relatively low salinity surface runoff and seepage, with relatively low soluble metal/metalloid concentrations (Appendix E, Geochemical Assessment).

The soluble multi-element results indicate that leachate from bulk waste rock has the potential to contain slightly elevated soluble aluminium, arsenic, molybdenum and/or selenium concentrations compared to applied ANZECC (2000[2018]) aquatic ecosystem protection and/or livestock drinking water quality guideline concentrations. Slightly elevated concentrations for some metals/metalloids for waste rock and coal reject materials are common at coal mines in the Bowen Basin and, generally, do not result in any significant water quality issues (Appendix E, Geochemical Assessment).

Waste rock materials are expected to have mixed sodicity and dispersion potential (non-sodic through to strongly sodic). Waste rock landforms will be constructed with short and low (shallow) slopes and will be progressively rehabilitated to minimise erosion.

Coal processing reject materials are expected to generate pH-neutral to alkaline, low salinity runoff and seepage. Approximately 64% of potential coal reject samples have been classified as NAF, 10% as 'low' to 'moderate' potentially acid forming (PAF), and 26% of samples as uncertain. Based on the sulphur concentrations, the results suggest the capacity for most PAF and uncertain materials to generate significant acidity is low (Appendix E, Geochemical Assessment). It should be noted that CHPP rejects are expected to comprise less than 5% of the volume of all mining waste rock handled during the Project (Appendix E, Geochemical Assessment).

Total metal/metalloid concentrations in coal reject are also expected to be low. Some coal reject materials could produce leachate containing slightly elevated concentrations of soluble arsenic and/or selenium and, to a lesser extent, aluminium, as is common from Permian coal measures in the Bowen Basin.

The geochemical characteristics of waste rock and potential coal rejects at the Project are consistent with the geochemical characteristics of these materials at Baralaba North Mine. This confirms the geological and geochemical consistency of the Baralaba Coal Measures in this district, from Baralaba North through to the Project (Appendix E, Geochemical Assessment).

Seepage generated by in-pit waste rock placement will report to nearby pits and be managed in the mine water system. Seepage generated from out-of-pit WRE areas is expected to follow the natural topography under the dump. This would lead to out-of-pit dump seepage draining to backfilled voids or the open cut pit. Uncontrolled release of seepage is not expected to occur from site and recovered seepage flows will be managed in accordance with the mine water management system. It is not expected that seepage from the WRE will cause any additional impacts to water quality in the receiving waterway.

9.8.4.8 Accidental release of hazardous materials or dangerous goods

There is the potential for accidental release of hydrocarbons or chemicals during activities resulting in localised contamination. Facility design and management of all required fuels and hydrocarbons will ensure there are effective means of secondary containment to prevent or minimise releases to the environment from any on-site fuel and oil storage. The associated risk of release and impacts to water values is low.

9.8.4.9 Water dependent assets

Regional water availability

The Project will source most of its water demands from both surface water runoff within the Project boundaries and groundwater ingress. The water management strategy for the Project will divert clean catchment water away from disturbed mining areas for release from the site, while rainfall runoff from disturbed areas, pit water and recycled water from the CHPP, will be captured and diverted to mine water dams as mine-affected water.

Water supply 'make-up' will be sourced from water allocations from the Dawson Valley WSS. Related entities of the Proponent currently hold over 1,418 ML of water allocation from the Fitzroy Basin, Dawson River Zones C/D and 315ML of water licences from the Broadmeadow properties. Utilising water allocations by the Project will not result in any additional impact to other existing allocation holders, as the resource will be accessed in accordance with the existing allocation conditions.

The Project is not anticipated to impact supply of water from the Benleith Water Scheme. Additionally, there is not anticipated to be any impact on the objectives of the Water Plan (Fitzroy Basin) 2011.

Aquatic ecosystems

The Dawson River and Banana Creek provide value as important aquatic ecosystem habitat in the region. Potential impacts associated with flooding, streamflow and contaminant release have been assessed in previous sections. The potential impacts to aquatic ecosystems as a result of the Project is considered to be low.

The water management system has been designed to minimise potential impacts on the HES wetland. The Project will not reduce the catchment area reporting to the wetland and will not have a significant impact on flooding interactions between the wetland and the Dawson River and Banana Creek. Impacts to the wetland have also been assessed as part of the aquatic ecology report (Ecological Service Professionals, 2023). The aquatic ecology report concluded that the aquatic ecosystem value of this wetland was moderate rather than high, and that this wetland would provide similar value habitat as other wetlands in the region (Ecological Service Professionals, 2023).

Two small wetlands of general ecological significance were also identified in the Project area. The wetlands are associated with small ephemeral drainage features. These wetlands lie outside of the Project footprint and are not expected to be significantly impacted by the Project.

9.8.4.10 Moura-Baralaba Road realignment

The Project includes the realignment of an approximate 4.5 km of the Moura-Baralaba Road to the east of the MLA (700057) which is subject to separate approvals. The road realignment is located outside of the 0.1% AEP regional flood level and will be designed so that there are negligible flow impacts. The new road will have a sealed surface preventing sediment runoff. A construction erosion and sediment control plan will be developed to prevent impacts during the construction of the road.

9.8.4.11 Electricity transmission line

The Project includes development of an ETL of approximately 8 km in length within a 20 m easement, and associated infrastructure. The ETL will link the Project with the Baralaba Substation, located approximately 6 km east-south-east of the Baralaba township. Two ETL alignment options are being considered where the final ETL alignment will be determined at a later date in consideration of the outcomes of the assessments conducted for the EIS and the preference of a third-party responsible for the infrastructure. The ETL will have minimal ground disturbance and the transmission line poles will be located outside of waterways to avoid impact overland flows or flooding. The ETL is expected to have negligible surface water impacts.

9.8.4.12 Final void

Diverting clean catchment into the final void would dilute groundwater inflows and slow the evapo-concentration process in the final void waterbody and, thereby, reduce salinity. A final void hydrology assessment has been conducted for two scenarios:

- Scenario 1—final void catchment area (i.e. base case, no diversion of any additional catchment into the final void).

- Scenario 2—final void catchment area, plus the diversion of additional rehabilitation landform runoff and enhanced spoil infiltration.

Scenario 2 (improved catchment inflows) is proposed to support an improved rehabilitation outcome and as such has been proposed in this application. The modelling results show:

- The final void water level is expected to approach an equilibrium level of 32 mAHD (92.5 GL of storage) after approximately 325 years which is approximately 61 m below natural surface.
- The equilibrium lake level remains approximately 40m to 50m below the pre-mining standing groundwater levels near the final void location (based on observed data this is typically 68-80 mAHD) (Watershed HydroGeo, 2023).
- At equilibrium, the model predicts multi-annual fluctuations in water level between 24.6 mAHD and 37.4 mAHD.
- EC in the final void was not shown to reach an equilibrium over a 500-year forecast with EC predicted to reach 5,650 µS/cm at 100 years post closure and 5,840 µS/cm when the void lake level reaches equilibrium conditions.
- The water quality mitigation indicates a minimum freeboard allowance of 55 m for a pit crest level of 93 mAHD indicating there is no risk of overtopping to the receiving environment.

The results also indicate the void is not at risk of overtopping to the receiving environment.

Continued salt accumulation is expected to occur as a result of runoff and groundwater ingress combined with evaporative concentration. In the proposed final void arrangement, there are no salt outflows, and therefore it is expected that TDS will continue to increase until saturation is at a very slow rate. The final void hydrology model assumes a constant salt load from spoil and groundwater inflows. It is more likely that the runoff water quality would improve over time as salts are leached from the landform, indicating the model results are conservatively high.

Under all climate change scenarios, the pit lake level is more than 50 m below ground and will remain as a groundwater sink. The associated risk of contaminant release and environmental harm is insignificant.

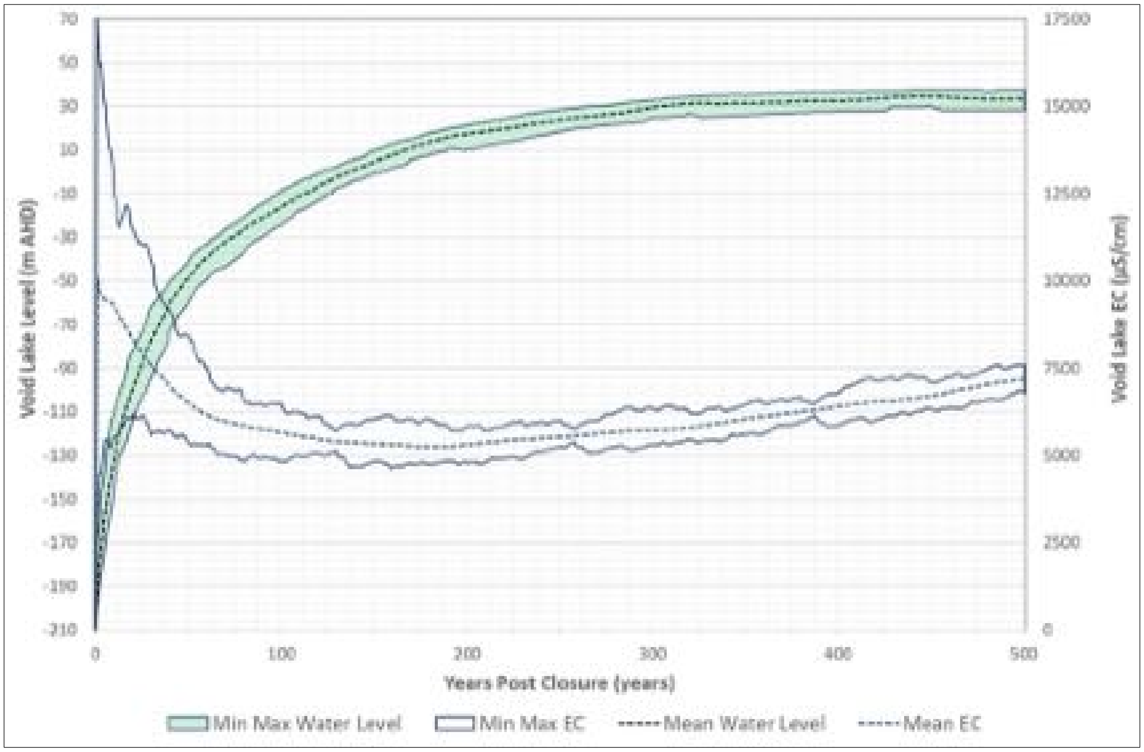

Figure 9.42: Final void water level (improved catchment inflow scenario)

9.8.4.13 Cumulative impacts

Streamflow and catchment

The Project is located approximately 11 km south of the Baralaba North Mine and approximately 27 km north of the Dawson Mine. The concurrent operation of these sites has the potential to result in cumulative impacts on the surface water environmental values. Cumulative impacts on surface from the Project and existing industry in the Dawson River catchment could include:

- impacts to water resources including existing surface water entitlements due external raw water supply demand for each operation;
- impacts to the Dawson River streamflow regime from a cumulative reduction in the Dawson River catchment area; and
- impacts to Dawson River water quality due to concurrent controlled mine water releases occurring from each operation.

Water allocations

The Baralaba North Mine and Dawson Mine are both located on the Dawson River and likely to have access to water entitlements from the Dawson River administered under the Water Plan (Fitzroy Basin) 2011. Entitlements under this plan are modelled using the regional Dawson Callide Sub-catchment Integrated Quantity-Quality Model, and cumulative impacts are considered before entitlements are granted. There are not expected to be any further cumulative impacts as a result of the Project accessing existing water allocations.

Controlled mine water releases

The mine water management system will operate in accordance with EA release conditions and in-stream trigger levels aligned with the WQOs in the 'Environmental Protection (Water and Wetland Biodiversity) Policy, 2019'.

The Project will conduct controlled releases of mine-affected water to the Dawson River in accordance with the EA conditions. The Dawson River also receives controlled releases of mine-affected water from the Baralaba North Mine, located approximately 11 km north of the Project and the Dawson Mine, located approximately 27 km south of the Project.

An assessment of a simultaneous release from the Baralaba North Mine, Dawson Mine, and the Project has been undertaken to assess the potential for water quality exceedances at the Beckers gauging station on the Dawson River.

A worst-case assessment was undertaken where all mines are releasing the maximum quantity of water with the maximum end-of-pipe EC during minimum Dawson River flows. The 90th percentile background Dawson River streamflow EC has conservatively been adopted for the assessment. Based on the worst-case assessment, the maximum expected EC at the Dawson River Beckers gauging station is 389 µS/cm, which is well below the receiving waters EC limit in the Baralaba North Mine EA (500 µS/cm). For the same scenario with a background streamflow equal to the high flow WQO objective of 210 µS/cm, Dawson River EC could potentially reach 300 µS/cm.

This is a highly conservative assessment as this scenario is based on the unlikely event that all mines are releasing the maximum quantity of water at the maximum allowable EC during minimum Dawson River flows. Also, in practice the timing of releases from the three mines are not likely to align due to the significant spatial distances between the mines.

A summary of the worst-case mine water release case accounting for release from the Baralaba North Mine, Dawson Mine and the Project is provided in Table 9.28 and Table 9.29 for the high flow EC WQO and 90th percentile background Dawson River streamflow EC, respectively.

Table 9.28: Cumulative release water quality (Dawson River EC High Flow WQO)

Dawson River flow rate (m^3/s)	Dawson River EC (µS/cm)	Baralaba North release		Dawson Mine release		Baralaba South release		Dawson River at Beckers EC (µS/cm)
		Rate (m^3/s)	EC (µS/cm)	Rate (m^3/s)	EC (µS/cm)	Rate (m^3/s)	EC (µS/cm)	
30	210	0.5	1,500	0.288	1,500			243
53	210	0.5	3,000	0.288	1,500			243
92	210	0.5	5,000	0.38	5,000			255
100	210		5,000	0.38	5,000	0.5	10,000	300
140	210	0.5	7000	0.55	5,000	0.5	10,000	287
190	210	0.5	10,000	0.82	5,000	0.5	10,000	282

Table 9.29: Cumulative release water quality (90th percentile background Dawson River EC)

Dawson River flow rate (m^3/s)	Dawson River EC (µS/cm)	Baralaba North release		Dawson Mine release		Baralaba South release		Dawson River at Beckers EC (µS/cm)
		Rate (m^3/s)	EC (µS/cm)	Rate (m^3/s)	EC (µS/cm)	Rate (m^3/s)	EC (µS/cm)	
30	300	0.5	1,500	0.288	1,500	-	-	331
53	300	0.5	3,000	0.288	1,500	-	-	332
92	300	0.5	5,000	0.38	5,000	-	-	345
100	300	0.5	5,000	0.38	5,000	0.5	10,000	389
140	300	0.5	7,000	0.55	5,000	0.5	10,000	376
190	300	0.5	10,000	0.82	5,000	0.5	10,000	371

9.8.4.14 Climate change impacts

Operational water balance

The Baralaba South Coal Project operational water balance model daily climate inputs were adjusted using the year 2050 climate projections to assess the impact of the “best” case, “worst” case and “maximum consensus” climate change scenarios on the water balance assessment results.

The year 2050 projected climate change variables reduce the total runoff reporting to storages and increases evaporation from storages in the operational water balance model. This results in a reduction in controlled and uncontrolled releases from the Project and overall reduction in the identified impacts to the receiving environment.

Final void water balance

The modelled climate change scenarios do not improve or worsen the impacts from the Project’s final void. Under all climate change scenarios assessed, the pit lake level is more than 50 m below ground and the pit is not at risk of overtopping. Water quality (TDS) in the pit lake is expected to be higher for the climate change scenarios with increased evaporation and reduced rainfall, although is not expected to have any adverse impacts to the receiving waterway as the final void is not expected to overtop.

9.8.5. Mitigation, management measures and monitoring

The water management system infrastructure has been developed to achieve the water resources and water quality objectives of:

- equitable, sustainable and efficient use of water resources;
- maintaining environmental flows, water quality, in-stream habitat diversity and naturally occurring inputs from riparian zones (including GDEs) to support the long-term maintenance of the ecology of aquatic biotic communities;
- the condition and natural function of water bodies are maintained including the stability of beds and banks of watercourses;
- protecting the environmental values of waters; and
- protecting the environmental values of wetlands.

A range of management strategies have been proposed to mitigate any adverse environmental impacts on water resources and water quality, and to assist in meeting the water quality objectives and protection of identified environmental values.

9.8.5.1 Diversion of clean catchments

The water management system minimises the clean catchment captured by site, reducing the Project's impact on streamflow in the receiving waterway. This is achieved by reducing the quantity of catchment diverted away from the Dawson River and into the mine water system. The design of clean catchment diversions throughout the Project has reduced to negligible the impact on streamflow, meeting all flow objectives for the Dawson River.

9.8.5.2 Mine-affected water containment

Mine-affected water storages have been designed such that the standard of containment for all water infrastructure containing mine water meets the environmental objectives for regulated structures containing contaminants from the DEHP 'Guideline for Structures which are Dams or Levees Constructed as part of Environmentally Relevant Activities' (DEHP, 2017).

The design containment standard for the mine water dams and the water balance modelling results ensure that overtopping events occur in less than 5% of years. Water balance modelling shows no overflows from mine-affected water storages.

Water management infrastructure has been designed to progress as mining operations advance as shown on Figure 9.43 to Figure 9.49.

9.8.5.3 Preferential process use

Any water dewatered from the pit will be used preferentially for supply to the CHPP and dust suppression. The water management system is designed to prioritise use of stored inventories of mine water, reducing the external raw water supply requirements.

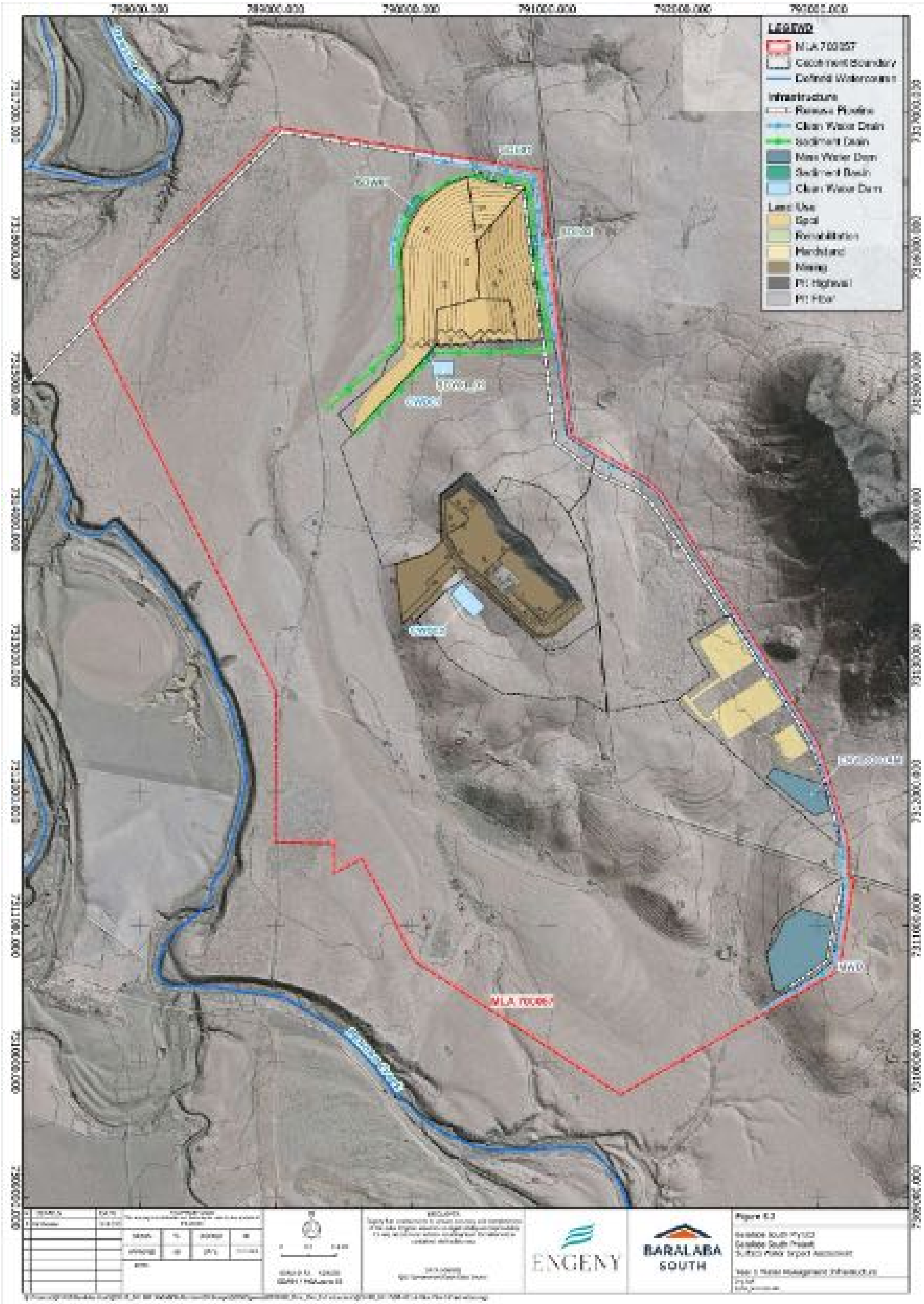

Figure 9.43: *Year 1 Water management infrastructure*

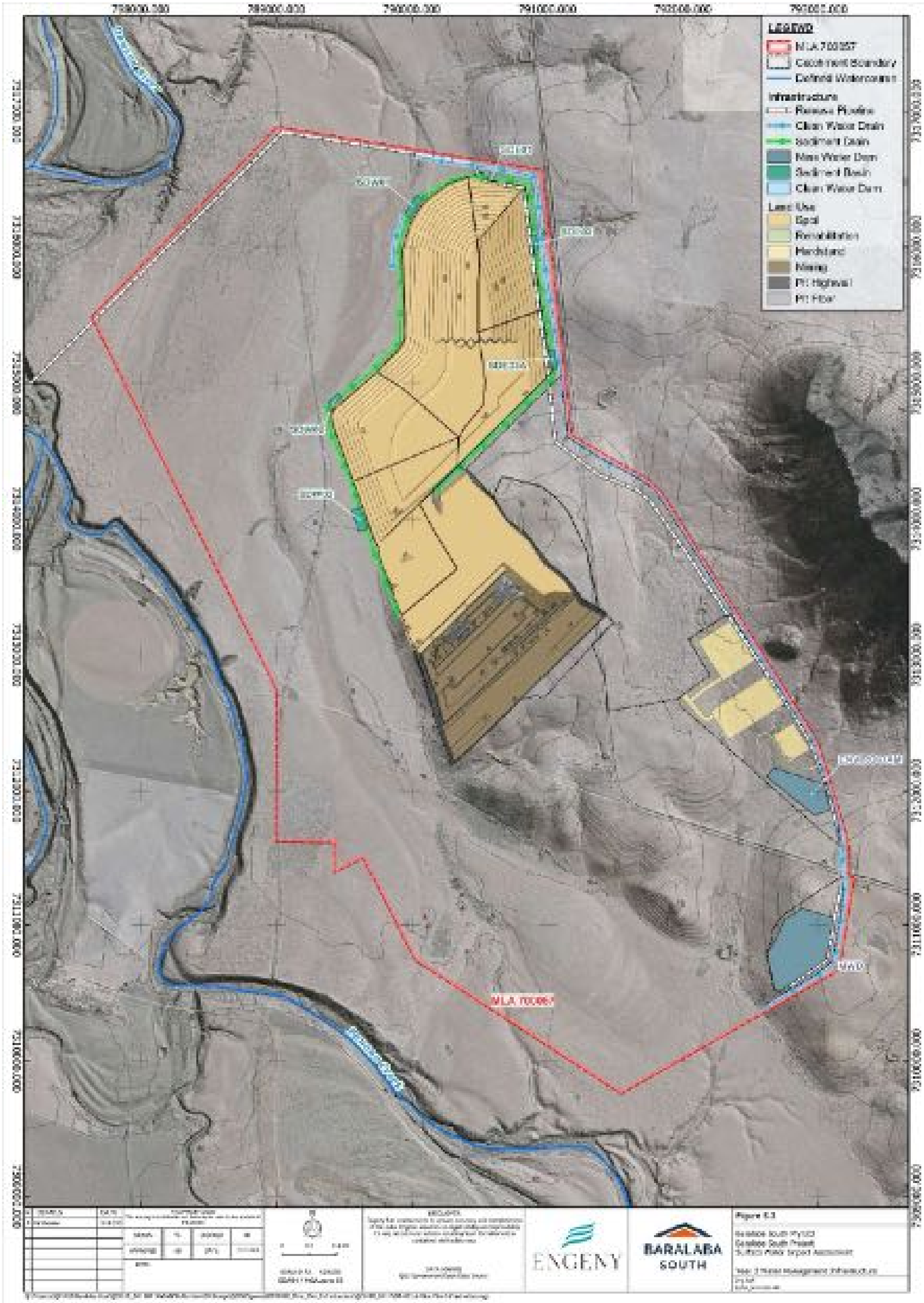

Figure 9.44: *Year 3 Water management infrastructure*

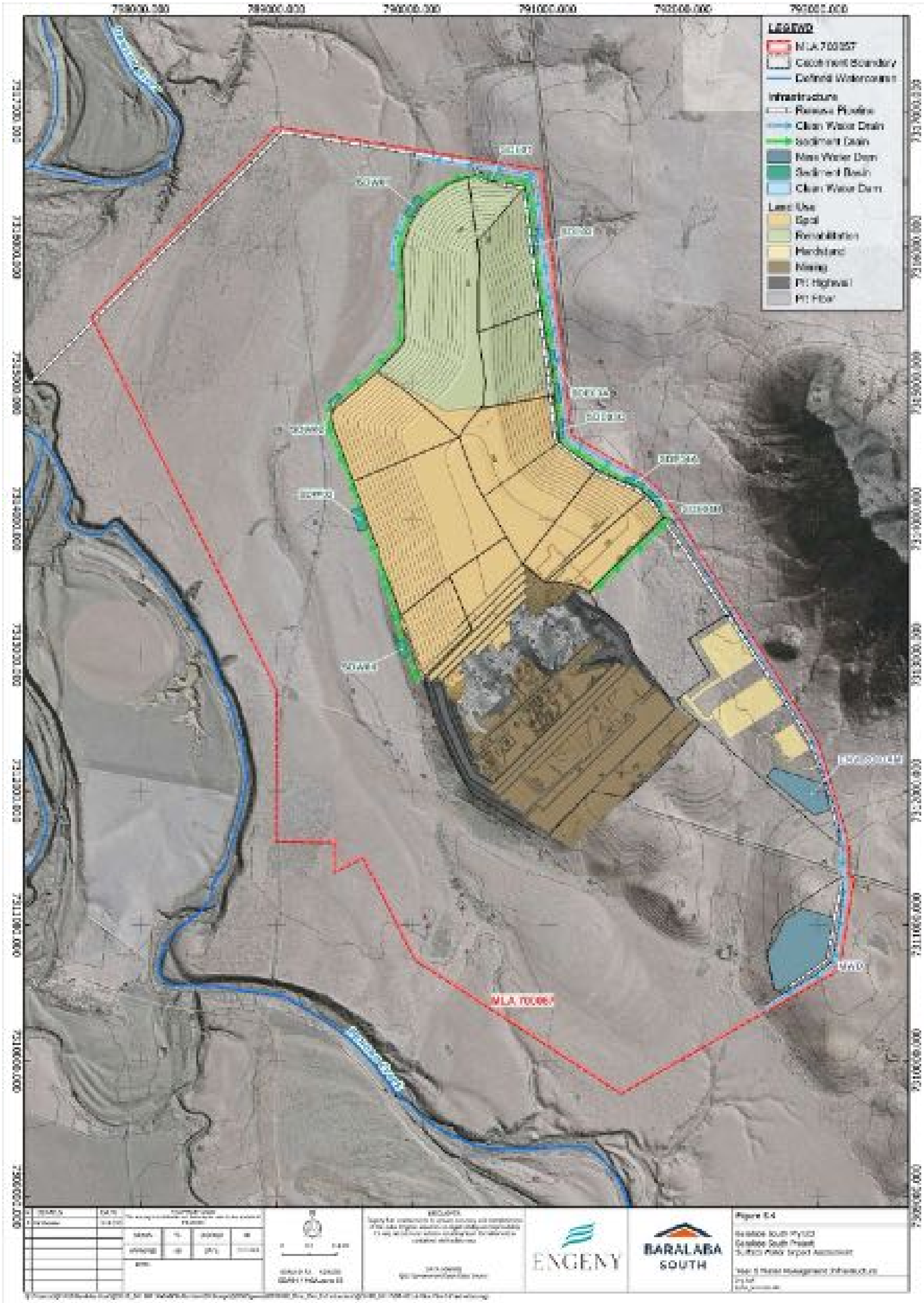

Figure 9.45: Year 6 Water management infrastructure

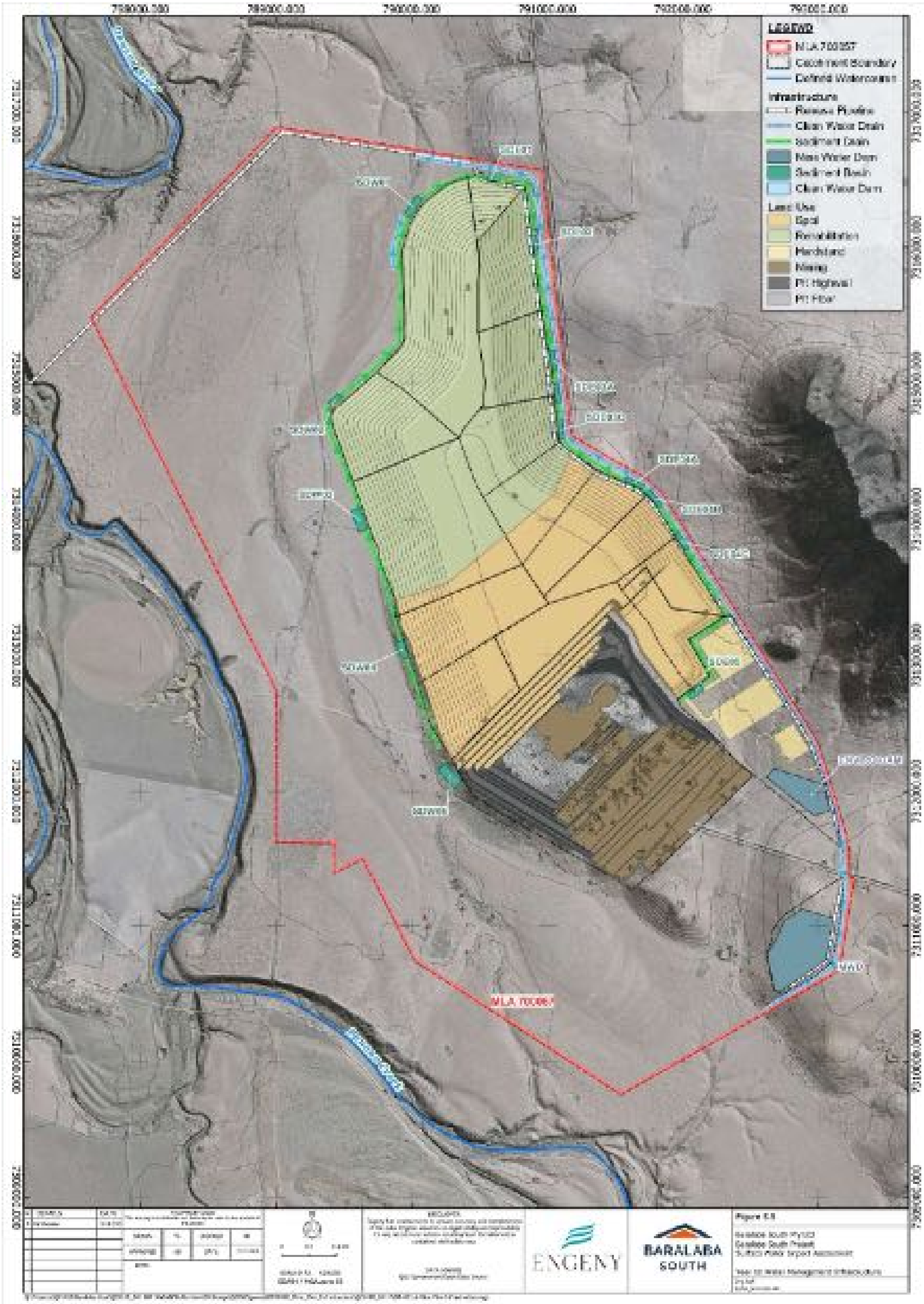

Figure 9.46: Year 11 Water management infrastructure

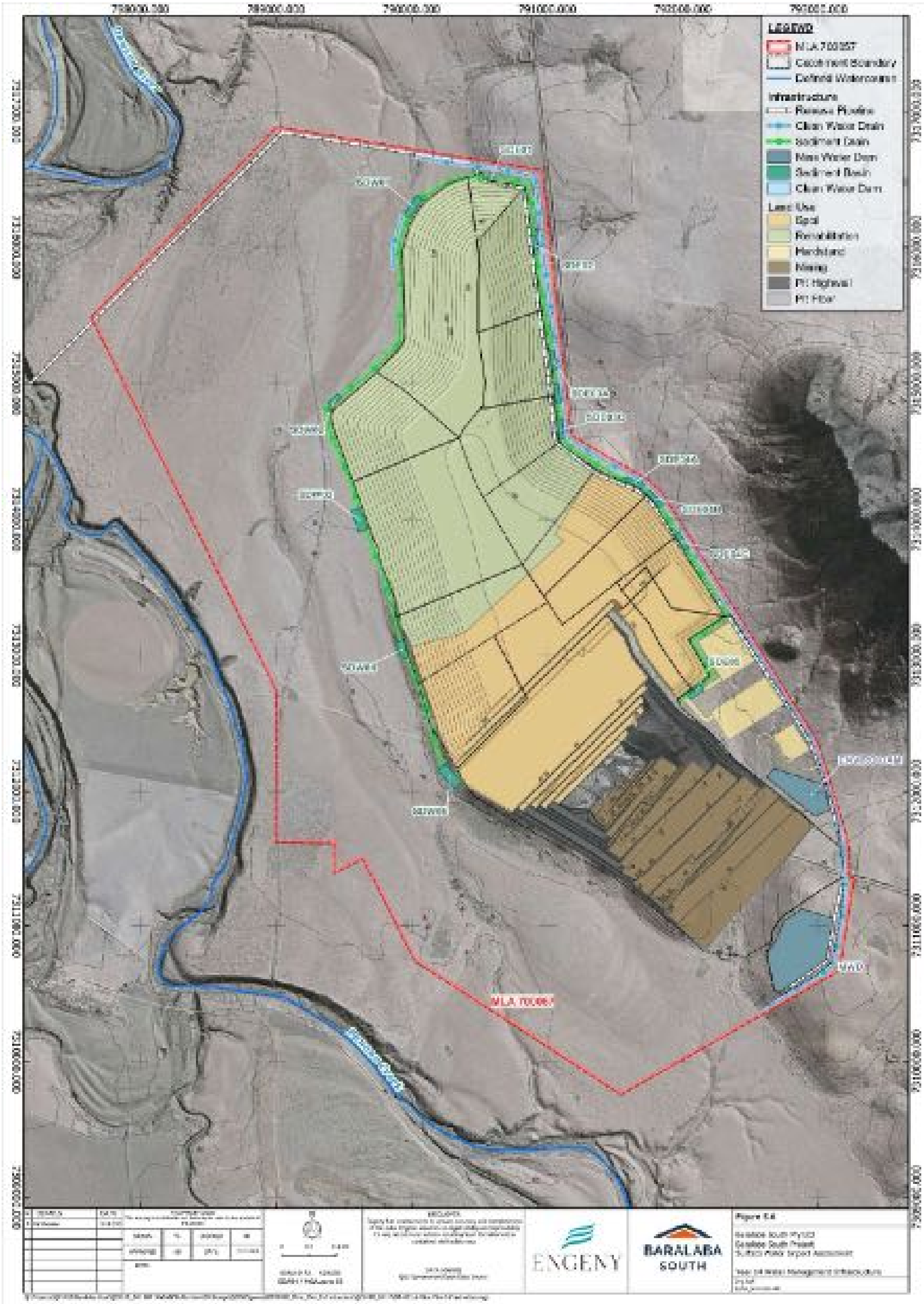

Figure 9.47: Year 14 Water management infrastructure

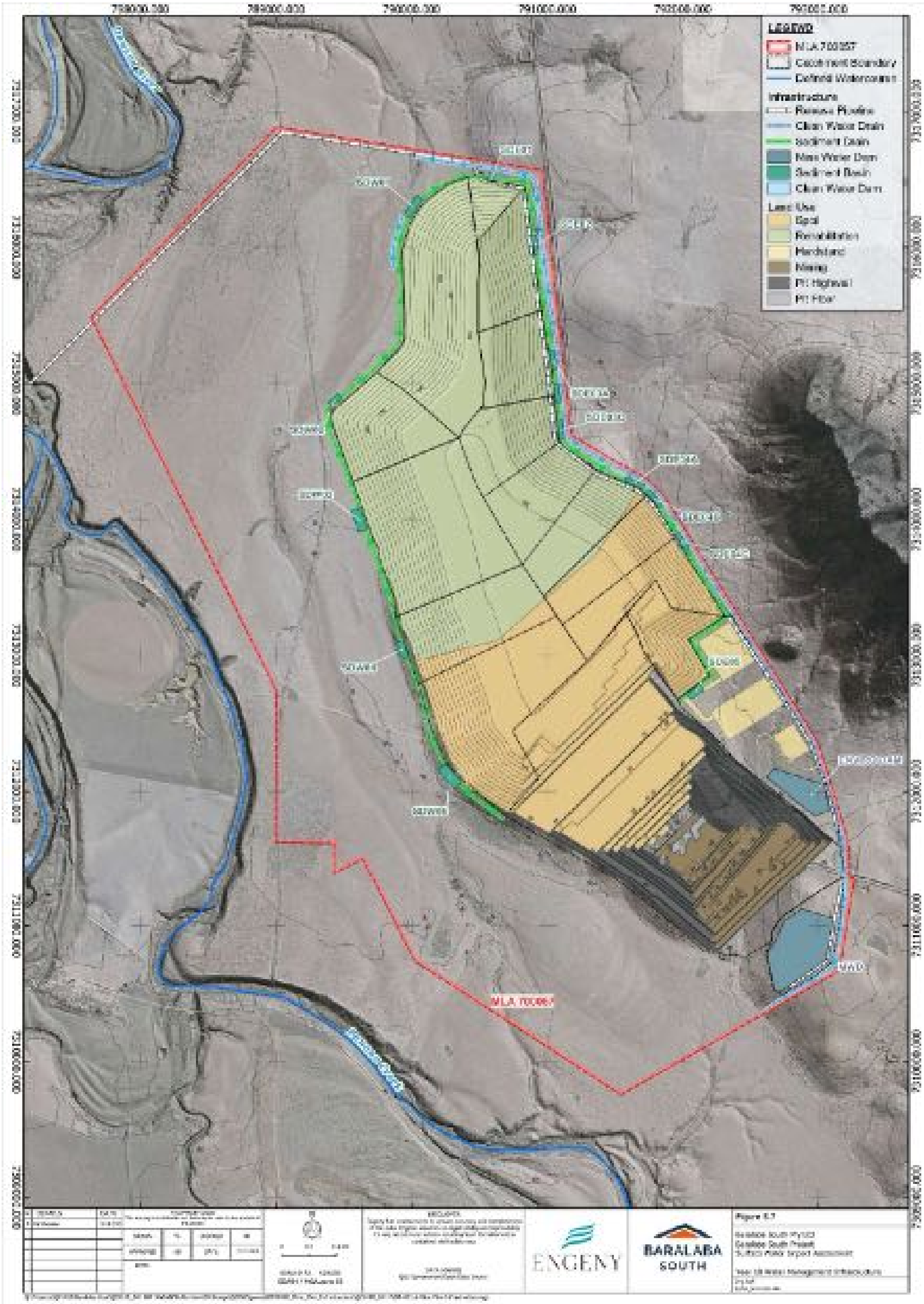

Figure 9.48: Year 19 Water management infrastructure

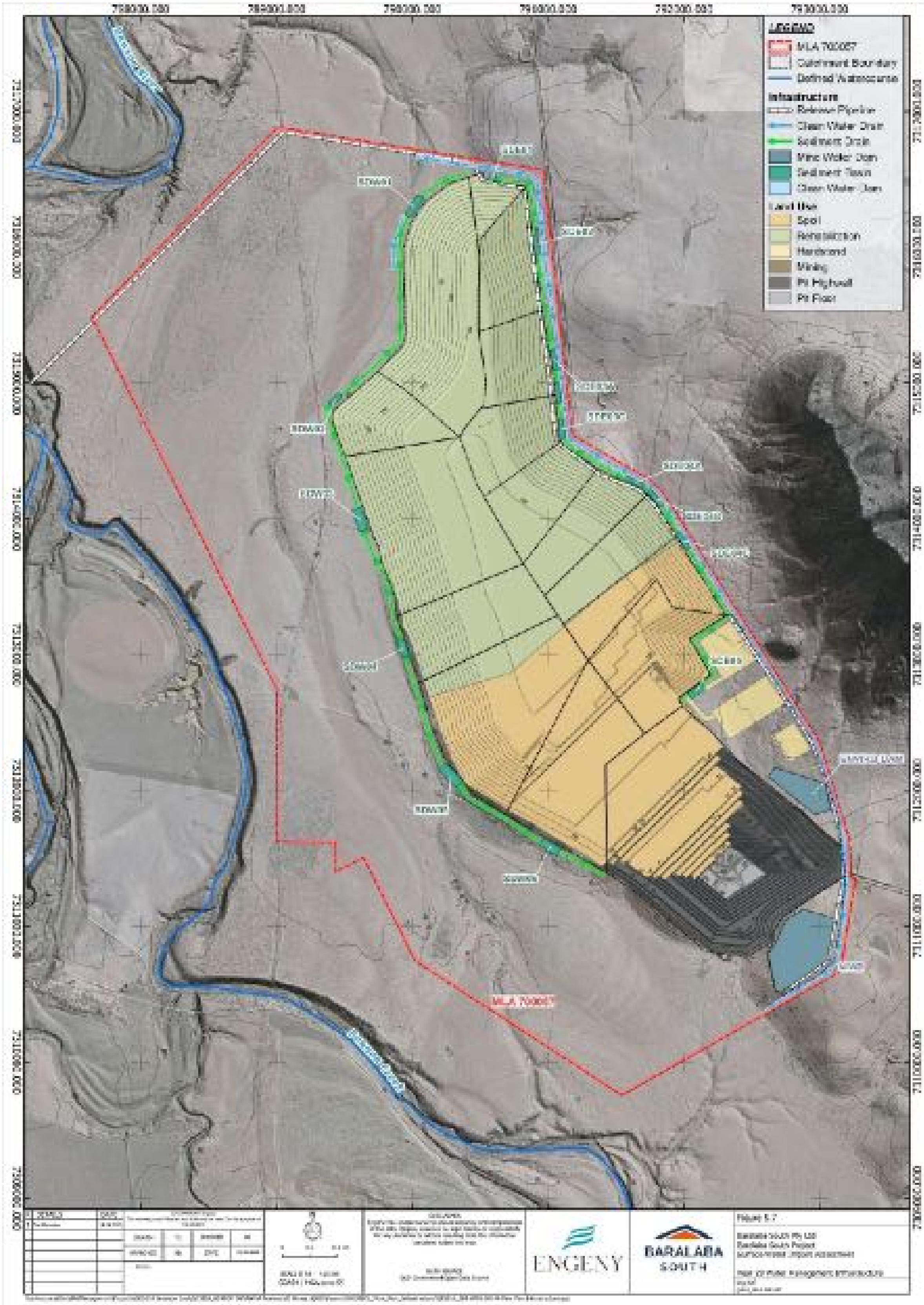

Figure 9.49: Year 23 Water management infrastructure

9.8.5.4 Mechanical dewatering

Mechanical dewatering of tailings allows for increased recycling of processing water, reducing the reliance on external water supply (Dawson River water allocations) to meet site water demands. The gross water demand of the plant is anticipated to be up to 50% less than that of other plants utilising conventional tailings management techniques.

9.8.5.5 Final landform design

The final landform has been designed to incorporate clean catchment diversions and drainage from the mine landforms to prevent harvesting of overland flow and risk of scour to the void walls. In addition, the final landform has been designed to provide suitable flood protection to prevent any flood inflow from the Dawson River system into the final void pit lake.

9.8.5.6 Surface water quality monitoring program

A surface water quality monitoring program will be implemented for the Project. Monitoring upstream, downstream and storage water quality will be used to assess potential impacts of the Project. Monitoring will be undertaken at background (i.e. control) sites located upstream of the release point on the Dawson River and along Banana Creek.

Proposed water quality monitoring locations are summarised in Table 9.30 and shown on Figure 9.35. Dawson River at Beckers and Dawson River at Baralaba are existing points monitored by DoR and Baralaba North Mine, respectively. The remaining locations are proposed to be monitored by the Proponent. Coordinates for the release location RP1 will be defined once detailed design of the structure has been completed.

Additional or alternative monitoring locations (e.g. other water storages on-site and/or surrounding environmental features) will be developed as part of site-specific plans as required.

Table 9.30: Proposed water quality monitoring locations

Monitoring location (ID)	Easting (GDA94)	Northing (GDA94)
U/S Banana Creek	149.897	-24.3091
U/S Dawson River	149.794	-24.3254
Dawon River Confluence	149.830	-24.254
MP1 Banana Creek	149.844	-24.2763
MP2 Release Location (RP1)	TBC	TBC
Northern Tributary	149.856	-24.236
D/S Dawson River	149.819	-24.2081
Dawson River at Baralaba DR1 (Baralaba North Mine SWMP)	149.805	-24.1825
Dawson River at Beckers (130322A)	149.822	-24.0873

Sample methodology

Water quality monitoring will be undertaken using a combination of laboratory and in situ sampling by trained personnel and in accordance with the Queensland ‘Monitoring and Sampling Manual’ (DES, 2018c). Sampling methodology will involve the following:

- sample collection to be undertaken using a grab sampler which has been decontaminated and rinsed with distilled water between sample locations;

- the use of appropriate sample containers which have been provided by the laboratory;
- samples will be labelled clearly with the sample number, site and date sampled;
- all samples will be forwarded to the laboratory in a secure and appropriately cooled container;
- samples are to be collected and handled within appropriate holding times for the analysis of concern, and this information can be obtained and confirmed from the laboratory responsible for the analysis of samples;
- water samples will be analysed by a NATA accredited laboratory for the proposed physico-chemical, biological and toxicant indicators for the Project are outlined in Table 9.31;
- all sample batches to be sent to a NATA accredited laboratory are to be accompanied by a chain of custody form;
- in situ measurements of water quality parameters including pH, EC, turbidity, dissolved oxygen, and temperature will be undertaken at each monitoring point; and
- additional samples will be taken for quality assurance and quality control (QA/QC), including duplicate samples and sample blanks. Specific identification codes will be used for these samples to ensure the laboratory conducting the sample analysis is not alerted to these samples being controls/blanks. Laboratory QA/QC data as obtained per laboratory analysis procedures will be requested and included in result review and analyses.

The water quality indicators specified in Table 9.31 have been developed based on identified WQOs for the receiving waterways, expected contaminants to be produced from the operation (based on the Baralaba North Mine water quality data and EA), and the 'Model Mining Conditions' (DES, 2017a). Analysis of metals will include both total and dissolved metal concentrations.

Water quality parameters will be measured against the WQOs defined in the EA, and where they are not met, investigations will be undertaken to determine the cause and any required corrective actions.

Streamflow/level monitoring data will be collected from the DoR stations and two of the proposed Project water monitoring sites (U/S Dawson River and D/S Dawson River).

Regular (quarterly/monthly) surface water quality monitoring will be undertaken until a statistically robust data set of baseline local water quality data has been obtained in accordance with the 'Queensland Water Quality Guidelines' (DEHP, 2009) and the 'National Water Quality Management Strategy' (ANZG, 2018).

Table 9.31: Proposed water quality indicators

Monitoring category	**Indicator**
Physico-chemical	• pH • Salinity (EC, Total Dissolved Solids) • Turbidity • Sulphate • Dissolved Oxygen • Total Suspended Solids • Colour
Biological	• Chlorophyll • Cryptosporidium • Blue-green Algae • Algal toxin

Monitoring category	Indicator
Toxicant	• Metals and Metalloids (As, Al, Ag, B, Ba, Be, Cd, Co, Cr, Cu, F, Fe, Hg, Li, Mo, Mg, P, Pb, Pd, Ni, Se, U, V, Zn) • Fluoride • Sodium • Carbonate, Hardness • Nitrogen (Ammonia, Nitrate/Nitrite, Total Organic Nitrogen) • Total Recoverable Hydrocarbons and Total Petroleum Hydrocarbons

9.8.5.7 Receiving environment monitoring program

A Receiving Environment Monitoring Program (REMP) will be developed for the Project in accordance with the 'Model Mining Conditions' (DES, 2017a) and in consideration of the 'Receiving Environment Monitoring Program Guideline' (DES, 2014a).

The aim of a REMP is to monitor and assess the potential impacts of controlled or uncontrolled releases of water and associated contaminants to the environment from a regulated activity. A REMP provides a basis for evaluating whether the discharge limits or other conditions imposed upon an activity have been successful in maintaining or protecting receiving environmental values over time (DES, 2014a).

The REMP design document will include:

- the environmental values to be enhanced or protected for receiving waters potentially affected by mine water releases;
- measurable indicators associated with the environmental values (e.g. physical, chemical, or biological indicators) and the WQOs for these indicators;
- suitable test sites within the receiving waters that are potentially impacted by releases;
- suitable control sites where a background or reference condition can be established;
- a description of the frequency and timing of sampling; and
- how the condition of, and impacts to, environmental values will be assessed.

REMP monitoring will be undertaken bi-annually at a minimum and will be undertaken to account for seasonal variability.

Water quality monitoring

The proposed water quality monitoring including the WQOs for water quality is described in section 9.8.5.6.

Biological monitoring

Macroinvertebrate sampling will be undertaken bi-annually to account for larval growth and recruitment associated with seasonal wet/dry cycles. The selection of macroinvertebrate monitoring sites will be conducted by a suitably qualified person engaged to undertake the survey and will consider sites previously sampled, REMP water quality monitoring sites and prevailing conditions.

Macroinvertebrate sampling will be undertaken in accordance with the AusRivas method by a suitably qualified person. Results from macroinvertebrate surveys will be assessed against historical data and compared against trends in water quality results. Macroinvertebrate survey results will be included in the annual REMP report.

Flow monitoring

Streamflow gauging will be undertaken during the operational phase of the Project to inform release opportunities and assess impacts. In addition to the flow gauging already undertaken at the DoR stations, streamflow/level monitoring will be undertaken at the Dawson River confluence with Banana Creek monitoring point to inform natural streamflow conditions for mine water release.

The results from flow monitoring will also be used to interpret the results from water quality monitoring against flow conditions.

Review and reporting

Results from monitoring and sample analysis will be collated, reviewed, and compared to the WQOs defined for the Project. The comparison will include consideration of background data, seasonality, occurrence of mine water discharge events and event specifics (e.g., mine water quality and contaminant levels, volume of discharge, streamflow, etc.).

Where results exceed an identified WQO, further investigations will be undertaken to determine possible causes of the exceedance. Further sampling may be warranted to verify the results. If required, an action plan will be developed and implemented to correct any causal issues.

An annual REMP report outlining the findings of the REMP, including all monitoring results and interpretations will be prepared and made available to DES on request. This report will include an assessment of background reference water quality, a comparative analysis of the condition of downstream water quality and WQO, and the suitability of any discharge limits to protect downstream environmental values.

9.8.5.8 Water Management Plan

A Water Management Plan will be prepared for the Project in consideration of the DES guideline for the 'Preparation of Water Management Plans for mining activities' (DEHP, 2012). It will include:

- A description of the baseline environment, including environmental values and water quality objectives of the receiving waterways, a description of receiving waterways, local and regional groundwater aquifers, current and historical mining and associated activities, site climate conditions and water quality monitoring of the receiving waterways and groundwater aquifers used to establish baseline conditions.
- A description of the potential sources of contaminants that could impact on water quality.
- A description of the water management system including objectives, site storages details and locations, transfer infrastructure, identification of bulk water storages and maintenance methodology for water infrastructure and freeboard in containment structures.
- The water release strategy including details of release infrastructure, trigger levels for commencing and ceasing releases and release monitoring requirements.
- A description of the water balance model including major water inflow and outflow mechanisms details, water balance model development (details of calibration of runoff parameters, key input assumptions) and water balance forecast results.
- A program for the monitoring and review of the Water Management Plan's effectiveness.
- Corrective actions and contingency procedures for emergencies.
- Assignment of responsibility for Water Management Plan actions.

The Water Management Plan will be updated annually prior to the wet season for the life of the Project. This will enable identification of changes to the water management system and associated impacts to the operational water balance and receiving environmental values. The update process will identify risks associated with the water management system and feedback to infrastructure and operational management improvements.

Details of the groundwater components of the Water Management Plan are described in section 9.10.5. Details regarding the flooding and regulated structure groundwater components of the Water Management Plan are described in section 9.9.

Controlled release strategy

Water captured within the site's water management system will be used preferentially on site for dust management which will reduce the requirement for controlled release events. Controlled releases will be utilised to manage site water storages where necessary. It is proposed that controlled water releases will occur from the MWD to a single release point at the Dawson River, immediately north of the confluence with Banana Creek shown on Figure 9.30.

<u>Pre-release monitoring</u>

Streamflow gauging will be undertaken during the operational phase to inform release opportunities and assess impacts. In addition to the flow gauging already undertaken at the DoR stations, streamflow/level monitoring be undertaken at two of the Project sites – U/S Dawson River and D/S Dawson River.

Prior to any controlled release event, water quality testing of key water quality parameters including pH, EC, suspended solids, turbidity and oil and grease will be undertaken to ensure water is of appropriate quality for release into the receiving environment. If water is identified as being outside the permitted release range, water will be treated prior to release. If required, treatments will include the following:

- neutralisation of water through the addition of an acid to lower pH or a base to raise the pH;
- treatment with flocculent to settle suspended sediments; and
- removal of oil with a hydrophobic oil boom.

Any treatment of water prior to the release will be undertaken in accordance with a site job safety analysis and risk assessment and records maintained in an electronic database.

<u>Release conditions</u>

Controlled releases will occur when flow in the Dawson River is above the minimum throw threshold of 100 m^3/s, the release storage water quality characteristics are less than the end-of-pipe limits (10,000 µS/cm) and EC in the Dawson River is maintained lower than 500 µS/cm.

<u>Release monitoring</u>

Water quality will be monitored in accordance with the Project's EA conditions outlined in schedule F. The proposed water quality monitoring for release is summarised in Table 9.32 and Table 9.33.

Table 9.32: Receiving waters contaminant trigger levels

Quality Characteristic	Trigger Level	Monitoring Frequency
pH (pH Units)	6.5–9.0	Daily during the release
Electrical Conductivity (µS/cm)	500	
Total Suspended Solids (mg/L)	350	
Sulphate (SO_4^{-2}) (mg/L)	250	

Table 9.33: Receiving water upstream background sites and downstream monitoring points

Description	Easting (GDA94)	Northing (GDA94)
Upstream (background) monitoring points		
U/S Banana Creek	149.897	-24.3091
U/S Dawson River	149.794	-24.3254
Dawson River / Banana Creek Confluence	149.830	-24.254
MP1 Banana Creek	149.844	-24.2763
Downstream monitoring points		
D/S Dawson River	149.819	-24.2081
Northern Tributary	149.856	-24.236
Dawson River at Baralaba DR1 (Baralaba North Mine) SWMP)	149.805	-24.1825
Dawson River at Beckers (130322A)	149.822	-24.0873

Note: Exact location coordinates to be confirmed.

Notification

In accordance with proposed EA conditions the administering authority will be notified as soon as practicable and no later than 24 hours after commencing to release mine-affected water to the receiving environment. Notification must include the submission of written advice to the administering authority.

In accordance with the proposed EA conditions the environmental authority holder will notify the administering authority as soon as practicable and nominally no later than 24 hours after cessation of a release event of the cessation of a release.

In accordance with the proposed EA conditions, if any release monitoring result indicates an exceedance of or non-compliance with any environmental authority limit the administering authority must be notified within twenty-eight (28) days of completion of analysis.

Reporting

Mine releases will be recorded and include the following details:

- water treatment method;
- water quality monitoring details (time, tests undertaken, time of dewatering) if required/recording requirements;
- release volumes and dates; and
- release water quality.

Records will be maintained in the Project electronic database.

Mine water management infrastructure management

During the operations phase, monitoring of water management infrastructure will be undertaken to include, sediment dams, clean water dams, mine water dams, pump and pipe networks and the drainage system. Monitoring of the water management infrastructure will include:

- visual inspections of water management infrastructure on a quarterly basis as well as pre / post significant rainfall events;
- monthly visual inspections of the pump and pipe network;
- quarterly water quality monitoring of mine water storages;
- records of all water usages and transfers will be maintained;
- metering of inflows and outflows will be monitored with accurate, fit for purpose flow meters to allow for the early detection of leaks, spills and blockages in pipe and pump infrastructure;
- quarterly monitoring of mandatory reporting levels and maintenance of dam volume as a requirement of the EA conditions;
- daily monitoring of meteorological conditions for flood, significant rainfall events or drought conditions to proactively manage water management storage volumes;
- quarterly monitoring storage capacity to ensure compliance with DSA volumes;
- assessing the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year; and
- ensuring the storage capacity in each regulated dam meets the DSA volume for the dam and is available by 1 November each year.

Water quality monitoring of mine water storages (sediment dams, clean water dams and mine water dams) will be undertaken quarterly for pH, EC, total suspended solids, and turbidity. Dams with a reasonable risk of contamination from oil and grease will be sampled bi-annually. The parameters proposed in the mine water management monitoring program (Table 9.34) will be subject to review over time. Sampling methodology will be undertaken as described in section 9.8.5.6.

Table 9.34: Mine water storages monitoring program

Parameter	Monitoring frequency	Analysis type
pH (pH Units)	Quarterly	Field
EC (µS/cm)		Field and Laboratory
Total Suspended Solids (mg/L)		Laboratory
Turbidity (NTU)		Field and Laboratory
Oil and Grease (mg/L)	Biannual	Laboratory

Emergency and contingency planning

The Water Management Plan will include proactive management measures for flood, drought, and severe weather events, these will include:

- testing of pit flood pumps prior to each wet season;
- monitoring of BOM 3-month rainfall outlooks;
- daily updates to the water balance model in the lead-up to an emergency situation (where possible, e.g., cyclone warning) and, in particular, survey of water levels as input to the model is considered critical;
- a reduction of water usage during extended periods of drought;

- monitoring of existing water usage and analysis of this data allowing early identification of inefficiencies in the system, and these inefficiencies will be targeted for reduction in forward planning; and
- annual review of the mine water balance and assessment of the system reliability for the upcoming season.

Adaptive management

Results from the monitoring and inspections undertaken through the Water Management Plan will be reviewed regularly, performance considered and used to inform updates to the Water Management Plan procedures. The review will allow for updates to occur in accordance with new/updated legislative and mandatory requirements.

Training

Information in the Water Management Plan will be included in the site induction and familiarisation training for relevant personnel.

The Proponent will ensure employees and contractors involved with monitoring, maintenance and operation of the water management infrastructure are appropriately trained.

9.8.5.9 Erosion and sediment control plan

During operations, the potential to transport contaminants via surface water flow will be managed through erosion and sediment control structures which comply with the EA Conditions. An Erosion and Sediment Control Plan will be prepared for the Project consistent with the IECA recommendations outlined in the 'Best Practice Erosion and Sediment Control Guideline' (IECA, 2018) to minimise erosion and sediment generation from disturbed areas and maintain water quality in downstream water systems. The Erosion and Sediment Control Plan will be prepared by a suitably qualified person and implemented during construction, operations, and rehabilitation.

The erosion and sediment control plan will define the following aspects of the erosion sediment control requirements for the site:

- limiting disturbance to prevent sediment runoff generation;
- erosion control measures aimed to prevent soil erosion from disturbed areas including revegetation and rehabilitation;
- documenting soil types and disturbed catchment areas on the site and their potential for sediment generation;
- design and management of drainage control measures to prevent erosion from concentrated flows and manage the flow of clean and sediment runoff;
- erosion and sediment control requirements associated with temporary disturbance and construction activities;
- design and management of sediment dams including dewatering and desilting requirements and suitable construction materials; and
- water quality testing of sediment dam to assess their performance and inform continual improvements of the erosion and sediment control system.

Sediment dams will form a key component of the Erosion and Sediment Control Plan. Sediment dams for the Mine Water System have been designed in accordance with the 'International Erosion Control Association Guidelines' methodology for Type D sediment basins (IECA, 2018). Sediment basins have been designed to contain sediment-affected runoff from disturbed areas including rehabilitated areas until they are suitably established. Eight sediment basins have been designed to capture runoff from the overburden emplacement areas and the MIA.

Sediment dams will be equipped with pumping infrastructure providing for transfer of water to the MWD. Mine water transfers will be utilised to assist with sediment basin settling volumes.

Sediment dams will be designed such that overtopping velocities are managed so they do not cause scour on the overtopping flow paths. Sediment dams will also include overflow control structures with scour protection (rock chutes, rock aprons and/or level spreaders) to ensure non-erosive discharges. Sediment dam spillway structures will be designed such that during overtopping events, velocity impacts in the receiving waterway are negligible.

Clean water drains have been designed to ensure clean water is diverted around disturbed areas, reducing the risk of contaminants and increased sediment loads being discharge to the receiving environment via surface water. Surface water runoff from disturbed areas will be managed via drains and bunds to direct runoff to erosion and sediment control structures.

Additional erosion and sediment controls to be included in the plan will include the following:

- topsoiled areas will be deep ripped to reduce compaction from heavy machinery, encourage infiltration of water and prevent erosion. Areas will be ripped along the contour to reduce the velocity of runoff water down the slope;
- where required, stockpiles will be constructed to less than 3 m high and contoured to encourage water drainage;
- the placement of topsoil stockpiles away from drainage areas, roads, machinery, transport corridors and stock grazing areas;
- preservation of vegetation around drainage lines and riparian zones to reduce the exposure of the B horizon if excavation is necessary;
- use of upslope diversion drains to reduce runoff from undisturbed areas onto disturbed areas;
- the use of downslope collection drains to divert surface water to sediment dams (e.g. mulch berms, sediment ponds and drop inlet protection) to contain sediment-laden runoff from disturbed areas;
- the use of sediment fences and filters to retain and filter suspended solids;
- where possible, traffic will be confined to maintained tracks and roads; and
- assessment of the integrity and effectiveness of erosion control measures will be undertaken at regular periods, especially following significant rainfall events.

Installed erosion and sediment control structures will not be removed until monitoring indicates that disturbed areas have been stabilised.

9.8.5.10 Contaminants management

The risk associated with the accidental mobilisation of contaminants on site will be proactively and reactively managed through the following measures:

- hazardous chemicals and dangerous goods will be stored in bunded storage areas within the MIA with spill clean-up kits located in close proximity, in accordance with relevant Australian Standards;
- transfers of fuels and chemicals within the MLA will be controlled and managed in accordance with Standard Operating Procedures developed for the Project to minimise the risk of spillage outside bunded areas;
- wastewater from wash down areas will be directed through oil and grease separators before being transferred to mine water storages;

- any contaminated material/major spillage of stored material in bunded areas will be collected and transported off-site by a licensed waste collection agency; and
- any significant leakage/spillage events will be reported immediately and the appropriates clean-up operations will be implemented.

Appropriate procedures, containment and spill control measures will be implemented at suitable locations where the transportation and loading, as well as storage of hazardous and/or dangerous materials occurs on-site. The design and management of all required fuels and hydrocarbons will ensure there are effective means of secondary containment to prevent or minimise releases to the environment from any fuel and oil storage on-site.

9.8.5.11 Adaptive management

Consistent with best practice in mine water management, the Proponent will further investigate the potential options and proposed approaches for separation of different water quality source waters on-site as part of the detailed design of the Water Management System and refine as required during the life of the Project.

An annual review of the performance of the Water Management System will be undertaken over the mine life to continually inform updates to the Water Management System.

The performance of the Water Management System will be assessed against:

- compliance with the Project's EA conditions:
- results of water monitoring and the REMP;
- water demand and supply requirements; and
- the implementation of mitigation measures.

To ensure adequacy of the Water Management System, the review of the Water Management System will include a review of the Project's water balance. Updates to the water balance model will be conducted, if required. The following data and information will be collected for the duration of the Project to inform regular updates and validation of the operational water balance model:

- water inventory of the mine water dams and sediment dams (dam water level);
- water quality sampling of the mine water storages and sediment dams;
- pumped flow meter data for major transfer and water demand offtakes (pit dewatering, CHPP water transfers, fill points);
- aerial surveys of the mine topography to review catchment area and land use development; and
- daily rainfall.

The model will be validated (or calibrated) to historical dam inventories using the recorded data listed above. The update and review of the model will be used to assess validity of the following model parameters, inputs, and assumptions:

- surface water runoff parameters for the various site land uses;
- salinity generation rates for the various site land uses;
- pumpable groundwater volumes reporting to the mining pit (using pit dewatering information);
- truck fill demands and water loss through the CHPP; and
- the classification of storages using water quality information (sediment storage or mine-affected storages).

9.8.5.12 Potential corrective actions

Where water quality results exceed an identified WQO, an investigation will be undertaken to determine the possible causes of the exceedance. This may include further sampling to verify the results and the identification and implementation of corrective actions.

Potential corrective actions will include where relevant:

- modification of construction, operation and/or rehabilitation activities as required;
- maintenance and/or management of erosion and sediment controls where inspections indicate the controls are not operating effectively;
- implementation of additional erosion control measures;
- implementation of additional waste rock management measures;
- Water Management System audit;
- modification of the Water Management System;
- review and revision of protocols for controlled releases;
- review and revision of monitoring trigger levels;
- increasing the monitoring frequency or sampling locations to inform the nature of the impacts and the effectiveness of the corrective actions implemented; and/or
- follow-up inspections and/or monitoring.

9.8.5.13 Progressive rehabilitation

The Project will implement progressive rehabilitation to disturbed areas to minimise potential runoff from exposed landforms containing increased sediment loads to an operational minimal, reducing the overall erosion and sediment risk. Rehabilitation activities will involve rehabilitation of overburden emplacements that will promote natural surface runoff properties through the construction of contour drains on the external slopes of rehabilitated landforms.

Progressive rehabilitation activities to minimise the risk of erosion and sedimentation will include:

- rehabilitating disturbed landforms as soon as practicable after disturbance;
- replacement of topsoil and subsoil consistent with existing soil profiles;
- reshaping disturbed landforms to a stable landform including the incorporation of contour drains; and
- establishing groundcover.

Progressive rehabilitation activities will result in the following outcomes:

- the potential generation of sediment from disturbed landforms' will be minimised;
- natural runoff properties which, after establishment, can be allowed to runoff into the receiving waterways, reducing the length of capture and treatment of disturbed catchments will be restored; and
- potential impact of contaminated water into the receiving environment will be minimised.

The rehabilitation strategy for the Project is provided in Chapter 3, Rehabilitation.

9.8.5.14 Annual review

An annual review of surface water quality trends and groundwater quality trends will be conducted by an appropriately qualified person or persons. The review will assess the change in surface water quality and groundwater quality over time compared to historical trends and impact assessment predictions.

9.8.6. Significant impact assessment

This section assesses whether the impacts on a water resource from the Project are likely to be significant according to the 'Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources' (DCCEEW, 2022). The significant impact criteria provides guidance that a significant impact on the hydrological characteristics of a water resource may occur where there are, as a result of the action:

- changes in the water quantity, including the timing of variations in water quantity;
- changes in the integrity of hydrological or hydrogeological connections, including structural damage (for example, large scale subsidence); or
- changes in the area or extent of a water resource.

A significant impact on the water quality of a water resource may occur where, as a result of the action:

- there is a risk that the ability to achieve relevant local or regional water quality objectives would be materially compromised, and as a result the action:
    - creates risks to human or animal health or to the condition of the natural environment as a result of the change in water quality;
    - substantially reduces the amount of water available for human consumptive uses or for other uses, including environmental uses, which are dependent on water of the appropriate quality;
    - causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment;
    - seriously affects the habitat or lifecycle of a native species dependent on a water resource; or
    - causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource;
- there is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives); or
- high quality water is released into an ecosystem which is adapted to a lower quality of water.

Assessment of Project impacts, according to guidance provided by the significant impact criteria (DCCEEW, 2022) is presented in sections 9.8.16.1 and 9.8.16.2.

9.8.6.1 Potential impacts to hydrological characteristics

Assessment of the Project impacts, according to guidance provided by the significant impact criteria (DCCEEW, 2022), to hydrological characteristics is provided in Table 9.35.

Table 9.35: Assessment of significant impact on changes to hydrological characteristics

Significance criteria	Assessment of significance
A significant impact on the hydrological characteristics of a water resource may occur where there are, as a result of the action:	
changes in the water quantity, including the timing of variations in water quantity	Controlled mine water releases would occur over a time period consistent with the existing duration of medium-high flows in the Dawson River and would not impact the duration of flow events. There are no controlled releases events predicted for the Project in 75% of years. The Project is expected to have a reduction in streamflow less than 0.045% (mean annual flow) at the Project location. The minor reduction in streamflow as a result of the Project is not predicted to impact the existing vegetation or channel morphology. Significant changes in the water quantity of watercourses, including the timing of variations in water quantity are considered unlikely to occur.
changes in the integrity of hydrological or hydrogeological connections, including structural damage (for example, large scale subsidence), or	Predicted groundwater drawdown from the Project would indirectly result in some minor leakage from the Dawson River (upstream of Neville Hewitt Weir) to the surficial geology by a peak of up to approximately 0.1 ML/day. When compared to the average surface water flows in the Dawson River for the previous 5 years, this is equivalent to less than a 0.01% reduction in flow. Banana Creek is an ephemeral watercourse and drawdown impacts are expected to be insignificant. Significant changes in-stream flow or flood characteristics have been avoided. The Project is unlikely to impact to impact the existing riparian vegetation or stream channel morphology. Significant changes to hydrological and hydrogeological connections throughout the Project area of influence are considered unlikely to occur.
changes in the area or extent of a water resource.	The Project will result in only minor local catchment reduction. The impact on the Dawson River mean annual streamflow volume is insignificant (0.08% at the Project location and 0.04% at the Dawson River at Beckers gauging station). There are small, unnamed tributaries which flow through the MLA and connect to the Dawson River downstream of the MLA. These minor tributaries are generally of limited environmental value, having previously been impacted by grazing land use. Clean water is diverted around mining operations, limiting downstream catchment loss. The total catchment of the main waterway draining through the MLA to the Dawson River is expected to experience a maximum catchment reduction of approximately 33% in year 23 of the Project. However, at mine closure, with the rehabilitated mine landforms redirected into this unnamed waterway, the permanent catchment reduced. The reduction in streamflow in small ephemeral waterways within the MLA is not expected to result in significant impacts to water values. The water management system has been designed to minimise potential impacts on the HES wetland. The Project will not reduce the catchment area reporting to the wetland and will not have a significant impact on flooding interactions between the wetland and the Dawson River and Banana Creek. Significant changes in the area or extent of the water resources are therefore considered unlikely to occur.
Conclusion	The predicted changes to surface water quantity, extent of surface water resources and hydrogeological connections indicate the Project is unlikely to have a significant impact on hydrological characteristics.

9.8.6.2 Potential impacts to water quality

Assessment of the Project impacts to the water quality of local watercourses (Banana Creek, Dawson River) and regional receiving waters (Dawson River, being a tributary of the Fitzroy River), which discharge to the Coral Sea, has been undertaken according to guidance provided by the significant impact criteria and is summarised in Table 9.36.

Table 9.36: Assessment of significant impacts on changes to water quality

Significance criteria	Assessment of significance
A significant impact on a water resource may occur where, as a result of the action:	
there is a risk that the ability to achieve relevant local or regional water quality objectives would be materially compromised, and as a result the action: • creates risks to human or animal health or to the condition of the natural environment as a result of the change in water quality; • substantially reduces the amount of water available for human consumptive uses or for other uses, including environmental uses, which are dependent on water of the appropriate quality; • causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment; • seriously affects the habitat or lifecycle of a native species dependent on a water resource; or • causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource.	Mine affected water storages have been designed such that the standard of containment for all water infrastructure containing mine water meets the relevant environmental objectives for regulated structures containing contaminants (EHP, 2017). The design containment standard for the mine water dams, and the water balance modelling results, ensure that there would be minimal actual or potential uncontrolled discharge of contaminants to waters that may or have the potential to cause an adverse effect on identified environmental values. The risk to human health or the natural environment condition as a result of change in water quality are appropriately managed through design of infrastructure and release conditions. Catchment harvesting has been minimised through clean catchment diversions and clean water release from dams capturing clean catchment runoff. The catchment harvesting or raw water uptake from the Project is not expected to have any impact on water availability to downstream water users. Utilisation of water allocations by the Project will not result in any additional impact to other existing allocation holders, as the resource will be accessed in accordance with the existing allocations. The Project is not anticipated to impact supply of water from the Benleith Water Scheme. Sediment dams have been designed to provide sufficient storage for settlement of suspended solids so that water quality during overtopping events has negligible impact on the water quality in the receiving waterway. Sediment dams include overflow control structures with scour protection to ensure non-erosive discharges. Overtopping flows from sediment dams are not expected to have significant impacts on water quality in the receiving environment. Seepage generated by in pit waste rock emplacement will report to nearby pits and be managed in the mine water system It is not expected that seepage from WREs will cause any additional impacts to water quality in the receiving waterway. The Project is not expected to affect the habitat or lifecycle of a native species dependent on a water resource (Section 9.12.5). The Project is unlikely to materially compromise the local or regional water quality objectives.

Significance criteria	Assessment of significance
there is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives); or	The water quality local to the Project is representative of the broader region. Waterways and wetlands of the Project area are already moderately disturbed and influenced by surrounding land uses, particularly agriculture. Controlled releases from the Project will be discharged directly to the Dawson River main channel from MWD via a pipeline. Controlled releases will mix directly with Dawson River under conditions which provide substantial dilution to achieve the receiving water quality release limits. Small areas of elevated EC concentrations are temporarily expected in the localised vicinity of the controlled release discharge location, however, the average salinity in the river immediately downstream of the discharge location will remain below the receiving waterway water quality limit of 500 µS/cm. This is due to the high dilution rate from the proposed release conditions and mixing of the release waters from high velocity and turbulence at the discharge point location as well as mixing with the natural turbulence of flow in the river. Strict release conditions have been proposed for all mine-affected water releases. A significant worsening of local water quality is unlikely to occur as a result of the proposed Project.
high quality water is released into an ecosystem which is adapted to a lower quality of water.	Clean water releases from the Project are defined as release from storages capturing only clean catchment runoff. These storages contain water which exhibits the same water quality characteristics as the receiving environment and does not come into contact with areas disturbed by mining activities. The release of clean water from site will not impact water quality or environmental values in the receiving waterways. No high quality water will be released into an ecosystem which is adapted to a lower quality of water.
Conclusion	The predicted surface water quality and ability of surface waters to meet WQOs indicate the Project is unlikely to have a significant impact on water quality characteristics.

9.9 Flooding and geomorphology

9.9.1. Flood characteristics and context

In undertaking an assessment of the Project's flood risks, the following matters have been considered:

1) Nearby water resources—the Project is located:
    a) Adjacent to the eastern floodplain of the Dawson River, near the confluence of Banana Creek and the Dawson River, near the Dawson River channel (Figure 9.8). The Dawson River is subject to seasonal flooding and is characterised by:
        i) a lower floodplain extending 1.5-3 km on either side of the river channel; and
        ii) several anabranch channels, both upstream and downstream of the Project, indicating that the river channel is laterally active.
    b) near one minor unnamed tributary to the Dawson River, which traverses the MLA and confluences with the Dawson River approximately 1 km to the north-west of the MLA boundary (Figure 9.34); and
    c) near a HES wetland, which is located within the MLA on the western boundary near Banana Creek, outside the Project footprint (Figure 9.38).

2) Proximity to agricultural properties, including habitable and non-habitable infrastructure and land use associated with each property—prime agricultural land is located on the floodplain of the Dawson River and its tributaries, and the area to the west of Banana Creek and the Dawson River is mapped as a Priority Agricultural Area under the RPI Act. The floodplain areas are used for irrigated and rain-fed cropping and, on improved pastures, beef cattle grazing. Away from the floodplain, cattle are typically grazed on native or improved dryland pastures. Properties located in proximity of the Project contain habitable and/or non-habitable structures. Dwellings located within or proximal to the flood model boundary are shown in Figure 9.50.
3) Proximity to infrastructure—the Project is located near the following infrastructure (Figure 9.50):
    a) the Baralaba North Mine, which is located approximately 11 km downstream of the Project on the Dawson River western floodplain;
    b) Baralaba township, which is downstream of the Project on the eastern bank of the Dawson River;
    c) Neville Hewitt Weir, which is downstream of the Project on the Dawson River;
    d) Baralaba-Woorabinda Road Bridge, which is downstream of the Project spanning across the Dawson River channel;
    e) Moura-Baralaba Road Bridge, which is upstream of the Project spanning across the Banana Creek channel;
    f) Moura-Baralaba Road, which runs parallel to the Dawson River on the eastern floodplain downstream of the Project (though the development of the mine will require the relocation of an approximate 4.5 km section of the existing Moura-Baralaba Road from within to outside the MLA area);
    g) Alberta Road, which runs parallel to the Dawson River on the western floodplain; and
    h) Baralaba-Woorabinda Road, which crosses the Dawson River western floodplain approximately 9 km downstream of the Project.

9.9.2. Flood modelling

9.9.2.1 Regional hydrological model

Engeny Water Management (2021b) developed a Unified River Basin Simulator (URBS) hydrologic model of the Dawson River catchment to assess the current flood risk and the potential impacts of the Project on flooding. Details of the model development are provided in Appendix C, Flood Impact Assessment.

The Dawson River CatchmentSIM model was subdivided into 244 sub-catchments (total catchment area 40,800 km^2) as follows:

- 114 sub-catchments representing the Upper Dawson River to the headwaters of the Nathan Gorge (23,660 km^2).
- 62 sub-catchments representing the Mimosa Creek catchment to the confluence with the Dawson River (8,820 km^2).
- 19 sub-catchments representing Banana Creek to the confluence with the Dawson River (1,170 km^2).
- 44 sub-catchments representing the lower Dawson River to the Beckers stream gauging station downstream of the Baralaba township (11,350 km^2).
- 5 sub-catchments representing the area downstream of the Beckers gauging station within the hydraulic model extent (300 km^2).

The sub-catchments were defined in the URBS model based on catchment area and catchment slope. Channel reaches were represented in the model using channel length and slope. The sub-catchment layout for the Dawson River URBS model is shown in Figure 9.51.

The Dawson River model was calibrated against rainfall and stream flow gauging data within the Dawson River catchment. The gauging stations used in the calibration process were (refer Figure 9.51):

- 130342A Hutton Creek at Fairview
- 130324A Dawson River at Utopia Downs
- 130376A Eurombah Creek at Brookfield
- 130344A Juandah Creek at Windamere
- 130302A Dawson River at Taroom
- 130313A Palm Tree Creek at La Palma
- 130325A Palm Tree Creek at Bloomfield
- 130341A Robinson Creek at Glenleigh
- 130375A Robinson Creek at Broadmere
- 130303B Dawson River at Glebe Recorder
- 130338A Dawson River at Glebe Weir Headwater
- 130320A Dawson River at Nathan Gorge
- 130354A Dawson River at Gyranda Weir Headwater
- 130318A Castle Creek at Old Walloon
- 130305A Dawson River at Theodore
- 130317A/B Dawson River at Woodleigh
- 130339A Conciliation Creek at Barranga
- 130316A Mimosa Creek at Redcliffe
- 130363A/B Roundstone Creek at Dawson Highway
- 130374A Dawson River at Bindaree
- 130322A Dawson River at Beckers

The Dawson River URBS model has been calibrated to the following six historic flood events: February 1978, May 1983, March 1997, December 2010, January 2013 and November 2021. The model has been used to develop design hydrology hydrographs ranging from the 20% AEP flood event up to the PMF event for the Dawson River. The calibrated model was then used to assess design event hydrology with the modelled peak flows validated to FFA of streamflow gauging data and the Regional Flood Frequency Estimation technique.

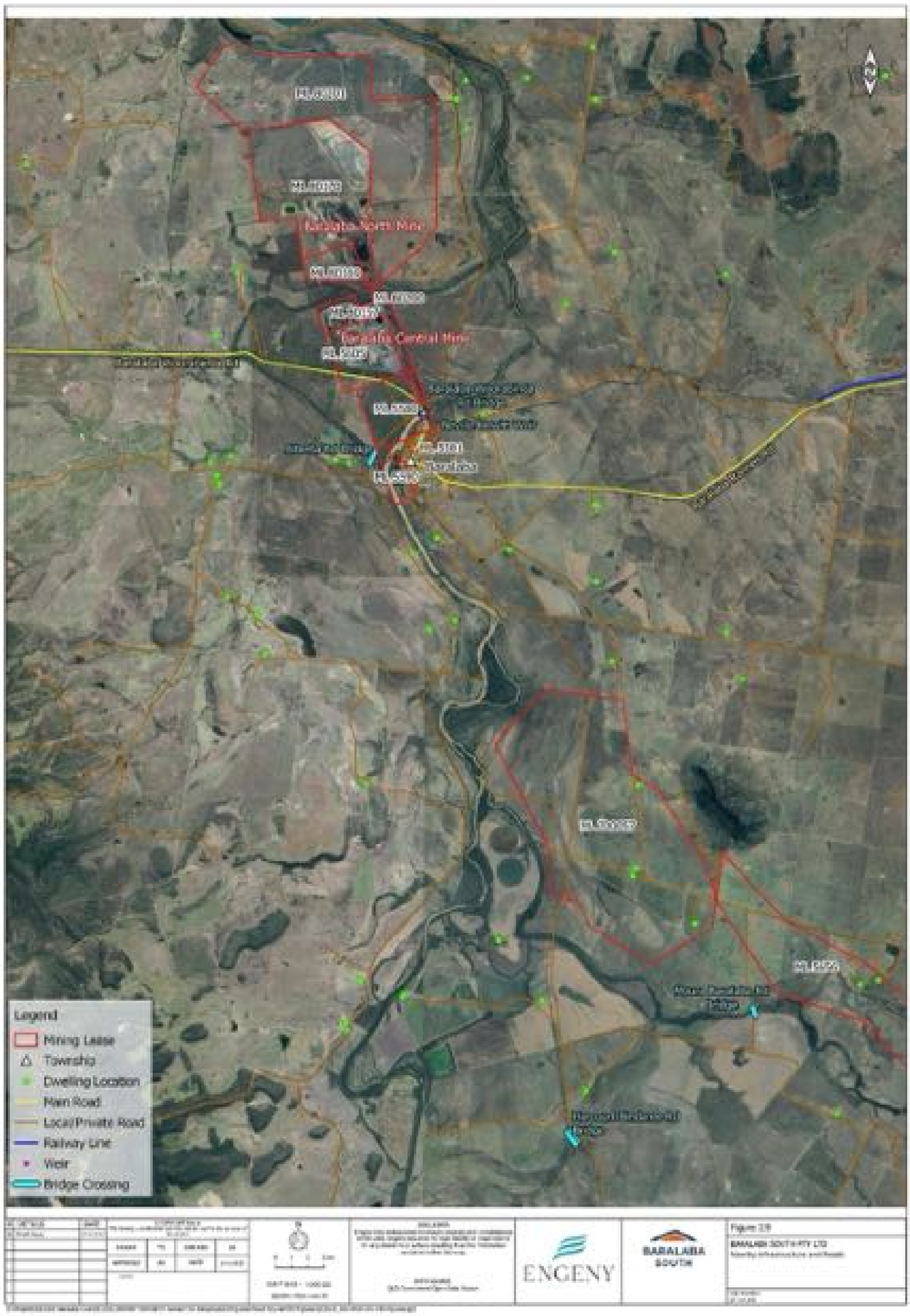

Figure 9.50: Nearby infrastructure and roads

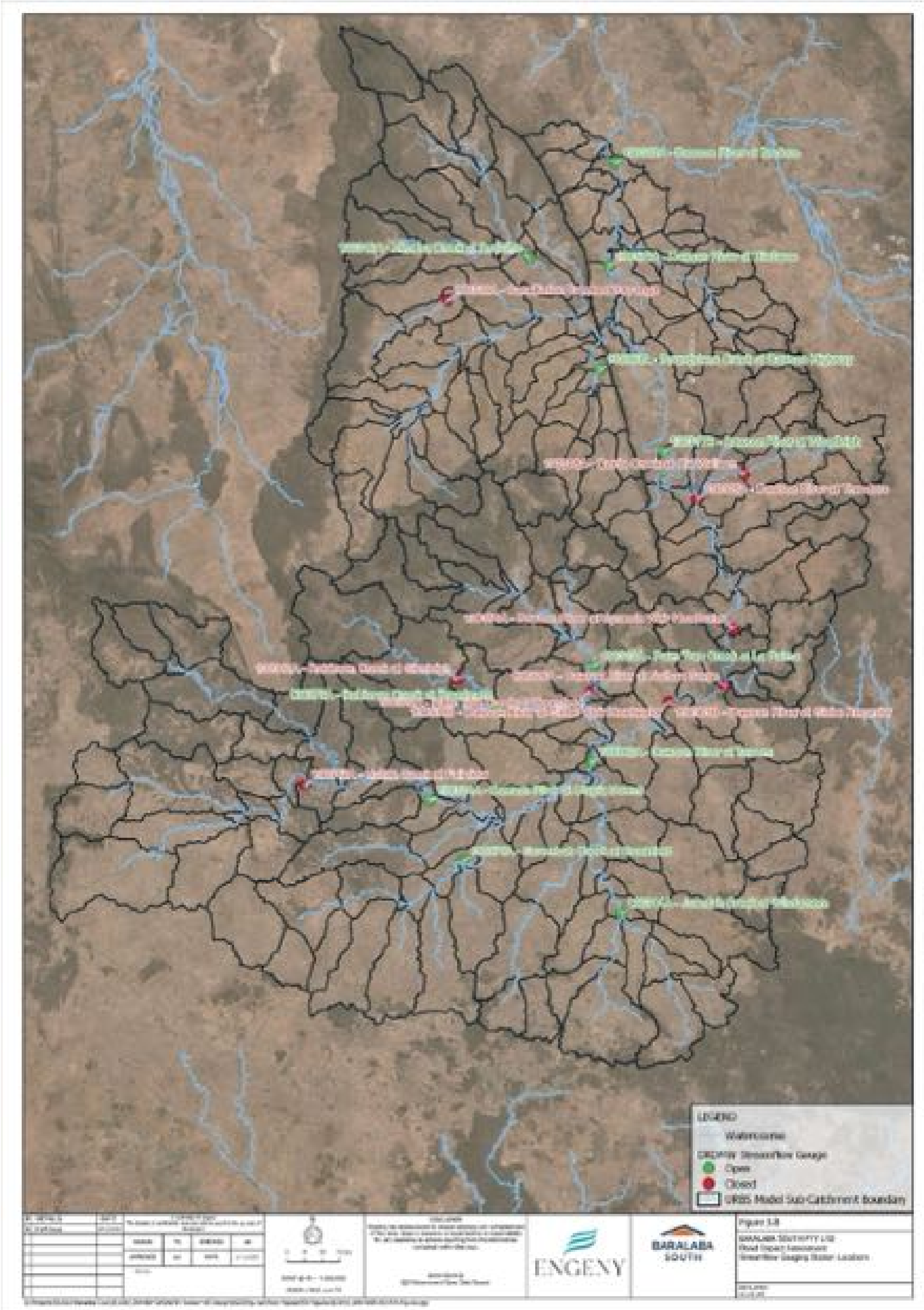

Figure 9.51: Streamflow gauging station locations and catchments

A hydrodynamic model has been developed using TUFLOW HPC software to assess Dawson River hydraulics and potential flood impacts resulting from the Project. The two-dimensional model extent covers a 44 km length of the Dawson River and Banana Creek floodplain with an upstream extent approximately 15 km upstream of the Bindaree (130374A) gauging station and a downstream extent 18.5 km downstream of the Beckers (130322A) gauging station. The upstream and downstream extents of the model were located to avoid influence of the adopted inflow and outflow boundary conditions on the model results at the Project location and the model calibration point locations.

The following hydraulic structures have been incorporated into the hydraulic model:

- Neville Hewitt Weir – located in the Dawson River channel at the Baralaba Township;
- The Baralaba-Woorabinda Road bridge – Crossing of the Dawson River downstream of the Neville Hewitt Weir; and
- Culvert crossing associated with the Baralaba North operations haul road – Crossing of the Dawson River Anabranch between the Baralaba North and Central mining areas.

The Dawson River TUFLOW hydraulic model was calibrated to the December 2010 and January 2013 historic flood events used in the hydrologic model calibration. For both the historic flood events the model has been calibrated to stream height gauging data at Beckers (130322A) and Bindaree (130374A) gauging stations.

The model has also considered the results of a flood debris survey for the 2010 flood event undertaken by Water Solutions (2014) as part of the investigations for the Baralaba North Continued Operations Project. Landholder consultation was undertaken by Baralaba South Pty Ltd, with assistance from AARC for the preparation of the Project EIS from November 2020 to March 2021 and again in October 2023. The landholder consultation produced local insight and information for consideration with the model development and validation. The landholder consultation also produced anecdotal flooding information from local landholders present during the December 2010 flood event, which allowed further validation of the 2010 flood model calibration results.

The landholder anecdotal flooding information and comparison with the December 2010 flood model results are presented in Chapter 6, flooding and Regulated Dams. Validation of the 2010 flood model calibration results against the anecdotal flood information shows:

- The flood model accurately reproduced the anecdotal flood extent on the Belvedere property located south of Banana Creek.
- Reports of the flood protection levees on the Harcourt property breaching from overtopping flows was replicated in the model results at the same locations.
- The flood model results showed flooding at the reported dwellings with the model results showing similar depths to the anecdotal information including:
    - Harcourt property reported a flood depth of 0.3 m in the western low set dwelling, and the flood model results show a flood depth of 0.3 m at the same location (no difference).
    - Harcourt property reported a flood depth of 0.85 m below the western high set dwelling (0.15 m below the 1 m high raised floor), and the flood model results show a flood depth of 0.4 m at the same location (0.35 m lower).
    - Harcourt property reported a flood depth of 1 m below highset eastern dwelling, and the flood model results show a flood depth of 1.2 m at the same location (0.2 m higher).
    - Riverland property reported a flood depth of 0.75 m at the raised dwelling, and the flood model results show a flood depth of 0.6 m at the same location (0.15 m lower).
    - Alberta Vale property reported a flood depth of 0.9 m inside the lowset dwelling, and the flood model results show a flood depth of 1.2 m at the same location (0.3m higher)

9.9.3. Existing flood characteristics

The baseline model was simulated for the 10%, 2%, 1% AEP to determine baseline flood results for comparison against the mine developed case model. The model was also simulated for the extreme events including the 0.1% AEP and PMF to determine potential impacts and flood risks for the Project.

The baseline flood mapping (the existing case) for peak flood depth, velocity, and flood inundation duration are provided in Appendix C, Flood Impact Assessment. In summary:

- Flood flows begin to break out of the Dawson River and Banana Creek channel in events greater than the 10% AEP and flow across the eastern floodplain at the Project site. The Project MLA area is partially inundated in the 2% AEP flood event but is not inundated in the 10% AEP flood event.
- The Dawson River floodplain has a flow width of approximately 5.5 km in flood events greater than 2% AEP adjacent to the Project.
- The flood extent in the 1% AEP event inundates approximately 50% of the Project MLA area however, inundates less than 16% of the proposed Project disturbance area.
- Flooding of the Dawson River at the Baralaba township is largely confined to the main river channel although minor flooding of the local school and properties boarding the river channel results in the 1% AEP flood event.
- Peak flow velocities in the 1% AEP flood event within the Dawson River channel adjacent to the Project are generally between 1.0 m/s and 3.0 m/s and peak flood velocities on the floodplain areas are generally below 1.0 m/s.
- Properties located on the Dawson River floodplain near the Project site are inundated for >250 hours in the 1% AEP flood event. It is noted the duration of inundation is heavily dependent on the storm duration.
- Peak flood wave travel time between the Bindaree (130374A) and Beckers (130322A) gauging stations is approximately 22 hours in the 10% AEP flood event and 18 hours in the 1% flood event.

The Banana Creek dominated flooding scenario has been simulated for a 1% AEP Banana Creek peak flow and a 10% AEP peak flow in the Dawson River. The 10% AEP flow is similar to the 2013 historical event, with the Dawson River flood flow is contained in the main channel. The 1% AEP flow in Banana Creek then results in widespread flooding of the lower reaches of Banana Creek before the Dawson River confluence adjacent the Project. The baseline Banana Creek flooding results show:

- The 10% AEP flood event is mostly contained within the Banana Creek channel, however, there is a small breakout flow path through the eastern side of the MLA before entering the Dawson River via an anabranch channel at the northern extent of the MLA.
- 1% and 0.1% AEP Banana Creek flood events engage the floodplain with floodwater breaking out of the Banana Creek channel upstream of the Project, flowing towards the Dawson River.
- The 1% and 0.1% AEP Banana Creek flood events also has a breakout flow path through the eastern side of the MLA, with flood waters spilling from the floodplain into the Dawson River channel at the eastern and northern extents of the MLA.
- Peak flood velocities for the Banana Creek dominated flooding are similar to the Dawson River scenario with peak flood velocities on the floodplain within the Project MLA between 0.6 m/s and 1.0 m/s.
- The extent of flooding for the 1% and 0.1% AEP Banana Creek flood events is similar to the Dawson River scenarios at the southern extent of the Project area however, is smaller at the Dawson River and Banana Creek confluence as waters enter the Dawson River channel.

9.9.4. Geomorphology

A Geomorphic Impact Assessment was undertaken by WRM Water & Environment Pty Ltd (WRM 2023) to assess the potential impacts of the Project on the geomorphology of the Dawson River channel, floodplain and tributaries. The Geomorphic Impact Assessment is based on the results of the detailed hydraulic modelling undertaken by Engeny (2023). The Geomorphic Impact Assessment is provided in Appendix D, Geomorphic Assessment.

A summary of the existing drainage characteristics of the Dawson River, Banana Creek and floodplain channels is provided in section 9.9.4.1. A summary of the results of the existing flooding characteristics is provided in section 9.9.4.2.

9.9.4.1 Drainage characteristics

The main drainage feature relevant to the Project is the Dawson River, which drains the floodplain from south to north. There are also several anabranches and flood channels across the floodplain which become active as floodwaters rise. The Baralaba Weir pool (formed behind Neville Hewitt Weir) extends upstream past the Project site along both the Dawson River and Banana Creek.

The Geomorphic Impact Assessment (Appendix D) identified one particularly significant flood channel (referred to as flood channel A, shown on Figure 9.52) which starts approximately 10 km upstream of the Project and causes Dawson River floodwaters to interact with Kianga Creek and Banana Creek flows, for Dawson River 20% AEP flows and larger.

Figure 9.52 illustrates the connectivity of the various floodplain channels for the 10% AEP Dawson River flooding event. The characteristics of these floodplain channels, as well as the Dawson River floodplain are discussed below. Approximate AMTD are estimated and shown on Figure 9.52 for the purpose of the following discussion.

Dawson River

The Dawson River in the reach passing the Project site (91 km AMTD to approximately 100 km AMTD, refer Figure 9.52) has a well-defined channel, about 150 m to 200 m wide and approximately 10 m to 15 m deep, carved through a relatively flat floodplain. The river channel forms the weir pool of Neville Hewitt Weir and as such, the bedform is wholly drowned in this reach.

The Dawson River has a perched channel, where the riverbanks are raised higher than the adjacent floodplain. The floodplain is between about 5 km to 6 km wide in the vicinity of the Project.

The river channel comprises a continuous active channel carrying the regulated flows, with multiple anabranches and flood channels in the vicinity of the Project. The presence of multiple anabranches and flood channels indicates historical and ongoing lateral activity of the Dawson River channel in the vicinity of the Project.

Banana Creek

Banana Creek discharges to the Dawson River at approximately 95 km AMTD, about 0.7 km west of the proposed Project boundary. Banana Creek in the vicinity of the Project is an ephemeral stream, with the final 9 km of the lower reach crossing the Dawson River floodplain adjacent to the Project and consequently affected by Dawson River backwater and floodwater. It is likely that this section of the Banana Creek channel is a palaeo-channel of the Dawson River.

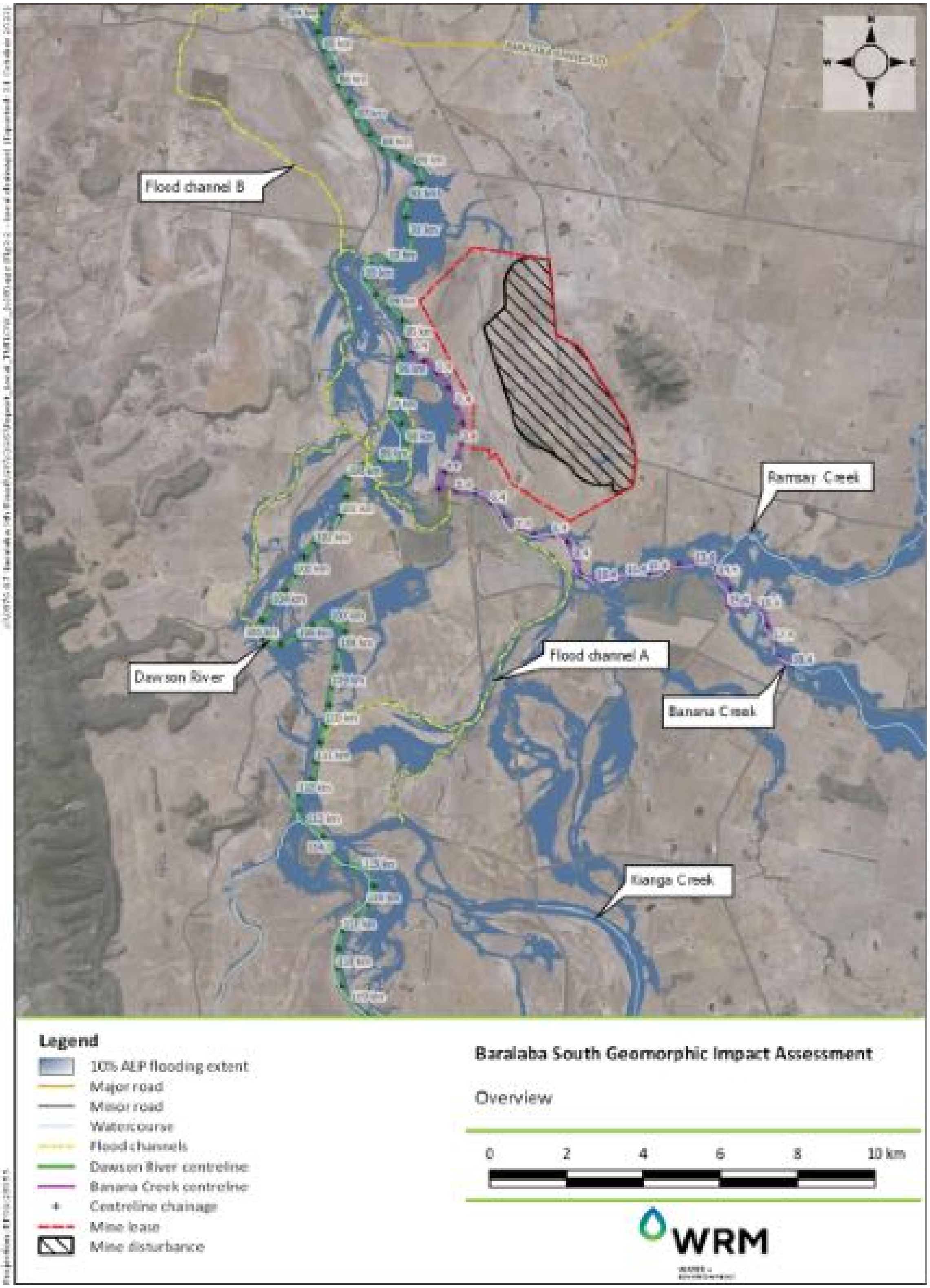

Figure 9.52: Local drainage characteristic

The Banana Creek channel on the Dawson River floodplain is about 150 m wide and is incised about 8 m to 10 m below the adjacent floodplain consistent with the Dawson River main channel. Like the Dawson River, the Banana Creek channel is slightly perched above the adjacent floodplain. The creek channel comprises of a 40 m wide low flow channel that has incised into the only Dawson River palaeo-channel surrounded by a lower bench about 8 m below the surrounding floodplain. The creek channel is heavily vegetated (including stands of mature trees), which indicates a reasonably stable channel.

The upper reach of Banana Creek that is not affected by Dawson River floodwaters is only 40 m wide and about 2 m to 4 m deep. The channel has low flood carrying capacity with significant flood flows draining along multiple flood channels.

Floodplain channels

There are several flood channels on the Dawson River floodplain in the vicinity of the Project. These channels only become active once Dawson River floodwaters reach a sufficiently high level, generally at about or even just below the 'bank-full' level.

Two notable flood channels on the Dawson River floodplain in the vicinity of the Project (refer Figure 9.52) include:

- Flood Channel A: connecting the Dawson River (about 110 km AMTD) and Banana Creek (about 7.5 km AMTD). Flood channel A is likely to be a remnant or palaeo-channel of the Dawson River.
- Flood Channel B: connecting the Dawson River (about 84.5 km AMTD) to an anabranch which loops northwest to bypass Baralaba town and the Neville Hewitt Weir, before turning east to pass north of the Baralaba North Mine and re-join the Dawson River at about 76.5 km AMTD. There is no specific channel in this location.

The flood channel across the Project area becomes active for the 10% AEP event where it receives minor overflows from Banana Creek and shallow overflows directly from the Dawson River. The flood channel drains local catchment flows for more frequent events or backwater flooding directly from the Dawson River.

9.9.4.2 Existing flooding characteristics

The results of flood modelling by Engeny (2023) of the Dawson River floodplain for the existing case were used by the Geomorphic Impact Assessment to characterise hydraulic conditions of relevance to the floodplain geomorphology including velocity, bed shear stress and stream power.

Modelling has been undertaken for two storm event scenarios:

- Scenario 1 has the storm centred across the entire Dawson River (Dawson River flood). Design discharges for this scenario use Dawson River design rainfalls (factored for catchment area) and Dawson River storm durations.
- Scenario 2 has the storm centred across the Banana Creek catchment (Banana Creek flood). Design discharges for this scenario use Banana Creek design rainfalls (factored for catchment area) and Banana Creek storm durations, which are shorter than for the Dawson River flood. Scenario 2 assumes that a 10% AEP design event is occurring concurrently in the Dawson River

The geomorphic assessment of baseline conditions considered velocity, bed shear stress, and stream power under a range of flood scenarios.

The analysis shows that there is a minor but distinct change in the hydraulic behaviour of the Dawson River between the reaches upstream and downstream of the Project under existing conditions, particularly for the larger events. It would appear that the Neville Hewitt Weir does not have a significant impact on the channel behaviour for these events. Rather, the greatest impact occurs as a result of the main channel crossing from the western side of the floodplain to the eastern side between chainages 89 km and 93 km. The narrower floodplain downstream from 89 km may also cause higher channel velocities and stream power for the larger events. This section also forces engagement of the floodplain in events 2% AEP and greater.

Banana Creek adjacent to the Project would appear to be dominated by Dawson River flows.

9.9.5. Potential impacts

The flood modelling summarised in section 9.9.2 was used to assess the flood impacts associated with the operational and post-mining phases of the Project (the mine developed case).

9.9.5.1 Extreme flood depth and extent

A flood protection levee is not required as the mining void remains out of the 0.1% AEP flood extent. For the duration of the Project, the out-of-pit WRE will be developed at the northern extent of the mining pit and will remain as a post-mining landform.

The out-of-pit WRE is not required to perform the function of pit flood protection immunity, however, the northern section of it is located partially within the Dawson River 0.1% AEP flood extent and may result in flooding impacts.

Post-mining, a low earthen embankment landform will be incorporated into the final landform design as a permanent feature of the landscape. This landform provides PMF protection to the final void, above the required 0.1% AEP design event flood protection target. Extreme event flood maps (0.1% and PMF) demonstrate the pit maintains 0.1% AEP flood protection for the Project duration and that the final void will maintain PMF immunity. The modelled peak flood depth and extent for the mine developed case for the 0.1% AEP and PMF flood events is shown on Figure 9.53 and Figure 9.54.

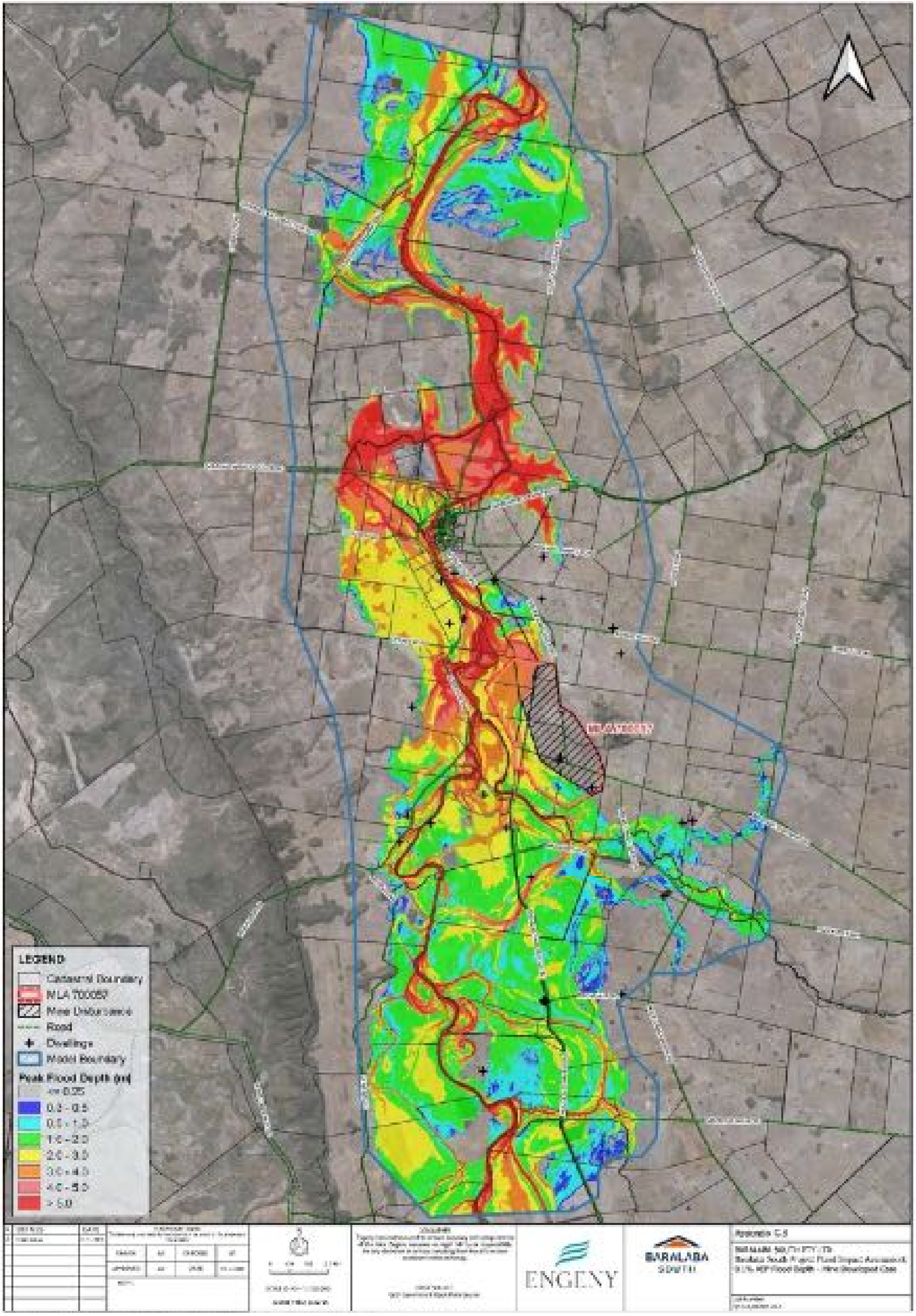

Figure 9.53:   0.1% AEP peak flood depth (mine developed case)

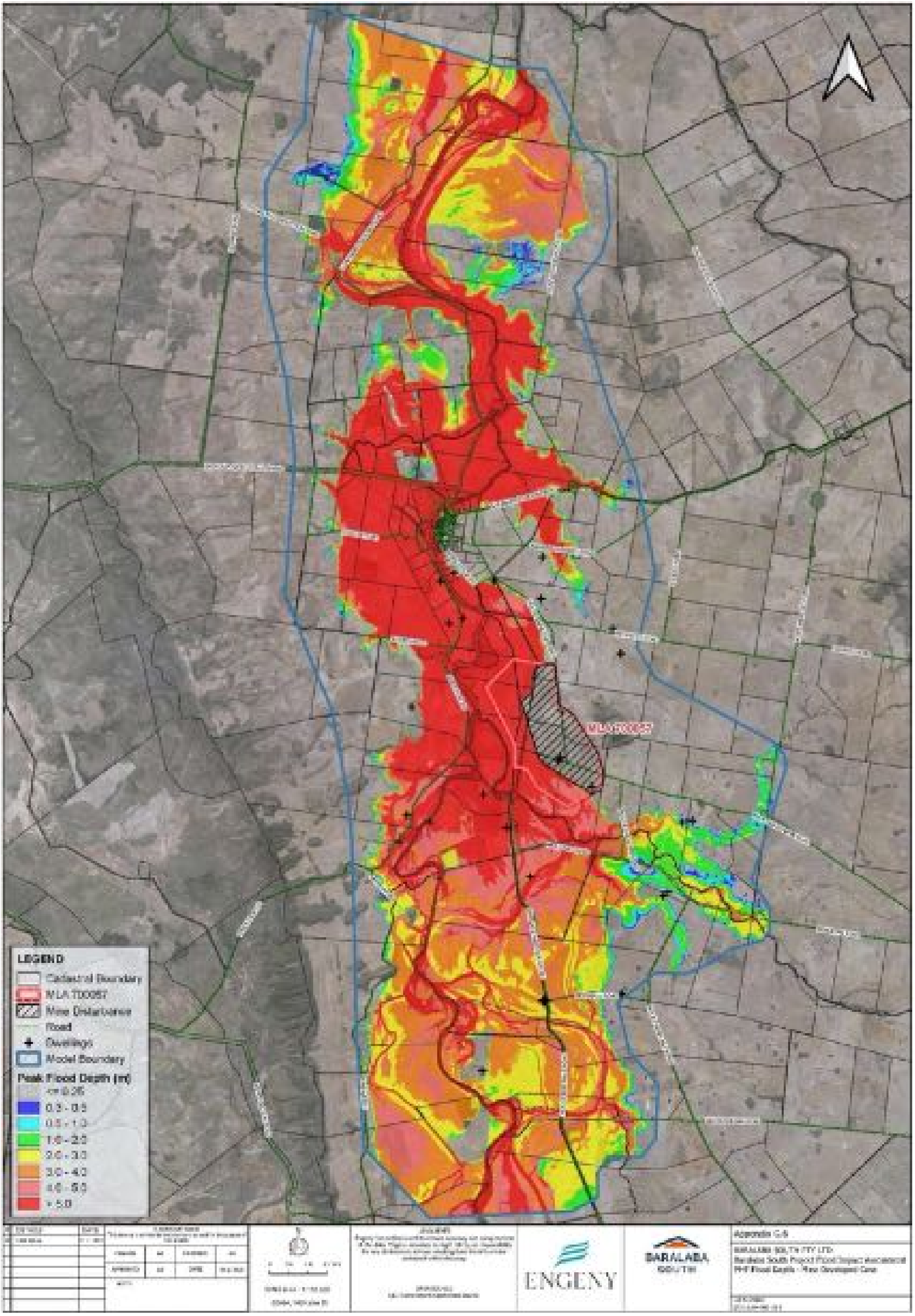

Figure 9.54: PMF peak flood depth (mine developed case)

9.9.5.2 Flood depth afflux

Flood depth mapping for the existing case and mine developed case is provided in Appendix C, Flood Impact Assessment for each AEP flood event up to 1% AEP. Flood depth afflux mapping showing the difference between the mine developed case and the existing case is also provided in Appendix C, Flood Impact Assessment for each AEP flood event. The modelled peak flood depths for the existing case and mine developed case for the 10% AEP flood event are shown on Figure 9.55 and Figure 9.56, respectively. Figure 9.57 shows the change in peak flood depth – the afflux (mine developed case compared to existing case) for the 10% AEP flood event.

Figure 9.58 and Figure 9.59 show the change in peak flood depth for the 2% and 1% AEP flood events, respectively.

The Flood Impact Assessment indicates that:

- There is no change in flood depth in flood events up to an including the 10% AEP since the Project footprint is located outside of the 10% AEP Existing Case flood extent.
- Flood afflux up to 200 mm is predicted for the 2% AEP and 1% AEP flood events in localised areas against the mine landform within the Project MLA.
- Flood afflux outside of the Project MLA will be less than 10mm for the 2% AEP flood event.
- Flood afflux of up to 40mm is predicted to occur outside of the Project MLA in a 1% AEP flood event between Banana Creek and the Project MLA, with up to 20 mm of flood afflux predicted on the Dawson River floodplain to the west of the Project MLA.
- Areas with flood afflux between 10mm and 20 mm in a 1% AEP are limited to the area immediately to the west of the Project MLA.
- The Project will cause a small (less than 10 mm) reduction in peak flood levels in the Dawson River channel and on the eastern floodplain downstream of the Project MLA in a 1% AEP flood event. This is due to the Project directing slightly more flood waters in larger flood events to the western floodplain and anabranch.
- The flood modelling of the Project shows no change in peak flood levels at the Baralaba township greater than 0.001 m for flood events up to the 1% AEP event.

Flood afflux impacts to neighbouring properties is discussed in section 9.9.5.9.

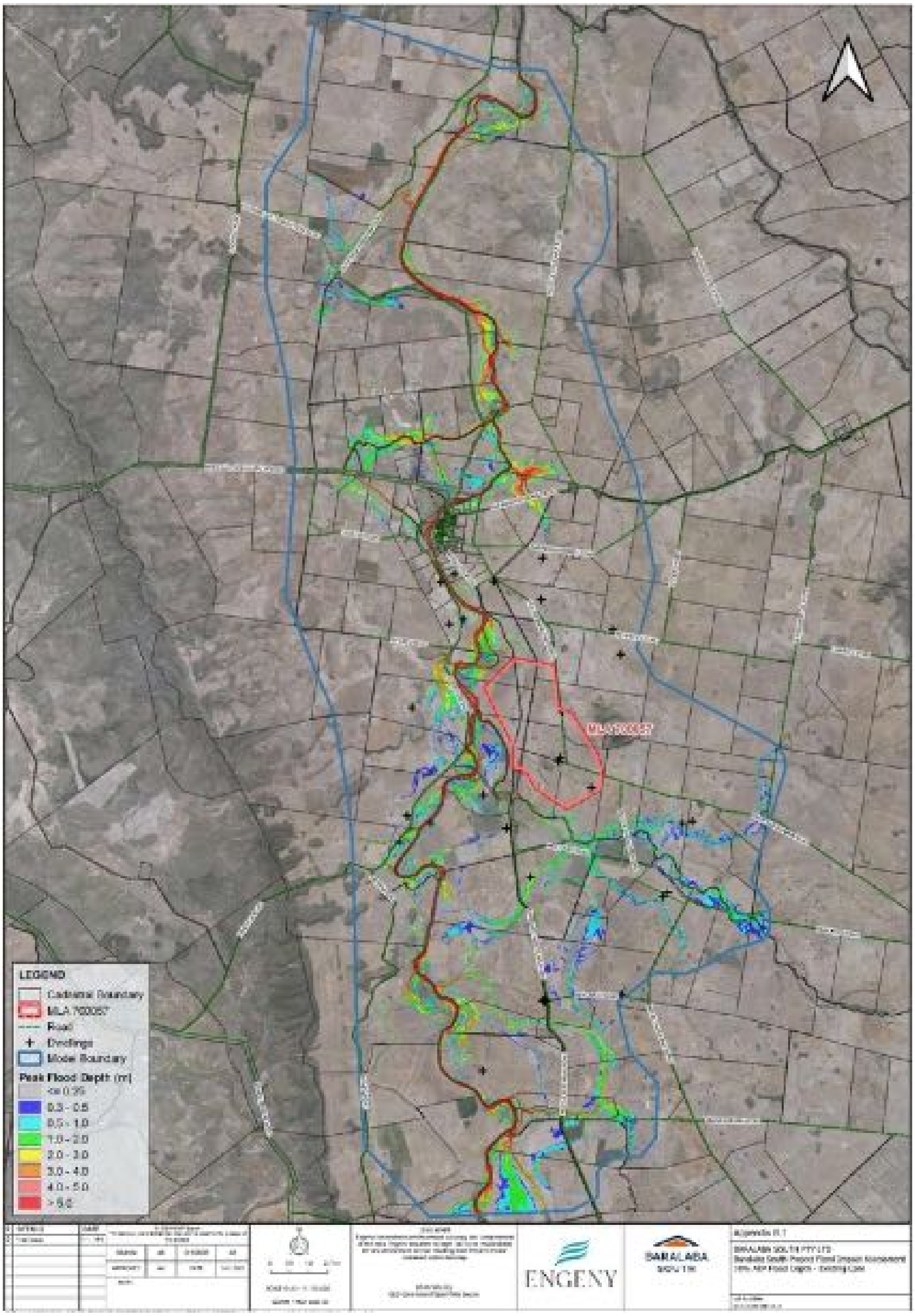

Figure 9.55: 10% AEP peak flood depth (existing case)

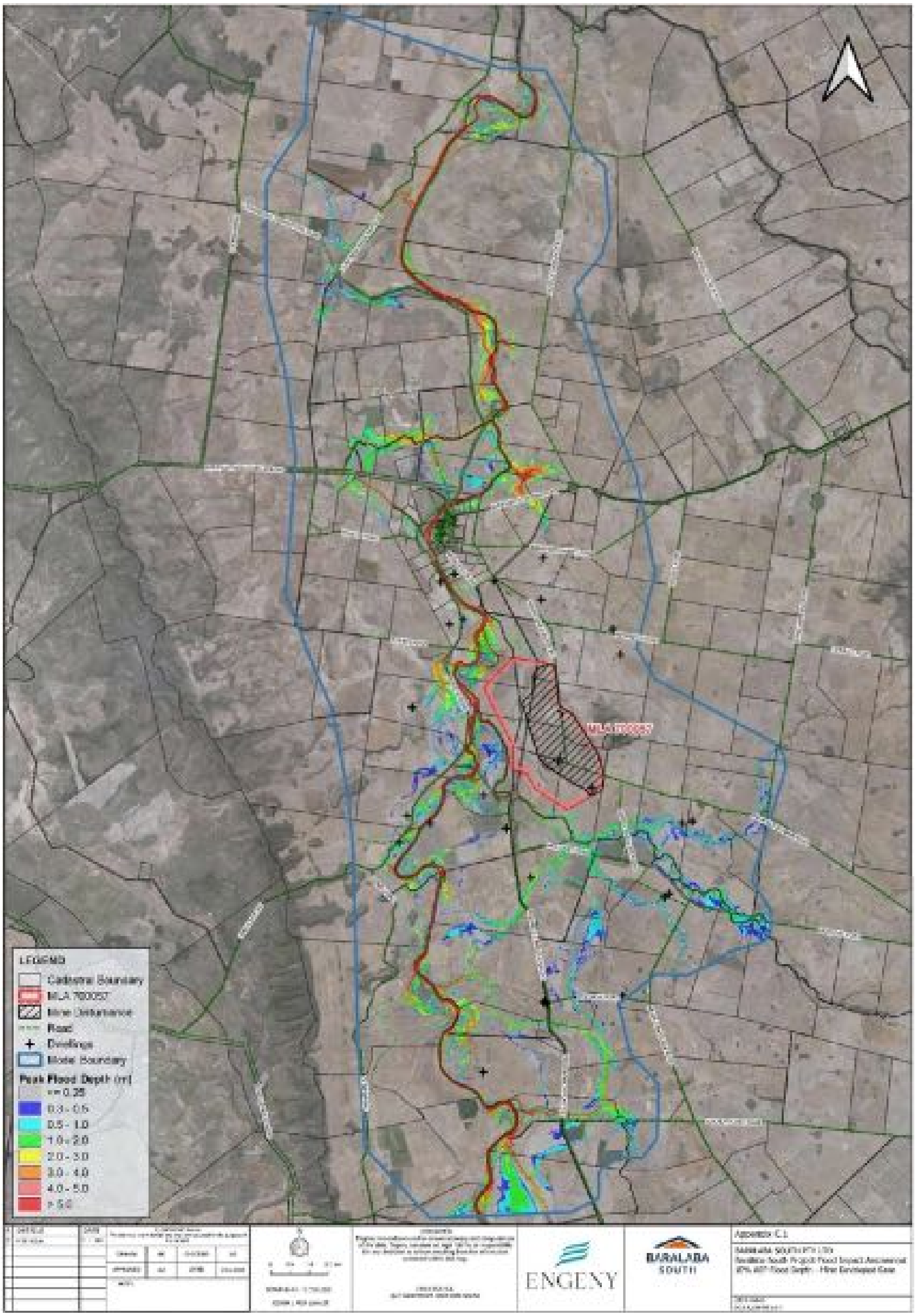

Figure 9.56: 10% AEP peak flood depth (mine developed case)

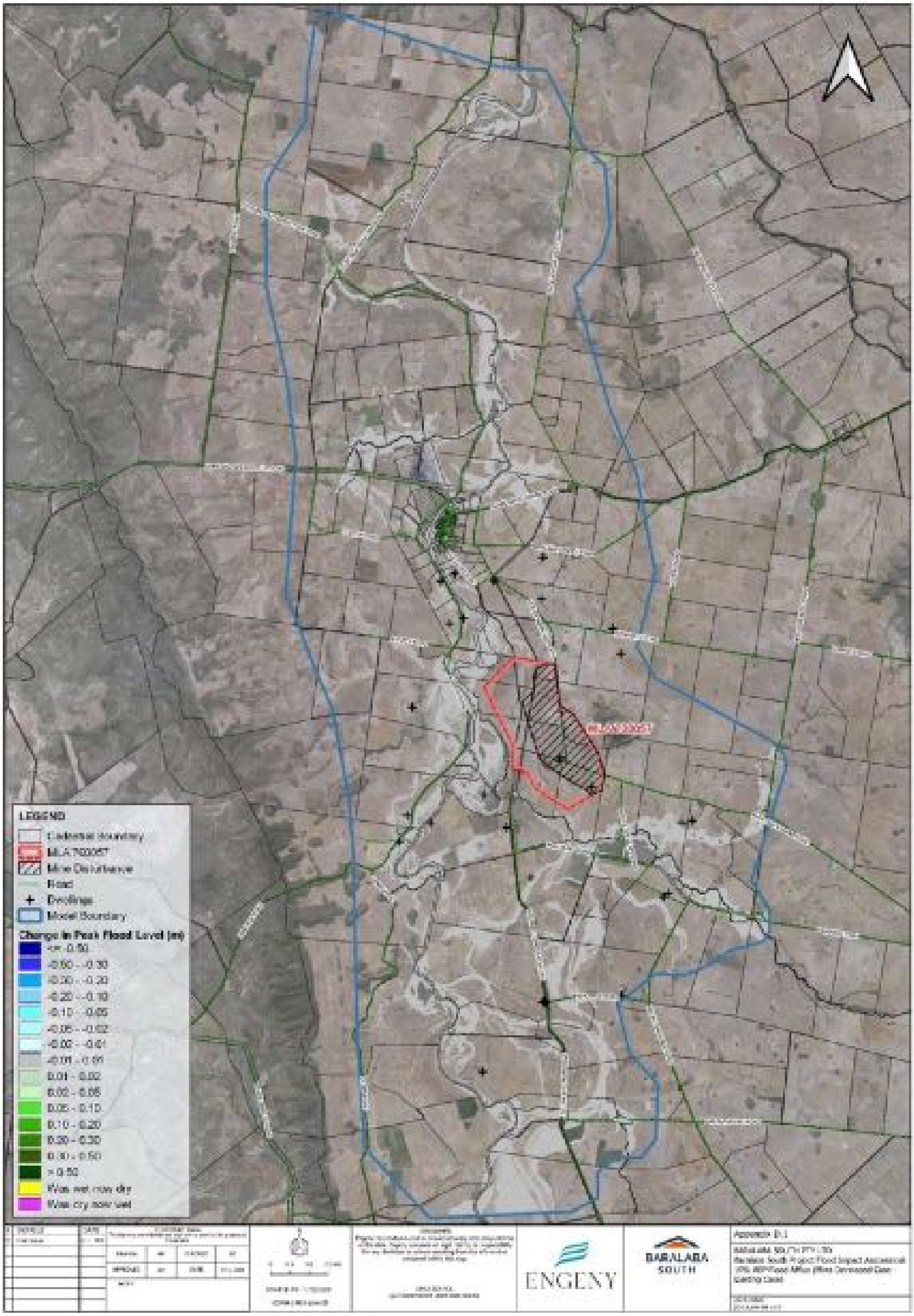

Figure 9.57: 10% AEP change in peak flood depth (mine developed case—existing case)

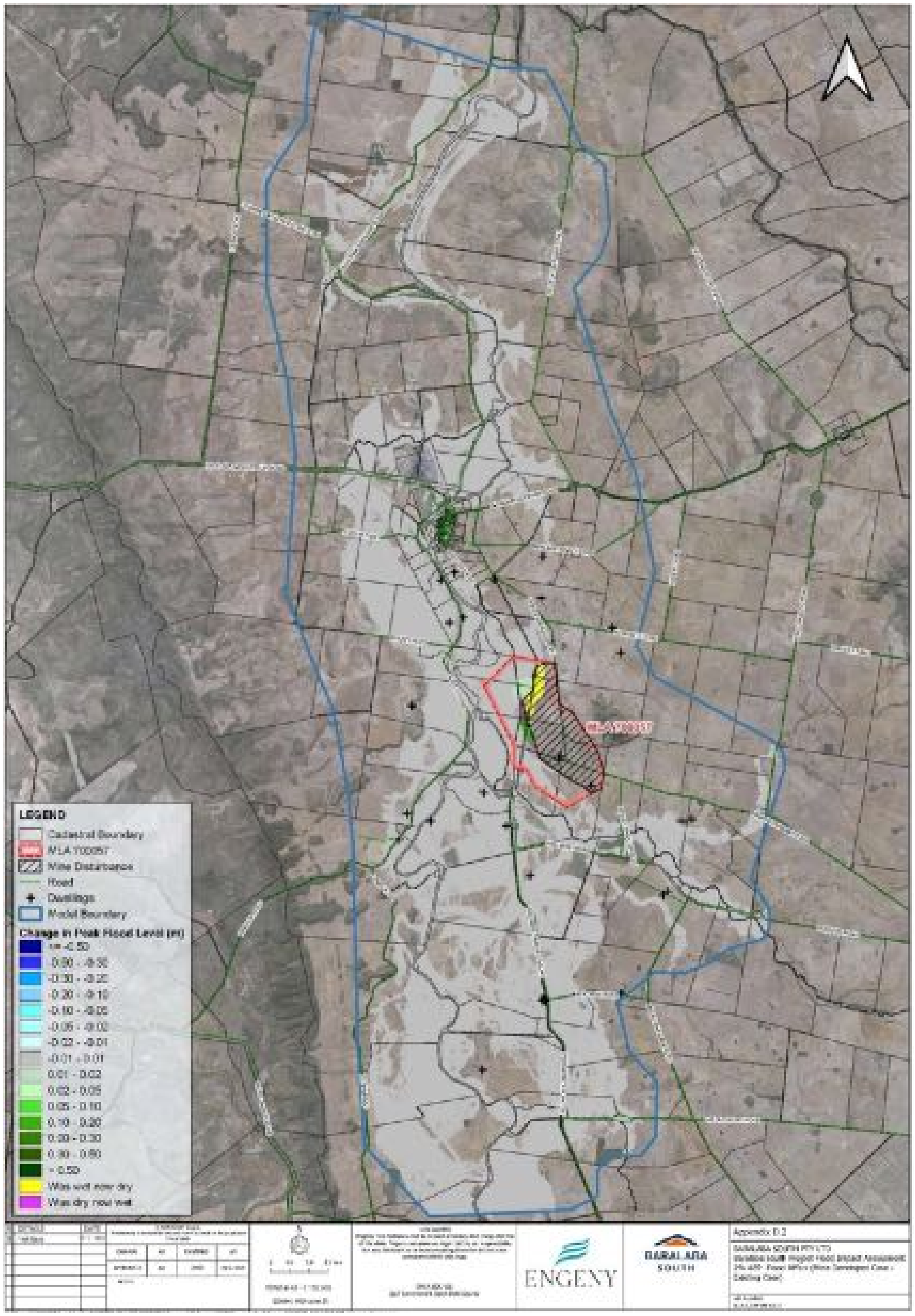

Figure 9.58: 2% AEP change in peak flood depth (mine developed case—existing case)

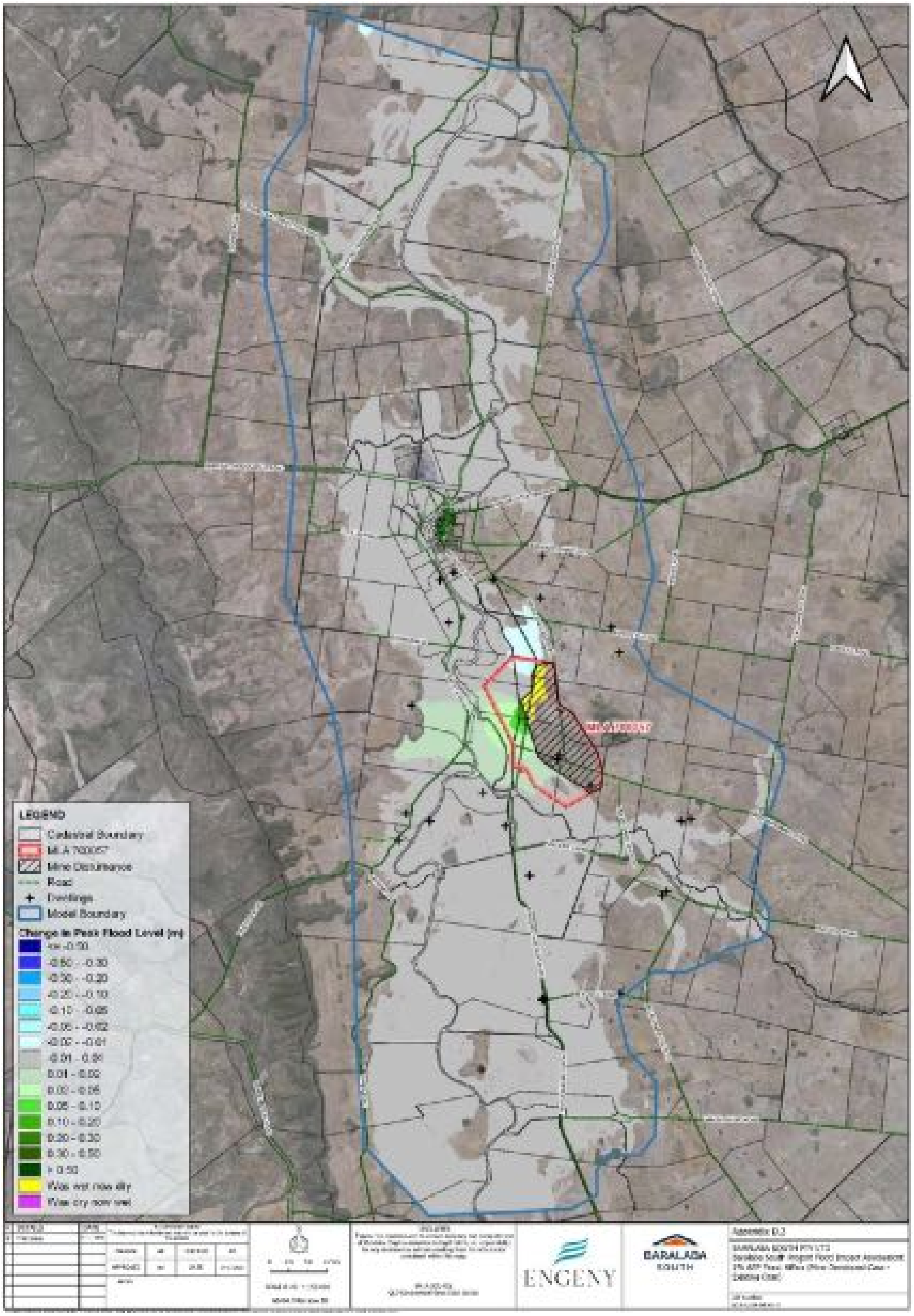

Figure 9.59: 1% AEP change in peak flood depth (mine developed case—existing case)

9.9.5.3 Flood velocity

Flood velocity mapping for the existing case and mine developed case is provided in Appendix C, Flood Impact Assessment for each AEP flood event up to 1% AEP, as well as afflux mapping illustrating the changes in flood velocities between the two respective cases.

The flood impact assessment indicates that:

- The Project will not impact flood velocities for all events up to and including the 10% AEP flood event.
- Areas with changes in peak flood velocity greater than 0.1m/s are limited to very localised areas immediately adjacent to the Project within the Project MLA for the 2% AEP and 1% AEP flood events.
- For all AEP flood events assessed, flood velocity changes greater than 0.1 m/s are not expected to occur outside of the Project MLA boundary.

In summary, the changes in flow velocity up to and including the 1% AEP event are predicted to be within 0.1 m/s to 0.3 m/s adjacent to the northern out-of-pit dump and will be contained within the MLA boundary. There are negligible changes to peak flood velocity outside of the Projects MLA boundary.

Figure 9.60 and Figure 9.61 show the change in peak flow velocity for the 2% and 1% AEP flood events, respectively.

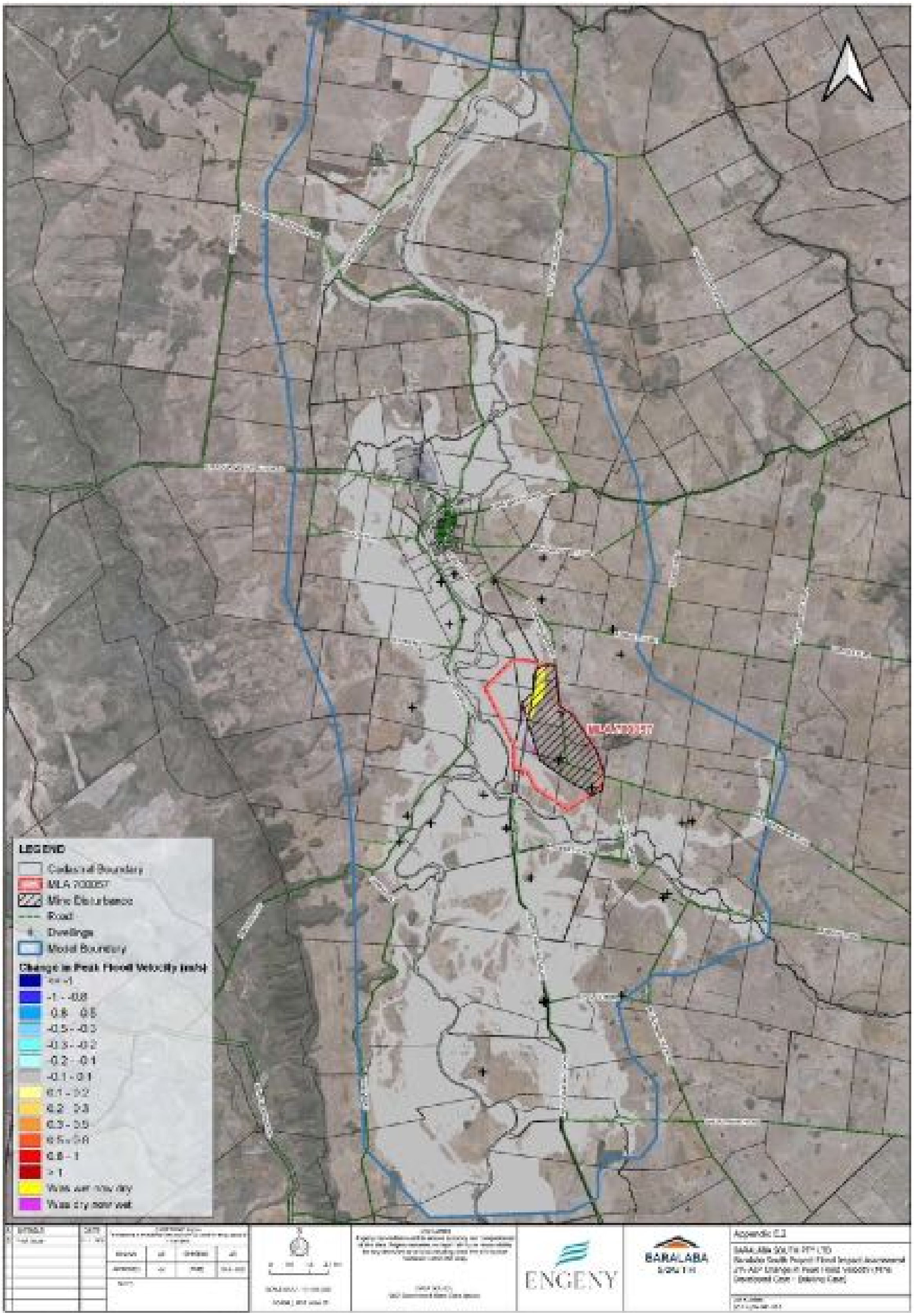

Figure 9.60: 2% AEP change in peak flood velocity (mine developed case—existing case)

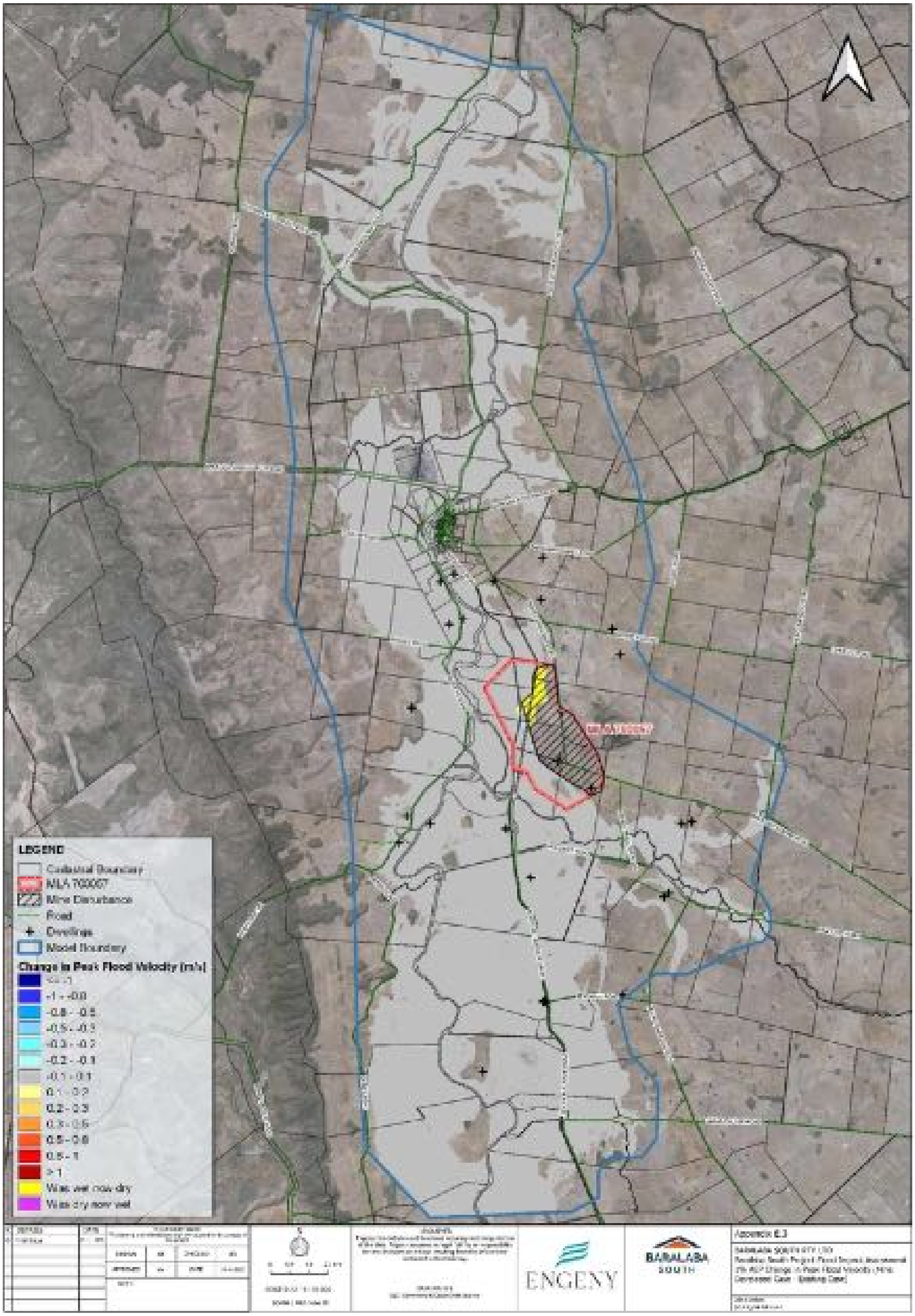

Figure 9.61: 1% AEP change in peak flood velocity (mine developed case—existing case)

9.9.5.4 Flood timing and flood travel times

Using the TUFLOW model, the impacts to flood timing and travel time along the Dawson River that may result from the Project have been assessed between the Bindaree gauging station (130374A) (upstream of the Project) and the Beckers gauging station (130322A) (downstream of the Project).

Table 9.37 summarises the changes in flood timing and flood travel times and shows:

- There is negligible change to peak flow rates at the Beckers gauging station downstream of the Project for all flood events up to the 1% AEP event.
- There is no change in the flood peak travel time from the Bindaree (130374A) gauging station to the Beckers (130322A) gauging station for all flood events up to the 1% AEP event.

Table 9.37: Flood timing and travel times impact summary

Value	Scenario	Flood event annual exceedance probability (AEP)		
		10% AEP	2% AEP	1% AEP
Peak flow at Beckers (m^3/s)	Existing case	1,844	3,610	6,149
	Mine developed case	1,844	3,611	6,152
	Change	0	1 (< 0.03%)	3 (< 0.05%)
Flood peak travel time from Bindaree to Beckers (hours)	Existing case	22.0	22.0	18.0
	Mine developed case	22.0	22.0	18.0
	Change	0.00	0.00	0.00

9.9.5.5 Flood inundation duration

The Flood Impact Assessment contained in Appendix C also mapped the Project's potential impacts on flood inundation duration. The results show that inundation duration is unchanged for flood events up to and including the 1% AEP.

Figure 9.62 and Figure 9.63 show the changes in inundation duration for the 2% AEP and 1% AEP flood events.

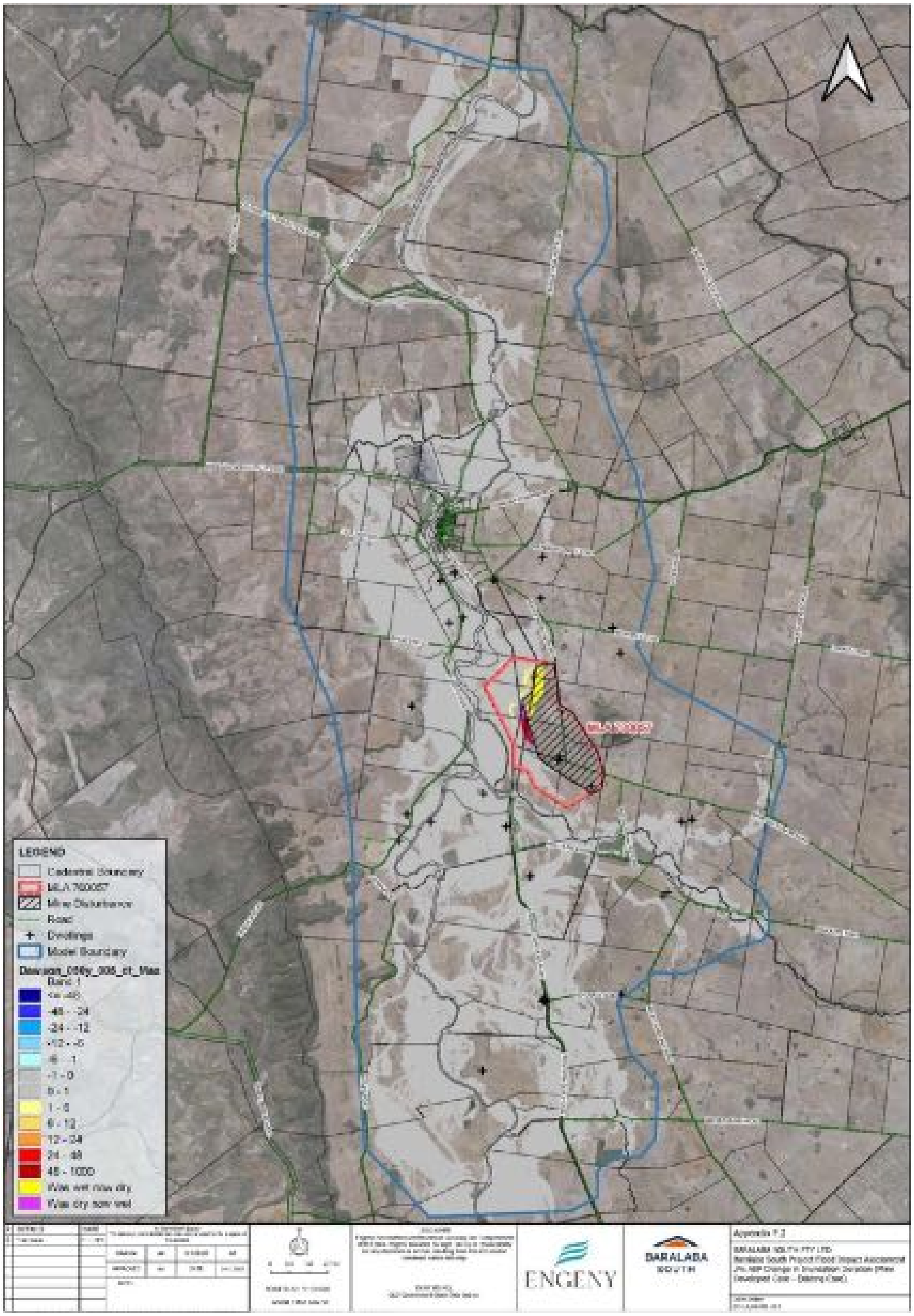

Figure 9.62: 2% AEP change in inundation duration (mine developed case—existing case)

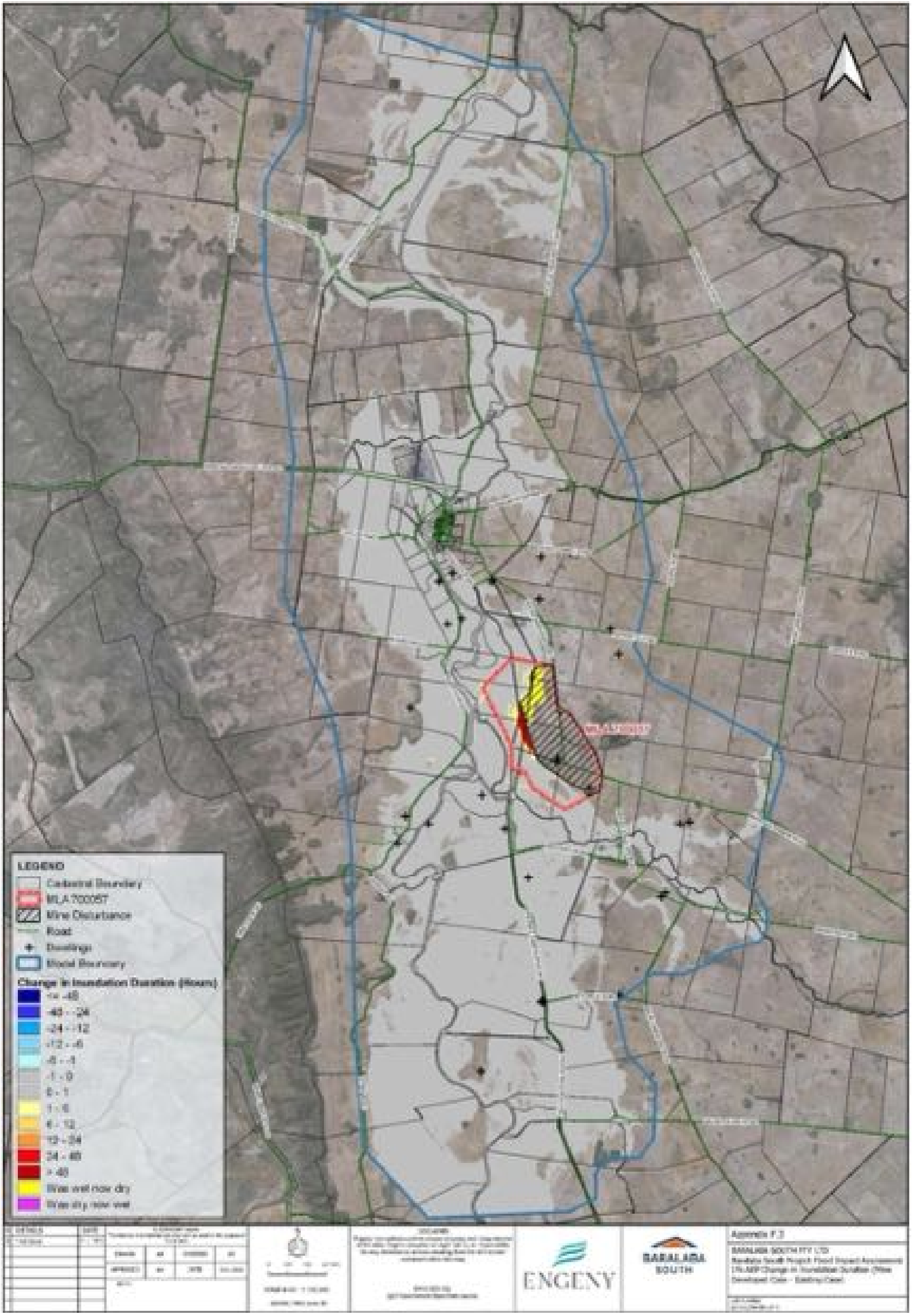

Figure 9.63: 1% AEP change in inundation duration (mine developed case—existing case)

9.9.5.6 Stream power and bed shear stress

The Flood Impact Assessment (Appendix C) evaluated the Project's impacts on stream power and bed shear stress in the Dawson River channel and floodplain areas, in the 10% and 1% AEP flood events. The stream power and bed shear stress assessment for the mine developed case shows:

- Stream power in the Existing Case is typically less than 10 W/m^2 on the Dawson River floodplain and less than 100 W/m^2 in the Dawson River channel for the 10% and 1% AEP flood events. Higher stream power is reported at channel meanders and locations with an increase in channel grade.
- Bed shear stress in the Existing Case is typically less than 10 N/m^2 on the Dawson River floodplain and less than 50 N/m^2 in the Dawson River channel for the 10% and 1% AEP flood events.
- The mine developed case results show no change to stream power and bed shear stress in the 10% AEP flood event.
- Only minor changes in-stream power and bed shear stress are predicted for the 1% AEP flood event and isolated to areas inside the MLA boundary, adjacent to the mine landforms.

9.9.5.7 Geomorphology

The Project will comprise open cut pits and related mining infrastructure constructed adjacent to the Dawson River floodplain. Only a small area of overburden will be placed on the floodplain. The mine disturbance boundary will be at least 1,300 m away from the top of bank (or edge of the channel) of Banana Creek and at least 2,000 m away from the Dawson River top of bank. No works are proposed within the Dawson River or Banana Creek channels, with the exception of proposed water release/extraction infrastructure on the bank of the Dawson River. The final mine landform has the potential to affect geomorphological behaviour of the Dawson River and Banana Creek channels and floodplain through:

- increased channel velocities, bed shear stress and stream power, which could increase the potential for channel erosion;
- reduced channel velocities, bed shear stress and stream power, which could increase the potential for channel sedimentation and reduced channel capacity; or
- changes in the distribution of flow, which could increase the erosion potential of the floodplain.

The geomorphic assessment concluded (Appendix D, Geomorphic Impact Assessment):

- The Project will have a negligible impact on the velocities, bed shear stress and stream powers along the Dawson River and Banana Creek channels for the 10% and 1% AEP events. Although peak flood levels increase along the channel for the larger events, the increase is negligible in comparison to the existing flood depths along each channel. Any changes are well within the range of velocities, bed shear stress and stream powers observed along the existing channel reaches. Consequently, the Project will not cause any material change in the morphology of the river channel. It will not change the sediment transport characteristics or erosion potential for any of the events investigated.
- There are no velocity impacts to the floodplain for the 10% AEP event, and only localised impacts adjacent to the final landform for the 1% AEP event. At this location, the peak velocities for the proposed conditions are no greater than at other locations on the floodplain. On this basis, the change in the erosion potential of the floodplain is expected to be negligible.
- A review of historical aerial photos suggests that the lateral migration of stream channels is relatively slow in this reach of the river system and that any change in the alignment of the river due to lateral erosion would occur over hundreds if not thousands of years.

Based on these findings, there would be no material geomorphological impacts on the Dawson River and Banana Creek channels and floodplains associated with the Project.

9.9.5.8 HES wetland

The modelled flood impacts of the Project at the HES wetland situated within and adjacent to the MLA are summarised in Table 9.38. The flood model results indicate the wetland becomes flooded at AEP's smaller than 10%, however, no change in flooding conditions occur in a 2% AEP flood event. Peak flood depths are increased by 0.02 m for a 1% AEP flood event, which is expected to have negligible impact to the wetland condition. Peak flood velocity remains unchanged for all flood events, which indicates no increased risk of erosion during flood events. Based on the assessment, the Project is not expected to result in flooding impacts to the HES wetland.

Table 9.38: HES wetland flood impacts

Flood event AEP	Peak flood depth (m)			Peak flood velocity (m/s)		
	Existing case	Mine developed case	Change	Existing case	Mine developed case	Change
10% AEP	Wetland not inundated in 10% AEP flood event					
2% AEP	0.85	0.85	<0.01	0.15	0.15	<0.01
1% AEP	1.99	2.01	0.02	0.38	0.38	<0.01

9.9.5.9 Nearby properties (infrastructure and agricultural land use) and roads

Flood impact objectives have been adopted for the Project and are outlined in Table 9.39. Assessment of modelled flood impacts against the flood impact objectives is provided below.

Table 9.39: Flood impact objectives

Land Use	Objective[1]
Existing habitable structures (e.g. dwellings)	• Where flooding is predicted to occur above habitable floors in the existing case, flood level afflux of ≤ 1 cm; and • Where flooding occurs below habitable floors in the existing case, flood level afflux does not cause above habitable floor flooding.
Existing non-habitable structures (e.g. agricultural sheds, carports, containers, meter boxes)	• Flood level afflux of ≤ 5 cm
Property with agricultural (cropping) land use	• Flood level afflux of ≤ 20 cm
Property with agricultural (grazing) land use	• Flood level afflux of ≤ 40 cm
Roads	• Less than 10% increase in un-trafficable road length

[1] Assessed for flood events up to and including 1% AEP flood event.

Habitable and non-habitable structures

Flood impacts in the location of habitable and non-habitable structures have been assessed against the Project flood impact assessment objectives provided in Table 9.39 (Appendix C, Flood Impact Assessment).

The flood model shows there are no changes in flooding at existing habitable and non-habitable structures in all events up to the 2% AEP flood event.

Afflux between 1 cm and 2 cm is predicted at a number of non-habitable structures in the 1% AEP flood event including:

- two unidentified structures on the Riverland property (4/FN514) adjacent the Banana Creek channel with predicted afflux up to 2.6cm (26mm);
- two sheds on the Alberta property (5/KM50) with predicted afflux of up to 1.4cm (14mm); and
- one silo on the Alberta property (6/KM50) with predicted afflux of up to 1.1cm (11mm).

Although flood afflux between 1 cm and 2 cm is predicted at five non-habitable structures, it impacts remain below the flood impact objective of 5 cm for non-habitable structures.

Afflux greater than 1 cm is not predicted to occur at any existing habitable dwelling for flood events up to the 1% AEP event.

Agricultural land use (cropping and grazing)

Flood impacts to agricultural land (cropping and grazing) have been assessed against the Project flood impact objectives (Table 9.39). All properties with cropping or grazing lands were assessed as meeting the flood impact objectives. Afflux to agricultural land outside of the Project MLA does not exceed 1cm for flood events up to the 2% AEP. Afflux of 1 cm to 3 cm in the 1% AEP flood event is predicted on the nearby properties 'Riverland', 'Alberta' and 'Mount Ramsay', however, remains well below the flood impact objective of 20 cm and 40 cm for cropping and grazing land uses respectively. The flood level afflux maps in Appendix C, Flood Impact Assessment illustrate the spatial variation in afflux across each of the properties.

Roads

Flood impacts to roads in the vicinity of the Project have been assessed against the Project flood impact objective for roads (Table 9.39). The flood impact objective for existing roads is less than a 10% increase in un-trafficable road length for the mine developed case. Roads have been assessed as un-trafficable when flood depths over the road are greater than 0.3 m which is the depth limit for when small sized vehicles become unstable.

Negligible changes to road inundation lengths are predicted for all events up to the 1% AEP flood event, therefore road trafficability is not expected to be impacted.

Other nearby infrastructure and towns

Infrastructure near the Project with potential to be affected by flooding in the mine developed case is shown in Figure 9.50.

Table 9.40 summarises the identified flood afflux impacts to nearby infrastructure for the mine developed case. The flood model shows there are negligible flood impacts to nearby infrastructure and the Baralaba township for flood events up to 0.1% AEP.

Table 9.40: Assessment of properties against flood impact objectives – agricultural land use (cropping and grazing)

Infrastructure ID	Potential impact
Baralaba Township	< 0.01 m flood level increase in all events up to 0.1% AEP flood event
Neville Hewitt Weir	< 0.01 m flood level increase in all events up to 0.1% AEP flood event
Baralaba-Woorabinda Road Bridge	< 0.01 m flood level increase in all events up to 0.1% AEP flood event
Moura-Baralaba Road Bridge	< 0.01 m flood level increase in all events up to 0.1% AEP flood event
Baralaba North Mine	< 0.01 m flood level increase in all events up to 0.1% AEP flood event

9.9.5.10 Banana Creek dominated flooding

Banana Creek dominated flooding was assessed for the existing case and mine developed case scenarios for the 10%, 1% and 0.1% AEP event to determine the extent of flooding impacts compared to the Dawson River flood discussed above. The Banana Creek dominated 10%, 1% and 0.1% AEP flood results for the existing case and mine developed case are presented in Appendix C, Flood Impact, as well as the change to flood depth (afflux) and peak velocity. The Banana Creek dominated flooding scenario shows:

- Similar to the Dawson River flooding scenarios, there are no impacts for the Banana Creek 10% AEP flood event.
- The extent of flooding impacts for the Banana Creek 1% and 0.1% AEP events is less than the Dawson River scenarios, however, shows larger increases in flood afflux within the MLA.
- The Banana Creek dominated flood afflux shows the Project results in flood depth increases of up to 30mm outside of the MLA boundary in the 1% AEP event, however, is limited to the area between the MLA and Banana Creek. Afflux between 10mm and 20mm is also predicted on the western Dawson River floodplain adjacent to the Project in a small number of isolated locations.
- Although the extent of impacts is less, the magnitude of impacts is predicted to be slightly higher immediately adjacent to the mine landform within the Project MLA.
- Banana Creek 1% AEP flood impacts for both peak flood depth (afflux and velocity) is lower than the Dawson River 1% AEP flood impacts outside of the Project MLA.

Based on the Banana Creek dominated flooding assessment it was determined that the Project will result in larger flooding impacts for a Dawson River dominated flood and represents the overall flood impacts for the Project.

9.9.5.11 Mine site infrastructure

The water management infrastructure stage plans presented in Appendix C, Flood Impact show the proposed mine landform over the Project Life. The flood model results show all mine water storages and site infrastructure proposed for the Project are located outside of the 0.1% AEP flood extent besides the northern section of the out-of-pit dump and number of small sediment dams.

Localised increases in peak flood velocity are identified in flood events greater than 10% AEP at the downstream toe of the out-of-pit dump landform at the northwest corner of the site. Flood velocities are expected to increase locally by up to 0.35 m/s, however, remain below 0.6 m/s in the mine developed case for the 1% AEP flood event. Although the expected flood velocities are low, localised erosion protection works such as rock armouring and establishment of floodplain vegetation (trees) may be implemented to prevent scouring and degradation of this area.

There are a number of sediment dams and located at the downstream toe of the out-of-pit dump. These dams have greater than 10% AEP flood immunity from the Dawson River. The sediment dams are used to contain sediment runoff from the WRE and do not contain hazardous materials and are designed and proposed to be operated in accordance with the Best Practice Erosion and Sediment Control Guidelines (IECA, 2018). The sediment and clean water dams located within the 0.1% AEP flood extent are to be of mostly excavated construction (embankment to provide spillway freeboard) to prevent risk of dam break during flooding of the Dawson River.

The proposed extent of open cut mining over the Project duration relative to the modelled existing 0.1% AEP flood extent is shown in Figure 9.64. The flood results show the open cut pit is located outside of the pre-mining 0.1% AEP flood extent for the duration of the Project and artificial landforms are not required to provide flood immunity.

The mining pit maintains 0.1% AEP climate change flood immunity without flood protection levees. The closure mine landform includes a rehabilitated final landform bund located around the southern extent of the final void with a crest elevation above the predicted PMF level to provide the residual void PMF immunity post closure.

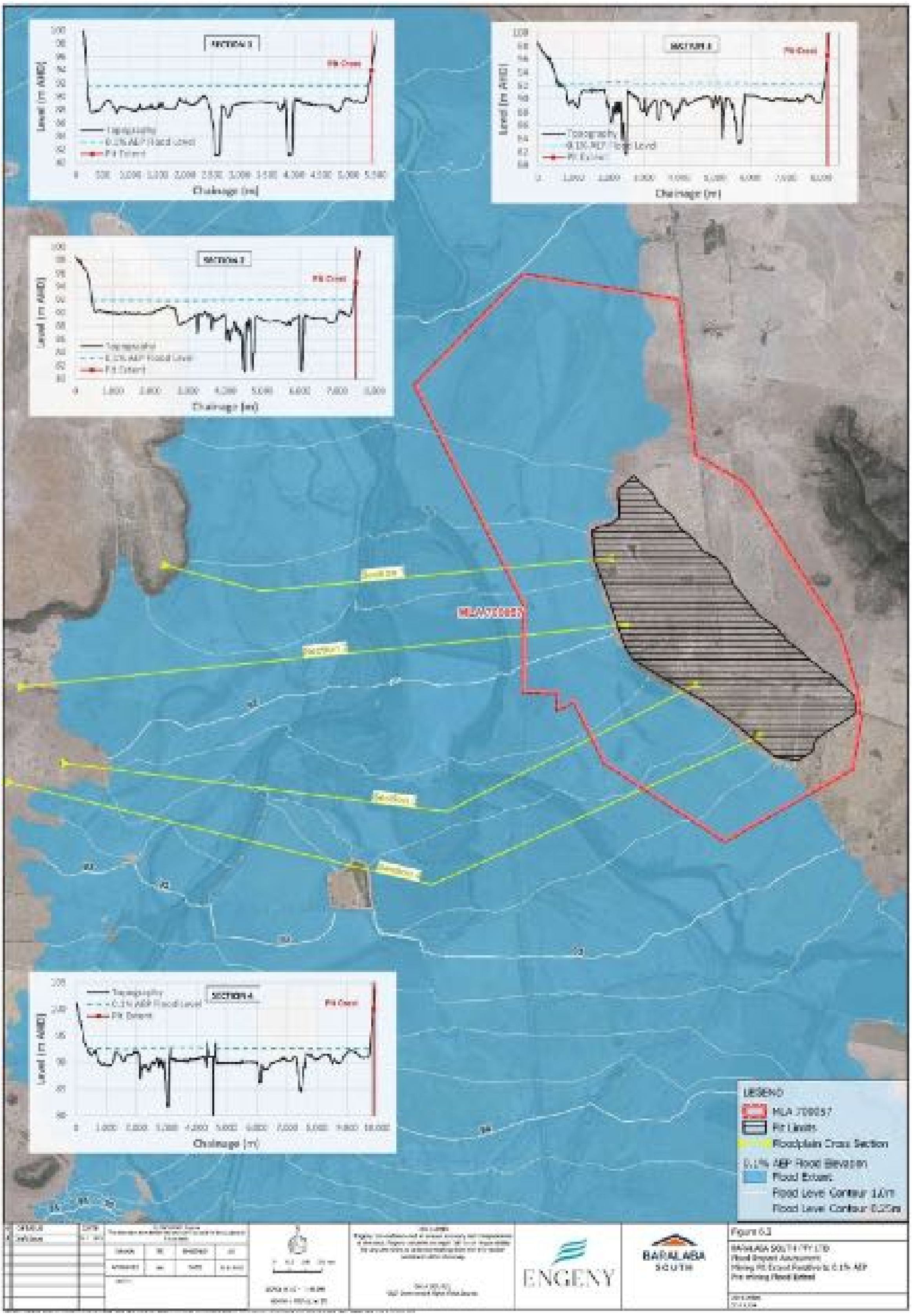

Figure 9.64: Mining pit extent relative to 0.1% AEP pre-mining flood extent

9.9.5.12 Cumulative impacts

The Flood Impact Assessment has considered existing structures that may affect flood behaviour, including structures that are proposed as part of the Project.

There are no known projects in the planning or development phase that may result in additional structures on the floodplain in the vicinity of the Project. Additionally, while the Project proposes the realignment of the Moura-Baralaba Road, this is beyond the influence of the effective flow area of the Dawson River floodplain and will not impact on the predicted flood impacts associated with the operational activities and final post-mining landform. For further information, see Appendix C, Flood Impact Assessment.

9.9.5.13 Sensitivity assessments

Using the Dawson River flood model, a number of sensitivity assessments were conducted to understand the sensitivity of the modelled Project impacts on flooding, including:

- A climate change sensitivity assessment—the assessment used the methodology outlined in the 'Australian Rainfall and Runoff Guideline' (Ball *et al.*, 2019) to develop a climate change design hydrology for the 1% and 0.1% AEP flood events. This was done by increasing design rainfall intensities using climate change factors provided by the 'Australian Rainfall and Runoff Guideline' for the Dawson River catchment. Climate change projection year 2070 has been adopted for the purposes of the assessment. The results from the sensitivity analysis indicate that flood levels are likely to increase due to climate change impacts on Dawson River hydrology. For example, for the mine developed case, the peak flood levels in the Dawson River are projected to increase by 0.25 m for the 1% AEP flood event and by 0.3 m for the 0.1% AEP flood event adjacent to the Project as a result of climate change. The changes to flood levels under the climate change projections are negligible and as a result, there are no key risk areas for climate change vulnerability for the Project and no alternative adaptation strategies are considered to be required.
- General sensitivity assessment— The December 2010 historical event sensitivity assessment was undertaken to assess flood impacts for a flood event with significantly more flood volume than a design flood event of a similar AEP. The assessments indicated peak flood level impacts associated with the mine developed case are not highly sensitive to the volume of the hydrograph and are instead more dependent on the peak flow rate in the Dawson River.

9.9.6. Mitigation, management measures and monitoring

The mitigation management, and monitoring measures outlined below are expected to avoid, minimise or mitigate the Project's impacts on flooding, with respect to the safety of people, property, and the environment.

9.9.6.1 Flood protection and final landform design

The current mine plan has been optimised to minimise adverse flooding impacts in the Dawson River and Banana Creek, and the adjoining floodplain areas. The mine design ensure protection against the 0.1% AEP peak flood event, climate change scenario.

Post-mining, the final landform design will include an earthen bund on the south-western corner of the final void that will act as a permanent feature of the landscape and will provide PMF design event protection to the final void. The height of the bund is proposed to be 98 mAHD (max 5 m above ground level), which is approximately 1 m to 1.5 m above the PMF level.

9.9.6.2 Nearby properties (infrastructure and agricultural land use)

Habitable and non-habitable structures

Mine planning has targeted minimal impact to the Dawson River floodplain to reduce flood impacts which has achieved the Project's flood impact objectives for habitable structures.

No further mitigation measures are considered necessary to prevent flood impacts on habitable structures.

Further consultation will be conducted with relevant landholders to assess whether the flood level afflux predicted to occur at non-habitable structures on their property will result in a material impact, and to identify whether any localised mitigation measures may be appropriate.

9.9.6.3 Mine site infrastructure

Erosion protection works, such as rock mulching, and monitoring of the areas identified as having localised increases in peak flood velocity near the north-west extent of the out-of-pit dump landform. Erosion protection works and floodplain vegetation establishment to prevent localised scouring and degradation of the area identified with increases in peak flood velocity. Monitoring is proposed to observe the performance of the erosion protection works following large flood events.

Site infrastructure, access road and haul roads are to be located above the Dawson River 0.1% AEP peak flood level. With all site infrastructure located above the Dawson River 0.1% AEP peak flood level there is no potential for additonal flood impacts associated with the Project.

Sediment Dams and clean water dams located within the 0.1% AEP flood extent are to be of mostly excavated construction to reduce risk of dam break during flooding of the Dawson River. The dams are proposed to be mostly excavated preventing the possibility of erosion and failure of a dam embankment in a large flood event.

Hazardous materials will be stored at the infrastructure areas at the eastern extent of the MLA boundary, which maintains PMF immunity. Any storage containers that hold hazardous materials will be secured in line with relevant Australian Standards to prevent the removal of the containers from the site by a flood event.

9.9.7. Monitoring

Mine water infrastructure will be inspected by an appropriately qualified and experienced person in advance of the wet season each year. In addition, following major flood events, a visual inspection of any water infrastructure in flood areas will be conducted to identify any impact from flood waters to conduct required maintenance activities.

Monitoring will be conducted in the areas near the north-western extent of the northern WRE area, that may have localised contact with flood water. Where erosion protection works are required, monitoring will be conducted to assess the effectiveness of such works following flood events.

Aerial imagery of the river channels will be obtained (possibly via drone or plane) prior to the commencement of construction and immediately following each flood that encroaches the final landform. The aerial imagery extends a distance of 5 km along the watercourse upstream and downstream of the Banana Creek confluence and about 5 km of Banana Creek. The purpose of collecting the imagery would be to define the geomorphic changes that occur (naturally or otherwise) along the reach for further assessment and evaluation by an appropriately qualified person if required.

9.10 Groundwater

9.10.1. Groundwater environment

9.10.1.1 Environmental values and water quality objectives

Environmental values associated with Queensland waters are protected under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP (Water and Wetland Biodiversity)). The EPP (Water and Wetland Biodiversity) achieves the objectives of the EP Act to protect Queensland's waters while supporting ESD. Queensland waters include water in rivers, streams, wetlands, lakes, groundwater aquifers, estuaries and coastal areas. The Project is located within:

- Surface Water: Lower Dawson River Sub-basin – WQ1309 (Figure 9.65); and
- Groundwater: Fitzroy Basin Groundwater Zones / Lower Dawson Groundwaters – WQ1310 (Figure 9.66)

The Project lies within Groundwater Chemistry Zone 34 of the Dawson River sub-basin, for which WQOs have been set (DEHP, 2011). This zone is described as “Saline: [high] Na, Cl” on the map accompanying DEHP (2011) (Figure 9.66).

Environmental values (EVs) and water quality objectives (WQOs) for waters are prescribed in Schedule 1 of the EPP (Water and Wetland Biodiversity). WQOs are long-term goals for water quality management that protect environmental values. Schedule 1 refers to the Dawson River Sub-basin Environmental Values and Water Quality Objectives, published by the Department in September 2011. WQOs are typically based on national water quality guidelines.

The Queensland Government has published consultation materials (including revised environmental values, WQOs and aquatic ecosystem protection mapping) for the Fitzroy Region groundwaters and surface waters, in 2020.

A summary of the environmental values applying to the Project is presented in Table 9.41.

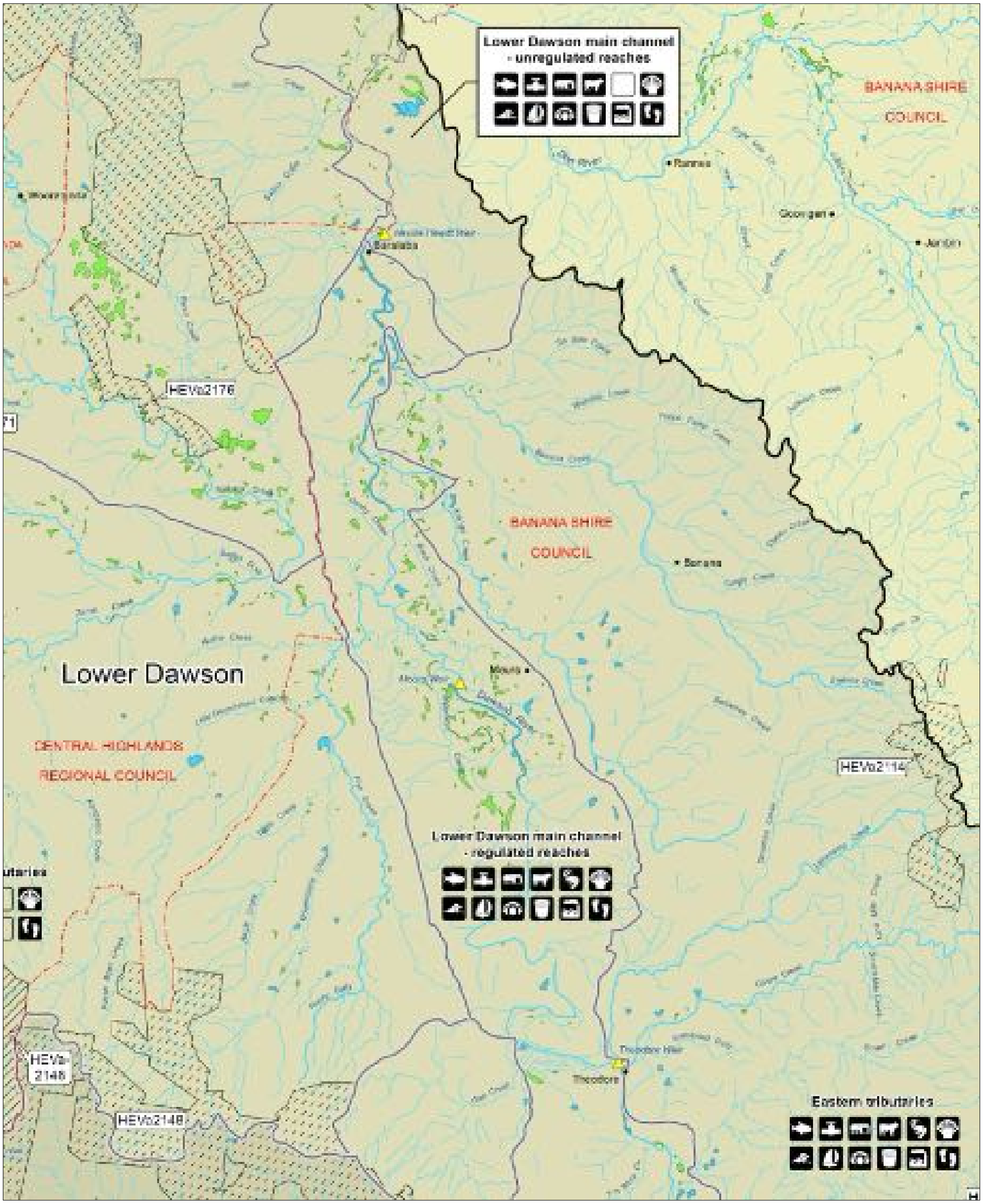

Figure 9.65: Environmental values—lower Dawson River Sub-basin—WQ1309

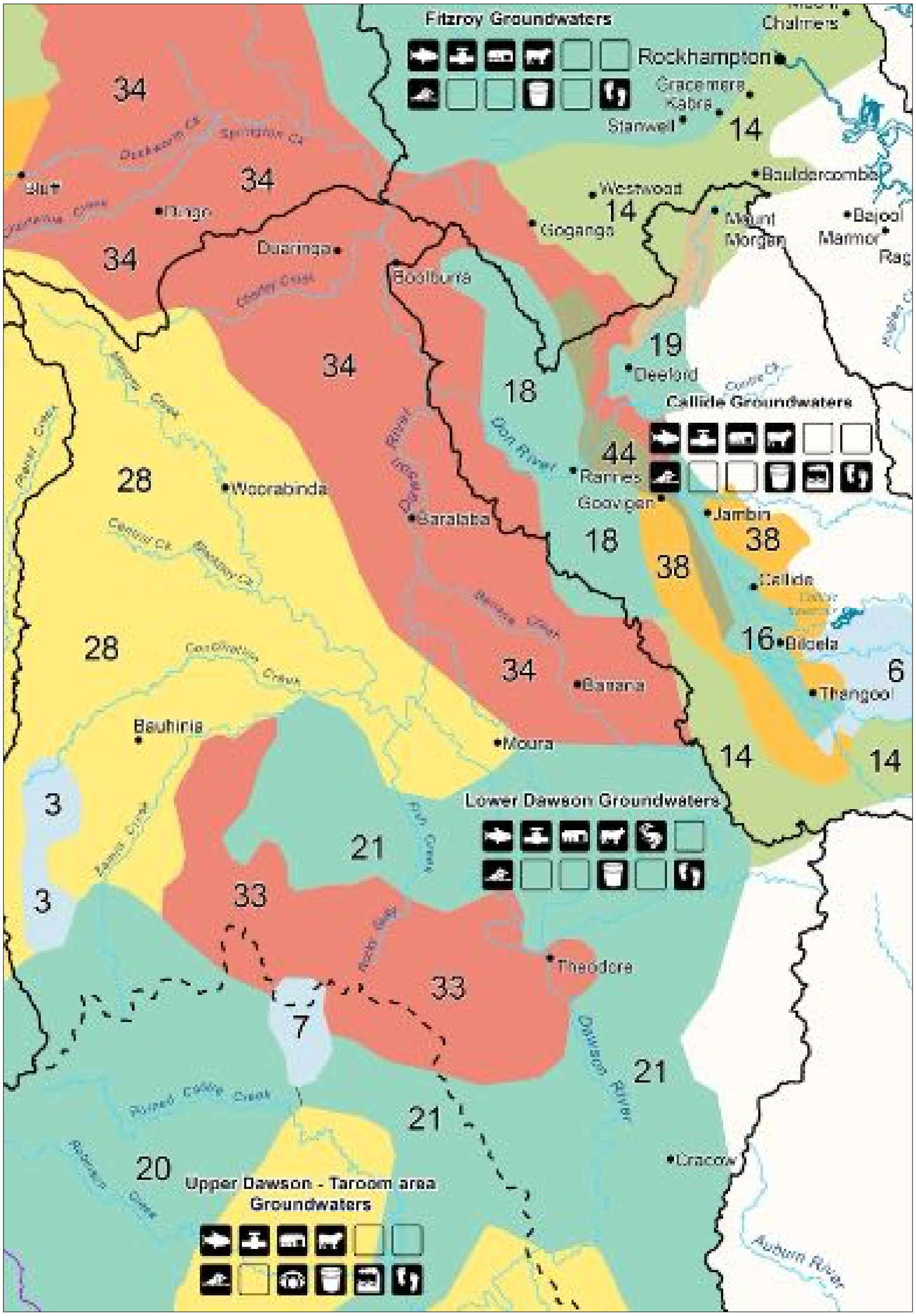

Figure 9.66: Environmental values—Fitzroy Basin Groundwater Zones—WQ1310

Table 9.41: Environmental values—surface waters and groundwaters relevant to the Project

Environment value	EPP (Water and Wetland Biodiversity) [Schedule 1]
	Groundwaters
	Fitzroy Basin groundwater zones/Lower Dawson groundwaters—WQ1310
	Lower Dawson groundwaters – groundwater chemistry Zone 34
Aquatic ecosystem	✓
Irrigation	✓
Farm supply/use	✓
Stock watering	✓
Aquaculture	✓
Human consumers of aquatic foods	
Primary recreation	✓
Secondary recreation	
Visual recreation	
Drinking water supply	✓
Industrial use	
Cultural and Spiritual Values	✓

9.10.1.2 Geology

The Project lies within the southern part of the Permo-Triassic aged Bowen Basin. In this part of the Bowen Basin the Mimosa Syncline, of which Baralaba lies on the eastern flank, is the significant structural feature. The Mimosa Syncline is characterised by a complex pattern of northerly trending folds and thrust (reverse) faults. The Project is situated in a structurally complex zone on the eastern limb of the Mimosa Syncline (Figure 9.67). Figure 9.67 illustrates how the Permian strata, including the coal measures, dip to the west towards the axis of the Mimosa Syncline, which is some 30-40 km west of Baralaba. The regional dip is relatively gentle, even flat, in the axis of the syncline. However, the strata steepen towards Baralaba and this structure brings the Permian Baralaba Coal Measures towards the surface in that area.

The economic coal seams lie in the Permian-age Baralaba Coal Measures. The coal measures are overlain by the Triassic-age Rewan Formation, comprising massive sandstone strata that are interbedded with successions of laminated mudstone, siltstone and sandstone.

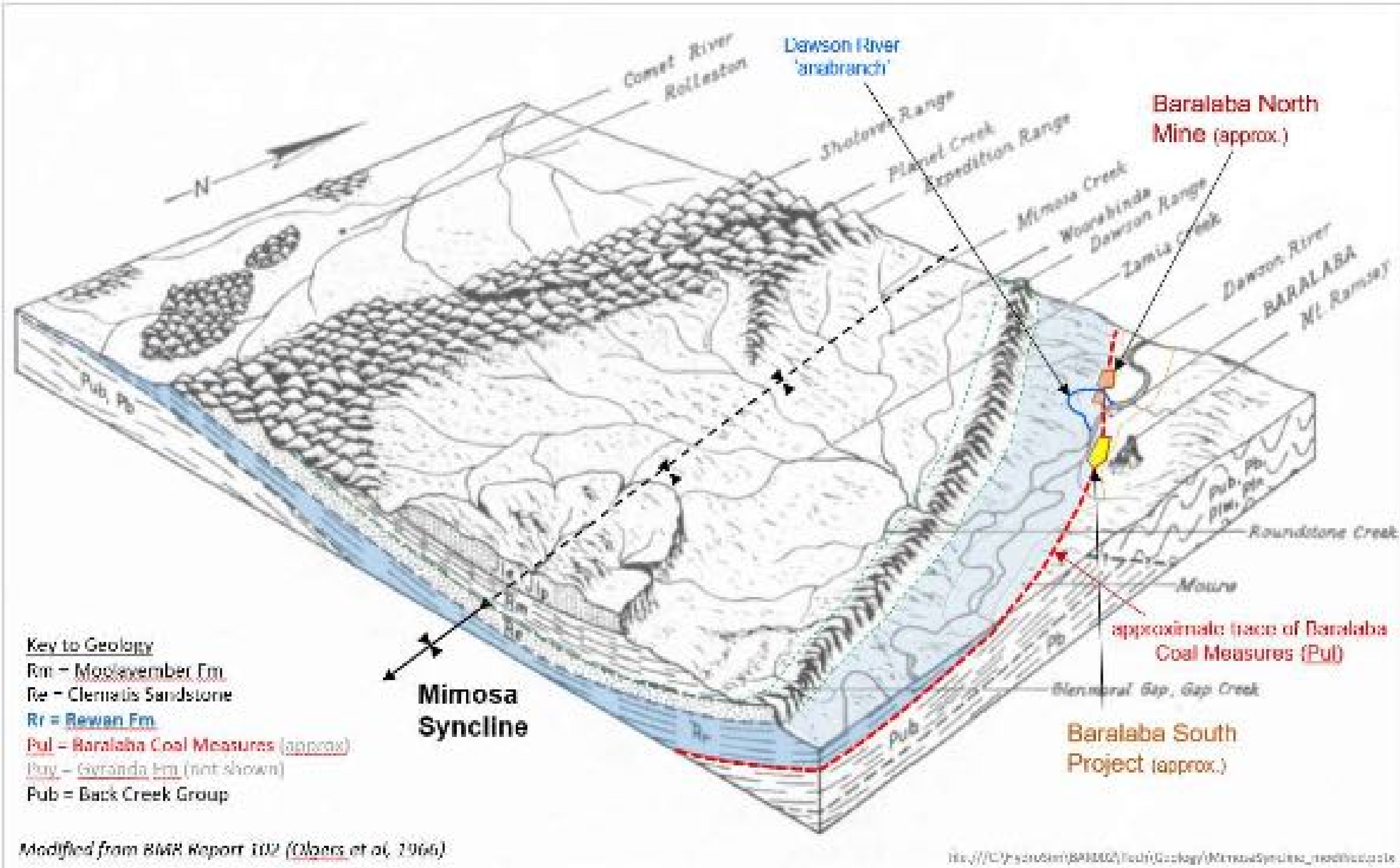

Figure 9.67: *Structural geology setting*

Mt Ramsay is an isolated igneous extrusive body trachyte which occurs east of MLA 700057. Based on the regional mapping, the western edge of this feature runs along the eastern edge of the ML boundary and is further than 500 m from the eastern edge of the proposed open cut pit.

Distinct local faults have been interpreted to the west of MLA 7000577. The local faults are generally north-west striking thrust faults dipping to the south-west at 60-80 degrees. The groundwater assessment considers these faults, both in the government mapping and the local geological (resource) mapping, in terms of their potential to act as hydraulic barriers or conduits.

The subsections below describe the hydrogeological properties of the geological units and structures associated with the Project.

Outcrop geology

The Permian Baralaba Coal Measures subcrop along a narrow (up to 3.5 km in width) corridor that trends north-north-west, and within MLA 700057 is buried under a veneer of Quaternary alluvium and some Tertiary-Quaternary colluvium.

At the base of the Baralaba Coal Measures is the basal sub-unit Kaloola Member containing minor coal horizons, which in turn is underlain by the Gyranda Formation. The Kaloola Member strata are dominantly fine-sandstones and siltstones with subordinate carbonaceous shale, tuffs and banded coal with some coking and thermal properties.

Overlying the Baralaba Coal Measures is the Rewan Formation of Triassic age. It comprises mainly siltstones and mudstones, as well as unconsolidated sediments (including clays), and a lateritic weathering profile obscuring the coal measures.

The base of the Great Artesian Basin is defined by the Lower Triassic Dunda Beds and Rewan Formation, a thick aquitard unit that lies beneath the Clematis Sandstone, the most easterly outcropping aquifer in the GAB. The Clematis Sandstone is part of the GAB recharge beds known as the Eastern Recharge Zone and lies more than 10 km to the west of the MLA.

Surficial geology

The Quaternary sediments consist of alluvial and colluvial sands and gravel, soil and clay. Available information indicates that the alluvium is heterogeneously distributed, but often comprises distinct layers of surficial clays, thick sands/gravels and basal sandy clays.

The sediments thicken beneath and immediately adjacent the Dawson River, and are typically about 15 m thick (HydroSimulations, 2014). The thickness of Quaternary sediments along Banana Creek are expected to be less than the Dawson River with an even lesser veneer of alluvium/colluvium across parts of MLA 700057.

The weathered rock (regolith) profile has an average depth of weathering of approximately 28 m (HydroSimulations, 2014).

9.10.1.3 Hydrogeological conceptual model

The conceptual model of the groundwater regime at the Project incorporates two main hydrogeological units in the Project area.

- Quaternary alluvial and colluvial sediments associated with the Dawson River and tributaries; and
- Permian strata, specifically the Baralaba Coal Measures, as well as the overlying Rewan Formation (regional aquitard) and underlying Gyranda Formation (a poorly productive aquifer).

Based on the review of the groundwater datasets and dependent assets, the limited groundwater users in the vicinity, the typically dry nature of the alluvial sediments (away from the Dawson River), the brackish-saline nature of the groundwater, and the fact that the Project is not in a defined groundwater management area in the Fitzroy Basin confirm that the identified groundwater systems are not significant aquifers. That is, despite being the main hydrogeological units in the Project area, the groundwater systems at the Project are of limited anthropogenic potential. Nevertheless, from an industrial use perspective, associated groundwaters that would be accessed by the Project would provide a beneficial industrial use through its use in the mine site water balance/supply.

Alluvial and colluvial strata

Along with the Permian coal measures, the alluvium present along the Dawson River (and Banana Creek confluence) is the main groundwater bearing unit near the Project.

Recharge of the surficial sediments is from direct rainfall and infiltration (loss) from streams, particularly where surficial clays are absent. This has been demonstrated by the isotope sampling results which indicate the alluvial bore closer to the Dawson River (i.e. A-OB2) is more readily recharged by rainfall, while bores sampled away from the river (i.e. A-OB4 and A-OB8) have more distinct signatures.

Further, the Neville Hewitt Weir (which has a full storage level at approximately 79 mAHD) maintains the Dawson River stage at this higher elevation than the majority of the groundwater levels observed around Baralaba. This recharge mechanism was identified by the results (i.e. relatively swift recovery) of the pumping tests conducted on site.

A number of alluvial bores have been recorded as dry within MLA 700057 and the isotope analysis by SLR of the groundwater at P-OB1 (Permian bore) indicated it was more readily recharged by rainfall. Because of its position away from the Dawson River, the colluvium is typically dry, being recharged only by direct rainfall.

There are 12 groundwater monitoring bores screened in alluvium present within the immediate vicinity of the Project area. The alluvium monitoring bores with the highest recorded groundwater elevations are those nearest to the Dawson River (A-OB12, A-OB11, A-OB1, A-OB2 and A-OB3). At an increasing distance from the Dawson River, alluvium screened monitoring bores indicate that the recharge mechanism is from the Dawson River to the alluvium (i.e. losing conditions). All alluvium bores in the southern transect (furthest from the Dawson River and its confluence with Banana Creek) were recorded as dry (A-OB6, A-OB7, A-PB2 and A-OB8).

Triassic and Permian strata

In the Permian coal measures, groundwater is typically stored and transmitted in the coal seams, while the sandstone/siltstone (interburden) units are of lower permeability. The Gyranda Formation underling the Baralaba Coal Measures is a poorly productive aquifer or an aquitard.

Recharge to these Permian strata is likely to be from rainfall recharge where it occurs at outcrop, noting that infiltration recharge rates in this area are quite low (typically on the order of 1% of average rainfall or less), as well as from downward leakage from the overlying alluvium, if and where saturated.

SKM (2014) conducted detailed analyses of the measured vertical head gradients at each of the VWPs in the Permian coal measures presented in Appendix B, Groundwater Modelling and Assessment, and demonstrated good correlation of sensor depths (mbg) vs head on sensor (m) at the Project area (i.e. a natural decline in potentiometric head with depth).

The Triassic aged Rewan Formation, which directly overlies the coal measures, is a known aquitard, being of tens to hundreds of metres thick and having relatively low permeability.

There is a total of six groundwater monitoring bores screened in the Permian Baralaba Coal Measures within the vicinity of the Project area. Two of these bores have been constructed in the interburden, three in coal seams and one in the Gyranda Formation. The groundwater elevations recorded in the coal seam bores show that groundwater flow is topographically controlled. Coal seam groundwater levels are approximately 77.5-78 mAHD, with the exception of bores located among rising topography in the south-east. The groundwater elevations in the interburden are similar to that recorded in the coal seams at approximately 74-75 mAHD.

By comparison to the other bores in the Permian Baralaba Coal Measures, the recorded groundwater elevations are highest further east near Mount Ramsay. This is reflective of the rising topography and also supports the overall general hydraulic gradient from east to west within the Project area. Recharge to the Permian Baralaba Coal Measures is likely to be from rainfall recharge, where it occurs at outcrop as well as from downward leakage from the overlying alluvium, if and where saturated (Appendix B, Groundwater Modelling and Assessment).

Existing (pre-mining) conditions

With reference to the conceptual groundwater model cross-section (Figure 9.68), the following are relevant to the existing hydrogeological conditions:

- Recharge rates are low, generally less than 1% of rainfall (higher to the west, on the GAB aquifers – see below), where average annual rainfall is around 700 mm/year. Minimal groundwater flux or recharge occurs through the Rewan Formation (aquitard) present across much of the study area.
- Evaporation rates are high, with potential evaporation being over 2,000 mm/year, with actual evapotranspiration between 600 and 700 mm/year for the Baralaba region.
- Surficial units (alluvium and colluvium) are generally relatively more permeable compared to Triassic and Permian rock units present in the area. Thickness varies from absent or a few metres to around 20 m.
- Of the Permo-Triassic strata in the Baralaba region, only the Clematis Sandstone (part of the GAB) and potentially the Duaringa Formation are thought of as significant aquifers, in the sense of producing useable quantities of groundwater. However, the Clematis Sandstone is distant (more than 10 km) from the Project, and there is only a single registered bores (RN 128844) penetrating the Duaringa Formation. This bore is 9 km north-east of the Baralaba North Mine (BNM), and 22 km north of the Project.
- The Rewan Formation (overlying the coal measures) and Gyranda Formation and other older units (underlying the coal measures) are known regional aquitards. The Rewan Formation in particular is thick (i.e. tens to hundreds of metres) and intervenes between the Baralaba Coal Measures and the Clematis Sandstone (GAB) aquifer.
- The Baralaba Coal Measures consist of coal seams with interburden consisting primarily of siltstones, sandstones and mudstones.
- The coal seams are more permeable than the surrounding interburden, although they are not highly transmissive, particularly because the coal seams are not usually more than a few metres thick.
- Local faults may act as permeable or conductive features, but more likely as barriers to flow. For the purposes of the assessment at Project and for conservatism, faulting is not assumed to be a barrier to flow.
- There is minimal anthropogenic groundwater use in the area, due to poorer groundwater quality associated with the Permian coal measures and low-yielding formations. Irrigated paddocks near the Project are located in areas immediately adjacent to the Dawson River and, given the lack of registered bores associated with these properties, these agricultural operations are considered to be reliant on regulated surface water extractions.
- The Dawson River is a losing watercourse, particularly upstream of Baralaba, where it is regulated by the Neville Hewitt Weir.
- Similarly, backwaters from the Dawson River to Banana Creek upstream of the confluence are also a losing system.
- Runoff is likely to be the primary source of flow to local drainage lines across the Project area, particularly when considering the depth to the groundwater table is typically 12-15 mbg or greater.
- Wetlands in the area are unlikely to be dependent on or connected to regional groundwater systems. The wetland systems are considered to exist due to the presence of clays in the shallow subsurface, which allow perched water tables to develop and persist after rain or flood events. This is based on the review by 3D Environmental, and inspection of groundwater levels in this study.

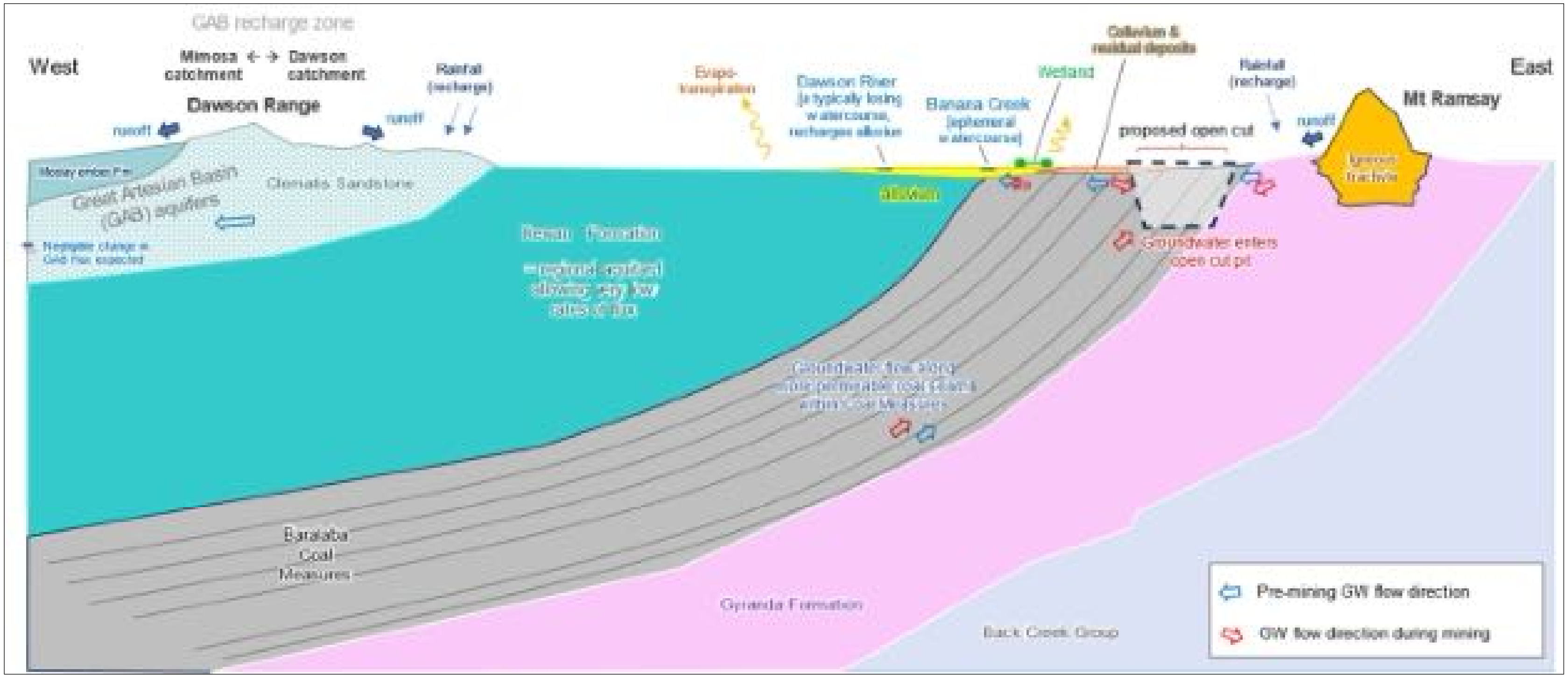

Figure 9.68: Conceptual model of conditions during mining

9.10.2. Description of baseline groundwater values

9.10.2.1 Groundwater levels

Using the groundwater datasets presented in Appendix B, Groundwater Modelling and Assessment, contour maps of measured and inferred water levels are presented on Figure 9.69. This also allows for the depth to water table/interpreted unsaturated depth in the vicinity of the Project site and surrounds to be estimated and this is presented as Figure 9.70.

For conservative assessment purposes, where multiple records exist at the one location, the maximum water levels (elevation) were used to assist with identifying areas of 'potential' interaction between vegetation and the water table.

Interpolation of the water table elevation was conducted using the ArcGIS 10 'Topo To Raster' tool, which is based on a spline interpolation method, and has the advanced functionality of allowing interpolation from multiple datasets, including points (e.g. observations at bores) and polyline contours (e.g. hand-drawn contours).

Flow directions can be inferred from a groundwater elevation contour map, as flow occurs from areas of high head to those of low head. From Figure 9.69, the inferred groundwater flow directions in the vicinity of the Project are predominantly topographically controlled as:

- convergent along Banana Creek (and alluvium) towards the confluence of and then northward along the Dawson River; and
- westward from Mount Ramsay and east of the Dawson Range through the Project site towards the Dawson River.

It is likely that the regulation of the Dawson River behind the Neville Hewitt Weir, which has raised the Dawson River stage above the natural levels upstream of the weir, has led to slightly elevated groundwater levels in this area, including to the west of the Project.

Figure 9.70 shows the depth to groundwater is typically 10-15 mbgl in the north of MLA 700057, 15-20 mbgl in the west of MLA 700057 and greater than 20 mbgl in the east of MLA 700057.

The map also shows that near the confluence of Banana Creek with the Dawson River and along the Dawson River, the depth to groundwater is typically 10-15 metres below ground level (mbgl) or 5-10 mbgl, while the depth to water is inferred to be approximately 10-15 mbgl along Banana Creek for the reach nearest the Project, even in the area where the BOM GDE mapping indicates the presence of potential GDEs, as well as near the HES wetland located on the western boundary of MLA 700057.

Further details regarding assessment methodology are provided in Appendix B, Groundwater Modelling and Assessment, along with groundwater level data.

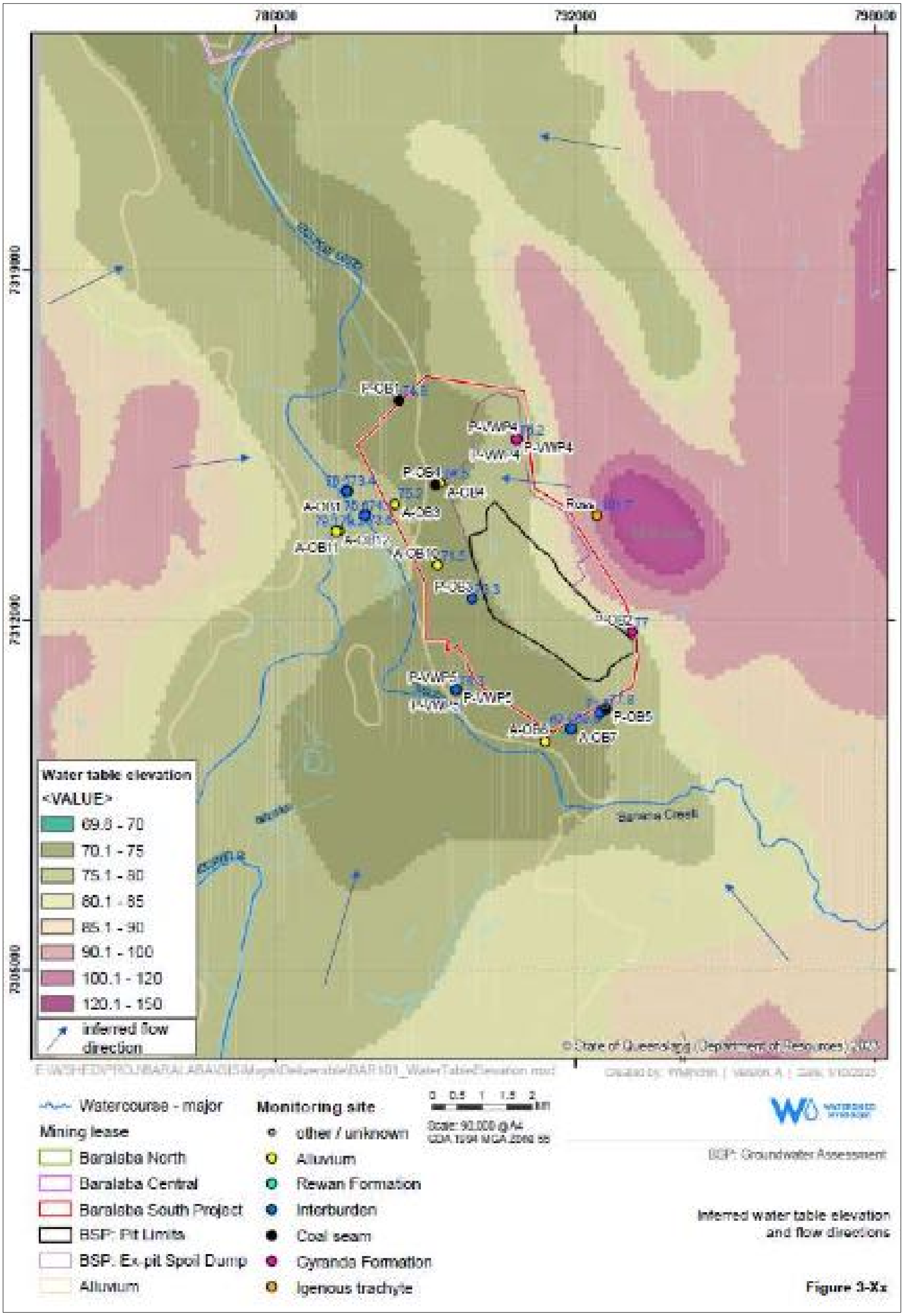

Figure 9.69: Inferred water table elevation and flow direction

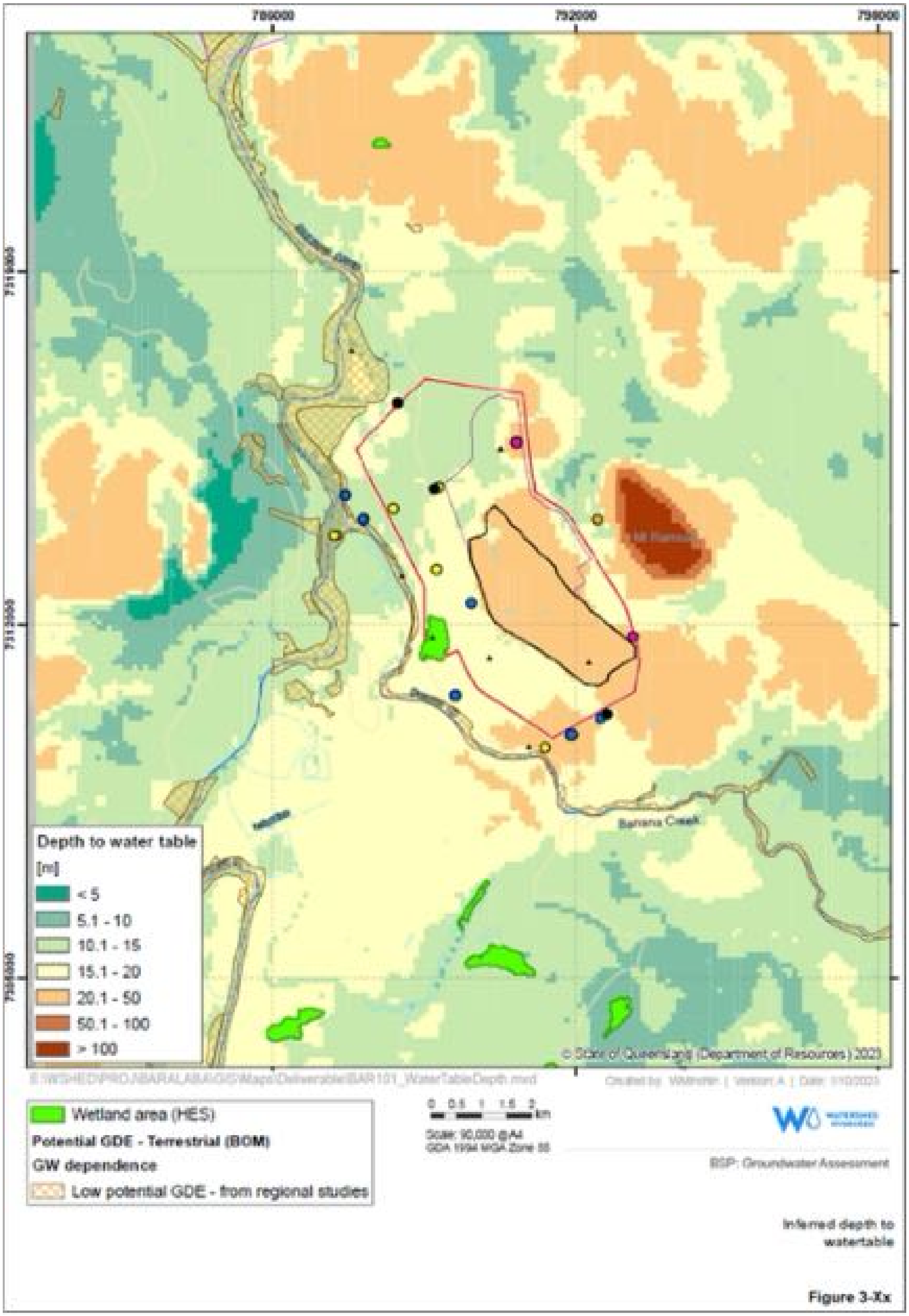

Figure 9.70: Depth to observed groundwater table/interpreted unsaturated depth

9.10.2.2 Groundwater quality

An assessment of baseline groundwater quality has been undertaken using data collected from groundwater quality sampling programs and is presented in detail in the Groundwater Modelling and Assessment Report (Appendix B). The groundwater sampling programs involve the collection of data for physio-chemical parameters, major ion hydrochemistry and isotope sampling at a range of bore types (shallow groundwater, deep groundwater and igneous trachyte). For the following sub-sections, it is assumed that this can be read as 'shallow' = alluvium and colluvium, 'deep' = Permo-Triassic strata.

2012 groundwater quality

A groundwater quality sampling program was initiated in the Project area in July–August and December 2012 (SKM, 2014). A summary of the physico-chemical parameters and major ion hydrochemistry data recorded in 2012 from the alluvium and Permian coal measures (i.e. Baralaba Coal Measures [interburden/ coal] and Gyranda Formation) is presented Table 9.42 and Table 9.43, respectively.

The results of these sampling rounds, as well as that conducted in 2017-2023 are discussed in the following sub-sections, noting that tables in this chapter typically include a (representative) selection of data, while a summary of the full historic dataset is presented in Appendix B, Groundwater Modelling and Assessment (specifically in Appendix C).

Table 9.42: Physico-chemical parameters and major ion hydrochemistry (2012)—alluvium

Bore ID	pH	EC (µS/cm)	TDS (mg/L)	Major ions (mg/L)						
				Na	Mg	Ca	K	Cl	SO4	HCO_3 [$CaCO_3$]
A-PB1	6.7	484	333	79	6	12	3	84	11.5	97.5
A-OB1	7.3	570.5	407	45	17.5	40	3.5	35	11	199
A-OB2	6.8	836	488	115	13	21	4.5	152	6.5	146
A-OB3	7.3	696	401	101	5	8.5	2	54	25	171
A-OB4	6.7	21,039	18,100	2,850	845	925	29	7,720	731	301
A-OB8+	7.3	4,400	2,310	835	42	45	11	1,000	328	—
A-OB10	6.6	28,558	1,895	2,640	1,245	1,895	29	10,035	855	294
A-OB11	7.1	664	452	64	27	42	5	4	119	242
A-OB12	7.5	421	421	54	24	43	6	89	5	212

Table 9.43: Physico-chemical parameters and major ion chemistry (2012): Permian coal measures

Bore ID	pH	EC (µS/cm)	TDS (mg/L)	Major Ions (mg/L)						
				Na	Mg	Ca	K	Cl	SO_4	HCO_3 [$CaCO_3$]
Baralaba Coal Measures [interburden]										
P-PB1	7.4	15,641	12,990	2,430	20.5	832.5	3	5,365	<1	37
P-OB3	6.5	31,765	28,350	3,910	1,115	1,475	29.5	10,550	1,205	270
Baralaba Coal Measures [coal seams]										
P-OB1	6.4	27,339	22,200	3,225	1,090	1,245	30	9,075	1,560	375
P-OB4	6.6	35,432	35,800	3,880	1,270	1,700	1,270	10,600	1,520	210
P-OB5	8.3	11,200	16,700	3,650	307	266	307	6,800	568	78
Gyranda Formation										
P-OB2	6.8	17,398	12,500	2,900	267.5	378	17	5,750	165	553

2017-2023 groundwater quality

To augment these datasets, a targeted baseline groundwater quality sampling program of alluvium and Permian coal measure bores within the Project area and surrounds was conducted by SLR Consulting during 2017–2018 and by 4T Consultants from 2019 to 2023.

Consistent with the findings of the 2012 baseline groundwater quality sampling program (SKM, 2014), the field data shows that alluvium groundwater quality varies depending on the influence/proximity to the Dawson River, with those nearest (A-PB1, A-OB1, A-OB2, A-OB11 and A-OB12) with fresher water quality.

The results of the 2017–2023 groundwater monitoring program are presented in Table 9.44 to Table 9.49.

Table 9.44: Groundwater quality sampling results—Alluvium (pH, EC and TDS)

Bore ID	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	Nov 19	Mar 20	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Mar 22	Aug 22	Oct 22	Jan 23	Apr 23	Jul 23
pH (pH units) (field)																									
A-PB1	-	6.07	6.12	6.19	6.41	6.35	6.48	6.49	I	6.46	6.5	6.49	6.48	6.56	6.54	6.57	7.56	7.44	6.5	6.63	6.6	-	-	-	-
A-OB1	6.42	6.49	6.26	6.16	6.26	6.33	6.52	6.53	I	6.46	6.45	6.45	6.38	6.39	6.37	6.44	6.44	6.83	6.41	6.62	6.58	6.4	6.72	6.95	-
A-OB2	6.41	6.48	7.00	6.27	6.48	6.6	6.75	6.75	I	6.55	6.52	6.51	6.48	6.55	6.5	6.52	8.21	6.88	6.52	6.62	6.63	6.79	6.81	7.04	7.29
A-OB3	-	6.75	6.55	6.54	B	B	B	B	I	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
A-OB4	6.31	6.29	6.3	6.43	7.40	6.32	6.4	6.36	I	6.39	6.43	6.36	6.35	6.37	6.33	6.35	6.35	6.58	6.4	6.47	6.42	6.23	6.69	7.42	7.33
A-OB7	6.62	6.95	6.64	6.92	6.64	6.65	6.73	6.7	I	6.68	6.7	6.66	6.65	6.68	6.63	6.64	6.68	6.53	6.72	6.77	6.73	6.71	6.7	6.83	-
A-OB8	6.89	6.94	6.57	6.47	6.50	6.42	6.61	6.59	6.53	6.57	6.52	6.48	6.5	6.48	6.44	6.48	6.47	6.36	6.49	6.57	6.52	6.34	6.66	6.68	-
A-OB10	6.42	6.2	6.15	6.36	7.11	6.3	6.39	6.39	6.49	6.44	6.37	6.37	6.38	—	6.39	6.38	6.42	6.63	6.44	6.5	6.46	6.3	6.56	6.81	7.29
A-OB11	6.08	6.14	6.37	6.23	6.25	6.3	6.46	6.35	I	6.53	6.49	6.51	6.49	6.52	6.42	6.4	6.46	6.29	6.46	6.46	6.17	6.39	6.91	6.6	-
A-OB12	6.17	6.25	6.25	6.28	6.48	6.56	6.64	6.53	I	6.49	6.43	6.43	6.41	6.48	6.35	6.38	6.44	6.18	6.4	6.79	6.46	6.32	6.72	6.7	-
EC (µS/cm) (field)																									
A-PB1	-	646	630	610	720	711	615	648	I	630	685	766	830	877	861	868	906	857	1,011	710	588	-	-	-	-
A-OB1	570	466	486	493	586	700	606	644	I	675	598	622	645	524	654	645	563	559	564	695	714	629	897	693	-
A-OB2	657	617	686	565	583	831	843	911	I	612	621	649	658	686	665	679	960	649	628	509	524	824	831	508	524
A-OB3	-	561	593	489	B	B	B	B	I	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
A-OB4	37,011	35,920	37,557	40,022	37,150	36,385	36,423	31,759	I	37,592	37,445	37,703	37,581	37,415	37,197	37,461	37,120	36,990	37,258	37,936	37,027	19,314	37,328	32,341	44,800
A-OB7	15,681	16,809	16,637	18,390	20,122	19,487	19,657	18,058	I	20,717	20,547	20,584	20,597	20,508	20,436	20,578	20,358	20,611	20,548	20,807	20,402	19,314	20,417	19,539	-
A-OB8	26,260	25,877	26,914	27,752	28,071	28,197	27,752	25,754	28,536	29,366	29,951	29,668	29,744	29,553	29,457	29,469	29,439	29,496	29,648	30,580	29,951	28,287	27,533	27,945	-
A-OB10	31,708	36,433	38,097	38,786	37,303	35,894	34,430	29,887	32,507	33,117	33,025	33,242	32,847	—	32,584	32,833	32,450	32,673	32,850	33,746	31,792	30,885	32,405	32,668	40,600
A-OB11	425	405	434	377	440	481	452	351	I	360	335	362.7	397	346	336	452	370	427	438	515	399	370	449	489	-
A-OB12	381	354	328	323	430	526	456	306	I	392	392	417	343	393	388	378	477	393	395	375	360	308	399	325	-
TDS (mg/L) (lab)																									
A-PB1	648	-	320	340	-	390	444	393	I	372	404	451	462	496	472	484	516	485	554	383	299	-	-	-	-
A-OB1	644	260	260	230	310	440	407	432	I	432	409	432	407	368	654	645	563	559	564	695	714	629	897	693	-
A-OB2	911	370	300	380	350	442	475	588	I	363	357	382	375	391	378	527	622	356	308	319	402	447	338	323	378
A-OB3	B	-	390	360	350	B	B	B	I	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
A-OB4	31,759	30,000	34,000	23,000	38,000	28,800	23,300	30,200	I	B	31,000	31,600	31,700	28,100	29,800	31,000	30,400	26,600	31,400	33,400	25,800	29,200	33,800	28,200	30,200
A-OB7	18,058	13,000	13,000	16,000	16,000	13,200	12,600	15,600	I	14,900	15,100	14,500	15,400	15,000	15,900	16,200	15,400	13,600	16,100	17,300	13,700	14,500	16,700	14,500	-
A-OB8	25,754	14,000	18,000	19,000	27,000	19,900	17,900	21,200	19,200	21,000	21,600	22,700	22,100	21,800	22,500	22,000	22,100	19,700	23,700	24,200	18,400	21,400	20,400	20,800	-

Bore ID	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	Nov 19	Mar 20	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Mar 22	Aug 22	Oct 22	Jan 23	Apr 23	Jul 23
A-OB10	29,887	32,000	37,000	33,000	38,000	27,800	19,500	28,200	23,400	27,800	26,900	28,400	26,900	-	26,000	28,800	26,800	23,400	28,800	30,400	24,400	25,500	31,300	26,000	28,300
A-OB11	351	210	210	220	240	258	298	262	I	228	213	252	213	243	300	279	308	248	320	314	276	254	254	339	-
A-OB12	306	180	160	140	190	259	287	219	I	251	243	258	211	243	230	239	289	230	228	230	204	197	231	208	-

(-) Bore Dry, not sampled. (B) Bore is blocked, not sampled. (I) Bore Inaccessible due to weather conditions, not sampled.
No results are presented for A-PB2 and A-OB6 as bores were dry.

Table 9.45: Groundwater quality sampling results—Permian coal measures (pH, EC and TDS)

Bore ID	Dec 17	Mar 18	Jun 18	Oct 18	Feb 19	May 19	Aug 19	Nov 19	Mar 20	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Apr 21	May 21	Jun 21	Mar 22	Aug 22	Oct 22	Jan 23	Apr 23	Jul 23
pH (pH units) (field)																									
Baralaba Coal Measures (interburden)																									
P-PB1	—	7.3	6.9	7.1	7.0	6.72	6.8	6.8	I	6.89	7.05	6.98	6.91	7.02	6.93	6.57	7.21	7.08	6.90	6.76	6.96	6.74	6.82	7.10	7.16
P-OB3	6.1	6.2	6.2	6.2	6.3	6.33	6.5	6.4	6.5	6.41	6.41	6.42	6.37	6.42	6.38	6.39	6.37	6.31	6.41	6.49	6.42	6.33	6.45	6.57	7.27
Baralaba Coal Measures [coal seams]																									
P-OB1	6.2	6.3	6.2	6.2	6.3	6.06	6.4	6.3	I	6.32	6.30	6.28	6.31	6.31	6.16	6.20	6.34	6.52	6.33	6.30	6.01	6.22	6.35	6.46	-
P-OB4	6.5	6.1	6.2	6.3	6.4	6.31	6.5	6.5	I	6.51	6.48	6.45	6.47	6.45	6.40	6.41	6.44	6.50	6.46	6.46	6.55	6.40	6.67	6.78	7.43
P-OB5	7.3	7.2	6.8	6.5	6.5	6.44	6.6	6.5	I	6.59	6.55	6.54	6.53	6.56	6.51	6.52	6.49	6.41	6.56	6.59	6.60	6.60	6.83	6.85	-
Gyranda Formation																									
P-OB2	—	6.1	6.1	6.3	6.4	6.19	6.4	6.3	6.4	6.42	6.42	6.37	6.35	6.35	6.32	6.38	6.38	6.29	6.40	6.47	6.43	6.30	6.73	6.51	7.32
EC (µS/cm) (Field)																									
Baralaba Coal Measures (interburden)																									
P-PB1	—	15,950	16,296	18,453	15,763	15,574	15,303	13,721	I	15,839	16,031	15,955	15,902	15,813	15,861	15,906	16,115	15,776	15,884	16,156	15,697	15,260	15,763	15,177	19,200
P-OB3	34,107	33,141	34,154	37,120	33,042	32,548	32,169	28,835	32,386	32,661	33,460	33,292	33,074	33,012	32,906	33,050	32,502	32,427	32,605	33,534	32,405	31,220	32,811	30,890	40,900
Baralaba Coal Measures [coal seams]																									
P-OB1	29,785	30,324	31,390	33,260	34,270	34,234	33,794	30,700	I	34,370	34,711	34,510	34,547	34,400	34,437	34,360	34,392	34,214	34,488	34,801	34,257	32,274	31,888	32,999	-
P-OB4	37,088	36,356	37,492	40,297	36,546	36,131	35,942	31,702	I	36,644	37,035	37,051	36,818	36,415	36,511	36,698	36,164	36,311	36,677	37,223	35,792	33,348	36,299	32,669	45,400
P-OB5	24,664	27,225	23,666	34,100	29,073	28,889	28,641	25,455	I	29,147	29,529	29,324	29,143	29,062	28,955	29,035	28,866	29,044	29,100	29,602	28,682	26,602	28,127	27,201	-
Gyranda Formation																									
P-OB2	—	19,480	19,503	21,075	19,085	19,000	18,964	16,669	18,797	19,560	19,435	19,371	19,242	19,196	19,126	19,351	18,750	19,252	19,316	19,970	19,514	18,182	19,372	17,180	26,500
TDS (mg/L) (Lab)																									
Baralaba Coal Measures (interburden)																									
P-PB1	-	11,000	12,000	12,000	-	9,750	8,880	11,000	I	10,800	11,000	11,100	11,000	11,000	10,800	10,700	11,000	9,780	10,600	13,000	10,800	11,100	12,000	10,500	11,100
P-OB3	30,000	31,000	19,000	27,000	-	24,600	18,200	26,700	22,900	26,400	27,500	27,700	25,800	27,600	25,500	28,000	26,800	27,400	26,900	31,400	22,400	24,800	30,400	26,700	27,200
Baralaba Coal Measures (coal seams)																									
P-OB1	25,000	28,000	21,000	29,000	-	26,100	23,600	28,500	I	27,300	28,500	29,000	26,400	27,700	27,800	29,500	29,200	249,000	27,200	29,600	25,600	26,700	31,000	23,000	-
P-OB4	27,000	31,000	25,000	35,000	-	28,700	20,200	31,100	I	34,100	28,300	31,800	28,800	31,300	30,200	29,800	30,600	30,000	30,800	35,200	28,300	28,400	33,800	28,900	30,200
P-OB5	13,000	12,000	12,000	24,000	-	19,200	17,200	20,800	I	20,100	20,200	17,800	18,200	20,700	19,600	20,100	20,600	19,800	21,000	22,200	21,700	19,100	21,400	19,700	-
Gyranda Formation																									
P-OB2	-	13,000	14,000	13,000	-	12,600	11,700	13,600	12,600	13,400	13,700	14,200	13,800	14,100	13,800	13,900	13,500	15,600	14,200	16,200	12,800	13,200	15,000	12,800	13,800

Note: TDS not sampled in February., (-) Bore dry, not sampled. (I) Bore inaccessible due to weather conditions, not sampled

Table 9.46: Statistical analysis of groundwater quality results: Alluvium (metals)

Alluvium metals concentrations (mg/L)—total and filtered															
Bore ID	Parameter	Al	Al (f)	As	As (f)	B	B (f)	Cd	Cd (f)	Cr	Cr (f)	Co	Co (f)	Cu	Cu (f)
A-PB1	Sample count	20	20	20	20	3	3	3	3	3	3	3	3	3	3
	Minimum	< 0.05	< 0.05	< 0.001	< 0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	20th percentile	0.172	0.01	0.001	0.001	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.0014	0.001
	Median	0.54	0.01	0.002	0.001	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.002	0.001
	95th percentile	3.262	0.05	0.003	0.003	0.05	0.05	0.0002	0.0002	0.0082	0.001	0.0064	0.001	0.0065	0.001
	Maximum	9.57	<0.05	0.003	0.003	< 0.05	< 0.05	< 0.0002	< 0.0002	0.009	<0.001	0.007	< 0.001	0.007	0.001
A-OB1	Sample count	24	24	24	24	4	4	4	4	4	4	4	4	4	4
	Minimum	0.46	<0.01	0.001	<0.001	< 0.05	< 0.05	<0.0002	<0.0002	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001
	20th percentile	6.298	0.01	0.002	0.001	0.056	0.05	0.0002	0.0002	0.004	0.001	0.001	0.001	0.0042	0.001
	Median	10.27	0.01	0.002	0.001	0.065	0.055	0.0006	0.0002	0.015	0.001	0.0505	0.001	0.0345	0.001
	95th percentile	31.2000	0.0500	0.0099	0.0020	0.0700	0.0600	0.0018	0.0002	0.0487	0.0010	0.1935	0.0027	0.1371	0.0027
	Maximum	78	< 0.05	0.013	0.002	0.07	0.06	0.0019	<0.0002	0.053	< 0.001	0.21	0.003	0.15	0.003
A-OB2	Sample count	23	23	23	23	3	3	3	3	3	3	3	3	3	3
	Minimum	< 0.05	<0.01	<0.001	<0.001	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	20th percentile	0.674	0.01	0.001	0.001	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.001	0.001
	Median	2.22	0.01	0.001	0.001	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.001	0.001
	95th percentile	12.1800	0.0500	0.0040	0.0029	0.0500	0.0680	0.0002	0.0002	0.0136	0.0010	0.0136	0.0019	0.0424	0.0010
	Maximum	14.9	< 0.05	0.004	0.004	< 0.05	0.07	< 0.0002	< 0.0002	0.015	< 0.001	0.015	0.002	0.047	0.001
A-OB3	Sample count	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Minimum	< 0.05	< 0.05	0.003	0.003	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001
	20th percentile	0.082	0.05	0.0038	0.0034	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.0014	0.001
	Median	0.13	0.05	0.005	0.004	0.05	0.05	0.0002	0.0002	0.001	0.001	0.001	0.001	0.002	0.001
	95th percentile	1.6330	0.0500	0.0050	0.0049	0.0500	0.0590	0.0002	0.0002	0.0028	0.0010	0.0046	0.0019	0.0038	0.0037
	Maximum	1.8	< 0.05	0.005	0.005	0.05	0.06	< 0.0002	< 0.0002	0.003	< 0.001	0.005	0.002	0.004	0.004
A-OB4	Sample count	24	24	24	24	4	4	4	4	4	4	4	4	4	4
	Minimum	< 0.05	<0.01	0.002	0.002	0.1	0.11	0.0009	< 0.0002	< 0.001	< 0.001	0.036	0.028	0.026	< 0.001
	20th percentile	2.584	0.05	0.005	0.0046	0.106	0.116	0.0012	0.00056	0.0058	0.001	0.0432	0.0346	0.0284	0.001
	Median	3.54	0.05	0.005	0.005	0.115	0.12	0.00155	0.0011	0.009	0.0055	0.0565	0.0415	0.0525	0.002
	95th percentile	16.8600	0.0925	0.0095	0.0094	0.1285	0.1285	0.0028	0.0034	0.0430	0.1035	0.1118	0.0619	0.9463	0.0430
	Maximum	18.1	51	0.016	0.017	0.13	0.13	0.003	0.0038	0.049	0.12	0.12	0.065	1.1	< 0.05

Alluvium metals concentrations (mg/L)—total and filtered															
A-OB7	Sample count	23	23	23	23	4	4	4	4	4	4	4	4	4	4
	Minimum	5.26	< 0.01	0.002	< 0.001	0.18	0.21	0.0018	0.0005	0.037	< 0.001	0.094	0.006	0.081	0.001
	20th percentile	13.48	0.01	0.0034	0.001	0.198	0.21	0.00198	0.0005	0.0694	0.001	0.1096	0.0066	0.1764	0.0022
	Median	17.4	0.01	0.004	0.001	0.215	0.22	0.0023	0.00055	0.1155	0.001	0.145	0.0075	0.34	0.004
	95th percentile	201	0.05	0.0233	0.0046	0.3645	0.2385	0.0052	0.0006	0.6500	0.0070	0.7140	0.0080	1.4260	0.0093
	Maximum	920	0.1	0.06	0.01	0.39	0.24	0.0057	0.0006	0.74	0.008	0.81	0.008	1.6	0.01
A-OB8	Sample count	24	24	24	24	4	4	4	4	4	4	4	4	4	4
	Minimum	0.7	< 0.01	0.003	0.001	0.13	0.05	0.0003	0.0003	0.017	< 0.001	0.003	0.003	0.052	0.021
	20th percentile	4.94	0.05	0.005	0.002	0.16	0.134	0.0006	0.0003	0.0188	0.0016	0.0066	0.003	0.1768	0.0228
	Median	8.305	0.05	0.006	0.005	0.19	0.255	0.00095	0.00035	0.056	0.002	0.0255	0.0035	0.32	0.0315
	95th percentile	44.9300	0.0925	0.0355	0.0050	0.3020	0.3625	0.0018	0.0007	0.2688	0.0207	0.1338	0.0040	0.4480	0.2014
	Maximum	140	0.1	0.068	0.01	0.32	0.37	0.0019	0.0007	0.3	0.024	0.15	0.004	0.46	0.23
A-OB10	Sample count	24	24	24	24	4	4	4	4	4	4	4	4	4	4
	Minimum	1	0.01	0.005	0.001	0.11	0.11	0.0014	< 0.0002	0.026	0.001	0.025	0.005	0.046	0.001
	20th percentile	3.9	0.05	0.005	0.0016	0.116	0.11	0.00176	0.00092	0.026	0.001	0.0292	0.0116	0.0628	0.0268
	Median	6.87	0.05	0.005	0.005	0.12	0.115	0.00245	0.0015	0.0295	0.001	0.0335	0.0165	0.177	0.0655
	95th percentile	31.6550	0.0500	0.0100	0.0050	0.1285	0.1200	0.0050	0.0025	0.0390	0.0104	0.1158	0.0179	0.3,225	0.1746
	Maximum	38	0.1	0.011	0.01	0.13	0.12	0.0054	0.0027	0.04	0.012	0.13	0.018	0.33	0.19
A-OB11	Sample count	23	23	23	23	4	4	4	4	4	4	4	4	4	4
	Minimum	0.25	< 0.01	0.004	0.002	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001	< 0.001	0.005	0.006	< 0.001	< 0.001
	20th percentile	2.5	0.01	0.0084	0.006	0.05	0.05	0.0002	0.0002	0.0034	0.001	0.0062	0.006	0.0022	0.001
	Median	8.68	0.01	0.009	0.007	0.05	0.05	0.0002	0.0002	0.005	0.001	0.008	0.006	0.004	0.001
	95th percentile	33.6200	0.0500	0.0231	0.0080	0.0500	0.0500	0.0004	0.0002	0.0305	0.0010	0.0609	0.0077	0.0254	0.0010
	Maximum	49.2	0.07	0.149	0.009	0.05	0.05	0.0004	< 0.0002	0.035	< 0.001	0.07	0.008	0.029	< 0.001
A-OB12	Sample count	23	23	23	23	4	4	4	4	4	4	4	4	4	4
	Minimum	0.41	< 0.01	0.008	0.007	< 0.05	< 0.05	< 0.0002	< 0.0002	< 0.001	< 0.001	0.002	0.002	< 0.001	< 0.001
	20th percentile	2.082	0.01	0.009	0.008	0.05	0.05	0.0002	0.0002	0.0028	0.001	0.0032	0.0026	0.0028	0.001
	Median	5.92	0.01	0.01	0.009	0.05	0.05	0.0002	0.0002	0.0055	0.001	0.0045	0.003	0.0055	0.001
	95th percentile	12.6600	0.0500	0.0120	0.0109	0.0585	0.0500	0.0004	0.0002	0.0368	0.0010	0.0144	0.0030	0.0410	0.0010
	Maximum	28	< 0.05	0.013	0.011	0.06	< 0.05	0.0004	< 0.0002	0.042	< 0.001	0.016	0.003	0.047	< 0.001

(f) Filtered, Data analysis is based on the sampling conducted by SLR Consulting in December 2017, March, June and October 2018 and sampling conducted by 4T Consultants in February, May, August and November 2019, March, September, October, November and December 2020 and January 2021. Sample count refers to the number of sampling results for the bore. To calculate the 20th percentile, median and 95th percentile data, less than symbols have been removed from the results.

Table 9.47: Statistical analysis of groundwater quality results: Alluvium (metals)

Alluvium metals concentrations (mg/L)—total and filtered

Bore ID	Parameter	Pb	Pb (f)	Hg	Hg (f)	Mo	Mo (f)	Ni	Ni (f)	Se	Se (f)	U	U (f)	Zn	Zn (f)
A-PB1	Sample count	3	3	20	20	20	20	3	3	20	20	20	20	20	19
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001	< 0.005	< 0.005	0.005	<0.005
	20th percentile	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.0014	0.01	0.01	0.001	0.001	0.0176	0.008
	Median	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.002	0.01	0.01	0.001	0.001	0.0345	0.02
	95th percentile	0.0028	0.001	0.0001	0.0001	0.005	0.0052	0.0073	0.002	0.01	0.01	0.005	0.005	0.17115	0.1859
	Maximum	0.003	< 0.001	< 0.0001	< 0.0001	< 0.005	0.009	0.008	0.002	0.01	0.01	< 0.005	< 0.005	1.2	0.95
A-OB1	Sample count	4	4	24	24	24	24	4	4	24	24	24	24	24	23
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.009	<0.005
	20th percentile	0.001	0.001	0.0001	0.0001	0.001	0.001	0.0026	0.001	0.01	0.01	0.001	0.001	0.046	0.009
	Median	0.016	0.001	0.0001	0.0001	0.001	0.001	0.0405	0.0015	0.01	0.01	0.001	0.001	0.07	0.015
	95th percentile	0.0599	0.0010	0.0002	0.0001	0.0050	0.0050	0.1137	0.0029	0.0100	0.0100	0.0050	0.0050	0.2561	0.0976
	Maximum	0.065	< 0.001	0.0004	< 0.0001	< 0.005	0.008	0.12	0.003	< 0.01	< 0.01	0.008	< 0.005	0.36	0.101
A-OB2	Sample count	3	3	23	23	23	23	3	3	23	23	23	23	23	22
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.006	<0.005
	20th percentile	0.001	0.001	0.0001	0.0001	0.001	0.001	0.0018	0.0014	0.01	0.01	0.001	0.001	0.0254	0.0074
	Median	0.001	0.001	0.0001	0.0001	0.001	0.001	0.003	0.002	0.01	0.01	0.001	0.001	0.039	0.0185
	95th percentile	0.0145	0.0010	0.0001	0.0001	0.0050	0.0050	0.0165	0.0029	0.0100	0.0100	0.0050	0.0050	0.1250	0.0889
	Maximum	0.016	0.001	0.0005	0.0002	< 0.005	0.008	0.018	0.003	<0.01	0.01	< 0.005	< 0.005	0.141	0.124
A-OB3	Sample count	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.005	< 0.005	0.001	0.001	< 0.001	< 0.001	< 0.005	< 0.005	0.006	< 0.005
	20th percentile	0.001	0.001	0.0001	0.0001	0.005	0.005	0.0014	0.0014	0.001	0.001	0.005	0.005	0.0124	0.005
	Median	0.001	0.001	0.0001	0.0001	0.005	0.005	0.002	0.002	0.001	0.001	0.005	0.005	0.022	0.005
	95th percentile	0.0028	0.0010	0.0001	0.0002	0.0050	0.0086	0.0065	0.0020	0.0010	0.0019	0.0050	0.0050	0.3352	0.0167
	Maximum	0.003	< 0.001	< 0.0001	0.0002	< 0.005	0.009	0.007	0.002	0.001	0.002	< 0.005	< 0.005	0.37	0.018
A-OB4	Sample count	4	4	24	24	24	24	4	4	24	24	24	24	24	22
	Minimum	0.005	< 0.001	< 0.0001	< 0.0001	< 0.005	0.002	0.032	0.01	< 0.001	< 0.001	0.008	0.008	0.045	0.02
	20th percentile	0.0092	0.001	0.0001	0.0001	0.005	0.005	0.0344	0.0154	0.05	0.0106	0.0106	0.01	0.066	0.032
	Median	0.019	0.001	0.0001	0.0001	0.005	0.005	0.0595	0.0225	0.05	0.05	0.012	0.01	0.0875	0.0555
	95th percentile	0.0847	0.8417	0.0009	0.0001	0.005	0.0092	0.1485	0.0303	0.0925	0.0925	0.0149	0.0139	0.2189	0.1651
	Maximum	0.095	0.99	0.0042	< 0.005	0.012	0.02	0.16	0.031	0.1	0.1	0.02	0.014	0.36	0.169
A-OB7	Sample count	4	4	23	23	23	23	4	4	23	23	23	23	23	22
	Minimum	0.034	< 0.001	0.0001	< 0.0001	0.002	0.002	0.11	0.008	< 0.001	< 0.001	< 0.005	< 0.005	0.059	0.008

Alluvium metals concentrations (mg/L)—total and filtered															
	20th percentile	0.0682	0.001	0.0001	0.0001	0.002	0.002	0.128	0.0092	0.01	0.01	0.008	0.007	0.086	0.0188
	Median	0.1255	0.001	0.0001	0.0001	0.002	0.002	0.175	0.01	0.01	0.01	0.009	0.007	0.121	0.0395
	95th percentile	0.6785	0.0087	0.0005	0.0003	0.0460	0.0100	0.8815	0.0100	0.0500	0.0500	0.0146	0.0089	0.7290	0.1580
	Maximum	0.77	< 0.01	0.0016	0.0003	1.92	0.011	1	0.01	0.1	0.1	0.055	0.01	4.3	0.18
A-OB8	Sample count	4	4	24	24	24	24	4	4	24	24	24	24	24	23
	Minimum	0.005	< 0.001	< 0.0001	< 0.0001	0.008	0.009	0.032	0.027	< 0.001	< 0.001	0.032	0.012	0.025	0.02
	20th percentile	0.0158	0.001	0.0001	0.0001	0.011	0.01	0.0968	0.0288	0.0106	0.01	0.0506	0.0424	0.1282	0.0478
	Median	0.1315	0.001	0.0001	0.0001	0.012	0.011	0.15	0.037	0.05	0.05	0.0595	0.049	0.178	0.107
	95th percentile	0.3165	0.0019	0.0008	0.0006	0.0234	0.0227	0.3385	0.1341	0.0585	0.0925	0.1155	0.0764	0.5375	0.2291
	Maximum	0.33	0.002	0.0014	0.0007	0.025	0.034	0.37	0.15	0.1	0.1	0.14	0.081	0.66	0.278
A-OB10	Sample count	4	4	24	24	24	24	4	4	24	24	24	24	24	23
	Minimum	0.006	< 0.001	< 0.0001	< 0.0001	< 0.005	< 0.001	0.034	0.007	0.003	< 0.001	< 0.005	0.003	0.055	0.021
	20th percentile	0.0144	0.001	0.0001	0.0001	0.005	0.005	0.0442	0.0148	0.05	0.01	0.005	0.005	0.075	0.047
	Median	0.0315	0.001	0.0001	0.0001	0.0065	0.005	0.052	0.02	0.05	0.05	0.005	0.005	0.1045	0.067
	95th percentile	0.049	0.001	0.0011	0.0009	0.0243	0.01	0.11	0.02	0.05	0.05	0.007	0.006	0.2327	0.1567
	Maximum	0.05	0.001	0.0014	0.0013	0.026	0.011	0.12	0.02	0.1	0.1	0.01	0.01	0.36	0.205
A-OB11	Sample count	4	4	23	23	23	23	4	4	23	23	23	23	23	22
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.002	0.002	< 0.001	< 0.001	0.004	< 0.001	0.007	0.005
	20th percentile	0.0016	0.001	0.0001	0.0001	0.001	0.001	0.0032	0.002	0.01	0.01	0.001	0.001	0.0434	0.0108
	Median	0.002	0.001	0.0001	0.0001	0.001	0.001	0.004	0.002	0.01	0.01	0.002	0.001	0.113	0.017
	95th percentile	0.0224	0.0010	0.0001	0.0001	0.0050	0.0050	0.0533	0.0020	0.0100	0.0100	0.0050	0.0050	0.2280	0.0356
	Maximum	0.026	< 0.001	< 0.0001	< 0.0001	< 0.005	0.008	0.062	0.002	< 0.01	< 0.01	0.007	< 0.005	0.61	0.042
A-OB12	Sample count	4	4	23	23	23	23	4	4	23	23	23	23	23	22
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.007	< 0.005
	20th percentile	0.0016	0.001	0.0001	0.0001	0.001	0.001	0.0028	0.001	0.01	0.01	0.001	0.001	0.0448	0.0144
	Median	0.0025	0.001	0.0001	0.0001	0.001	0.001	0.005	0.0015	0.01	0.01	0.001	0.001	0.072	0.026
	95th percentile	0.0277	0.0010	0.0003	0.0001	0.0050	0.0050	0.0239	0.0020	0.0100	0.0100	0.0050	0.005	0.1962	0.1270
	Maximum	0.032	< 0.001	0.0004	0.0002	< 0.005	0.01	0.027	0.002	< 0.01	< 0.01	0.005	< 0.005	0.227	0.203

(f) Filtered. Data analysis is based on the sampling conducted by SLR Consulting in December 2017, March, June and October 2018 and sampling conducted by 4T Consultants in February, May, August and November 2019, March, September, October, November and December 2020 and January 2021. Sample count refers to the number of sampling results for the bore. To calculate the 20th percentile, median and 95th percentile data, less than symbols have been removed from the results.

Table 9.48: Statistical analysis of groundwater quality results—Permian (metals)

Permian metals concentrations (mg/L)—total and filtered															
Bore ID	**Parameter**	**Al**	**Al (f)**	**As**	**As (f)**	**B**	**B (f)**	**Cd**	**Cd(f)**	**Cr**	**Cr(f)**	**Co**	**Co (f)**	**Cu**	**Cu (f)**

Permian metals concentrations (mg/L)—total and filtered															
Baralaba Coal Measures (interburden)															
P-PB1	Sample count	23	23	23	23	3	3	3	3	3	3	3	3	3	3
	Minimum	< 0.01	< 0.01	0.009	0.008	0.12	0.11	< 0.0002	< 0.0002	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001
	20th percentile	0.024	0.01	0.0084	0.0062	0.128	0.118	0.0002	0.0002	0.001	0.001	0.001	0.001	0.001	0.001
	Median	0.05	0.01	0.012	0.011	0.14	0.13	0.0002	0.0002	0.001	0.001	0.001	0.001	0.001	0.001
	95th percentile	0.242	0.05	0.0149	0.0139	0.176	0.175	0.0002	0.0002	0.0028	0.001	0.001	0.001	0.001	0.001
	Maximum	0.28	< 0.05	0.016	0.016	0.18	0.18	< 0.0002	< 0.0002	0.003	< 0.001	0.001	0.001	0.001	< 0.001
P-OB3	Sample count	25	25	25	25	4	4	4	4	4	4	4	4	4	4
	Minimum	< 0.05	< 0.01	0.001	0.001	0.18	0.16	< 0.0002	< 0.0002	0.001	< 0.001	0.001	0.001	< 0.001	< 0.001
	20th percentile	1.244	0.05	0.0038	0.002	0.212	0.196	0.0002	0.0002	0.0016	0.001	0.0016	0.0016	0.001	0.001
	Median	3.495	0.05	0.005	0.005	0.22	0.22	0.0002	0.0002	0.002	0.001	0.002	0.002	0.001	0.001
	95th percentile	14.818	0.09	0.01	0.009	0.458	0.458	0.00173	0.00173	0.0088	0.00865	0.0088	0.0088	0.0537	0.0537
	Maximum	18	< 0.5	3.17	< 0.01	< 0.5	< 0.5	< 0.002	< 0.002	< 0.01	< 0.01	< 0.01	< 0.01	0.063	0.063
Baralaba Coal Measures (coal seams)															
P-OB1	Sample count	23	23	23	23	4	4	4	4	4	4	4	4	4	4
	Minimum	< 0.05	<0.01	0.002	0.001	0.18	0.17	< 0.0002	< 0.0002	< 0.001	< 0.001	0.003	0.003	< 0.001	< 0.001
	20th percentile	0.9	0.026	0.005	0.004	0.186	0.176	0.0002	0.0002	0.001	0.001	0.0036	0.0036	0.001	0.001
	Median	2.9	0.05	0.005	0.005	0.2	0.195	0.0002	0.0002	0.001	0.001	0.005	0.005	0.001	0.001
	95th percentile	6.385	0.05	0.0099	0.0069	0.21	0.21	0.0002	0.0002	0.00525	0.001	0.00855	0.0077	0.001	0.001
	Maximum	25.6	0.1	0.01	0.01	0.21	0.21	< 0.0002	< 0.0002	0.006	< 0.001	0.009	0.008	< 0.001	< 0.001
P-OB4	Sample count	24	24	24	24	4	4	4	4	4	4	4	4	4	4
	Minimum	< 0.05	< 0.01	< 0.001	< 0.001	0.22	0.23	< 0.0002	< 0.0002	0.002	< 0.001	< 0.01	< 0.01	< 0.001	< 0.001
	20th percentile	0.05	0.05	0.005	0.002	0.226	0.242	0.0002	0.0002	0.0026	0.0016	0.013	0.0136	0.0028	0.001
	Median	0.1	0.05	0.005	0.005	0.23	0.265	0.0002	0.0002	0.004	0.0025	0.016	0.0165	0.0065	0.001
	95th percentile	0.5	0.0925	0.00925	0.00925	0.4595	0.467	0.00173	0.00173	0.00925	0.00895	0.017	0.017	0.00985	0.00865
	Maximum	3.43	0.5	< 0.01	< 0.01	0.5	0.5	< 0.002	< 0.002	< 0.01	< 0.01	0.017	0.017	< 0.01	< 0.01
P-OB5	Sample count	23	23	23	23	4	4	4	4	4	4	4	4	4	4
	Minimum	< 0.05	< 0.01	0.002	0.001	0.78	0.78	< 0.0002	< 0.0002	0.002	< 0.001	< 0.001	< 0.001	0.005	< 0.001
	20th percentile	0.054	0.05	0.005	0.004	0.78	0.78	0.0002	0.0002	0.0026	0.0016	0.001	0.001	0.005	0.001
	Median	0.1	0.05	0.005	0.005	0.835	0.82	0.0002	0.0002	0.003	0.0025	0.001	0.001	0.0075	0.001
	95th percentile	0.247	0.098	0.0098	0.0096	1.3235	1.319	0.00173	0.00173	0.0098	0.00895	0.00865	0.00865	0.0185	0.00865
	Maximum	< 0.5	< 0.5	< 0.01	< 0.01	1.4	1.4	< 0.002	< 0.002	0.011	< 0.01	< 0.01	< 0.01	0.02	< 0.01
Gyranda Formation															

Permian metals concentrations (mg/L)—total and filtered															
P-OB2	Sample count	24	24	24	24	3	3	3	3	3	3	3	3	3	3
	Minimum	< 0.05	< 0.01	< 0.001	< 0.001	1.6	1.6	< 0.0002	< 0.0002	< 0.001	< 0.001	0.001	0.001	0.019	0.009
	20th percentile	0.224	0.01	0.001	0.001	1.68	1.68	0.0002	0.0002	0.0014	0.001	0.0014	0.0014	0.0258	0.0126
	Median	1.285	0.01	0.002	0.001	1.8	1.8	0.0002	0.0002	0.002	0.001	0.002	0.002	0.036	0.018
	95th percentile	3.2685	0.05	0.00755	0.00455	1.89	1.89	0.0002	0.0002	0.0155	0.0019	0.002	0.002	0.1026	0.0918
	Maximum	4.43	0.1	0.01	0.01	1.9	1.9	< 0.0002	< 0.0002	0.017	0.002	0.002	0.002	0.11	0.1

(f) Filtered Data analysis is based on the sampling conducted by SLR Consulting in December 2017, March, June and October 2018 and sampling conducted by 4T Consultants in February, May, August and November 2019, March, September, October, November and December 2020 and January 2021. Sample count refers to the number of sampling results for the bore. Calculate the 20th percentile, median and 95th percentile data, less than symbols have been removed from the results.

Table 9.49: Statistical analysis of groundwater quality results—Permian (metals)

Permian metals concentrations (mg/L)—total and filtered															
Bore ID	**Parameter**	**Pb**	**Pb (f)**	**Hg**	**Hg (f)**	**Mo**	**Mo (f)**	**Ni**	**Ni (f)**	**Se**	**Se (f)**	**U**	**U (f)**	**Zn**	**Zn (f)**
Baralaba Coal Measures (interburden)															
P-PB1	Sample count	3	3	23	23	23	23	3	3	23	23	23	23	23	22
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	0.001	0.001	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.009	0.009
	20th percentile	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.01	0.01	0.001	0.001	0.0348	0.038
	Median	0.001	0.001	0.0001	0.0001	0.002	0.001	0.001	0.001	0.01	0.01	0.001	0.001	0.054	0.044
	95th percentile	0.001	0.001	0.00019	0.0001	0.005	0.005	0.0019	0.0019	0.05	0.046	0.005	0.005	0.1274	0.1089
	Maximum	< 0.001	< 0.001	0.0003	< 0.0001	0.009	0.006	0.002	0.002	0.05	0.05	< 0.005	< 0.005	0.19	0.121
P-OB3	Sample count	4	4	25	25	25	25	4	4	25	25	24	25	25	24
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.005	< 0.001	0.002	0.001	< 0.001	< 0.001	<0.005	< 0.001	0.005	<0.005
	20th percentile	0.001	0.001	0.0001	0.0001	0.005	0.005	0.002	0.0016	0.0064	0.0064	0.005	0.005	0.0414	0.0148
	Median	0.001	0.001	0.0001	0.0001	0.005	0.005	0.0025	0.002	0.05	0.05	0.005	0.005	0.078	0.05
	95th percentile	0.00865	0.00865	0.00054	0.0001	0.009	0.01	0.00895	0.0088	0.05	0.05	0.00925	0.009	0.2004	0.1597
	Maximum	< 0.01	< 0.01	< 0.001	< 0.001	< 0.05	< 0.05	< 0.01	< 0.01	0.1	0.1	< 0.05	< 0.05	0.238	0.185
Baralaba Coal Measures (coal seams)															
P-OB1	Sample count	4	4	23	23	23	23	4	4	23	23	23	23	23	22
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	<0.005	< 0.001	0.003	0.003	< 0.001	< 0.001	< 0.005	< 0.001	0.021	0.005
	20th percentile	0.001	0.001	0.0001	0.0001	0.005	0.0026	0.0036	0.0036	0.0266	0.01	0.005	0.005	0.1148	0.0526
	Median	0.001	0.001	0.0001	0.0001	0.005	0.005	0.0055	0.0045	0.05	0.05	0.005	0.005	0.196	0.0935
	95th percentile	0.001	0.001	0.0006	0.0001	0.005	0.005	0.00785	0.00585	0.05	0.05	0.005	0.0095	0.5215	0.2351
	Maximum	< 0.001	< 0.001	< 0.0001	< 0.0001	0.01	0.01	0.008	0.006	0.1	0.1	0.01	0.01	1.23	0.256
P-OB4	Sample count	4	4	24	24	24	24	4	4	24	24	24	24	24	23
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.005	0.003	< 0.01	< 0.01	< 0.001	< 0.001	< 0.005	0.002	0.006	< 0.005
	20th percentile	0.001	0.001	0.0001	0.0001	0.005	0.005	0.0142	0.0136	0.05	0.01	0.005	0.005	0.05	0.028
	Median	0.001	0.001	0.0001	0.0001	0.005	0.005	0.024	0.023	0.05	0.05	0.005	0.005	0.091	0.06
	95th percentile	0.00865	0.00865	0.000555	0.000185	0.0097	0.01255	0.0327	0.03765	0.05	0.05	0.00925	0.01	0.2236	0.1548
	Maximum	< 0.01	< 0.01	< 0.001	< 0.001	< 0.05	< 0.05	0.033	0.039	0.1	0.1	< 0.05	< 0.05	0.238	0.167

Permian metals concentrations (mg/L)—total and filtered															
P-OB5	Sample count	4	4	23	23	23	23	4	4	23	23	23	23	23	22
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.005	< 0.005	0.003	0.002	< 0.001	< 0.001	0.002	< 0.001	0.013	< 0.005
	20th percentile	0.001	0.001	0.0001	0.0001	0.006	0.005	0.0072	0.005	0.01	0.01	0.005	0.005	0.053	0.0252
	Median	0.001	0.001	0.0001	0.0001	0.008	0.006	0.012	0.0085	0.05	0.05	0.005	0.005	0.087	0.084
	95th percentile	0.00865	0.00865	0.00076	0.0001	0.0202	0.047	0.01485	0.01085	0.05	0.05	0.0095	0.0095	0.2907	0.1928
	Maximum	< 0.01	< 0.01	< 0.001	< 0.001	< 0.05	0.08	0.015	0.011	0.1	0.1	<0.05	<0.05	0.31	0.21
Gyranda Formation															
P-OB2	Sample count	3	3	24	24	24	24	3	3	24	24	24	24	24	23
	Minimum	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.003	0.003	< 0.001	< 0.001	0.002	0.001	0.008	0.008
	20th percentile	0.001	0.001	0.0001	0.0001	0.001	0.001	0.003	0.003	0.01	0.01	0.002	0.002	0.064	0.0436
	Median	0.001	0.001	0.0001	0.0001	0.001	0.001	0.003	0.003	0.01	0.01	0.002	0.002	0.104	0.092
	95th percentile	0.001	0.001	0.000285	0.0001	0.005	0.005	0.012	0.0048	0.05	0.044	0.005	0.005	0.25595	0.2566
	Maximum	< 0.001	< 0.001	0.0004	0.0002	0.01	0.01	0.013	0.005	0.1	0.1	0.01	0.01	0.38	0.38

(f) Filtered Data analysis is based on the sampling conducted by SLR Consulting in December 2017, March, June and October 2018 and sampling conducted by 4T Consultants in February, May, August and November 2019, March, September, October, November and December 2020 and January 2021. Sample count refers to the number of sampling results for the bore. To calculate the 20th percentile, median and 95th percentile data, less than symbols have been removed from the results.

9.10.2.3 Water dependent assets

Agricultural groundwater users

Groundwater within and surrounding the Project area is generally considered unsuitable for stock watering, farm supply and irrigation. Groundwater appears to have had limited use as stock water supply historically. Water supply for agriculture is generally sourced directly from Dawson River allocations in the region.

A review of Queensland Government's Groundwater Database (Queensland Globe) and Australian Groundwater Explorer (BoM) was conducted to identify the location and source aquifers of existing groundwater bores in the Project area. Results from the desktop search have been evaluated against the registered numbers within the existing groundwater monitoring network at the Project and surrounds (Table 9.50).

Three private landholder bore users have been identified within 5 km of the Project, with these results subsequently refined based on a landholder bore survey (4T Consultants, 2019). The results of the bore survey are summarised as:

- Ross Bore—located approximately 500 m east of the Project on Lot 26 of FN153 with a total drilled depth of 52.67 m and intersecting mapped Cretaceous Intrusives (Igneous Trachyte) associated with Mount Ramsay. The recorded groundwater elevation is at approximately 102–103 mAHD and is much higher than the surrounding Permian Baralaba Coal Measures. It is understood the private landholder bore is currently equipped for use.
- Riverland 1 and 2—consists of paired bores approximately 3 m apart located approximately 1.5 km west of the Project on Lot 4 of FN514 between the Dawson River and Banana Creek, and immediately south of their confluence adjacent the Dawson River. The bores have been recorded as being 18 mAHD and 22 mAHD deep, respectively, intersecting the sands and gravels of the Quaternary alluvium. Aerial imagery shows two centre-pivot irrigation areas existing nearby on the property; however, it is understood that the supply of irrigation water is sourced from the Dawson River, not the groundwater bores. Neither bore is equipped.
- Webb bore—located approximately 3.5 km south of the Project on Lot 35 on FN141 on the southern side of Banana Creek. It is recorded as a 'deep bore' (approximately 78 mAHD) and as 'not equipped'.

Table 9.50: Groundwater database searches and other private landholder bores

Database ID	Type/use	Further details
RN 100077/100077	Private landholder bore[1]	2 km south of the Project (south of Banana Creek); refer also to 4T Consultants, 2019
RN 100078/100078	Excavation/dam	Quarry
RN 100317/100317	Mineral bore	MIH Banana 2/2A
RN 128188/128188A	Private landholder bore[2]	1.5 km west of the Project (at the confluence of Banana Creek and Dawson River); refer also to 4T Consultants, 2019

1: The location of the desktop record RN 100077 was ground-truthed, and the landholder indicated that it had been filled in and destroyed in the past. An alternate existing bore on the property was identified (Webb Bore).
2: The location of the desktop record RN 128188 was ground-truthed and no bore exists; however, two existing bores on the nearby property were surveyed (Riverland 1 & 2).

Springs

No springs have been identified within or surrounding the Project site (Appendix G Aquatic Ecology).

Groundwater dependent ecosystems

The Groundwater Assessment (Appendix C) shows 'low potential' for groundwater dependence for all the potential 'Terrestrial' GDEs associated with riparian vegetation and watercourses in the Project area. The low potential for groundwater dependence is consistent with the unsaturated depth.

Two hydrogeological cross-sections have been developed to illustrate the local site geology and observed and predicted groundwater conditions in the vicinity of the potential GDEs. Cross-section A-A' intersects the Dawson River and cross-section B-B' is through the HES wetland.

Figure 9.71 presents cross-section A-A' and shows groundwater flow within the alluvial sediments associated with the local drainages of Banana Creek and the Dawson River is towards the west of the Project. Groundwater levels are generally hydraulically disconnected with (i.e. deeper than) surface waters.

The depth of the water table is approximately 15 m below the HES wetland (Figure 9.70) with negligible predicted groundwater level change at the end of the Project mining (Figure 9.72). The HES wetland is considered to be a 'perched' system, i.e. separate from the regional groundwater system, with the presence of underlying clays.

Based on the available evidence (i.e. groundwater level monitoring, vegetation mapping and site survey and reconnaissance by Eco Solutions & Management [2023], Ecological Service Professionals [2023] and 3D Environmental [2023]), the wetlands are considered reliant on direct rainfall, runoff and floodwaters, which are held near the surface by the shallow clays.

Details of the GDE assessment for the Project are addressed further in section 9.14 and Appendix H, Groundwater Dependant Ecosystems Assessment.

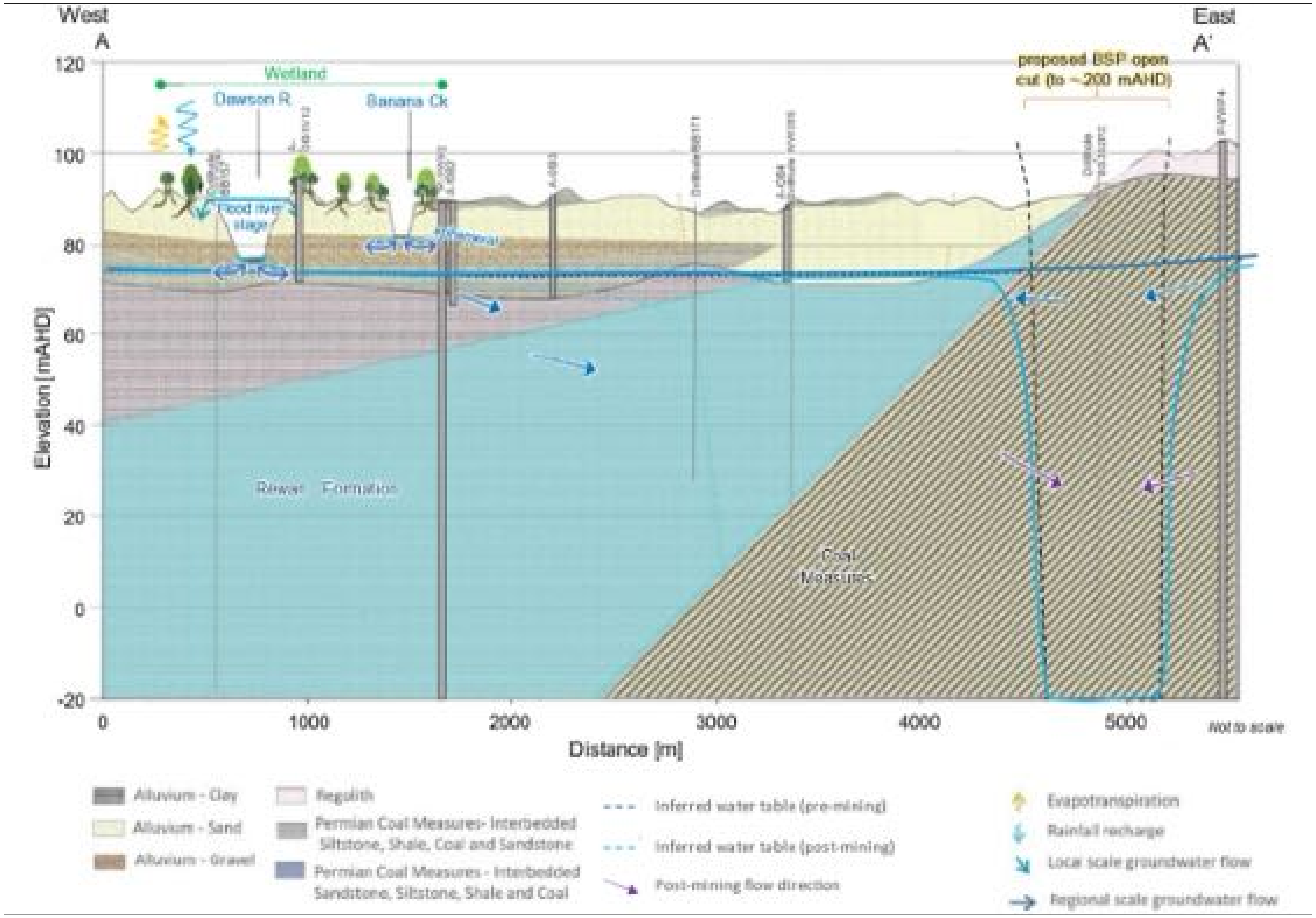

Figure 9.71: Cross-section A-A: groundwater levels and likely groundwater interaction at wetlands

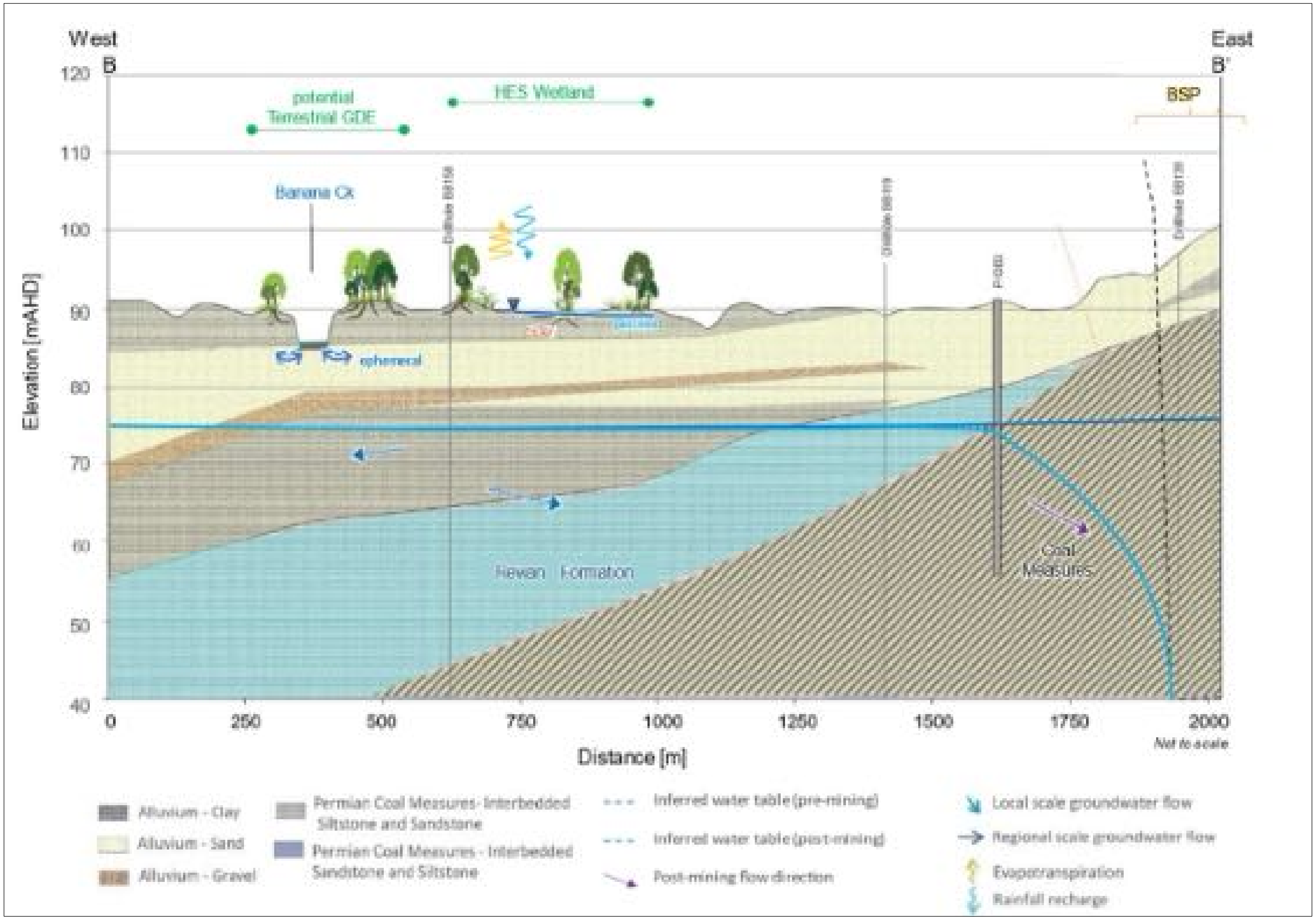

Figure 9.72: Cross-section B-B: groundwater levels and likely groundwater interaction at wetlands

Targeted GDE assessment has been undertaken by 3D Environmental (2023) (Appendix H) to assess the groundwater dependence of the vegetation in the Project area and assesses the potential impacts of the Project, including groundwater drawdown, on potential terrestrial GDEs. The assessment method and findings are discussed in detail in section 9.14.

The assessment identified that groundwater dependency within the MLA and adjacent areas associated with the Dawson River flood plain is controlled by small discontinuous lenses of sand that are distributed sporadically throughout the heavy clay soils that otherwise characterise the flood plain sediments. GDEs identified, which include those at GDE Area 1, GDE Area 6 and GDE Area 9 are all associated with overland flow paths of the main Dawson River channel, which would act to increase infiltration into the soil profile due to prolonged ponding of surface water. The sandy lenses support shallow, fresh and seasonal groundwater resources that are perched above and disconnected from the regional groundwater table. Recharge of the sandy lenses occurs during surface water infiltration, which is associated with overbank flow and intense rainfall events, and seasonality will depend on climatic factors including transpiration rates and flood interval.

While it is not possible to precisely define the extent of groundwater dependent vegetation due to the sporadic nature of the sandy lenses, this assessment indicates that they are discrete, restricted in extent, generally discontinuous and more likely to coincide with overland flow paths and flood channels. Because of these factors, there are no identified causal pathways for impact which have capacity to alter GDE function and cause ecological harm.

Areas confirmed not to represent GDEs includes the mapped HES wetland within the MLA and the predominant extent of Coolibah woodland that occupies upper terraces of the Dawson River flood plain.

Stygofauna

Field sampling was undertaken by Stygoecologica (Appendix I, Stygofauna Assessment) over 5 rounds during 2017-2019 to identify the presence of stygofauna within the Project disturbance area and surrounds. Field sampling identified a limited stygofauna community associated with the alluvial aquifer adjacent the Dawson River.

A total of 3 taxa (Oligchaeta, Polydesmida and Diplura) and 24 individuals were collected during the surveys. The stygofauna community was assessed as having low ecological value due to the depauperate, sporadic and localised nature of the community recorded.

Drinking water

There are no known environmental values in relation to cultural and spiritual values of groundwater within the Project area. No WQOs are currently provided for cultural and spiritual values.

Industrial users

The Project would use groundwater that drains directly to the open cut pit. The groundwater would be pumped to holding dams, where water collected would be incorporated into the site water balance. Other regional mines including Baralaba North take groundwater (indirectly through drawdown) for industrial purposes.

No WQOs are provided for industrial use, as water quality requirements vary within and between industries. Similarly, ANZECC & ARMCANZ (2000) does not provide guidelines for industry and indicates that industrial water quality requirements need to be considered on a case-by-case basis. Based on this approach, associated groundwaters accessed by the Project would provide a beneficial industrial use.

Cultural values

There are no known environmental values in relation to cultural and spiritual values of groundwater within the Project area. No WQOs are currently provided for cultural and spiritual values.

9.10.3. Groundwater modelling

9.10.3.1 Numerical groundwater model

Model workflow has been designed to facilitate history matching or calibration of the groundwater model leading to predictive modelling that incorporates quantitative uncertainty analysis. The workflow adopts the industry standard parameter estimation and uncertainty analysis software, PEST and PESTPP (Watermark Numerical Computing, 2018; White *et al.*, 2020) as a central element, coupled with a MODFLOW groundwater model. Much of the pre-processing was done in Groundwater Vistas 8, as well as other custom python scripts.

Sensitivity analysis

PESTPP-IES has been used, and done so in combination with pilot points for hydraulic conductivity and storage parameters to develop a large number of alternative model realisations. This highly parameterised method is focused on simulating the key predictions or "Quantities of Interest" multiple times with a range of parameter values to provide a quantified estimate of uncertainty.

This therefore precludes the need for a formal sensitivity analysis which is typically done to assess the scale of changes to model outputs as a result of changing input parameters, Doherty (2022) states: *With the availability of regularised, highly parameterised inversion, sensitivity analysis, undertaken for this reason, is no longer required*".

Modelling software

The numerical groundwater model for Baralaba Coal operations has evolved over the past decade but remains in the MODFLOW family of model software. MODFLOW (McDonald and Harbaugh, 1988), originally developed by the United States Geological Survey (USGS) is the most widely used code for groundwater modelling and has long been considered an industry standard.

The current Project numerical groundwater model was developed by HydroSimulations/SLR in 2020-21. The main changes to the model were:

- an extension to the south to cover the Project area; and
- a change to use the MODFLOW-USG-Transport software (sometimes referred to as "MODFLOW-USG-T").

Further details of the MODFLOW-USG model design and construction (including geometry, mesh, boundary conditions, etc.) used for the Project numerical groundwater model is provided in Appendix B, Groundwater Modelling and Assessment.

A summary of the key components of the numerical groundwater model are outlined below. A detailed description of the numerical groundwater model including calibration characteristics is presented in Appendix B, Groundwater Modelling and Assessment.

Model structure

The Project numerical groundwater model covers an area of approximately 2,000 km^2 and extending roughly 38 km from west to east (actually WSW to ENE) and 53 km from south to north (actually SSE to NNW). The model is centred on the Dawson River valley, but by comparison to the BNCOP model, has been extended approximately 10 km to the south to better cover the Project area. A rectangular model grid has been retained for the Project numerical model. Each cell in the model grid is a regular 200 m by 200 m. Over the 17 model layers the Project numerical groundwater model has a total of 855,950 cells, with 640,428 of these being active.

Geological model

The regional 3D geological model was built covering 120 km x 120 km, an area significantly larger than the numerical groundwater model domain. The larger model area took advantage of substantial geological datasets and information from a variety of local and regional sources.

The key points for the geological and stratigraphic framework for the Project numerical groundwater model are:

- Coal seams which were grouped together, typically in pairs, e.g. Layer 4, were constructed using the combined coal seam thickness of the relevant coal seams.
- CSG bores provided useful data for extrapolating the stratigraphic layers away from the local-scale geological models. However, they usually only provided the top and sometimes the base of the Baralaba Coal Measures, and rarely provide information on the thickness or elevation of the component overburden or coal seams.
- In the area between the Project and the Baralaba North Mine, the coal seam and interburden elevations were interpolated.
- Away from the local-scale geological models, and towards the northern, southern and western edges of the model coal seam thickness was extrapolated using the nearest edge of the local-scale geological models, and the interburden layers thickened or thinned according to the Baralaba Coal Measures top and bottom elevations at the nearest exploration bore.

Model layers and Faulting

Layer geometry and corresponding aquifer parameters are attributed using the MODFLOW BAS and BCF packages. The top surface of Layer 1 in the model relies on topographical data (DEM – Digital Elevation Model) which is the 3-second resolution data from the Shuttle Radar Topography Mission (SRTM) dataset.

Geological faults have been incorporated into the numerical groundwater model in two ways:

1) Those from regional and local-scale geological have been incorporated into the geological model surfaces. That is, flow barrier boundary conditions and/or zones of enhanced permeability have not been used to simulate these structures. As coal continuity is assumed across these structures, estimates for distant environmental effects would be conservative.
2) The faults identified in the Transient Electromagnetic (TEM) survey data at the BNM have been simulated using flow barriers (MODFLOW HFB package). They have been specified in model Layers 2-16 (i.e. not in Layer 1, which is the alluvium and colluvium). In Layers 3-16 the HFBs have been set with a horizontal hydraulic conductivity equal to that of the least permeable Permian stratum in the groundwater model, while in Layer 2 the hydraulic conductivity is specified as an order of magnitude lower than the surrounding weathered material.

Besides the elevated topography associated the igneous trachyte at Mt Ramsay, the structure has been conservatively represented as a continuation of the Gyranda Formation in the model, and not a barrier to groundwater flow.

Model stresses

The transient historic groundwater model was run for the period 1970 to present day. This historical period is discretised into a total of 45 stress periods. The subsequent predictive period is set as 2024 to 2500, represented as a further 45 stress periods (a total of 90 for the historical and predictive period). Stress periods are set at an annual resolution for the duration of Project mining, extending to decades and then centuries to represent very long-term post-closure conditions (Appendix B, Groundwater Modelling and Assessment for further detail). This allows simulation of the progressive changes to the groundwater system in response to mining and dewatering.

Boundary conditions

Regional flow

MODFLOW's GHB package was used to apply general head conditions at the upstream and downstream extents of the model associated with the alluvium and weathered Permian units in Layer 1. General head conditions were also applied at the western extent of the model, consistent with the approach adopted for the Baralaba North Continued Operations Project EIS (BNCOP) numerical groundwater model.

Inactive areas

Inactive areas lie to the west of the Dawson Range and to the east of the Dawson River valley. Inactive areas were included as a stress in the numerical groundwater model.

Watercourses

River cells (using the MODFLOW RIV package) were applied along the Dawson River, Banana Creek and other watercourses and/or drainage features. In addition, a pre-Neville Hewitt Weir stage based on topography for all watercourses in the first model stress period, which was then altered for all River cells upstream of Baralaba to be 78 mAHD (or above, if topographic data indicated this), based on the storage level of the weir.

A user-specified head was applied to all river cells of 6 m above the riverbed for a single model stress period in early 2011 to represent the occurrence of significant flooding along the Dawson River. After that period, river stages returned to the previously specified level.

Rainfall recharge

Rainfall recharge was applied to each active model cell as a percentage of actual rainfall using the MODFLOW RCH package. Four zones of differing recharge rates were set-up in the model based on the outcrop geology as follows:

- alluvium;
- Permian regolith;
- Clematis Sandstone and Duaringa Formation; and
- colluvium.

Initial recharge rates were allowed to vary in the calibration process, with consideration of the recharge analysis provided elsewhere in the Bowen Basin.

Flood recharge has only been represented by increasing the stage on River cells (using the MODFLOW RIV package) for a selected stress period (in 2011). Due to the flooding period in 2011 that was a result of high rainfall, the rainfall recharge has been increased at this time and the river stage has been increased above the surface to create high recharge to groundwater.

Evapotranspiration

Evapotranspiration was simulated using the MODFLOW EVT package. Two conceptual zones were set based on vegetation cover (trees versus grasses). A simple analysis of trees versus grassland/bare areas was completed in GIS based on aerial photography. Results of this analysis were then used to assign zones for the MODFLOW EVT package. Evapotranspiration rates have been set using 'Actual ET' data from the BOM.

Prior mining and dewatering

The numerical groundwater model incorporated dewatering activities associated with the Baralaba North Mine using drain cells (MODFLOW DRN package).

No prior mining or associated dewatering activities have occurred within the Project. No prior dewatering by neighbouring properties have been undertaken.

Parameterisation – hydraulic properties

Aquifer hydraulic properties, hydraulic conductivity (horizontal: Kh; and vertical: Kv), specific yield (Sy) and specific storage (Ss), were assigned to the groundwater model using a combination of pilot points and parameter zones.

To allow PEST to adjust hydraulic conductivity and storage parameters in the groundwater model, the pre-processing software PLPROC (Watermark Numerical Computing) is used with pilot points. A maximum possible 242 points per model layer was used.

Further description of hydraulic properties, including the initial value and ranges of hydraulic conductivity and aquifer storage are described in Appendix B, Groundwater Modelling and Assessment.

Observation data

History matching or calibration has considered three types of observation:

- Groundwater levels or heads (as absolute elevation);
- Transient change in groundwater levels (from the groundwater levels); and
- Estimated groundwater inflow to the BNM pits.

This is consistent with the suggested history matching datasets in Tomlin *et al.* (2023), noting that baseflow or leakage observations are not available at this site. The total number of observations (7,958) are summarised by observation type:

- groundwater levels: 4,053;
- groundwater level change: 3,903; and
- inflow (Baralaba North estimates): 2.

Approach to calibration

Model history matching is the process of replicating hydrogeological targets by varying key model parameters such as hydraulic conductivity and storage within the range of reasonable values and some of the boundary condition parameters.

The modelling relies on many available values of hydraulic conductivities and storage parameters Some trial-and-error calibration and testing of the model was carried out to adjust boundary conditions and hydraulic conductivity (horizontal and vertical), and storage parameters of model layers or zones to test model stability and plausible representation to groundwater levels.

Along with trial-and-error methods, PESTPP-IES (White *et a*l., 2020) has been used to carry out automated calibration. PESTPP-IES does not focus solely on 'calibration'. White *et al.* (2020) state that the exploration and regularisation of parameters "implemented by PESTPP-IES thus attempts to ensure that parameters comprising each realisation are changed from their initial values by the smallest amount required for model outputs to reproduce field observations "acceptably" well". So while performing 'calibration', PESTPP-IES also generates a set of plausible alternative model realisations that fit the observations or targets to this "acceptable" degree.

Modelled mine inflow

The target mine inflow for BNM underpinned the PEST modelling of inflow between 0.6 and 2.0 ML/day. PESTPP-IES generally improved the representation of inflow to the BNM, with iteration 1 having a slightly narrower range in inflow, and iteration 2 reducing the inflow to more appropriate volumes, albeit still slightly higher than the upper estimate (2 ML/day).

Modelled water balance

A tabulated water balance for the whole model domain in Table 9.51. This presents the average water balance for the (transient) historical period, 2005-2023.

In general, the largest simulated influx and outflux components being river leakage (35.1 ML/day) is expected, as well as this being primarily balanced by evapotranspiration (32.8 ML/day). Recharge is low, as is baseflow to watercourses, and this is consistent with the conceptual model. Net groundwater storage change is relatively small for this period, representing a slight increase in modelled groundwater levels across the model for the selected period.

At the end of the calibration period (late 2023, stress period 45), the modelled mass balance error was less than 0.04%, which is within 1-2% error.

Table 9.51: Simulated water balance average 2005 - 2023

Modelled component	**Catchment process**	**Simulated flux (ML/d)**	
		In	**Out**
Recharge	Infiltration recharge	7.6	0
River leakage	Groundwater interaction w/ watercourses and springs (leakage/baseflow)	35.1	13.6
Evapotranspiration	Evapo-transpiration from water table	0	32.8
Head dep bounds	Regional groundwater flow	26.4	16.2
Drains	Inflow to BNM	0	0.6
Storage	Groundwater storage	6.9	12.8
Total (ML/d)		**76**	**76**

9.10.3.2 Simulated (posterior) parameters

This section presents a summary of resultant modelled parameters at the end of the PESTPP-IES history matching process, i.e. the ‘posterior’ parameters:

- Modelled hydraulic conductivity parameters are displayed in Figure 9.73.
- Modelled storage parameters are displayed in Figure 9.74.
- Modelled recharge and drain conductance are displayed in Figure 9.75.

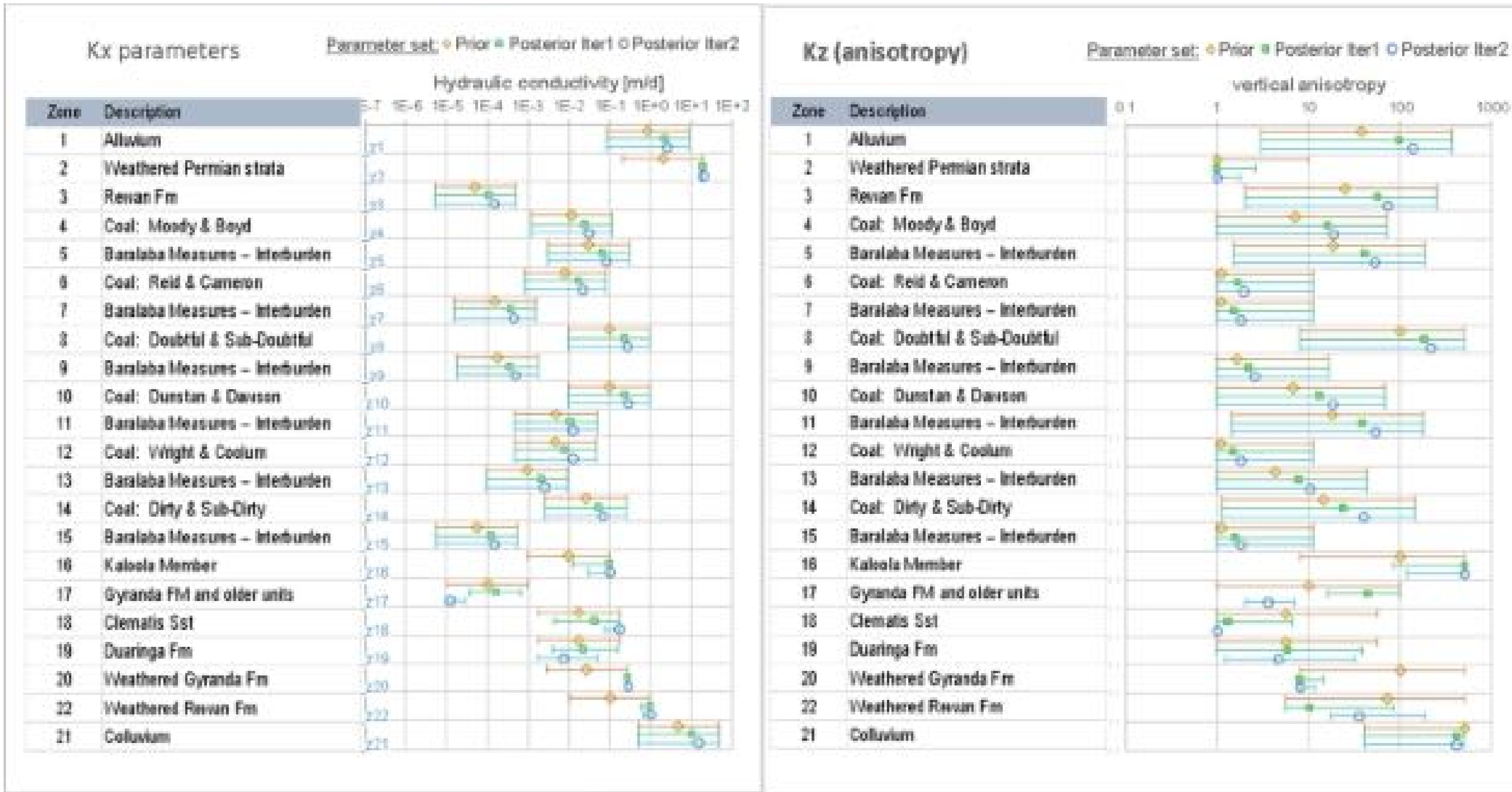

Figure 9.73: Modelled hydraulic conductivity parameters

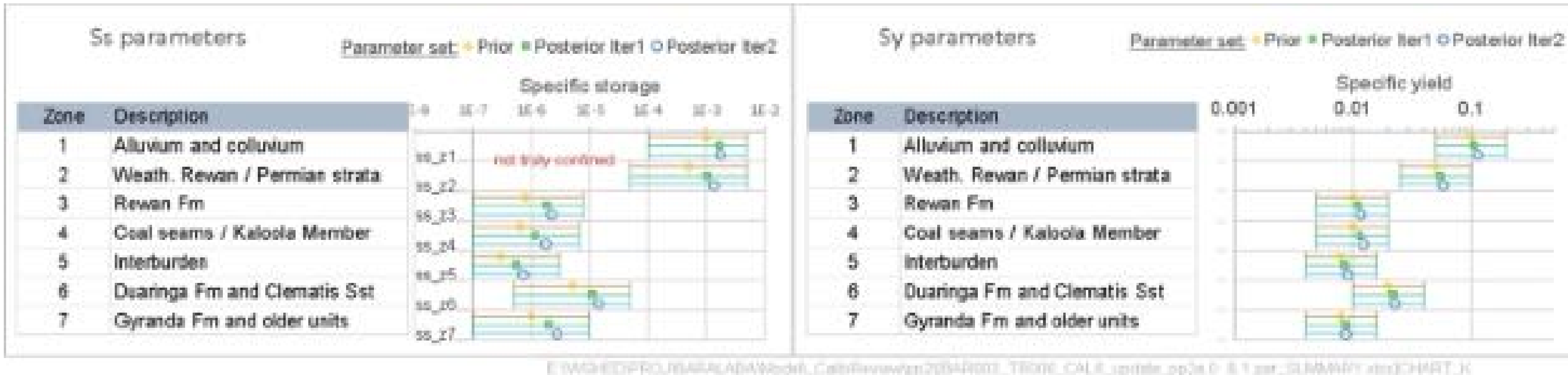

Figure 9.74: Modelled storage parameters

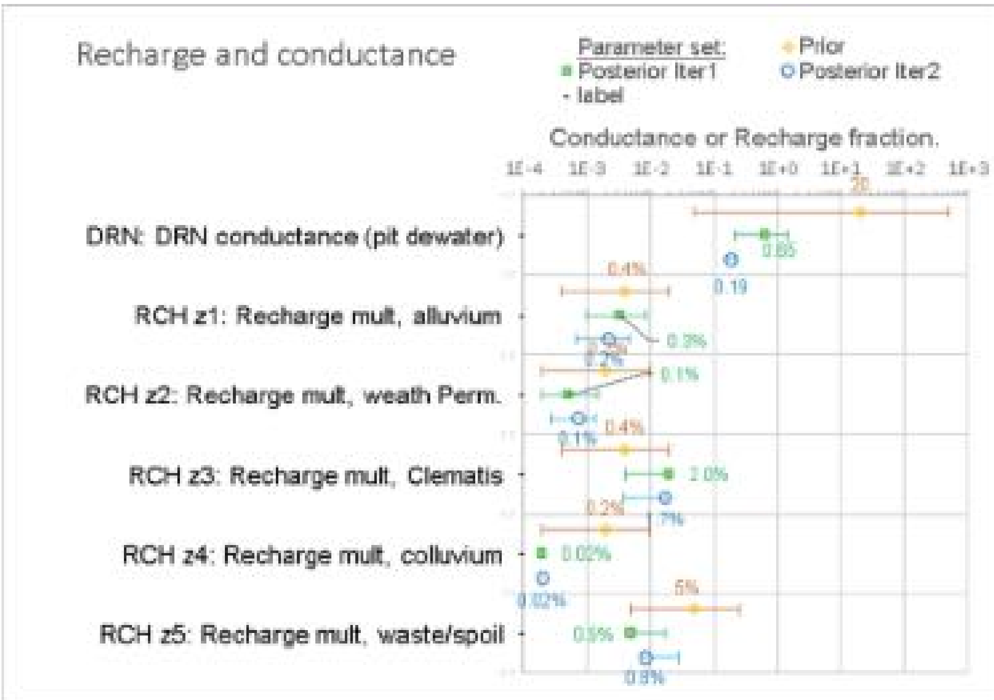

Figure 9.75: Modelled recharge and drain conductance

9.10.3.3 Climate change sensitivity

The potential impacts of climate change on the groundwater model outcomes were assessed using data on annual rainfall and evaporation in the Project area from the 'Climate Change in Australia (CCiA) Model East Coast Climate Futures Projections' (2017). Impacts associated under the predicted climate in 2030 and 2090 have been selected to represent the median year of the Project and longer-term projections, respectively.

Interpretation of these results is that there is more likely to be:

- a slight increase in annual rainfall, probably in the range 5-15%, but closer to 5%; and
- a slight increase in potential evaporation, probably in the range of 1-5%, but closer to 5%.

The more likely changes in rainfall (approximately 7%) are predicted to result in changes in rainfall recharge in the order of 20% in the future. However, some rainfall projections indicate that higher rainfall would be derived from larger, more frequent high rainfall events, which could lead to more runoff and lower recharge. As such, the approach taken for this assessment has been to conduct a transient simulation for the prediction period perturbing rainfall recharge by -20% and +20% to represent postulated climate change scenarios, noting that in the short-term, climate variability, rather than climate change, will govern whether rainfall is similar to the long-term average or not. Potential evaporation from groundwater was not modified.

Further details regarding climate change assessment methodology and model inputs are outlined in Appendix B, Groundwater Modelling and Assessment.

9.10.3.4 Model limitations/uncertainty minimisation

There are four sources of scientific uncertainty affecting groundwater model simulations:

1) Structural/Conceptual - geological structure and hydrogeological conceptualisation assumptions applied to derive a simplified view of a complex hydrogeological reality (any system aspect that cannot be changed in an automated way in a model).
2) Parameterisation - hydrogeological property values and assumptions applied to represent complex reality in space and time (any system aspect that can be changed in an automated way in a model via parameterisation).
3) Measurement Error - combination of uncertainties associated with the measurement of complex system states (heads, discharges), parameters and variability (3D spatial and temporal) with those induced by upscaling or downscaling (site-specific data, climate data).
4) Scenario Uncertainties - guessing future stresses, dynamics and boundary condition changes (e.g. mining, climate variability, land and water use change).

Each of the above has been considered during the development of the Project numerical model and the qualitative uncertainties are described in Appendix B, Groundwater Modelling and Assessment.

It is also noted that the overall target model confidence level classification for the Project numerical groundwater model is Class 2, and has been largely achieved and exceeded for several key criteria (based on the criteria in Barnett *et al.*, 2012), most notably (sections 6.2.1 and 6.15):

- groundwater head observations and bore logs are available and with a reasonable spatial coverage around the Project area and regionally;
- aquifer-testing data is available to define key parameters;
- calibration statistics (average residual, mass balance closure error) are acceptable and is calibrated to heads; and
- the length of the forward predictive model is not excessive compared to length of the mining simulated within the transient calibration period (from 2005 to 2023).

While there is a reasonable amount of groundwater level and pressure data for the Project area, being a ‘new’ mining area where groundwater systems are of limited potential, the area is naturally limited by a lack of flow/flux (i.e. mine inflow and stream baseflow) data, to calibrate against, primarily as: (1) no mining has occurred to date within MLA 700057; and (2) with the exception of the Dawson River, other drainage features are ephemeral.

9.10.4. Potential impacts

9.10.4.1 Predicted groundwater inflows

Groundwater inflows to the Project open cut mining operations have been extracted from the predictive model. The model predicted groundwater take/inflows estimates, presented as a daily average for an average annual period, for the Project are presented in Figure 9.76. The total inflow is presented with and without the inclusion of the inflow at cross passages, and is summarised as the 5th, 50th and 95th percentile estimates from the model ensemble.

It is noted that the predicted groundwater inflow estimates include any moisture in ROM coal, and are before evaporative losses from pit floor or walls. Estimates do not account for direct rainfall or surface water ingress.

The model ensemble predicts groundwater inflows to range up to 1.5 ML/day (peaking in Year 23), with an average of 0.3 (5th percentile) to 0.75 ML/day (95th percentile) for the operational life of the mine. The predicted total volume of the Project open cut inflow is 2,250 to 6,900 ML for the proposed life of the mine (median estimate 3,700 ML).

The effects of the climate change are uncertain, as briefly described in section 9.10.3.3. Based on the two climate change groundwater model scenarios for the Project, groundwater take/inflow estimates could vary as follows (from the base realisation):

- -20% rainfall recharge: average take/inflows reduced to a range of 0.25 ML/day to 0.7 ML/day (median estimate of 0.4 ML/day), being -5% to essentially no change; and
- +20% rainfall recharge: average take/inflows increased to a range of 0.35 ML/day to 0.8 ML/day (median estimate of 0.4 ML/day), again representing a relatively small change.

The small changes are likely related to the low rainfall recharge in this area. Literature indicates that shallow aquifers and surface water system are more sensitive to climate change, rather than 'deep' aquifer systems.

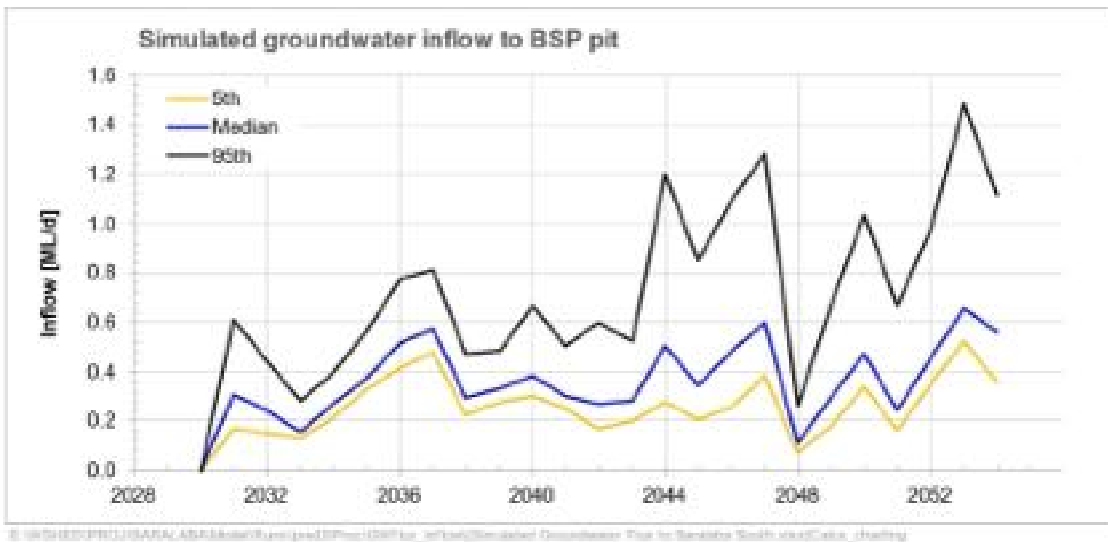

Figure 9.76: Estimated groundwater inflow to the Project

9.10.4.2 Associated water take

This section summaries the estimates of 'take' or groundwater captured or lost from the hydrogeological system. Table 9.52 presents indicative ranges for associated water take derived from model-predicted groundwater inflow.

Table 9.52: Associated water take (ML/year)

Water Source/Management Zone	Estimated Take^ (ML/yr)	
	Median	Upper
Groundwater: un-declared area within the Water Plan (Fitzroy Basin) 2011.		
Year 1	115	224
Year 2	97	164
Year 3	59	103
Year 4	99	146
Year 5	143	204
Year 6	192	283
Year 7	215	296
Year 8	108	171
Year 9	124	176
Year 10	150	244
Year 11	114	183
Year 12	103	220
Year 13	109	191
Year 14	180	438
Year 15	140	311
Year 16	180	402
Year 17	244	468
Year 18	47	96
Year 19	114	249
Year 20	195	379
Year 21	95	245
Year 22	175	359
Year 23	273	541

9.10.4.3 Predicted groundwater drawdown

The potential impact of the Project activities on groundwater drawdown have been extracted from the numerical groundwater model runs and hydrographs of drawdown through time have been prepared. The maximum drawdown predicted in every model cell in a number of selected 'stratigraphic' layers, as well as the drawdown in the simulated water table has been calculated during construction (2024-2030), and in the long-term for the following stratigraphic units or layers:

- the lower coal measures and Permian strata (model layer 16); and
- the water table (calculated here as the modelled water level in the uppermost saturated model layer, i.e. uppermost saturated or partially saturated stratigraphic unit).

The maximum modelled drawdown predicted to occur between 2030 and 2054 is presented in Figure 9.77 and Figure 9.78; the latter for the water table. The median or 50th percentile estimate of the maximum drawdown from the ensemble is the focus on these maps, but the key drawdown contours from the 95th percentile ('realistic worst-case') are also shown to illustrate uncertainty in the predictions. For the water table drawdown, the 5th percentile estimate ('realistic best case') is also shown.

Figure 9.77 shows the relatively extensive cone of depression in the Permian strata. The cone of depression is large because of the high hydraulic conductivity, the lack of direct rainfall or river recharge, and the confined nature of the coal measures. This outcome is not considered a problem because it does not manifest as measurable drawdown in the water table (where the environmental values are), and because there are so few anthropogenic bore users in the coal measures. However, it is shown on Figure 9.77 that the contours do intersect the location of the Ross Bore to the east of the Project.

The water table drawdown (Figure 9.78) is focused on the Project open cut, and it can be seen that the 1 m contour of the cone of depression is essentially contained within the northern and eastern boundaries of the MLA, and extends beyond the MLA boundary to the west (by up to 800 m [50th percentile] to 1,200 m [95th percentile]), and extends further to the south (by 3.5-4.5 km) along the strike of the coal seams. The 5th percentile estimate of drawdown is almost completely contained within the MLA boundary.

To the west, the cone of depression in the water table is mitigated by the presence of the higher permeability and porosity alluvium and the presence of the watercourses.

In order to understand the potential drawdown within the alluvial and colluvial deposits around the Project, Figure 9.79 shows the maximum predicted saturated groundwater drawdown in alluvium and colluvium deposits due to the Project, i.e. the 50th percentile maximum drawdown is limited to the inferred saturated thickness of these deposits (model layer 1), based on the inferred groundwater levels.

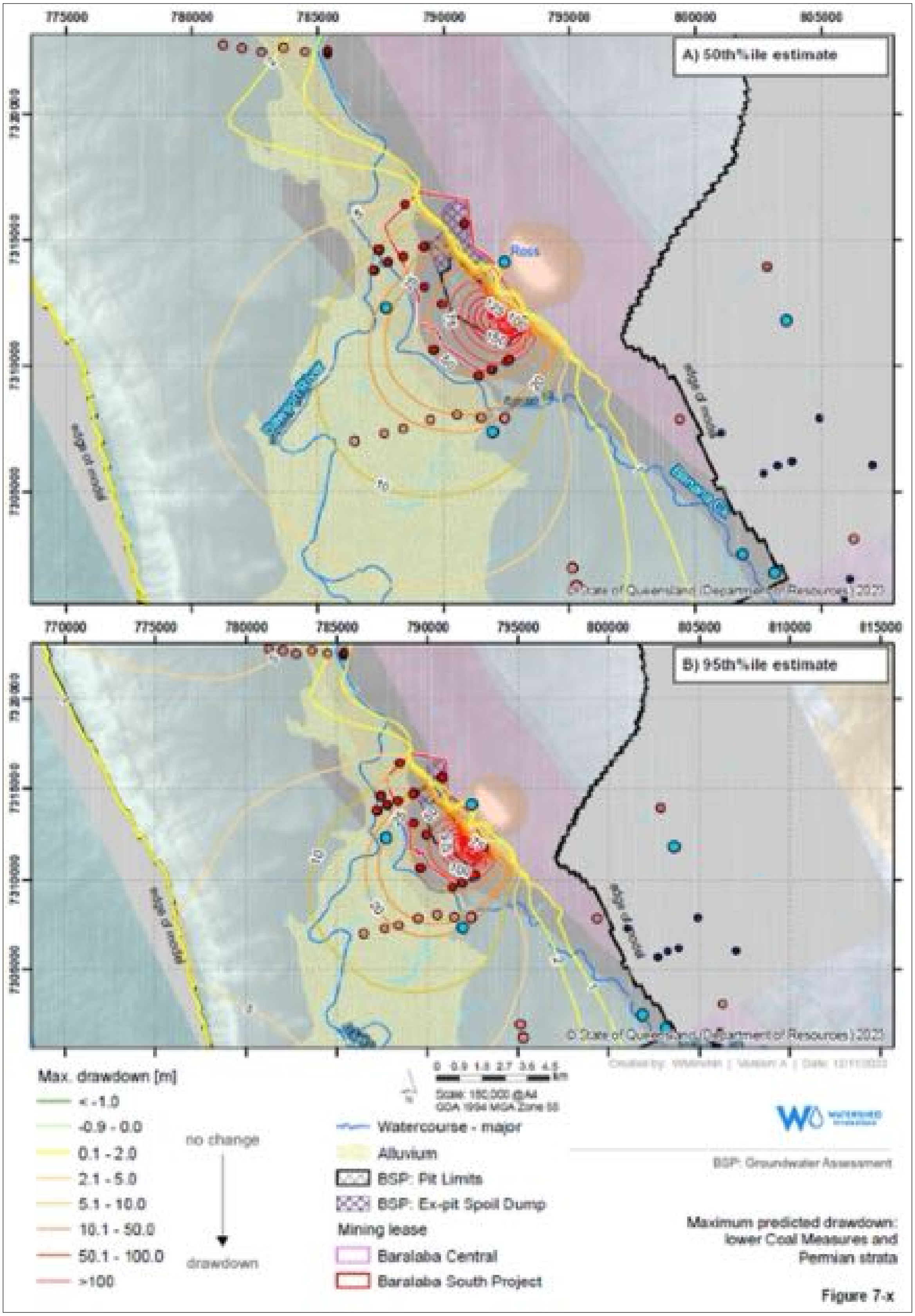

Figure 9.77: Maximum predicted drawdown in Permian strata during mining (2030-2054)

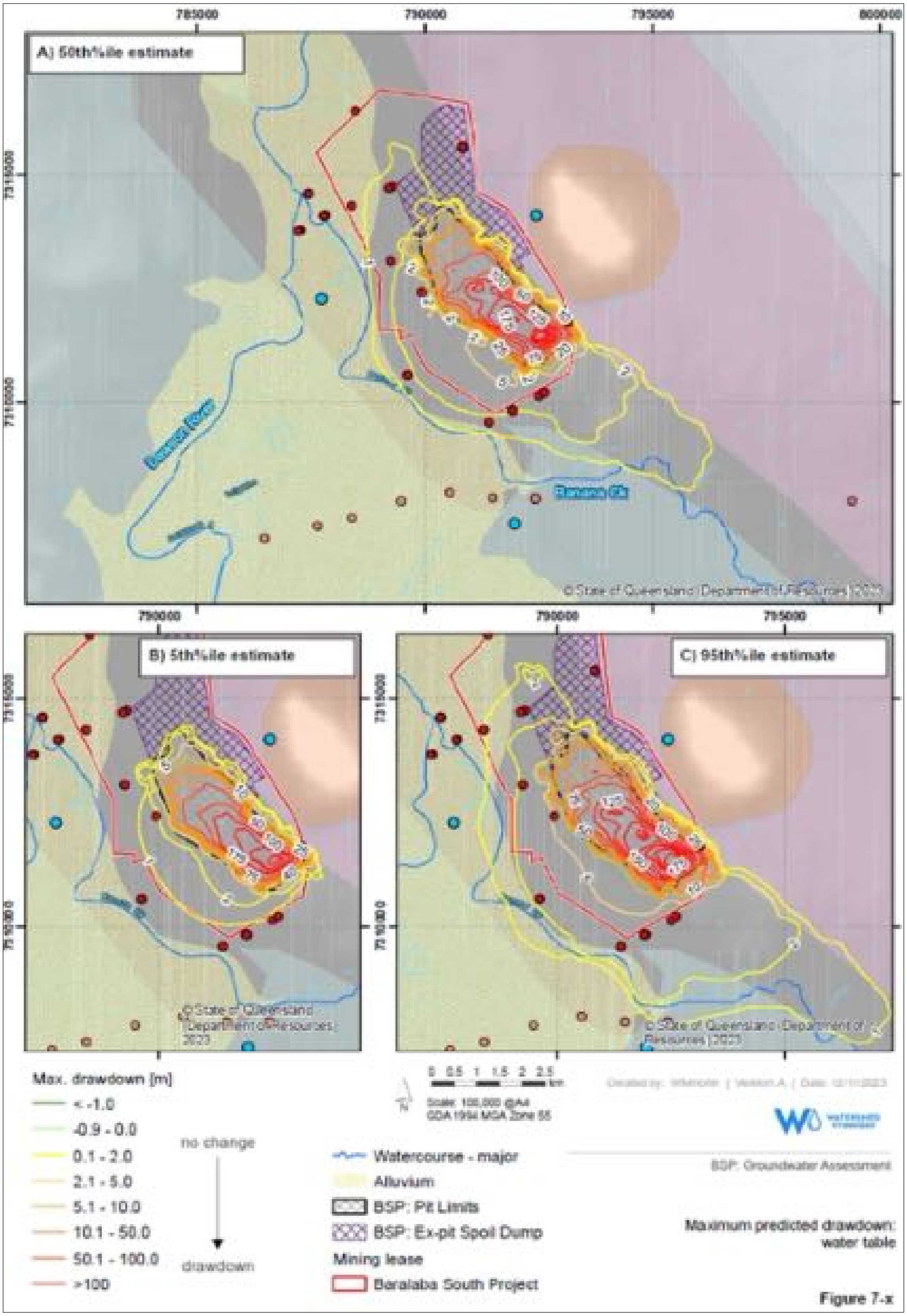

Figure 9.78: Maximum predicted drawdown in the water table during mining (2030-2054)

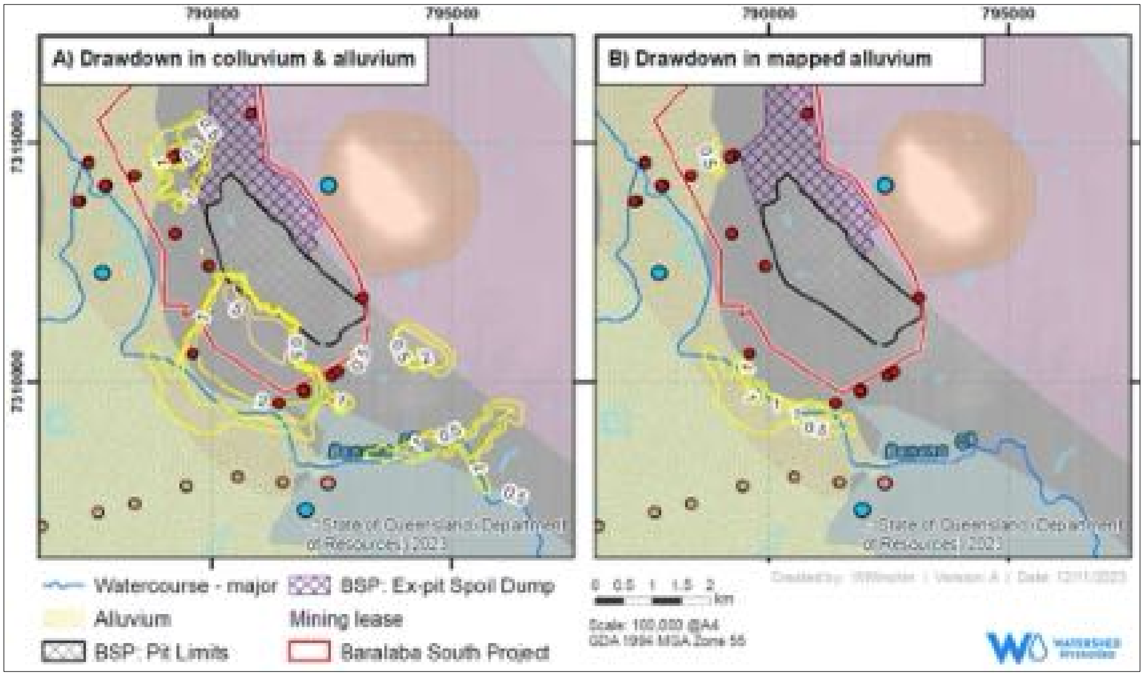

Figure 9.79: Modelled drawdown in surficial deposits

The figure includes the drawdown across all surficial deposits, and restricted to the mapped alluvium only, showing contours down to 0.5 m. Figure 9.79 indicates that there is up to 8 m predicted drawdown within the colluvium just to the west or south-west of the open cut pit, and this cone of depression extends to the west towards Banana Creek. Other small cones of depression are evident to the south-east (near Banana Creek) and north-west of the pit.

Figure 9.79 also shows this drawdown restricted further to the alluvium shown by the Queensland Government mapping. This means that the maximum drawdown is approximately 1 m within this mapped alluvium, mainly around the reach of Banana Creek where it flows on the Dawson River Alluvium (and outside of the MLA boundary), as well as a small cone of depression (also approximately 1 m drawdown) to the north-west of the open cut (within the MLA boundary)

9.10.4.4 Drawdown impacts at private landholder bores

The maximum groundwater drawdown predicted as a result of mining at the Project on the private landholder bores are described in Table 9.53.

The results indicate the Project would have a negligible impact on groundwater levels or groundwater yield at the Riverland and Webb landholder bores. The maximum predicted drawdown of 0.15-0.7 m at the Ross Bore during mining would be similar to natural variation in the recorded groundwater table.

Table 9.53: Predicted maximum drawdown at private landholder bores due to the Project

Bore	Hydrogeological unit	Maximum drawdown during mining	Maximum drawdown after mining	Relative location	Other comments
Ross Bore	Cretaceous Intrusive (Igneous Trachyte)	0.15 (5th %ile) 0.4 (50th %ile) 0.7 (95th %ile)	1.5 (5th %ile) 2.25 (50th %ile) 4.2 (95th %ile)	Located 500 m east of MLA 700057	Bore in use (stock watering)
Riverland 1 & 2	Quaternary Sediments (Alluvium)*	0.01 (5th %ile) 0.11 (50th %ile) 0.13 (95th %ile)	0.02 (5th %ile) 0.15 (50th %ile) 0.17 (95th %ile)	Located 1.5 km west of MLA 700057	Bore(s) not in use
Webb Bore	Triassic and Permian coal measures*	0 (5th %ile) 0 (50th %ile) 0 (95th %ile)	0 (5th %ile) 0 (50th %ile) 0 (95th %ile)	Located 3.5 km south of MLA 700057	Bore not in use

9.10.4.5 Drawdown impacts on groundwater dependent ecosystems

3D Environmental (2023) has assessed the dependence of vegetation in the Project area and surrounds on groundwater through the measurement of leaf water potential, soil moisture potential, stable isotopes and physical observation. The assessment concluded that groundwater dependence within the MLA and adjacent areas associated with the Dawson River floodplain is controlled by small discontinuous lenses of sand that are distributed sporadically throughout the heavy clay soils that otherwise characterise the floodplain sediments (Appendix H, Groundwater Dependent Ecosystems Assessment). The sandy lenses support fresh groundwater resources on a seasonal basis that are perched above and disconnected from the regional groundwater table. Recharge of the sandy lenses occurs during surface water infiltration associated with overbank flow and intense rainfall events.

Groundwater modelling completed for the Baralaba South Project indicates Groundwater drawdown associated with mining void development is not predicted to impact the ecological function of GDEs both inside and outside the MLA which utilise and rely upon the perched seasonal groundwater resources. Drawdown will interact with the saline basal colluvial groundwater system with depressurisation and drainage of the system towards the mining void. There may also be some increased leakage from Banana Creek to the underlying sediments, which Watershed HydroGeo (2023) considers negligible due to a conservative model stimulation based on a fixed head / consistent source of water, noting that Banana Creek flows only irregularly.

Groundwater drawdown will only be propagated beneath Banana Creek during periods when the alluvium or colluvium, is saturated and would only induce leakage of surface flow from this watercourse when the watercourse is flowing, and a saturated connection exists between the alluvial groundwater table and surface water in the creek. In this instance, the impact of drawdown and the induced leakage would likely be negligible in comparison to the rate of groundwater recharge. There will be no interaction between the perched discontinuous sandy lenses which seasonally support vegetation groundwater dependence and the drawdown in the deeper colluvial groundwater unit due to the physical separation of these units, and the lack of hydraulic connection. Because of these factors, there are no identified causal pathways for impact which have capacity to alter GDE function and cause ecological harm.

With implementation of management and monitoring controls, it is considered that the risk to GDE's posed by mine development is insignificant. The assessment of potential impacts to GDEs is addressed in detail within section 9.14 and Appendix H, Groundwater Dependant Ecosystem Assessment.

9.10.4.6 Drawdown impacts on stygofauna

The Project is not predicted to significantly impact stygofauna due to the alluvium largely being unsaturated within the pit extent and the limited groundwater level drawdown predicted in the shallow groundwater systems. Groundwater level drawdown is largely contained within the Permian coal measures, wherein no stygofauna of significance had been recorded during either the 2012 or 2017–2019 sampling programs.

Further assessment of the Project risks to stygofauna are provided in Appendix I, Stygofauna Assessment.

9.10.4.7 Effects of groundwater-surface water interactions

Drawdown effects on the baseflow/leakage for the Dawson River and Banana Creek in the vicinity of the Project have been modelled with results suggesting that two types of watercourses are present in the vicinity of the Project:

1) the Dawson River and its anabranches which are regulated at Neville Hewitt Weir—the relatively permeable alluvium, low recharge rates and high evapotranspiration and impoundment at the weir lead to consistently losing (surface water) river conditions; and
2) Banana Creek (and other minor tributaries of the Dawson River), being ‘losing’ creeks with water flows occurring from the watercourse into the alluvium.

The drawdown effects on the baseflow/leakage at the watercourses and drainage features defined near the Project have been assessed in Appendix B, Groundwater Modelling and Assessment, with the results of the analysis presented in Table 9.54, which includes a comparative analysis of the predicted groundwater-surface water interactions with and without the Project.

While the predicted groundwater drawdown from the Project in the Permian strata would be limited in the shallow groundwater systems, it would incidentally transfer indirectly to some, albeit immeasurable, leakage from the Dawson River (upstream of Neville Hewitt Weir) to the surficial geology by a peak of up to approximately 0.2 ML/day, although more likely 0.16 ML/d, which when compared to the average surface water flows in the Dawson River for the past 5 years (approximately 1,469 ML/day for Beckers - 2018-22) is a 0.01% reduction in flow.

Similarly, the modelled leakage predicted from Banana Creek is considered negligible as it only flows on occasions following rainfall events (while in the model it is conservatively simulated as a fixed head or consistent source of water, which is conservative with respect to river-aquifer interaction, but perhaps not with respect to the potential extent of drawdown).

These small to negligible changes are primarily due to a combination of the relatively low permeability of the Triassic (e.g. the Rewan Formation) and steeply dipping Permian stratigraphy that largely prevents drawdown in the coal measures from propagating up into the shallow groundwater system.

The numerical groundwater model verifies the conceptual model that there is poor connection between the groundwater system and ephemeral drainage features. This is largely due to the 12-15 m depth to groundwater which in turn limits the ability of drawdown to capture any localised baseflows that may occur at or near the invert of the watercourses and drainage features.

Table 9.54: Groundwater predicted baseflow/enhanced leakage

Watercourse reach	Modelled groundwater-surface water flux (average 2030-2054) [ML/d]		Predicted Change due to the Project (Predictive Model Run Minus 'Null' Run)	
	Model without mining (Null)	**Model with BNM and Baralaba South Project**	**Effect During Mining at Baralaba South Project [ML/d]**	
Dawson River (d/s Neville Hewitt Weir) [Zone C]	Mean +3.79 Range +2.48 to +5.22 [consistent Leakage]	Mean +3.80 Range +2.49 to +5.23	0.01 ML/d	Negligible
Dawson River (u/s Neville Hewitt Weir) [Zone D]	Mean +1.94 Range +1.20 to +2.63 [consistent Leakage]	Mean +2.04 Range +1.26 to +2.73	0.06 to 0.1 (average 0.09)	Peak effect of <0.01% of average flow^
Dawson River (Upstream) [Zone E]	Mean +1.41 Range +1.18 to +1.56 [consistent Leakage]	Mean +1.40 Range +1.17 to +1.55	0.01 ML/d	Negligible
Banana Creek*	Mean +0.06 Range +0.01 - +0.11 [consistent Leakage#]	Mean +0.16 Range +0.11 to +0.22	0.1 additional loss#	Negligible as Banana Creek only flows on occasions following rainfall events
			# this is filtered to include only model realisations where Banana Creek is predominantly losing, as per the conceptual model. Modelled loss up to 0.15 ML/d if including realisations where baseflow dominates, but this is not considered likely.	

^ Based on average gauged flow in the Dawson River of 2,371 ML/d (@ Beckers 130322A) [Beckers average for 2018-22 = 1,469 ML/d]).

* Note that a small section of the lower reach of Banana Creek, at the confluence of the Dawson River, is mapped as being within the 'effective upstream limit of Neville Hewitt Weir' which has likely raised the stage in part above the natural levels.

9.10.4.8 Great Artesian Basin impacts

The numerical groundwater model demonstrates that the Project would not cause a change in flow direction of groundwater in the hydrogeological units that constitute the GAB.

Capture of groundwater from the GAB units was assessed using ZoneBudget mass balance functionality and comparing the results from the models run both with and without the Project. The modelled incidental reduction in GAB groundwater resources caused by the Project operation were up to:

- Incremental Project effect: median estimate < 0.1 m^3/day (<0.008 ML/yr) and 95th percentile estimate of 0.4 m^3/day or 0.026 ML/yr.
- Cumulative Baralaba North Mine and Project effects (2030-onward): median estimate 0.2 m^3/day (<0.07 ML/yr) and 95th percentile estimate of 2 m^3/day or 0.76 ML/yr (noting that the peak mining effect of approximately 6 m^3/day is simulated as occurring prior to the commencement of the Project).

Over such a broad model domain, these modelled rates of groundwater capture are minor, and immeasurable, and the model supports the conclusion that there would be effectively no decline in groundwater levels in the hydrogeological units that constitute the GAB as a result of the Project.

9.10.4.9 Groundwater quality

There is not expected to be any measurable change in the quality of groundwater as a consequence of mining, either in Permo-Triassic strata (within which groundwater level drawdown would be largely contained) or in younger units, such as alluvium or colluvium.

Based on the geochemical characterisation of overburden, runoff and potentially enhanced infiltration/recharge across or within the backfill spoil and out-of-pit emplacements are likely to be less saline than the naturally occurring groundwaters associated with the Permo-Triassic sediments in the area, and therefore not considered a risk to local groundwater exceeding the WQOs.

The localised hydraulic sink that will form as mining develops will minimise the potential migration of saline or poorer quality groundwater from within the open cut pit to other areas. Consequently, there will be negligible impacts on groundwater quality in aquifers or surface water quality in downstream waters due to interaction with groundwater (Appendix B, Groundwater Modelling and Assessment).

9.10.4.10 Cumulative impacts

The results of the predictive model run presented in the above sections included the cumulative impacts of the approved Baralaba North Mine. Consistent with the cumulative modelling and assessments conducted for the BNCOP numerical groundwater model (HydroSimulations 2014), the results demonstrate there is unlikely to be any interference between the Project and the Baralaba North Mine operations in the north. Thus, the predicted cumulative drawdown impacts at private landholder bores, springs, wetlands, GDEs and on stygofauna are equivalent to the Project alone.

Further, it is demonstrated that the predicted baseflow impacts/leakage in the Dawson River downstream of the Neville Hewitt Weir (relevant to the Baralaba North Mine) is negligible.

9.10.4.11 Post-mining void recovery

Post-mining groundwater levels

Recognising that there are several factors which effect the final void equilibrium lake levels (including void surface catchment area, varying evaporation rates, rainfall scenarios and potential for inundation due to flooding [i.e. final landforms]), the post-mining equilibrium levels were determined in an integrated manner with Engeny. The groundwater model initially provided modelled stage groundwater inflow estimates to the void (at the end of mining within the Project, and then a further post-mining period). This was done by setting constant head boundary conditions to a range of stage levels to get the modelled long-term inflow in response to these. The resulting stage groundwater inflows are shown in Table 9.55.

Table 9.55: Initial stage groundwater inflows to the final void

Lake stage (mAHD)	Estimated inflow (ML/d)
-150	1.29
-100	0.64
-75	0.64
-50	0.41
-25	0.40
0	0.35
20	0.21

Lake stage (mAHD)	Estimated inflow (ML/d)
30	0.19
40	0.18
50	0.21
60	0.17
70	0.14
80	0.01

Subsequent simulation of the recovery of void lake water levels were based on transient lake recovery levels provided by Engeny (2023). Engeny have indicated that:

- The final equilibrium lake level would be approximately 32 mAHD, likely ranging between 28 and 37.5 mAHD according to variability in rainfall and evaporation; and
- It would take approximately 325 years for this to be achieved (i.e. approximately 2375).

To establish the post-mining equilibrium target groundwater levels in the Project numerical groundwater model the time- variant constant head package was used, with the final void lake stage level target set at 32 mAHD.

The post-mining recovery model was then run and groundwater levels for year 2500 are presented on Figure 9.80. The results of this are summarised as follows:

- In the Project final void, lake water levels are predicted to recover to approximately 40 m below pre-mining standing water levels (based on observed data, this is typically 68-80 mAHD – and the modelling is consistent with this; Figure 9.80) and therefore remain as a sink.
- The continued residual capture of water from the Permian strata means that there remains a residual long-term drawdown. At this equilibrium level the 1 m water table drawdown contours extended 2 km to the north of the pit limit (but effectively within the MLA boundary) and 3 km to the south (south-east) of Project footprint (Figure 9.80).
- There is predicted to be some recovery of groundwater levels at the backfilled (northern end) of the Project, nearest the Dawson River/Banana Creek confluence, yet the relative permeability of those sediments and uncertainty about the infiltration into those means that some drawdown will persist within them.
- Groundwater levels are predicted to rise to approximately 10 m residual drawdown within the limits of the Project pit, and up to 5 m residual drawdown at the northernmost extent of the backfilled pit, when compared to the pre-mine standing groundwater level (Figure 9.80). Recovery is relatively quick (in the order of a decade) due to the likely enhanced recharge rates through the backfill spoil at the northern end of the Project.

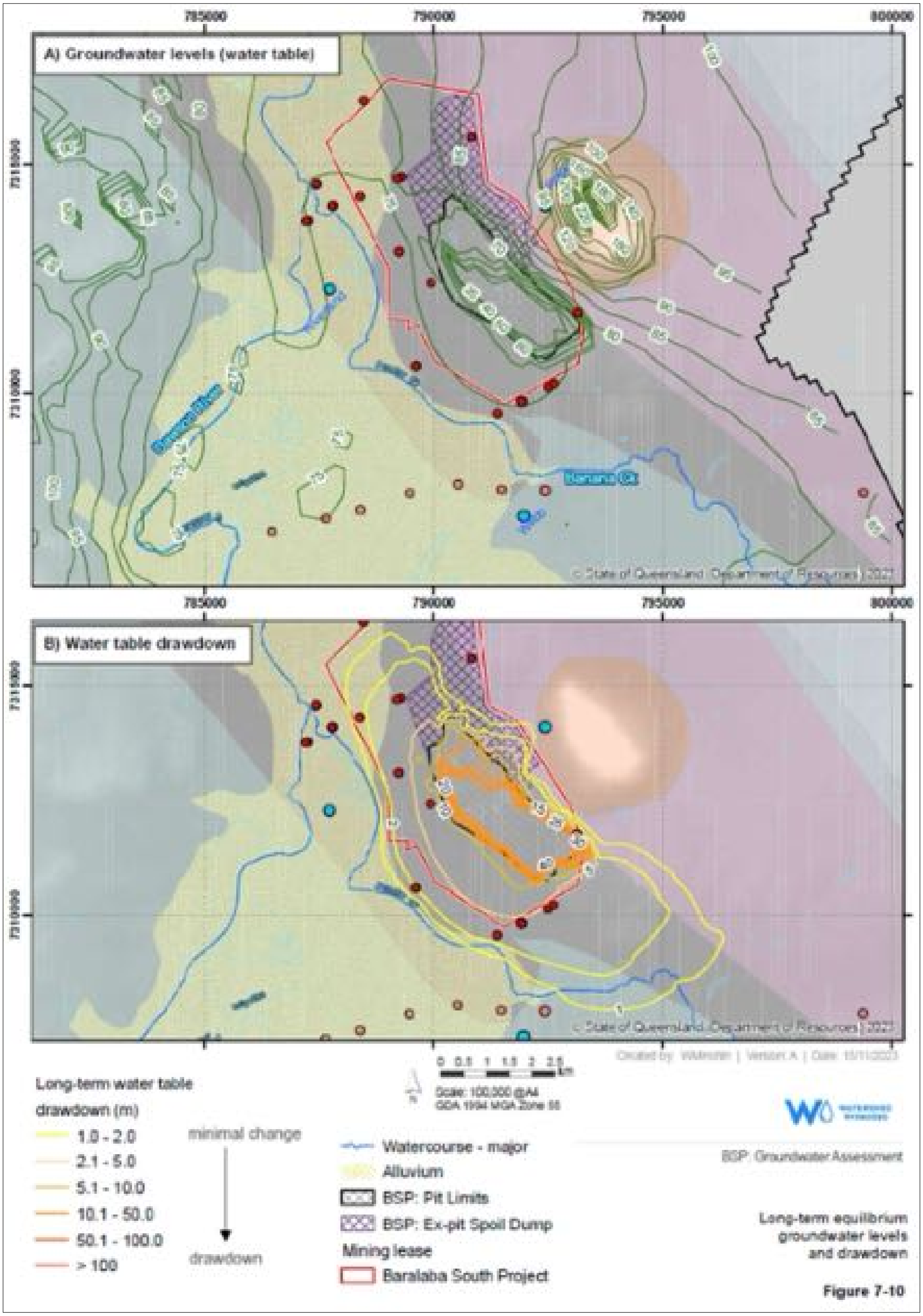

Figure 9.80: Post-mining equilibrium water table elevation and drawdown (2500)

9.10.5. Mitigation, management measures and monitoring

A suite of mitigation, management and monitoring measures will be implemented to ensure the water resource values of ground waters are maintained and the performance objectives outlined in the TOR for the Project are met.

9.10.5.1 Groundwater monitoring program

The existing groundwater monitoring program will continue to be monitored throughout the life of the Project. Exceptions to this will include existing bores within the disturbance footprint (i.e. P-WVWP4 and POB2) where monitoring will be maintained for pre-mining baseline data only. Additional shallow alluvial bores have also been proposed:

- one paired with the existing bore P-OB1;
- one near the HES wetland; and
- one to the south or south-east the Project site near to Banana Creek.

A summary of the proposed monitoring network is provided in Table 9.56.

Sample methodology

Groundwater monitoring will be undertaken by a competent person and will be undertaken in accordance with the latest edition of the administering authorities Water Quality Sampling Manual. Groundwater level monitoring will be undertaken quarterly at the monitoring bores detailed in Table 9.56. Water levels will be measured either manually or through the use of data loggers. Groundwater level samples will be undertaken prior to the collection of groundwater quality samples.

Groundwater quality sampling will be carried out ensuring:

- bores are purged prior to the collection of a representative sample;
- monitoring equipment requiring calibration is calibrated and maintained in accordance with manufacturer's instructions;
- the use of appropriate sample containers which have been provided by the laboratory;
- samples will be labelled clearly with the sample number, site and date sampled;
- all samples will be kept cold and forwarded to the laboratory in a secure and appropriately cooled container;
- samples are to be collected and handled within appropriate holding times for the analysis of concern, this information can be obtained and confirmed from the laboratory responsible for the analysis of samples;
- water samples will be analysed by a NATA accredited laboratory for analysis;
- all sample batches to be sent to a NATA accredited laboratory are to be accompanied by a chain of custody form; and
- trip blanks (analyte-free solutions) and triplicate samples are collected and analysed for quality assurance purposes.

Groundwater quality monitoring will continue to be undertaken on a quarterly basis, as outlined in Table 9.56. Each quarterly event will include sampling and field analysis of EC and pH. Water samples will also be collected and submitted to a NATA accredited laboratory annually for analysis of:

- physio-chemical indicators (pH, EC and TDS); and

- major ions (calcium, fluoride, magnesium, potassium, sodium, chloride, sulphate);

Groundwater monitoring will be undertaken by a competent person and will be undertaken in accordance with the latest edition of the administering authorities Water Quality Sampling Manual. Groundwater level monitoring will be undertaken quarterly at the monitoring bores detailed in Table 9.56. Water levels will be measured either manually or through the use of data loggers. Groundwater level samples will be undertaken prior to the collection of groundwater quality samples.

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- monitoring equipment requiring calibration is calibrated and maintained in accordance with manufacturer's instructions;
- the use of appropriate sample containers which have been provided by the laboratory;
- samples will be labelled clearly with the sample number, site and date sampled;
- all samples will be kept cold and forwarded to the laboratory in a secure and appropriately cooled container;
- samples are to be collected and handled within appropriate holding times for the analysis of concern, this information can be obtained and confirmed from the laboratory responsible for the analysis of samples;
- water samples will be analysed by a NATA accredited laboratory for analysis;
- all sample batches to be sent to a NATA accredited laboratory are to be accompanied by a chain of custody form; and
- trip blanks (analyte-free solutions) and triplicate samples are collected and analysed for quality assurance purposes.

Groundwater quality monitoring will continue to be undertaken on a quarterly basis, as outlined in Table 9.56. Each quarterly event will include sampling and field analysis of EC and pH. Water samples will also be collected and submitted to a NATA accredited laboratory annually for analysis of:

- physio-chemical indicators (pH, EC and TDS); and
- major ions (calcium, fluoride, magnesium, potassium, sodium, chloride, sulphate);

Bore construction, maintenance and decommissioning

The drilling and installation of additional groundwater bores will be undertaken by a licensed contractor. Bores will be cased and constructed to prevent any hydraulic connection between various strata through the bore annulus. Maintenance of bores will be undertaken as soon as practicable where corrective actions will be dependent on the identified issue and cause. If the issue cannot be corrected in situ, the bore will either be re- drilled and re-installed in the same location (over drill the existing bore and install a new bore) or a new bore will be installed adjacent the faulty bore as a replacement.

At the cessation of groundwater monitoring for the mine the bores will be retained subject to a landholder agreement or decommissioned. Decommissioning activities will be undertaken in accordance with standard industry practices at the time of decommissioning, ensuring that no cavity remains and that there is no bore connection between various strata.

Groundwater triggers

Preliminary groundwater quality and drawdown triggers have been developed for the Project and are included in Chapter 19, Proposed Environmental Authority Conditions. These triggers will be revised prior to commencing operations, after collecting additional baseline groundwater quality and level data.

Drawdown triggers were developed with reference to the Water Act and IESC Information Guidelines Explanatory Note: Uncertainty analysis—Guidance for groundwater modelling within a risk management framework (Middlemis and Peeters, 2018), using the following criteria:

- Default drawdown limits from the Water Act of 2 m for unconsolidated aquifers and 5 m for consolidated aquifers were applied as a baseline, and adopted for bores where modelling predicted a drawdown of less than this default values.
- Drawdown triggers are based on the difference between the predicted water level without the Project (zero drawdown) and the minimum (lowest) predicted water level at any time during the life of the Project.
- Where modelling predicted a drawdown greater than the default triggers, and with negligible impact on landholder bores, groundwater level drawdown trigger values were assigned equal to the maximum 90th percentile model drawdown prediction at each bore over the life of the Project as derived from the model uncertainty analysis.

For groundwater quality, trigger levels were developed using the following approach:

- The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) guideline values for 95% species protection were applied where suitable.
- When the ANZG (2018) guideline values were not suitable, the WQO values from groundwater chemistry zone 34 (WQ 1310 Fitzroy Basin) were applied.
- When both ANZG (2018) guideline values and WQO values from groundwater chemistry zone 34 were unsuitable, triggers were derived by grouping the bores and using the 80th percentile of the combined bores.
- If the value determined using the grouping of bores was also not suitable, and if the bore had at least eight observations that did not exhibit a statistically significant increasing trend, then bore-specific interim limits are proposed.

Monitoring program review

A comparative analysis of the results from the groundwater monitoring program and groundwater quality triggers will be undertaken as soon as practicable upon receipt of the groundwater monitoring results. Groundwater quality trigger levels will be reviewed in line with the Department of Science, Information Technology and Innovation (DSITI) guideline, 'Using monitoring data to assess groundwater quality and potential environmental impacts' (DSITI, 2017). Consistent with the DSITI (2017) guidelines, the triggers will be established in consideration of the Water Plan (Fitzroy Basin) 2011 WQOs, ANZECC (2000[2018]) criteria and site-specific conditions. Trigger criteria will be established for each groundwater unit potentially impacted by the Project, being alluvium and the Permian coal measures.

Table 9.56: Proposed bore monitoring network

Bore ID	Easting	Northing	Ground level (mAHD)	Screened interval (mbgl)	Stratigraphy	Water level monitoring	Water quality	Purpose
A-PB1	787806	7314088	88.4	11.5–23.5	Alluvium	Q†	—	Monitor change in water levels and quality in alluvium for early detection of potential impacts from site activities beyond those predicted, and monitor interaction between alluvium and coal measures
A-PB2	791931	7309808	91.5	11.5–23.5	Alluvium	Q†	—	
A-OB1	787440	7314586	88.9	10–22	Alluvium	D	Q/A	
A-OB2	787802	7314105	88.3	11.5–17.5	Alluvium	D	Q/A	
A-OB3	788393	7314309	87.9	12–30	Alluvium	Q	Q/A	
A-OB4*	789290	7314733	87.5	8–17	Alluvium	Q*	—	
A-OB6	791402	7309557	91.4	9–18	Alluvium	D	Q/A	
A-OB7	791935	7309829	91.7	11–26	Alluvium	D	Q/A	
A-OB8	792501	7310136	91.4	10–22	Alluvium	D	Q/A	
A-OB10*	789247	7313094	87.5	8–20	Alluvium	D*	—	
A-OB11	787270	7313771	86.2	9–15	Alluvium	D	Q/A	Determine background information on groundwater trends in alluvium at the Dawson River
A-OB12	787220	7313767	87.2	9.6–15.6	Alluvium	D	Q/A	
P-PB1	787805	7314101	88.3	38	BG (interburden)	Q	Q/A	Monitor change in water levels and quality in coal measures for early detection of potential impacts from site activities beyond those predicted
P-OB1	788477	7316388	87.4	105	BG (coal seam)	Q	Q/A	
P-OB2	793140	7311758	105.3	147	BG (interburden)	Q	Q/A	
P-OB3*	789939	7312422	89.6	29	BG (interburden)	Q*	—	

Bore ID	Easting	Northing	Ground level (mAHD)	Screened interval (mbgl)	Stratigraphy	Water level monitoring	Water quality	Purpose
P-OB4*	789205	7314695	87.1	76	BG (coal seam)	Q*	—	
P-OB5	792626	7310218	91.4	184	BG (coal seam)	Q	Q/A	
P-VWP1	787442	7314568	89.0	38	Interburden	D	—	Monitor depressurisation of Permian Baralaba Coal Measures and Rewan Formation in response to mining to verify against predicted changes
				105	Interburden	D	—	
				147	Interburden	D	—	
P-VWP2	787789	7314089	88.51	29	Overburden	D	—	
				76	Rewan Formation	D	—	
				184	Interburden	D	—	
				234	Interburden	D	—	
P-VWP3	791922	7309816	91.6	55	Interburden	D	—	
				121	Interburden	D	—	
				155	Interburden	D	—	
				175	Interburden	D	—	
P-VWP4	790829	7315606	101.0	25	Interburden	D	—	
				80	Interburden	D	—	
				150	Interburden	D	—	
				200	Interburden	D	—	

Bore ID	Easting	Northing	Ground level (mAHD)	Screened interval (mbgl)	Stratigraphy	Water level monitoring	Water quality	Purpose
P-VWP5	789621	7310598	90.4	66	Interburden	D	—	
				138	Interburden	D	—	
				185	Interburden	D	—	
Proposed A1	788477	7316388	87.4	~15	Alluvium	Q	Q/A	Paired bore with P-OB1 and between the Dawson River and out-of-pit waste rock dump Monitor change in water levels and quality for early detection of potential impacts from site activities beyond those predicted
Proposed A2	789319	7312065	TBC	~15	Alluvium	Q	Q/A	Baseline data on alluvium near HES wetland and proposed out-of-pit waste rock embankment Monitor change in water levels and quality for early detection of potential impacts from site activities beyond those predicted
Proposed A3	794800	7309250	~94	~5-20	Alluvium	D	-	Alluvium bore to monito baseline and change in water levels for detection of effects from Project activities.
Proposed A4	793100	310622	~100	TBC	Permian coal measures	D	-	Drilled to 200 m depth to understand geology (faulting) and permeability (via packer testing). Monitoring bore to be installed to depth based on this testing/analysis.

Note: Coordinates in MGA94 Zone 55
* within disturbance footprint, to monitor for baseline data only, no triggers to be applied
D: Daily – bore equipped with level logger/VWP
Q/A: Quarterly field water quality and annual full suite of water quality

BG: Blackwater Group
† - Near other existing bores therefore water level monitoring proposed only
Q: Quarterly

9.10.5.2 Groundwater pit inflow monitoring program

Groundwater pit inflow will be monitored during the open cut mining operational phase. The partition of groundwater inflow/seepage rates will be estimated through annual review of the following:

- pit dewatering/pumping records;
- the operational site water balance model;
- catchment (rainfall runoff);
- coal moisture; and
- evaporation considerations to partition groundwater inflow/seepage rates.

Any observations of unexpected or significantly increased groundwater inflows directly to the open cut pit will be recorded and monitored during the operation of the Project.

9.10.5.3 Private landholder bores

Periodic (e.g. seasonal/quarterly, or less frequently if otherwise agreed) water level monitoring will be conducted at private landholder bores in the vicinity of the Project during the operational life of the mine to validate predictions of no significant impact.

Mitigation measures will be implemented in the unlikely event that monitoring and/or subsequent investigation from monitoring confirms that drawdown impacts on an existing groundwater supply user are due to the Project.

If required, make-good measures may include the following measures:

- deepening the affected groundwater supply bore; or
- constructing a new groundwater supply bore; or
- providing a new alternative water supply source, provided that any such attributed impacts are demonstrated to be due to mining at the Project and not due to natural variations, such as rainfall deficit or other factors.

The Proponent will ensure that as a minimum the proposed mitigation measures are acceptable to the affected groundwater user.

9.10.5.4 Groundwater model validation

An ‘annual monitoring report’, consistent with contemporary EA reporting requirements for relevant groundwater datasets, will be prepared and submitted each year to the Queensland Government for the annual return period.

The numerical groundwater model will be reviewed and, if necessary, updated in accordance with the guideline ‘Underground Water Impact Reports and Final Reports’ (DES, 2017). Any details of verification of the numerical groundwater model predictions or updates to the numerical groundwater model (e.g. recalibration, additional sensitivity analysis or revised forward predictions) will be accounted for in these reports.

9.10.5.5 Annual review

An annual review of the Water Management Plan will be undertaken. The annual review will consider the results of groundwater monitoring and management measures and the development of mining activities. The review will assess the change in groundwater quality over time compared to historical trends and impact assessment predictions. The Water Management Plan will be updated pending the outcomes of the review or updates/changes in legislative requirements.

9.10.6. Significant impact assessment

This section assesses whether the impacts on a water resource from the Project are likely to be significant according to the 'Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources' (DCCEEW, 2022). The significant impact criteria provide guidance on when a significant impact to the hydrological characteristics of a water resource may occur, and is described in further detail in section 9.8.6.

Assessment of Project impacts, according to guidance provided by the significant impact criteria (DCCEEW, 2022) is presented in sections 9.8.16.1 and 9.8.16.2.

9.10.6.1 Potential impacts to hydrological characteristics

Assessment of the Project impacts according to guidance provided by the significant impact criteria (DCCEEW, 2022), to aquifers is provided in Table 9.57.

Table 9.57: Significant impact on changes to hydrological characteristics

Significance criteria	Assessment of significance
A significant impact on the hydrological characteristics of a water resource may occur where there are, as a result of the action:	
changes in the water quantity, including the timing of variations in water quantity	Inflows to the open cut mine will result in drawdown of groundwater resources. Groundwater user are limited, due to quality, with minor impacts to one bore identified (0.15-0.7m drawdown). The Project numerical groundwater model demonstrates that the Project would not cause a change in level or flow direction of groundwater in the hydrogeological units that constitute the GAB. Changes in the quantity of local groundwater availability are not expected to be significant.
changes in the integrity of hydrological or hydrogeological connections, including structural damage (for example, large scale subsidence), or	While the predicted groundwater drawdown due to the Project in the Permian strata would be limited in the shallow groundwater systems, it would incidentally transfer indirectly to some, albeit immeasurable, leakage from the Dawson River to the surficial geology by a peak of up to approximately 0.2 ML/day, although more likely 0.16 ML/day, which when compared to the average surface water flows in the Dawson River for the past 5 years (approximately 1,469 ML/d for Beckers - 2018-22) is a 0.01% reduction in flow. Similarly, the modelled leakage predicted from Banana Creek is considered negligible as it only flows on occasions following rainfall events (while in the model it is conservatively simulated as a fixed head or consistent source of water, which is conservative with respect to river-aquifer interaction, but perhaps not with respect to the potential extent of drawdown). No significant drawdown effects that would cause a reduction in water availability are predicted at the HES wetland. Significant changes to hydrological and hydrogeological connections throughout the Project area of influence are considered unlikely to occur.
changes in the area or extent of a water resource.	The predicted lateral extent of groundwater drawdown and recovery is presented in section 9.10.4.3. Significant changes in the area or extent of the groundwater resources are considered unlikely to occur.

Significance criteria	Assessment of significance
Conclusion	The predicted changes to groundwater quantity, extent of impacts to groundwater resources and hydrogeological connections indicate the Project is unlikely to have a significant impact on hydrogeological values.

9.10.6.2 Potential impacts to water quality

Assessment of the Project impacts to local and regional groundwater quality according to guidance provided by the significant impact criteria is shown in Table 9.58.

Table 9.58: Assessment of significant impacts on changes to groundwater quality

Significance criteria	Assessment of significance
A significant impact on a water resource may occur where, as a result of the action:	
there is a risk that the ability to achieve relevant local or regional WQOs would be materially compromised, and as a result the action: • creates risks to human or animal health or to the condition of the natural environment as a result of the change in water quality; • substantially reduces the amount of water available for human consumptive uses or for other uses, including environmental uses, which are dependent on water of the appropriate quality; • causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment; • seriously affects the habitat or lifecycle of a native species dependent on a water resource; or • causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource.	The groundwater drawdown associated with mining void development is not predicted to impact the ecological function of any GDEs that utilise and rely on the perched seasonal groundwater resources as there is no hydraulic connectivity between the sandy lenses and the regional groundwater table (including potentiometric surfaces of the alluvial aquifer and the Permian coal measures) which will be directly impacted by mining, there is low hydraulic connectivity between the sandy lenses, and there is no causal pathway identified which will affect the recharge of perched aquifer systems, which is controlled by surface flows and surface water infiltration. The Project is not predicted to significantly impact stygofauna due to the alluvium largely being unsaturated within the pit extent and the limited groundwater level drawdown predicted in the shallow groundwater systems. The Project would have a negligible impact on groundwater levels or groundwater yield at the Riverland and Webb landholder bores. The maximum predicted drawdown of 0.15-0.7 m at the Ross Bore during mining would be similar to natural variation in the recorded groundwater table. There is not expected to be any measurable change in the quality of groundwater as a consequence of mining, either in Permo-Triassic strata (within which groundwater level drawdown would be largely contained) or in younger units, such as alluvium or colluvium. The Project is therefore unlikely to materially compromise local or regional groundwater quality objective.

Significance criteria	Assessment of significance
there is a significant worsening of local water quality (where current local water quality is superior to local or regional WQOs); or	Based on the geochemical characterisation of overburden, runoff and potentially enhanced infiltration/recharge across or within the backfill spoil and out-of-pit emplacements are likely to be less saline than the naturally occurring groundwaters associated with the Permo-Triassic sediments in the area, and therefore not considered a risk to local groundwater. The localised hydraulic sink that will form as mining develops will minimise the potential migration of saline or poorer quality groundwater from within the open cut pit to other areas. Consequently, there will be negligible impacts on groundwater quality in aquifers or surface water quality in downstream waters due to interaction with groundwater. A significant worsening of local groundwater quality is unlikely to occur as a result of the proposed Project.
high quality water is released into an ecosystem which is adapted to a lower quality of water.	No high quality water will be released into an ecosystem which is adapted to a lower quality of water.
Conclusion	The predicted groundwater quality unlikely to be significantly impacted by the Project

9.11 Terrestrial ecology

To describe the biodiversity and natural environmental values of the Project, an assessment of terrestrial ecology values for the Project area was undertaken by Ecological Survey & Management (Appendix F, Terrestrial Ecology Assessment). The objectives of Appendix F, Terrestrial Ecology Assessment, were to assess the potential impacts of the Project on terrestrial ecology values of the Project area and surrounding areas, including on MNES.

As the Project was determined to be a controlled action in October 2012 (EPBC Referral 2012/6547) subsequent ‘listing events’, such as the new listing of a species or ecological community under the EPBC Act are not required to be assessed. As such, only those species listed as threatened (Endangered or Vulnerable) under the EPBC Act at the time of declaration of the controlled action decision are considered in the assessment of MNES. Where the EPBC listing status of a species listed at the time the declaration was made has changed, the most current listing status is presented.

9.11.1. Methodology

9.11.1.1 Study area

The terrestrial ecology study area for the Project comprises:

- the Project site (MLA 700057);
- the water release/extraction infrastructure and water pump station areas;
- the realignment area of the Moura-Baralaba Road;
- the proposed ETL (incorporating two ETL alignment options) (herein referred to as the ETL study area); and
- an additional investigation area (incorporating the vegetation adjacent to the Project area).

The terrestrial ecology study area is shown in Figure 9.81. The third-party infrastructure will be subject to separate permitting processes and may be subject to change.

9.11.1.2 Desktop assessment

A desktop assessment was undertaken to identify and present the ecological values mapped in the terrestrial ecology study area. The desktop assessment included a review of Commonwealth and State databases and mapping, literature reviews, ecology assessments completed at nearby locations and aerial photographs. Database searches were undertaken within 25 km of the boundary of the terrestrial ecology study area and therefore incorporates the Moura-Baralaba Road realignment, off-lease water release/extraction infrastructure and the ETL study area. The results of the desktop assessment (described in Appendix F, Terrestrial Ecology Assessment) informed the field survey design and methodology.

9.11.1.3 Field survey

The terrestrial ecology surveys have been undertaken by suitably qualified ecologists in accordance with all required permits and approvals. Seasonal surveys were undertaken within the Project area over five days in the 2017 post-wet season (16-20 May 2017) and over five days in the 2017 dry season (16-20 December 2017). An additional targeted flora survey was carried out on 9 March 2018. This survey was restricted to a patch of non-remnant vegetation where threatened flora species were recorded during the dry season survey within the Project area.

Additional ecology surveys were undertaken of the additional investigation area over nine days in the 2020 post-wet season (6-14 May 2020) and of the ETL study area over three days in the 2020 dry season (23-25 September 2020).

The field assessments were conducted in accordance with the following survey guidelines:

- 'Survey guidelines for Australia's threatened birds' (DEWHA, 2010a);
- 'Survey guidelines for Australia's threatened bats' (DEWHA, 2010b);
- 'Survey guidelines for Australia's threatened reptiles' (SEWPaC, 2011a);
- 'Survey guidelines for Australia's threatened mammals' (SEWPaC, 2011b);
- 'EPBC Act referral guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and Australian Capital Territory)' (DoE, 2014a);
- 'Draft Referral guidelines for the nationally listed Brigalow Belt reptiles' (SEWPaC, 2011c);
- 'Referral guidelines for 14 birds listed as migratory species under the EPBC Act' (DoE, 2015a);
- SPRAT Database (DoEE, 2019b-g) profiles for relevant EPBC Act listed species and communities;
- 'Approved Conservation Advice for the Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community' (DoE, 2013b);
- 'Terrestrial Vertebrate Fauna Survey Guidelines for Queensland' (Eyre *et al.*, 2018);
- 'Methodology for survey and mapping of REs and vegetation communities in Queensland', version 4.0 - 5.1 (Neldner *et al*., 2017, 2019 and 2020); and
- 'Flora Survey Guidelines—Protected Plants' (DEHP, 2016b; DES, 2019).

The total flora survey effort included:

- 11 detailed secondary sites;
- 68 tertiary sites;
- 53 quaternary sites;
- 102 quaternary photo monitoring sites;
- 15 habitat quality plots;
- random traverses; and

- collection of ancillary information.

A summary of the total fauna survey effort is provided in Table 9.59, and complete details of all field assessment methodologies available in Appendix F, Terrestrial Ecology Assessment. The location of each secondary, tertiary and quaternary flora site is shown in Figure 9.82, while locations of each fauna survey site are shown in Figure 9.83.

Table 9.59 Summary of fauna survey effort

Survey technique	Survey effort				Target fauna species
	2017 post-wet season	2017 dry season	2020 surveys	Total	
Elliott traps	200 trap nights	200 trap nights	—	400 trap nights	Small mammals, some reptiles
Pitfall traps	32 trap nights	32 trap nights	—	64 trap nights	Small mammals, reptiles and frogs
Funnel traps	48 trap nights	48 trap nights	—	96 trap nights	Small mammals, reptiles and frogs
Spotlighting (on foot)	8 person hours on foot	7 person hours on foot	18 person hours on foot	33 person hours on foot	Mammals, reptiles, nocturnal birds
Call playback	3 sessions	3 sessions	12 sessions	18 sessions	Nocturnal birds, and Koalas
Infrared cameras	8 trap nights for cameras at systematic trap sites	8 trap nights for cameras at systematic trap sites	—	16 trap nights	Medium to large mammals and reptiles
Bird survey	13 person hours	14 person hours	10 person hours	37 person hours	Birds
Active searching	5 person hours	6 person hours	9.5 person hours	20.5 person hours	All conservation significant species, including mammals, reptiles and birds
Bat recorder (Anabat)	6 nights	5 nights	8 nights	19 nights	Bats
Koala Spot Assessment Technique (SAT) Surveys	4 sites	N/A	31 sites	35 sites	Koalas
Opportunistic/incidental bird survey	72 diurnal person hours	72 diurnal person hours	138 diurnal person hours	282 diurnal person hours	Birds, macropods, medium to large reptiles
	24 nocturnal person hours	24 nocturnal person hours	56 nocturnal person hours	104 nocturnal person hours	

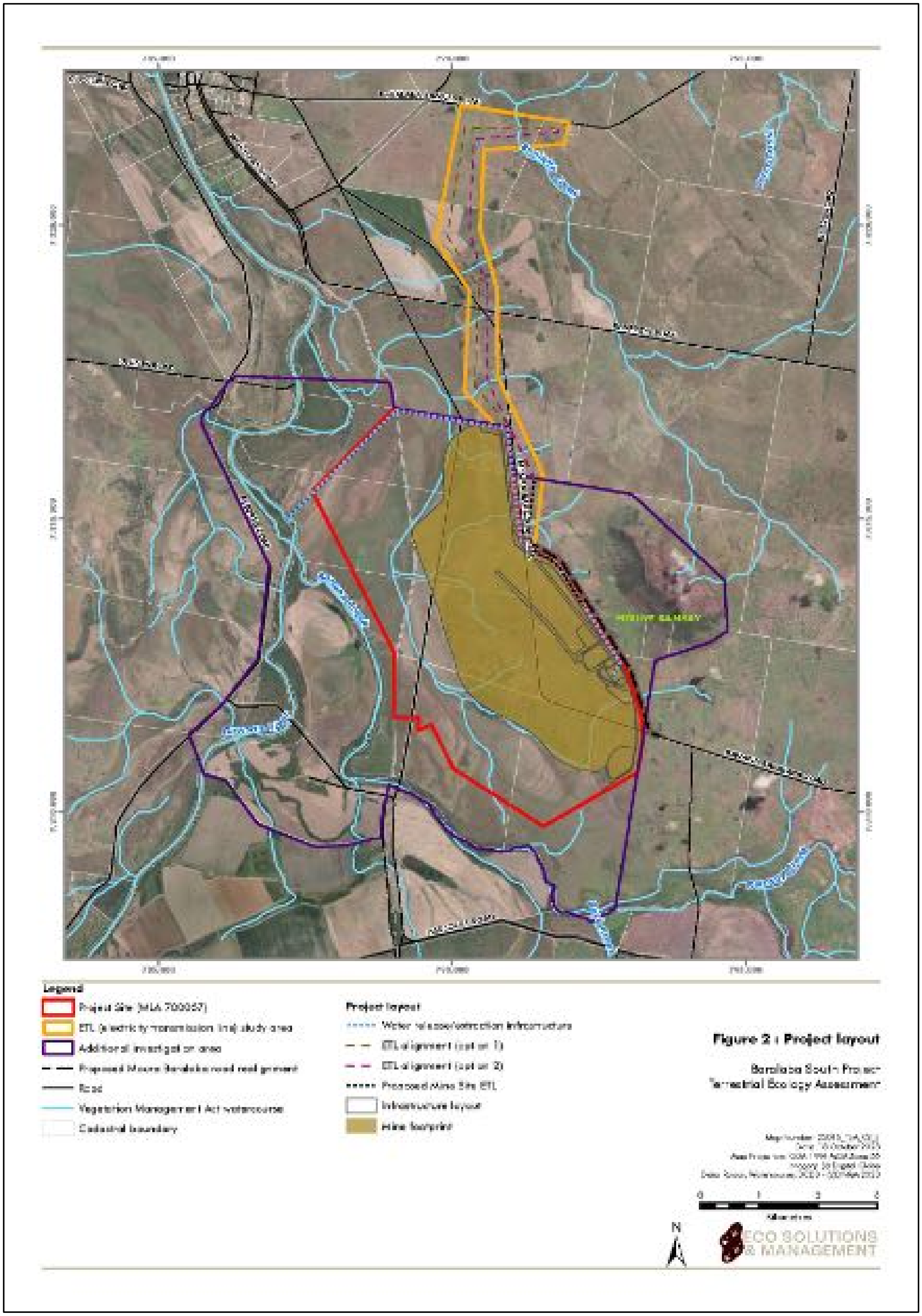


Figure 9.81: *Terrestrial ecology study area*

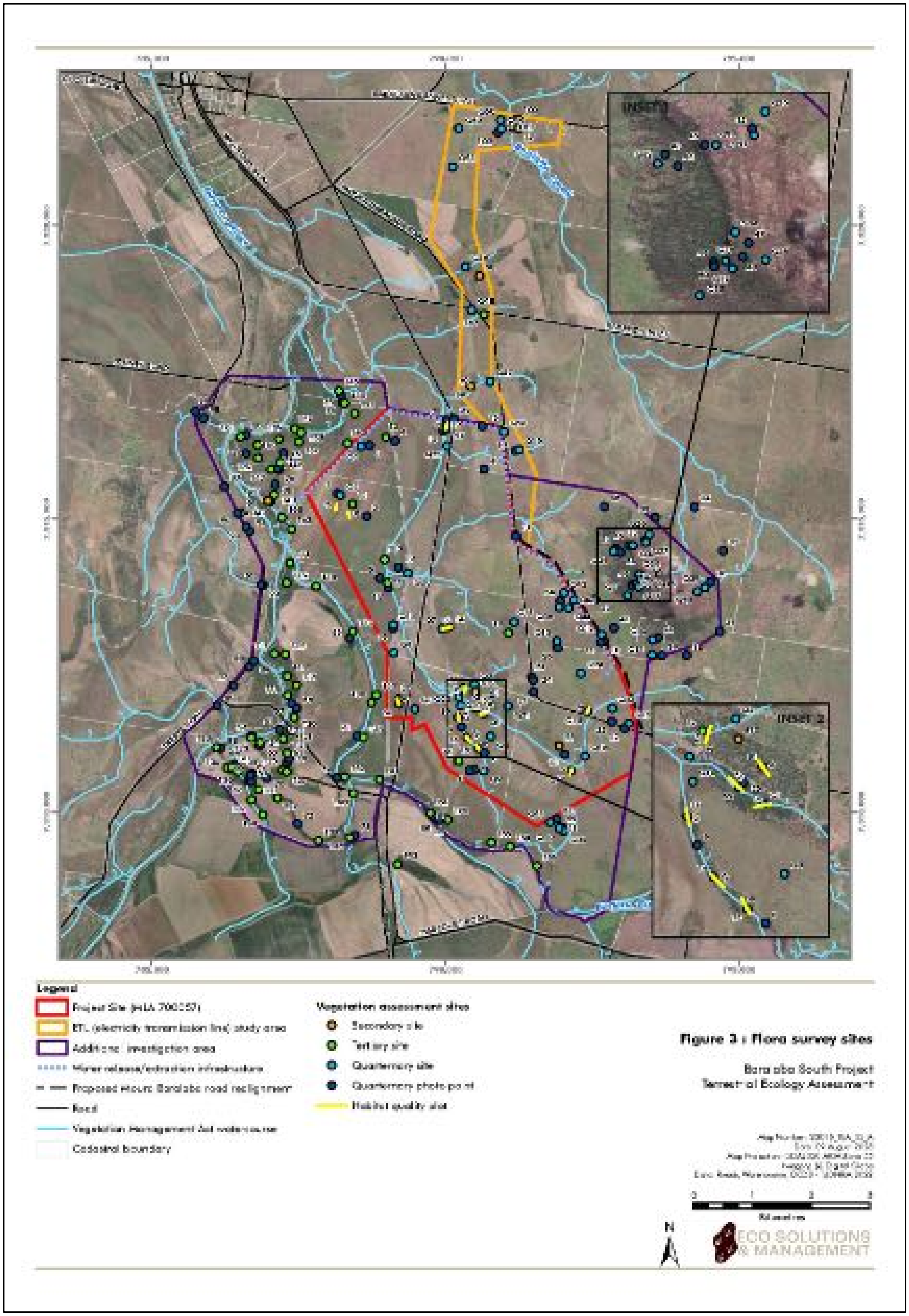


Figure 9.82: Flora survey sites

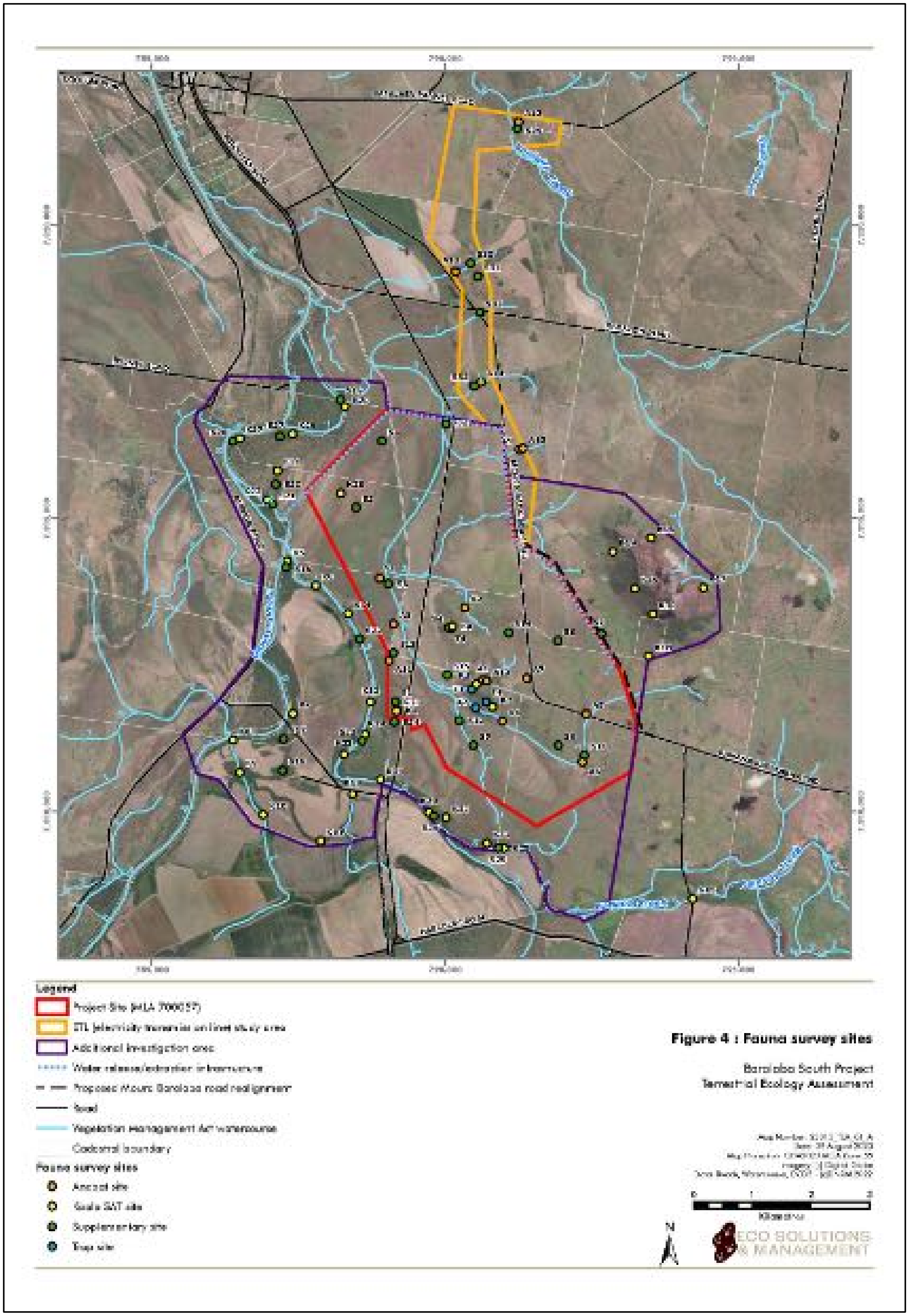


Figure 9.83: Fauna survey sites

9.11.2. Terrestrial ecological values

9.11.2.1 Protected areas

The Project does not form part of, or directly adjoin, any protected areas (i.e. national parks, conservation reserves, state forests etc.). The closest protected area is Dawson Range State Forest, which is located approximately 14 km west of the Project. The Project area is separated from this reserve by primarily cleared land and the Dawson River.

9.11.2.2 Regional ecosystems

Most of the Project area and ETL study area has been cleared of remnant and regrowth vegetation. A total area of 26.4 ha of remnant vegetation occurs in the Project area. The additional investigation area supports larger continuous patches of remnant vegetation, both along the Dawson River, Banana Creek and Mount Ramsay, however, significant areas within the additional investigation area have been cleared for agricultural purposes.

Field validated mapping of the remnant vegetation in the Project area was inconsistent with the Queensland Government mapping. Three regional ecosystems are considered to occur:

- RE 11.5.9 – *Eucalyptus crebra* and other *Eucalyptus spp*. and *Corymbia spp.* woodland on Cainozoic sand plains and/or remnant surfaces.
- RE 11.5.15 - Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces.
- RE 11.3.3 *Eucalyptus coolabah* woodland on alluvial plains - was also recorded in the south-western corner of the Project area and it extended south into the additional investigation area. Although Government mapping indicates this is regrowth vegetation, data collected in the field indicates this patch has the height and cover requirements to be mapped as remnant vegetation. RE 11.3.3 is recognised as a floodplain wetland, vegetation management wetland and HES wetland by the Queensland Government (PW1).

Vegetation representative of high value regrowth RE 11.3.3a was recorded to the south of the patch of remnant eucalypt woodland (RE 11.5.9). This community was moderately to highly fragmented by historic clearing and was associated with a drainage basin that holds water for extended periods. Several additional small patches of regrowth vegetation are scattered throughout the Project area and ETL study area and correspond with REs 11.3.1, 11.3.3, 11.4.8, 11.4.9a and 11.5.15 (Table 9.60). These patches are too small to be considered mappable entities in accordance with the 'Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland V 5.1' (Neldner *et al.*, 2020). Nonetheless some of these patches may contribute to habitat for significant species or TECs and have been included in mapping for protected matters where relevant.

The additional investigation area supports larger continuous patches of remnant vegetation, both along the Dawson River, Banana Creek and Mount Ramsay, however, significant areas within the additional investigation area have also been cleared for agricultural purposes.

Remnant regional ecosystems and regrowth vegetation is on Figure 9.84. The regional ecosystems identified during field surveys are described in Appendix F, Terrestrial Ecology Assessment.

Table 9.60: Field validated remnant, high value regrowth vegetation: terrestrial ecology study area

RE code	Short descriptions (Queensland Herbarium 2019)	VM Act status	Biodiversity status	EPBC Act status	Remnant (high value regrowth) area (ha)
Project area					
11.3.3/a	*Eucalyptus coolabah* woodland on alluvial plains	Of concern.	Of concern.	Endangered: Portions of vegetation within the Project area represent the Coolibah–Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions TEC.	16.6 (45.9)
11.5.9	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces	Least concern.	No concern at present.	Not listed.	8.7 (5.3)
11.5.15	Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces	Least concern.	Endangered.	Not listed: Vegetation within the Project area does not represent the Semi-evergreen Vine thicket TEC.	1.1 (0.0)
Water release/extraction infrastructure					
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Least concern.	No concern at present.	Not listed.	0.1 (0.0)
ETL study area					
11.4.9a	*Acacia harpophylla*, *Lysiphyllum carronii* +/- *Casuarina cristata* open forest to woodland	Endangered.	Endangered.	Endangered: Patches of this RE represent the Brigalow (*Acacia harpophylla* dominant and codominant) TEC.	0.0 (7.6)
Additional investigation area					
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered.	Endangered.	Endangered: Patches of this RE represent the Brigalow (*Acacia harpophylla* dominant and codominant) TEC.	23.5 (1.5)

RE code	Short descriptions (Queensland Herbarium 2019)	VM Act status	Biodiversity status	EPBC Act status	Remnant (high value regrowth) area (ha)
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	Of concern.	Of concern.	Endangered – a number of patches potentially contribute to the Coolibah–Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions TEC.	344.6 (71.7)
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains	Of concern.	Of concern.	Not listed.	15.5 (0.0)
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Least concern.	No concern at present.	Not listed.	286.5 (0.0)
11.3.27	Freshwater wetlands	Least concern.	Of concern.	Not listed.	7.9 (0.0)
11.7.2x3#	*Acacia rhodoxylon* tall shrubland to scrub on Cretaceous igneous rocks	Least concern.	No concern at present.	Not listed.	107.0 (0.0)
11.9.1	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* on fine-grained sedimentary rocks	Endangered.	Endangered.	Not listed - Vegetation in the additional investigation area does not represent the Brigalow (*Acacia harpophylla* dominant and codominant) TEC.	5.7 (0.0)
11.12.1	*Eucalyptus crebra* woodland on igneous rocks	Least concern.	No concern at present.	Not listed.	81.2 (0.0)
11.12.4a	Semi-evergreen vine thicket with open patches of *Acacia fasciculifera, Archidendropsis thozetiana, Pleigynium timorense* and various other species	Least concern.	No concern at present.	Not listed.	96.5 (0.0)

Note: # This RE does not currently align with a RE listed in the REDD (Queensland Herbarium 2019) and has been recommended by the Brigalow Belt Bioregion mapping coordinator (Queensland Herbarium) as an interim descriptor for the corresponding vegetation that was recorded on Mount Ramsay.

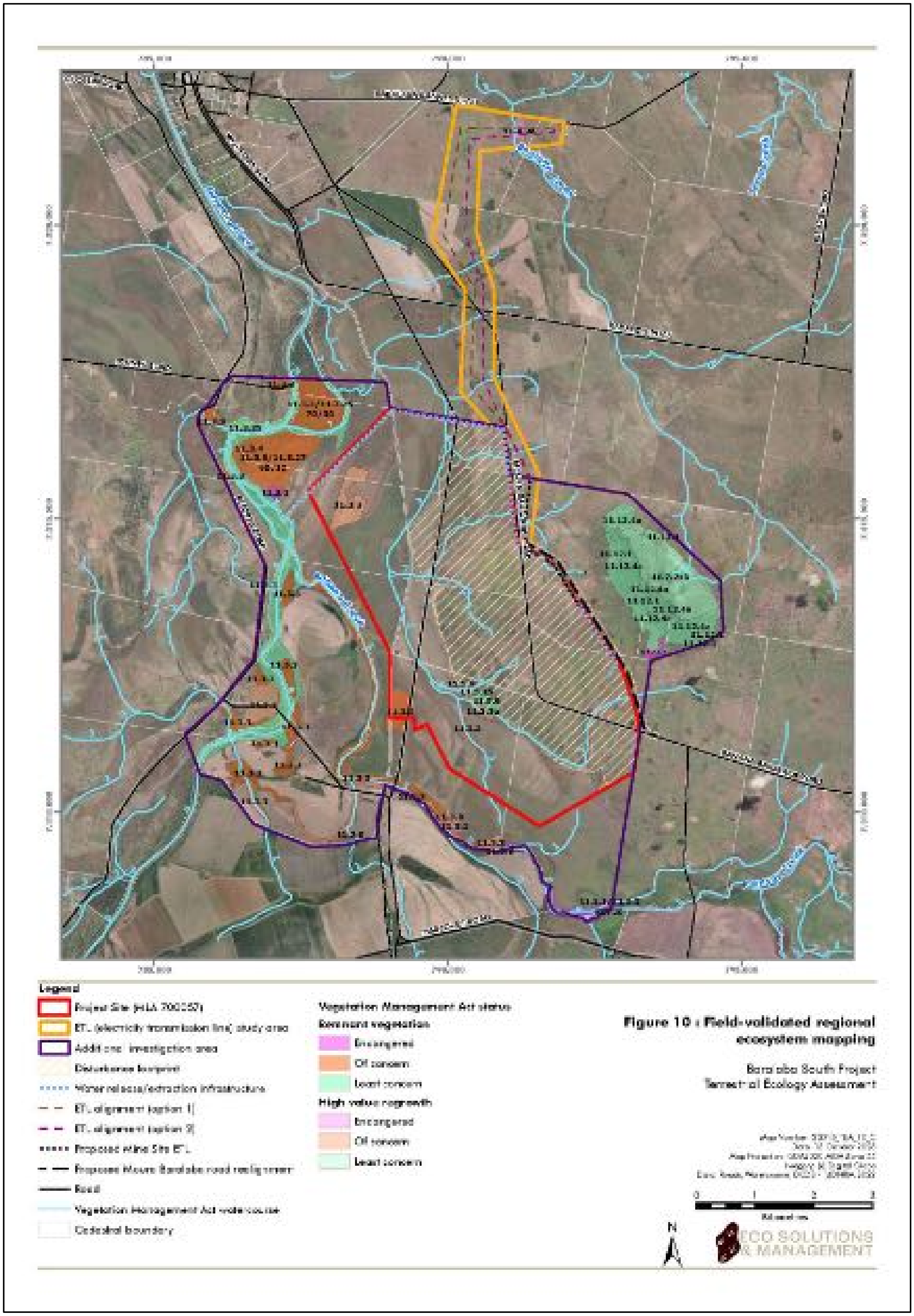


Figure 9.84: Field validated Regional Ecosystems in the terrestrial ecology study area

9.11.2.3 Threatened ecological communities

Four TECs defined under the EPBC Act were identified through database searches as potentially occurring within the terrestrial ecology study area. Field surveys identified two TECs occurring in the terrestrial ecology study area (Table 9.60):

- Brigalow (*Acacia harpophylla* dominant and codominant) (Brigalow TEC); and
- Coolibah–Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (Coolibah TEC).

Both of these communities are listed as endangered under the EPBC Act.

A summary of the two TECs that occur within the terrestrial ecology study area are provided below. The spatial extent and distribution of the field validated TECs is illustrated in Figure 9.85.

Brigalow (Acacia harpophylla dominant and codominant) threatened ecological community

Areas of Brigalow (*Acacia harpophylla*) vegetation were recorded in the terrestrial ecology study area and many of these patches, although not all necessarily meeting remnant or regrowth status, exhibit the key diagnostic features and meet the condition thresholds of the EPBC Act listed endangered Brigalow TEC.

Four small patches of Brigalow TEC have been mapped within the Project area and two small patches have been mapped within the ETL study area. These patches are comprised of vegetation representing RE 11.3.1 and RE 11.4.9a and are shown in Figure 9.84. The Brigalow patches in the Project site and one within the ETL study area are not large enough to be considered a mappable entity under the VM Act and as such are not shown in Figure 9.84. A total of 43.6 ha of Brigalow TEC has been identified in the terrestrial ecology study area, including 4.1 ha within the Project area and 9.9 ha in the ETL study area (Figure 9.85).

Coolibah–Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions threatened ecological community

Three patches of Coolibah dominated woodland vegetation (RE 11.3.3 *Eucalyptus coolabah* woodland on alluvial plains) were found to satisfy the listing criteria for the Coolibah TEC in the Project area. A total of 55.7 ha of Coolibah woodland meet the diagnostic criteria and condition thresholds stipulated in the DCCEEW's listing advice for the TEC (TSSC 2011) and have been mapped within the Project site (Figure 9.85). A detailed evaluation of how these patches meet the diagnostic criteria and condition thresholds for the Coolibah TEC is provided in Appendix F, Terrestrial Ecology Assessment.

Although not specifically assessed for TEC status, patches of vegetation consisting of RE 11.3.3 along the Dawson River, Banana Creek and their tributaries could also meet the diagnostic criteria and condition thresholds for the Coolibah TEC. These patches consist of approximately 428.7 ha, however, none of these patches will be disturbed by the Project.

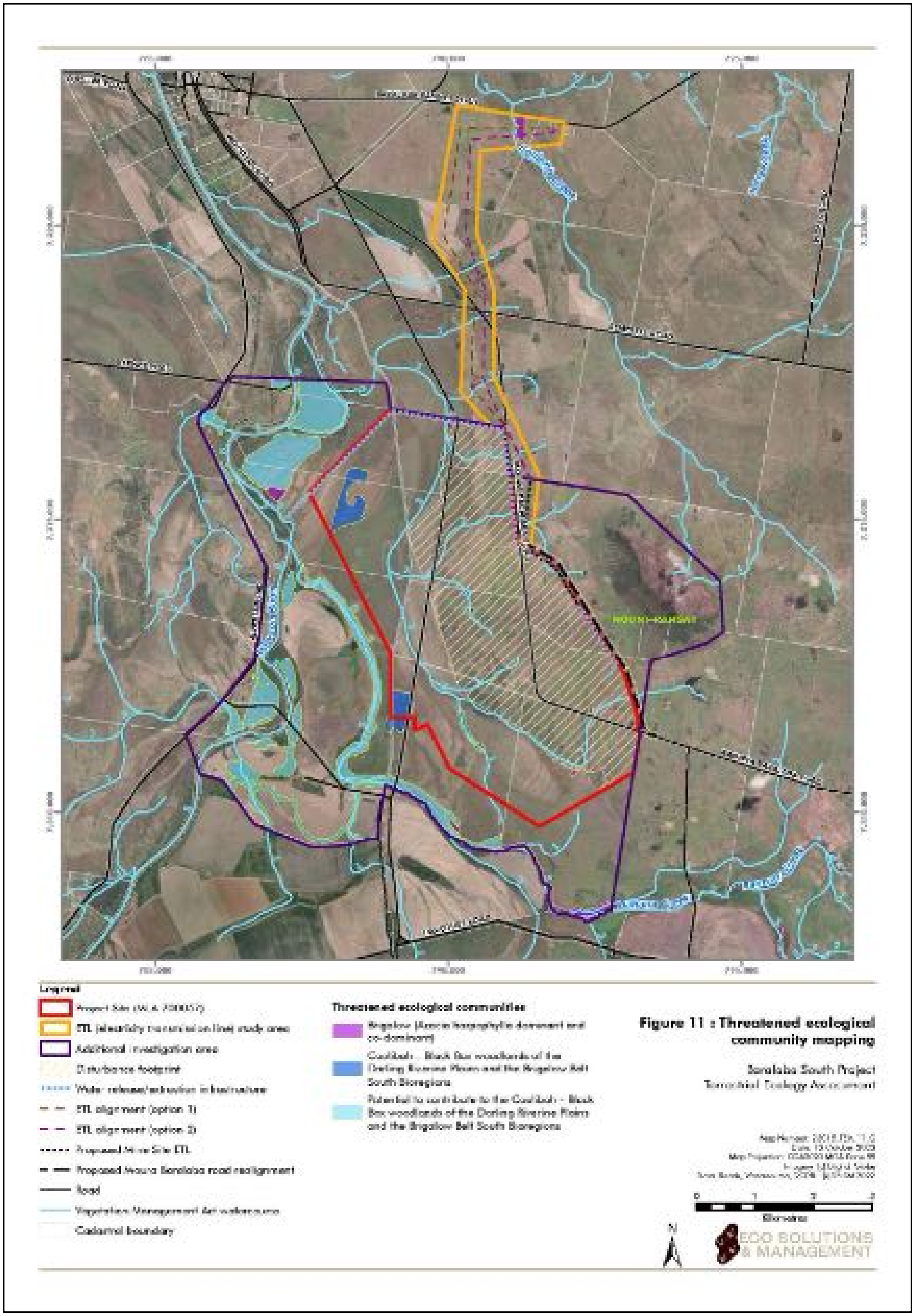


Figure 9.85: Field validated threatened ecological communities in the terrestrial ecology survey area

9.11.2.4 Threatened flora species

Database searches returned seven threatened flora species listed under the EPBC Act at the time of the Referral Decision as potentially occurring within 25 km of the Project area (Table 9.61). A summary of each listed species identified in database searches, including likelihood of occurrence, is presented in Table 9.61 and a detailed description, including species habitats and likelihood of occurrence, is provided in Appendix F, Terrestrial Ecology Assessment.

Flora surveys identified one threatened species listed as endangered under the EPBC Act within the Project area – *Xerothamnella herbacea*. No other species was recorded during the surveys and no other species are considered likely to occur based on habitat requirements and distribution of the species. Further discussion and the assessment of impacts to *X. herbacea* is provided in section 9.11.9.1, the other species in Table 9.61 are not considered further.

Table 9.61: EPBC listed flora species identified in database searches: likelihood of occurrence.

Scientific name	Common name	EPBC Act status	Likelihood of occurrence
Arthraxon hispidus	Hairy-joint Grass	V	Low
Bertya opponens	—	V	Low
Cadellia pentastylis	Ooline	V	Low
Cossinia australiana	Cossinia	E	Low
Dichanthium queenslandicum[1]	King Bluegrass	E	Low
Dichanthium setosum	—	V	Low
Xerothamnella herbacea	—	E	Known

Note: Blue cells indicate species identified in the terrestrial ecology study area.
E = endangered
V = vulnerable
[1] King Bluegrass was listed as vulnerable under the EPBC Act at the time of the EPBC Act Controlled Action Decision (EPBC Referral 2012/6547), and has since been transferred to the endangered category, as such this species is still considered a relevant MNES for the Project.

9.11.2.5 Threatened fauna species

Database searches returned 15 threatened fauna species listed under the EPBC Act at the time of decision on the referral as potentially occurring within the terrestrial ecology study area (Table 9.62).

At the time of the EPBC Act Controlled Action Decision (EPBC Referral 2012/6547), the Curlew Sandpiper, Eastern Curlew, Painted Honeyeater, White-throated Needletail, Grey Falcon, Ghost Bat and Greater Glider were not listed as threatened under the EPBC Act and therefore are not considered as a listed threatened species MNES for the Project. The Australian Painted Snipe was listed as vulnerable under the EPBC Act at the time of the Referral Decision and has since been transferred to the endangered category, as such this species is considered a relevant MNES for the Project. The Koala was listed as vulnerable under the EPBC Act at the time of the Referral Decision and has since been transferred to the endangered category, as such this species is considered a relevant MNES for the Project. Only those species listed at the time of the controlled action decision are presented within Table 9.62, however, for those that were listed, the current listing class is provided.

Three threatened fauna species were identified within the terrestrial ecology study area — the Ornamental Snake (*Denisonia maculata*), Squatter Pigeon (southern) (*Geophaps scripta scripta*), and Koala (*Phascolarctos* *cinereus*). These three species were listed as vulnerable under the EPBC Act at the time of the controlled action decision. These species are discussed in further detail in the following sections.

A summary of the likelihood of occurrence and survey presence each threatened species returned in the database searches is presented in Table 9.62. In addition to the four species identified within the terrestrial ecology study area, the Australian Painted Snipe (*Rostratula australis)* is considered to have a moderate likelihood of occurring in the study area.

Table 9.62: Threatened and special least concern (non-migratory) fauna species (database searches)

Species name	Common name	EPBC Act status	Likelihood of occurrence
Reptiles			
Delma torquata	Collared Delma	V	Low
Denisonia maculata	Ornamental Snake	V	Known
Egernia rugosa	Yakka Skink	V	Low
Furina dunmalli	Dunmall's Snake	V	Low
Birds			
Erythrotriorchis radiatus	Red Goshawk	V	Low
Geophaps scripta scripta	Squatter Pigeon (southern)	V	Known
Neochmia ruficauda ruficauda	Star Finch (southern)	E	Low
Poephila cincta cincta	Southern Black-throated Finch	E	Low
Rostratula australis^	Australian Painted Snipe	E	Moderate
Turnix melanogaster	Black-breasted Buttonquail	V	Low
Mammals			
Chalinolobus dwyeri	Large-eared Pied Bat	V	Low
Dasyurus hallucatus	Northern Quoll	E	Low
Nyctophilus corbeni	Corben's Long-eared Bat	V	Low
Phascolarctos cinereus	Koala	E	Known
Pteropus poliocephalus	Grey-headed Flying-fox	V	Low

Note: Key: Blue cells indicate species identified in the study area during field surveys; CE = critically endangered; E = endangered; M = migratory; V = vulnerable.

9.11.2.6 Migratory species

Database searches returned 16 species listed as migratory under the EPBC Act as potentially occurring in the terrestrial ecology study area. No listed migratory species were identified in the terrestrial ecology study area during the seasonal field surveys. However, two migratory species have a moderate potential to occur in the Project area — Glossy Ibis (*Plegadis falcinellus*) and Latham's Snipe (*Gallinago hardwickii*).

A summary of the likelihood of occurrence and survey presence of each migratory species returned in the database searches is presented in Table 9.63. A description of the preferred habitat of migratory species returned in database searches and an assessment of their likelihood of occurrence within the terrestrial ecology study area is outlined in Appendix F, Terrestrial Ecology Assessment. The assessments of significance of impact to the two Glossy Ibis and Latham's Snipe are provided in section 9.11.10.

Table 9.63: Migratory fauna species (non-threatened) identified in database searches

Species name	Common name	EPBC Act status	Likelihood of occurrence
Actitis hypoleucos	Common Sandpiper	M	Low
Apus pacificus	Fork-tailed Swift	M	Low
Calidris acuminata	Sharp-tailed Sandpiper	M	Low
Calidris ferruginea^	Curlew Sandpiper	M	Low
Calidris melanotos	Pectoral Sandpiper	M	Low
Cuculus optatus	Oriental Cuckoo	M	Low
Gallinago hardwickii	Latham's Snipe	M	Moderate
Hirundapus caudacutus^	White-throated Needletail	M	Low
Monarcha melanopsis	Black-faced Monarch	M	Low
Monarcha trivirgatus	Spectacled Monarch	M	Low
Motacilla flava	Yellow Wagtail	M	Low
Myiagra cyanoleuca	Satin Flycatcher	M	Low
Pandion haliaetus	Osprey	M	Low
Plegadis falcinellus	Glossy Ibis	M	Moderate
Rhipidura rufifrons	Rufous Fantail	M	Low
Tringa stagnatilis	Marsh Sandpiper	M	Low

Note: Key: M = migratory.
^ The Curlew Sandpiper, Eastern Curlew, and White-throated Needletail were listed as migratory species at the time of the EPBC Act Controlled Action Decision (EPBC Referral 2012/6547), as such are still considered MNES in terms of migratory species.

9.11.2.7 Introduced flora and fauna

Introduced flora

Four terrestrial recorded in the terrestrial ecology study area are recognised as 'Weeds of National Significance' (WoNS) by the Australian Government are also recognised by the Queensland state declared Category 3 Restricted flora species under the Biosecurity Act (Table 9.64).

Table 9.64: Weeds of National Significance

Species	Common Name	Classification
Opuntia aurantiaca	Tiger Pear	WoNs, B Act Category 3 Restricted flora
Opuntia stricta	Common Prickly Pear	WoNs, B Act Category 3 Restricted flora
Opuntia tomentosa	Velvet Prickly Pear	WoNs, B Act Category 3 Restricted flora
Parthenium hysterophorus	Parthenium Weed	WoNs, B Act Category 3 Restricted flora

All terrestrial weed species have generally been recorded infrequently in small numbers within both remnant and non-remnant vegetation in the terrestrial ecology study area.

Introduced fauna

Five of the introduced pest fauna species recorded in the ecology survey area are priority pest species recognised by the Australian Government, or contribute to threatening processes under the EPBC Act. These species are shown in Table 9.65

Table 9.65: Introduced fauna

Species	Common Name	Classification
Rhinella marina	Cane Toad	Biosecurity Act, Invasive biosecurity matter
Canis familiaris	Wild Dog	Priority pest animal, Biosecurity Act, Categories 3, 4 and 6
Oryctolagus cuniculus	European Rabbit	Priority pest animal, Biosecurity Act, Categories 3, 4 and 6
Felis catus	Feral Cat	Priority pest animal, Biosecurity Act, Categories 3, 4 and 6
Sus scrofa	Feral Pig	Priority pest animal, Biosecurity Act, Categories 3, 4 and 6

A description of introduced flora species and fauna is in the terrestrial ecology study area is provided in Appendix F, Terrestrial Ecology Assessment. The potential for the Project to introduce additional weed and/or pest species, and the management of known weed and pest species is described in Chapter 8, Biosecurity.

9.11.3. Direct impacts

9.11.3.1 Land clearance

Vegetation and habitats will be progressively cleared for the Project. Figure 9.83 shows the distribution of remnant and regrowth vegetation communities. Remnant and regrowth of concern and least concern communities under the VM Act will be impacted within the Project area and at water release/extraction infrastructure area. The ETL is anticipated to require removing regrowth endangered vegetation (Brigalow TEC).

Clearing will cause a direct impact by removing vegetation that also provides suitable habitat for a range of flora and fauna species. Fauna habitat resources for foraging, sheltering and breeding within the disturbance footprint that may be impacted by the Project include the following:

- understorey and groundcover - shelter and forage habitat for amphibians, reptiles, small birds and ground-dwelling mammal;

- fallen logs, coarse woody debris and leaf litter - shelter habitat for amphibians, reptiles and ground-dwelling mammals;
- hollow-bearing trees and stags - shelter and breeding habitat for reptiles, birds and arboreal mammals and microbats;
- food trees, shrubs, grass and herbs - forage resources for small birds, Koalas and other herbivorous mammals;
- nectar producing trees and shrubs - foraging habitat for insects, blossom-dependent birds, arboreal mammals and megachiropteran bats (i.e. flying-foxes); and
- gilgai and constructed dams – water resources and aquatic habitat for a range of amphibians, mammals, birds and reptiles.

Approximately 10.1 ha of remnant vegetation and up to 5.5 ha of high value regrowth vegetation will potentially be cleared or disturbed for the Project, some of which provides suitable habitat for threatened species. An estimated total of 1.4 ha of Brigalow TEC will be cleared or disturbed as part of the Project operations. There is no Coolibah TEC proposed to be disturbed by the Project.

Impacts within the ETL study area have been estimated based on a maximum impact scenario using the two alignment options presented in Figure 9.23. There is potential for this maximum area of impact to be reduced during the detailed design of the ETL.

Additional areas of non-remnant vegetation that do not represent high value regrowth will also require clearing, some of which represents TECs and provides suitable habitat for threatened species. These areas have been factored into habitat mapping and impact assessments.

9.11.4. Indirect impacts

9.11.4.1 Fragmentation and edge effects

Vegetation clearing can result in fragmenting habitat that can impact flora and fauna species. The clearing for the Project is unlikely to significantly fragment habitat due to the highly disturbed and largely cleared landscape in which the proposed Project is located. However, there is potential for the Project to create minor local barriers or impairment movement of some fauna species, between Mount Ramsay and the Dawson River and Banana Creek. However, the almost exclusively cleared nature of the area between Mount Ramsay and the Dawson River and Banana Creek suggest that faunal movements between these landscape features is likely to be minimal and limited to mobile species (such as birds) and species tolerant of cleared disturbed areas.

The Project area is characterised by fragmented patches of remnant, regrowth and non-remnant vegetation that have been isolated by historic broad-scale land clearing in the region. Contiguous intact vegetation is largely confined to the Dawson River and Banana Creek riparian corridor. The Project area does not provide corridor habitat for fauna movement. There is potential for the Project to create some minor local barriers or impairment of movement between Mount Ramsay, the Dawson River and Banana Creek to fauna species with capacity to move large distances through open areas.

A further consequence of clearing vegetation is that it can produce “edge effects”. Edge effects are impacts that can occur at the interface between natural habitats and cleared areas or developed land. Edge effects may cause modifications to the local environment in terms of altered species and structural composition due to increased light, wind shear, and weed invasion.

Clearing for the Project will primarily occur across the Project site. However, historic clearing and thinning has been undertaken throughout the Project area and surrounding areas already, leaving no areas that are not already subject to edge effects. Given the open structure of the woodland habitat that remains in the Project area, edge effects to remaining patches are not likely to be significant.

9.11.4.2 Vehicle strike

The movement of haul trucks on haul roads within the site has the potential to result in injury or mortality of fauna. Ground-dwelling fauna are most susceptible to this impact, although birds and microbats may also be impacted.

The mining operations will operate 24 hours per day, 7 days per week. All trafficable areas will be subject to enforced speed limits that would reduce the risk of animal strikes. Relevant signage, safe driving procedures and staff inductions addressing this risk would increase awareness and contribute to reducing the risk of this impact.

The vibration of approaching haul trucks may also provide animals with warning and prompt fauna to move away from the path of approaching vehicles.

9.11.4.3 Artificial lighting

Potential impacts of light spill from lighting associated with the Project is likely to be limited and restricted to infrastructure areas around the MIA, ROM and CHPP. Species identified within the Project are adaptable and likely to persist in areas close to infrastructure (i.e. generally able to adapt to environmental conditions over small areas). Most fauna species would habituate to the levels of artificial light or temporarily move away from areas of night lighting. The extent of impact will vary between species and habitat types as light shed will be greater in more open habitat types. The types of common and adaptable species identified in the study area that are more likely to persist in areas close to infrastructure areas, are generally able to adapt to environmental conditions over small areas. Lighting is not likely to significantly impact fauna.

9.11.4.4 Noise and vibration

Noise and vibration associated with construction and operation of the Project has the potential to disrupt the routine activities of fauna species. Ongoing noise and vibration emissions associated with the Project will be generated from various sources, such as mining equipment and blasting activities.

Most fauna species exhibit a high degree of adaptability to the noise and vibration from machinery and blasting. Noise or vibration from mining activities may cause some birds to modify their behaviour, potentially altering feeding activity or abandon nests during breeding season. It is noted that sudden loud noises may also startle bird and mammal species. Depending on the magnitude of construction and mining noise, there may be some species that will be affected by noise and, therefore, will forego utilisation of habitat within the noise disturbance zones. However, animals are likely to adapt to the disturbance and/or move to similar habitats in the surrounding landscape.

9.11.4.5 Dust

Construction and mining activities have the ability to generate dust, which has the potential to impact vegetation and fauna. However, recent studies on the impacts of dust from unsealed roads, including haul roads, on vegetation and fauna, have found no evidence that dust has any detrimental impacts on vegetation or fauna abundance (Cumberland Ecology 2015; Jones *et al*. 2016).

Trinity (Appendix L, Air Quality and Greenhouse Gas Assessment) investigated potential impacts of dust deposition on vegetation in close proximity to the MLA. It was found that impacts due to dust deposition on vegetation are likely to be indiscernible compared with changes due to temperature and water availability (Appendix L, Air Quality and Greenhouse Gas Assessment).

Much of the remnant vegetation surrounding MLA 700057 would be subject to dust deposition rates equal to or only marginally above background levels and as a result there is no anticipated detrimental effect on their functioning due to the operation of the Project (Appendix L, Air Quality and Greenhouse Gas Assessment).

In general, dust has the potential to impact fauna if it also introduces toxic compounds such as heavy metals into soil and animal tissue. The geochemical assessment (refer Appendix E) indicates that bulk overburden and interburden (spoil) materials – and potential coal reject materials – have low levels of metal and metalloid enrichment, which is consistent with Permian-age coal measures throughout eastern Australia, and consistent with the Rangal coal measures in the Bowen Basin. Thus, there is no substantial risk of such contamination occurring in the areas surrounding the Project. Overall, the potential impacts of dust from the BSP onto fauna are likely to be insubstantial.

Standard dust minimisation and suppression strategies such as watering of haul roads will be implemented for the Project to minimise dust generation. Mined areas, particularly waste rock emplacements, will also be progressively rehabilitated and vegetated following mining, which will also reduce the potential for dust generation. Dust is considered unlikely to cause a significant impact on the ecological values of the areas surrounding the Project.

9.11.4.6 Erosion and sedimentation

The Project has the potential to generate erosion in disturbed areas and sedimentation of waterways downstream from clearing vegetation to develop the open cut pits, and construct haul roads and other infrastructure. Vegetation clearance protocols and erosion and sediment control measures will be implemented to minimise potential impacts.

9.11.4.7 Introduced species

Given the existing extent of disturbance and presence of weeds throughout the Project area (Appendix F, Terrestrial Ecology Assessment), the proposed Project is unlikely to increase terrestrial weed populations. Similarly, as all Project activities will occur within the same basin, the Project is unlikely to result in the addition of new invasive aquatic flora species.

Pest animals are already present and able to move freely throughout the landscape and/or readily colonise new areas (Appendix F, Terrestrial Ecology Assessment). The Project is unlikely to introduce new terrestrial pest animals to the area. The clearing of vegetation may temporarily attract some predatory native and feral animals; however, any impact will be managed accordingly by implementing a Weed and Pest Management Plan (section 9.11.7.4).

9.11.5. Facilitated impacts

Facilitated impacts relate to impacts from other Projects (including by third parties) that are made possible (facilitated) by the Project being assessed (this Project). Facilitated impacts may be expected to occur through the development of an infrastructure Project (e.g. a dam, road or rail line), where that development would enable the development of other Projects which otherwise may not have been viable (e.g. the development of a road leads to urban development in an undeveloped area).

The Project will not develop any infrastructure that will facilitate developing any other Projects. Mining operations will not facilitate the development of any other Projects which could not already be developed. Although the Project will include a realignment of the Moura-Baralaba Road, this road already exists, and the realignment will not enable other Projects.

The ETL will link the Project to the Baralaba Substation, approximately 6 km east of Baralaba. The construction of the ETL to the Project area does not facilitate the connection of any future Projects to the electricity network which would in turn allow for the development of these Projects. The ETL does not link any undeveloped areas (apart from the Project area) to the electricity network and the establishment of such a short length is not considered to be an economic impediment to any other Projects that were to occur in the region.

Similarly, the water extraction/release infrastructure traverses directly to the Dawson River from the Project. It does not allow for other potential Projects to utilise this infrastructure for the extraction/release water from/to the Dawson River. As with the ETL, the installation of future Projects in the region is not considered an economic impediment to their development.

Post-mining it is expected that where possible the Project area will be reinstated to grazing lands at a similar suitability to that existing prior to mining or, where this cannot be achieved, used for alternative use that provides a similar value to that pre-mining or able to provide long-term ecological value to the region. It is not considered that the return lands to an agricultural use or alternative use that provides similar value will facilitate the development of Project which cause additional (facilitated) impacts to those identified for the Project.

As such, there is not expected to be any facilitated impacts from the Project on any flora or fauna values.

9.11.6. Cumulative impacts

The Brigalow Belt Bioregion has a long history of clearing and landform modification associated with agricultural pursuits, forestry, mining, gas production and the development of townships. The construction of the roads, rail lines and pipeline easements required to facilitate development of the region has further reduced and fragmented the extent of remnant vegetation persisting in the landscape present. The current extent of remnant vegetation in the bioregion has been estimated by the Queensland Herbarium as being at 15,038,111 ha or 41.2% of the pre-clearing cover (Accad *et al*., 2019). This is higher than the estimated extent of remnant vegetation within the Dawson River Downs subregion, which is 93,330.4 ha or 9.5% of the pre-clearing extent (Accad *et al*., 2019).

The Project will result in impacts to 10.1 ha of remnant vegetation, which represents approximately 0.01% of the current extent of remnant vegetation in the subregion. The area of remnant vegetation proposed to be impacted cleared is comprised of 0.1 ha of concern RE (RE 11.3.3) and 9.9 ha of least concern REs (REs 11.3.25, 11.5.9 and 11.5.15).

The Baralaba North Continued Operations Project, located approximately 11 km north of the Project, was approved in 2014. The EIS estimated a total of 277 ha of remnant vegetation would be cleared for the expansion of the existing mine (Cockatoo Coal Limited, 2014). The Dawson Mine is located approximately 25 km to the south of the Project; however, the extent of approved vegetation clearance is not publicly available.

Cumulatively, direct impacts on native vegetation from developments including other mining Projects in the region will result in incremental losses or modification of remnant vegetation, including TECs and habitat for species of conservation significance. In addition, clearing for mining and infrastructure Projects can interrupt connectivity between areas of habitat, leading to reduced opportunities for fauna to successfully forage, breed and colonise new territories. Fragmentation of habitat can also affect genetic diversity through limiting opportunities for breeding individuals to interact, as well as pollination and dispersal of plant propagules.

The provision of environmental offsets in line with Commonwealth and/or State Government policies provide an opportunity to mitigate cumulative impacts. Offsets were required for the Baralaba North Continued Operations Project and will also be provided for the Project to provide adequate compensation for significant residual impacts to matters of environmental significance and to yield no net conservation loss.

9.11.7. Mitigation, management and monitoring

To manage potential impacts on flora and fauna values as a result of the Project, the following framework has been adopted for the Project. This framework is consistent with the recommended 'management hierarchy' from the DES. The management hierarchy is as follows:

- avoid impacts wherever possible;
- minimise unavoidable impacts; and
- where necessary, offset significant residual impacts.

The avoidance, mitigation and management measures detailed in the following sections for the Project have been developed in consideration with the 'SMART' principle (Specific, Measurable, Achievable, Relevant, Time-bound).

Avoidance, mitigation and management measures for the Project have been grouped according to the nature of the potential impact and the proposed activity, these mitigation and management measures have been categorised as those relating to habitat and vegetation disturbance and as site operational impacts.

9.11.7.1 Vegetation clearing protocols

A number of controls for clearing activities are proposed in order to minimise and mitigate impacts on flora and fauna habitats and vegetation communities. These controls will be adopted to limit any potential impacts to flora and fauna species and their habitats as a result of clearing activities for the Project and to minimise the risk of injury or death to native fauna. These include:

- Clearing activities will be undertaken sequentially and in accordance with the 'Permit to Disturb' process whereby any and all disturbance that involves individual trees (dead or alive), vegetation and soil disturbance will require an approval from the Environmental Officer. This protocol will ensure the area of vegetation and habitat to be cleared is that which is required for the safe construction and operation of the Project.
- During clearing activities vegetation will be felled in the direction of the clearance zone to avoid impacts to adjoining retained vegetation and habitat.
- When possible, clearing activities will be designed to be undertaken outside of peak breeding periods for threatened fauna species.
- When possible, important habitat values, such as hollow-bearing trees and fallen logs, will be retained or salvaged during clearing activities and used for fauna habitat in rehabilitated areas; for example, the proposed clearing associated with the development of the water release/extraction infrastructure will be designed to avoid the removal of any habitat trees within the remnant vegetation areas (RE 11.3.25).
- Environmental buffer areas and relocation areas will be clearly delineated prior to the start of clearing activities. Access to these areas will be limited to minimise disturbance to the protected values.
- Controls will be installed to prevent unauthorised access into areas of vegetation to be retained and to prevent any damage to these values during clearing activities.
- Sediment control works will be considered and implemented where necessary during clearing activities, for example in areas where remnant pools are located adjacent to construction activities;
- Any necessary rehabilitation of drainage features and/or watercourses will be undertaken using native flora species;
- All staff and contractors will be required to notify the Environmental Officer of any incidents of accidental damage to vegetation or injury/death of fauna during clearing activities.
- Appropriate control measures would be implemented in the instance of unauthorised clearing/injury or death of native fauna. Whereby, the Environmental Officer may order a 'stop work' to resolve and assess the obligation to report any incidents to the regulatory authorities.

When possible, an environmental buffer area will be retained, providing protection for nearby watercourses and wetlands by the Project to enhance water quality and habitat connectivity. The 'Regional Vegetation Management Code for the Brigalow Belt and New England Tablelands Bioregions' (DERM, 2009) recommends a high bank buffer of:

- 50 m for stream order 1 or 2 watercourses;
- 100 m for stream order 3 or 4 watercourses; and
- 200 m for stream order 5 or greater watercourses.

Consistent with the 'Regional Vegetation Management Code for the Brigalow Belt and New England Tablelands Bioregions' (DERM, 2009), a buffer of 500 m along the Dawson River and a 200 m buffer along the Banana Creek will also be retained. Significant earthworks and clearing will be avoided within these buffer areas. Minor surface disturbance, such as pipelines, tracks and monitoring infrastructure, may occur within these buffer areas.

9.11.7.2 Pre-clearing inspections

Inspection of areas to be cleared will be undertaken prior to clearing to confirm whether any animal breeding places for threatened or near threatened species are present or likely to be present. If breeding places for threatened or near threatened species are present or likely to be present, the Proponent will engage a spotter/catcher to manage the potential impacts to fauna during the clearing activities.

9.11.7.3 Conservation significant species management

A Species Management Program will be developed and implemented during construction and mining operations. The purpose of this plan is to manage and minimise the risk of impacts on animals and animal breeding places protected under the *Nature Conservation (Wildlife Management) Regulation 2020*. The Species Management Program will be developed in consideration of the key threatened processes identified for the species which are relevant to the Project.

The Species Management Program will be used in conjunction with the 'Permit to Disturb' protocol that will be implemented during both construction and operations stages of the Project. The Species Management Program will set out the specific commitments and/or requirements to be implemented prior to and during vegetation clearing, which may include:

- Any clearing activities planned within areas known to contain threatened plant species or within an area mapped as 'high risk' in the Flora Survey Trigger Map will require a Protected Plants Survey as per the requirements of the *Nature Conservation (Plants) Regulation 2020*. Any Protected Plants Surveys will be conducted in accordance with the requirements of the *Nature Conservation (Plants) Regulation 2020*.
- The level of survey effort and methodologies required for pre-clearance survey(s), for example the type of trapping to be undertaken including the number of nights prior to clearing activities, or the identification of breeding/nesting habitat values in order to avoid impacts to animal breeding places.
- During pre-clearance surveys and clearing activities, a suitably qualified fauna spotter-catcher, as per the requirements of the *Nature Conservation (Animals) Regulation 2020*, is to be present.
- Targeted fauna searches by a suitably qualified fauna spotter-catcher for known and/or likely to occur conservation significant species in areas mapped as habitat within the proposed clearing areas, for example searches for the Ornamental Snake, Australian Painted Snipe, Koala, and Squatter Pigeon (southern).
- Specific protocols for handling and relocating various fauna species encountered prior to or during clearing activities.
- Information regarding suitable approaches and specific clearing techniques to minimise disturbance to fauna habitats and populations; for example, the timing of clearing activities to occur outside of the known/likely to occur conservation significant species breeding seasons.
- Where possible, disturbance to significant habitat values (e.g. hollow-bearing trees and logs) will be avoided during clearing activities. In areas where disturbance cannot be avoided, where possible these habitat values will be relocated or substitution of nesting features (e.g. hollows and logs) will be placed in suitable areas.
- Procedures regarding the management and reporting of any fauna interactions resulting in the injury or mortality of wildlife on-site.
- Protocols will be developed for the treatment and rehabilitation of injured wildlife; these protocols will include requirements around emergency euthanasia and information regarding wildlife carers.

- Protocols around the management of any conservation significant species habitat values or populations not previously identified within the Project area or within the adjacent properties (Broadmeadow Property). These protocols will include measures such as disturbance avoidance, property management strategies (e.g., grazing practices) and/or monitoring measures.
- Requirements around any conservation significant species monitoring within the Project area, offset areas or within Project owned properties (Broadmeadow Property).

The Species Management Program will detail the individual responsibilities of personnel (employees and contractors) to operate in accordance the program, such that roles would include but not be limited to:

- manager - obtaining all relevant approvals and permits necessary prior to the occurrence of any vegetation clearing activities;
- senior executive - ensure all workers are trained and competent to perform relevant duties and maintain an acceptable level of risk under the plan;
- on-site environmental officer - direct implementation of the plan on site, including communications with site supervisors to confirm pre-clearing, clearing and construction activities are undertaken in accordance with the plan; and
- suitably qualified and experienced person - undertake pre-clearance surveys in accordance with the plan.

The plan will be reviewed for its effectiveness in the event of any changes made to legislative requirements.

Internal audits and an independent evaluation will inform compliance of the program. Where future recommendations resulting from audits are identified, management measures to address the recommendations will be implemented.

9.11.7.4 Weed and Pest management

A Weed and Pest Management Plan will be developed and implemented for the Project and will describe the measures required to manage weeds and feral animals in consideration of the identified key threatening process for the MNES values identified on-site. The Weed and Pest Management Plan will be developed in consideration of the Banana Shire Council's existing and planned management programs and include:

- delivering education and awareness training about weeds and pest animals to all staff and contractors through site inductions;
- implementing the following prevention measures:
  - maintenance of roads and tracks to minimise weeds on tracks and reduce the spread of weeds by vehicle movements;
  - monitoring and managing as required topsoil stockpiles to ensure that they do not become infested with weeds;
- ensure bi-annual pest monitoring is undertaken for the Project area by a suitably qualified person;
- designing and implementing appropriate treatment control programs to contain and reduce the extent of restricted pest weed species at the site and prevent the introduction of new species—this may involve chemical and mechanical methods, depending on the sensitivity of the receiving environment;
- monitoring weed infestations;
- rehabilitation of disused areas will be undertaken as soon as possible to avoid the opportunistic spread of weeds;
- employees/contractors will be required to notify the Environmental Officer of any new sightings of pest species or new weed infestations;
- waste storage facilities associated with the Project will contain restricted access to prevent any harmful contact with fauna; and

- a rubbish-free, clean environment will be upheld to deter the presence of feral animals.

The Project will liaise with neighbours and local land managers to contribute, where practical, to a broader pest animal management program aimed at reducing the Feral Cat, Wild Pigs, Wild Dog and Red Fox populations in the region.

9.11.7.5 Site rehabilitation

The general rehabilitation goals for the Project are to leave an area that is:

- safe to humans and wildlife;
- non-polluting;
- stable; and
- able to sustain an agreed post-mining land use.

These goals align with the relevant performance outcomes for land rehabilitation in the EP Regulation. In addition to the general rehabilitation goals listed above, further site-specific goals for the Project include:

- minimising the loss of pre-existing agricultural land value by reinstating, where possible, grazing lands at a similar suitability to that existing prior to mining;
- where this cannot be achieved, identifying alternative uses that provide a similar value to the value able to be generated from the land prior to mining or an alternative land use, or uses, able to provide long-term ecological value to the region; and
- minimising or avoiding the potential for post-mining lands having no or little value to the area or region.

In accordance with the PMLU, it was identified that land disturbance cannot be avoided for the Project and as such the rehabilitation objective is to return land to the previous land use, predominantly improved pasture grazing.

Rehabilitation of disturbed areas will occur progressively throughout the life of the mine and will continue for three years post-production. Mining operations will commence in the north-west of the Project area and progress in a south-easterly direction. Rehabilitation will utilise suitable topsoils and subsoils stripped from construction and mining areas, and where viable, stored to maintain soil quality and promote native vegetation from the soil seed bank. Areas of in-pit and out-of-pit spoil disposal will be rehabilitated as soon as they become available in the operating life. A rehabilitation strategy has been developed in order to achieve the relevant performance outcomes, minimise the loss of land and water bodies with ecological and productive value, and to ensure that high impact areas are capable of being managed and rehabilitated to achieve acceptable land use capability and suitability, to be stable and self-sustaining, and to prevent surface and groundwater contamination.

In order to assess the Project's rehabilitation activities, a Rehabilitation Monitoring Program will be developed. This Rehabilitation Monitoring Program will detail the objectives, methodology, timing and frequency appropriate for the Project. The results of rehabilitation monitoring will be captured through various monitoring reports.

9.11.7.6 Site operations

<u>Bushfire prevention and management</u>

A series of bushfire prevention management measures will be implemented for the Project. These include, but are not limited to:

- retention of adequate fire breaks between the surrounding bushland and the Project with buffers in accordance with the approved disturbance footprint;

- ensuring all flammable chemicals are handled and stored to avoid spills/leaks that could result in increased fire risk;
- maintaining access tracks to ensure available use for firefighting and Queensland Fire and Emergency Service; and
- an Emergency Response Plan to include the following fire management measures:
  - emergency incident response;
  - training requirements for emergency response crews, including rescue, first aid, firefighting etc.; and
  - appropriate communication protocols.

A range of additional mitigation, management and monitoring measures will be undertaken to minimise the potential impacts to surface and groundwater resources. The following programs, plans and systems will be implemented and described elsewhere in this chapter:

- Water management system (see section 9.8.1);
- Surface water quality monitoring program (see section 9.8.5.6);
- Water Management Plan (see section 9.8.5.8);
- Erosion and Sediment Control Plan (see section 9.8.5.9);
- Contaminants management (see section 9.8.5.10);
- Receiving Environment Monitoring Program (see section 9.8.5.7);
- Groundwater Monitoring Program (see section 9.10.5.1); and
- Groundwater Pit Inflow Monitoring Program (see section 9.10.5.2).

9.11.8. Impact assessment - threatened ecological communities

9.11.8.1 Brigalow (*Acacia harpophylla* dominant and codominant)

Description

The Brigalow TEC is characterised by a range of open forests and woodland, dominated by Brigalow (*Acacia harpophylla*) trees and shrubs. The community ranges in structure although usually occurs on acidic and salty clay soils (DoE, 2013b). This TEC comprises both remnant and regrowth vegetation in Queensland and New South Wales and in Queensland is represented by a number of REs in the Brigalow Belt, south-east Queensland bioregions, but primarily occurs in the Brigalow Belt Bioregion (Environment Australia, 2001).

Current threats

The main threats to Brigalow TEC are those activities that reduce its extent, cause a decline in the condition of the vegetation or impede its recovery, including:

- clearing particularly for mining and agricultural activities;
- fire, particularly where exotic grasses are present within or adjacent to the remnant;
- plant and animal pests, particularly by exotic pastures and in combination with clearing. Other pest plants include *Opuntia* spp., Mother-of-millions (*Bryophyllum delagoense*) and Asparagus Fern (*Asparagus* spp.); as well as grazing by cattle and native herbivores; and
- lack of knowledge about climate change, how to best manage plant and animal pests and how to restore degraded communities (DCCEEW, 2023a).

Management plans

The following plans and advice are in place for the Brigalow TEC and have been considered in preparing this assessment:

- Conservation Advice: Approved Conservation Advice has been prepared for the Brigalow TEC, which outlines key diagnostic criteria and condition thresholds for the communities as well as threats and priority conservation actions required for the TEC. The Conservation Advice is an important consideration in the assessment of impacts to the Brigalow TEC and defines all patches of Brigalow vegetation that meet the key diagnostic criteria and condition thresholds as being considered critical to the survival of the Brigalow TEC.
- Threat Abatement Plan: Threat abatement plans are listed for the Cane Toad in relation to this TEC.
- Recovery Plan: There is currently no recovery plan for the Brigalow TEC.
- Referral Guideline: There are no referral guidelines for the Brigalow TEC. There is an information sheet, for Queensland purposes only, regarding clearing of Brigalow regrowth under the EPBC Act.

Survey effort

Seasonal field flora surveys were undertaken over 23 days and carried out in compliance with the Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, Versions 5.1, 5.0 and 4.0, current at the time of the field surveys (Neldner *et al*., 2020; 2019; 2017). Assessment sites were performed throughout the study area to thoroughly assess the vegetation present.

The validation and mapping of remnant vegetation was undertaken at a total of 132 vegetation assessment sites and 102 quaternary photo points across all flora surveys (Figure 9.82). Of the 132 vegetation assessment sites, 11 were detailed secondary sites, 68 tertiary sites and 53 quaternary sites (Figure 9.82).

The flora surveys were designed to assess the structural and floristic characteristics of Brigalow communities within the study area against the relevant DCCEEW TEC condition thresholds and diagnostic criteria. The secondary and tertiary sites completed within these vegetation types were considered sufficient to assess whether the communities satisfy the condition criteria.

Further details about the field methods, survey timing, climatic conditions and limitations used to assess the Project area are provided in Appendix F, Terrestrial Ecology Assessment.

<u>Survey outcomes and habitat assessments</u>

Areas of Brigalow vegetation were recorded within the Project site and many of these patches, although not all necessarily meeting remnant or regrowth status, exhibit the key diagnostic features and meet the condition thresholds of the EPBC Act listed endangered Brigalow TEC. These patches are comprised of vegetation representing REs 11.3.1 and 11.4.9a. A total of 32.6 ha of Brigalow TEC has been identified in the study area. There is no Brigalow TEC in the Project site, however, there is 7.6 ha in the ETL study area. This TEC does not occur in the water release/extraction infrastructure area or road realignment.

Patches that meet the key diagnostic characteristics and condition thresholds for the TEC are considered to be critical to the survival of the Brigalow TEC (TSSC 2013b). Therefore, the Brigalow TEC within the study area is critical habitat for this TEC.

Impact assessment

Indirect impacts to this TEC are considered unlikely. Indirect impacts related to noise and vibration, dust, lighting, erosion and sedimentation will be temporary, able to be managed and therefore minimal. Due to the previously fragmented nature of the patches of this TEC in the landscape, edge effects and fragmentation are not expected to be significant and remaining patches of TEC in the Project area are not proposed to be impacted by changes in surface water or flooding regimes.

There will be no facilitated impacts as a result of the Project.

Based on Queensland Government remnant RE mapping, there is approximately 14,687.9 ha of REs that potentially represent the Brigalow TEC in the Dawson River Downs subregion, in which the Project area is located (Accad *et al*., 2019). This is likely to be an underestimation of the extent of Brigalow TEC given the mapping does not capture all regrowth vegetation, remnants of less than 5 ha or less than 75 m in width (Neldner *et al*., 2017). The proposed impact of 1.4 ha accounts for approximately 0.01% of Brigalow TEC in the subregion in which the Project area is located and this is considered unlikely to significantly contribute to cumulative impacts to this TEC in the subregion.

Avoidance, mitigation, and management

Impacts to some areas of Brigalow TEC cannot be avoided due to the location of the coal seams, however, impacts to Brigalow patches along the ETL study area will be avoided where possible as part of the detailed design and siting of the proposed ETL.

Plans and procedures will be implemented during mine construction, operation and rehabilitation, which will manage and monitor impacts to terrestrial ecology. In particular, the following protocols and plans will be developed to manage clearing in and near retained Brigalow TEC:

- vegetation clearing protocols, including a ‘Permit to Disturb’ procedure;
- Weed and Pest Management Plan; and
- Erosion and Sediment Control Plan.

Rehabilitation requirements

Rehabilitation of disturbed areas will occur progressively throughout the life of the mine and will continue after mining has ceased until rehabilitation objectives have been met.

Suitable topsoils and subsoils will be stripped from construction and mining areas, and where viable stored to maintain soil quality and used in rehabilitation to promote native vegetation from the soil seed bank. Revegetation will be also undertaken where required across the mine site.

Significant Impact Assessment

Table 9.66 provides an assessment of the significance of impacts to the Brigalow TEC against the Commonwealth Significant Impact Guidelines.

Table 9.66: Assessment of significance of impacts: Brigalow (A.harpophylla dominant and codominant) Threatened Ecological Community

Significance criteria	***Assessment of significance***
An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:	
• reduce the extent of an ecological community	The Project will result in the clearing of 1.4 ha of Brigalow TEC. Based on Queensland Government remnant RE mapping, there is approximately 14,687.9 ha of REs that potentially represent the Brigalow TEC in the Dawson River Downs sub-region, in which the study area is located (Accad *et al*., 2019). This is likely to be an underestimation of the extent of Brigalow TEC given the mapping does not capture all regrowth vegetation, remnants of < 5 ha or < 75 m in width (Neldner *et al*., 2017). As a result of the history of clearance in the Brigalow Belt, many remaining Brigalow TEC remnants are formed by narrow linear strips within road reserves and are therefore often not captured in the Queensland Government mapping. Overall, this proposed impact of 1.4 ha accounts for approximately 0.01% of Brigalow TEC in the region in which the Project area is located.
• fragment or increase fragmentation of an ecological community, for example by clearing vegetation for road or transmission lines	Patches of Brigalow TEC within the Project site are small and isolated and would be totally removed as a result of the Project. There is potential for the ETL to fragment TEC patches, whereby a 20 m wide easement may traverse one or both patches within the ETL study area. However, this is unlikely to significantly increase fragmentation of this TEC given the already highly fragmented nature of these isolated patches.
• adversely affect habitat critical to the survival of an ecological community	The Brigalow TEC within the Project area is considered unlikely to represent habitat critical to the survival of the community as it is unlikely to be necessary for activities such as breeding or dispersal, long-term maintenance of the community, maintaining genetic diversity or recovery of the community.
• modify or destroy abiotic (non-living) factors (such as water, nutrients, or soils) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	Impacts to this TEC will be confined to the Project site and ETL study area. There are limited patches of this TEC immediately downstream or adjacent to the Project area. A number of controls will be put in place to maintain environmental surface water flows downstream and prevent erosion and sedimentation of surface waters. Changes to the flooding regime are predicted to be minor and are unlikely to affect floodplain communities. Additionally, Brigalow TEC in the Project area is unlikely to be groundwater dependent. Therefore, the Project is not predicted to give rise to impacts on surface water or groundwater that would impact Brigalow TECs that will remain in or adjacent to the Project area.
• cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	Impacts proposed to the Brigalow TEC as a result of the Project are in the form of clearing rather than modification.

Significance criteria	*Assessment of significance*
• cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: o assisting invasive species, that are harmful to the listed ecological community, to become established, or o causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	The Project area is located within a highly modified rural landscape where introduced plants (e.g. Buffel Grass and pest animals, e.g. European Rabbit) are already present and were identified as part of the field surveys. The Project is considered unlikely to increase the threat of these already established invasive species in the landscape. Additionally, the Project is unlikely to result in mobilisation of pollutants of any kind into this TEC within or adjacent to the Project area. A Weed and Pest Management Plan will be developed and implemented for the Project to manage weeds and feral animals. The plan will identify appropriate treatment control programs, that are selected in consideration of the sensitivity of the environment in which they are to be applied. A site Water Management Plan, Erosion and Sediment Control Plan and REMP will also be implemented to maintain surface water quality.
• interfere with the recovery of an ecological community.	Approximately 1.4ha of Brigalow TEC is proposed to be cleared for the Project. There is currently no recovery plan for the Brigalow TEC.
Conclusion	The proposed clearing of 1.4 ha of Brigalow TEC for the Project is not considered to have a significant residual impact on the TEC due to the small amount of clearing that is proposed and the small and isolated nature of the patches in the landscape context.

9.11.9. Impact assessment - threatened species

9.11.9.1 Xerothamnella herbacea

Description

The listing advice for *X. herbacea* indicates that it is known from two sites north-east of Chinchilla, a single record from near Theodore and a record near Yelarbon east of Goondiwindi, Queensland (TSSC, 2008a). However, large populations of this species have been recorded within the Moura and Biloela regions in recent years (Appendix F, Terrestrial Ecology Assessment). This species occurs in Brigalow dominated communities in shaded situations, often in leaf litter and is often associated with gilgais (shallow ground depressions). Soils are generally heavy, grey to dark brown clays (TSSC, 2008a).

Current threats

Current known threats to *X. herbacea* include competition by invasive plants, particularly Green Panic and Buffel Grass, which occupy similar habitats and locations. These plants can outcompete *X. herbacea* and increase fire fuel loads and alter fire regimes in habits in which this species occurs (TSSC, 2008a).

Potential threats have also been identified such as road widening, surface erosion, grazing and trampling by cattle and native macropods (TSSC, 2008a).

Management plans

There are no management plans or recovery plans in place for this species. The Commonwealth government provides the following plans and advice for *X. herbacea,* which have been considered in preparing this assessment:

> *Conservation Advice: approved conservation advice has been prepared for X. herbacea, which provides priority research and management actions for the species, as well as specifying key threats.*

Survey effort

Seasonal field flora surveys were undertaken over 23 days and carried out in compliance with the Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland, Versions 5.1, 5.0 and 4.0, current at the time of the field surveys (Neldner *et al*., 2020; 2019; 2017). Assessment sites were performed throughout the study area to thoroughly assess the Queensland Government mapped remnant vegetation. An additional day of field survey was focused on assessing population distribution and abundance of threatened flora previously identified within the Project site, including *X. herbacea*.

Detailed flora species lists were collated at all secondary sites and traverse lists were compiled to account for additional species that were recorded outside of the secondary site plots. Large portions of the study area were traversed on foot and the random meander technique applied (Cropper, 1993). This method is essential for the detection of cryptic, pest and other significant species. This method was supplemented with 'educated walks' (Garrard *et al*., 2008) in habitat areas that possessed a higher likelihood of supporting threatened flora species.

Significant flora species listed under the EPBC Act and NC Act that were recorded or predicted to occur from database searches were reviewed and, where relevant, formed the focus of targeted flora species surveys. Detailed traverses of habitat considered suitable for significant flora species were undertaken.

Areas identified as high risk for the presence of significant plants on the Protected Plants Flora Survey Trigger Map were assessed using the Queensland Flora Survey Guidelines - Protected Plants Versions 2.01 and 2.0, current at the time of the field surveys (DEHP, 2016b; DES, 2019h). This guideline requires the timed meander method to be employed in areas of high risk.

Further details about the field methods, survey timing, climatic conditions and limitations used to assess the Project area are provided in Appendix F, Terrestrial Ecology Assessment.

Survey outcomes and habitat assessments

A population of approximately 90 individuals of this species was recorded in 10 locations within a fragmented and considerably degraded patch of non-remnant Dawson River Gum scrubby open woodland (RE 11.4.8) in the central eastern portion of the Project site (Figure 9.86). This species was recorded during the late dry season survey (December 2017) following moderate rainfall totals delivered during spring storms prior to the survey. The number of individuals present at each location was low and ranged from one individual to around 20 individuals.

The woodland community was markedly fragmented with dead stags common throughout the canopy layer. The shrub layer was comprised of vine thicket species such as Scrub Boonaree, Stiff-leaved Denhamia, Wild Lime and Wallaby Apple (*Pittosporum spinescens*). Cattle grazing was prevalent and an ongoing disturbance throughout the area, which has led to the fragmentation of the shrub layer and weed infiltration throughout much of the ground layer.

There is potential for a mixed community of RE 11.3.1/11.3.3 along Banana Creek in the south of the additional investigation area to support this species. However, this species was not recorded in this habitat despite extensive searches in this area.

Populations of this species are not known from Projects within the region (i.e. within 25 km of the Project site) and the population within the Project site is near the northern limit of this species distribution. Eco Solutions & Management knows of this species occurring east of Moura in the vicinity of the Baralaba Mine TLO facility approximately 30 km south of the Project area, as well as a very large population of more than 78,000 individuals at a location approximately 40 km south-east of the Project area.

Impact assessment

The Project will result in the removal of all individuals of this species within the population identified in the Project site.

Indirect impacts to the population within the Project site are not relevant given the population will be removed. Indirect impacts to any other populations in the region related to dust, erosion and sedimentation are unlikely as these will be temporary, or able to be managed and any surrounding populations would be separated by greater than 200 m from Project activities. No populations or potential habitat is proposed to be fragmented. Potential surface water, flooding and groundwater impacts are unlikely to significantly affect the Dawson River or Banana Creek.

There will be no facilitated impacts as a result of the Project.

There is no publicly available information about impacts to this species as a result of other Projects in the region.

Avoidance, mitigation, and management

Impacts to the population of *X. herbacea* within the Project site cannot be avoided due to the location of the coal seams.

A comprehensive groundwater monitoring network is proposed for the duration of the Project to allow early identification of changes in vegetation condition outside of the Project area that may have resulted from Project activities, e.g. changes in groundwater conditions, surface water flows or the flooding regime. This will be relevant to vegetation along the Dawson River and Banana Creek that although unlikely, have the potential to support populations of this species.

Rehabilitation requirements

Rehabilitation of disturbed areas will occur progressively throughout the life of the mine and will continue after mining has ceased until rehabilitation objectives have been met.

Suitable topsoils and subsoils will be stripped from construction and mining areas, and where viable stored to maintain soil quality and used in rehabilitation to promote native vegetation from the soil seed bank. Revegetation will be also undertaken where required across the mine site.

Significant impact assessment

Table 9.67 provides an assessment of the significance of impacts to *X. herbacea* against the Commonwealth Significant Impact Guidelines.

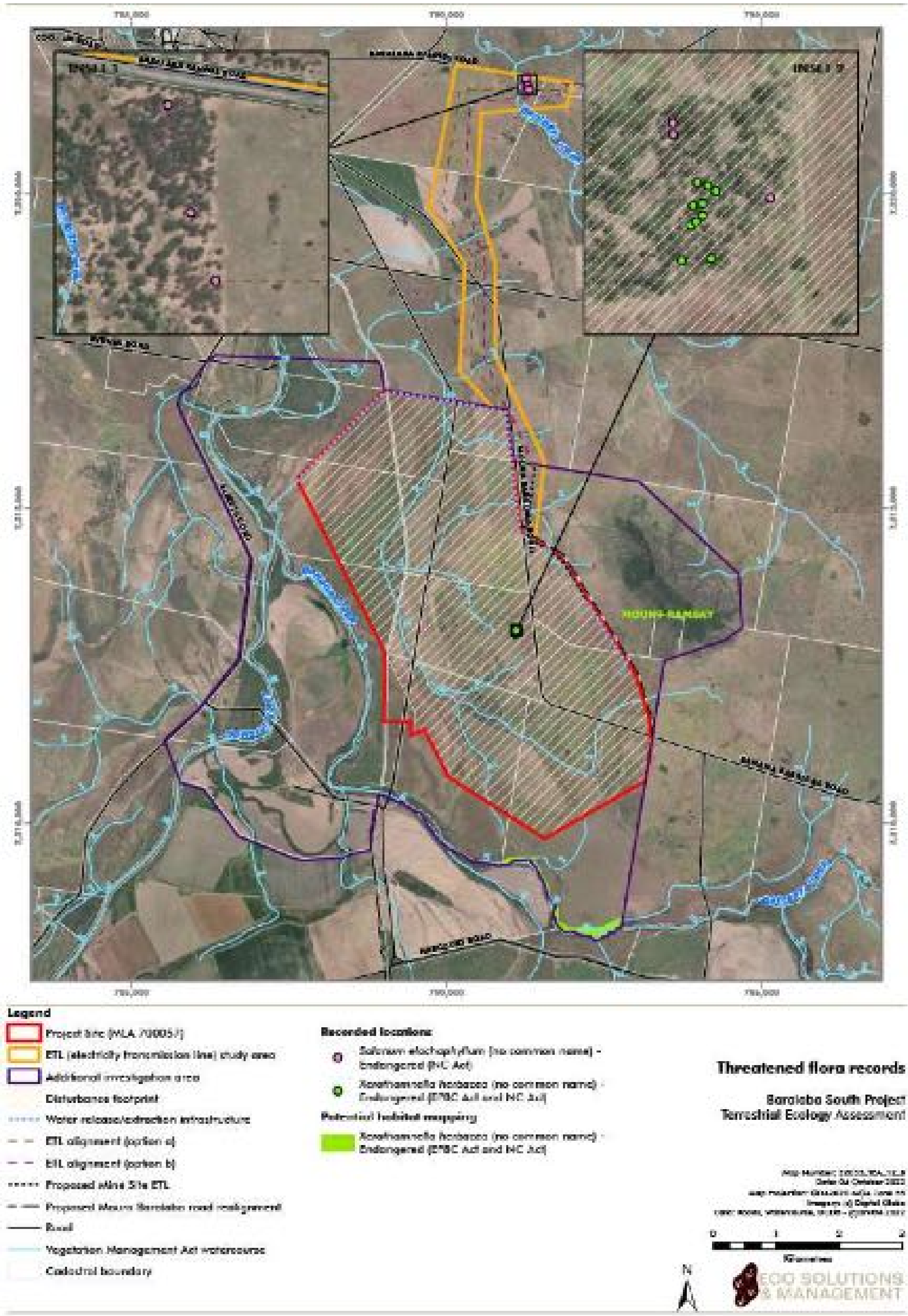


Figure 9.86: *Threatened flora records within the terrestrial ecology study area*

Table 9.67: Assessment of significance of impacts for the Xerothamnella herbacea

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:	
• lead to a long-term decrease in the size of a population	The Project will result in clearing of all individuals within the population of *X. herbacea* identified in the Project site.
• reduce the area of occupancy of the species	This species has a restricted distribution in central Queensland and there are very few published records of this species. Eco Solutions & Management is aware of a number of other records within the larger locality, including a very large population of more than 78,000 individuals approximately 40 km south-east of the Project area. However, the population within the Project site is nearing the northern limit of this species' known distribution and removing this population has the potential to reduce the area of occupancy of the species.
• fragment an existing population into two or more populations	There is only one population within or adjacent to the Project area, although other populations are known within 30 km south of the Project area along the Dawson River (C. Hansen pers. comm.). The clearing of this population will not result in fragmentation of a population.
• adversely affect habitat critical to the survival of a species	There is no information about critical habitat for this species. There is currently no habitat for *X. herbacea* listed on the Commonwealth's Register of Critical Habitat. While the occurrence of this population in the Project site is near the northern limit of this species known distribution, there are other records and potential habitat for this species in the region. The population within the MLA is not considered critical to the survival of the species as it is unlikely to be necessary for activities such as breeding or dispersal, long-term maintenance of the species, maintaining genetic diversity or recovery of the species.
• disrupt the breeding cycle of a population	This population would be cleared in its entirety therefore, there would be no opportunity to impact the breeding cycle of this population.
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There is limited habitat available for this species in the broader study area due to historic clearing of potentially suitable habitats and the extent of invasive grass species that dominant the ground layer throughout vegetated and non-vegetated areas of the study area. A small stretch of approximately 22.9 ha of RE 11.3.1/11.3.3 along Banana Creek is recognised as potential habitat for this species. However, this area was intensively searched during surveys and the species was not detected. No direct impacts to this additional potential habitat are proposed. Changes to the flooding regime are predicted to be minor and are unlikely to affect floodplain communities. Therefore, the Project is not expected to affect availably or quality of potential habitat areas along the Dawson River and Banana Creek.
• result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	The Project area is located within a modified rural landscape where introduced plants and feral animals are already present. Invasive species and feral animals such as Buffel Grass, Green Panic and Feral Pigs have been identified as part of field surveys in the study area. These invasive species already pose a threat to *X. herbacea* habitat within the study area and in the surrounding landscape and the Project is unlikely to increase this threat. Similarly, the Project is unlikely to introduce new invasive weed species that are not already present and established in the study area as controls will be put in place as standard and industry recognised controls will be put in place as part of the Weed and Pest Management Plan.

Significance criteria	Assessment of significance
• introduce disease that may cause the species to decline, or	Disease is not a known threat to *X. herbacea*. The Project is unlikely to introduce disease that may cause the species to decline.
• interfere with the recovery of the species	There is currently no recovery plan for *X. herbacea*.
Conclusion	The Project is considered likely to have a significant impact on *X. herbacea* due to the clearing of a population that is near the northern limit of its known distribution.

9.11.9.2 Ornamental Snake

Description

The Ornamental Snake is found in close association with frogs, which form the majority of its prey. It is known to prefer woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions with clay soils but is also known from lake margins, wetlands and waterways (DCCEEW, 2023b).

The SPRAT profile and Draft Referral guidelines for the nationally listed Brigalow Belt reptiles specifically describe 'pure grassland associated with gilgais' and 'cleared areas formerly mapped as open forests to woodlands associated with gilgai formations and wetlands i.e. REs 11.3.3, 11.4.3, 11.4.6, 11.4.8, 11.4.9 and 11.5.16' as suitable habitat for this species (DCCEEW, 2023b; SEWPaC, 2011a).

The Ornamental Snake requires microhabitat features such as cracking clay soils, rotting logs or stumps, coarse woody debris, leaf litter or surface rock. These features are required because they either support the prey food of this species (i.e. frogs) or provide refuge habitat for the Ornamental Snake (DCCEEW, 2023b).

Current threats

Current known threats to the Ornamental Snake include:

- habitat loss and fragmentation through clearing (roads, ploughing, railways, mining-related activities, pipeline constructions);
- habitat degradation by overgrazing by stock, especially cattle, or grazing of gilgai during the wet season leas to soil compaction and compromising of soil structure;
- alteration of landscape hydrology in and around gilgai environments;
- alteration of water quality through chemical and sediment pollution of wet areas;
- contact with the Cane Toad;
- predation by feral species; and
- invasive weeds (DCCEEW 2023b).

Management plans

The following plans and advice are in place for the Ornamental Snake, which have been considered in preparing this assessment:

- Conservation Advice: Approved Conservation Advice has been prepared for the Ornamental Snake, which provides priority research and management actions for the species, as well as specifying key threats (TSSC, 2014);

- Recovery Plan: There is currently no Commonwealth recovery plan in place for this species. The DCCEEW SPRAT Profile identifies that a recovery plan is not required, as approved Conservation Advice provides sufficient direct for recovery of the species (DCCEEW, 2023b);
- Referral Guideline: The Draft Referral guidelines for the national listed Brigalow Belt reptiles outline important habitat for the Ornamental Snake. The guideline also enables the Proponent to undertake an initial assessment to determine whether a significant impact is likely on the species (SEWPaC, 2011a);
- Draft recovery plan for the Queensland Brigalow Belt Reptiles (Richardson, 2006), which provides which provides priority research and management actions for the species, as well as specifying key threats for Ornamental Snake; and
- Fitzroy Natural Resource Management Region Back on Track Actions for Biodiversity (DERM, 2010).

Survey effort

Seasonal fauna surveys were undertaken over 22 days and carried out in consideration of relevant Commonwealth and Queensland surveys guidelines. Survey methods and effort included, but was not limited to:

- four systematic trap sites;
- 33 person hours spotlighting;
- 20.5 person hours active searching; and
- 282 diurnal and 104 nocturnal person hours of opportunistic observations.

Spotlighting, active searching, pitfall and funnel traps and incidental/opportunistic observations are methods most relevant for the detection of the Ornamental Snake and these were undertaken in preferred habitat in the Project area. However, the duration of active searching and spotlighting required for the Ornamental Snake under the DCCEEW survey guidelines for Brigalow Belt reptiles was not achieved. The DCCEEW Draft Referral guidelines for the nationally listed Brigalow Belt reptiles require 1.5 person hours diurnally and nocturnally per hectare over at least three days and nights (SEWPaC, 2011a). This equates to more than 148 hours of active searching and another 148 hours of spotlighting, which would require several weeks of survey in preferred habitat in the Project area.

Despite not meeting the DCCEEW survey guidelines, the Ornamental Snake was confirmed within the Project site during the surveys with the survey effort applied to the Project area.

Further details about the field methods, survey timing, climatic conditions and limitations used to assess the Project area provided in Appendix F, Terrestrial Ecology Assessment.

Survey outcomes and habitat assessments

Two individuals of Ornamental Snake were detected during spotlighting sessions in non-remnant Coolibah with Brigalow woodland (RE 11.3.3) associated with a stream order 1 drainage line in the south-western portion of the Project site during seasonal surveys (Figure 9.87).

Approximately 99.7 ha of Ornamental Snake habitat has been identified within the Project site and ETL study area, including 34.6 ha of marginal foraging habitat in the form of highly degraded gilgai formations.

There is no potential habitat for this species within the proposed road realignment or water extraction/release infrastructure area.

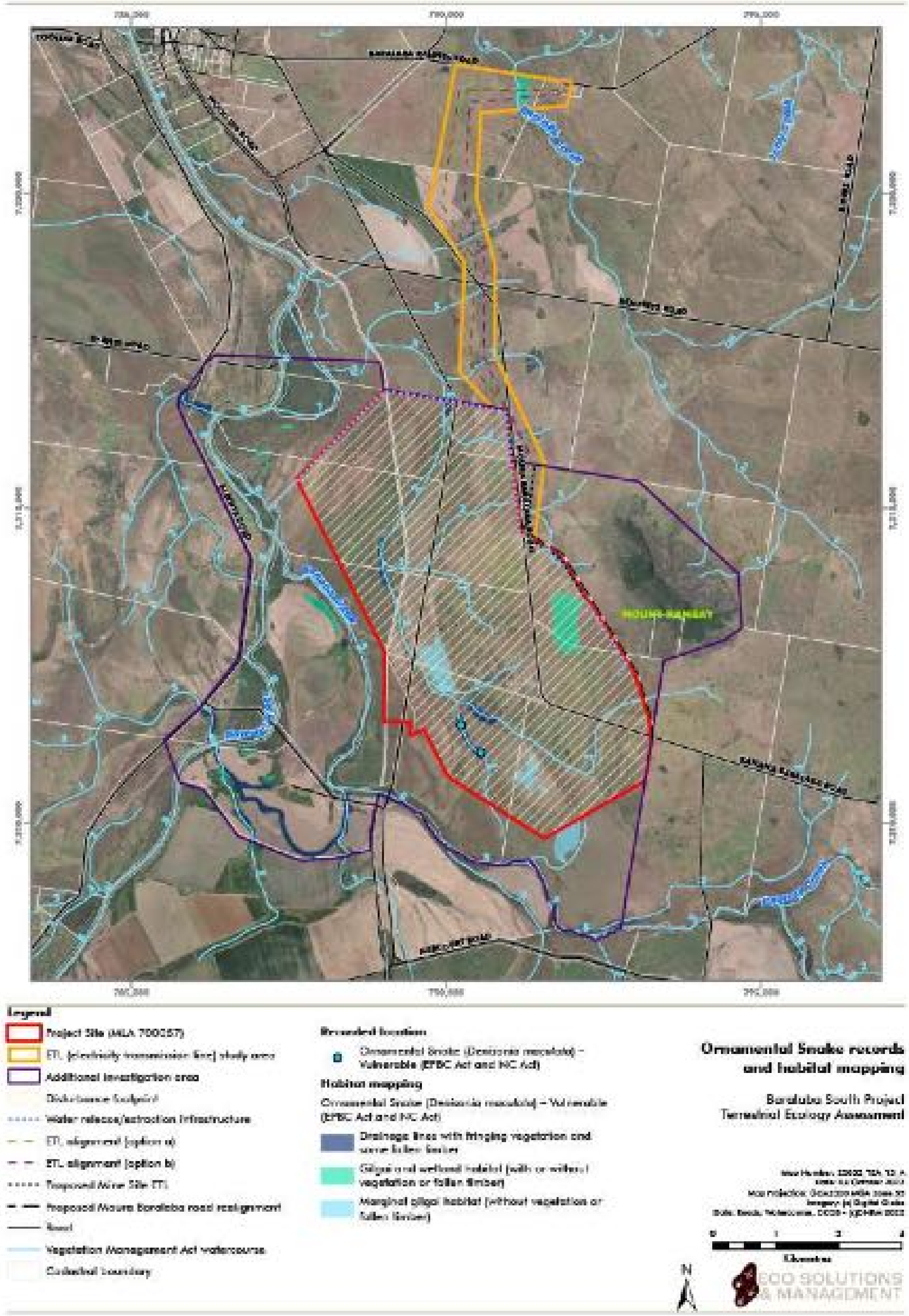


Figure 9.87: Ornamental Snake records and habitat within the terrestrial ecology study area

Importance of the population

The Draft Referral guidelines for the nationally listed Brigalow Belt reptiles identify important habitat for this species as being 'habitat where the species has been identified during a survey' (SEWPaC, 2011a). As this species was recorded in habitat within the Project area, the habitat in the Project area is considered to be important habitat in accordance with the Draft referral guidelines.

The Draft Referral guidelines also outline that because Brigalow Belt reptiles can be difficult to detect, important habitat should be considered a surrogate for important populations. Therefore, the population within the Project area should be considered an important population in line with the Draft Referral guidelines.

Impact assessment

Of the better quality habitat, 34.9 ha is proposed to be cleared for the Project. No clearing of marginal habitat is proposed.

Indirect impacts to Ornamental Snake are considered unlikely. Indirect impacts related to noise and vibration, dust, lighting, vehicle strike, erosion and sedimentation will be temporary, and reasonably simply managed and therefore minimal. Due to the already fragmented nature of the patches of this habitat in the landscape, edge effects and fragmentation are not expected be significant and remaining areas of habitat in the study area are not proposed to be impacted by changes in surface water or flooding regimes

There will be no facilitated impacts as a result of the Project.

Incremental impacts to Ornamental Snake habitat are likely as a result of mine Projects in the region, for which authorisation to clear vegetation and habitat has been granted. These Projects are approved with conditions and in accordance with the EO Act and EPBC Act, where significant impacts are likely, offsets will form part of those conditions. Similarly, where significant impacts are proposed as part of this Project, offsets will be provided. Therefore, in line with the offset legislation, the Project will provide adequate compensation for significant residual impacts to the Ornamental Snake and should not contribute significantly to cumulative impacts.

Avoidance, mitigation, and management

Impacts to some areas of Ornamental Snake habitat cannot be avoided due to the location of the coal seam however, impacts to habitat along the ETL study area will be avoided where possible as part of the detailed design and siting of the proposed ETL.

A range of plans and procedures will be implemented during mine construction, operation and rehabilitation, which will manage and monitor impacts to terrestrial ecology. In particular, the following protocols and plans will be developed to manage clearing in and near Ornamental Snake habitat to minimise harm to individuals and protect habitat to be retained, including:

- vegetation clearing protocols, including a 'Permit to Disturb' procedure;
- Species Management Program;
- Weed and Pest Management Plan; and
- Erosion and Sediment Control Plan.

Rehabilitation requirements

Rehabilitation of disturbed areas will occur progressively throughout the life of the mine and will continue after mining has ceased until rehabilitation objectives have been met.

Suitable topsoils and subsoils will be stripped from construction and mining areas, and where viable stored to maintain soil quality and used in rehabilitation to promote native vegetation from the soil seed bank. Revegetation will be also undertaken where required across the mine site.

Significant impact assessment

Table 9.68 provides an assessment of the significance of impacts to the Ornamental Snake against the Commonwealth Significant Impact Guidelines.

Table 9.68: Assessment of significance of impacts for the Ornamental Snake

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
• lead to a long-term decrease in the size of an important population of a species	The population of Ornamental Snake in the Project area is considered to be an important population. The project will involve clearing of approximately 34.9 ha of habitat. Therefore, the Project may lead to a decrease in the size of an important population.
• reduce the area of occupancy of an important population	The Project will result in removal of a total of 34.9 ha of habitat for an important population. However, potential gilgai habitat is widespread in the region, including in the vicinity of Banana Creek within the additional investigation area, and there are a number of records south of the Project area, in the vicinity of Banana and Moura (CSIRO 2019). Therefore, removal of the habitat in the Project area is unlikely to reduce the area of occupancy of this species.
• fragment an existing important population into two or more populations	The population of Ornamental Snake that uses the Project area is considered to be an important population. It is proposed that all patches of habitat within the Project site will be cleared for the Project, therefore, fragmentation of these habitat patches will not occur. However, fragmentation of the patch in the north of the ETL study area is likely as a result of clearing for a 20 m wide ETL easement. However, this is unlikely to significantly impact this habitat given the already highly fragmented nature of this patch. Furthermore, this species is able and known to move across cleared paddocks during foraging and dispersal activities. Additionally, aerial photographs indicate large patches of potential gilgai habitat is present to the north, north-east, east and south-east within 5 km of the Project area. The Project does not severe connectivity between habitats in those surrounding areas, e.g. between the Dawson River or Banana Creeks and those gilgai habitats.
• adversely affect habitat critical to the survival of a species	Habitat critical to the survival of the species is not defined in the guidelines for this species. Habitat in which the Ornamental Snake was observed does not align with important habitats defined in the Draft Referral guidelines for the nationally listed Brigalow Belt reptiles or the primary vegetation types, microhabitats or refuge habitats described in the DCCEEW SPRAT Profile for the species (DCCEEW 2023b; SEWPaC, 2011a). Therefore, these habitats along creek lines are not considered to be critical to the survival of the species. The habitat within the Project site and ETL study area is considered unlikely to represent habitat critical to the survival of the species in terms of the definition within the Significant Impact Guidelines. The habitat is used for foraging and potentially breeding for the local population of the species but the habitat is unlikely to be necessary for foraging or breeding for the species as a whole. The habitat is considered unlikely to be necessary for the long-term maintenance of the species, maintaining genetic diversity or recovery of the species.

Significance criteria	Assessment of significance
• disrupt the breeding cycle of an important population	The population of Ornamental Snake that uses the Project area is considered to be an important population. Standard industry recognised measures will be employed during the vegetation clearing stages of the Project to minimise harm and disruption to animals and breeding places in accordance with the requirements of the Queensland Nature Conservation (Animals) Regulation 2020. This will reduce the risk and extent of disruption to the breeding cycle of Ornamental Snake that occur in the Project area.
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Approximately 34.9 ha of Ornamental Snake wetland and gilgai habitat will be impacted by the Project. Although gilgai habitat will remain in the local area, the clearing of habitat has the potential to cause the species to decline in the local area. Indirect impacts associated with the Project will be managed to the extent that they are unlikely to degrade retained habitat within the Project area to the extent this species is likely to decline.
• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The Project area is located within a modified rural landscape where introduced plants and feral animals are already present. Invasive species and feral animals such as Buffel Grass, Green Panic, Feral Pigs and Wild Dogs have been identified as part of field surveys in the study area. These invasive species already pose a threat to Ornamental Snake within the Project area and in the surrounding landscape, through predation and degradation of habitat, and the Project is unlikely to increase this threat. Similarly, the Project is unlikely to introduce new invasive species that are not already present and established in the Project area as standard and industry recognised controls will be put in place as part of the Weed and Pest Management Plan.
• introduce disease that may cause the species to decline, or	There are few diseases and viruses known to affect snakes in Australia and these are predominantly related to Pythons. The diseases are often (but not always) related to captive snakes, have been known to be introduced by exotic species and usually spread by other affected snakes. It is considered unlikely that the Project will introduce a disease that may cause the Ornamental Snake to decline.
• interfere substantially with the recovery of the species	Although the Project will result in the removal of potential and known habitat for the species, the Proponent will implement mitigation strategies to assist in minimising impacts to the species. As such, the Project is considered unlikely to interfere substantially with the recovery of the species as a whole.
Conclusion	The area of habitat proposed to be cleared and the importance of the habitat present indicate the Project is likely to have a significant residual impact on the Ornamental Snake.

9.11.9.3 Australian Painted Snipe *(Rostratula australis)*

Description

The Australian Painted Snipe (*Rostratula australis*) is currently listed as endangered under the EPBC Act and the NC Act. However, this species was listed as vulnerable under the EPBC Act and NC Act at the time of the controlled action decision.

This secretive, cryptic, crepuscular (active at dawn, dusk and during the night) species occurs in terrestrial shallow wetlands, both ephemeral and permanent, usually freshwater but occasionally brackish. They also use inundated grasslands, salt-marsh, dams, rice crops, sewage farms and bore drains with rank emergent tussocks of grass, sedges, rushes or reeds or samphire, and often with scattered clumps of Lignum, Canegrass or sometimes Tea Trees. This species has been known to use wetland areas lined with trees, or that have some scattered fallen or washed-up timber (DCCEEW, 2023h).

Wetland habitat suitable for breeding is noted as being critical for the Australian Painted Snipe in the listing advice for the species. Breeding habitat is described in the advice as:

> *…continuous reed beds, stand of reed-like vegetation, rice fields and areas with no surrounding low cover… Nests are made among tall rank tussocks, frequently on small, muddy islands or mounds surrounded by shallow fresh water, sometimes on shores of swamps or on banks of channels. Nesting typically occurs in ephemeral wetlands that are drying out after an influx of water, provided they have complex shorelines and a combination of very shallow water, exposed mud and dense low cover* (TSSC, 2013a).

The SPRAT profile for the species also recognises dense low cover and sometimes some tall dense cover is also present in breeding habitat (DCCEEW, 2023h).

Current known threats

The primary threat to the Australian Painted Snipe is loss and degradation of wetland habitats, through:

- alteration of drainage, reduced flooding and the diversion of water for irrigation and reservoirs;
- changes in vegetation assemblages from cropping and possibly altered fire regimes; and
- grazing causing trampling and altered nutrient levels (TSSC, 2013c).

Potential future threats include:

- changes in hydrological regimes due to climate change;
- predation by feral species; and
- invasion by exotic plants (TSSC, 2013c).

Management plans

The following plans and advice are in place for the Australian Painted Snipe, which have been considered in preparing this assessment:

- **Conservation advice:** Approved Conservation Advice has been prepared for the Australian Painted Snipe, which provides priority research and management actions for the species, as well as specifying key threats (TSSC, 2013c).
- **Recovery plan:** There is currently no Commonwealth recovery plan in place for this species. However, The Action Plan for Australian Birds 2000 provides a brief recovery outline for this species (Garnett and Crowley, 2000).
- **Information sheet:** An information sheet has been prepared for this species that provides details about the habitat of this species, why it is threatened and implications of the EPBC Act (DEH, 2003).

Survey effort

Seasonal fauna surveys were undertaken over 22 days and carried out in consideration of relevant Commonwealth and Queensland surveys guidelines. Survey methods and effort included, but was not limited to:

- four systematic trap sites;
- 33 person hours spotlighting;
- 16 infrared cameras nights;

- 20.5 person hours active searching;
- 37 person hours bird surveying; and
- 282 diurnal and 104 nocturnal person hours of opportunistic observations.

Spotlighting, infrared cameras, active searching, bird survey and incidental/opportunistic observations are methods most relevant for the detection of the Australian Painted Snipe and these were undertaken in preferred habitat in the Project area. The survey effort for the Project generally complied with survey guidelines. However, this is a very cryptic bird that is known to inconsistently use habitats and there is no guarantee that it would be recorded even during favourable conditions.

Further details about the field methods, survey timing, climatic conditions and limitations used to assess the Project area provided in Appendix F, Terrestrial Ecology Assessment.

Survey outcomes and habitat assessments

The Australian Painted Snipe was not recorded in the study are during the seasonal surveys, however, vegetated sections of wetlands and broad drainage lines in the west and south-west of the Project site that support Lignum, provide some areas of suitable habitat for this species, and it is considered the species has a moderate likelihood of occurrence.

The gilgai areas in the Project site appear to have been blade ploughed in the past and support a low abundance of sedges indicating that they do not hold water for prolonged periods. Nonetheless, these gilgai are likely to provide some wetland features and this species is known to use heavily disturbed areas that exhibit wetland characteristics, including cleared gilgai. Although these cleared gilgai provide seasonal foraging habitat for this species this species is likely to use these disturbed habitats opportunistically during the wet season when gilgai are holding water. Cleared gilgai generally lack canopy cover that forms part of the breeding habitat requirements for this species (DCCEEW, 2023h). Therefore, cleared gilgai habitat is considered to comprise marginal foraging habitat for this species in the study area.

Similarly, gilgai and wetland habitats in the additional investigation area may provide foraging habitat for this species (Figure 9.88).

Two broad habitat types are considered to occur in the study area for the Australian Painted Snipe and differ in their naturalness and presence of fringing vegetation that provides cover for this species:

- wetland and drainage lines with fringing vegetation
- cleared gilgai that forms marginal habitat for this species.

Approximately 86.2 ha of potential wetland and drainage line habitat for the Australian Painted Snipe has been mapped within the Project site and ETL study area as well as an additional 84.4 ha of marginal habitat in the form of cleared gilgai habitat.

Impact assessment

Approximately 1 ha of wetland and drainage line habitat is proposed to be cleared for the Project as well as an additional 33.9 ha of marginal gilgai habitat (Figure 9.87).

Indirect impacts to Australian Painted Snipe are considered unlikely. Indirect impacts related to noise and vibration, dust, lighting, vehicle strike, erosion and sedimentation will be temporary, and able to be managed and therefore minimal. Due to the already fragmented nature of the patches of this habitat in the landscape, edge effects and fragmentation are not expected be significant and remaining areas of habitat in the study area are not proposed to be impacted by changes in surface water or flooding regimes.

There will be no facilitated impacts as a result of the Project.

There is no publicly available information about impacts to this species as a result of other Projects in the region. However, there is potential for incremental impacts to Australian Painted Snipe habitat as a result of mine Projects in the region, for which authorisation to clear vegetation and habitat has been granted. These Projects are approved with conditions and in accordance with the EO Act and EPBC Act, where significant impacts are likely, offsets will form part of those conditions. Where impacts are unlikely to be significant, the contribution to the cumulative impact is also unlikely to be significant.

Avoidance, mitigation and management

Impacts to some areas of Australian Painted Snipe habitat cannot be avoided due to the location of the coal seams, however, impacts to habitat along the ETL study area will be avoided where possible as part of the detailed design and siting of the proposed ETL.

A range of plans and procedures will be implemented during mine construction, operation and rehabilitation, which will manage and monitor impacts to terrestrial ecology. In particular, the following protocols and plans will be developed to manage clearing in and near Australian Painted Snipe habitat to minimise harm to individuals and protect habitat to be retained, including:

- vegetation clearing protocols, including a ‘Permit to Disturb’ procedure;
- Species Management Program;
- Weed and Pest Management Plan; and
- Erosion and Sediment Control Plan.

Rehabilitation requirements

Rehabilitation of disturbed areas will occur progressively throughout the life of the mine and will continue after mining has ceased until rehabilitation objectives have been met.

Suitable topsoils and subsoils will be stripped from construction and mining areas, and where viable stored to maintain soil quality and used in rehabilitation to promote native vegetation from the soil seed bank. Revegetation will be also undertaken where required across the mine site.

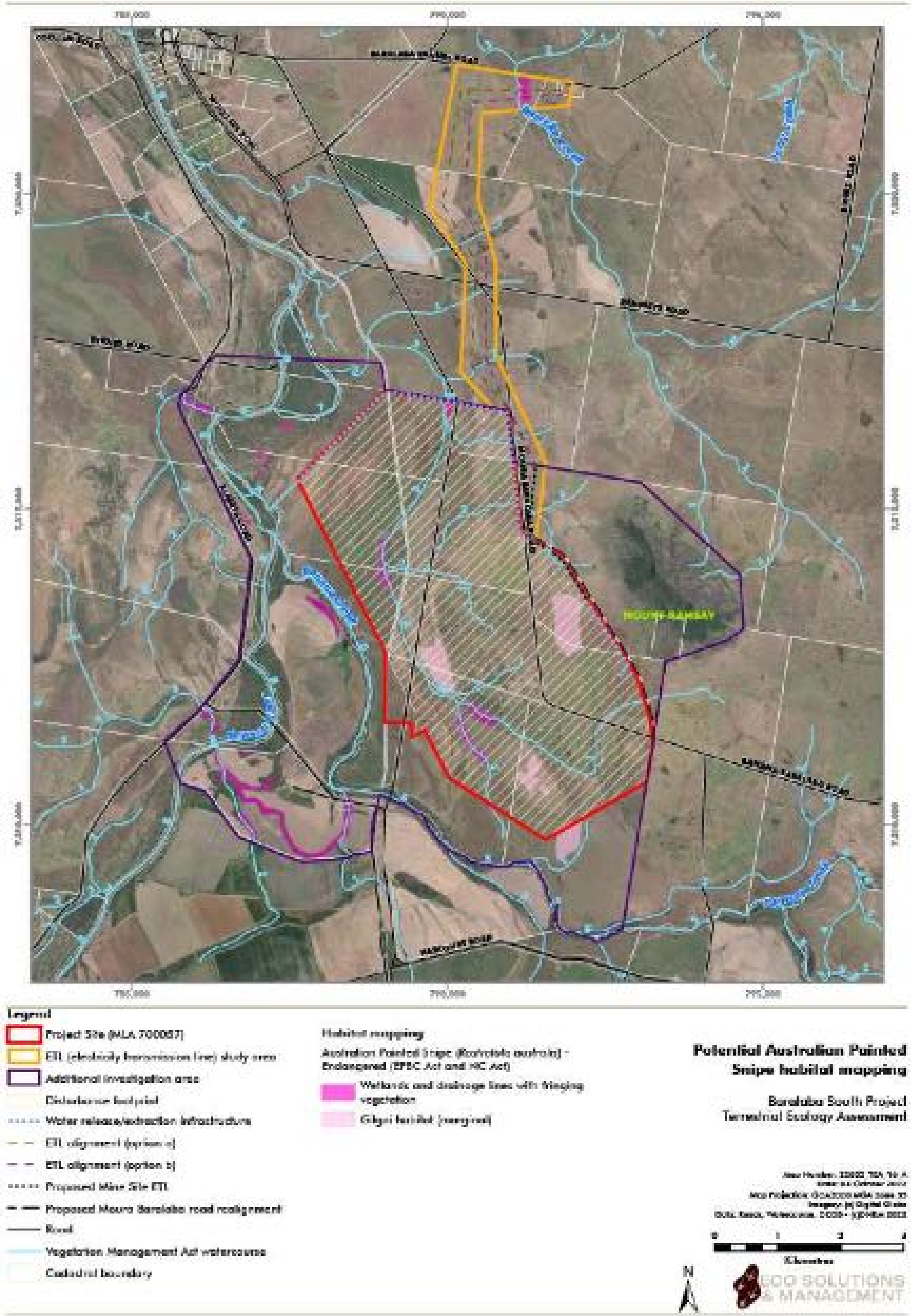


Figure 9.88: Australian Painted Snipe potential habitat within the terrestrial ecology study area

Significant impact assessment

Table 9.69 provides an assessment of the significance of impacts to the Australian Painted Snipe against the vulnerable species criteria in the Commonwealth Significant Impact Guidelines, as this was the species listing under the EPBC Act when the Project was determined a controlled decision.

Table 9.69: Assessment of significance of impacts for the Australian Painted Snipe

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
• lead to a long-term decrease in the size of an important population of a species	The Project area is unlikely to support and important population, the Project will involve clearing approximately 1 ha of potentially suitable habitat and another 33.9 ha of marginal habitat in the Project site and ETL study area. However, this species was not recorded in the study area during surveys and the potential habitats present are ephemeral. The species is considered in Australia to be a single contiguous breeding population (Garnett *et al*., 2011) and is often a solitary breeder. In addition, the species is thought to possibly be migratory or dispersive. Therefore, the presence of this species, should it occur in the study area, is unlikely to be permanent. Considering this, the Project is considered unlikely to decrease the size of a population of this species.
• reduce the area of occupancy of an important species	The Project is unlikely to support an important population. Removal of potential habitats in the Project site and ETL study area is unlikely to affect this species' use of the area given floodplain habitats are present elsewhere in the region in association with the Dawson River and Banana Creek. Therefore, the area of occupancy of this species should not be impacted by the Project.
• fragment an existing important population into two or more populations	The Project area is unlikely to support an important population. The Australian Painted Snipe is thought to be migratory or dispersive and is widely distributed across the majority of eastern Australia. Therefore, any population of Australian Painted Snipe that may use suitable habitat in the study area is unlikely to be fragmented into two or more populations. The presence of a population in the Project area is likely to be periodical in response to seasonal conditions. The ability of this species to move between remaining habitats will not be compromised as a result of the Project.
• adversely affect habitat critical to the survival of a species	Wetland habitat suitable for breeding is noted as being critical for the Australian Painted Snipe in the listing advice for the species (TSSC, 2013a). The potential habitat proposed to be cleared is not regarded as particularly significant or indicative of habitat critical to the survival of the species, as the habitat consists of shallow water at times, it does not provide continuous reed beds, muddy islands or mounds and shorelines or banks are limited. It is considered unlikely to be necessary for foraging, breeding, roosting or dispersal, the long-term maintenance of the species, maintaining genetic diversity or recovery of the species.
• disrupt the breeding cycle of an important population	The Project area is unlikely to support an important population. It is not known if the species breeds in the Project site or ETL study area, although potential habitat present does not exhibit particularly suitable characteristics for breeding. Nonetheless, the Project will employ standard industry recognised measures during the vegetation clearing stages of the Project to minimise harm and disruption to animals and breeding places in accordance with the requirements of the Queensland Nature Conservation (Wildlife Management) Regulation 2020. This will reduce the risk and extent of disruption to the breeding cycle of Australian Painted Snipe that may be present.

Significance criteria	Assessment of significance
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Approximately 1 ha of potentially suitable Australian Painted Snipe habitat will be impacted by the Project as well as an additional 33.9 ha of marginal habitat. However, this is unlikely to cause the species to decline as it is unlikely to be permanently used. Indirect impacts associated with the Project, such as noise, dust, light, weeds and pest animals will be managed to the extent that they are unlikely to degrade retained habitat within the study area to the extent this species is likely to decline. Changes to the flooding regime are predicted to be minor and are unlikely to affect floodplain communities and therefore unlikely to affect availability of Australian Painted Snipe habitat in this area. Potential drawdown outside the Project area would be limited and groundwater dependence of riparian vegetation along the Dawson River and Banana Creek, is unlikely. Therefore, the Project is not predicted to give rise to impacts on surface water or groundwater that would impact Australian Painted Snipe habitat outside the Project area.
• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The Project area is located within a modified rural landscape where introduced plants and feral animals are already present. Invasive species and feral animals such as Buffel Grass, Green Panic, Feral Pigs and Wild Dogs have been identified as part of field surveys in the study area. These invasive species and likely others, such as the Red Fox, already pose a threat to the Australian Painted Snipe and its potential habitat within the Project area and in the surrounding landscape and the Project is unlikely to increase this threat. Similarly, the Project is unlikely to introduce new invasive species that are not already present and established in the study area as controls will be put in place as standard and industry recognised controls will be put in place as part of the Weed and Pest Management Plan.
• introduce disease that may cause the species to decline, or	Disease is not a known threat to this species. Therefore, the Project is considered unlikely to introduce disease that may cause the Australian Painted Snipe to decline.
• interfere substantially with the recovery of the species	There is currently no Commonwealth recovery plan in place for this species. The Project area is unlikely to support a permanent population of the Australian Painted Snipe and the area proposed to be impacted is unlikely to provide suitable breeding habitat for this species. Therefore, clearing of 23.8 ha of potentially suitable habitat and an additional 68.3 ha of marginal habitat, is considered unlikely to interfere with the recovery of the species.
Conclusion	The Project is unlikely to significantly impact the Australian Painted Snipe as it is unlikely to breed in the Project site or ETL study area or use the Project area permanently.

9.11.9.4 Koala (Phascolarctos cinereus)

Description

The Koala is widespread in sclerophyll forest and woodland on foothills and plains on both sides of the Great Dividing Range from about Chillagoe, Queensland to Mt Lofty Ranges in South Australia (Menkhorst and Knight, 2011).

Any forest or woodland containing species that are known Koala food trees, or shrubland with emergent food trees provides potential Koala habitat. Koalas are known to occur in modified or regenerating native vegetation communities and are not restricted to remnant vegetation (DAWE, 2020b). The EPBC Act referral guidelines for the vulnerable Koala defines Koala food trees as those of the following genus: Angophora, Corymbia, Eucalyptus, Lophostemon and Melaleuca. The guideline also notes that 'primary' and 'secondary' food trees may be referred to in other state or Commonwealth guidelines or policies, however, all are considered to be food trees for the purposes of the EPBC Act referral guidelines for the vulnerable Koala (DotE, 2014). The abundance of primary food trees is thought to influence the density of Koalas in a population (Phillips and Callaghan, 2011).

Importance of the population

The population of Koala that may use the Project area is considered unlikely to be an important population for the following reasons:

- **Key source populations either for breeding or dispersal:** The Project area is considered likely to support only a low density of Koalas. The suitable open woodland habitat within the Project site is fragmented and more widespread throughout the broader region. Therefore, dispersal and breeding are likely to occur throughout the larger region rather than in the Project site itself. It is therefore unlikely to support be a key source population for breeding or dispersal.
- **Populations that are necessary for maintaining genetic diversity:** Individual Koalas that may use the Project area would likely belong to a larger meta-population of Koalas that would occur within areas of suitable habitat throughout the broader region. Any population of Koalas using the Project area would not necessarily be unique, large, isolated or genetically disjunct from any other Koalas occurring in the region. Therefore, any individuals using the Project area would not be considered necessary for maintaining genetic diversity.
- **Populations that are near the limit of the species range:** The Project area is not at or near the limit of this species' range. The Koala occurs throughout coastal and inland areas of eastern Australia and the Project area is located more or less centrally within the known distribution of this species (DotE, 2014).

Current known threats

Current known threats to the Koala include:

- wide-scale climate change drivers associated with increased frequency and intensity of drought and high temperatures; bushfires; and shrinking climatically suitable habitat areas;
- disease and mortality caused by the Koala Retrovirus and Chlamydia;
- habitat loss and fragmentation mainly through urban development, grazing, agriculture, timber harvesting and mining; and
- predation by the domestic dog and vehicle strikes primarily associated with urban expansion but also present in rural environments (DAWE, 2022).

Management plans

The following plans and advice are in place for the Koala, which have been considered in preparing this assessment:

- **Conservation Advice**: Conservation Advice has been prepared for the Koala, which provides priority research and management actions for the species, as well as specifying key threats (TSSC, 2012).
- **Threat Abatement Plan:** There is no threat abatement plan in place for the Koala.
- **Recovery Plan:** There is currently no recovery plan in place for the Koala, however, the DCCEEW SPRAT Profile identifies that a recovery plan is required (DCCEEW, 2023h).
- **Information sheet:** A review of Koala habitat assessment criteria and methods (Youngentob *et al.*, 2021) has been prepared for the species, which aims to provide: region-specific habitat descriptions based on preferred Koala food and habitat trees; information about habitat extent, movement, threats and refugia; review of current methods for on-ground Koala assessment.
- **Referral Guideline:** The EPBC Act Referral Guidelines for the vulnerable Koala outline important habitat for the Koala, and a habitat assessment tool is provided to assess if the habitat within the impact area is critical to the survival of the species. The guidelines also enable the Proponent to undertake an initial assessment to determine whether a significant impact is likely on the species (DoE, 2014a).

Survey effort

Seasonal fauna surveys were undertaken over 22 days and carried out in consideration of relevant Commonwealth and Queensland survey guidelines. Survey methods and effort included, but were not limited to:

- 33 person hours spotlighting;
- 18 call playback sessions;
- 16 infrared cameras nights;
- 35 Koala SAT survey sites; and
- 282 diurnal and 104 nocturnal person hours of opportunistic observations.

Spotlighting, call playback, SAT survey sites and opportunistic methods are most relevant for detecting the Koala and these methods were undertaken in preferred habitat in the Project area. The survey generally complies with Koala survey guidelines and this species' scratchings were recorded in the study area along Banana Creek.

Further details about the field methods, survey timing, climatic conditions and limitations used to assess the Project area provided in Appendix F, Terrestrial Ecology Assessment.

Survey outcomes and habitat assessments

No evidence of the Koala was detected in the Project area during the seasonal fauna surveys. However, scratches of this species were identified on Queensland Blue Gum along Banana Creek in the additional investigation area during the post-wet season survey in 2020. All remnant REs and some areas of non-remnant regrowth woodlands in the study area are considered to provide habitat for the Koala due to the presence and moderate to abundant cover of Koala food trees. There are 111.1 ha within the Project site and another 0.4 ha in the water release/extraction infrastructure area (Figure 9.89). It has been determined that the habitat within the Project site does not constitute critical habitat for the Koala (i.e. a habitat quality score of 4), primarily due to the fragmented nature of this habitat, limited connectivity outside the Dawson River corridor and lack of refuge habitat within the Project site. The Project site is unlikely to provide dispersal opportunities for the Koala outside the Dawson River corridor.

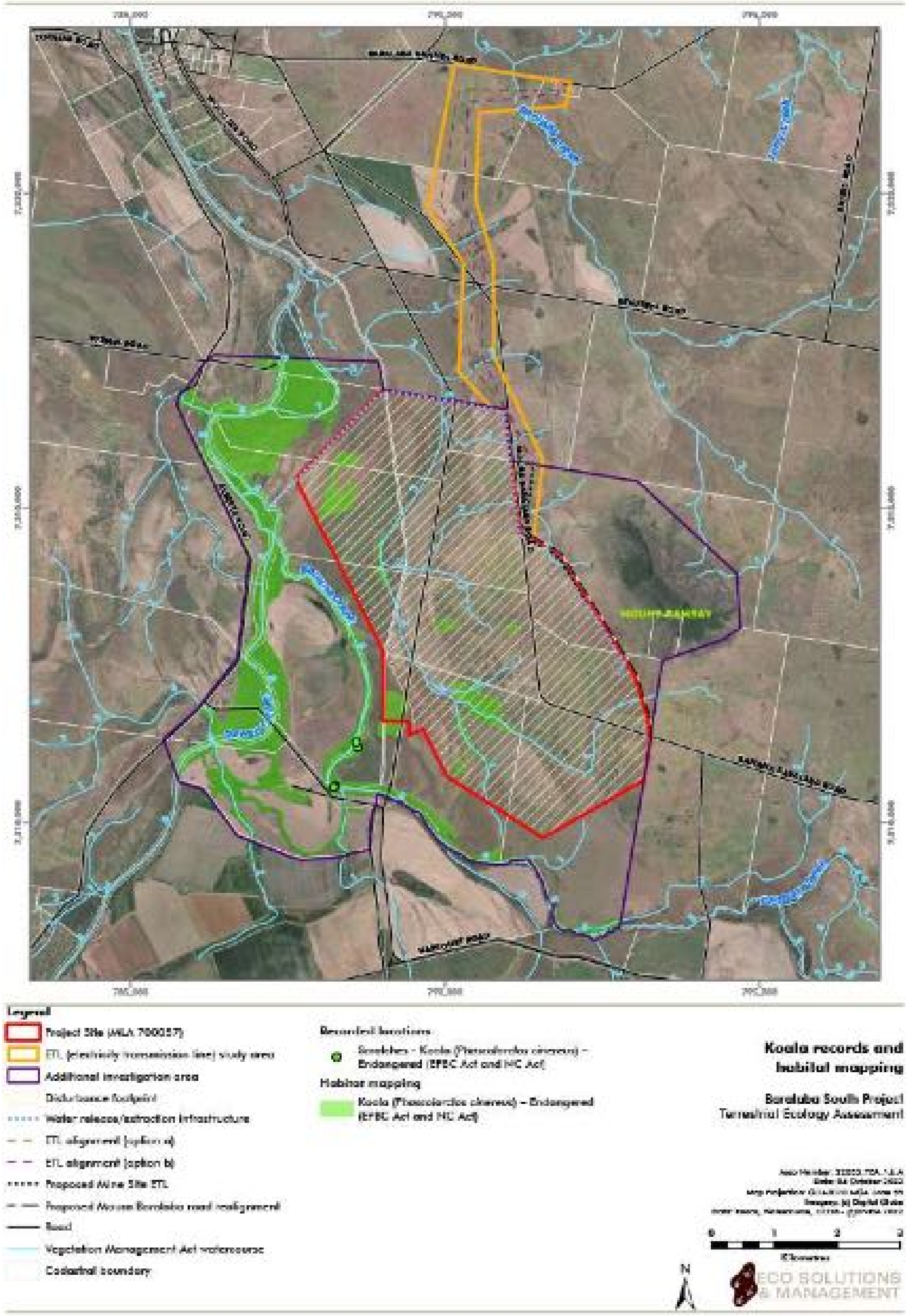


Figure 9.89: Koala records and habitat within the terrestrial ecology study area

Riparian and alluvial habitat in the additional investigation area, associated with the Dawson River and Banana Creek, is likely to provide refuge habitat and is likely to be critical for the survival of the species. The water release/extraction infrastructure area sits on the edge of this habitat.

Impact assessment

A total of 26.5 ha of potential habitat for the Koala in the Project site is proposed to be cleared for the Project. However, as noted above this habitat is not considered to constitute critical habitat for the Koala and is therefore marginal quality habitat for this species. Impacts to an additional 0.4 ha is required for the water release/extraction infrastructure on the edge of the Dawson River. However, this impact will involve understory vegetation only. No Koala food trees are proposed to be cleared within this area.

The *EPBC Act referral guidelines for the vulnerable Koala* (DotE, 2014) were consulted in preparing this assessment to assist with determining whether the impact is considered to be significant. It is noted in Section 7 of these guidelines that the higher the score of critical habitat for the Koala the greater risk of significant impact. An example is provided in Section 7, whereby clearing of 100 ha of habitat with a score of 5 (critical habitat) is considered likely to result in a significant impact. In this regard, a similar area of clearing impact with a lower score (not critical) is less likely to be significant to the Koala.

Indirect impacts to Koalas are considered unlikely. Indirect impacts related to noise and vibration, dust, lighting, vehicle strike, erosion and sedimentation will be temporary, and able to be managed and therefore minimal. There will be minimal impacts to retained habitat in the Project site and due to the open structure of the community in the south-west corner of the Project site, edge effects and fragmentation are not expected to be significant. Remaining areas of habitat in the study area are not proposed to be impacted by changes in surface water or flooding regimes.

There will be no facilitated impacts as a result of the Project.

Incremental impacts to Koala habitat are likely as a result of mine Projects in the region, for which authorisation to clear vegetation and habitat has been granted. These Projects are approved with conditions and in accordance with the EO Act and EPBC Act, where significant impacts are likely, offsets will form part of those conditions. Similarly, where significant impacts are proposed as part of this Project, offsets will be provided. Therefore, in line with the offset legislation, the Project will provide adequate compensation for significant residual impacts to the Koala and should not contribute significantly to cumulative impacts.

Avoidance, mitigation and management

Impacts to Koala habitat within the Project site cannot be avoided due to the location of the coal seam. However, impacts to Koala food trees along the Dawson River will be avoided. Clearing of trees is not required to site the water release/extraction infrastructure in this riparian habitat.

A range of plans and procedures will be implemented during mine construction, operation and rehabilitation, which will manage and monitor impacts to terrestrial ecology. In particular, the following protocols and plans will be developed to manage clearing in and near Koala habitat to minimise harm to individuals and protect habitat to be retained, including:

- vegetation clearing protocols, including a ‘Permit to Disturb’ procedure;
- Species Management Program;
- Weed and Pest Management Plan; and
- Erosion and Sediment Control Plan.

Rehabilitation requirements

Rehabilitation of disturbed areas will occur progressively throughout the life of the mine and will continue after mining has ceased until rehabilitation objectives have been met.

Suitable topsoils and subsoils will be stripped from construction and mining areas, and where viable stored to maintain soil quality and used in rehabilitation to promote native vegetation from the soil seed bank. Revegetation will be also undertaken where required across the mine site.

Significant impact assessment

Table 9.70 provides an assessment of the significance of impacts to the Koala against the Commonwealth Significant Impact Guidelines.

Table 9.70: Assessment of significance of impacts for the Koala

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
• lead to a long-term decrease in the size of an important population of a species	The population of Koala that potentially occurs within the Project site is not considered to be an important population. The extent of clearing is unlikely to decrease the size of the population present given the extent of better quality and potential refuge habitat available elsewhere in the region.
• reduce the area of occupancy of an important population	The population of Koala that potentially occurs within the Project site is not considered to be an important population. The vegetation within the Project site is commonly found throughout the surrounding region and is not considered to be unique or particularly significant for the Koala. Due to the availability of better quality and refuge habitat associated with the Dawson River and Banana Creek to the west of the Project site, which will facilitate the continued occupancy and dispersal of Koalas in the local region, the Project is considered unlikely to reduce the area of occupancy of this species. Koala food trees are not proposed to be cleared in the Dawson River riparian habitat as part of construction of the water release/extraction infrastructure.
• fragment an existing important population into two or more populations	The population of Koalas that potentially occur within the Project site is not considered to be an important population. The habitat areas present within the Project site are generally small patches within a highly fragmented landscape. Connectivity of habitat will not be compromised as a result of the Project to the extent that the local Koala population would become fragmented. This is because dispersal across the Project site to the east from better quality habitat associated with the Dawson River is unlikely due to the lack of habitat east of the Project site, including on Mount Ramsay. Dispersal of this species is most likely within habitats along the Dawson River corridor and less likely out into the smaller and fragmented patches that occur within the largely cleared Project site. Koala food trees will not be impacted in the water release/extraction infrastructure area on the edge of Dawson River riparian habitat.
• adversely affect habitat critical to the survival of a species	The potential marginal habitat within the Project site is not considered to be habitat critical to the survival of the Koala primarily due to its fragmentated state, distance from other habitat patches and lack of refuge habitat. Habitat along the Dawson River and Banana Creek have been identified as potentially critical habitat due to refuge value, however, Koala food trees within potential refuge habitat along the Dawson River will not be cleared as part of construction of the water release/extraction infrastructure. Impacts will be limited to understory vegetation. Therefore, no critical habitat is proposed to be impacted.

Significance criteria	Assessment of significance
• disrupt the breeding cycle of an important population	The population of Koalas that potentially occur within the Project site is not considered to be an important population. Standard industry recognised measures will be employed during the vegetation clearing stages of the Project to minimise harm and disruption to animals and breeding places in accordance with the requirements of the Queensland NC Act. This will reduce the risk and extent of disruption to the breeding cycle of Koalas should they occur in the Project site. Further, indirect impacts associated with the Project such as noise and light, will be managed to the extent that they are unlikely to disrupt the breeding cycle of the Koala.
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project is considered unlikely to isolate habitats or degrade remaining habitats to the extent that the species is likely to decline. Connectivity of habitats within the landscape will be maintained in the broader region. Indirect impacts associated with the Project such as noise, dust, light, weeds and pest animals will be managed to the extent that they are unlikely to degrade retained habitat within the study area to the extent this species is likely to decline. It is also noted that none of these indirect impacts are recognised as threats to the Koala. Changes to the flooding regime are predicted to be minor and are unlikely to affect floodplain communities and therefore unlikely to affect availability of Koala habitat in this area. Potential drawdown outside the Project area would be limited and groundwater dependence of riparian vegetation along the Dawson River and Banana Creek, is unlikely. Therefore, the Project is not predicted to give rise to impacts on surface water or groundwater that would impact Koala habitat outside the Project area.
• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The Project area is located within a modified rural landscape where introduced plants and feral predators are present. Invasive and predatory species, including feral animals such as the Feral Cat and Wild Dog have been identified as part of recent field surveys in the study area. Other species such as Foxes are likely to occur in the broader landscape and the study area is accessible to such species. These predatory species already pose a risk to the Koala in the potential habitat areas present and the Project is unlikely to increase this threat. Similarly, the Project is unlikely to introduce new invasive or predatory species that are not already present and established in the Project area as standard and industry recognised controls will be put in place as part of the Weed and Pest Management Plan.
• introduce disease that may cause the species to decline, or	Three viruses are known to affect Koalas in the wild, Chlamydia and Koala Regrovirus (KoRV-A and KoRV-B). Studies have shown that 100% of Koalas in the wild have the Retrovirus, and the majority of Queensland and New South Wales populations are infected with Chlamydia (Hanger and Loader, 2009). While a large proportion of the Koala population in any given area may be infected with these diseases, not all show outward signs of the diseases. Chronic stress from habitat loss, disturbance, degradation, heat stress and poor nutrition have been suggested to trigger the development of disease on Koalas (Younentob *et al.*, 2021). Clearing associated with the Project is not considered to introduce or increase the prevalence of these diseases in the local Koala population. This is because use of the habitat in the Project area is likely to be limited and retention of refuge habitat associated with the Dawson River and connectivity of this riparian corridor provides extensive areas of habitat in the broader region.

Significance criteria	Assessment of significance
• interfere substantially with the recovery of the species	The Project will result in clearing of 94.6 ha of Koala habitat. This habitat is not considered to be critical to the survival of the Koala. An additional 0.1 ha of habitat that is likely to provide refuge habitat for this species along the Dawson River will be impacted through understory and ground layer clearing. No Koala food trees will be impacted in this refuge habitat. Further, the Dawson River corridor will continue to facilitate Koala movement opportunities throughout the region as well as providing refuge habitat for this species. Indirect impacts associated with the Project will be managed to the extent they are unlikely to interfere with the recovery this species. Therefore, it is considered unlikely the Project will interfere substantially with the recovery of the Koala.
Conclusion	The clearing of 26.5 ha of habitat that is not considered critical to the survival of the Koala is unlikely to result in a significant residual impact to the Koala.

9.11.9.5 Squatter Pigeon (southern) (*Geophaps scripta scripta*)

Description

The Squatter Pigeon (southern) is listed as vulnerable under the EPBC Act and Queensland NC Act. This species is known to inhabit tropical dry, open sclerophyll woodlands and occasionally open savannah. It appears to favour sandy soil dissected with low gravelly ridges and is less common on heavy soils with dense grass cover. It is nearly always found in close association with permanent water (Higgins and Davies 1996). This species is also often recorded from areas that do not support remnant vegetation, however, in these areas, it seems to be associated with clear, disturbed sites such as tracks and stockyards (DCCEEW, 2023d; S. Marston, Pers. obs.). These habitat areas are likely to provide breeding, foraging and dispersal habitat.

The SPRAT profile emphasises the importance of woodland trees, which provide protection from predatory birds. Where scattered trees still occur, and the distance of cleared land between remnant trees or patches of habitat does not exceed 100 m, individuals may be found foraging in, or moving across modified or degraded environments (DCCEEW, 2023d).

Current known threats

The main threats to the Squatter Pigeon (southern) are as follows:

- loss of habitat due to clearing for agricultural or industrial purposes;
- degradation of habitat, trampling of nests, by grazing herbivores (i.e. sheep, cattle, rabbits);
- predation by feral cats and foxes;
- degradation of habitat through infestation by Buffel Grass and other improved pasture species and weeds; and
- thickening of understory vegetation (DCCEEW, 2023d).

Management plans

The following plans and advice are in place for the Squatter Pigeon (Southern), which have been considered in preparing this assessment:

- **Conservation Advice:** Approved Conservation Advice has been prepared for the Squatter Pigeon, which nominates conservation and management actions for the species. Conservation actions include survey and monitoring priorities, as well as research priorities (TSSC, 2015).
- **Threat Abatement Plan:** Threat abatement plans are in place for the Squatter Pigeon for the threat of feral cats, rabbits and the European Red Fox (DEWHA 2008a; DotE 2015b; DoEE 2016).
- **Recovery Plan:** A recovery plan has not been prepared for the Squatter Pigeon, and the DCCEEW SPRAT Profile explains that one is not required as the Approved Conservation Advice provides sufficient direction to implement priority actions and mitigate against key threats (DCCEEW, 2023d).
- **Referral Guidelines:** The Squatter Pigeon is addressed in the Survey Guidelines for Australia's Threatened Birds EPBC Act Survey Guidelines 6.2 (DEWHA, 2010a). No specific referral guidelines are available or the Squatter Pigeon (southern).

Survey effort

Seasonal fauna surveys were undertaken over 22 days and carried out in consideration of relevant Commonwealth and Queensland surveys guidelines. Survey methods and effort included, but was not limited to:

- 20.5 person hours active searching
- 37 person hours bird surveying
- 282 diurnal and 104 nocturnal person hours of opportunistic observations.

Bird survey, active searching and opportunistic methods are most relevant for detecting the Squatter Pigeon (southern) and these methods were undertaken in preferred habitat in the Project area. The survey generally complies with Squatter Pigeon survey guidelines, although flushing surveys are recommended by the DCCEEW, and these were not undertaken. Previous experience in this area has shown that this technique is often not required as the species is typically recorded incidentally during surveys. The survey methods that were employed resulted in detection of this species at multiple locations within the study area and therefore flushing surveys were not considered necessary.

Further details about the field methods, survey timing, climatic conditions and limitations used to assess the Project area provided in Appendix F, Terrestrial Ecology Assessment.

Survey outcomes and habitat assessments

This species was recorded at a number of locations in the ETL study area, on the edge of the Project site and in the additional investigation area during the seasonal surveys. Suitable habitat for the Squatter Pigeon (southern) has been identified in the Project site and in the water release/extraction infrastructure area (Figure 9.90).

Habitat mapping for the Squatter Pigeon (southern) (Figure 9.90) within the study area has been undertaken in consideration of the SPRAT profile for the species and most recent advice from the DAWE. Squatter Pigeon (southern) habitat is categorised as:

- **foraging habitat**—grassy woodlands dominated by Eucalyptus, Corymbia, Acacia or Callitris tree species, on sandy or gravelly soils (including but not limited to areas mapped as Queensland land zones 3, 5 or 7) within 3 km of a waterbody; and
- **breeding habitat—**foraging habitat within 1 km of a waterbody.

Waterbodies that are suitable for the Squatter Pigeon (southern) are described in the SPRAT profile for the species as 'permanent or seasonal rivers, creeks, lakes, ponds and waterholes, and artificial dams' (DCCEEW, 2023d). Given this definition, first and second order watercourses or drainage channels are generally not considered to be suitable for this species because of their highly ephemeral nature and tendency to drain quickly and would not include cattle troughs or plastic lined dams.

Suitable habitat in the Project site and water release/extraction infrastructure area consists of the polygons of REs 11.3.25, 11.5.9, 11.5.15, 11.3.3 and 11.3.3a. This woodland vegetation supports a grassy ground layer and is associated with sandy soils. There are two constructed dams to the north and east that are not separated from this vegetation by more than 100 m of cleared land.

Approximately 84.8 ha of habitat suitable for the Squatter Pigeon (southern) has been mapped within the Project site and water release/extraction infrastructure area, including 83.3 ha of breeding habitat.

Importance of the population

The population of Squatter Pigeon (southern) that uses the study area is considered unlikely to be an important population for the following reasons:

- **Key source populations are either for breeding or dispersal:** This species is regularly recorded in the central Queensland region and remains common north of the Carnarvon Ranges. All sub-populations of this species occurring south of the Carnarvon Ranges in central Queensland are considered to be important sub-populations (DCCEEW, 2023d). The habitat within the study area remains reasonably common throughout the region and habitat present is considered unlikely to be of particular significance for breeding or dispersal.
- **Populations are necessary for maintaining genetic diversity:** The population of the Squatter Pigeon (southern) within the region is considered unlikely to be important in maintaining genetic diversity within the species. The inherent mobility of a bird species is likely to increase genetic exchange between individuals in comparison to less mobile species whose access to potential mates may be limited. Because of the relatively high rates of genetic exchange in more mobile species, it is less likely that any single population represents an important population for maintaining genetic diversity. The species is noted as being likely to comprise a single contiguous breeding population (DCCEEW, 2023d). It is therefore considered unlikely that the population in the study area, would be particularly important in maintaining genetic diversity of the species.
- **Populations are near the limit of the species range:** The range of the Squatter Pigeon (southern) extends north to the Burdekin region (approximately 550 km north of the study area). The species once occurred in southern New South Wales, although it has not been recorded in New South Wales for some time (DCCEEW, 2023d). The current extent of the Squatter Pigeon ranges to the Border Rivers region of northern New South Wales. The study area is well within the known distribution of this species.

Impact assessment

Approximately 21.9 ha of habitat considered both breeding and foraging habitat for the Squatter Pigeon (southern) is proposed to be cleared for the Project.

Indirect impacts to the Squatter Pigeon are considered unlikely. Indirect impacts related to noise and vibration, dust, lighting, vehicle strike, erosion and sedimentation will be temporary, and able to be managed and therefore minimal. There will be minimal impacts to retained habitat in the Project site and due to the open structure of the community in the south-west of the Project site, edge effects and fragmentation are not expected to be significant. Remaining areas of habitat in the study area are not proposed to be impacted by changes in surface water or flooding regimes.

There will be no facilitated impacts as a result of the Project.

Incremental impacts to Squatter Pigeon habitat are likely as a result of mine Projects in the region, for which authorisation to clear vegetation and habitat has been granted. These Projects are approved with conditions and in accordance with the EO Act and EPBC Act, where significant impacts are likely, offsets will form part of those conditions. Where impacts are unlikely to be significant, the contribution to the cumulative impact is also considered unlikely to be significant.

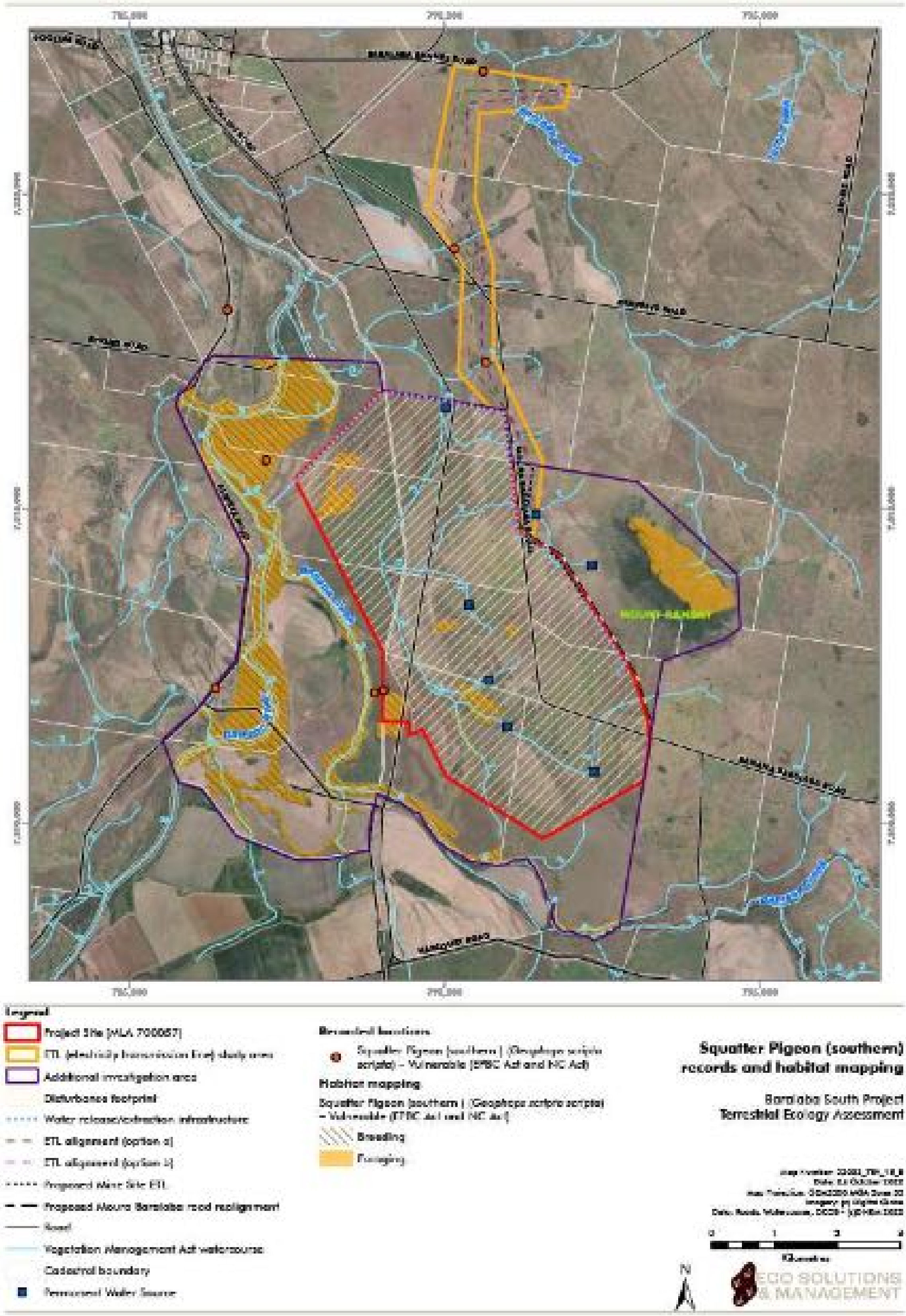


Figure 9.90: Squatter Pigeon (southern) records and habitat within the terrestrial ecology study area.

Avoidance, mitigation and management

Impacts to some areas of Squatter Pigeon habitat cannot be avoided due to the location of the coal seams, however, impacts to Squatter Pigeon habitat along the Dawson River will be minimised where possible as part of the detailed design and siting of the proposed water release/extraction infrastructure. In this area the infrastructure will traverse the narrowest section of riparian vegetation where possible and disturbance will be selective and limited to the understory and ground layer to minimise overall disturbance to the riparian community.

A range of plans and procedures will be implemented during mine construction, operation and rehabilitation, which will manage and monitor impacts to terrestrial ecology. In particular, the following protocols and plans will be developed to manage clearing in and near Squatter Pigeon habitat to minimise harm to individuals and protect habitat to be retained:

- vegetation clearing protocols, including a ‘Permit to Disturb’ procedure;
- Species Management Program;
- Weed and Pest Management Plan; and
- Erosion and Sediment Control Plan.

Rehabilitation requirements

Rehabilitation of disturbed areas will occur progressively throughout the life of the mine and will continue after mining has ceased until rehabilitation objectives have been met.

Suitable topsoils and subsoils will be stripped from construction and mining areas, and where viable stored to maintain soil quality and used in rehabilitation to promote native vegetation from the soil seed bank. Revegetation will be also undertaken where required across the mine site.

Significant impact assessment

Table 9.71 provides an assessment of the Significance of impacts to the Squatter Pigeon against the Commonwealth Significant Impact Guidelines.

Table 9.71: Assessment of significance of impacts for the Squatter Pigeon (southern)

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
• lead to a long-term decrease in the size of an important population of a species	The population of Squatter Pigeon (southern) that occurs within the Project area is not considered to be an important population. The clearing of 21.9 ha of habitat is unlikely to decrease the size of the population present given the extent of similar habitat available in the region.
• reduce the area of occupancy of an important population	The population of Squatter Pigeon(southern) that occurs within the Project area is not considered to be an important population. The vegetation within the Project area is commonly found throughout the surrounding region and is not considered to be unique or particularly significant for the Squatter Pigeon (southern). The Squatter Pigeon (southern) is also known to commonly occur in disturbed habitats. Therefore, due to the availability of similar habitat within the broader region and the mobility of this avian species, the Project is considered unlikely to affect the Squatter Pigeon’s area of occupancy.

Significance criteria	Assessment of significance
• fragment an existing important population into two or more populations	The population of Squatter Pigeon (southern) that occurs within the Project area is not considered to be an important population. The habitats proposed to be cleared are already fragmented and isolated from other vegetated habitats and the proposed clearing will remove the entirety of each patch rather than fragment them further. The Squatter Pigeon (southern) is a highly mobile species and is known to disperse across cleared and degraded landscapes between preferred habitat areas. The removal of these patches of habitat is considered unlikely to present a significant barrier to this species from moving throughout the landscape. Connectivity of habitat will not be affected by the Project and will remain along the Dawson River and Banana Creek. Therefore, the Project is unlikely to fragment the population of Squatter Pigeon (southern) occurring in the local area into two or more populations.
• adversely affect habitat critical to the survival of a species	Squatter Pigeon (southern) habitat is relatively broad by definition. Therefore, very few areas, including the habitats in the Project area, would be described as habitat critical to the survival of the species. The potential habitat that is to be disturbed within the Project site and water release/extraction infrastructure area is not regarded as particularly significant or indicative of critical habitat due to its relatively small and isolated nature. It is considered unlikely to be necessary for foraging, breeding, roosting or dispersal, the long-term maintenance of the species, maintaining genetic diversity or recovery of the species. Given the mobility of avian species the Project is considered unlikely to affect habitat critical to the survival of the species.
• disrupt the breeding cycle of an important population	The population of Squatter Pigeon (southern) that occurs within the Project area is not considered to be an important population. It is possible the Squatter Pigeon (southern) breeds within the broader study area. Standard industry recognised measures will be employed during the vegetation clearing stages of the Project to minimise harm and disruption to animals and breeding places in accordance with the requirements of the Queensland NC Act. This will reduce the risk and extent of disruption to the breeding cycle of Squatter Pigeons (southern) that occur in the Project area.
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Sub-populations in this region have not been identified as being of particular importance for the long-term survival or recovery of this species. The proposed impacts to 68.3 ha of habitat for the Squatter Pigeon (southern) will not remove habitats, isolate habitats or degrade remaining habitats to the extent that the species is likely to decline. This is because the habitat in the Project area is not considered to be critical for this species and expansive areas of similar habitat occur throughout the Brigalow Belt region. Indirect impacts associated with the Project, such as noise, dust, light, weeds and pest animals will be managed to the extent that they are unlikely to degrade retained habitat to the extent this species is likely to decline. Changes to the flooding regime are predicted to be minor and are unlikely to affect floodplain communities and therefore unlikely to affect availability of Squatter Pigeon (southern) habitat in this area. Potential drawdown outside the Project area would be limited and groundwater dependence of riparian vegetation along the Dawson River and Banana Creek, is unlikely. Therefore, the Project is not predicted to give rise to impacts on surface water or groundwater that would impact Squatter Pigeon (southern) habitat outside the Project area.

Significance criteria	Assessment of significance
• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The study area is located within a modified rural landscape where introduced plants and feral predators are present. Invasive and predatory species, including feral animals such as the Feral Cat and Wild Dog have been identified as part of recent field surveys in the study area. Other species such as Foxes are likely to occur in the broader landscape and the study area is accessible to such species. These predatory species already pose a risk to the Squatter Pigeon (southern) in the potential habitat areas present and the Project is unlikely to increase this threat. Similarly, the Project is unlikely to introduce new invasive or predatory species that are not already present and established in the study area as standard and industry recognised controls will be put in place as part of the Weed and Pest Management Plan.
• introduce disease that may cause the species to decline, or	Disease is not a known threat to this species. Therefore, the Project is unlikely to introduce any disease that may cause the Squatter Pigeon (southern) to decline.
• interfere substantially with the recovery of the species	This species is noted as 'remaining common north of the Carnarvon Ranges in central Queensland' (DCCEEW, 2023d). There is no recovery plan for this species. The Squatter Pigeon (southern) is known to occur in disturbed areas and potential for this species to occupy adjacent areas in the landscape will remain during and after the proposed Project. The Project will not remove habitat critical to the survival of the species and the population is unlikely to be important. The proposed clearing is relatively small in relation to the extent of habitat that persists within the region. Therefore, it is considered unlikely the Project will interfere substantially with the recovery of the species.
Conclusion	The Project is considered unlikely to result in a significant residual impact to the Squatter Pigeon (southern) as the species remains common in its northern distribution and the Project area is unlikely to support an important population or critical habitat for the species.

9.11.10. Impact assessment—migratory species

Two migratory birds, Glossy Ibis and Latham's Snipe, are considered to have a moderate potential to occur in the Project area based on the habitat types present. Both of these species are discussed below.

Description

The Glossy Ibis utilises the shallows of swamps, floodwaters, sewage ponds and flooded, moist irrigated pasture (Morcombe and Stewart, 2013). The species also occasionally feeds in sheltered marine habitats (Morcombe and Stewart, 2013). Latham's Snipe prefers soft wet ground or shallow water with tussocks, wet paddocks, seepage below dams, irrigated areas, scrub or open woodland (Pizzey *et al*., 2012).

Current known threats

The main threats listed for the Glossy Ibis and the Latham's Snipe is the loss and degradation of wetland habitat (DCCEEW, 2023g; c). This is most likely through changes in the drainage or hydrological regimes of wetlands, altered fire regimes, grazing, increased salinity, clearing, groundwater extraction and invasion by exotic plants (DCCEEW, 2023g; c).

Hunting is also a listed threat for the Latham's Snipe (DCCEEW, 2023c).

Management plans

There are no specific management plans in place for the Glossy Ibis or Latham's Snipe.

There is no published Conservation Advice, listed relevant threat abatement plans or recovery plans for the Glossy Ibis although the threat abatement plan for the European Red Fox is listed in relation to the Latham's Snipe. There is also a Wildlife Conservation Plan for Migratory Shorebirds in relation to the Latham's Snipe (DoE, 2015c).

Survey effort

Seasonal fauna surveys were undertaken over 22 days and carried out in consideration of relevant Commonwealth and Queensland surveys guidelines. Survey methods and effort included, but was not limited to:

- four systematic trap sites;
- 33 person hours spotlighting;
- 16 infrared cameras nights;
- 20.5 person hours active searching;
- 37 person hours bird surveying; and
- 282 diurnal and 104 nocturnal person hours of opportunistic observations.

Spotlighting, infrared cameras, active searching, bird survey and incidental/opportunistic observations are methods most relevant for the detection of the migratory birds potentially occurring and these were undertaken in preferred habitat in the Project area. The survey effort for the Project generally complied with survey guidelines. However, these are cryptic birds that are known to inconsistently use habitats and there is no guarantee that they would be recorded even during favourable conditions.

Further details about the field methods, survey timing, climatic conditions and limitations used to assess the Project area provided in Appendix F, Terrestrial Ecology Assessment.

Survey outcomes and habitat assessments

Neither of these species were recorded during field surveys, however, both are considered to have a moderate likelihood of occurrence in the study area.

Habitat occurs in the study area for the two migratory birds considered to potentially occur. The study area provides foraging habitat but is less likely to provide breeding habitat for any migratory species.

Dams and paddocks in the study area, when inundated, potentially provide habitat for the Glossy Ibis, while vegetated drainage lines potentially provide habitat for Latham's Snipe similar to the Australian Painted Snipe.

Potentially suitable habitat within the Project area is not simply estimated for the Glossy Ibis, as its habitat preferences are varied. It may use cleared gilgai, dams, or wetlands along the Dawson River and this occupancy is likely to be temporary and opportunistic. Habitat for the Latham's Snipe is considered to closely correspond with Australian Painted Snipe habitat, and it also is likely to use this habitat temporarily and opportunistically. Approximately 31.1 ha of potential wetland and drainage line habitat for the Australian Painted Snipe has been mapped within the Project site and ETL study area as well as an additional 68.5 ha of marginal habitat in the form of cleared gilgai habitat (refer also Australian Painted Snipe habitat mapping on Figure 9.88).

Potential habitat for these species does not occur in the proposed road realignment or water release/ extraction infrastructure area.

Impact assessment

Two key concepts are important in assessing the significance of impacts against the EPBC Act Significant Impact Guidelines. They are defined below.

Important habitat

Determining if an area of 'important habitat' for a migratory species listed under the EPBC Act occurs within the Project site and ETL study area is necessary in addressing the significant impact criteria for migratory species. Important habitat for a migratory species is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecological significant proportion of the population of the species, and/or
- habitat that is of critical importance to the species at particular life cycle stages, and/or
- habitat utilised by a migratory species which is at the limit of the species range, and/or
- habitat within an area where the species is declining (DotE, 2013).

It is considered unlikely that the Project site and ETL study area provides important habitat for any migratory species as:

- no migratory species were observed in the study area during the seasonal surveys;
- there are large tracts of similarly disturbed areas on floodplains adjacent to the Dawson River and Banana Creek in the study area and broader region;
- the Project site and ETL study area is not at the limit of the distribution of either of the species considered to potentially occur; and
- the area in which the Project is proposed is not a specific area in which either the Glossy Ibis or Latham's Snipe is known to be declining. The extent of occurrence of the Latham's Snipe is considered to be stable at present (DCCEEW, 2023c).

Ecologically significant proportion

An ecologically significant proportion of a migratory species will differ between species, however, the species' population status, genetic distinctiveness and species-specific behavioural patterns (for example, site fidelity and dispersal rates) should be considered in evaluating this (DoE, 2013a).

The broader study area is unlikely to provide important habitat for any migratory species. It is also unlikely to support an ecologically significant proportion of the population of a migratory species, as this would have been evident during the seasonal surveys. There was no evidence of important habitat areas, roost sites or other features that could be used by large numbers of these birds.

The Project will result in the clearing of potential habitat for these species, in the order of 1.0 ha of potential wetland and drainage line habitat and another 33.9 ha of marginal cleared gilgai habitat. Despite this clearing and disturbance, areas of potential habitat will remain within the broader region as habitats within the Project area are not particularly rare or unique in the region.

Indirect impacts to these migratory birds are considered unlikely. Indirect impacts related to noise and vibration, dust, lighting, vehicle strike, erosion and sedimentation will be temporary, and able to be managed and therefore minimal. Due to the already fragmented nature of the patches of these habitats in the landscape, edge effects and fragmentation are not expected be significant and remaining areas of habitat in the study area are not proposed to be impacted by changes in surface water or flooding regimes.

There will be no facilitated impacts as a result of the Project.

There is no publicly available information about impacts to this species as a result of other Projects in the region. However, there is potential for incremental impacts migratory bird habitat as a result of mine Projects in the region, for which authorisation to clear vegetation and habitat has been granted. These Projects are approved with conditions and in accordance with the EO Act and EPBC Act, where significant impacts are likely, offsets will form part of those conditions. Where impacts are unlikely to be significant, the contribution to the cumulative impact is also unlikely to be significant.

Avoidance, mitigation and management

Impacts to some areas of potential Glossy Ibis and Latham's Snipe habitat cannot be avoided due to the location of the coal seams, however, impacts to habitat along the ETL study area will be avoided where possible as part of the detailed design and siting of the proposed ETL.

A range of plans and procedures will be implemented during mine construction, operation and rehabilitation, which will manage and monitor impacts to terrestrial ecology. In particular, the following protocols and plans will be developed to manage clearing in and near potential habitat to minimise harm to individuals and protect habitat to be retained, including:

- vegetation clearing protocols, including a 'Permit to Disturb' procedure;
- Species Management Program;
- Weed and Pest Management Plan; and
- Erosion and Sediment Control Plan.

Statutory requirements

The Project will not be inconsistent with Australia's obligations under the Bonn Convention, CAMBA, JAMBA, ROKAMBA or an international agreement approved under subsection 209(4) of the EPBC Act. The terrestrial ecology assessment has:

- conducted a thorough desktop assessment to identify migratory species with the potential to be impacted by the Project;
- identified the habitat and lifecycle requirements of migratory species and considered their likelihood of occurrence;
- undertaken field surveys to target migratory species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for migratory species within the study area;
- identified potential impacts of the Project on migratory species and their habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on migratory species and their habitat; and
- assessed the significance of the impacts in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE, 2013a), which has indicated the Project will not result in a significant impact to migratory species.

Rehabilitation requirements

Rehabilitation of disturbed areas will occur progressively throughout the life of the mine and will continue after mining has ceased until rehabilitation objectives have been met.

Suitable topsoils and subsoils will be stripped from construction and mining areas, and where viable stored to maintain soil quality and used in rehabilitation to promote native vegetation from the soil seed bank. Revegetation will be also undertaken where required across the mine site.

Significant impact assessment

Table 9.72 provides an assessment of the significance of impacts to migratory birds against the Commonwealth Significant Impact Guidelines.

Table 9.72: Assessment of significance of impacts for the Glossy Ibis and Latham's Snipe

Significance criteria	Assessment of significance
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
• substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;	The habitats proposed to be impacted are unlikely to provide important habitat for a migratory species, therefore, important habitat will not be substantially modified, destroyed or isolated by the Project.
• result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or	The habitats proposed to be impacted are unlikely to provide important habitat for a migratory species. The Project area is located within a modified rural landscape where introduced plants and feral predators are present. Invasive and predatory species, including feral animals such as the Feral Cat and Wild Dog have been identified as part of recent field surveys in the study area. Other species such as Foxes are likely to occur in the broader landscape and the study area is accessible to such species. These predatory species already pose a risk to the Glossy Ibis and Latham's Snipe in the potential habitat areas present and the Project is unlikely to increase this threat. Similarly, the Project is unlikely to introduce new invasive or predatory species that are not already present and established in the study area as standard and industry recognised controls will be put in place as part of the Weed and Pest Management Plan.
• seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the migratory species.	An ecologically significant proportion of the population of a migratory species is considered unlikely to occur in the potential habitats proposed to be impacted as this would have been recognisable during the seasonal surveys or evidence of such use identifiable. Therefore, the Project is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.
Conclusion	The Project will not result in a significant residual impact to migratory species listed under the EPBC Act.

9.12 Aquatic ecology

To describe the biodiversity and natural environmental values of the Project, an assessment of aquatic ecology values for the Project area has been undertaken by Ecological Service Professionals (Appendix G, Aquatic Ecology Assessment). The objectives of Appendix G, Aquatic Ecology Assessment, were to assess the potential impacts of the Project on aquatic ecology values of the Project area and surrounding areas and particularly on MNES.

As the Project was determined to be a controlled action in October 2012 (EPBC Referral 2012/6547) subsequent 'listing events', such as the new listing of a species or ecological community under the EPBC Act are not required to be assessed. As such, only those species listed as threatened (Endangered or Vulnerable) under the EPBC Act at the time of declaration of the controlled action are considered in the assessment of MNES, however, where the EPBC listing status of a species listed at the time the declaration was made has changed, the most current listing status is presented.

9.12.1. Existing environment

9.12.1.1 Desktop assessment

A desktop assessment was undertaken to identify potential aquatic ecosystem values within the aquatic ecology study area. The desktop assessment included a review of Commonwealth and State databases and mapping, literature reviews and completed ecology assessments from nearby locations. Database searches were undertaken within a 50 km of the boundary of the Project area. The results of the desktop assessment and database searches (described in Appendix G, Aquatic Ecology Assessment) informed the field survey design and methodology.

9.12.1.2 Field survey

Two seasonal aquatic ecology surveys have been completed by suitably qualified ecologists in accordance with all required permits and approvals: one dry season survey (5–9 June 2017) and one wet season survey (13–19 March 2018).

The field assessment was conducted in accordance with following guidance material:

- ‘Model Water Conditions for Coal Mines in the Fitzroy Basin’ (ESR/2015/1561) (DES, 2013);
- ‘Monitoring and Sampling Manual: Environmental Protection (Water) Policy’ (DES, 2018c);
- ‘Environmental Protection (Water) Policy 2009 Dawson River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Dawson River Sub-basin except the Callide Creek Catchment’ (DEHP, 2011);
- ‘Australian and New Zealand Guidelines for Fresh and Marine Water Quality’ (ANZG, 2018);
- ‘Queensland Australian River Assessment System (AusRivAS) Sampling and Processing Manual’ (DNRM, 2001);
- ‘Survey guidelines for Australia’s threatened reptiles’ (SEWPaC, 2011a);
- SPRAT Database (DoEE, 2019b-g) profiles for relevant EPBC Act listed species; and
- ‘Terrestrial Vertebrate Fauna Survey Guidelines for Queensland’ (Eyre *et al*., 2018).

Surveys were undertaken at 10 sites located on the Dawson River, Banana Creek, Shirley’s Gully, minor unnamed waterways/drainage lines and mapped wetlands within the MLA (Figure 9.91).

A summary of the aquatic ecology survey effort for each survey method used is provided in A supplementary site inspection was completed in August 2023 to verify the validity of the baseline survey results and to ground truth the location and characteristics of waterways to be disturbed by the Project.

Full details of field methodology and laboratory analyses are provided in Appendix G, Aquatic Ecology Assessment.

Table 9.73 and a summary of the survey locations and ecological indicators assessed at each location is provided in Table 9.74. A reconciliation of the survey effort undertaken against the recommended survey effort specified in the relevant threatened species survey guidelines is provided in Table 9.75.

A supplementary site inspection was completed in August 2023 to verify the validity of the baseline survey results and to ground truth the location and characteristics of waterways to be disturbed by the Project.

Full details of field methodology and laboratory analyses are provided in Appendix G, Aquatic Ecology Assessment.

Table 9.73: Summary of aquatic ecology survey effort

Method	Survey effort			Targeted fauna
	2017 dry season	2018 post-wet season	Total	
Boat e-fisher	3 sites 48 minutes	4 sites 57.5 minutes	1.76 hours	Turtles and fish
Fyke net	5 sites 117.5 minutes	4 sites 125 minutes	242.5 hours	Turtles and fish
Box traps	5 sites 206.25 hours	4 sites 85 hours	291.25 hours	Turtles and fish
Seine nets	1 sweep	N/A	1 sweep	Turtles and fish
Spot lighting	N/A	4 sites 13 hours	13 hours	Turtles, fish and platypus
Day time searching	Continuous	Continuous	Continuous	Turtles, fish and platypus
Macroinvertebrate sampling	5 site samples	4 site samples	9 samples	Macroinvertebrates including Macrocrustaceans

9.12.1.3 Aquatic habitat condition

A description of the wetlands and watercourses within the MLA and adjacent areas is provided in section 9.8.

Aquatic habitat of the region

The aquatic habitat condition of waterways and wetlands in the Dawson River sub-basin are variable, ranging from good condition and of high ecological value within some area of the Dawson River and low to moderate habitat condition and value in the minor waterways and wetlands (Appendix G, Aquatic Ecology Assessment).

Bank stability in the region has been assessed as mostly stable but has been impacted by areas of erosion due to stock and vegetation clearing.

The in-stream habitat of riverine wetlands and major watercourses of the region are dominated by pool habitat, typically containing shallow and deep pools, woody debris, detritus, low coverage of in-stream aquatic plants and overhanging and trailing bank vegetation fringing the edges providing additional stream cover.

Wetlands within the Project area

Habitat condition in the LW (LW1), located within the centre of the MLA, is considered poor, with minimal in-stream habitat features and a high level of disturbance (i.e. modified/dammed wetland). The habitat condition of the PWs (PW1 and PW2) is considered fair, with more available diverse in-stream habitat features and lower disturbance from surrounding land uses.

The PW at site PW2 and the LW hold water for extended periods, providing dry season refuge for aquatic fauna; however, connectivity to other waterways is rare (only during significant rainfall events). The assessment found that these wetlands do not provide unique habitat features or suitable habitat for listed species.

High Ecological Significance wetlands

The HES wetland (PW1) located on the western boundary of the MLA, is ephemeral in nature and was dry during both surveys; however, it is evident that inundation occurs under certain conditions (i.e. during significant wet seasons). The proximity of the wetland to the Dawson River Anabranch provides the possibility for aquatic fauna to find refuge in the wetland after periods of high flow and flood events. However, connectivity to other waterways is expected to be rare and the wetland would not provide long-lasting habitat. The HES wetland does not offer any increased aquatic value than other PWs in the Project area, as indicated by site PW2.

Minor waterways and drainage lines within the Project area

Aquatic habitat condition at sites within the Project area was poor to fair. The minor waterways within the Project area were generally considered to be in poor condition. They were characterised as ephemeral drainage lines or overland flow paths with no defined bed or banks, and had minimal in-stream habitat features, were dry or largely disconnected. The minor waterways were highly disturbed by cattle access and riparian zone clearing associated with the adjacent land uses.

Waterways upstream, adjacent to and downstream of the Project area

Aquatic habitat conditions at Banana Creek (BC1 and BC2), Shirley's Gully (SG1), the Dawson River (DR1) and the Dawson River Anabranch (DA1) is considered fair (Figure 9.92), but overall, was better than the waterways and wetlands within the Project area. Good bank stability, good variety of flow regimes (during wet periods) and good variety and availability of in-stream habitat were identified within the three major waterways. A reduced but mainly intact riparian zone has remained along the waterways despite land disturbance on adjacent lands. These sites are considered suitable to support a variety of aquatic fauna, providing dry season refuges, connectivity and passage to upstream and downstream habitats during periods of flow. These sites provide some favourable fauna habitat features, including in-stream structure for resting and refuge (particularly for turtles) and some sections of the banks are considered to potentially provide suitable habitat for turtle nesting and/or Platypus burrows.

Table 9.74: Aquatic ecology survey site locations: ecological indicators assessed

Location	Site	Latitude	Longitude	June 2017						March 2018						
				Aquatic habitat	Water quality	Sediment quality	Aquatic plants	Fish & turtles	Macroinvertebrates	Aquatic habitat	Water quality	Sediment quality	Aquatic plants	Fish & turtles	Macroinvertebrates	Listed species
Downstream of the Project area																
Dawson River	DR1	-24.2022°	149.8139°													
Dawson River Anabranch	DA1	-24.2337°	149.8383°													
Shirley's Gully	SG1	-24.2306°	149.8428°													
Within the Project area																
Unnamed waterway tributary	UW1T	-24.2604°	149.8451°													
Unnamed waterway	UW2	-24.2555°	149.8548°													
Lacustrine wetland	LW1	-24.2652°	149.8599°													
Palustrine wetland	PW1	-24.2806°	149.8494°													
	PW2	-24.2795°	149.8614°													

Location	Site	Latitude	Longitude	June 2017						March 2018						
				Aquatic habitat	Water quality	Sediment quality	Aquatic plants	Fish & turtles	Macroinvertebrates	Aquatic habitat	Water quality	Sediment quality	Aquatic plants	Fish & turtles	Macroinvertebrates	Listed species
Upstream/adjacent to the Project area																
Banana Creek	BC1	-24.3093°	149.8981°													
	BC2	-24.2919°	149.8462°													

Note: **Blue** cells indicate ecological indicator was assessed at this site.
White cells indicate ecological indicator was not surveyed as the particular indicator was not present during inspection.
Red cells indicate ecological indicator was not assessed at this site due to suitable habitat not being present at this site.

Table 9.75: Referral guidelines summary of survey efforts—aquatic fauna

Species name	Common name	EPBC conservation status	Commonwealth survey guidelines	EPBC act referral guidelines	Effort and method undertaken
Rheodytes leukops	Fitzroy River Turtle	V	• Readily observed in riffle zones diving with face mask and snorkel or collected by seine netting. • Partly carnivorous diet indicates it may enter traps baited with meat. (SEWPaC, 2011a)	• No referral guidelines	Seasonal surveys undertaken: • 1.76 hours of Boat e-fisher • 242.5 hours of Fyke net • 291.25 of box traps • 1 sweep seine nets • 13 hours of spotlighting • Continuous day time searching • Guideline requirements fulfilled
Maccullochella peelii	Murray Cod	V	• Boat-based electrofishing conducted according to the Australian Code of Practice (NSW Fisheries, 1997) and operated in a way to minimise possible damage to fish. • Daytime snorkelling. • Lure fishing and angling using barbless hooks. (SEWPaC, 2011d)	Draft referral guidelines: • boat-based electrofishing • skilled catch and release • day time snorkelling • spotlighting at night • doppler imaging • fine meshed fyke nets • larval drift nets (DoE, 2016a)	Seasonal surveys undertaken: • 1.76 hours of Boat e-fisher • 242.5 hours of Fyke net • 291.25 of box traps • 1 sweep seine nets; • 13 hours of spotlighting • Continuous day time searching • Guideline requirements fulfilled

Note: V = Vulnerable

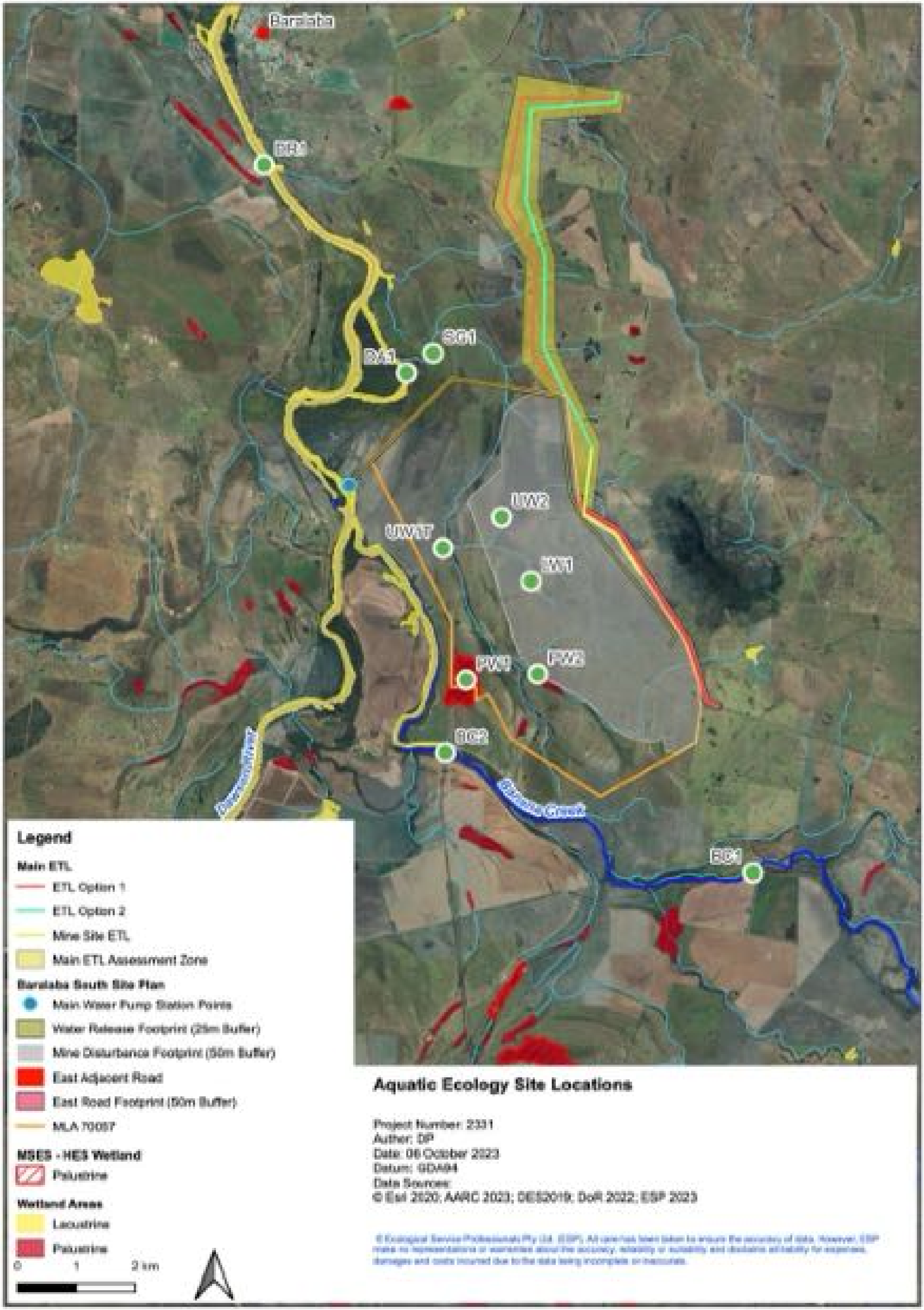


Figure 9.91: Aquatic ecology survey sites

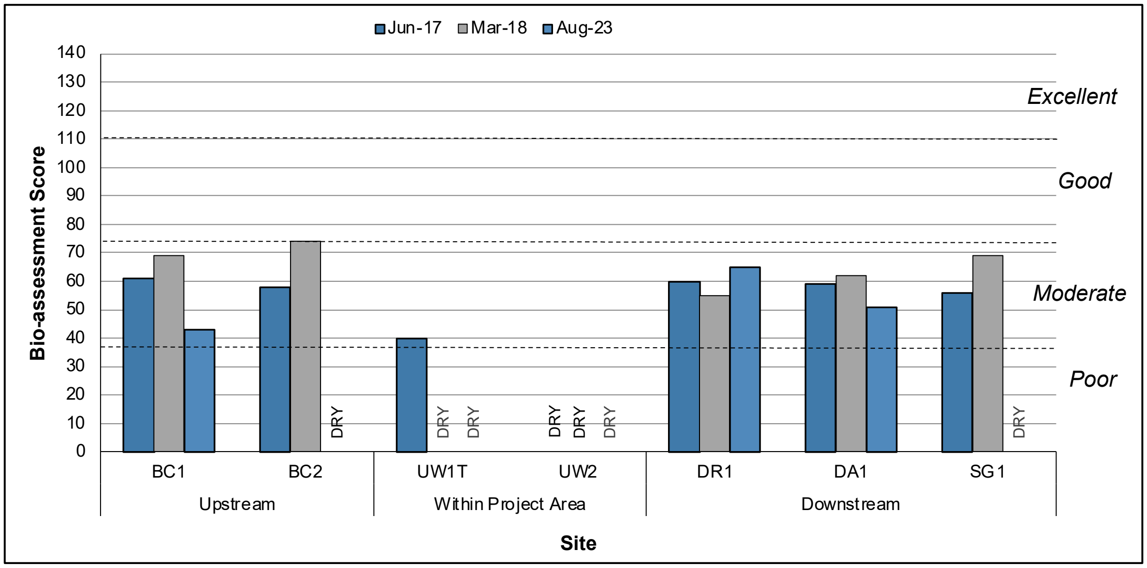


Figure 9.92: Aquatic habitat bio-assessment scores

9.12.1.4 Macroinvertebrate diversity

No listed macroinvertebrate species were recorded during field surveys for the Project. None are known to occur in the Dawson River Sub-basin or have been recorded in previous surveys of the region in the Dawson River or surrounding waterways and wetlands (Appendix G, Aquatic Ecology Assessment).

Macroinvertebrates were sampled from bed and edge habitat at each site that was holding water during the field surveys. The results show:

- Taxonomic richness was greater in edge samples than in bed samples. However, taxonomic richness was generally low in edge habitat when compared to the WQOs, but generally low to moderate in bed habitat.
- PET richness typically low to moderate across all sites and habitat types and summarised as follows:
    - Wetland sites had a PET richness consistently below the WQO range throughout the assessment.
    - Minor waterway sites had a PET richness consistently equal to or below the WQO range throughout the assessment.
    - Banana Creek sites had a PET richness equal to or below the WQO range in edge habitat and below the WQO range in bed habitat.
    - The Dawson River and the anabranch sites had a PET richness consistently equal to the lower WQO or within the WQO range throughout the assessment.
- SIGNAL 2 scores in edge habitat were low, with all sites below the WQO range throughout the assessment except for one site (BC2) on Banana Creek in June 2017 and one site (DA1) on the Dawson anabranch in March 2018.

Water quality data supports this, with high concentrations of nutrients recorded at all sites, which is typical of waterways surrounded by agricultural land.

9.12.1.5 Aquatic flora diversity

The aquatic plant species recorded in the study area are typical of the region and indicate a low to moderate diversity and abundance of aquatic flora. A total of 32 species of plants, from 20 families, were recorded at sites within the study area across both surveys.

Species richness was highest in the GES palustrine wetland (PW2) within the Project area during both surveys, while the sites on unnamed waterways and the HES palustrine wetland had the lowest species richness.

Most waterways had low coverage of in-stream aquatic plants with low diversity and coverage of floating and submerged species recorded, except at the GES palustrine wetland (PW2). The low abundance and diversity present are suggestive of the impacts due to surrounding land uses (cattle grazing, trampling and broad acre cropping) in combination with harsh physical conditions (i.e. drought and erosion) (Appendix G, Aquatic Ecology Assessment).

No listed threatened aquatic plants were recorded during the field surveys. There are no published records of listed threatened aquatic species occurring within 10 km of the study area and have been recorded during previous surveys undertaken on the Dawson River and surrounding waterways and wetlands within the region.

Two flora species listed as restricted invasive species under the *Biosecurity Act 2014* with a control category of 3 were recorded in both surveys on the Dawson River and Shirley's Gully, but not within the Project area. These include:

1) *Hymenachne amplexicaulis* (Olive Hymenachne*)* (also listed as WoNS*);* and
2) *Pistia stratiotes* (Water Lettuce).

9.12.1.6 Aquatic fauna diversity

A total of 21 species of fish from 13 families were recorded within and around the Project area (Appendix G, Aquatic Ecology Assessment). Fish communities were typical of the region characterised by common and widespread species. Within the Project area, diversity was low, while the major waterways surrounding the Project area supported a higher biodiversity, including three species endemic to the Dawson River sub-basin: *Scleropages leichardti* (Southern Saratoga), *Scortum hillii* (Leathery Grunter) and *Macquaria ambigua* (Golden Perch). Banana Creek and Shirley's Gully also provide fish breeding habitat and refuge during high flow periods in the Dawson River. Two pest species of fish were recorded: *Gambusia holbrooki* (Mosquito Fish) and *Carassius auratus* (Goldfish).

Two species of turtles considered widespread and common throughout waterways in Queensland were recorded in the Project area, which were *Emydura krefftii* (Krefft's River Turtle) and *Wollumbina latisternum* (Saw-shelled Turtle). These species are known from the region and have been previously recorded in surveys of the Dawson River and surrounding waterways and wetlands. No turtle nests were observed during the surveys at any site.

No listed species of turtles were recorded in the study area during the field surveys. The Fitzroy River Turtle *(Rheodytes leukops*) and the White-throated Snapping Turtle (*Elseya albagula*) are known in the broader region, however, the waterways and wetlands within the Project area are not considered suitable to support the inhabitation or breeding requirements of the listed turtle species. The major waterways surrounding the Project contain suitable habitat, including permanent pools and in-stream structure for resting and refuge. No ideal banks for nesting (i.e. sandy alluvial banks) have been noted on these waterways; however, some potential nesting banks have been noted around the Dawson River and Anabranch.

No platypus were sighted at any of the sites in the current surveys and no evidence of platypus, such as burrows were observed, and given the habitat requirements and distribution range of platypus it is not considered likely that platypus would occur in the waterways within the study area.

9.12.2. Listed aquatic species

9.12.2.1 Aquatic macroinvertebrates

No listed threatened macroinvertebrate or macrocrustacean species were recorded during the field surveys, are known to occur in the Dawson River Sub-basin.

9.12.2.2 Aquatic flora

No listed threatened species of aquatic plants were recorded during the surveys or are expected to occur, based on previous records, studies within the region and their preferred habitat (e.g. artesian springs).

9.12.2.3 Threatened aquatic fauna

Fitzroy River Turtle

The Fitzroy River Turtle is listed as vulnerable under both the EPBC Act and the NC Act.

The Fitzroy River Turtle is endemic to the Fitzroy River basin in Queensland and occurs widely within the permanent water habitats of the middle and lower reaches of the Fitzroy, Dawson, Mackenzie, and Comet Rivers and associated tributaries (Limpus *et al*., 2011).

There are several records of the species from the Dawson River in the surrounding region, including:

- a living record 70 km downstream of the Project area, near the town of Boolburra;
- a partial skull collected from the Moura Weir 45 km upstream of the Project area (ALA, 2019). It is difficult to ascertain whether this specimen was washed downstream and simply recovered from this location;
- downstream of Neville Hewitt Weir, 20 km downstream of the Project; and
- the Neville Hewitt Weir (unpublished) (Venz *et al*., 2002; Limpus *et al*., 2011), although it is difficult to determine if these records represent a relictual population persisting in unfavourable conditions or a healthy breeding population.

Records of occurrence and modelled distribution of the species around the Project area are shown on Figure 9.93.

The species has only been recorded in waters of the Dawson River main channel, and not in any of the smaller waterways in the region likely due to lack of suitable habitat.

No Fitzroy River Turtles or suitable habitat for the species were identified in the Project area during the surveys and these waterways are not considered to support suitable habitat for the species.

Although no individuals of the species were recorded during the surveys in in the Dawson River, Dawson River Anabranch, Shirley's Gully or Banana Creek, these areas provide suitable habitat to support the species, including permanent pool habitat and available in-stream structure for resting/refuge. The habitat within these watercourses adjacent to and downstream of the Project is characterised by a large, deep weir pool created by the Neville Hewitt Weir downstream of the Project. Although these waterways do not provide the preferred/key riverine habitat characteristics such as pool and riffle sequences, diversity of substrate and habitat types in the vicinity of the site, they may provide some suitable habitat features and individuals have previously been recorded here. Potential nesting banks were recorded on the well-vegetated earthen banks of the Dawson River and Anabranch but not within Banana Creek or Shirley's Gully.

Given the species was not recorded during the field surveys and that or preferred habitat is not present, the occurrence of the species is likely to transient in the areas adjacent to the Project area, rather than permanent.

An assessment of the potential Project impacts on the Fitzroy River Turtle is detailed in section 9.12.5.

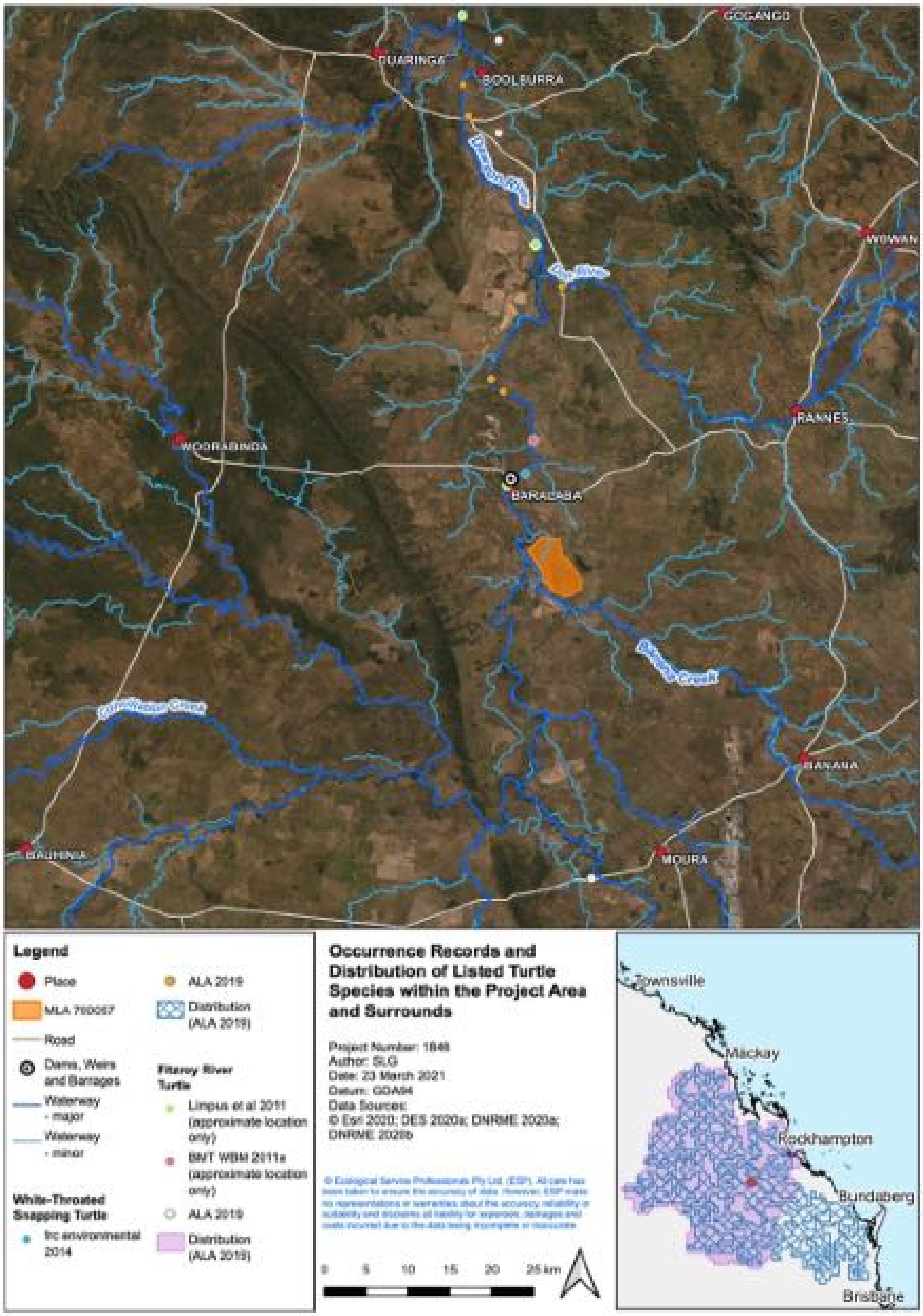


Figure 9.93: Occurrence records and distribution of listed turtle species: Project area and surrounds

Murray Cod

The Murray Cod is listed as vulnerable under the EPBC Act.

The Murray Cod occurs naturally in the warm water habitats of the Murray Darling basin, extending from southern Queensland through New South Wales, Australian Capital Territory, Victoria and South Australia. The Murray Cod has been translocated into the Fitzroy River basin and stocked into several dams across Queensland.

There are no published records of the Murray Cod in the vicinity of the Project area or within the Dawson River sub-basin (DES, 2019c; ALA, 2019). The closest published records of this species are in the Condamine-Balonne sub-basin, approximately 290 km south-east of the study area, and Lake Maraboon in the Nogoa River sub-basin, approximately 210 km to the north-west of the Project area.

No Murray Cod were recorded during previous surveys completed on the Dawson River and surrounding waterways and wetlands in the region (Appendix G, Aquatic Ecology Assessment). This species is considered unlikely to occur in the vicinity of the Project area.

Given the species is unlikely to occur within the study area, potential impacts to this species are not considered further.

9.12.3. Potential impacts

The potential impacts associated with the Project which have the potential to impact aquatic MNES values (Fitzroy River Turtle) are considered below.

9.12.3.1 Direct impacts

The removal and modification of aquatic habitat within the disturbance area comprising ephemeral watercourses, drainage lines and wetlands will arise due to the Project's activities, including:

- The unnamed waterways and the mapped lacustrine (farm dams) and palustrine wetlands (ephemeral wetlands) of GES within the disturbance area will be lost.
- There will be a small area of disturbance on the banks of the Dawson River to construct the proposed water release and extraction infrastructure.
- The waterways crossed by the proposed Moura-Baralaba Road realignment will be modified, but the scale of this disturbance is minor in nature.
- No direct impacts to waterways are likely as a result of the ETL.

Within the disturbance area, waterways provide only low aquatic ecosystem value and wetlands provide moderate aquatic ecosystem value. The estimated total area of wetlands to be lost is less than 3 ha which will occur over one lacustrine and two palustrine wetlands of GES. These GES wetlands provide some aquatic habitat when wet but they are poorly connected and provide limited available habitat to aquatic flora and fauna apart from those established within the wetlands currently. Overall, the aquatic habitats of these waterways and wetlands are common and typical of the region, and while their removal will mean a loss of available aquatic habitat for aquatic communities, this is not expected to impact aquatic ecology on a regional scale.

No threatened aquatic species or habitat has been identified in the Project area. All species identified within the Project area are considered common with a broad distribution in the region, removal of habitat for these species will not have a significant impact on a regional scale. Potential habitat for threatened aquatic species has been identified in the major waterways surrounding the Project area; however, the Project is not expected to impact on this potential habitat.

Construction of this water extraction/release infrastructure will result in the disturbance of a small area of riparian vegetation and streambank habitat (<1,000 m^2 total); however, no canopy trees are proposed to be removed.

The proposed Moura-Baralaba Road realignment will cross over a number of ephemeral waterways. The crossings will result in the removal of aquatic habitat and riparian vegetation from the banks of the waterways around the footprint of the road crossings.

The ETL and associated infrastructure will have minimal ground disturbance and the transmission line poles will be located outside of waterways to not impact overland flows or flooding. It is not envisaged that there will be a need for any waterway crossings (e.g. for access tracks). As such, no direct impacts to waterways are expected as a result of the ETL.

9.12.3.2 Indirect impacts

Surface water flows

Changes in catchment have been assessed and the results presented in Appendix A, Surface Water Impact Assessment. The Project is expected to result in a total reduction of 0.024% in catchment area contributing to the Dawson River at Beckers gauging station and 0.007% of the Fitzroy River at Riverslea. The Project is expected to have a reduction in streamflow less than 0.045% (mean annual flow) which is not expected to impact the existing Dawson River riparian vegetation or channel morphology. It can therefore be concluded that catchment excised by the Project will have negligible impact on streamflow in the Dawson River (Appendix A, Surface Water Impact Assessment).

The loss of catchment area is expected to result in a moderate reduction in flows for the minor waterways that will remain within and immediately downstream of the Project area (Appendix A, Surface Water Impact Assessment). The downstream reach of the north-western waterway (Shirley's Gully) is of moderate aquatic ecological value and will experience a reduction in flow from the loss of upstream catchment. This will result in an overall minor (localised) impact to the aquatic ecosystem, noting that conditions in the reaches upstream of the Neville Hewitt Weir pool are not expected to be significantly different than those that occur in many of the ephemeral waterways of the region, with this habitat still available to aquatic flora and fauna during times of flow. The lower reaches of the gully are within the Neville Hewitt Weir pool and provide refuge habitat for aquatic flora and fauna; this will not change as a result of the loss of catchment area as water here backs up from the Dawson River.

The Project will not reduce the catchment area reporting to the wetland and not have a significant impact on flooding interactions between the Wetland and the Dawson River and Banana Creek (Appendix A, Surface Water Impact Assessment).

Water releases

Mine water is proposed to be released to prevent the accumulation of mine water on site and reduce the risk of uncontrolled mine water releases to natural waterways.

Mine water releases have been modelled to occur from the MWD located south-east of the MIA. Mine water will be released through a pumped transfer at a maximum rate of 500 L/s, around the northern extent of the MLA area directly to the Dawson River channel. Releases of mine-affected waters are not expected to influence streamflow volume or duration in the Dawson River, resulting in a negligible impact to local hydrology. The proposed strategy is to release into the Dawson River, with all controlled releases made in accordance with the approach outlined in condition F11 of the Model Mining Conditions (DES, 2017) which is based on 'Model Water Conditions for Coal Mines in the Fitzroy Basin' (DES, 2013).

Accordingly, all release events will coincide with medium-high streamflow conditions in the Dawson River and will occur for a length consistent with natural flows (Appendix A, Surface Water Impact Assessment). No changes to the duration of natural medium-high flows in the Dawson River are predicted (Appendix A, Surface Water Impact Assessment). Further, no significant changes in water quality are predicted to result.

There may be localised impacts to aquatic flora and fauna within the mixing zone during controlled water releases as a result of the high EC, however, any such impacts would be intermittent short-term and reversible, as aquatic flora and fauna would recolonise the area once releases cease. No impacts to aquatic flora and fauna beyond the mixing zone are expected.

Similarly, modelling for the unlikely occurrence of uncontrolled releases has shown that they are unlikely to result in a significant impact. Potential uncontrolled releases might only occur during high flow events in the Dawson River and would be of minimal volume and short duration when compared to the volume and duration of flow in the receiving waterway, and would have low to moderate EC (Appendix A, Surface Water Impact Assessment). Overtopping flows from sediment dams are not expected to have impacts on water quality affecting vegetation within the overflow pathways between the Project MLA and the Dawson River. Water from any uncontrolled release that did occur would flow towards the Dawson River and Banana Creek, and would not flow towards, or into, the HES wetland (Appendix A, Surface Water Impact Assessment).

Surface water quality

Potential water quality contaminant sources associated with the Project include:

- Surface runoff from disturbed areas.
- Surface runoff from mine waste or stockpiles.
- Process waste streams and entrained water.
- Seepage, overtopping or dam failure of site water storages.
- Seepage from waste rock emplacements.
- Groundwater ingress to the open cut pit.

During mining operations, potential influences on water quality will include increased sedimentation and turbidity, concentrations of contaminants (namely metals and hydrocarbons) and saline and acid drainage. The site water management system is designed to divert all clean water around operations and capture all contaminated water into sediment dams and mine-affected water dams. The potential for impacts on aquatic environmental values due to changes in water quality is low.

Seepage generated in the out-of-pit and in-waste rock emplacements is expected to be of low salinity and neutral to alkaline pH (Appendix E, Geochemical Assessment), so is not expected to influence water quality in the receiving environment or impact the aquatic ecosystem. The geochemical assessment of potential spoil and coal reject materials completed found spoil to be low risk and NAF. Potential coal reject material was also found to be low risk and mostly classified as NAF, although it was partially classified as PAF with a ‘low’ to ‘moderate’ capacity to generate significant acidity (Appendix A, Surface Water Impact Assessment). As a result, terrestrial or aquatic ecosystems are not expected to be impacted by surface water runoff, process waste streams or seepage.

Water quality is discussed in greater detail in Chapter 4, Surface Water.

Water demand and supply

The Project will source most of its water from surface water runoff and groundwater ingress into the mining pit. However, during very dry years (less than 5% of years for the majority of the Project life), water will be sourced from the Dawson River under existing water entitlements, via the water extraction infrastructure (Appendix A, Surface Water Impact Assessment). This is particularly the case during Years 2 to 6, when dust suppression demands are the highest and groundwater inflows are at their lowest. The maximum annual demand on Dawson River water licences is expected to be 881 ML in the 5th percentile during Year 3 of the Project (Appendix A, Surface Water Impact Assessment).

This has the potential to impact on the aquatic ecology downstream of the off–take point, however, the severity and extent of impact would be influenced by the river water levels and flows at the time of extraction.

As the water offtake is from the impounded reaches of the river, the main impact of water extraction will result in reduction of water levels within the river (rather than a change in habitat diversity). The main impact of this water level reduction would be a loss of aquatic plants and associated macroinvertebrates at the water's edge. Mobile species (fish and turtles) would still have refuge habitat to move into in the centre of the river channel, and as such, impacts to these species as a result of water extraction are not expected.

Groundwater drawdown

The predicted groundwater drawdown associated with development of the mining void is shown in Figure 9.96 which shows the predicted maximum extent of Project related drawdown in alluvium. While the predicted groundwater drawdown due to the Project would be limited in the shallow groundwater systems, it would incidentally result in some groundwater leakage from the Dawson River (upstream of Neville Hewitt Weir) by up to approximately 0.17 ML/day, which when compared to the average surface water flows in the Dawson River for the past 5 years (and recently prescribed passing flow conditions for the Dawson River) is less than a 0.01% reduction in flow (Appendix B, Groundwater Modelling and Assessment). This was considered in the modelling of the streamflow impacts of the Project on the Dawson (Appendix A, Surface Water Assessment). The predicted reduction in mean annual flow (0.045% reduction adjacent to the Project area, with a decreasing impact with distance downstream) is negligible and is not expected to result in impacts to the existing Dawson River channel morphology or riparian vegetation; the EFOs for the Dawson River at the closest downstream node (Becker's gauging station) will be met.

Groundwater quality

There is not expected to be any measurable change in the quality of groundwater as a consequence of mining, either in Permo-Triassic strata (within which groundwater level drawdown would be largely contained) or in younger units, such as alluvium or colluvium. The localised hydraulic sink that will form as mining develops will minimise the potential migration of saline or poorer quality groundwater from within the open cut pit to other areas. Consequently, there will be negligible impacts on groundwater quality in aquifers or surface water quality in downstream waters due to interaction with groundwater (Appendix B, Groundwater Modelling and Assessment).

The disconnected sandy lenses which support GDEs on a seasonal basis are underlain by partially confined groundwater systems associated with the regional alluvial aquifer and the Permian sediments/coal measures. The potential for saline water from these groundwater units to contaminate any fresh perched groundwater system is negligible as there is no risk of upward propagation of saline groundwater under hydrostatic pressure (Appendix B, Groundwater Modelling and Assessment).

Rock spoil is expected to be NAF and have a negligible risk of developing acidic conditions (Appendix E, Geochemical Assessment). The spoil is also expected to generate low salinity rainfall runoff and seepage which will be captured by sediment dams. Uncontrolled release of seepage is not expected to occur from site and recovered seepage flows will be managed in accordance with the mine Water Management System. It is not expected that seepage from waste rock emplacements will cause any additional impacts to water quality in the receiving waterway (Appendix A, Surface Water Impact Assessment).

Based on the low salinity of runoff and seepage, and the management of mine-affected water storages and sediment dams under the mine Water Management System, it is considered that there is low risk of impact to the water quality of, or introducing toxicants, to the alluvial aquifers which support GDEs. As a result, terrestrial, aquatic or GDEs are not expected to be impacted as a result of any uncontrolled release of seepage.

Introduced species

Two species of invasive aquatic plants (Water Lettuce and Olive Hymenachne) were recorded as part of the field surveys in the Dawson River and Anabranch and are also known from the wider Dawson River Sub-basin. Two species of invasive fish (Eastern Mosquitofish and Goldfish) were recorded as part of the field surveys and are known from the wider Dawson River Sub-basin. Given additional "make-up" water is being sourced from the Dawson River adjacent to the Project, it is unlikely that new species will be introduced as a result of any water supply pipelines associated with the Project. Changes to water quality resulting from the Project may promote conditions that encourage the proliferation of invasive fish and aquatic plants, which can thrive in poor water quality (e.g. high nutrient waters). However, where impacts to water quality are appropriately managed (as is proposed), this outcome is not predicted.

There is potential that aquatic weeds may enter and establish in the HES wetland when it is inundated by flood waters from the Dawson River, however, the risk of this occurring is not increased compared with the current scenario, as the frequency of flooding in the wetland will not change. In addition, works in and around wetlands and waterways outside of the Project area where invasive plant species occur have the potential to spread aquatic weeds if vehicle and other plant and equipment are not appropriately washed down.

9.12.3.3 Cumulative impacts

The cumulative impacts of the Baralaba South Project and the Baralaba North Mine and Dawson Mine on the hydrology of the Dawson River and tributaries have been modelled. In summary, these assessments concluded that there would be negligible cumulative impacts to the Dawson River streamflow (reduction of approximately 0.024% in mean annual flow) (Appendix A, Surface Water Impact Assessment). This minor reduction is not predicted to result in changes to the extent or availability of preferred Fitzroy River Turtle habitat, such as riffles and runs, downstream of the Neville Hewitt Weir.

9.12.4. Mitigation, management measures and monitoring

A range of mitigation, management and monitoring measures will be undertaken to minimise the potential impacts to surface and groundwater resources. The following programs, plans and systems will be implemented and described elsewhere in this chapter:

- Water management system (see section9.8.1);
- Surface Water Quality Monitoring Program (see section 9.8.5.6);
- Water Management Plan (see section 9.8.5.6);
- Erosion and Sediment Control Plan (see section 9.8.5.9);
- Contaminants management (see section 9.8.5.10);
- Receiving Environment Monitoring Program (see section 9.8.5.7);
- Groundwater Monitoring Program (see section 9.10.5.1); and
- Groundwater Pit Inflow Monitoring Program (see section 9.10.5.2).

9.12.5. Significant impact assessment

9.12.5.1 Fitzroy River Turtle

Description

The Fitzroy River Turtle is a medium to dark brown freshwater turtle with an oval shell, growing up to 25 cm in length with scattered darker spots on the upper shell surface (DoE, 2020). It has a pale yellow or cream underside, dull olive-grey exposed fleshy parts and a distinct narrow white ring around the eye in adults, or a silvery-blue iris in hatchlings (Cogger, 2000; Hamann *et al*., 2007; DoE, 2020). The Fitzroy River Turtle has relatively long forelimbs with five long claws and large cloacal bursae (Cogger, 2000; Wilson & Swan, 2003).

This species is a benthic omnivore, with a diet consisting of insects, macroinvertebrates (principally larvae and pupae of *Trichoptera* and *Lepidoptera*), crustaceans, gastropods, worms, freshwater sponges, algae and aquatic plants including ribbonweed (*Vallisneria* sp.*)* (DEWHA, 2008).

Habitat and ecology

The Fitzroy River Turtle is largely sedentary with a relatively small home and movements typically restricted between riffle zones and adjacent pools. The average home range for nine individuals in 2001 was between 417 to 679 m, and typically remaining a distance between 258 to 359 m to a riffle zone (Tucker *et al*., 2001). However, large scale movement may potentially occur for the purpose of dispersal, courtship and nesting migrations and repositioning following flood displacement (Tucker *et al*., 2001). This species does follow movement patterns relating to flow rate (Tucker *et al*., 2001), in that it:

- moves slightly upstream of riffle zones under moderate flow;
- moves downstream of riffle zones under base flows; and
- No obvious directional movement patterns under flood conditions.

The Fitzroy River Turtle's preferred habitat is clear flowing watercourses that have (Cogger *et al.,* 1993; Tucker *et al.,* 2001; Limpus *et al*., 2011):

- Rocky, gravelly or sandy substrates;
- Large deep pools (between 1 and 5 m deep) that provide refuge areas and are associated with shallow riffles zones that provide favourable foraging habitat for macroinvertebrates;
- In-stream features such as undercut banks, submerged boulders, tree roots and logs, which provide rest and refuge spots;
- In-stream vegetation (in particular ribbonweed [*Vallisneria* sp.]) which is a preferred food source and provides favourable foraging habitat for macroinvertebrates; and
- Healthy riparian vegetation fringing the waterway including blue gums (*Eucalyptus tereticornis*), river oaks (*Casuarina cunninghamiana*), weeping bottlebrushes (*Callistemon viminalis*) and paperbarks (*Melaleuca linariifolia*) (DEWHA, 2008).

During wet periods, the turtles prefer habitats with moderate flow and 1–2.5 m visibility to assist while foraging in riffles. During dry periods, when the riffle zones dry, the turtles inhabit deeper pools with standing or slow-flowing water.

While flowing waters are thought to be preferred by the species, the Fitzroy River Turtle is also known to inhabit the shallow upstream margins of impoundments and have been recorded within impounded waters, including breeding populations (Limpus, C. [DES] pers. comm. 2020). However, deep water areas (> 5 m) typical of impoundments are considered largely unsuitable to the species due to low oxygen levels, little or no light penetration, cold temperatures and low available of favourable foraging habitats (Limpus *et al*., 2011).

Nesting habitat is typically restricted to areas with alluvial sand/loam banks 1-4 m above water level, deposited after flooding events. Some nesting sites have been found 15 m from the water on flat sandbanks (DEWHA, 2008). Banks that have a relatively steep slope, low density of ground or understorey vegetation and partial shade cover are considered to be preferred based on limited data. Females have an annual reproductive potential of 46 to 59 eggs (29 mm long and 21 mm wide) laid within three clutches which are deposited in nesting chambers 170 mm deep (DEWHA, 2008; Hamann *et al*., 2007). Nesting occurs in spring (September to November), with hatching occurring between November and March (Limpus *et al*., 2011). Sexual maturity is reached between 15 and 20 years (Hamann *et al*., 2007).

Distribution and records

The Fitzroy River Turtle is endemic to the Fitzroy River basin in Queensland and occurs in an estimated total area of less than 10,000 km^2 within the permanent water habitats of the middle and lower reaches of the Fitzroy, Dawson, Mackenzie and Comet Rivers and associated tributaries (DEWHA, 2008; Limpus *et al*., 2011). Their distribution extends from the Fitzroy Barrage to the upper areas of the Dawson (to at least Theodore Weir), Nogoa and Connors Rivers.

Areas where the species is known to occur include waterways around Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralaba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek and Gogango (Cogger *et al*., 1993). Known key breeding spots for the Fitzroy River Turtle include Glenroy and Redbank crossings on the Fitzroy River, Theodore Weir on the Dawson River, Cardowan pump pool on the Connors River and Marlborough Creek (Limpus *et al*., 2011).

The closest published records of this species in the Atlas of Living Australia are in the Dawson River approximately 70 km downstream near the town of Boolburra, and 45 km upstream to the south near Moura (ALA, 2019) (Figure 9.93). However, the record from Moura is from a skeleton lodged with the museum (Amey, A. [Queensland Museum] pers. comm. 2020), as such it is difficult to ascertain whether there are individuals or a population of this species at Moura Weir, or whether this specimen was washed downstream and simply recovered from this location.

However, during surveys previously completed within the region for the Baralaba Mine, a Fitzroy River Turtle was recorded at a site on the Dawson River downstream of Neville Hewitt Weir, 20 km downstream of the study area; the exact location of this record is unpublished (BMT WBM, 2011a). There are also unpublished records that indicate two Fitzroy River Turtles have been recorded within the waters of the Neville Hewitt Weir; the exact location of the records is unknown, but the Neville Hewitt Weir impoundment is within the study area (Venz *et al*., 2002; Limpus *et al*., 2011). Because freshwater turtles are relatively long-lived (approximately 20 years to maturity), it is difficult to determine if the presence of this species in these locations represents a relictual population persisting in unfavourable conditions, or whether those individuals are part of a healthy breeding population (Venz *et al*., 2002).

The species has only been recorded in waters of the Dawson River main channel, and not in any of the smaller waterways in the region likely due to lack of suitable habitat. This species occurs within the permanent freshwater riverine reaches, with no known records of occurrences in spring-fed waterholes and streams or small farm dams created outside of the permanent riverine habitats, nor has it been detected in permanent billabongs that parallel the main stream on the floodplains of the lower Fitzroy (Limpus *et al*., 2011; Limpus, C. [DES] pers. comm. 2020).

Current known threats

The most significant threat to the Fitzroy River Turtle is the predation and trampling of eggs by agricultural stock. Breeding is being undermined because communal nesting sites along riverbanks are now heavily exploited by Foxes (*Vulpes vulpes*), pigs (*Sus scrofa*), dingos (*Canis lupus*), cats (*Felis catus*), goannas (*Varanus gouldii*) and water rats (*Hydromys chrysogaster*). With over 90% of nests being lost to predation, the turtle population now consists almost entirely of adults, with no juveniles recruiting into the population (Limpus *et al*., 2011). Artificial barriers increase this threat as turtles have to move further over land to find suitable habitat which may increase the risk of interactions with feral animals (DoEE, 2017c). Fishing and recreational boats may also cause injury or mortality (Limpus *et al*., 2011).

Other dominant threats identified include (DEWHA, 2008):

- loss and disturbance of habitat from mining and agriculture (particularly cotton and cattle farming);
- invasive weeds, which may increase the difficulty of access to the preferred nesting sites;
- water salinity, pollution and siltation in rivers and creek habitat, which affects food resources and cloacal respiration;

- damming of rivers, which restricts water flow and may threaten this species by impacts on dietary ecology or cloacal respiration; dams and weirs may also act as a physical barrier which restricts access to feeding and nesting sites; and
- water quality changes such as increased sediment and nutrient load from dam and weir construction works, and increased runoff of pesticides and herbicides from irrigation, which are likely to have detrimental effects on the dietary ecology of this species (Venz *et al*., 2002).

Survey effort

The Fitzroy River Turtle can be difficult to survey as they rarely enter traps. The highly turbid waters of the Dawson River and tributaries within the study area restricted the use of preferred survey techniques for this species, including snorkelling. The presence of snags precluded the use of seine nets, except for in Banana Creek. The main survey techniques relied upon were:

- spotlighting from boat in the Dawson River and Shirley's Gully (over a 1 km distance) and from the bank in Banana Creek (over a 100 m distance) (19.25 hours over four days);
- electrofishing from boat (as above this method did not target turtles but turtles were incidentally recorded);
- baited fyke nets (117.5 hours over three days in the dry season survey and 125 hours over four days in the post-wet season survey);
- Seine netting (one sweep at site BC2 in Banana Creek during the dry season survey); and
- daytime searching for nests and assessment of potential habitat.

The effectiveness of evening spotlighting was also impacted by the highly turbid water, which is a known limitation of surveying in turbid environments for this species (Limpus, C. [DES] pers. Comm., 2020). To compensate, additional effort was employed to assess the suitability of habitat at each site to support the Fitzroy River Turtle (and White-throated Snapping Turtle) and reviewing available data on the occurrences of listed turtle species in the region to inform the likelihood of their occurrence in the study area.

Survey outcomes and habitat assessments

There is no suitable habitat for the Fitzroy River Turtle within the Project area.

The habitat provided within the Dawson River, Dawson River Anabranch, Shirley's Gully and Banana Creek adjacent to and downstream of the Project is characterised by a large, deep weir pool created by the Neville Hewitt Weir downstream of the Project. These reaches are mapped as lacustrine wetland by DES under the Queensland Wetlands Mapping Program (Figure 9.91). The waterways do not provide the preferred/key riverine habitat characteristics for the Fitzroy River Turtle (such as pool and riffle sequences, diversity of substrate and habitat types) in the vicinity of the site, although it is acknowledged that the Fitzroy River Turtle and White-Throated Snapping Turtle can and does occur in the upper reaches of weir pools in the Dawson River (Limpus *et al*., 2011; Limpus, C. [DES] pers. Comm., 2020). It was therefore considered that the Dawson River and Anabranch, Shirley's Gully and Banana Creek provided potentially suitable habitat for the Fitzroy River Turtle. As the Fitzroy River Turtle was not detected during the field surveys and as there is no key or preferred habitat present (due to the relatively deep water as a result of the Neville Hewitt Weir downstream), the occurrence of the Fitzroy River Turtle in the areas adjacent to the Project is considered likely to be transient rather than permanent.

No ideal banks for nesting (i.e. sandy alluvial banks) were noted at sites on Dawson River, Dawson River Anabranch, Shirley's Gully or Banana Creek, however, potential nesting banks were noted around the Dawson River and Anabranch; Fitzroy River Turtles have been known to nest in well-vegetated earthen banks, which characterised the banks of these waterways.

Impact assessment

There is no suitable habitat for the Fitzroy River Turtle within the disturbance footprint. As such, there will be no direct impacts to this species or its habitat within the Project. The proposed water infrastructure site is within the Neville Hewitt Weir inundation area, which does not provide preferred habitat for this species. The worst-case estimate of the area of potential stream bank to be affected is less than 500 m^2.

The potential impacts to water quality in the receiving environment of the Dawson River as a result of planned releases are predicted to be minor and not significant in an ecological context, with the exception of localised impacts in the mixing zone. As the proposed release point is not located in an area containing preferred habitat for the Fitzroy River Turtle, it is considered highly unlikely that the controlled releases will impact on this species or its habitat; particularly as it is a mobile species.

The modelled impacts to the hydrology and flooding of the Dawson River as a result of the Project are minor in an ecological context, and they are unlikely to change the nature of the habitat available upstream and downstream of the Neville Hewitt Weir (i.e. weir pool habitat and regulated riverine habitat respectively). Most notably, there will be no significant reductions in flow downstream of the weir and as such, no impacts to the existing Dawson River channel morphology (including the presence of run and riffle habitat) or riparian vegetation are expected. As such, the changes are not likely to result in noticeable impacts to the extent or quality of Fitzroy River Turtle habitat present in the river.

It is not expected that the Project will result in the introduction of any new aquatic pest species to the Dawson River, and as such no indirect impacts to the habitat of the Fitzroy River Turtle are expected as a result of this. Likewise, as there will be no major changes to the habitat present within the Neville Hewitt Weir pool (i.e. no changes to water depths, velocity or water quality), there is no predicted change to the current extent of aquatic weed species within the study area.

No indirect impacts to Fitzroy River Turtle habitat are expected as a result of impacts to groundwater, as the waterways providing Fitzroy River Turtle habitat are not considered to be aquatic (surface-expression) GDEs, no impacts to the riparian vegetation (which is a terrestrial GDE) are expected, and negligible impacts to flows in the river are predicted as a result of groundwater leakage from the Dawson River (Appendix B, Groundwater Modelling and Assessment).

The Project will not result in any other actions that have the potential to impact on Fitzroy River Turtles or their habitats. As such, no facilitated impacts to the Fitzroy River Turtle are predicted.

Potential cumulative impacts to the Fitzroy River Turtle could arise as the result of indirect impacts, e.g. changes to the water quality and hydrology of the Dawson River (including the anabranch) and its tributaries, as a result of the cumulative impacts of the Baralaba South Coal Project along with other Projects in the area.

The cumulative impacts of the Baralaba South Coal Project and the Baralaba North Mine and Dawson Mine on the hydrology of the Dawson River and tributaries have been modelled. In summary, these assessments concluded that there would be negligible cumulative impacts to the Dawson River streamflow (reduction of approximately 0.024% in mean annual flow) (Appendix A, Surface Water Impact Assessment). This minor reduction is not predicted to result in changes to the extent or availability of preferred Fitzroy River Turtle habitat, such as riffles and runs, downstream of the Neville Hewitt Weir.

Avoidance, mitigation, and management

There is no potential Fitzroy River Turtle habitat within the Project footprint; as such, direct impacts have been avoided. The exception is the potential for a very small area (< 500 m^2) to be affected by construction of water extraction or discharge infrastructure. The potential impacts of this will be minimised and mitigated by reducing the construction footprint of the water extraction infrastructure as far as practical and limiting disturbance of the bank on which it will be positioned.

The potential indirect impacts to Fitzroy River Turtle habitat as a result of impacts to water quality and hydrology will be minimised and mitigated by developing and implementing the following management and monitoring plans for the site:

- Water Management Plan;
- Erosion and Sediment Control Plan;
- Progressive Rehabilitation and Closure Plan;
- Water Quality Monitoring Program;
- Receiving Environment Monitoring Program (REMP).

The REMP is to monitor the impacts of the Project on the environmental values of the receiving environment (including water quality, flows and biological health indicators such as macroinvertebrates), and to provide feedback for continuous improvement of environmental management if required.

Rehabilitation requirements

Rehabilitation of disturbed areas will occur progressively throughout the life of the mine and will continue after mining has ceased until rehabilitation objectives have been met.

Suitable topsoils and subsoils will be stripped from construction and mining areas, and where viable stored to maintain soil quality and used in rehabilitation to promote native vegetation from the soil seed bank. Revegetation will be also undertaken where required across the mine site.

Significant impact assessment

Table 9.76 provides an assessment of the significance of impacts to the Fitzroy River Turtle against the Commonwealth Significant Impact Guidelines.

Table 9.76: Assessment of significance of impacts for the Fitzroy River Turtle

Significant Impact Criteria (DoE, 2013a)	**Residual Significant Impact Assessment for the Project**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
• lead to a long-term decrease in the size of an important population of a species	An important population of the Fitzroy River Turtle has not been identified within the waters of the Neville Hewitt Weir pool. Regardless, with the appropriate mitigation measures in place, mortality of individual Fitzroy River Turtles is not expected, nor are impacts to breeding (noting that it has not been established that breeding of this species occurs within the study area). Likewise, no significant impacts to water quality or hydrology are predicted downstream of the Neville Hewitt Weir, and as such no impacts to individuals or breeding populations in the reaches downstream of the weir are predicted.
• reduce the area of occupancy of an important population	An important population of the Fitzroy River Turtle has not been identified within the waters of the Neville Hewitt Weir pool. Regardless, the Project is not expected to have any direct or indirect impacts to the habitat of Fitzroy River Turtle (either upstream or downstream of the weir); and as such the area of occupancy for this species will not be reduced.
• fragment an existing important population into two or more populations	An important population of the Fitzroy River Turtle has not been identified within the waters of the Neville Hewitt Weir pool. Regardless, the Project will not result in the fragmentation of Fitzroy River Turtle habitat or populations.
• adversely affect habitat critical to the survival of the species	It has not been established that the waters of the Neville Hewitt Weir pool provide habitat critical to the survival of the species; rather, it is highly likely that they do not. Regardless, the Project will not result in any adverse impacts to Fitzroy River Turtle habitat.

Significant Impact Criteria (DoE, 2013a)	Residual Significant Impact Assessment for the Project
• disrupt the breeding cycle of an important population	It has not been established that there is a breeding population of Fitzroy River Turtle in the Neville Hewitt Weir pool. Regardless, the Project will not result in any adverse impacts to Fitzroy River Turtle breeding habitat, or any reductions in water or habitat quality (that could lead to decreased fitness or breeding success).
• modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project will not result In any adverse impacts to potential Fitzroy River Turtle habitat, either as a result of direct impacts or indirect impacts (e.g. to water quality or flows).
• result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The Project will not result in the establishment of an invasive species within the Fitzroy River Turtle's habitat.
• introduce disease that may cause the species to decline	The Project does not have the potential to introduce a disease that may cause the Fitzroy River Turtle population to decline.
• interfere substantially with the recovery of the species	The Project will not interfere with the recovery of the Fitzroy River Turtle, as it will not directly or indirectly impact this species or its habitat.
Conclusion	Given the small footprint of water extraction infrastructure on the Dawson River, continuity of connectivity and insignificant impacts to water quality and hydrology downstream of the Project, it is considered unlikely that the Project will have a significant residual impact on the Fitzroy River Turtle.

9.13 Stygofauna

9.13.1. Background ecology

Stygofauna are animals that live in groundwater and consist of invertebrates including crustaceans, worms, snails, mites and insects. Stygofauna use inputs of organic matter from the surface to provide the basis of the food web and through this process stygofauna play an important part in maintaining groundwater quality.

Stygofauna can be categorised into four types, relative to their dependence on groundwater systems, as follows (Appendix I, Stygofauna Assessment):

- Stygobites and phreatobites are stygofauna that are completely dependent on groundwater:
  - Stygobites are obligate subterranean species, restricted to groundwater systems.
  - Phreatobites are stygobites that are restricted to the deep groundwater substrata of alluvial aquifers.
- Stygoxenes and stygophiles are stygofauna that can live in within surface water or groundwater systems.
  - Stygoxenes are stygofauna that have no affinity with groundwater systems but are regularly recorded in caves and alluvial sediments. Stygoxenes include planktonic groups and a variety of benthic crustacean and insect species which passively infiltrate alluvial sediments (Gilbert *et al*., 1994).
  - Stygophiles are stygofauna that actively utilise groundwater system resources and/or actively seek protection from unfavourable surface water conditions.

9.13.2. Methodology

A desktop assessment was used to determine the suitability of groundwater ecosystems of the Project area to provide habitat for stygofauna on the basis of geological, hydrological and water quality characteristics of local groundwater ecosystems, and included:

- review of previous stygofauna studies conducted in the vicinity of the Project to determine the recorded presence and distribution of stygofauna in the region; in particular, the stygofauna assessments completed for the Project area in 2012 (SKM, 2014) and the Baralaba North Coal Mine in 2014 (Eco Logical, 2014) approximately 10 km north in the alluvial aquifer of the Dawson River Anabranch;
- review of groundwater quality (pH and EC) data within and surrounding the Project area (Appendix B, Groundwater Modelling and Assessment); and
- review of hydrological data for the Project (Appendix A, Surface Water Impact Assessment).

The hydrogeology and surface water quality of the Project area are described in section 9.8 and section 9.10.

Four sampling surveys for stygofauna were undertaken for the Project across 12 groundwater bore sampling sites (Stygoecologia, 2019) (Table 9.77 and Figure 9.94).

The sample sites were selected as representatives of each of the major habitats of groundwater systems and aquifers and considered the south-west flow of shallow groundwater allowing for sites sampled to be located within, adjacent to, up-flow or down-flow of the Project area and selected based on suitability for stygofauna because:

- they were shallow monitoring piezometers of less than 100 m; and
- they accessed groundwater situated in the unconsolidated alluvial sediments.

The stygofauna assessment was undertaken in accordance with the requirements of the 'Guideline for the Environmental Assessment of Subterranean Aquatic Fauna' (DSITIA, 2014). An ecological valuation of the aquifers and associated GDEs was undertaken in accordance with the 'Risk Assessment Guidelines for Groundwater Dependent Ecosystems', (Serov *et al*., 2012) to determine the value of each aquifer and GDE and level of dependency on groundwater.

Full details of field methodology and laboratory analyses are provided in Appendix I, Stygofauna Assessment.

Table 9.77: Stygofauna assessment sites

Stygofauna sampling site	Aquifer unit	Altitude (mAHD)	Total depth (m)
Within Project area			
A-OB3	Quaternary alluvium	87.9	30
A-OB4	Quaternary alluvium	875	17
A-OB10	Quaternary alluvium	87.5	23
Adjacent to Project area			
A-PB1	Quaternary alluvium	88.4	22.3
A-PB2	Quaternary alluvium	88.9	29.1
A-OB1	Quaternary alluvium	88.9	29.1
A-OB2	Quaternary alluvium	88.3	20

Stygofauna sampling site	Aquifer unit	Altitude (mAHD)	Total depth (m)
A-OB6	Quaternary alluvium	91.4	29
A-OB7	Quaternary alluvium	91.7	26
A-OB8	Quaternary alluvium	91.4	23
A-OB11	Quaternary alluvium	86.2	17
A-OB12	Quaternary alluvium	87.2	18

9.13.3. Aquifer characteristics

The main aquifer units of the Project area include the Dawson River Alluvium and the underlying Permian Blackwater Group coal measures.

Previous studies (SKM, 2014) have identified stygofauna (*Cyclopoida Copepoda* and a damaged mite) in the alluvium but concluded that there were no stygofauna present within the Permian coal measures which is consist with other regional studies. As such, the Stygofauna assessment (Appendix I, Stygofauna Assessment) focused on the Dawson River Alluvium.

The Dawson River Alluvium is a shallow groundwater system with water levels during the survey period between 19.93- 8.07 mbgl. Groundwater elevation was highest near the Dawson River at bores A-OB12, A-OB11, A-OB1, A-OB2 and A-OB3 and reduced with increasing distance from the Dawson River. Groundwater EC ranged between 327.7 µS/cm (A-OB12) to 40,022 µS/cm (A-OB4), with bores adjacent the Dawson River recording lower EC compared to bores further away. Groundwater pH within the alluvial bores was generally slightly acidic to neutral, pH values recorded were between pH 6.08 to pH 7.00.

9.13.4. Stygofauna community

Stygofauna were recorded at four of the 12 sites sampled. A total of 3 taxa and 24 individuals were collected throughout the five surveys. Stygofauna recorded included:

- Phreatobites from the family *Naididae* (aquatic worms) were recorded at three sites A- OB1, A-OB2 and A-OB3; and
- Stygophiles from the family *Haplodesmidae* (centipedes) and *Campodeidae* (primitive insects) were recorded at three sites A-OB1, A-OB2 and A-OB8.

The Stygophiles collected in the samples was determined to be coincidental (i.e. falling into the bore, occupying the vegetation adjacent to the bore, living within the bore above the water table) and are not considered further.

All the stygofauna associated with the alluvium were collected from the unconfined alluvial aquifers of the Dawson River Alluvium associated with the river channel; the diversity of stygofauna from these locations is low. There was no groundwater dependent fauna present in bores within the floodplains of the Project area.

None of the recorded species of stygofauna are listed as threatened under either the state or Commonwealth legislation. The ecological value associated with the stygofauna in the study area is considered to be low due to the restricted nature of the habitat and the low number of disturbance tolerant taxa. The alluvial aquifer geology consists of the fine-grained sands and clays which limit or prohibit the occurrence of stygofauna (Appendix C, Flood Impact Assessment).

Further details regarding the stygofauna assessment undertaken for the Project is provided in Appendix I, Stygofauna Assessment.

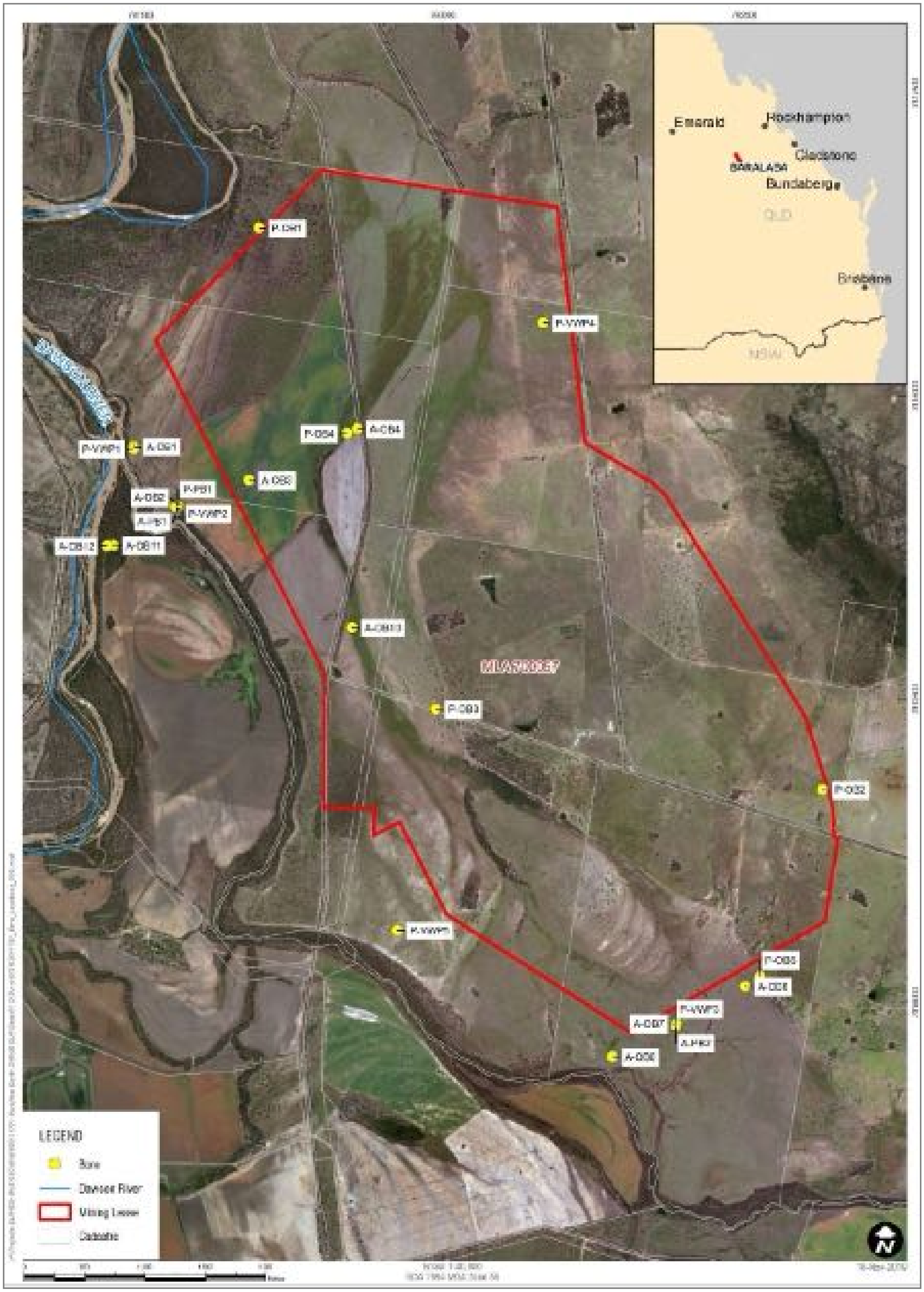


Figure 9.94: Bore locations within and around the Project area

9.13.5. Potential impacts

9.13.5.1 Risk to stygofauna

The assessment concluded that:

- Stygofauna were present within the alluvial aquifer associated with the river channel adjacent to the Baralaba South Coal Project but were absent from the floodplain;
- the biodiversity of the stygofauna community within the Baralaba South Coal Project is low with some taxa having a possibly high degree of endemism.
- there is an apparent connectivity between aquifers and the associated watercourses;
- the ecological value of the stygofauna community is classed as low; and
- the ecological risk from the Baralaba South Coal Project development on the stygofauna community is classed as low.

The Project is not predicted to significantly impact stygofauna due to the alluvium largely being unsaturated within the pit extent and the limited groundwater level drawdown predicted in the shallow groundwater systems. Groundwater level drawdown is largely contained within the Permian coal measures, wherein no stygofauna had been recorded during either the 2012 or 2017-19 sampling programs.

9.13.6. Mitigation, management and monitoring

The existing groundwater monitoring program will continue to be monitored throughout the life of the Project. Exceptions to this include existing bores within the disturbance footprint where monitoring will be maintained for pre-mining baseline data only. Two additional shallow alluvial bores are also planned to be installed included one near the HES wetland. Groundwater monitoring will be undertaken by a competent person and will be undertaken in accordance with the latest edition of the administering authorities Water Quality Sampling Manual.

9.14 Groundwater dependent ecosystems

9.14.1. Survey methodology

A study of potential GDEs within the vicinity of the Project site was undertaken by 3D Environmental in 2020. This study included a field assessment in August 2020 and included assessment of 13 sites that were considered to be potentially groundwater dependent, including the mapped HES wetland (Figure 9.96).

The GDE study methodology included assessment of leaf water potential (LWP), soil moisture potential (SMP), xylem stable isotope analysis from groundwater bore sampling. The findings of the GDE Assessment, considering the IESC 'Information Guidelines Explanatory Note: Assessing Groundwater Dependent Ecosystems' (Doody et.al., 2019) are presented in detail in section 9.14.

The BOM 'National Atlas of Groundwater Dependent Ecosystems' (2020) is shown on Figure 9.96.

No aquatic or subterranean GDEs are mapped within the ML or adjacent areas. Terrestrial GDEs classed as low potential for groundwater interaction (regional study) are mapped to the west of the ML along the Dawson River, Banana Creek and Shirley's Gully.

9.14.2. Results

Water held in the regional alluvial aquifer is mostly an unsuitable resource to support GDEs due to high levels of salinity, and considerable depth to the water table (>10m). Exceptions occur directly adjacent to a stream channel where bank recharge with fresh surface water can occur, and channel incision decreases the depth to the groundwater table. Groundwater dependency in the Project area and adjacent areas associated with the Dawson River flood plain is controlled by small discontinuous lenses of sand that are distributed sporadically throughout the heavy clay soils that otherwise characterise the flood plain sediments.

GDEs identified, are all associated with overland flow paths of the main Dawson River channel, which would act to increase infiltration into the soil profile due to prolonged ponding of surface water. The sandy lenses support shallow, fresh and seasonal groundwater resources that are perched above and disconnected from the regional groundwater table. Recharge of the sandy lenses occurs during surface water infiltration, which is associated with overbank flow and intense rainfall events, and seasonality will depend on climatic factors including transpiration rates and flood interval.

The field results found considerable variation in the LWP measurements between GDE assessment areas, with LWP measures from four GDE areas indicative of potential utilisation of a source of fresh, saturated soil moisture. These were GDE Area 1, GDE Area 6, GDE Area 9 and GDE Area 10, although GDE Area 5, GDE Area 7 and GDE Area 8 may be indicative of saline groundwater usage (Figure 9.95). Other localities present LWP values that are too low for the local groundwater salinity regime or are associated with groundwater salinity that is too high to represent a viable source of moisture for transpiration. (Appendix H, Groundwater Dependent Ecosystem Assessment).

Stable isotope analysis indicates only three of the assessment sites present strong evidence of groundwater utilisation, these being:

- GDE Area 1: which is formed by an overflow channel which links Banana Creek to the Dawson River across the Dawson River floodplain. This is a relatively restricted linear area (7.2 ha) of mature riparian vegetation that is classified as RE 11.3.3 (high value regrowth) (Appendix F, Terrestrial Ecology Assessment). The ecohydrological characteristics of this site indicate relatively low soil matric potentials in the upper 4.8 m of the soil profile. With evidence from high LWP values, the negative SMP results provide physical evidence of a sandy lens at depth. This sand is inferred to be a seasonal aquifer that is perched above the more saline regional groundwater table. Stable isotope analysis of twig samples indicates strong similarity to groundwater water samples providing three lines of evidence supporting this locality as being groundwater dependent.
- GDE Area 6: on the main channel of Banana Creek, provides evidence for a zone of high-water availability below the upper soil profile which is characterised by thick plastic clay with low matric potential. The zone of high-water availability is inferred to be a sandy interval which lies directly beneath the river channel, below the depth of the Auger hole (installed to 3.3 mbgl). Based on LWP measurements, the sandy interval is saturated or near saturated and would be directly recharged during river flow. It is expected that any sandy interval would be centred along the river channel and would subtend the river terraces laterally in discontinuous pockets. This assessment is supported by stable isotope analysis which indicates the water source utilised by trees is of similar isotopic composition to surface water in the Neville Hewitt Weir, consistent with groundwater recharge associated with channel flow.
- GDE Area 10: which presents as a flood overflow channel on the upper alluvial terrace of the Dawson River floodplain. The overflow channel is proximal to and flows parallel to the Dawson River (Neville Hewitt Weir). The high LWP values are causally linked to a sandy soil horizon that was intersected during auger profiling. Groundwater dependence is confirmed by overlap of stable isotope signatures extracted from twigs with the isotopic composition of groundwater samples.

These GDE sites are all attributed to sandy intervals in the soil profile which, in the case of GDE Area 1 and GDE Area 10, would be recharged during overbank flow events where overflow channels distribute floodwaters across the floodplain. The period of saturation in the sandy intervals would be seasonal; dependent on the period between flood events and climatic regimes which influence transpiration rates. For these GDE areas, it is also likely that the sandy horizon is perched above, and hydraulically disconnected from the regional alluvial aquifer. For GDE Area 6, saturation of the sandy profile would more likely be permanent or near permanent due to direct hydraulic connectivity with surface water in the stream channel.

For all these assessment areas, it is noted that adjacent assessment areas do not demonstrate the likelihood of groundwater dependency. This is particularly notable in GDE Area 10, where three adjacent sites all demonstrate LWP results indicative of relative water deficit suggesting moisture utilisation from hydraulically tight clays in the vadose zone.

In summary, the GDE assessment concluded that:

- There are no springs or seeps in the Project area.
- Groundwater dependency of vegetation across the floodplain is linked to the hydraulic capacity of substrates in the deeper soil profile with sandy lenses / interbeds hosting groundwater on a seasonal basis. Where these sandy lenses interact with mature flood plain vegetation, seasonal groundwater dependence is implied.
- The sandy interbeds in the soil profile have a restricted and discontinuous distribution beneath the flood plain surface and there is no evidence of hydraulic connectivity between sandy lenses.
- Riparian vegetation that occupies major riverine channels does not necessary imply groundwater dependence and there are extensive areas, both within and fringing the channels of Dawson River and Banana Creek, that are reliant on soil moisture held by clays in the vadose zone.
- It is not possible to infer the exact extent and location of these discontinuous sandy lenses though it can be inferred that they are discontinuous and limited in extent. The potential distribution of vegetation that may be reliant on seasonal groundwater resources held in the sandy lenses, which greatly exaggerates the extent of groundwater dependent vegetation. None of these areas are in the Project footprint.
- The HES wetland is not considered to be groundwater dependent. The wetland is considered to be reliant on surface water inflow (i.e. direct rainfall, runoff and floodwaters) that are held near the surface by the underlying shallow clay substrate and the wetland is not dependent on groundwater.
- The coolabah woodland that occupies the upper terraces of the Dawson River flood plain is not considered to be a GDE. Due to the depth and salinity of the alluvial aquifer across the broader flood plain, coupled with the heavy clay soils that pose an impediment to deep tap root penetration, it is considered unlikely that the Coolibah woodlands which dominate remnant vegetation on the floodplain have capacity to utilise the regional alluvial aquifer.
- Sandy lenses appear to be restricted to localities directly below the river channel, or where overflow flood channels traverse the floodplain creating flood depressions. It is important to note that not all areas associated with the flood channels of either the Dawson River, or Banana Creek are considered groundwater dependent.
- Sandy intervals that may be associated with the soil profile below major river channels are likely to be permanently saturated due to hydraulic connectivity with surface flows, and these also provide a source of moisture for groundwater dependent species including river red gum which occupy inner benches on major drainage channels. Like the sandy lenses that are conceptualised as having a localised occurrence beneath the flood plain, there is no evidence that sandy intervals below the drainage channel have any extensive medial or lateral continuity.

A conceptual model of the Dawson River floodplain illustrating the ecohydrological function of vegetation in relation to sandy lenses, seasonal bank and aquifer recharge during post wet season, flooding/overbank flow, and late dry season scenarios is shown in Figure 9.97, Figure 9.98 and Figure 9.99, respectively.

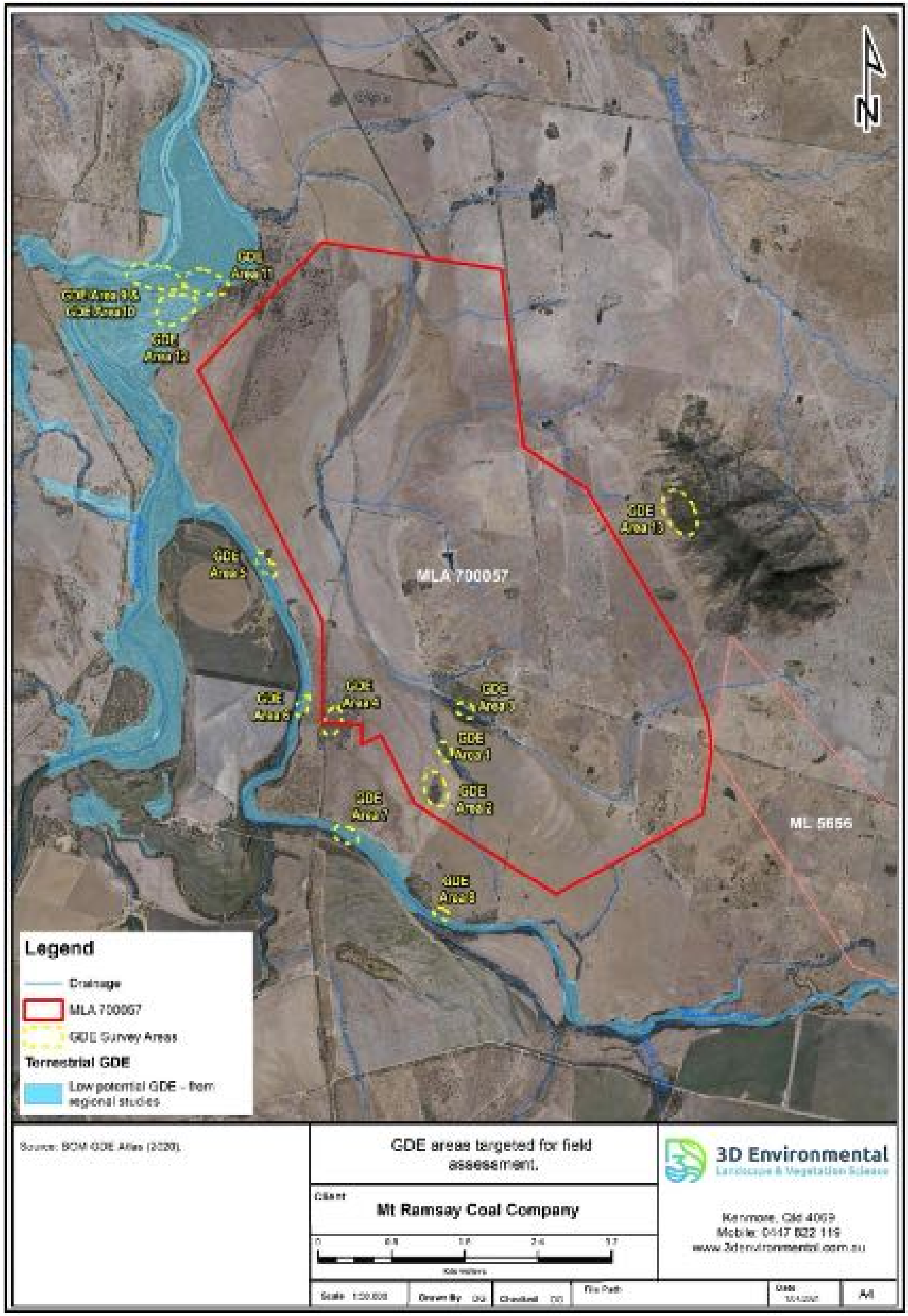


Figure 9.95: GDE assessment field locations

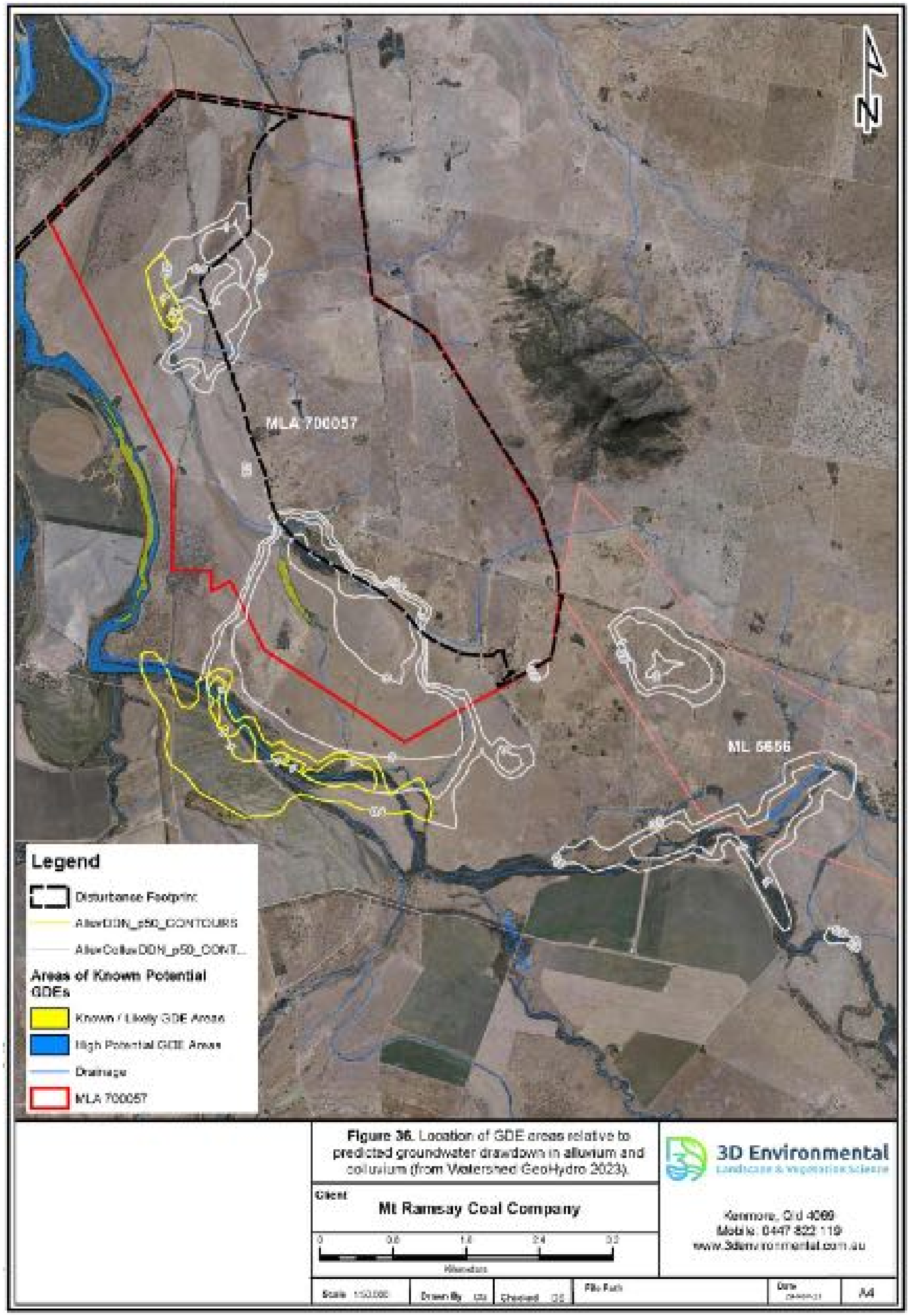


Figure 9.96: Known and high potential GDE areas relative to predicted groundwater drawdown

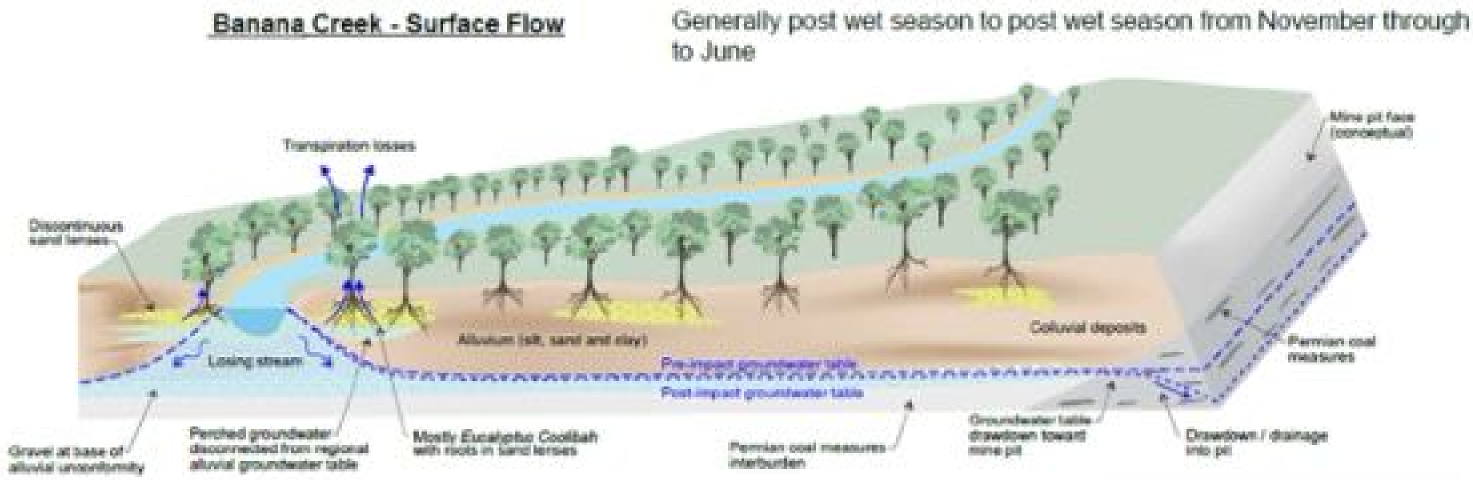


Figure 9.97: *Ecohydrogeological model of the Dawson R. at its confluence with Banana Ck: surface flow conditions*

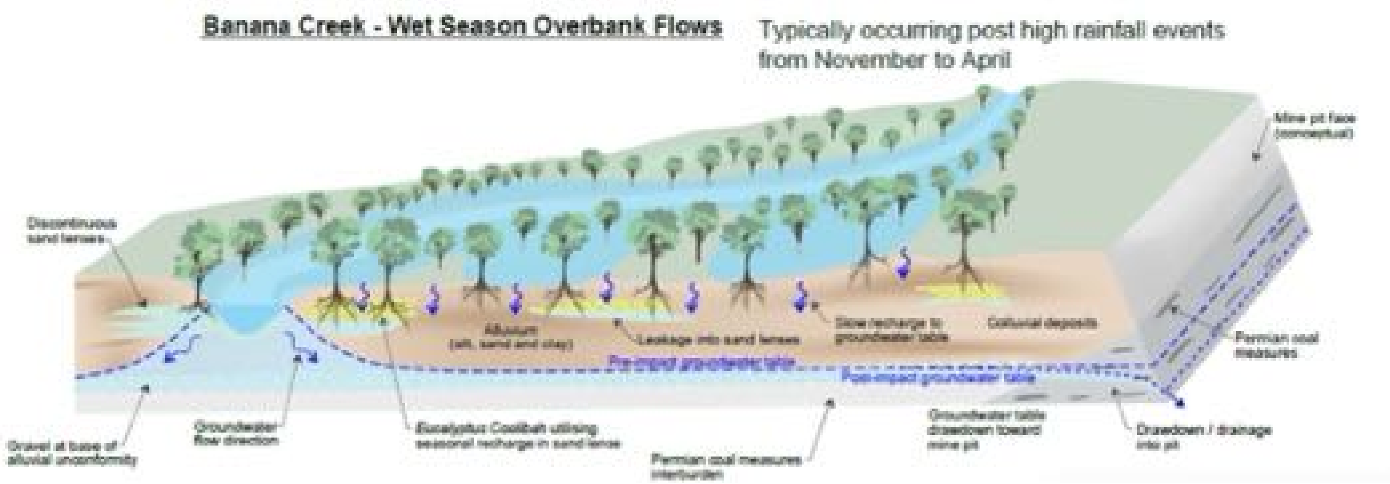


Figure 9.98: Ecohydrogeological model of the Dawson R. at the confluence of Banana Ck: bank overflow conditions

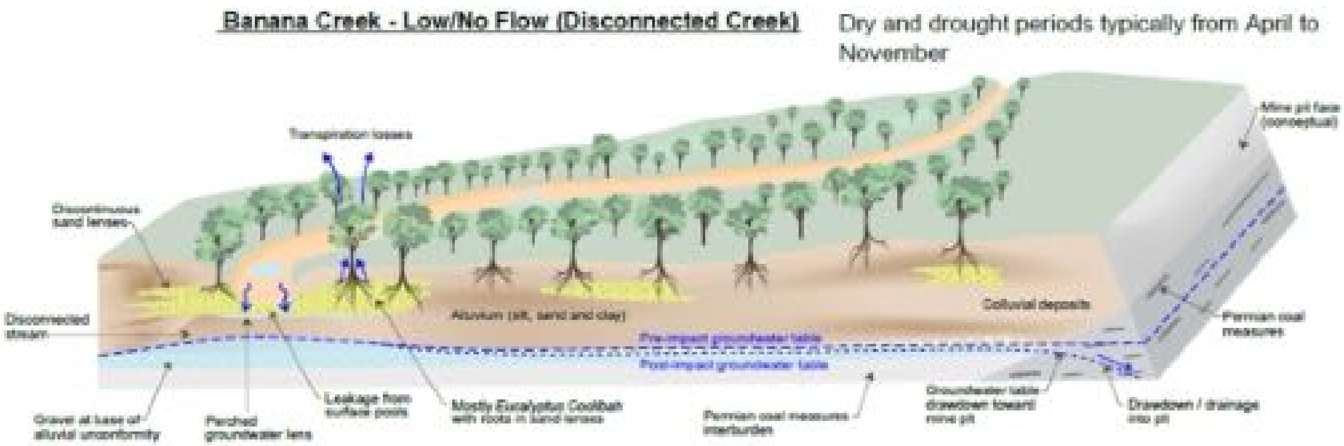


Figure 9.99: Ecohydrogeological model of the Dawson R. at the confluence of Banana Ck: low/no flow conditions

9.14.3. Impact assessment

The GDE Toolbox (Richardson *et al*., 2011), provides a starting point for investigating potential impacts on GDEs exposed to threat through the following impact mechanisms:

- a total or partial loss or reduction in the volume or pressure of the aquifer being utilised by GDEs;
- a change in the magnitude and timing of volume fluctuations in the aquifer being utilised by GDEs;
- changes to the interaction between surface flows and aquifers being utilised by a GDE; and
- change in chemical composition of an aquifer detrimentally impacting the health of a GDE.

These potential changes can result in:

- loss of canopy vigour leading to senescence of groundwater dependent vegetation:
- changes to sub-canopy and groundcover because of increased light penetration through the canopy of senescing vegetation; and
- change in species composition with replacement of species not adapted to changing ecological parameters with species that have greater capacity to absorb change.

Direct clearing of a GDE system is an additional impact which needs to be considered for the Project.

9.14.3.1 Direct clearing

No direct clearing of field verified GDE areas will occur during any stage of Project development.

9.14.3.2 Groundwater drawdown

Drawdown will interact with the saline basal colluvial groundwater system with depressurisation and drainage of the system towards the mining void. There may also be some increased leakage from Banana Creek to the underlying sediments, which Watershed HydroGeo (2023) considers negligible due to a conservative model stimulation based on a fixed head / consistent source of water, noting that Banana Creek flows only irregularly, as discussed in the flood modelling report (Engeny, 2023).

Groundwater drawdown will only be propagated beneath Banana Creek during periods when the alluvium (or colluvium, as it is mapped by the Qld government geology mapping) is saturated and would only induce leakage of surface flow from this watercourse when the watercourse is flowing, and a saturated connection exists between the alluvial groundwater table and surface water in the creek. In this instance, the impact of drawdown and the induced leakage would likely be negligible in comparison to the rate of groundwater recharge. There will be no interaction between the perched discontinuous sandy lenses which seasonally support vegetation groundwater dependence and the drawdown in the deeper colluvial groundwater unit due to the physical separation of these units, and the lack of hydraulic connection. Because of these factors, there are no identified causal pathways for impact which have capacity to alter GDE function and cause ecological harm.

With implementation of management and monitoring controls, it is considered that the risk to GDE's posed by mine development is insignificant.

9.14.3.3 Change In the magnitude and timing of volume fluctuations

Volume fluctuations in both the regional alluvial aquifer and perched aquifers associated with sandy lenses are regulated by surface flows rather than upward propagation of groundwater from the coal seams.

9.14.3.4 Changes to the interaction between surface flows and aquifers

The Neville Hewitt Weir has artificially raised surface water levels both in the Dawson River channel as well as attenuating the impoundment upstream along Banana Creek. This has artificially raised surface water levels both in the Dawson Channel as well as attenuating the impoundment upstream along Banana Creek. This has most likely impacted the capacity of the river to recharge the alluvial groundwater system, providing sustained bank recharge rather than recharge on a seasonal basis.

Negligible change to surface flows in the Dawson River and Banana Creek are predicted in the Project surface water modelling (Appendix A, Surface Water Impact Assessment) and it is highly unlikely that changes to flood behaviour will be detrimental to the health of GDEs occurring on frontages of either Dawson River or Banana Creek and their associated floodplain.

9.14.3.5 Change in chemical composition of an aquifer

There is not expected to be any measurable change in the quality of groundwater as a consequence of mining, either in Permo-Triassic strata (within which groundwater level drawdown would be largely contained) or in younger units, such as alluvium or colluvium. The localised hydraulic sink that will form as mining develops will minimise the potential migration of saline or poorer quality groundwater from within the open cut pit to other areas. Consequently, there will be negligible impacts on groundwater quality in aquifers or surface water quality in downstream waters due to interaction with groundwater (Appendix B, Groundwater Modelling and Assessment).

The disconnected sandy lenses which support GDEs on a seasonal basis are underlain by partially confined groundwater systems associated with the regional alluvial aquifer and the Permian sediments/coal measures. The potential for saline water from these groundwater units to contaminate any fresh perched groundwater system is negligible as there is no risk of upward propagation of saline groundwater under hydrostatic pressure (Appendix B, Groundwater Modelling and Assessment).

Rock spoil is expected to be NAF and have a negligible risk of developing acidic conditions (Appendix E, Geochemical Assessment). The spoil is also expected to generate low salinity rainfall runoff and seepage which will be captured by sediment dams. Uncontrolled release of seepage is not expected to occur from site and recovered seepage flows will be managed in accordance with the mine Water Management System. It is not expected that seepage from waste rock emplacements will cause any additional impacts to water quality in the receiving waterway (Appendix A, Surface Water Impact Assessment).

Based on the low salinity of runoff and seepage, and the management of mine-affected water storages and sediment dams under the mine Water Management System, it is considered that there is low risk of impact to the water quality of, or introducing toxicants, to the alluvial aquifers which support GDEs.

9.14.3.6 Cumulative impacts

In relation to overlapping groundwater drawdown, Watershed HydroGeo (2023) conclude that there is unlikely to be any interaction between the Project and the Baralaba North Mine (except at depth, within the coal measures), or any other mining tenure in the vicinity and thus the predicted (water table) groundwater drawdown impacts would be equivalent to those modelled for the Project alone.

9.14.4. Risk assessment and management

Findings of the 3D Environmental (Appendix H, Groundwater Dependent Ecosystem Assessment) study aligns with the conceptual groundwater model for the Project and the results of permeability testing conducted.

Drawing on information on GDE presence and function, a risk assessment has been prepared which presents the likelihood of an impact occurring and the consequence associated with that impact (Table 9.78).

Based on risk assessment protocols described in Doody *et al.* (2019) and the Queensland guideline 'Groundwater dependent ecosystems: EIS information guideline' (DES 2022), all GDE areas identified within this assessment are considered 'High Value' ecological receptors. This is due to the attribution of conservation values recognised as significant under relevant Qld legislation (e.g., RE 11.3.3 which is classified as of concern under the VM Act), or their classification as Essential Habitat for threatened wildlife listed under either the NC Act or other prescribed environmental matters under the EPBC Act.

As there is no direct causal pathway identified that may result in impact to GDEs in the vicinity of the Project, it is considered sufficient that ongoing monitoring of groundwater levels and quality and surface water quality will provide a management measure that is sufficiently robust to underpin detection of potential changes to GDE function that may be attributed to mine related groundwater drawdown or contamination.

The residual risk to GDEs was assessed to be insignificant. The Project is not expected to cause a significant impact on GDEs.

Table 9.78: Risk assessment for potential impacts to GDEs and residual risk scores

Impact pathway	**Pre-mitigated risk**			**Comments**	**Mitigation measures**	**Residual risk ranking**		
	Likelihood	Consequence	Risk			Likelihood	Consequence	Risk
Direct clearing of a GDE	5	Severe	Low	No clearing of GDEs will be undertaken in association with any stage of Project development	1	1	Severe	Insignificant
A total or partial loss or reduction in the volume or pressure of the aquifer being utilised by GDEs.	2	Negligible	Insignificant	The sandy lenses that support GDEs on a seasonal basis are not hydraulicly connected between lenses and not connected to the regional alluvial aquifer or the aquifer supported by the Permian sediments/coal seams.	Groundwater monitoring	1	Negligible	Insignificant
A change in the magnitude and timing of volume fluctuations in the aquifer being utilised by GDEs1.	2	Negligible	Insignificant	Volume fluctuations in the perched groundwater system are regulated by surface flows and local surface water infiltration. These processes will not be impacted during mine development. While minoring drawdown is modelled within the alluvium underlying Banana Creek, this drawdown will only be propagated during periods where there is a hydraulic connection between surface flows and groundwater. In this instance, the impact of drawdown and the induced leakage would likely be negligible in comparison to the rate of groundwater recharge.	Groundwater monitoring	1	Negligible	Insignificant

Impact pathway	Pre-mitigated risk			Comments	Mitigation measures	Residual risk ranking		
	Likelihood	Consequence	Risk			Likelihood	Consequence	Risk
Changes to the interaction between surface flows and aquifers being utilised by a GDE.	2	Low	Low	No significant changes to surface flows on either Banana Creek or the Dawson River are predicted throughout the life of the mining operation.	Water Management Plan Erosion and Sediment Control Plan Groundwater monitoring			
Change in chemical composition of an aquifer detrimentally impacting the health of a GDE1	2	Low	Low	Uncontrolled releases of mine water that has potential to impact the chemical composition of infiltrating surface waters will not occur during the life of the mine.	Water Management Plan Erosion and Sediment Control Plan Groundwater monitoring	1	Low	Insignificant

[1.] Assumes freshwater aquifers/groundwater with EC<1,500 µS/cm. Withdrawal of saline aquifers/groundwater may have a positive impact on vegetation/habitat condition of a GDE.

9.15 Social matters

9.15.1. Social environmental values

The SIA (Appendix S) provides a detailed description of the key characteristics of the local and nearby regional communities within the SIA study area using information collected as part of the social baseline. An overview is provided below.

9.15.1.1 Population and demography

At the 2021 Census estimated population of the local communities consisted of 260 in Baralaba, 14,319 in Banana Local Government Area and 27,836 in the Central Highlands Regional LGA. (Appendix S, Social Impact Assessment).

At the time of the 2021 Census, Baralaba's population had increased by 1.6% but Banana Shire LGA had similar decreases since the previous 2016 Census, with the exception of Woorabinda, which experienced a.04% increase in population. Based on 2021 Census data, Biloela (5,667 people) and Moura (1,843 people) are the two largest communities, while Baralaba (260 people), Theodore (3,798 people), and Duaringa (278 people) are small rural towns. Woorabinda had a population of 1,019 people in 2021, with around 92% of the population identifying as Aboriginal and/or Torres Strait Islander. The non-resident component of the population has also been considered in the SIA. Baralaba and Moura have significant percentage of non-resident population at 36% for Baralaba and 17% for Moura in 2021. (Appendix S, Social Impact Assessment).

The household structure of the local communities reflects that of Queensland generally with around three-quarters (73%) of all households being families. Family structure was also found to be reflective of Queensland, with most families comprised of couples with children, except for Woorabinda and Baralaba. In Baralaba, 46% were families without children (or who have left home) while Woorabinda comprised 66% single parent families (Appendix S, Social Impact Assessment). The 2021 Census data indicates that young people between the ages of 15 and 24 leave the local communities, particularly among the non-Indigenous community. Baralaba workshop participants noted that young adults have increasingly been leaving town to pursue opportunities in larger centres.

9.15.1.2 Employment, local business and housing

According to the 2021 Census, the Banana Shire LGA had an unemployment rate of 2.8% while the Central Highlands Regional LGA was 5.4%, both lower than the rate for Queensland. Unemployment rates within the Banana LGA were Baralaba at 2.3%, Moura at 4.7% and Biloela at 3.0% – compared to Gladstone (7.39%), Rockhampton (5.69%) and Queensland (5.8%). Conversely, the Woorabinda unemployment rate was significantly higher at 21.7%. Queensland Government Statistician's Office reporting indicates that Banana Shire is experiencing a similar unemployment rate in 2023 (2.1%), while Woorabinda's unemployment rate has dropped significantly to 5.4% (March quarter 2023), compared to Gladstone and Rockhampton unemployment rates of over 4% and state unemployment of 3.8%.

For the LGAs, most residents were in full-time jobs in 2021, with 20.5% of the Baralaba labour force in part-time employment (24.2% of workers in the broader Banana LGA were part-time, 27.6% in Woorabinda and 24.3% in the Central Highlands). This is compared to 30.5% of the entire state's labour force being in part-time employment at the time of the 2021 Census. (Appendix S, Social Impact Assessment).

Figure 9.100: SIA study area and regional communities

In 2021, the predominant industries of employment in Baralaba were education and training, and construction, while mining was the largest industry in Moura and Biloela. Agriculture was the broader Banana LGA's main industry of employment, while most Central Highlands employees worked in the mining industry. Public administration and education and training were the major employment industries for Woorabinda, Gladstone's manufacturing sector was the largest employer, while in Rockhampton and the across the state, health care and social assistance was the main sector of employment.

In 2016, there were 5,701 registered businesses in the Banana Shire LGA, Central Highlands Regional LGA and Woorabinda Aboriginal Shire LGA—none of which employed more than 200 employees (Appendix S, Social Impact Assessment). A total of 2,570 businesses were registered in the Banana Shire LGA where 99% of businesses were classed as small businesses, employing fewer than 20 people. Of these, 62.1% registered businesses in the Banana Shire LGA and 48.9% of businesses in the study area were in the agriculture, forestry and fishing industry (Appendix S, Social Impact Assessment).

A review of businesses considered to have the potential to support the operation, or the workforce, has been conducted. The review indicated that local communities are well equipped to provide services and products (Appendix S, Social Impact Assessment).

The 2021 Census data indicated that 60% of Baralaba residents owned their homes outright or with a mortgage, with just less than a third rented. All Woorabinda houses are government-owned, as they fall under a Deed of Grant in Trust. The availability of rental accommodation in local communities was low, while the availability of houses for sale was high (Appendix S, Social Impact Assessment).

9.15.1.3 Social infrastructure

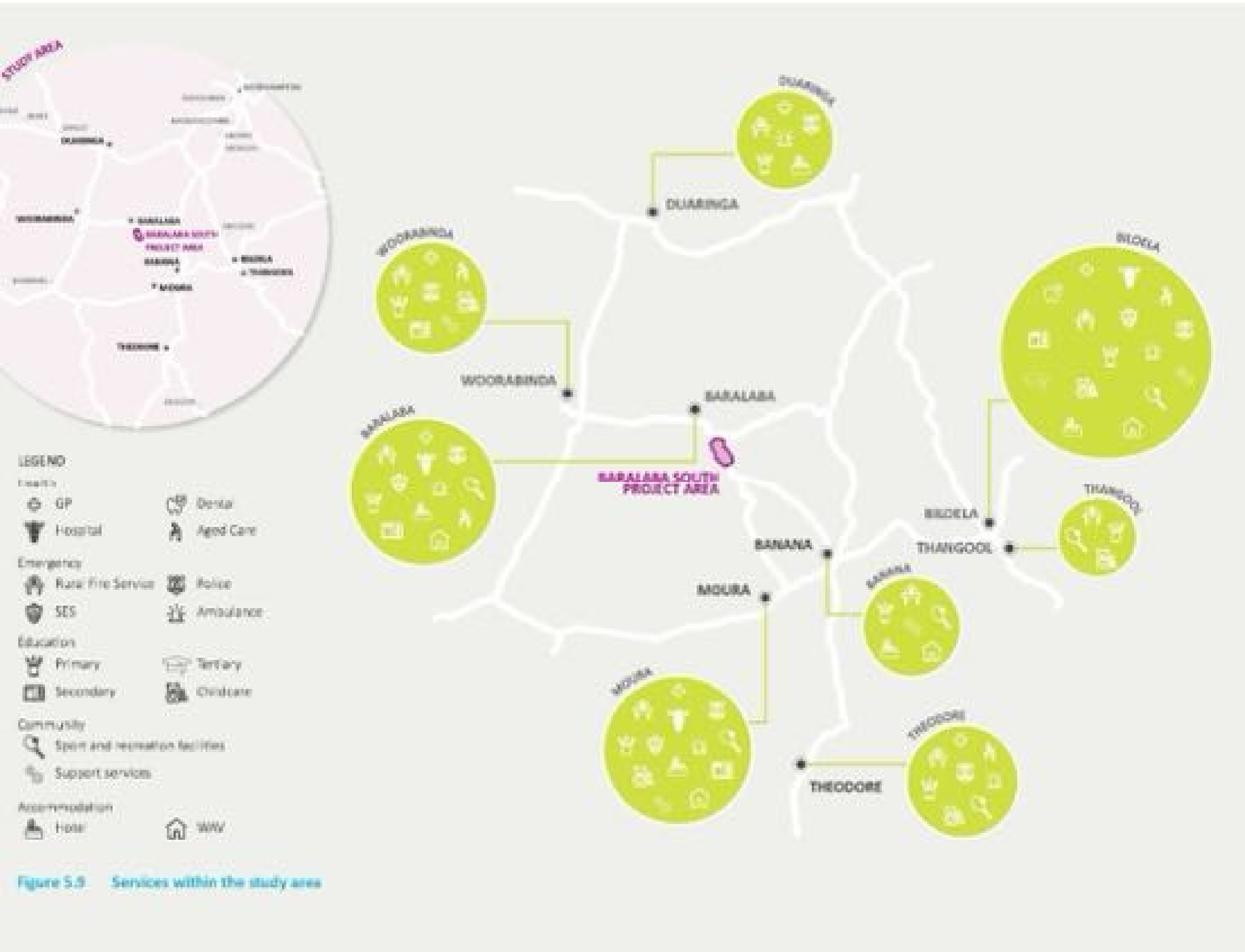
In relation to social infrastructure, which refers to existing services providers, the My Community Directory website indicates the following totals within 100km of the Banana LGA, throughout the towns of Baralaba, Biloela, Moura, Banana, Thangool, Theodore, Duaringa and Woorabinda (Appendix S, Social Impact Assessment):

- 150 human services organisations including health, disability, and aged care;
- 222 education and employment services;
- 78 sport recreation services;
- 4 conservation services; and
- 102 community clubs and interest groups.

All local communities have a fire service, with every community except Banana, Thangool and Woorabinda having all three – ambulance, police and fire services. The towns that did not have all three services were within a 13–40 km drive to the nearest station. Baralaba, Biloela, and Moura also have their own State Emergency Service divisions (Appendix S, Social Impact Assessment).

There is a variety of service providers available throughout the communities, although services are somewhat concentrated within the larger towns. Biloela is the largest of the towns and is regarded as the regional and administrative centre (Banana Shire Council, 2017). As a regional centre, Biloela is resourced with the most social infrastructure and provides services to the other local communities. Some 52 human services (such as health and aged care), 89 education and employment services, 33 sports, recreation, one conservation organisations and 67 clubs, and 12 churches and places of worship recorded within 25km of Biloela (Banana Shire Community Directory, 2023). This indicates that there is a range of social services and organisations available for the community. Moura is the second largest community, with a total of 89 various services listed in the My Community Directory Banana Shire Community Directory, 2023).

The distribution of services within the local communities is shown in Figure 9.101.



1: Services available within local communities (Source Social Impact Assessment Baralaba South Coal Project (EMM, 2021))

9.15.1.4 Community values

The small-town, community based, and rural aspects of life are important to local people across the Banana Shire LGA. Banana Shire Council states that they strive to "improve the quality of life for our communities, through the delivery of efficient, effective and sustainable services and facilities" (Banana Shire Council, 2017).

The Central Highlands Regional Council describes itself as a "diverse region with unique prospects for continuous growth through lifestyle, employment, investment and tourism opportunities" (Central Highlands Regional Council, 2019).

The Woorabinda Aboriginal Shire Council is committed to the "economic development as well as the health and safety of the Woorabinda community" (Moul, 2017).

Central themes of economic prosperity and opportunity, community relationships, and a laidback country lifestyle are evident throughout the region (Appendix S, Social Impact Assessment). During community workshops conducted for the SIA held in Baralaba, Moura and Biloela, participants were asked to identify the strengths and vulnerabilities inherent in their communities, as well as the issues and opportunities the Project may have for their communities. Regardless of the specific townships, most saw their community as friendly, close knit and caring (Appendix S, Social Impact Assessment). Each community has a strong connection to agriculture and the rural lifestyle.

9.15.1.5 Vulnerable groups

Vulnerable groups in the community include Aboriginal and Torres Strait Islander people, the ageing, youth, and people with disabilities. Aboriginal and Torres Strait Islander people are classified as vulnerable due to the disproportionate disadvantage they experience when compared to the general population. The population of communities within the SIA study area indicates an ageing population, with the exception of Woorabinda. Unemployment figures for 2021 for the Banana and Central Highlands Study Areas were significantly lower than for the comparative economic Study Areas (Gladstone and Rockhampton) and Queensland. The Banana LGA unemployment rate was 2.8%, with Baralaba at 2.3%. Conversely, the Woorabinda unemployment rate was significantly higher at 21.7%. 2023 data indicates that Banana Shire is experiencing a similar unemployment rate in 2023, while Woorabinda's unemployment rate has dropped significantly to 5.4%. In 2021, the regional Study Areas had lower proportions of part-time employees than the state's 30.5% part-time workforce. (Appendix S, Social Impact Assessment).

9.15.1.6 Stakeholder engagement and community consultation program

Stakeholder engagement and community consultation has been conducted for the Project:

- By Baralaba Coal Company with assistance with from AARC Environmental Solutions and Think Business Solutions, to inform the preparation of the EIS, and in particular, the assessment of the existing environment, potential impacts, and development of measures to avoid, mitigate, minimise or offset potential Project impacts;
- by Think Business Solutions as a component of the SIA prepared to examine the likely impacts of the Project on the nearby regional communities as part of the EIS, in accordance with the SRRC Act; and
- by Baralaba South Project team with assistance from Think Business Solutions, to inform the development of draft Social Impact Management Plans (SIMPs) for the Project, namely the:
    - Community Health and Wellbeing Plan;
    - Workforce Management Plan;
    - Housing and Accommodation Plan;
    - Local Business and Industry Procurement Plan; and
    - Community and Stakeholder Engagement Plan.

Stakeholder and community consultation has been conducted through a variety of consultation mechanisms, including:

- face-to-face or telephone interviews with landholders, including:
  - landholders situated within the operational land;
  - landholders adjoining the operational land;
  - landholders on which the proposed ETL and associated infrastructure is located;
  - landholders proximal to the Project; and
  - landholders proximal to the product haulage route;
- community workshops;
- face-to-face or telephone interviews with community stakeholders, including:
  - local residents;
  - health services;
  - emergency services;
  - education services;
  - community organisations and community support groups;
  - housing and accommodation service providers;
  - business and industry groups and networks; and
  - employment and training providers and related organisations;
- online survey targeting nearby regional communities;
- meetings with Traditional Owners and Indigenous groups;
- email and telephone correspondence with the community and stakeholders;
- responses to community enquiries;
- publication of application materials on the DES website;
- briefings to and consultation with local, State and Commonwealth governments;
- community drop-in information sessions; and
- Project newsletters, fact sheets and question-and-answer brochures, provided to the community and stakeholders via email or at meetings, and made available on the Baralaba Coal Company website.

Key issues raised by stakeholders and the community included:

- potential impacts of flooding on farming livelihoods;
- potential impacts on surface water and groundwater, including water quality and water availability (water extraction allocations);
- potential impacts on Benleith Water Scheme, including blast and vibration on scheme infrastructure;
- amenity impacts, including dust, noise/vibration, lighting and visual amenity;
- increased traffic, road conditions, safety and transport of product coal;
- potential impacts on agricultural production/operations (e.g. weeds and pests, organic certification) and property values;
- potential impacts on way of life (e.g. community participation and potential impacts associated with the DIDO and FIFO components of the workforce);
- potential impacts on cultural heritage;

- potential impacts on soil resources and mine rehabilitation;
- post-mining land use;
- opportunities from population growth;
- local employment and training opportunities;
- local business procurement opportunities;
- community investment; and
- consultation and engagement mechanisms.

There is support from sections of community who are seeking the economic benefits in relation to local employment, procurement, increased property prices and the proposed PMLU (Appendix S, Social Impact Assessment).

Details of the consultation undertaken, and the outcomes of the consultation, are provided in the Public Consultation Report (Attachment 3) and SIA (Appendix S).

9.15.2. Potential impacts

As described in Chapter 2, Project Description, the majority of mine construction and development activities will occur over approximately 24-months from 2029 with operations starting 2030. This will include a peak construction workforce of 268 people and peak operational workforce of 521 people (including coal haulage and the TLO facility).

The majority of the construction workforce is expected to be sourced from Rockhampton and Gladstone and approximately 5% locally and will drive in and out from the mine on a daily basis, with approximately 60% anticipated to travel to and from the mine from the south (e.g. Banana and Moura) and 40% anticipated to travel to and from the mine from the north (e.g. Baralaba).

The mine will have an operational life of up to 23 years; however, it is anticipated that external factors may influence production schedules and mine life. The peak operational workforce for the Project and the Baralaba North operating mine will require approximately 710 people. The recruitment of workers from local and regional communities will be prioritised, and employees will be encouraged to relocate to live locally.

In accordance with fatigue management requirements, all personnel who do not have homes within a one hour’s drive of the Project will either need to relocate or stay in temporary accommodation. While it is not possible to accurately estimate the number of workers that will choose to relocate to live locally, the SIA assumes it would not be a large number, given the experience of other mining projects in rural and remote locations. A further assumption has been made that workers from Baralaba North will transition to Baralaba South Project over time and that 5% of the 710 operational workforce (30 workers) at a minimum and 20% at a maximum (120 workers) would choose to relocate and require accommodation in local towns.

The Baralaba South Project Economic Impact Assessment (AEC, 2023) estimates that at peak operation, some 130 workers will reside locally and between 5% and 20% of these will be people new to the area – requiring five to 25 dwellings. The accommodation camp expansion requirements are anticipated to be up to 255 rooms prior to construction to provide for the maximum combined Baralaba North and South total workforce requiring temporary (on shift) accommodation.

Social impacts are the issues that affect people and the potentially impacted communities in which they live as a result of a Project (DSDMIP, 2018). Types of social impacts include:

- changes to community values and/or the way the community functions;
- impacts on how people live, work, play and interact with one another on a day-to-day basis;
- impacts on culture, history, and the ability to access cultural resources;

- impacts on communities' physical safety, exposure to hazards or risks, and access to and control over resources;
- impacts on communities' quality of life, including liveability and aesthetics, as well as the condition of their environment (e.g. air quality, noise levels and access to water);
- impacts on communities' access to and quality of infrastructure, services and facilities;
- impacts on communities' physical and mental health and wellbeing, as well as their social, cultural and economic wellbeing; and
- changes to livelihoods (e.g. whether peoples' jobs, properties or businesses are affected or whether they experience advantage/disadvantage).

A detailed assessment of the likely impacts (positive and negative) of the Project on affected communities is provided in Appendix S, Social Impact Assessment, and addresses each of the following core matters:

- workforce management;
- housing and accommodation;
- local business and industry; and
- health and community wellbeing.

Potential social impacts and benefits of the Project as perceived by the community include (Appendix S, Social Impact Assessment):

- Population growth during construction and operation, with the potential to benefit community vitality and:
  - increase in demand for social services (e.g. emergency services, health services, education, childcare and community services) and infrastructure (e.g. roads);
  - increase in demand for rental properties;
  - increase in property prices; and
  - increase in the non-resident proportion of the population—the capacity to meet the accommodation needs of the non-resident workforce is considered high.
- The creation of employment opportunities in the construction, operations and post-mining phases of the Project, as well as training opportunities, including for Indigenous people.
- The potential for workplace health and safety incidents.
- The creation of opportunities for local and regional businesses and services through supply opportunities and expenditure.
- Potential impacts on the community's surroundings, health and wellbeing, such as potential Project impacts on water resources/flooding, agricultural land, amenity (e.g. dust, noise, blasting and lighting), road safety and the proposed PMLU.

The significance of the potential social impacts and benefits has been assessed as low, moderate, high or extreme based on an assessment of likelihood and consequence (Appendix S, Social Impact Assessment). Factors such as the probability, scale, duration and intensity of the potential impact, as well as the characteristics of the community or stakeholders which may be affected, have been considered. Enhancement, mitigation and/or management strategies for the potential social benefits and impacts have been identified (detailed in section 9.15.3), and a residual significance assessment (to assess the extent of impact after management measures have been applied) has been undertaken. The significance assessment is detailed in Appendix S, Social Impact Assessment.

The potential for cumulative impacts of the Project were also considered in the SIA. The assessment concluded that provided the potential impacts of the Project are suitably managed through the implementation of management strategies for workforce management, housing and accommodation, local business and procurement, health and community wellbeing and stakeholder engagement, any cumulative impacts are considered to be manageable (Appendix S, Social Impact Assessment).

The Project will be operated with stringent environmental management controls and in accordance with all legislative and government requirements.

A Community Consultative Committee (CCC) has been established for Baralaba North and also includes matters relating to the Project. As production reduces from Baralaba North the CCC will transition to the Project. The CCC functions as a conduit between the Project and the community, for information sharing and feedback. The CCC operates in accordance with the Community Engagement Management Plan.

More specifically, the purpose of the CCC is to:

- Establish good working relationships and promote information sharing between the Project, local community, stakeholder groups and councils.
- Allow the Project to keep the community informed, seek community views, and respond to matters raised by the community.
- Allow community members and local councils to seek information and provide feedback on the development and implementation of the Project to assist with the delivery of balanced social, environmental and economic outcomes for the community.

The Project will manage and monitor potential impacts on environmental values in accordance with the Project's EA. The mitigation measures, management and monitoring for potential impacts on environmental values are described in detail in the various chapters of the EIS. A range of environmental management plans and monitoring programs will be developed and implemented as required for the Project. Chapter 18, Proposed Environmental Management and Monitoring Commitments, provides a consolidated description of all management and monitoring commitments for the Project.

9.15.3. Mitigation and management measures

Social impact mitigation and benefit enhancement measures have been developed for the Project in consideration of the significance assessment conducted for the identified potential social impacts described in section 9.15.2. Draft SIMPs have been developed for the Project and outline the mitigation and enhancement measures that will be implemented for the Project, namely:

- Appendix T Community and Stakeholder Engagement Plan.
- Appendix U Draft Community Health and Wellbeing Plan
- Appendix V Draft Housing and Accommodation Plan
- Appendix W Draft Workforce Management Plan.
- Appendix X Draft Local Business and Industry Procurement Plan.

A summary of the social impact management commitments is provided in Table 9.79.

The Draft SIMPs are provided in Appendices T to X and are summarised in the following sections.

Table 9.79: Summary of social impact management commitment

Initiative	Budget/Target
Facilitate annual Project emergency simulation training for local health and emergency services	$10,000 p.a.
Continue to maintain the public haul road impacted by the Project from the Baralaba North Mine site to the TLO and then the Baralaba South mine site to the TLO once fully transitioned	$2,000,000 to $3,000,000 p.a. (subject to condition/requirements)
Continue to implement the Community Sponsorship and Donations Program	$25,000 p.a.
Contribute to maintaining the Benleith Water Scheme	Up to $100,000 (subject to detailed assessment/discussion with the scheme manager)
Incentivise Baralaba South employees to reside locally if there is available accommodation: • develop 'welcome packs' to help relocating employees integrate into local communities • subsidise employee local housing purchase • subsidise employee local rental payments; and • assist with relocation costs	$50,000 p.a.
Continue to renovate company houses and add them to the Baralaba rental pool and once renovated, provide ongoing maintenance.	Up to $100,000 for renovations and then up to $25,000 p.a. in ongoing maintenance
Provide long-term local training and employment opportunities	25% local operation workforce (residing within one hour of the Project)
Hold business briefings in local towns to communicate Project procurement opportunities	Project briefings in Baralaba, Moura and Biloela
Provide procurement opportunities for local and Indigenous businesses	25% local and Indigenous content

9.15.3.1 Community and stakeholder engagement plan

A Draft Community and Stakeholder Engagement Plan has been developed for the Project's construction and operational phases and is provided in Appendix T. The purpose of the Community and Stakeholder Engagement Plan is to facilitate engagement, consultation and collaboration with stakeholders.

Key objectives of the Community and Stakeholder Engagement Plan are to:

- strengthen relationships with local communities and stakeholders;
- understand community and stakeholder priorities to best mitigate any Project impacts;
- develop effective communication tools to disseminate information to and receive feedback from stakeholders; and
- build a positive presence in the Banana LGA, as well as in the adjacent Central Highlands LGA and Woorabinda Aboriginal Shire.

A range of engagement mechanisms will be used to consult and engage with the community and stakeholders. Engagement mechanisms will include:

- a dedicated Community Relations Officer based in the Baralaba Coal Company Town Office in Baralaba;
- briefings or workshops (e.g. local business briefings to promote Project supply opportunities);
- individual meetings;
- direct correspondence (letters, emails, telephone calls, video conference);
- community feedback telephone line, and complaints management;
- newsletters or fact sheets to communicate Project changes or updates;
- publications (e.g. on community noticeboards or advertised in local newspapers);
- local government (Council) briefings;
- state or Commonwealth government meetings, correspondence or site visits;
- opportunistic stakeholder interactions;
- provision of relevant Project information on the company's website;
- participation in local events; and
- a Community Reference Group

The framework and processes for the CCC are set out in the Community Engagement Management Plan (Appendix T Community Stakeholder Engagement Plan).

A Community Relations Officer has been employed and is based in Baralaba to support the implementation of this Community and Stakeholder Engagement Plan and to act as a liaison between the Project and the community and stakeholders. The contact details of the Community Relations Officer are promoted in the local community.

A Stakeholder Consultation Register is used to record and maintain relevant stakeholder contact details, record the stakeholder consultation activities conducted for the Project and facilitate Project initiatives and responses to enquiries. The Project will maintain a community feedback telephone line that is dedicated to the receipt of community complaints and enquiries.

Table 9.80 summarises the Project's community and stakeholder engagement action plan. Further details are provided in Appendix T, Draft Community and Stakeholder Engagement Plan.

Table 9.80: Community and stakeholder engagement action plan

Objective	Action	Timing	Monitor	Monitoring Frequency	Performance Indicator
Facilitate open and transparent consultation and engagement with the community and stakeholders	Maintain the CCC for the Project to identify issues, disseminate information, and provide a forum for discussion	First meeting within three months of construction commencement	Monitor CCC meeting minutes	Quarterly during construction and the first two years of operation; thereafter, at least two times a year	CCC maintained
	Maintain the CRO role to liaise with the local community and stakeholders	Ongoing	Monitor Stakeholder Consultation Register for CRO activities, and provide summary of activities to management	Bi-annually	CRO role maintained CRO active liaison with the community and stakeholders
	Maintain the Town Office in Baralaba	Ongoing	Monitor outcomes of investigation and outcome communicated to the local community and stakeholders	Prior to construction, review prior to operations	Town Office maintained
	Communicate ways the community and stakeholders can consult or engage with the Project	At the commencement of construction and operations, ongoing	Monitor methods used to communicate engagement opportunities and the use of methods by the community and stakeholders	Bi-annually	Engagement mechanisms effectively communicated
	Establish and maintain Project related information on the company's website	At the commencement construction and operation, ongoing	Monitor information on website against website commitments in this Community and Stakeholder Engagement Plan	Bi-annually	Website maintained to provide information to stakeholders and interested parties about the Project
	Implement the Project Complaints Management Process	During construction and operation	Monitor response times to complaints	Bi-annual review of complaints timeframes	Responses to complaints provided in a timely manner
	Develop a consultation program for the preparation of the PRC Plan	At time of PRC Plan development	Monitor record of consultation conducted for PRC Plan development	Prior to PRC Plan submission to government	Consultation program developed and implemented

Objective	Action	Timing	Monitor	Monitoring Frequency	Performance Indicator
	Develop and maintain a Stakeholder Consultation Register	During construction and operations	Monitor information in Stakeholder Consultation Register against register commitments in this Community and Stakeholder Engagement Plan	Bi-annually	Stakeholder Consultation Register developed and maintained
Ensure employees & contractors represent the Project in a way that enhances the Project's reputation and community relations	Embed community engagement objectives in employee & contractor inductions and daily communications mechanisms (e.g. toolbox talks and site noticeboards).	During construction and operations	Monitor the methods used to communicate engagement objectives Monitor employee & contractor behaviour against community feedback captured in the Stakeholder Consultation Register	Monthly	Community engagement objectives effectively communicated Employee & contractor behaviour breaches addressed in a timely manner

9.15.3.2 Community health and wellbeing plan

The objectives of the Community Health and Wellbeing Plan are to ensure the Project:

- avoids or mitigates negative social impacts and capitalises on opportunities to improve the health and wellbeing of both local and regional communities; and
- does not adversely impact the level of service to local and regional communities from existing social services, facilities and infrastructure.

The Project will become a major local employer and a long-term member of both the local and regional communities. Project personnel will contribute to population growth and stability and increase the availability of people to participate in community activities.

Strategies to ensure the Project does not adversely impact the level of service to local and regional communities include:

- notification of local social services (e.g. health, emergency and education services) of Project timeframes, including the likely workforce ramp-up for both construction and operation;
- the provision of on-site medical and first aid facilities; to reduce the demand on local services;
- measures to encourage non-resident workers to use their home-based medical services to avoid placing undue demand on local medical services;
- investigation of opportunities for local health services to provide services required by the workforce (e.g. pre-employment medical checks) to support the viability of existing services);
- details of the Emergency Response Plan to be developed further to manage emergencies at the mine;
- regular testing of the site's emergency response capability;
- collaboration with the Queensland Police Service, Queensland Ambulance Service and Queensland Fire and Emergency Service to ensure local emergency services personnel are familiar with the mine site and key Project personnel;
- the employment of appropriately trained personnel to respond to various levels of emergency;
- notification of education services of the approximate numbers of personnel seeking to relocate to the local area and monitoring through the Community Reference Group; and
- consultation with service providers to monitor impacts and mitigate impacts if required.

Employee health and wellbeing is fundamental to the Project's success, as well as to the Project's relationship with the local community. As described in section 9.15.3.4, employee-support strategies and a Code of Conduct will be implemented to achieve a safe and motivated workforce that respects and is integrated with the local community. Employees will be encouraged to participate in community life and integrate with the local community through community services and sporting organisations.

As described in section 9.15.1.6 and section 9.15.1.3, a number of potential impacts to the community's health and wellbeing were raised during community and stakeholder consultation relating to potential Project impacts on environmental aspects such as water resources, flooding, agricultural land, amenity (e.g. dust, noise, blasting, lighting and visual amenity), road traffic and impacts associated with the proposed PMLU.

Table 9.81 summarises the Project's community health and wellbeing action plan. Further details are provided in Appendix U, Draft Community Health and Wellbeing Plan.

Table 9.81: Community health and wellbeing action plan

Objective	Action	Stakeholder/potential partnerships	Timing	Monitor	Monitoring Frequency	Performance Indicator
Minimise impacts on the level of service to local and regional communities from existing social services, facilities and infrastructure – health services	Notify local health services of Project timing in relation to likely ramp-up of Project workforce	Local health service providers, local community	Pre-construction, prior to CHPP construction commencing, prior to operations	Monitor the stakeholder consultation register for notification	Prior to construction, prior to CHPP construction commencing and prior to operations	Local health services notified of ramp-up of Project workforce
	Encourage non-resident workers to use home-based medical services	Employees, local health service providers, local community	During construction and operations	Extent of non-resident employee use of health services in consultation with Baralaba Hospital and Multipurpose Health Service, Baralaba Private Clinic	Bi-annually during construction and the first year of operation, annually thereafter	Low use of local health services for services that could have been obtained in home town prior to, or post, work shift
	Provide on-site medical and first aid facilities in accordance with the requirements of health and safety regulations	Employees	During construction and operations	Incident reporting provided to management for review	Monthly	On-site medical and first aid facilities for workers provided
	Engage with local health service providers to investigate opportunities to provide services required by the workforce (e.g. pre-employment medical checks for local residents, other prescribed health assessments such as Coal Board medicals)	Employees, local health service providers	Prior to operations	Monitor the stakeholder consultation register and the development of partnerships	Prior to operations	Opportunities for local health service providers to provide specific health services to the Project explored, and developed/implemented where appropriate

Objective	Action	Stakeholder/potential partnerships	Timing	Monitor	Monitoring Frequency	Performance Indicator
Minimise impacts on the level of service to local and regional communities from existing social services, facilities and infrastructure – health services (cont.)	Monitor impacts on health services and implement measures to mitigate impacts if required	Local health service providers, local community	During construction and operations	Consult with the CAN	Bi-annually during construction and the first year of operation, annually thereafter	Impacts on health services monitored and measures implemented to mitigate impacts if required
Minimise impacts on the level of service to local and regional communities from existing social services, facilities and infrastructure – other services	Notify local schools and any childcare services of the commencement of operations, and approximate numbers of personnel seeking to relocate to the local area	Employees, local education and childcare providers	Prior to operations	Monitor the stakeholder consultation register for notification	Prior to operations	Local schools and childcare services notified of commencement of operations and approximate numbers of personnel seeking to relocate to the local area
	Monitor impacts on social services, facilities and infrastructure (e.g. schools and childcare centres) through the Community Consultative Committee and implement measures to mitigate impacts where required	Employees, social services, facilities and infrastructure	During operations	Monitor the stakeholder consultation register for feedback Monitor through Community Consultative Committee	Bi-annually during construction and the first year of operation, annually thereafter	Impacts on community services monitored and measures implemented (through the Community Consultative Committee) to mitigate impacts where required

Objective	Action	Stakeholder/potential partnerships	Timing	Monitor	Monitoring Frequency	Performance Indicator
Minimise impacts on the level of service to local and regional communities from existing social services, facilities and infrastructure – emergency services	Notify emergency services of Project timing in relation to likely ramp-up of Project workforce	Queensland Police Service, Queensland Ambulance Service, Queensland Fire and Emergency Services, Banana Shire Local Disaster Management Group	Pre-construction, prior to CHPP construction commencing, prior to operations	Monitor the stakeholder consultation register for notification	Prior to construction, prior to CHPP construction commencing and prior to operations	Local emergency services notified of ramp-up of Project workforce
	Conduct risk assessment to identify potential emergency situations, ways to minimise risks and the level and type of emergency response capability required		Prior to construction and prior to operations	Audit to monitor conduct of risk assessment	Prior to construction and prior to operations	Risk assessment conducted by suitably trained and experienced personnel to inform development of Emergency Response Plan
	Consult with local emergency services to develop emergency response procedures and mine site familiarisation		Prior to construction and prior to operations	Monitor development of emergency response procedures	Prior to construction and prior to operations	Emergency response procedures developed in consultation with local emergency services Emergency response procedures reviewed annually, and if necessary revised Mine site familiarisation for local emergency personnel

Objective	Action	Stakeholder/potential partnerships	Timing	Monitor	Monitoring Frequency	Performance Indicator
Minimise impacts on the level of service to local and regional communities from existing social services, facilities and infrastructure – emergency services (cont.)	Develop and implement Emergency Response Plan	Employees, Queensland Police, Queensland Ambulance Service, Queensland Fire and Emergency Services	Prior to construction and prior to operations	Monitor development of Emergency Response Plan	Prior to construction and prior to operations	Emergency Response Plan developed Emergency Response Plan reviewed annually, and if necessary revised
	Conduct emergency response training	Employees, Queensland Police Service, Queensland Ambulance Service, Queensland Fire and Emergency Services	Prior to construction, during construction, prior to operations, during operations	Monitor the conduct of emergency response training and mine site familiarisation	Prior to construction and thereafter annually	Emergency response training implemented
	Implement an effective Safety and Health Management System to limit the number of mining-related emergencies	Employees	During construction and operations	Ensure incident reporting provided to management for review	Monthly	Effective Safety and Health Management System implemented, and measures identified for continual improvement implemented
Implement measures to mitigate potential health and wellbeing impacts on local communities, including neighbouring landholders	Manage and monitor potential environmental impacts in accordance with the Project’s environmental authority	Neighbouring landholders, local community	During construction and operations	In accordance with various environmental management and monitoring plans prepared for the Project	In accordance with various environmental management and monitoring plans prepared for the Project	Management and monitoring implemented in accordance with the Project’s environmental authority

Objective	Action	Stakeholder/potential partnerships	Timing	Monitor	Monitoring Frequency	Performance Indicator
Implement measures to mitigate potential health and wellbeing impacts on local communities, including neighbouring landholders (cont.)	Communicate environmental monitoring and management outcomes through the Community Consultative Committee and Community Relations Officer direct engagement with stakeholders	Neighbouring landholders, local community	During construction and operations	Monitor Community Consultative Committee meeting minutes and stakeholder consultation register	On a regular basis consistent with Community and Stakeholder Engagement Plan	Environmental monitoring and management outcomes communicated via the Community Consultative Committee and Community Relations Officer direct engagement with stakeholders
	Monitor groundwater levels and implement make-good measures if required where the Project has impacted the landholder bore	Direct neighbours	During operations	In accordance with Water Management Plan	In accordance with Water Management Plan	Groundwater levels monitored and make-good measures implemented if the Project has impacted the landholder bore
	Monitor blasting and implement make-good measures if required where the Project has materially impacted Benleith Water Scheme infrastructure	Direct neighbours, Benleith Water Board, Benleith Water Scheme members	During operations	In accordance with Noise and Vibration Management Plan	In accordance with Noise and Vibration Management Plan	Blasting monitored and make-good measures implemented if the Project has impacted Benleith Water Scheme infrastructure
	Assist in maintaining the viability of the Benleith Water Scheme	Benleith Water Board, Benleith Water Scheme members	Pre-construction, during construction and operations	Monitor scheme participation and redistribution of scheme allocations held by the Proponent	Bi-annually during construction and the first year of operations, annually thereafter unless there is redistribution of allocations back to the scheme	Project has maintained participation in the Benleith Water Scheme where allocations have been acquired, or redistributed allocations back to the scheme

Objective	Action	Stakeholder/potential partnerships	Timing	Monitor	Monitoring Frequency	Performance Indicator
Implement measures to mitigate potential health and wellbeing impacts on local communities, including neighbouring landholders (cont.)	Continue to implement Baralaba Coal Company's Road Use Management Plan for the Project	Local community, neighbouring landholders, Banana Shire Council	Prior to operations	Monitor implementation of Road Use Management Plan	Prior to operations	Road Use Management Plan implemented
	Communicate traffic changes associated with the proposed Moura-Baralaba Road realignment to directly neighbouring landholders and publish in local media for broader notification	Local community, neighbouring landholders, Banana Shire Council	Prior to road works commencing	Monitor stakeholder consultation register and evidence of broader notification	Prior to road works commencing, and as appropriate during road construction	Traffic changes associated with the Moura-Baralaba Road realignment communicated to directly neighbouring landholders and published in local media for broader notification
Maintain long-term respectful relations with the Gaangalu Nation People and Gangulu Endorsed Parties, including managing cultural heritage in accordance with the CHMP and meeting the requirements of any native title agreement	Acknowledge (on signage and/or as agreed with the Gaangalu Nation People) that the Project is located in Gaangalu Nation country	Gaangalu Nation People, Gangulu Endorsed Parties	During construction	Monitor consultation with Gaangalu Nation People and acknowledgment	Within the first year of construction	Agreement reached with Gaangalu Nation People in relation to acknowledgment of Gaangalu Nation country
	Provide the Gaangalu Nation People and Gangulu Endorsed Parties with updates on Project status	Gaangalu Nation People, Gangulu Endorsed Parties	Prior to construction during construction, prior to operations, during operations	Monitor consultation with Gaangalu Nation People and Gangulu Endorsed Parties and for provision of Project updates	Prior to construction and bi-annually thereafter	Project status updates provided to Gaangalu Nation People and Gangulu Endorsed Parties
	Conduct cultural heritage management measures in accordance with the CHMP	Gaangalu Nation People, Gangulu Endorsed Parties	During construction and operations	Monitor implementation of CHMP	Bi-annually during construction, annually during operations	Cultural heritage has been managed in accordance with the CHMP

Objective	**Action**	**Stakeholder/potential partnerships**	**Timing**	**Monitor**	**Monitoring Frequency**	**Performance Indicator**
Maintain long-term respectful relations with the Gaangalu Nation People and Gangulu Endorsed Parties, including managing cultural heritage in accordance with the CHMP and meeting the requirements of any native title agreement (cont.)	Include cultural-awareness training in employee induction programs	Employees, Gaangalu Nation People, Gangulu Endorsed Parties	During construction and operations	Audit induction program	Bi-annually during construction and the first year of operation, annually thereafter	Cultural-awareness component of induction program implemented
Enhance community cohesion	Assist and encourage Project personnel to integrate with the local community through participating in community and sporting organisations	Employees, local community	During operations	Document how the Project has encouraged community participation and integration	Annually	Employees encouraged to participate and integrate with the local community Participation in community organisations maximised
Invest in the community and its development in support of local communities	Implement Community Sponsorship and Donations Program to support community culture and wellbeing	Local community	During construction and operations	Monitor the provision of sponsorships and donations	Annually	Community Sponsorship and Donations Program implemented Community participation in Community Sponsorship and Donations Program

9.15.3.3 Housing and accommodation plan

The objectives of the Housing and Accommodation Plan are to ensure Project housing and accommodation arrangements:

- do not contribute to significant affordability and availability impacts on housing and accommodation in local and regional communities; and
- are well planned, enhance worker wellbeing and do not place an excessive burden on existing infrastructure, facilities and services used by local and regional communities.

As described in section 9.15.3.2, the Project will prioritise the recruitment of local residents who will commute daily from their homes through the implementation of its recruitment strategy.

Strategies will be implemented to encourage non-local workers to relocate to the local area. This includes:

- the development and distribution of a Welcome Pack to provide an overview of community liveability, services and infrastructure;
- an incentives program that provides financial benefits to employees who choose to live locally; and
- investigation of the opportunity to partner with local organisations or community groups to provide settlement support.

The Project will develop and maintain an accommodation register to document the accommodation utilised by its workers and to assist with monitoring against the Housing and Accommodation Plan's objectives. Local service providers and real estate agents will be consulted to monitor the impact that workforce influx has on the real estate market.

Baralaba Coal Company owns and operates a Workers Accommodation Village in Baralaba, approximately 8 km north of the Project. Consultation with the Banana Shire Council identified the expansion of the accommodation camp in Baralaba as the preferred location to accommodate the Project's non-resident workforce. The accommodation camp has a short travel time to the Project site (approximately 10 minutes distant by car), which would minimise the length of the working day for workers staying at the camp.

The Baralaba accommodation camp will be expanded to cater specifically for the Project construction and operations workforce. The accommodation camp expansion requirements are anticipated to be up to 255 rooms prior to construction to provide for the Project construction workforce.

Table 9.82 summarises the Project housing and accommodation action plan. Further details are provided in Appendix V, Draft Housing and Accommodation Plan.

Table 9.82: Housing and accommodation action plan

Objective	Action	Responsibility	Stakeholders/ Potential Partnerships	Timing	Monitor	Monitoring Frequency	Performance Indicator
Encourage employees to live in local towns and provide support for community integration	Develop and maintain a Welcome Pack to distribute to prospective employees	Proponent/ Principal Contractor	Employees, Banana Shire Council, Baralaba and District Progress Association, Moura Community Progress Group, Moura Chamber of Commerce	Prior to operations, during operations	Maintain an accommodation register to monitor the number of employees who relocate to live locally	Bi-annually during operations	Welcome Pack provided to prospective employees
	Provide incentives to employees to live in the local area. Incentives offered will include: • Allowances for employees providing their own local accommodation • Rental subsidies to encourage personnel to rent in the private real estate market Assistance with relocation costs.	Proponent/ Principal Contractor	Employees, relocation service providers	Prior to operations, during operations	Maintain an accommodation register to monitor uptake of incentives program	Bi-annually during operations	Incentives communicated to employees. Up to 10 employees and their families relocated to the local area
	Develop and maintain an accommodation register	Proponent/ Principal Contractor	Employees	During construction and operations	Audit to confirm accommodation register has been maintained	Bi-annually during construction and operations	Register implemented and maintained
	Investigate partnerships to provide settlement programs offered by local organisations or community groups	Proponent/ Principal Contractor	Employees, local organisations and community groups	Prior to operations, during operations	Monitor the stakeholder feedback register and the development of partnerships	Prior to operations	Partnership options investigated to support employee settlement in local area

Objective	Action	Responsibility	Stakeholders/ Potential Partnerships	Timing	Monitor	Monitoring Frequency	Performance Indicator
Minimise impacts on local property market	Accommodate the non-resident component of the workforce in the Baralaba WAV	Proponent/ Principal Contractor	Banana Shire Council	During construction and operations	Maintain accommodation register to monitor the number of employees who choose to live in the Baralaba accommodation camp. Monitor personnel satisfaction with accommodation camp and take corrective action if required	Bi-annually during construction and operations	Baralaba accommodation camp provides accommodation for the majority of the workforce. Personnel satisfaction with the accommodation camp has been assessed, and corrective actions taken if required
	Identify the housing required by Project personnel (e.g. number of bedrooms and social infrastructure requirements) and compare housing needs to available housing options	Proponent/ Principal Contractor	Employees, local real estate agents	During recruitment of operational personnel	Assess housing requirements of relocating personnel against housing availability	During recruitment of operational personnel	Personnel housing requirements considered against housing availability
	Consult with local service providers and real estate agents to monitor the workforce influx and property market	Proponent/ Principal contractor	Local real estate agents, CCC, Banana Shir Emergency Support Centre	During Operation	Monitor housing availability and affordability. Monitor number of workers that relocate, the type of housing used and location	Bi-annually during the first three years of operation, annually thereafter	Worker influx and local property market monitored, and housing and accommodation strategy adapted as required

9.15.3.4 Workforce management plan

The objectives of the Workforce Management Plan are to:

- prioritise recruitment of workers from local and regional communities and workers who will relocate to live in regional communities;
- reduce the proportion of workers engaged in FIFO arrangements, where operationally feasible; and
- support the health and wellbeing of the Project workforce.

The following recruitment hierarchy will be implemented for the Project:

- first, local residents who will commute daily from their homes (within one hour's drive from the Project);
- second, people from other regions who will move to local towns and commute daily from their homes
- third, people from nearby regional communities; and
- fourth, people from other regions.

Preference will be given to recruiting employees for the Project from local and regional communities, however, given the size of the proposed construction and operations workforces, a proportion may need to be sourced from further afield.

The Project will provide equal opportunities for employment and will recruit based on candidates' skills, potential skills and job suitability without regard to gender, race or disability status. As a component of its recruitment strategy, the Project's equal employment opportunity and local employment focus will be promoted to surrounding communities to encourage local participation in the Project, including participation by under-represented groups. The Project will aim to create an environment of fairness and equity that leverages the unique skills and abilities of its employees – regardless of their age, background or beliefs.

As a component of its recruitment strategy, the Project's equal employment opportunity and local employment focus will be promoted to surrounding communities to encourage local participation in the Project, including by under-represented groups. Several strategies are included in the Workforce Management Plan to maximise local employment and improve the skills and capacity of local and regional communities through the provision of training opportunities.

Table 9.83 summarises the Project's workforce employment and training action plan and Table 9.84 summarises the Project's workforce behaviour management action plan. Further details are provided in Appendix W, Draft Workforce Management Plan.

Table 9.83: Workforce employment and training action plan

Objective	Action	Responsibility	Stakeholders/ Potential Partnerships	Timing	Monitor	Monitoring frequency	Performance Indicator
Maximise local employment through implementation of recruitment hierarchy	Promote and advertise opportunities locally through online sources, local and regional papers, community Facebook pages, company website and/or physical locations to allow local access	Proponent/ Principal Contractor	Local and regional communities, employment providers	Prior to construction, during construction and operations	Maintain a workforce employment register and monitor workforce number and composition	Biannual during construction, annual during operation	Local workers have been actively sought Operation workforce is 25% local
	Work with employment providers to assess and meet Baralaba South employment needs and to recruit local residents						
	Work with employment providers to develop and implement entry level recruitment program(s) for the Project						
	Develop and maintain a workforce employment register	Proponent/ Principal Contractor	Local and regional communities, employment providers	During construction and operations	Monitor maintenance of workforce employment register	Bi-annually	Workforce employment register has been developed and maintained
Provide equal opportunity employment	Develop and implement the Baralaba South Diversity Policy	Proponent/ Principal Contractor	Local and regional communities, employment providers	Prior to construction, during construction and operations	Audit of employment practices against the Diversity Policy	Annually	Diversity Policy has been developed and implemented Employment practices are consistent with Diversity Policy

Objective	Action	Responsibility	Stakeholders/ Potential Partnerships	Timing	Monitor	Monitoring frequency	Performance Indicator
Improve skills and capacity of local and regional communities and existing workforce by providing training opportunities	Provide and communicate training opportunities to the local and regional community	Proponent/ Principal Contractor	Local and regional communities, employment and training providers, Gaangalu Nation People, Woorabinda Aboriginal Shire Council, DTATSIPCA	Prior to construction, during construction and operations	Maintain a workforce training register and monitor number and type of training provided	Annually	Training opportunities communicated Training opportunities provided
	Work with Queensland Government and specialist employment agencies to identify initiatives to enhance training and employment opportunities for First Nations Australians, people with a disability and other under-represented groups		Employment and training providers, Gaangalu Nation People, Woorabinda Aboriginal Shire Council, DTATSIPCA	Prior to construction, during construction and operations			Baralaba South Diversity Policy applied Initiatives implemented to encourage workforce participation from under-represented groups
	Identify, implement and communicate First Nations training and employment opportunities	Proponent/ Principal Contractor	Employment and training providers, Gaangalu Nation People, Woorabinda Aboriginal Shire Council, DSDSATSIP	Prior to construction, during construction and operations	Maintain a workforce training register and monitor number and type of training provided	Annually	First Nations training and employment opportunities identified and offered First Nations employment maximised Operation workforce is 4% Aboriginal and/or Torres Strait Islander
Improve skills and capacity of local and regional communities and existing workforce by providing training opportunities (cont.)	Work with First Nations stakeholders to identify potential candidates for training and employment at the Project		Gaangalu Nation People, Woorabinda Aboriginal Shire Council, DTATSIPCA	Prior to construction, during construction and operations			First Nations candidates identified and engaged with Appropriate mentoring program in place to support First Nations trainees/employees

Objective	Action	Responsibility	Stakeholders/ Potential Partnerships	Timing	Monitor	Monitoring frequency	Performance Indicator
	Include cultural-awareness training in the Project's mandatory employee induction program		Baralaba South Employees	Prior to construction, during construction and operations	Monitor induction program	Annually	Cultural-awareness component of induction program implemented
	Develop and maintain a workforce training register		Baralaba South Employees	During construction and operations	Monitor maintenance of workforce training register	Bi-annually	Workforce training register has been developed and maintained

Table 9.84: Workforce behaviour management action plan

Objective	Action	Responsibility	Stakeholders/ Potential Partnerships	Timing	Monitor	Monitoring Frequency	Performance Indicator
Enhance community cohesion	Develop and implement Workforce Code of Conduct	Proponent/ Principal Contractor	Employees	Prior to construction, during construction and operations	Audit of Induction Program and other initiatives to inform employees of Code of Conduct	Bi-annually during construction, annually during operation	Code of Conduct implemented
		Proponent/ Principal Contractor	Employees	During construction and operations	Assess employees' Code of Conduct awareness level	Bi-annually during construction, annually during operation	Employees are familiar with Code of Conduct expectations
		Community Relations Officer	Local community	During construction and operations	Monitor stakeholder and community complaints and report antisocial or disruptive behaviour to Project Manager/General Manager	Daily	Antisocial or disruptive workforce behaviour in the local community is addressed
		Community Relations Officer	Local community	During construction and operations	Reporting of number of incidents relating to workforce behaviour in the community to Project Manager/ General Manager	Monthly during construction, monthly during operation	The reported incidents of antisocial or disruptive workforce behaviour in the local community is low

Objective	Action	Responsibility	Stakeholders/ Potential Partnerships	Timing	Monitor	Monitoring Frequency	Performance Indicator
		Community Relations Officer	Local Police	During construction and operations	Consult with Police, to identify antisocial or disruptive behaviour	Bi-annually	Meeting held with Police to review workforce behaviour
		Community Relations Officer	Local community	During construction and operations	Structured community satisfaction assessment of employee behaviour	Bi-annually during construction, annually during operation	Community satisfaction assessment conducted and findings reported to Project Manager/General Manager
	Incorporate social considerations in the Project Induction Program to educate employees on local community values and general behaviour expectations	Proponent/ Principal Contractor	Employees	Prior to construction, during construction and operations	Audit workforce induction program	Prior to construction, bi-annually during construction and annually during operations	Social considerations included in Project Induction Program
	Implement the Baralaba accommodation camp Code of Conduct	Proponent/ Principal Contractor	Local community, Baralaba accommodation camp	During construction and operations	Consult with Baralaba accommodation camp to identify antisocial or disruptive behaviour	Bi-annually	Code of Conduct implemented at WAV Meeting held with Baralaba WAV to review workforce behaviour

9.15.3.5 Local Business and Industry Procurement Plan

The objectives of the Local Business and Industry Procurement Plan are to:

- maximise opportunities for competitive and capable local businesses to provide goods and services to the Project; and
- reduce barriers to entry for local businesses where feasible.

The Local Business and Industry Procurement Plan has been developed in consideration of the Australian Industry Participation Framework, Code of Practice for Local Content (Queensland Resources Council, 2013), the Queensland Charter for Local Content and the Queensland Procurement Policy.

The Project will provide opportunities for local and regional (including Indigenous businesses) to participate in its supply chain which will contribute to business sustainability and growth and indirectly to employment and economic development.

The Plan includes several local business and industry procurement strategies to:

- communicate and encourage local industry to participate in the Project's supply chain;
- ensure processes and procedures provide fair, full and reasonable opportunity to local businesses;
- maximise local business participation; and
- mitigate potential negative Project impacts on existing businesses that may occur from competition for resources.

Prior to construction commencing, a Local and Regional Business Register will be developed for the Project. The register will be developed in consultation with the Industry Capability Network Qld (ICN Qld), Callide Dawson Chamber of Commerce, Moura Chamber of Commerce, Gaangalu Nation People/Gangulu Endorsed Parties, Department of Tourism, Innovation and Sport (DTIS), Department of Seniors, Disability Services and Aboriginal and Torres Strait Islander Partnerships (DSDSATSIP) and Baralaba North Mine. The register will be used to inform and support Project initiatives to communicate and encourage local businesses to participate in the Project's supply chain.

Local business briefings will be held to promote Project supply opportunities in advance of the Project's construction phase. The briefings will provide the opportunity to engage directly and build relationships with local businesses, obtain information on local businesses, their interest in, and capacity and capability to support the Project and inform local businesses about how to participate in the Project.

The Project will also promote supply opportunities through stakeholder and partnership networks (e.g. ICN Qld, DTIS, DSDSATSIP, Banana Shire Council, Woorabinda Aboriginal Shire Council, Callide Dawson Chamber of Commerce and Moura Chamber of Commerce).

Strategies to provide fair, full and reasonable opportunity to local businesses include:

- facilitating and supporting the delivery of a tender-readiness program for local businesses;
- invitations to local businesses to tender for relevant work packages;
- providing the opportunity for local businesses to prequalify for supply contracts to streamline the procurement processes for local businesses;
- providing opportunities for local businesses to identify issues and barriers in meeting requirements of supply contracts; and
- supporting local businesses to improve their capability and systems to they can participate in the Project.

The Project will seek to engage Aboriginal and Torres Strait Islander businesses in direct procurement opportunities, through the strategies described above. Additional strategies to maximise Indigenous business participation in the Project are described in the Local Business and Industry Procurement Plan.

While the focus will be to involve local subcontractors and suppliers in the Project supply chain, the Project understands that because it is new, it may stretch other local businesses' resources through employment and procurement demand. The Project will monitor impacts on local businesses through the Community Reference Group and Stakeholder Consultation Register and will work with the Project management team to mitigate any negative impacts.

Table 9.85 summarises the Project's local business and industry procurement action plan. Further details are provided in Appendix W, Draft Local Business and Industry Procurement Plan.

Table 9.85: Local business and industry procurement action plan

Objective	Action	Responsibility	Stakeholders/ potential partnerships	Timing	Monitor	Monitoring frequency	Performance indicator
Identify the Project's local and regional procurement opportunities.	Finalise work packages that are suitable for local and regional businesses to tender.	Proponent/ Principal Contractor	Local and regional businesses (including Indigenous businesses), ICN Qld, Callide Dawson Chamber of Commerce, Moura Chamber of Commerce, Baralaba North Mine, Department of Tourism, Innovation and Sport (DTIS), DSDSATSIP	Pre-construction and prior to operations	Monitor appropriateness and number of work packages.	Prior to construction, bi-annually during construction and the first two years of operations, annually thereafter	Work packages are suitable for local and regional business participation while not negatively impacting Project performance.
Communicate and encourage local and regional businesses to participate in the Project's supply chain.	Develop a Local and Regional Business Register.			Pre-construction, during construction, prior to operations, during operations	Monitor maintenance of register and cross-referencing to work packages, services and goods supply categories.	In advance of construction, bi-annually during construction and first two years of operations, annually thereafter	Local and Regional Business Register developed. Local and Regional Business Register cross-referenced to potential work packages, services and goods supply categories.
	Advertise and hold industry briefings to inform local businesses about Project procurement opportunities and build relationships with businesses.			Pre-construction and prior to operations	Monitor the participation in industry briefings by local businesses and the type and proportion of businesses compared to those listed on the Local and Regional Business Register.	Within a month of industry briefings	Industry briefings widely advertised in the local area. Industry briefings held. Local and Regional Business Register updated.

Objective	Action	Responsibility	Stakeholders/ potential partnerships	Timing	Monitor	Monitoring frequency	Performance indicator
Communicate and encourage local and regional businesses to participate in the Project's supply chain (cont.).	Promote supply opportunities through stakeholder/ partnership networks.	Proponent/ Principal Contractor	Local and regional businesses (including Indigenous businesses), ICN Qld, Callide Dawson Chamber of Commerce, Moura Chamber of Commerce, Baralaba North Mine, DTIS, DSDSATSIP	Pre-construction, during construction, prior to operations, during operations	Monitor using the stakeholder consultation register for enquiries from local businesses.	Prior to construction, bi-annually during construction and first two years of operations, annually thereafter	Supply opportunities have been promoted to local and regional businesses through partnership networks.
	Communicate capability requirements.			Pre-construction, during construction, prior to operations, during operations	Monitor the methods by which capability requirements have been communicated (e.g. online [e.g. ICN], through partnership networks, company or contractor website, local business briefings).	Prior to construction, bi-annually during construction and the first two years of operations, annually thereafter	Capability requirements have been communicated to local and regional businesses.
Provide full, fair and reasonable opportunities for local and regional businesses to participate in the supply chain and maximise participation.	Facilitate and support delivery of a tender-readiness program for local businesses.			Pre-construction and prior to operations	Monitor participation in the local tender-readiness program.	During program implementation	The Project has facilitated and supported a tender-readiness program for local businesses.

Objective	Action	Responsibility	Stakeholders/ potential partnerships	Timing	Monitor	Monitoring frequency	Performance indicator
Provide full, fair and reasonable opportunities for local and regional businesses to participate in the supply chain and maximise participation (cont.).	Invite local and regional businesses on the register to tender for relevant packages	Proponent/ Principal Contractor	Local and regional businesses (including Indigenous businesses), ICN Qld, Callide Dawson Chamber of Commerce, Moura Chamber of Commerce, Baralaba North Mine, DTIS, DSDSATSIP	Pre-construction, during construction, prior to operations, during operations	Monitor uptake of supply contracts by local and regional businesses. Annual analysis of local and regional expenditure data, including expenditure applicable to Indigenous businesses.	Bi-annually during construction and the first two years of operations, annually thereafter	Local and regional businesses have been invited to tender for relevant work packages, services or goods. Local and regional businesses are part of the construction supply chain. Local and regional businesses are part of the operations supply chain. 25% of good and services are sourced from local, regional and Indigenous businesses
	Provide local businesses with opportunities to prequalify for supply contracts				Monitor the number of local (including Indigenous) businesses that obtain pre-qualification for supply contracts, and analyse data against the Local and Regional Business Register.	Bi-annually during construction and the first two years of operations, annually thereafter	Local businesses have been provided with opportunities to pre-quality for supply contracts.
Provide full, fair and reasonable opportunities for local and regional businesses to participate in the supply chain and maximise	Provide opportunities for local businesses to identify issues and barriers in meeting requirements of supply contracts.	Proponent/ Principal Contractor	Local and regional businesses (including Indigenous businesses), ICN Qld, Callide Dawson Chamber of Commerce, Moura Chamber of Commerce, Baralaba	Pre-construction, during construction, prior to operations, during operations	Monitor the issues and barriers nominated by local businesses and consider opportunities to address. Monitor using the stakeholder consultation register.	Bi-annually during construction and the first two years of operations, annually thereafter	Local businesses have been provided with opportunities to identify issues and barriers in meeting requirements of supply contracts.

Objective	Action	Responsibility	Stakeholders/ potential partnerships	Timing	Monitor	Monitoring frequency	Performance indicator
participation (cont.).	Engage with and support local businesses to improve their capability and systems so they can participate in the Project.		North Mine, DTIS, DSDSATSIP	Pre-construction, during construction, prior to operations, during operations	Monitor the nature of support provided using the stakeholder consultation register.	Bi-annually during construction and the first two years of operations, annually thereafter	The Project has sought to engage and support local businesses to improve their capability and systems to enable them to participate in the Project.
Minimise negative Project impacts on existing businesses from competition for resources.	Monitor direct negative Project impacts on existing local businesses.		Local businesses	During construction and operations	Monitor through Community Reference Group and Stakeholder Consultation Register.	Annually	The Project has sought to identify direct negative Project impacts on existing local businesses and implemented mitigation measures when required.

9.16 Economic matters

9.16.1. Existing environment

An Economic Impact Assessment (EIA) has been undertaken for the Project by AEC (2023) and is provided in Appendix Y, Economic Impact Assessment. The EIA has been prepared in accordance with the 'Economic Impact Assessment Guideline' (DSDMIP, 2017).

The study area for examining the economic impacts of the Project is based on the Project's location, export location and consideration of the likely sources of labour, goods and services that will be utilised by the Project. This represents the regional economy most likely to be directly and/or indirectly affected by the Project (Appendix Y, Economic Impact Assessment).

The Project is located within the Banana Shire LGA. However, given the Project is proximal to the Central Highlands Regional LGA, the Central Highlands – East Statistical Area 2 has been included as part of the local catchment for the EIA. The extent of the local catchment for the purpose of the EIA is shown in Figure 9.102. The regional catchment for the purpose of the EIA is shown on Figure 9.103 and includes the Banana Shire LGA, Central Highlands Regional LGA, Woorabinda Aboriginal Shire LGA, Gladstone Regional LGA, Rockhampton Regional LGA and Livingstone Shire LGA. Economic modelling has also been undertaken for Queensland (Appendix Y, Economic Impact Assessment).

Some impacts examined in the EIS included analysis at a more localised level. For example, agricultural impacts have been analysed using a combination of data for the Banana Statistical Area Level 2 and the Central Queensland Statistical Area Level 4.

9.16.2. Description of economic environmental values

A detailed summary of the existing economic environment is provided in the EIA (Appendix Y) and includes an assessment and overview of the prevailing economic conditions. A summary of the existing economic values of the local and regional catchments is provided below.

Population in the local catchment has been declining in recent years, with population projections indicating this is expected to continue through to 2041.The population in the local catchment was relatively stable between 2008 and 2013; however, it has declined each year since 2013. The regional catchment has also experienced weakened population growth since 2013, including population contractions in 2016 and 2017. The population decline is considered likely to reflect the declines in construction activity that occurred after 2014–2015, as major construction projects in the region were completed (e.g. Queensland Curtis LNG Project, Australia Pacific LNG Project and Gladstone LNG Project) (Appendix Y, Economic Impact Assessment).

In economics, Gross Value Added (GVA) is the measure of the value of goods and services produced in an area, industry or sector of an economy. The local catchment is heavily reliant on the mining industry, with mining contributing 73.3% to the local catchment's total industry GVA and 35.4% of jobs (Appendix Y, Economic Impact Assessment). The mining industry is also a significant contributor to the regional catchment, accounting for 42.3% of total industry GVA and providing 9.4% of jobs. The regional catchment has strategic assets supporting mining operations with two of Queensland's major ports in Gladstone and Rockhampton (Appendix Y, Economic Impact Assessment).

GRP is a measure of the market value of all final goods and services produced in an area. GRP in both local and regional catchments has been falling year-by-year since its peak in 2016-17 (in chain volume measures), which was mostly due to a decline in mining activity in both the local catchment and the rest of the regional catchment since 2016-17. The contraction in mining activity was primarily caused by extreme weather events, COVID-19 and embargoes placed on Australian coal by China in late 2020. A reduction in GVA from manufacturing and financial and insurance services industries also contributed to the falling GRP in the rest of the regional catchment over the past five years (Appendix Y, Economic Impact Assessment).

The local catchment's unemployment rate was 3.2% in March 2023. It had mostly been lower than Queensland's over the past ten years. The area recorded 23 consecutive quarters of lower unemployment before rising above the state's rate of 4.3% in December 2021. Since then, the local catchment's unemployment has declined, reaching the lowest rate within the last ten years in December 2022 (of 3.1%). The low unemployment rates in the local catchment are reflective of a relatively transient (largely mining) workforce in the local catchment. (Appendix Y, Economic Impact Assessment).

House sales and rental prices in both the local and regional catchment peaked in 2011-2012 and have since declined.

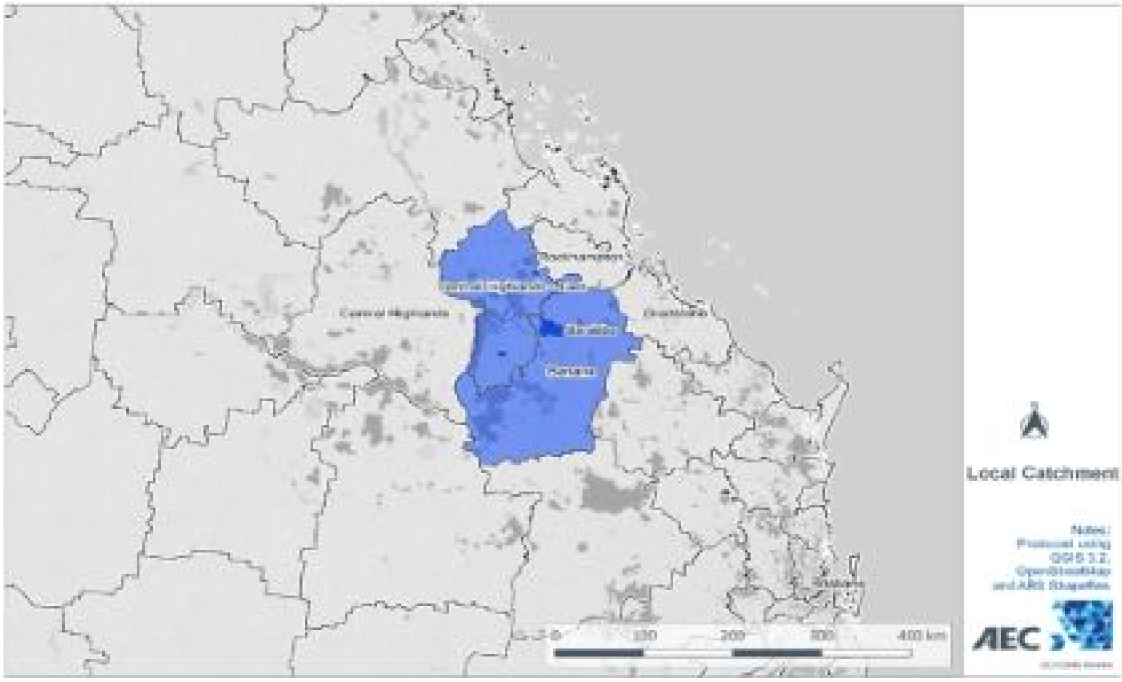


Figure 9.102: Map of EIA local catchment

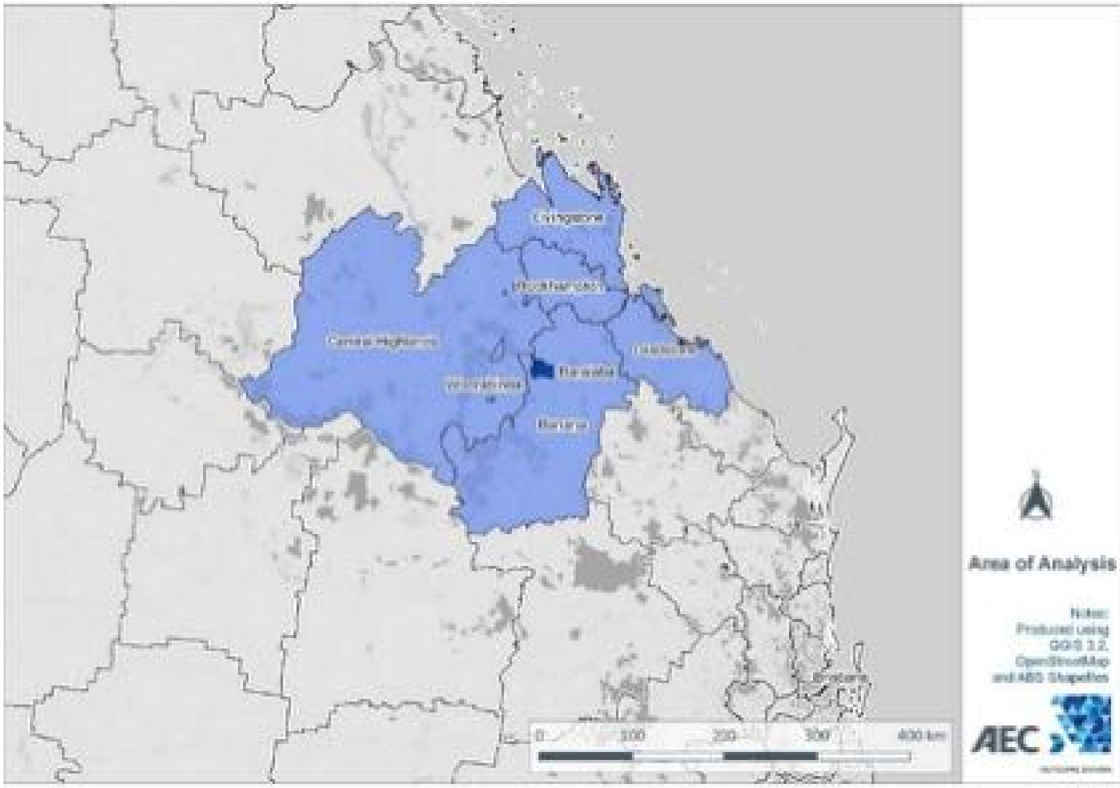


Figure 9.103: Map of EIA regional catchment

9.16.3. Potential impacts

The Project will have beneficial impacts on the economy as it will:

- contribute to economic growth;
- increase employment and household incomes;
- provide support for local and regional businesses; and
- contribute to government taxation revenues through a variety of taxes and duties which can be used by government to provide additional infrastructure and services to support business and households throughout Australia.

Key beneficial impacts arising from the Project are summarised in Table 9.86.

Potential adverse impacts of the Project are summarised in Table 9.87. Potential adverse impacts on the economy include impacts on agricultural production, on local businesses from competition for resources, on local property values and on industry from the Australian dollar and exchange rates. It is recognised that impacts on local property values and the Australian dollar/exchange rates can provide beneficial impacts for some stakeholders and adverse impacts for others.

As stated in Appendix Y, Economic Impact Assessment, it is not anticipated that the Project will have any tangible impact on the normal supply/demand of extractive resource availability in the region or Queensland either during or after construction. The demand on extractive resources for Project construction is an estimated 56,200 m^3 of quarry material. It is anticipated that a substantial amount of quarry material will be extracted from borrow pits and suitable clay and rock materials from the box cut spoil within MLA 700057. Any quarry materials extracted from within the MLA are deemed a mineral under the MR Act and no additional authorisations are required to be held for the extraction of quarry materials. If required, additional quarry materials required for Project construction will be obtained from quarries in the region. Given the volume of quarried materials available in Queensland and a number of major quarry operations located in proximity to the Project site, and accessibility to substantial quarrying material from within the Project disturbance area, the Project is unlikely to impact on the normal supply/demand of extractive resources.

The EIA also considers cumulative impacts should other projects be undertaken concurrently, and how the potential impacts identified in Table 9.86 and Table 9.87 could be exacerbated by the conduct of other projects in the region (Appendix Y, Economic Impact Assessment).

The cost–benefit analysis for the Project indicates that, assuming a discount rate of 7%, the net present value of the Project to the Queensland economy is estimated at $715.6 million.

Table 9.86: Summary of beneficial economic impacts of the Project

Impact	Description
Economic growth	The Project will contribute to economic growth through increased industry output and GRP during construction and operation (i.e. production), as well as decommissioning and rehabilitation, which will flow from both direct and indirect impacts. The Project is estimated to support an additional: • $13.5 million in GRP per annum in the regional catchment during construction; • $170.2 million GRP per annum in the regional catchment during operations; and • $1.6 million GRP per annum in the regional catchment during post-mine decommissioning and rehabilitation. At peak, the Project is estimated to result in an increase in GRP of 0.5% compared to what would be expected to occur without the Project.
Employment and incomes	The Project will increase employment and household incomes during construction, operation and decommissioning/rehabilitation, compared to what would occur without the Project—flowing from both direct and indirect impacts. Including both direct and flow-on (supply chain) impacts, the Project is estimated to support an additional: • 114 full-time equivalent (FTE) jobs per annum in the regional catchment during construction; • 333 FTE jobs per annum in the regional catchment during operations; and • 4 FTE jobs per annum in the regional catchment during post-mine decommissioning and rehabilitation.
Support for local businesses	The Project will create opportunities to secure new contracts and increase sales to supply and service the needs of the Project through flow-on impacts in the supply chain during all phases of the Project. Much of the flow-on impacts are expected to be realised within the regional catchment, boosting businesses in surrounding regions of the Project site. Prominent industry beneficiaries from flow-on from this Project include transport and storage, trade and business services. The Project will also result in the support of local suppliers and contractors, providing additional security and longevity of business incomes (and employment) in the region.
Government revenue	The Project will provide a lift in local, state and Australian Government taxation revenues through a variety of taxes and duties. Overall, the Project is estimated to deliver an annual average of: • $68.7million in additional revenue to the Australian Government, through personal income tax, fringe benefits tax, company tax and GST, compared to what would occur without the Project; and • $62.6 million in additional revenue to the Queensland Government compared to what would occur without the Project, primarily through royalty payments. • These additional revenues can be used by government to provide additional infrastructure and services to support business and households throughout Australia.

Table 9.87: Summary of potential adverse economic impacts of the Project

Impact	Description
Impacts on agricultural production	The Project is located in an area primarily used for cattle grazing which may be adversely impacted as a result of the Project. Based on a total Project disturbance area of approximately 1,300 ha (including transmission lines), of which approximately 892 ha is grazing land, there could be approximately $104,000 per annum in potential value lost in cattle grazing over the life of the Project at peak grazing land disturbance. The land will be progressively rehabilitated to return the land to a PMLU for grazing (assumed to be returned to approximately 75% of original grazing land use over a ten-year period post-mining). Over 100 years, the impact to agriculture from the Project is estimated to have a net present value of approximately $1.01 million (using a 7% discount rate). This assumes the land disturbed would otherwise provide a value of grazing production of approximately $116.6/ha (in line with the average value in the Banana SA2 in 2021) and all of this value would be lost as a result of the Project until the land is rehabilitated.
Impacts on local businesses from competition for resources	There will be increased competition for labour and resources, leading to inflationary pressure and increased costs to businesses as well as potential difficulties for local businesses attracting and retaining staff, particularly for manufacturing. The increase in real wages also highlights the increasing costs to businesses as real wages are higher than the base case throughout the mine life. However, compared to the base case (i.e. without the Project) activity, the impacts of the Project on real wages and industry output are estimated to be relatively small, and will be offset to some degree by the benefits generated throughout the supply chain.
Impacts on local property values	The Project is not anticipated to have an impact on the local property market during construction. All non-local workers will be accommodated within the expanded Baralaba accommodation camp owned by the Baralaba Coal Company. Non-local workers during operations are also expected to be accommodated in the accommodation camp, however, there may be potential for some of the approximately 25% of local workforce to represent workers relocating to the local catchment. Assuming between 5% (low range estimate) and 20% (high range estimate) of the local workforce reflects people relocating to the local catchment, this would equate to an additional demand of 5 and 25 dwellings at peak operations (this would reflect only a small portion of the annual level of rental bonds lodged in the local catchment of between 650 and 1,000 bonds per annum in the past five years). While this impact is included as a potential adverse impact, given the current population decline and relatively stagnant property market in the local catchment, it is anticipated that any impact the Project has on attracting residents, and associated demand on the local property market, will likely be of benefit to the local community rather than place any undue burden on the cost of housing.
Impacts on industry from AUD and exchange rates	The Project has the potential to support the Australian dollar through demand for imported goods and services as well as production of coal for export. This could adversely impact on trade-exposed sectors of the Australian economy (i.e. sectors that compete in global markets such as agriculture, manufacturing and tourism) by increasing the cost of domestic goods and services to foreign buyers. Industries such as agriculture, manufacturing and tourism are strong contributors to the Queensland and national economy, though the contribution of these industries can fluctuate due to a number of macroeconomic factors (including exchange rates). However, considering the total export value of the Project relative to total national exports, it is expected there is a low probability of the Project impacting on the value of the Australian dollar and exchange rates, and any impacts would be negligible.

9.16.4. Mitigation and management measures

Some areas of the Project site are currently used for grazing activities. The Project will likely result in the cessation of grazing activity on this land during Project operation until post-mine land rehabilitation is undertaken, which has the potential to adversely impact on agricultural production in the region (Appendix Y, Economic Impact Assessment). The Project will minimise disturbance of productive land in areas not required by mining activities. A PRC Plan will be prepared and implemented for the Project that will detail the progressive rehabilitation of the site over the Project life. As described in detail in Chapter 3, Rehabilitation, grazing will form the primary PMLU (with the exception of the final void area) to minimise adverse impacts on agricultural production in the local area.

To maximise the benefits of the Project in the region, Baralaba South Project (and contractors engaged by the Proponent) will maximise the amount of labour sourced locally. A Draft Workforce Management Plan has been prepared to prioritise recruitment of workers from local and regional communities and workers who will relocate to live in regional communities (as described in section 9.15.3.2). While Project personnel will have the choice to live locally or commute, operational employees will be encouraged to live locally. The Project will provide equal opportunities for employment and will recruit based on candidates' skills, potential skills and job suitability without regard to gender, race or disability status. The Draft Workforce Management Plan (Appendix W) outlines strategies that will be implemented to provide employment and training opportunities for local and regional communities, including under-represented groups.

To maximise the benefits of the Project in the region (and Queensland), the local supply chain will be encouraged and provided opportunities to supply goods and services to support the Project. As described in section 9.15.3.5, a Draft Local Business and Industry Procurement Plan has been developed for the Project to identify how local industry will be encouraged to register as a supplier, pre-qualify, tender for supply opportunities and develop the required capabilities to participate in the Project. Monitoring will be conducted to progressively monitor the effectiveness of the Local Business and Industry Procurement Plan including the uptake of supply contracts by local business. Opportunities will be provided for suppliers to identify issues and difficulties in meeting compliance requirements of supply contracts. The Draft Local Business and Industry Procurement Plan is provided in Appendix X.

The Project will likely result in some workers relocating to the Banana Shire, in particular the nearby towns of Moura and Biloela where dwelling availability is greatest within the local catchment, to take up jobs generated by the Project either directly or indirectly. This has the potential to increase demand and prices for residential property. While this may provide some support for a recently weakened property market, too much upward pressure has the potential to be detrimental (Appendix Y, Economic Impact Assessment). While the property market in Biloela has been weakening in recent years, the property market has started to recover in Moura (Appendix Y, Economic Impact Assessment).

As described in section 9.15.3.2, a Draft Housing and Accommodation Plan has been developed to manage the Project's impacts on housing and accommodation and is provided in Appendix V (Draft Housing and Accommodation Plan). The Project will use the expanded Baralaba accommodation camp to accommodate the DIDO/FIFO component of the workforce which will significantly reduce any direct impacts on the local property market (Appendix Y, Economic Impact Assessment). The Project will also provide incentives for relocation to the local area which may reduce the financial burden of upward pressures on prices (Appendix Y, Economic Impact Assessment), including allowances to employees providing their own local accommodation, rental subsidies to encourage personnel to rent in the private market and assistance with relocation costs (Appendix V, Draft Housing and Accommodation Plan). The incentives program will be subject to review and will be dependent on the results of monitoring of Project effects on housing availability and affordability. Potential impacts of the Project on property prices and housing affordability will be monitored and minimised to the extent possible to ensure prices do not create cost pressures on the local community (Appendix V, Draft Housing and Accommodation Plan).

9.17 Ecologically sustainable development considerations

ESD is defined by the Australian Government's 'National Strategy for Ecologically Sustainable Development' (1992) as:

> *…using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.*

The objectives that are reflected in the strategy are as follows:

- enhance individual and community wellbeing and welfare by following a path of economic development that safeguards the welfare of future generations;
- provide for equity within and between generations; and
- protect biological diversity and maintain essential ecological processes and life-support systems.

Aligning decision-making concurrently with these abovementioned objectives should achieve the strategy's overarching goal of:

> *…development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.*

Guiding principles are provided to silo efforts appropriately towards this outcome:

- Decision-making processes should effectively integrate both long- and short-term economic, environmental, social and equity considerations.
- Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- The global dimension of environmental impacts of actions and policies should be recognised and considered.
- The need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised.
- The need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised.
- Cost-effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms.
- Decisions and actions should provide for broad community involvement on issues which affect them.

As outlined in Schedule 3A of the EPBC Act, ESD principles relevant to the Project include:

- precautionary principle (lack of full scientific certainty should not be used as a reason for postponing mitigation measures);
- intergenerational equity and intrageneration equity (ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations);
- conservation of biological diversity and ecological integrity; and
- improved valuation, pricing and incentive mechanisms should be promoted.

Reflective of the principles above, consideration has been given to incorporate these principles into all phases of the Project design and environmental impact assessment—in particular, the design, planning and rehabilitation stages. Application of measures arising in accordance with ESD guiding principles relevant to the Project are detailed in the following subsections.

9.17.1. Precautionary principle

The precautionary principle stipulates the need to consider uncertainty and reinforce the extent of risk when contemplating actions that may result in threats of irreversible environmental damage. In environmental assessments, qualified professionals often have to predict when the environmental outcomes are likely to be post-development. The principle precludes, regardless of scientific certain for the outcome, that measures should be enacted.

A Hazards and Safety Assessment has been undertaken for the Project to identify Project related risks and develop appropriate mitigation measures and strategies. The assessment considers both on-site and off-site risks to people, property and the environment (in the presence of controls) and is included in Chapter 17 of the EIS.

Potential short-term, long-term and cumulative impacts have been acquired from qualified professionals to determine the likelihood of environmental degradation and irreversible impacts. In the preparation of this EIS, definitive features of air quality (inclusive of greenhouse emissions), surface water, groundwater, socioeconomic, transport, climate, aquatic and terrestrial ecology, noise, soil and land, cultural heritage and visual amenity have been assessed.

In response to these assessment findings, a series of monitoring programs, avoidance actions, mitigation measures and environmental offsets have been proposed to adequately address the predefined risks. These include, but are not limited to, operational controls (e.g. haul road watering) and physical controls. Contingency protocols have also been considered in the design, operational and rehabilitation phases.

Peer reviews have been undertaken by recognised technical experts regarding:

- Surface Water Impact Assessment;
- Groundwater Modelling and Assessment; and
- Flood Modelling and Assessment.

The peer reviews are provided in Attachments 5 to 8 of this EIS, respectively.

9.17.2. Intergenerational equity

Intergenerational equity is defined in the ‘Intergenerational Report Australia in 2055’ (Commonwealth of Australia, 2015), *as* ‘the choices today enacted build a strong and resilient economy that will lay down the foundation for future prosperity’. In particular, intergenerational equity seeks to ensure the health, diversity and productivity of the environment is preserved to enable this prosperity for future generations. The following measures have been integrated into the Project to guarantee this principle is addressed:

- assessment of the Project’s contribution to climate change and greenhouse gas emissions;
- consideration of potential short-term, long-term and cumulative impacts on air quality (inclusive of greenhouse emissions), surface water, groundwater, socioeconomic, transport, climate, aquatic and terrestrial ecology, noise, soil and land, cultural heritage and visual amenity have been addressed in the preparation of this EIS; and
- monitoring programs, avoidance actions, mitigation measures and biodiversity offsets have been proposed to adequately address the predefined risks.

Consideration has been given to the increase in social welfare, wellbeing and infrastructure that arises from an increase in economic activity. Benefits are realised by the expansion of employment and regional business opportunities for current and future generations.

The continuation of employment opportunities is to be properly accounted for during the closure period in order to withhold social equity. Consecutive royalties and taxes would be paid by both the Proponent and Project employees to all three levels of government, then distributed back on the basis of shared services such as health, education, police, community services and roads. Longevity of employment opportunities are to be accompanied by an employment transition strategy prior to mine closure. This strategy should seek to ensure skills are transferable post-closure or otherwise offer a support alternative to employees during the transition.

9.17.3. Conservation of biological diversity and ecological integrity

Biological diversity refers to the diversity in three states:

1) gene variation (within a population);
2) species variation (between populations); and
3) ecosystem diversity (different habitat and communities present).

Comparatively, ecological integrity can be defined as the resilience of an ecosystem to maintain function ecosystem health with a diverse range of species and habitat present.

The majority of the study area has been cleared in the past to facilitate agricultural land uses, namely cattle grazing. As a result of these past land management activities, intact, native vegetation communities have been reduced to small, isolated patches, most of which are associated with the drainage lines that occur throughout the western portion of the study area. Regrowth vegetation is present in various stages of recovery following past clearing events.

A total of 325 flora species have been recorded during the field surveys, presenting 87 families and 220 genera. The species inventory has included 45 introduced species, which account for 13.8% of the total number of flora species recorded. Two significant flora species have been recorded in the study area—only one is listed as endangered under the EPBC Act. The field validated vegetation mapping identified communities that are consistent with two TECs listed under the EPBC Act.

A total of 150 species of terrestrial vertebrate fauna have been recorded during the field surveys, including five introduced species. Native species includes 11 amphibians, 101 birds, 10 mammals and 12 reptiles. One fauna species listed under the EPBC Act has been identified in the study area during the field surveys, namely the Ornamental Snake, listed as vulnerable. No species listed as migratory under the EPBC Act have been identified in the study area during the seasonal field surveys.

Assessments of ecological values are described in section 9.11, section 9.12, section 9.13 and section 9.14.The assessments conclude that the ecological values within the Project footprint are limited and have been previously modified by past grazing land uses. As such, these are representative of a reduced biological diversity and ecological integrity. In accordance with ESD principles, the Project addresses the conservation of biodiversity and ecological integrity by proposing an environmental management framework designed to conserve ecological values when practicable and provide for environmental offsets when not.

9.17.4. Valuation

The Economic Impact Assessment (Appendix Y) is an analysis of the Project and incorporates environmental values via direct valuation where practicable.

The Project is estimated to support an additional $13.5 million in GRP per annum in the regional catchment during construction, $170.2 million GRP per annum in the regional catchment during operations and $1.6 million GRP per annum in the regional catchment during post-mine decommissioning and rehabilitation. At peak, the Project is estimated to result in an increase in GRP of 0.5% compared to what would be expected to occur without the Project.

The Cost–Benefit Analysis (Appendix Y, Economic Impact Assessment) for the Project shows that, assuming a discount rate of 7%, the net present value of the Project to the Queensland economy is estimated at $715.6 million. The cost–benefit analysis identifies that the Project is economically desirable for Queensland, with benefits outweighing costs across all discount rates examined.

9.18 Consideration of the Project against the objectives of the EPBC Act

The Proponent has considered a range of alternatives to the proposed Project as described in section 9.6,including alternative flood plain encroachment management, scale of operation, infrastructure layout, processing method and product transport. The Project design has been refined to reduce the disturbance footprint and minimise impacts to ecological values.

The proposed mitigation measures are expected to be effective in:

- Avoiding facilitated impacts on MNES
- Addressing the recognised threats to the relevant species and communities; and
- Achieving consistence with relevant approved Conservation Advice, recovery plans and threat abatement plans.

All MNES known or likely to occur within the extent of impact of the Project, or listed in the TOR have been assessed in accordance with the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DoE 2013)(sections 9.11 and 9.12)

Each assessment includes:

- a description of communities or species' EPBC Act listing status, distribution and ecology;
- the desktop assessment methodology used to inform the Project field surveys;
- the survey effort implemented;
- the survey outcomes;
- a robust assessment and mapping of potential habitat;
- a description of the potential impacts to each threatened community and species;
- specific measures that are proposed to avoid, mitigate and manage the potential impacts;
- a description of the statutory requirements considered in the assessment; and
- an assessment of the likelihood of significant impacts.

In accordance with section 3 of the EPBC Act, the following objectives have been used to assess efforts undertaken by the Proponent to satisfy compliance. These objectives seek to achieve the following:

- provide protection of the environment, especially those aspects of the environment that are matters of national environmental significance;
- promote ESD through the conservation and ecologically sustainable use of natural resources;
- promote the conservation of biodiversity;
- provide for the protection and conservation of heritage;
- promote a cooperative approach to the protection and management of the environment involving governments, the community, landholders and Indigenous people;
- assist in the cooperative implementation of Australia's international environmental responsibilities;
- recognise the role of Indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity; and
- promote the use of Indigenous people's knowledge of biodiversity, with the involvement of and in cooperation with the owners of the knowledge.

The Proponent considers it has achieved consistency with objectives of the EPBC Act, as the Project has adequately attained the following requirements:

- Protection of the environment by a comprehensive assessment of MNES impacts and forms a series of mitigation measures to preserve threatened ecological communities, terrestrial and aquatic species and water resources.
- A Biodiversity Offset Strategy has been prepared to ensure residual impacts are properly identified and addressed to conserve or increase ecological value/integrity, with particular focus on biodiversity values (section 9.19).
- Preservation of cultural heritage through an assessment of both indigenous and non-indigenous surveys has formed a series of management protocols to avoid damage or losses. A Cultural Heritage Investigation and Management Agreement (CHIMA) was approved in consultation with the Aboriginal Party (Gangulu Nation People) as a CHMP pursuant to Section 107 of the ACH Act by the Department of Treaty, Aboriginal and Torres Strait Islander Partnerships on 10 October 2012.
- Stakeholder consultations with government, the community, landholders and Indigenous people have commenced and will continue as the Project develops. This includes all EIS notification periods, community meetings and a series of individual engagement proceedings (Attachment 3, Public Consultation Report).
- No significant impacts are predicted for migratory species that are protected under international agreements (Appendix F, Terrestrial Ecology Assessment).
- The Project can be undertaken in a manner that protects significant water resources and water-dependent assets (Appendix A, Surface Water Impact Assessment, Appendix C, Flood Impact Assessment and Appendix J, Biodiversity Offsets Strategy). No significant impact on water-dependent assets is predicted for the Project.

9.19 Environmental offsets

A Biodiversity Offset Strategy has been prepared for the Project to address the predicted significant impacts to MNES from the Project. The strategy is summarised below and provided in Appendix J, Biodiversity Offsets Strategy.

9.19.1. Regulatory framework

Under the EPBC Act Environmental Offsets Policy 2012 (EPBC Act Environmental Offsets Policy) (SEWPaC, 2012b), environmental offsets are actions taken to counterbalance significant residual impacts on MNES. Offsets are used as a last resort in instances where an action will give rise to significant residual impacts, even after the application of management measures.

The EPBC Act Environmental Offsets Policy specifies that an offset package must be built around direct offsets (i.e. land-based), which should form a minimum of 90% of the total offset requirement. Other compensatory measures (i.e. indirect offsets) can provide up to a maximum of 10% of the total offset requirement. Offsets should align with conservation priorities for the impacted protected matter and be tailored specifically to the attribute of the protected matter that is impacted in order to deliver a conservation gain.

Direct Offsets are those that result in a measurable conservation gain by:

- improving the condition and function of existing habitat for the protected matter;
- creating new habitat for the protected matter;
- reducing threats to the protected matter;
- increasing the values of a heritage place;
- averting the loss of a protected matter or its habitat that is under threat (the risk of loss is avoided as a result of securing an offset for conservation purposes or undertaking management to remove or reduce threats); and
- being located strategically to enhance connectivity to existing areas of threatened ecological communities or species habitat.

Other compensatory measures (indirect offsets) may supplement a direct offset by:

- implementing priority actions outlined in relevant recovery plans;
- targeted research such as assessing the effectiveness of revegetation techniques for a threatened ecological community; and
- educational programs that may be identified in recovery plans or other approved management plans for the relevant MNES and be targeted towards behavioural change and improvement in the viability of the protected matter.

The 'Offsets assessment guide' (Offsets Assessment Guide) which accompanies the EPBC Act Environmental Offsets Policy, has been developed to assist with determining the size and scope of an offsets package. The Offsets Assessment Guide is essentially a balance sheet approach to estimate impacts and offsets for threatened species and ecological communities (SEWPaC, 2012b).

9.19.2. Significant impacts

Assessments of significant impacts on MNES are provided in the previous sections. Assessments concluded that there is a potential for significant impacts to one threatened ecological community and two threatened species listed under the EPBC Act. A summary of the impacts is provided in Table 9.88.

Table 9.88: MNES significant impacts summary

Protected matter	EPBC Act status	Likelihood of occurrence	Total area (ha)/ no. of individuals present	Total maximum area (ha)/individuals to be cleared	Potential for significant impact?[1]
TECs					
Brigalow TEC	Endangered	Present	14.0 ha	1.4 ha	No
Threatened flora					
Xerothamnella herbacea	Endangered	Present	~90 individuals	~90 individuals	Yes
Threatened fauna					
Squatter Pigeon habitat	Vulnerable	Present	84.7 ha	21.9 ha	No
Ornamental Snake habitat	Vulnerable	Present	65.0 ha (+50.5 ha marginal habitat)	34.9 ha	Yes
Australian Painted Snipe habitat	Endangered	Moderate	31.1 ha (+68.5 ha marginal habitat)	1 ha (+33.9 ha marginal habitat)	No
Koala habitat	Vulnerable[2]	Moderate	111.1 ha	26.5 ha	No, habitat not critical to survival
Migratory bird species					
Glossy Ibis habitat	Migratory	Moderate	As per Australian Painted Snipe		No
Latham's Snipe habitat	Migratory	Moderate	As per Australian Painted Snipe		No

Note: [1]Based on assessment of impacts in accordance with the EPBC Act Significant Impact Guideline (DEWHA 2009)

[2]The Koala was listed as vulnerable at the time of the controlled action decision

9.19.3. Offset requirements

Biodiversity offsets are required to compensate for significant residual impacts on MNES. With reference to the significant residual impact assessments completed as part of the Terrestrial Ecology Assessment (Appendix F) and summarised in Table 9.88, the Project will have a significant impact on the following MNES:

- *Xerothamnella herbacea*: approximately 90 individuals of this species will be cleared; and
- Ornamental Snake: 34.9 ha of habitat for this species will be cleared.

The Proponent will therefore be required to deliver offsets under the EPBC Act Environmental Offsets Policy for these two MNES.

The impact calculator component of the Offset assessment guide has been completed for MNES being significantly impacted and the results are provided in Table 9.89 below.

Table 9.89: Offset summary

Protected attribute description	Quantum of impact	
Xerothamnella herbacea		
This species was recorded in 10 locations within a fragmented and considerably degraded patch of regrowth vegetation in the central eastern portion of the Project disturbance footprint. The number of individuals present at each location was low and ranged from one individual to around 20 individuals.	Quantum of impact (number of individuals)	90
Ornamental Snake		
The Project disturbance footprint Ornamental Snake habitat in the form of: • drainage lines with fringing vegetation and some fallen timber • gilgai and wetland habitat (with or without vegetation or fallen timber) • marginal gilgai habitat (without vegetation or fallen timber). These habitats were found to vary in condition based on the history of disturbance (i.e. vegetation clearing, blade ploughing, cattle grazing, weed invasion), presence, depth and condition of gilgai, and abundance of fallen timber.	Area (ha)	34.9
	Quality (scale 0-10)	4
	Total quantum of impact (adjusted ha)	17.45

9.19.4. Proposed offset approach

Given the requirement for a minimum of 90% of Commonwealth offset conditions to be carried out by way of a land-based offset, the primary objective is to deliver a Proponent driven, land-based offset by securing suitable land capable of fulfilling both Commonwealth and State offset requirements.

A parent or related company of the Proponent owns several properties surrounding the Project and the Baralaba North Mine, which were targeted for provision of offset supply areas. As such, the preferred approach for offset delivery would be the establishment of an offset site on one or more of these properties.

Additionally, the Commonwealth offset policy allows up to 10% of the offset obligation to be delivered through other compensatory measures, such as education or research. If the identified land-based offset cannot meet 100% of the offset obligation, the Proponent may pursue such a compensatory measure.

9.19.5. Assessment of offset supply

Six properties have been identified which support the required offsetable values. Comprehensive field surveys and habitat quality scoring were undertaken to determine the presences and quality of each of the MNES requiring offsets within each of the properties. As far as practicable, it has been the Proponent’s intention to co-locate offsets for each matter significantly impacted by the Project within the same offset property. However, all ecological values requiring offsetting occur within one or more of the properties investigated. The potential offset properties are shown on Figure 9.104.

Table 9.90: Comparison of MNES on each offset investigation area

Significantly impacted matter	Offset investigation area					
	Property A	**Property B**	**Property C**	**Property D**	**Property E**	**Property F**
Xerothamnella herbacea	Not present	Not present	Not present	Not present	Not present	Present
Ornamental Snake habitat	Present	Present	Present	Present	Present	Present

Analysis has identified that ample opportunity exists to locate all potential offset supply within target properties. The percentage of the offset requirement for each of the values requiring offsetting was assessed using the EPBC Act offset calculator and field data. Table 9.91 specifies the potential offset supply areas available for each matter within the target properties.

Table 9.91: Potential offset supply areas

Significantly impacted matter	Offset investigation area					
	Property A	**Property B**	**Property C**	**Property D**	**Property E**	**Property F**
Xerothamnella herbacea	—	—	—	—	—	2,079.0%
Ornamental Snake habitat	487.14%	73.32%	Not considered	Not considered	509.81%	Not considered

Following State and Commonwealth government approval of the Project, including consideration and endorsement of Appendix J, Biodiversity Offsets Strategy, the following steps will be completed:

- in consultation with relevant stakeholders select properties that can fulfil offset supply requirements;
- prepare an Offset Management Plan for each applicable offset supply property; and
- legally secure offset supply area/s.

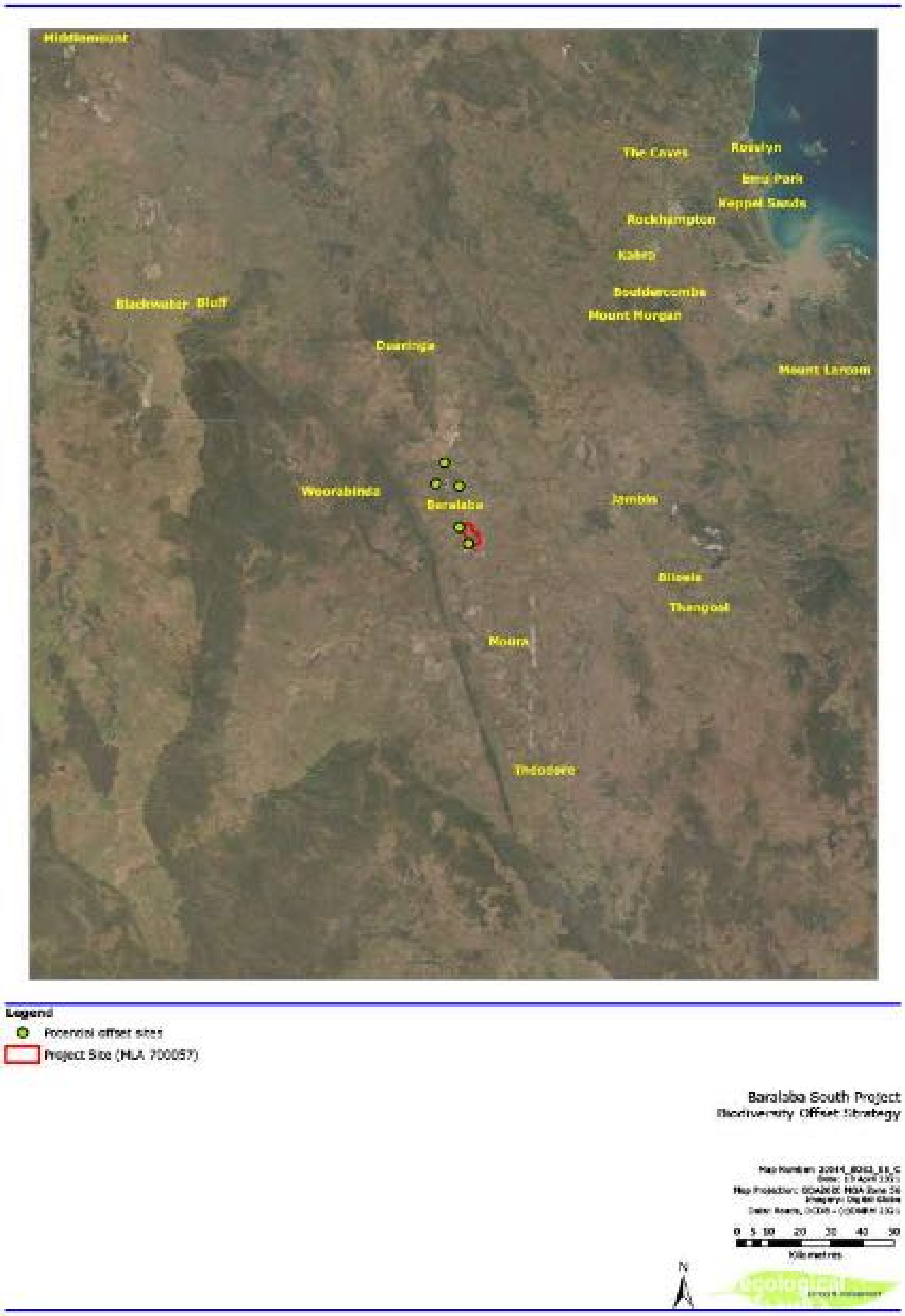


Figure 9.104: Location of proposed offset properties

9.19.6. Management of offset sites

The management measures to protect and enhance the condition of the MNES values within the offset site will be specified in an Offset Management Plan (OMP) which will be designed to address the existing threats to each of the MNES. The identified existing threats for each MNES are outlined in Table 9.92.

Table 9.92: Existing threats to MNES to be managed in offset sites

Existing threat	*Xerothamnella herbacea*	Ornamental Snake
6		
Weed invasion and expansion	✓	✓
Degradation and grazing by cattle	✓	✓
Degradation by feral animals (e.g. Pigs)	✓	✓
Fire		✓
Vegetation clearing and thinning	✓	✓
Restricted movement due to density of exotic grasses		✓
Siltation following high flow events	✓	

The management measures detailed in the OMP will be both site and species/community specific, however, at a minimum, to address the existing threats, the OMP will include management measures, such as:

- active revegetation to improve the cover of native species;
- weed control to reduce weed cover, prevent or minimise introduction of any new weed species and reduce competition with native species regeneration;
- implementation of controlled livestock grazing regimes to encourage natural regeneration of native vegetation and prevent further degradation of habitat while assisting to reduce fuel load;
- management of fuel levels to avoid high intensity bushfires;
- management of feral animals; and
- habitat enhancement through supplementing fallen woody debris where practicable (for Ornamental snake).

9.19.7. Offset monitoring and reporting

The OMP will be developed for each offset site and will include the management measures, performance objectives, responsibilities, corrective action and timeframes for delivery. The management measures developed will be MNES specific and designed to improved ecological condition and improve the capacity of the offset to achieve conservation gains. The OMP(s) will be prepared and approved by DAWE prior to the commencement of the action.

9.20 Conclusion

The construction, operation and closure of the Project is considered to be environmentally acceptable in consideration of the requirements of the EPBC Act, the principles of ESD and the precautionary principle. This conclusion is formed on the basis of:

- Project design having considered the potential environmental impacts, including cumulative impacts, on MNES during all phases of development. Most significantly, the potential for impacts relating to surface water and flooding have been minimised through the strategic design of water management infrastructure.
- Mitigation measures being proposed for all impacts to MNES relevant to the Project. These measures are predicted to be effective in reducing potential adverse impacts on the MNES. Monitoring commitments have been included to ensure the effectiveness of strategies over the mine life.
- Where impacts to MNES are unavoidable, environmental offsets are proposed in accordance with both Commonwealth and State policy.
- The Project is predicted to provide significant value to the community in the form of employment, provision of services, payment of taxes and royalties. The manner in which the action is to be taken is considered consistent with the goals of protecting biological diversity and maintaining essential ecological processes and life-support systems.