LAKE VERMONT MEADOWBROOK PROJECT
ENVIRONMENTAL IMPACT STATEMENT

CHAPTER 21 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

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21 Matters of National Environmental Significance

21.1 Introduction

The Lake Vermont Meadowbrook Project (the Project) is a 'controlled action' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); as per EPBC Referral 2019/8485. The Environmental Impact Statement (EIS) for the proposed Project has been prepared under the Queensland *Environmental Protection Act 1994* (EP Act) pursuant to the bilateral agreement for assessment between the Commonwealth and Queensland Governments.

The Project's controlling provisions are:

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

The purpose of this chapter of the EIS is to address potential impacts of the action on Matters of National Environmental Significance (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.

21.1.1 Title of the action

The title of the Project is the Lake Vermont Meadowbrook Project.

21.1.2 Proponent

The proponent for the Project is Bowen Basin Coal Pty Ltd (Bowen Basin Coal) (ABN: 22 065 321 440). The registered address and postal address for Bowen Basin Coal is:

Level 7
12 Creek Street
Brisbane City, Queensland, 4000

Bowen Basin Coal is a private company established in 1994 and owned by the Lake Vermont Joint Venture, an unincorporated Australian joint venture operating in Queensland. The Lake Vermont Joint Venture is comprised of QCMM (Lake Vermont Holdings Pty Ltd) (70%), Marubeni Resources Development Pty Ltd (10%), CHR Vermont Pty Ltd (10%) and Coranar (Australia) Pty Ltd (10%). QCMM is 100% owned by Jellinbah Group Pty Ltd. Lake Vermont Resources Pty Ltd manages the Lake Vermont Joint Venture operations, including the existing Lake Vermont Mine located on Mining Lease (ML) 70331, ML 70477 and ML 70528, on behalf of the joint venture participants. Mining at Lake Vermont Mine is undertaken under contract, by Thiess Mining Services (Thiess).

Bowen Basin Coal supplies high-quality coking coal, pulverised coal injection (PCI) coal, and industrial coal products to international customers and is committed to the communities in which it operates. The company's operations provide significant benefits to the local community, as well as to the broader Central Queensland region and the Queensland economy as a whole. Bowen Basin Coal is committed to regularly reviewing environmental performance and publicly reporting on progress.

Bowen Basin Coal is listed on the Suitable Operator Register (Suitable Operator Reference: 340700) in accordance with the requirements of the EP Act.

21.1.2.1 Environmental record of the proponent

Bowen Basin Coal has adhered to its regulatory responsibilities in association with its exploration and mining operations. Bowen Basin Coal has not been the subject of any environmental legal proceedings that have resulted in fines or prosecution.

21.1.2.2 Environmental, health, safety and community policies

Resultant of the contract mining operation of Bowen Basin Coal, the Lake Vermont Mine operates under both Jellinbah and Thiess environmental policies.

Jellinbah Group believes responsible environmental management is fundamental to the company's position as an effective and successful company in the Australian Coal Mining Industry. The Company manages its operations with commitment to ecologically sustainable development and continual improvement to minimising the impact of its activities on the environment, achieved through environmental best practices and ongoing planning, education, training and rehabilitation. Jellinbah Group's Environmental Policy is provided as Figure 21.1.

Thiess operates under the global environmental policy of its parent company (CIMIC Group Limited). The CIMIC Global Environmental Policy applies to all its entities, including Thiess, and outlines a commitment to always respect the environment in which they live and work. Thiess also operates an ISO14001 certified Environmental Management System (EMS) to ensure consistency in how they plan, implement and review activities to achieve agreed environmental objectives. All projects are required to implement a site-specific Environmental Management Plan (EMP) to ensure compliance and continuous improvement of environmental performance. The CIMIC Global Environmental Policy is provided as Figure 21.2.

21.1.3 Objective of the action

The objective of the Project is to develop the metallurgical coal resource located to the north and directly adjoining the existing Lake Vermont Mine, to secure the long-term future of the operation.

The Project addresses the forecast reduction in coal production that will occur at the existing Lake Vermont Mine, by combining output from the existing open-cut operations and the Project extension. The Project extension proposes underground mining development, as well as a new satellite open-cut pit. The Project will enable total coal production to be maintained at the currently approved output for an extended period of approximately 20 years, with the overall Project life spanning approximately 53 years (inclusive of final rehabilitation). Proposed Project mining and production rates are detailed in Section 21.2.1.

The existing Lake Vermont Mine currently extracts approximately 11.5 to 12 Million tonnes per annum (Mtpa) of run-of-mine (ROM) coal, to produce approximately 9 Mtpa of product coal. Mining activity at the existing Lake Vermont Mine will gradually decline from 2023, with further sharp decreases (to approximately 4 Mtpa and less) from 2028 until the end of the mine life (currently scheduled for 2061). The Project, therefore, proposes to provide additional product coal to augment the reduced open-cut output, thereby maintaining production levels at approximately 9 Mtpa from 2028 through to 2048. Following completion of the Project underground extension in 2048, the proposed Project open-cut satellite pit will supplement the existing operations, albeit with production levels continuing to tail off until Project mining completion in 2055. Final mining completion at the existing Lake Vermont Mine will still occur through to approximately 2061.

Other key objectives of the Project are:

- to continue to operate profitable mining operations that provide high-quality hard coking coal, PCI coal and industrial coal for export markets;
- to maximise recovery of economically mineable coal resources within Bowen Basin Coal's mining tenements;
- to design, construct and operate the expanded mine to minimise impacts on the social and natural environments;

Jellinbah Group

Environmental Policy

Jellinbah Group Pty Ltd believes responsible environmental management is fundamental to the company's position as an effective and successful company in the Australian Coal Mining Industry. The company manages its operations with commitment to ecologically sustainable development and continual improvement to minimising the impact of its activities on the environment, achieved through environmental best practices and ongoing planning, education, training and rehabilitation.

The key strategies of Jellinbah Resources Pty Ltd Environmental Policy are to:

- *Comply with all relevant; legislation, regulation and policies relating to environmental issues.*
- *Monitor and review environmental performance in accordance with environmental management plans.*
- *Establish and evaluate environmental objectives and targets aimed at continual improvement.*
- *Identify, report, investigate and resolve all environmental incidents and non-conformances.*
- *Design and perform all company operations with minimal impact on the environment by enacting all practicable steps to:*
    - *minimise land clearance and prevent waste generation,*
    - *effectively manage waste rock and tailings storage facilities,*
    - *conduct ongoing rehabilitation; and*
    - *efficiently use energy and water.*
- *Maintain an effective environmental management system through regular environmental monitoring, reporting, reviewing and auditing to ensure operations minimise any adverse impacts on the environment.*
- *Ensure all our staff, contractors and persons working on behalf of the company are communicated and educated in this policy to the extent that they understand and are equipped with the skills to support and maintain our environmental management system acting in a manner consistent with this policy.*
- *Educate and communicate employees, their families, local communities and regulatory bodies about our systems and practices in an accurate, transparent and timely manner.*
- *Engage with stakeholders on concerns and values regarding the company's projects and developments.*

It is a requirement of the company that all those who provide services or products to Jellinbah Resources Pty Ltd ensure their compliance with the relevant environmental procedures and practices as dictated by this policy.

Greg Chalmers
Chief Executive Officer

Figure 21.1: Jellinbah Group Environmental Policy

CIMIC

ENVIRONMENTAL POLICY

This Policy sets out the minimum requirements for Environmental Matters across CIMIC Group Limited and entities it controls (**the Group**).

This Policy applies to all employees of the Group, third parties engaged by the Group, and all alliances and joint ventures in all jurisdictions.

Any employee of the Group found to have breached this Policy may be subject to disciplinary action.

The **objectives** of this Policy are to prevent and minimise environmental damage from the Group's activities, complying with all environmental obligations and promoting sustainable resource use in its operations (**Environmental Matters**).

Requirements

Each Operating Company will comply with all applicable environmental legal, regulatory and contractual requirements, and deliver all contract works under an environmental management system certified to regulation standards.

The Operating Companies are responsible for managing the Environmental Matters associated with their operations and displaying continuous improvement in their environmental performance.

Each Operating Company is to provide reports to the CIMIC CEO for presentation to the CIMIC Board Ethics Compliance & Sustainability Committee commenting on Environmental Matters, as required.

CIMIC[i] is required to ensure compliance with those obligations that cannot be delegated to its Operating Companies.

Policy Information

Owner:	Chief Human Resources Officer, CIMIC
Approved by:	Chief Executive Officer, CIMIC
Effective date:	*23 September 2016*

Note: CIMIC Group policies may be amended from time to time.

Figure 21.2: The CIMIC Global Environmental Policy

- to maximise the use of Bowen Basin Coal owned land and existing infrastructure at the Lake Vermont Mine to minimise the environmental impacts from additional infrastructure and provide Project efficiencies; and
- to comply with all relevant statutory obligations and continue to improve processes to achieve sound environmental management.

The Project will provide ongoing employment opportunities for workers currently employed at the Lake Vermont Mine. It will also allow Bowen Basin Coal to continue to support local and regional suppliers of the operation, through providing additional security and longevity of employment within the region.

The Queensland metallurgical coal industry is a significant supplier to international markets, with a history of providing the global steel manufacturing industry with high-quality hard coking coal and PCI. In 2019, the Lake Vermont Mine contributed 8.9 Mt of metallurgical coal to the export market and has been ranked as the ninth largest supplier to the export coal market (Queensland Government 2022).

The Project is ideally positioned to efficiently meet the market demands for metallurgical coal by having access to the Lake Vermont Mine's existing infrastructure. The Project will maximise the use of this existing infrastructure to minimise environmental impacts. Existing infrastructure that will be utilised includes:

- the Lake Vermont Mine Coal Handling and Preparation Plant (CHPP);
- coal handling facilities;
- train load-out facilities and rail infrastructure;
- road infrastructure for site access;
- water supply infrastructure (pipeline);
- electricity supply infrastructure;
- product coal stockpiles;
- co-disposal coal reject facilities; and
- other supporting infrastructure.

21.1.4 Location of the action

21.1.4.1 Regional context

The Project is located approximately 25 km north-east of Dysart and approximately 160 km south-west of Mackay, within the Isaac Regional Council local government area (LGA) (Figure 21.3 and Figure 21.4).

The Project is characterised by the following:

- It is within the Brigalow Belt North Bioregion, as defined by the 'Interim Biogeographic Regionalisation for Australia' (DoEE 2016) (Figure 21.4).
- It is approximately 50 km to the north-east of the Peak Range National Park — protected areas, such as national parks and nature refuges, near the Project are shown in Figure 21.3.
- It is within the Isaac-Connors Sub-catchment of the Fitzroy Basin, as defined by the 'Water Plan (Fitzroy Basin) 2011' (Figure 21.5).
- It is within the Isaac-Connors Groundwater Management Area (Figure 21.6), and a portion of the Project within the Isaac-Connors Alluvium Groundwater Sub-area, as declared under the 'Water Plan (Fitzroy Basin) 2011'. The Project is not within or proximate to the Great Artesian Basin.
- It is outside of zones mapped as Priority Living Areas, Priority Agricultural Areas, Priority Development Areas and Strategic Environmental Areas under the Regional Planning Interests Act 2014 (RPI Act) (Figure 21.7). The Project contains a small area mapped as potential SCL under the RPI Act (referred to as SCL trigger area on Figure 21.7).
- It is on some land mapped as an Important Agricultural Area by the 'Queensland Agricultural Land Audit' (Figure 21.8).

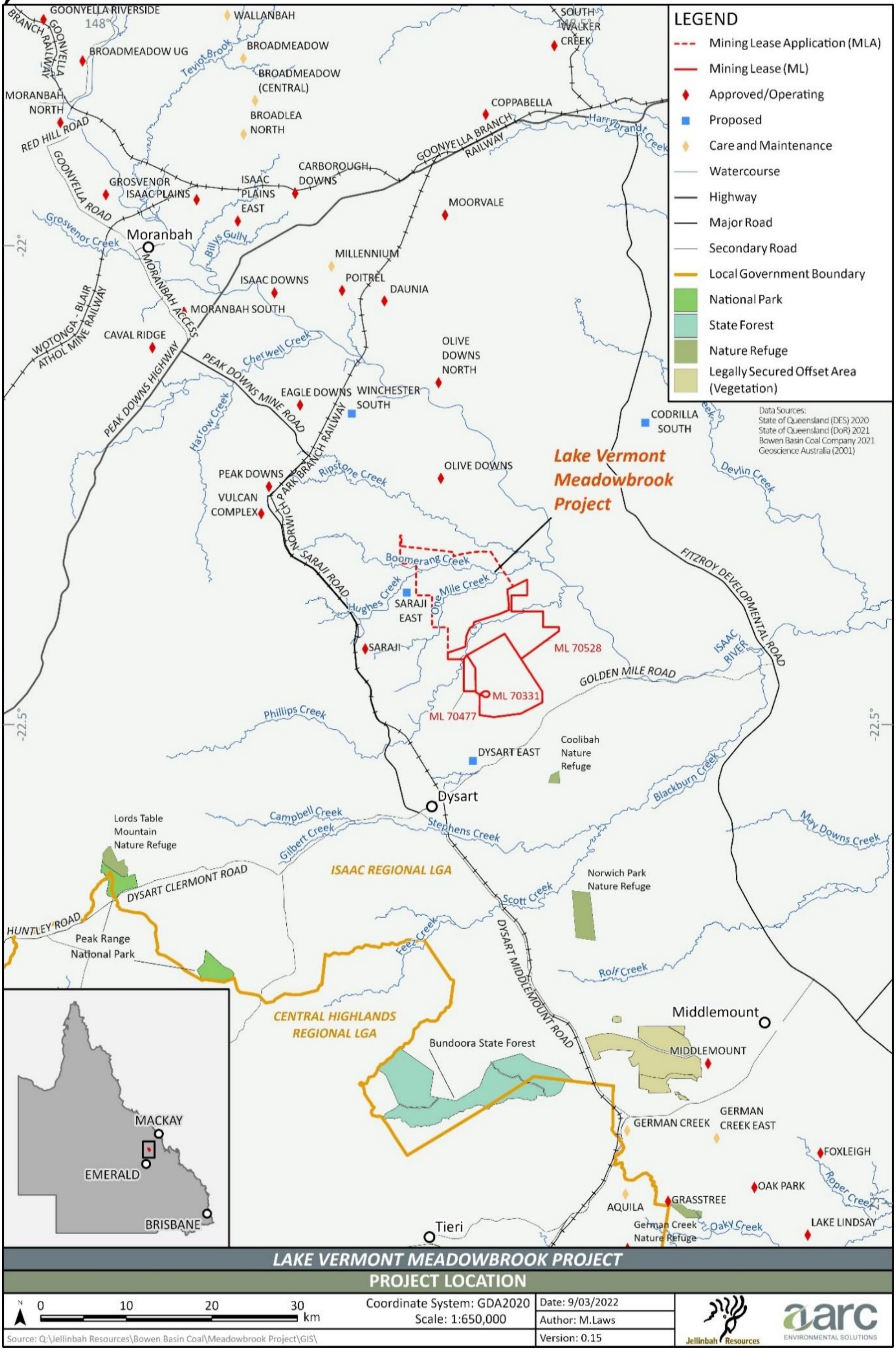

Figure 21.3: Project location

Figure 21.4: Brigalow Belt Bioregion

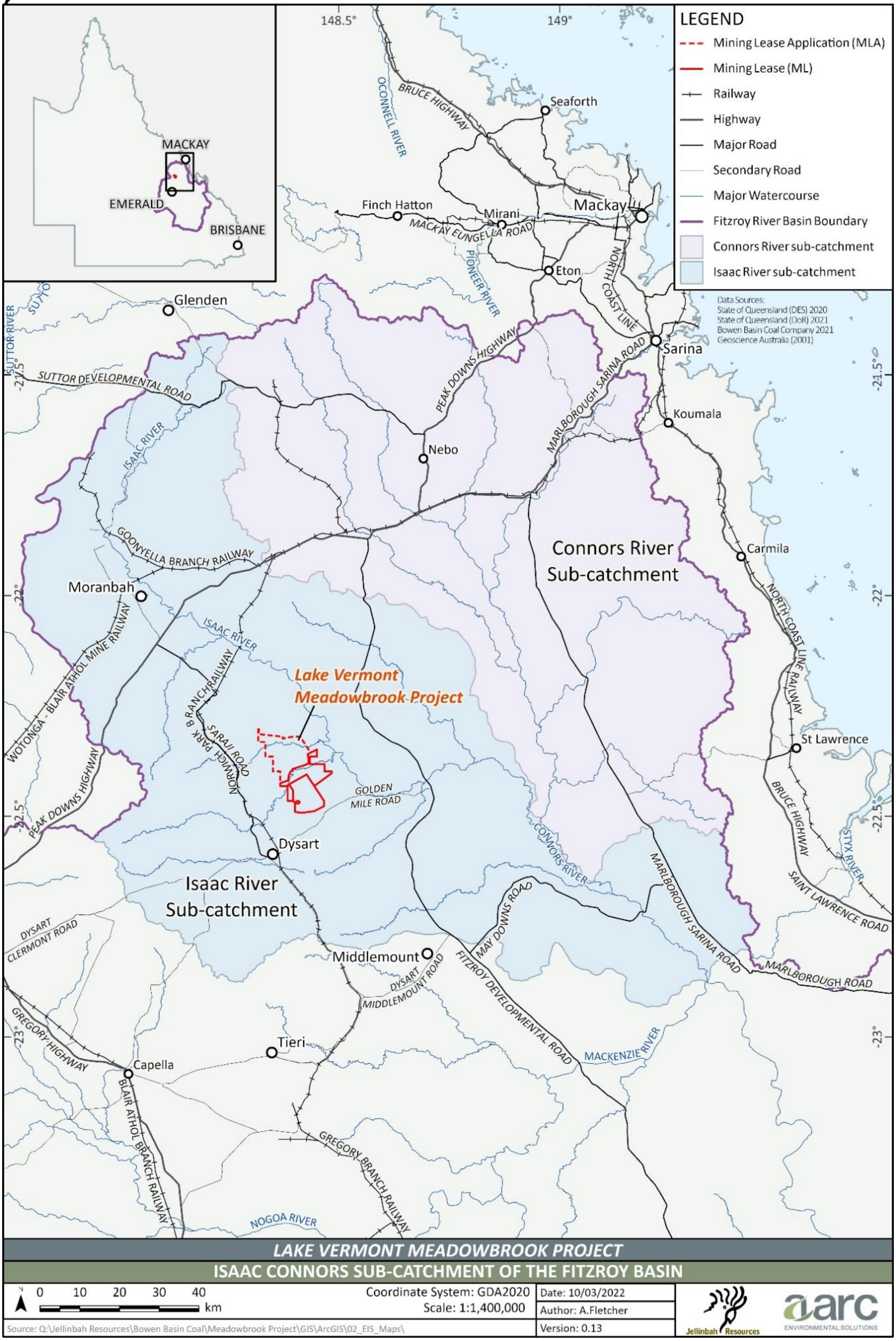

Figure 21.5: Isaac-Connors sub-catchment of the Fitzroy Basin

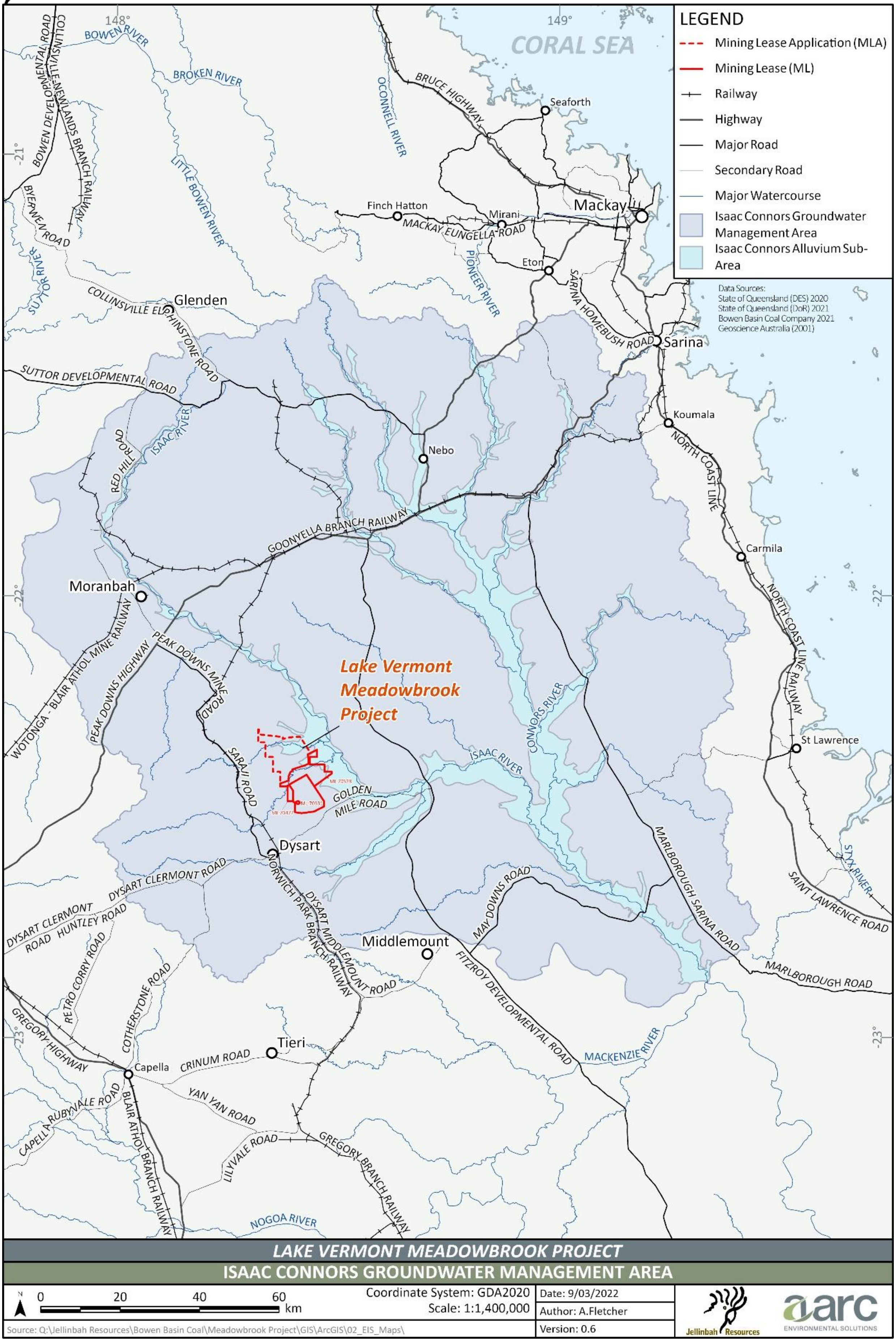

Figure 21.6: Isaac-Connors Groundwater Management Area

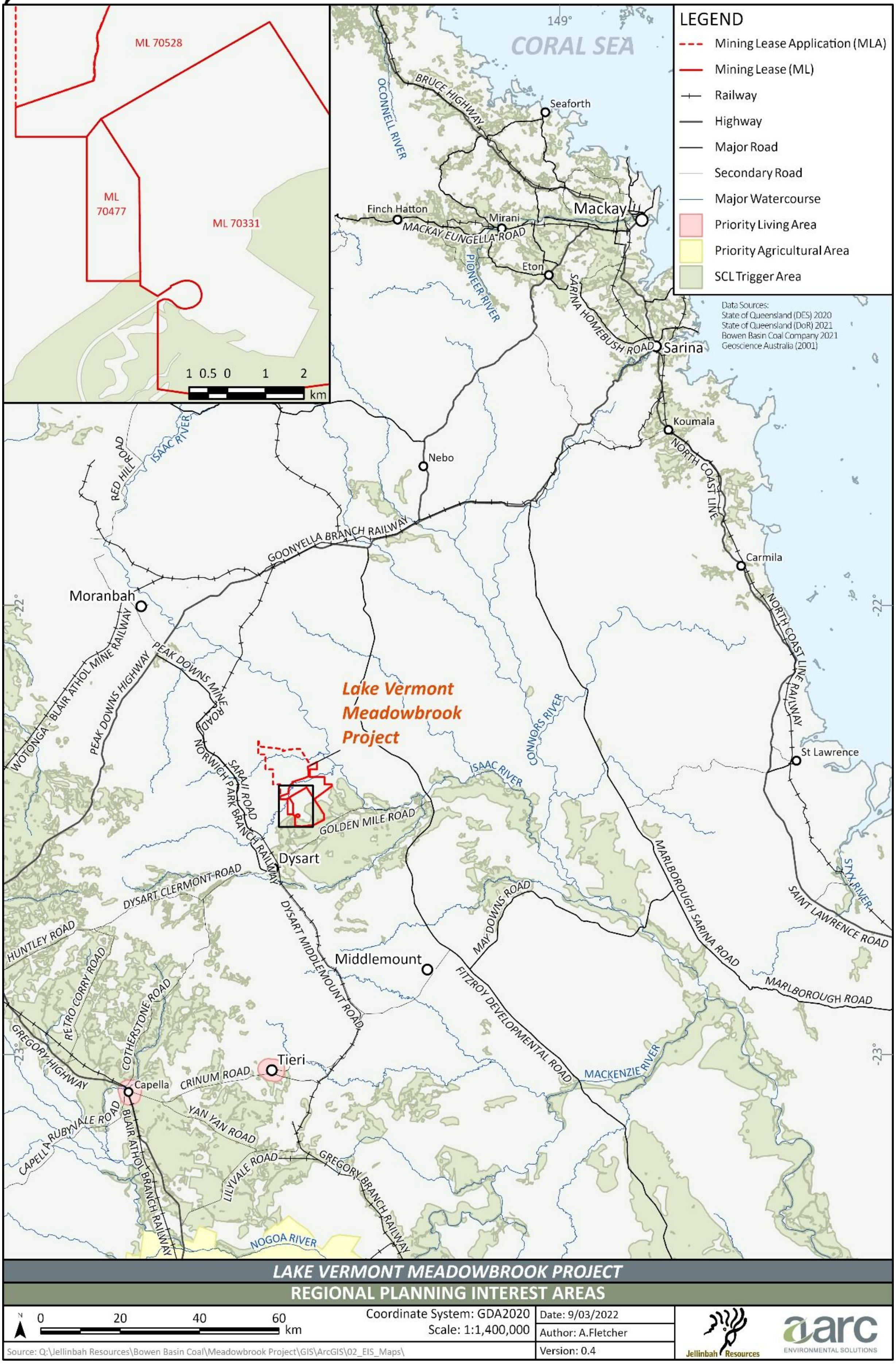

Figure 21.7: Regional planning interest areas

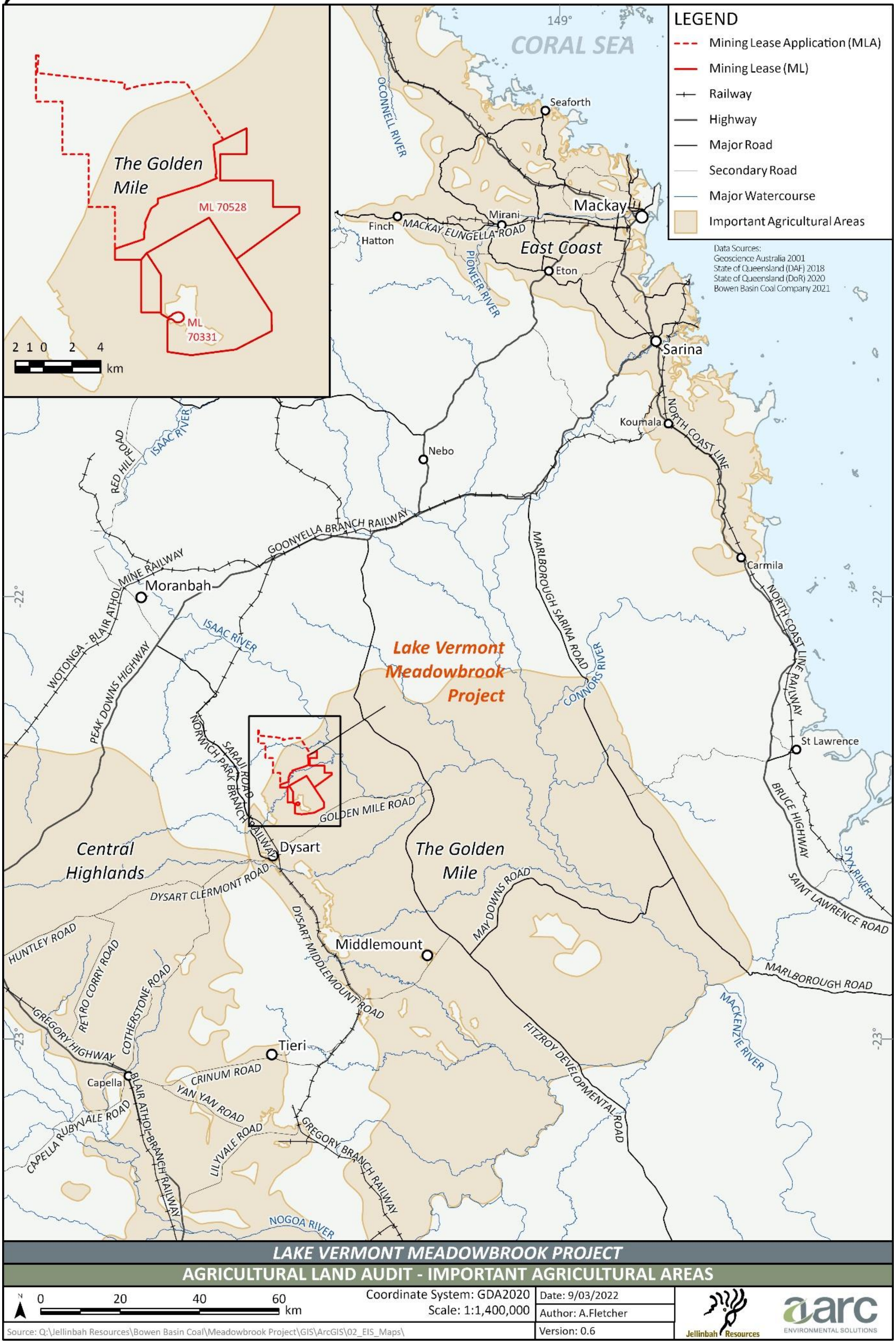

Figure 21.8: Queensland Agricultural Land Audit – Important Agricultural Area

- It is within land zoned as Rural under the 'Isaac Regional Planning Scheme' (IRC, 2021) and land zoned as Regional Landscape and Rural Production Area under the 'Mackay, Isaac and Whitsunday Regional Plan' (DLGP 2012). A small area of the Project is on land mapped as good quality agricultural land in the 'Mackay, Isaac and Whitsunday Regional Plan' (DLGP 2012). The area mapped as good quality agricultural land is consistent with the SCL trigger area mapped under the RPI Act near the proposed infrastructure corridor.
- It is within the Barada Barna People (QC2012/007) Native Title application area but not within the Barada Barna People's Native Title Determination. The Barada Barna People are the native title holders of the general Project region (Figure 21.9). Native title has been extinguished over all land within the Mine Lease Application (MLA) area and does not form part of the Barada Barna People's Native Title Determination.

The Project is located within Queensland's highly productive Bowen Basin, an area rich in coal and gas deposits (Figure 21.3). Existing (i.e. approved) and proposed nearby coal mining operations are identified in Section 21.1.5.3.

21.1.4.2 Local context

The Project is an extension to the immediate north of the existing Lake Vermont Mine, which operates within ML 70331, ML 70477 and ML 70528 (Figure 21.10). Lake Vermont Mine is approved under Queensland Environmental Authority (EA) EPML00659513. The activities of the existing Lake Vermont Mine are not within the scope of this EIS, with Lake Vermont Resources to continue to undertake open-cut mining operations and related activities at the Lake Vermont Mine in accordance with the terms of its existing approvals.

The land within the MLA is currently used for beef cattle grazing and resource exploration activities. A number of ephemeral watercourses, including Boomerang Creek, One Mile Creek and Phillips Creek, flow in an easterly direction across the Project site, towards the Isaac River (Figure 21.3).

The Proponent owns all the land within the Project site (and proposed MLA area). The BHP Mitsubishi Alliance's (BMA's) Saraji Mine and proposed Saraji East Project are located to the immediate west of the Project, while Pembroke's Olive Downs Mine is located to the north and Whitehaven Coal's proposed Winchester South Project to the north-west. Petroleum tenements for the Arrow 'Bowen Gas Project' overlay the Project site. Overlapping tenure matters are addressed through Queensland's State legislative processes.

Dysart is located approximately 25 km to the south-west of the Project, which is where the Lake Vermont Accommodation Village is situated.

21.1.4.3 Topography and watercourses overview

Ground elevations to the west of the Project are marginally higher in elevation than the east (approximately 10 mAHD), with the Project generally draining west to east, towards the Isaac River (Figure 21.11). The Isaac River passes to the east of the Project flowing in a south-easterly direction. The land surface between Phillips Creek and Boomerang Creek is a broad, flat floodplain that slopes gently eastwards from approximately 180 m AHD west of the Project site to around 170 m AHD east of the site (Figure 21.11).

The Project site is within the Isaac-Connors sub-catchment, an area encompassing 22,325 km^2 within the greater Fitzroy Basin catchment.

The primary watercourses that traverse the Project site are Boomerang Creek (a fifth order stream), Phillips Creek (a fourth order stream) and One Mile Creek (a third order stream). Ripstone Creek (also a third order stream) is located the north of the Project area (Figure 21.11).

Boomerang Creek, One Mile Creek and Phillips Creek are all defined watercourses under the Queensland *Water Act 2000* (Water Act). These waterways all drain into the Isaac River and east to the Coral Sea, via the Mackenzie River and Fitzroy River.

It is noted that the Olive Downs Coking Coal Project has approval to divert Ripstone Creek near the northern boundary of the Project MLA. The Surface Water Assessment for the Olive Downs Coking Coal Project concluded that the Ripstone Creek diversion will not significantly change the hydraulic behaviour of this watercourse (Hatch 2018).

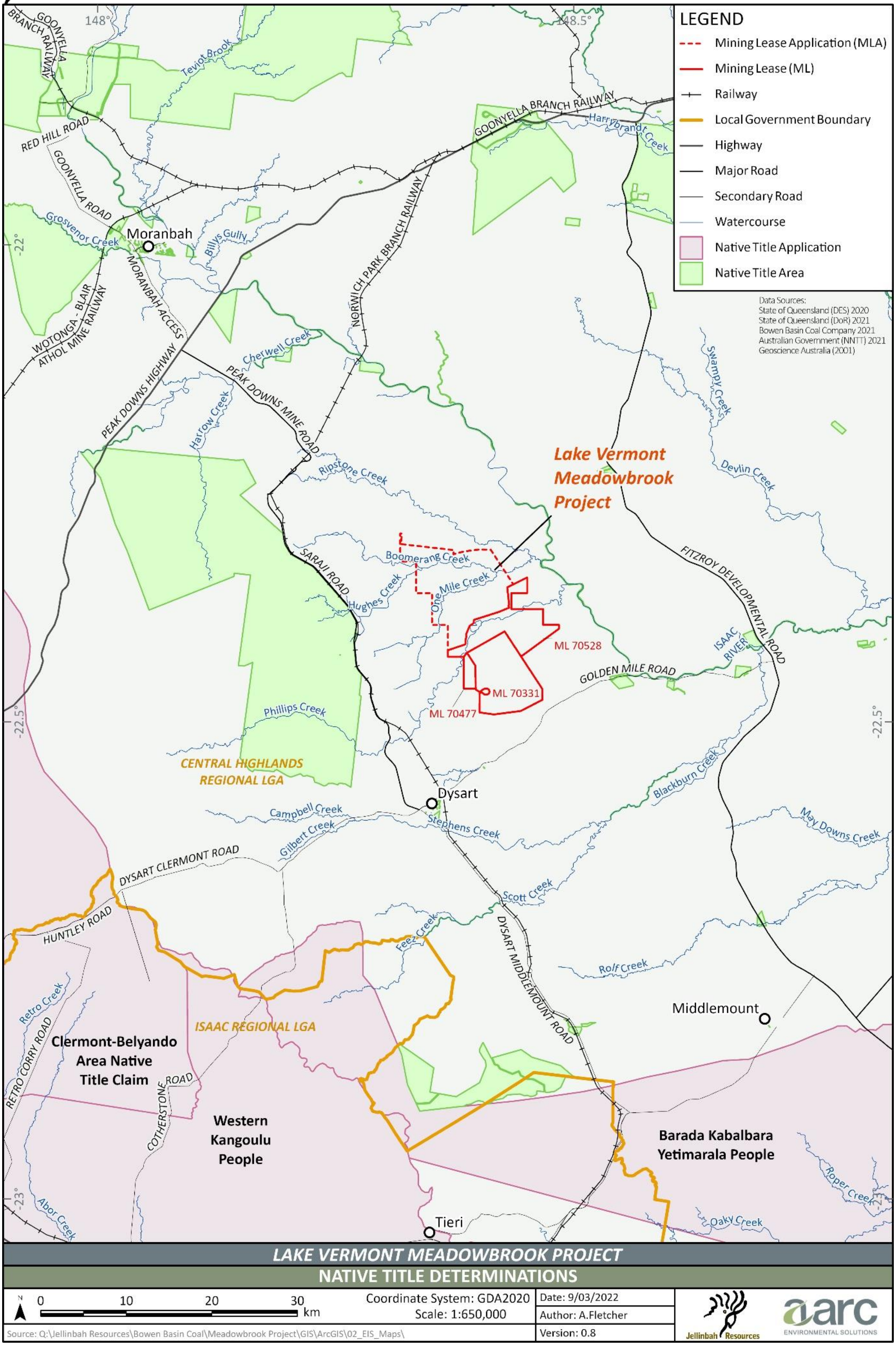

Figure 21.9: Native Title determinations

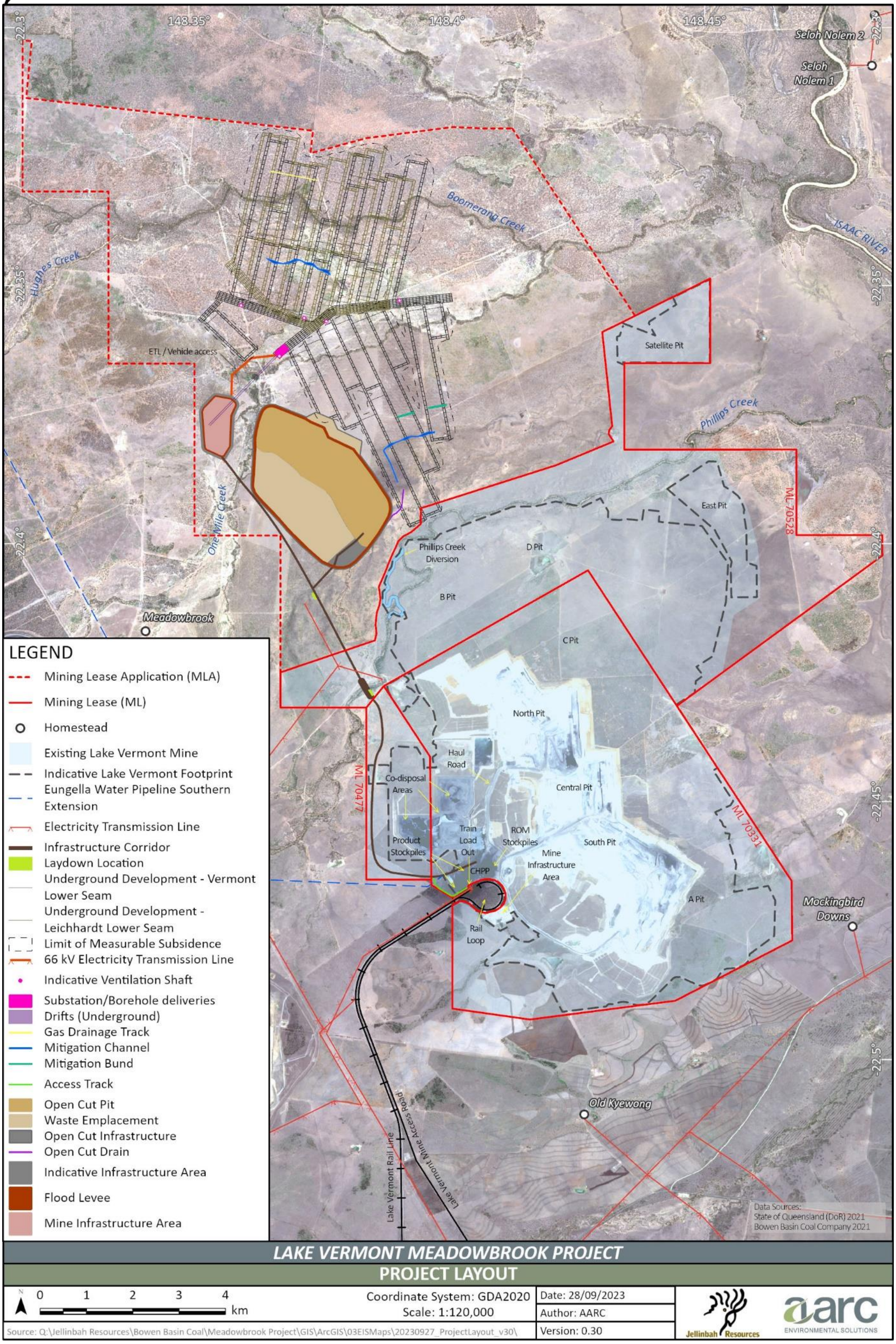

Figure 21.10: Project layout

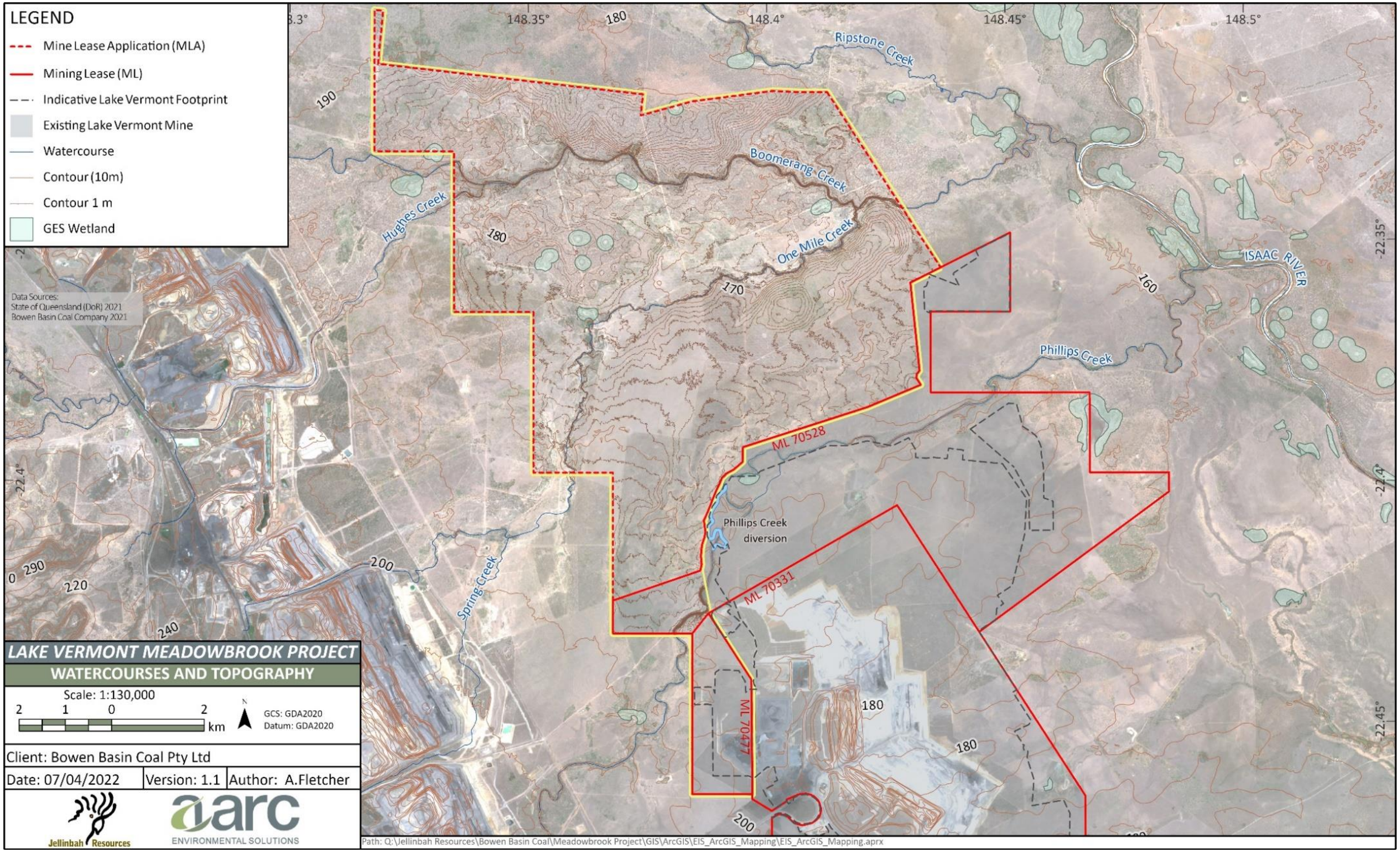

Figure 21.11: Project watercourses and topography

Similarly, the Saraji Mine has an existing diversion/levee on Phillips Creek (upstream of the proposed Project) with a further diversion of Phillips Creek having also been approved downstream as part of the Lake Vermont Mine operations (Figure 21.11). The Lake Vermont Mine diversion has not yet been constructed.

21.1.4.4 Geological overview

The Project is located in the western limb of Queensland's Bowen Basin, a north–south trending retro-arc basin that extends more than 250 km north to south and up to 200 km west to east. The Project lies at the eastern end of the Collinsville Shelf that is characterised by a thin accumulation of sediments gently dipping easterly, with minor structural deformations. The eastern boundary of the Collinsville Shelf occurs at the Isaac Fault, a major thrust fault which has throws of 150 m to 400 m in the Project area.

Figure 21.12 shows a geological map of the Project area that has been prepared by removing the Cainozoic (Quaternary and Tertiary) cover sediments revealing the faulted relationship between the underlying Permian and Triassic rocks of the Project area. Figure 21.12 is based on the Bowen Basin solid geology of Sliwa *et al.* (2008), except it has been modified by Project geologists (Minserve) based on geological drilling and interpretation within the Project area.

Figure 21.12 also shows a number of local scale faults that have been mapped from seismic and drilling data collected for the Project. Both normal and reverse faults have been identified by 3D seismic surveys, consistent with neighbouring mining areas in the Rangal Coal Measures. A higher number of reverse style structures occur closer to the Isaac Fault. These faults can be significant in terms of the deposit geology where the throws of the faults are in the order of 10 m to 15 m (having the potential to completely offset the coal seams). As the coal seams tend to be the conduits for groundwater flow in the Permian sediments, these faults also have the potential to disrupt groundwater flow. Geological faulting is discussed in further detail in Appendix A, Subsidence Assessment, Section 2.2.5.

The regional stratigraphy of the Bowen Basin contains a number of lateral equivalents that are referred to by different names in the northern and southern areas of the Bowen Basin. The stratigraphic relationship is summarised below in Table 21.1. The local stratigraphy of the Project area is discussed in detail in Section 21.11.

Table 21.1: Bowen Basin regional stratigraphy

Age	Group	Formation	
		Southern Bowen Basin	**Northern Bowen Basin**
Quaternary		Alluvium	Alluvium
Tertiary		Alluvium	Alluvium
		Main Range Basalt	Main Range Basalt
		Duaringa Formation	Duaringa Formation
Triassic	Rewan Group	Arcadia Formation	Arcadia Formation
		Sagittarius Sandstone	Sagittarius Sandstone
Late Permian	Blackwater Group	Rangal Coal Measures	Rangal Coal Measures
		Burngrove Formation	Fort Cooper Coal Measures
		Fairhill Formation	
		MacMillan Formation	Moranbah Coal Measures
		German Creek Formation	
Middle Permian	Back Creek Group	Ingelara Formation	Blenheim Formation

Within the Project area, the Permian and Triassic-age sediments of the Bowen Basin are overlain with a veneer of unconsolidated to poorly consolidated Tertiary and Quaternary sediments. The surface geology for the Project area is shown in Figure 21.13. The detail shown in Figure 21.13 is based on 1:100,000 scale digital geology of the region and Project area and indicates areas where Cainozoic sediments and basalt (to the west of the Project area) overlay the Permo–Triassic Bowen Basin sediments.

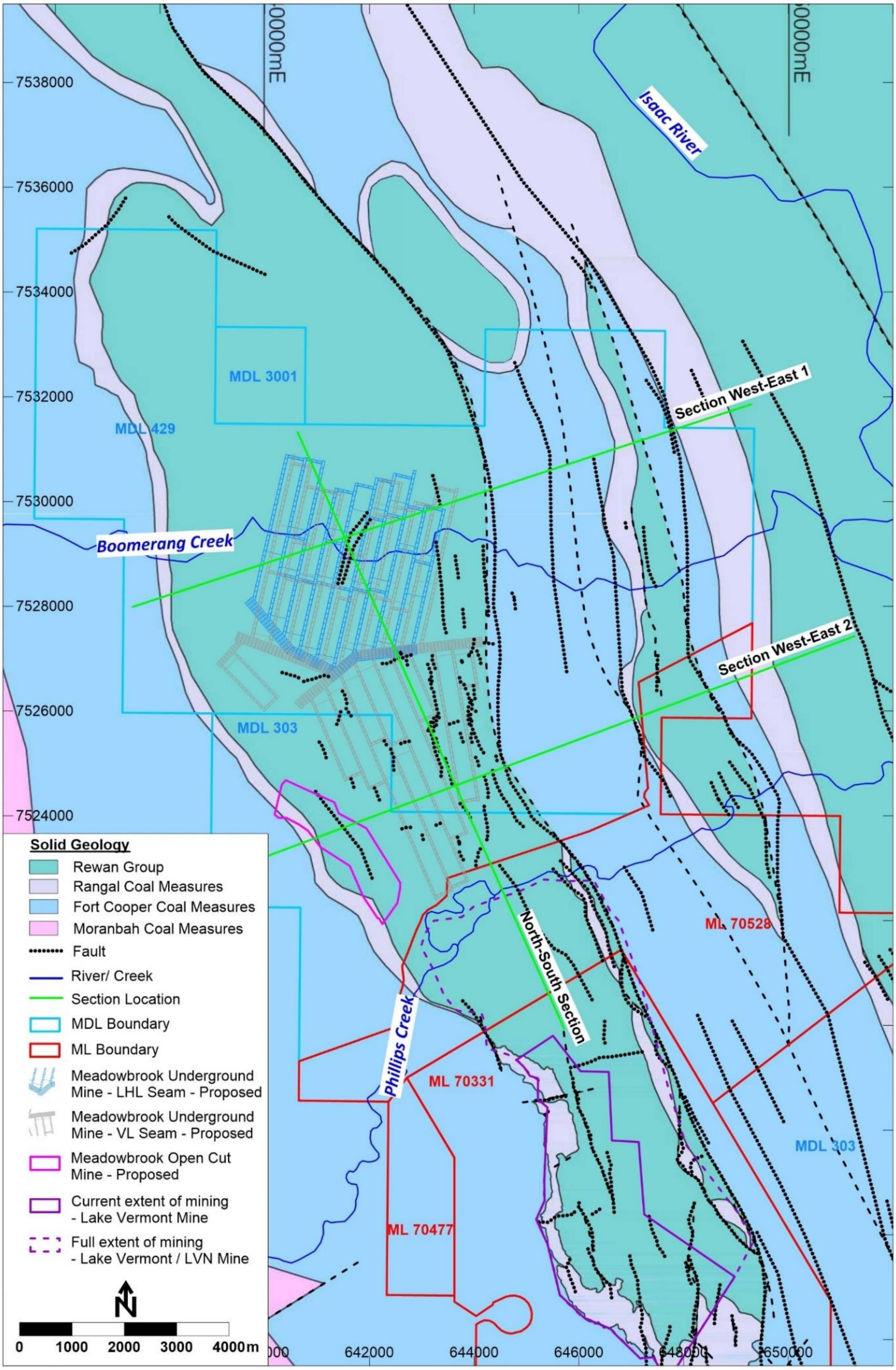

Figure 21.12: Geology of the Project site

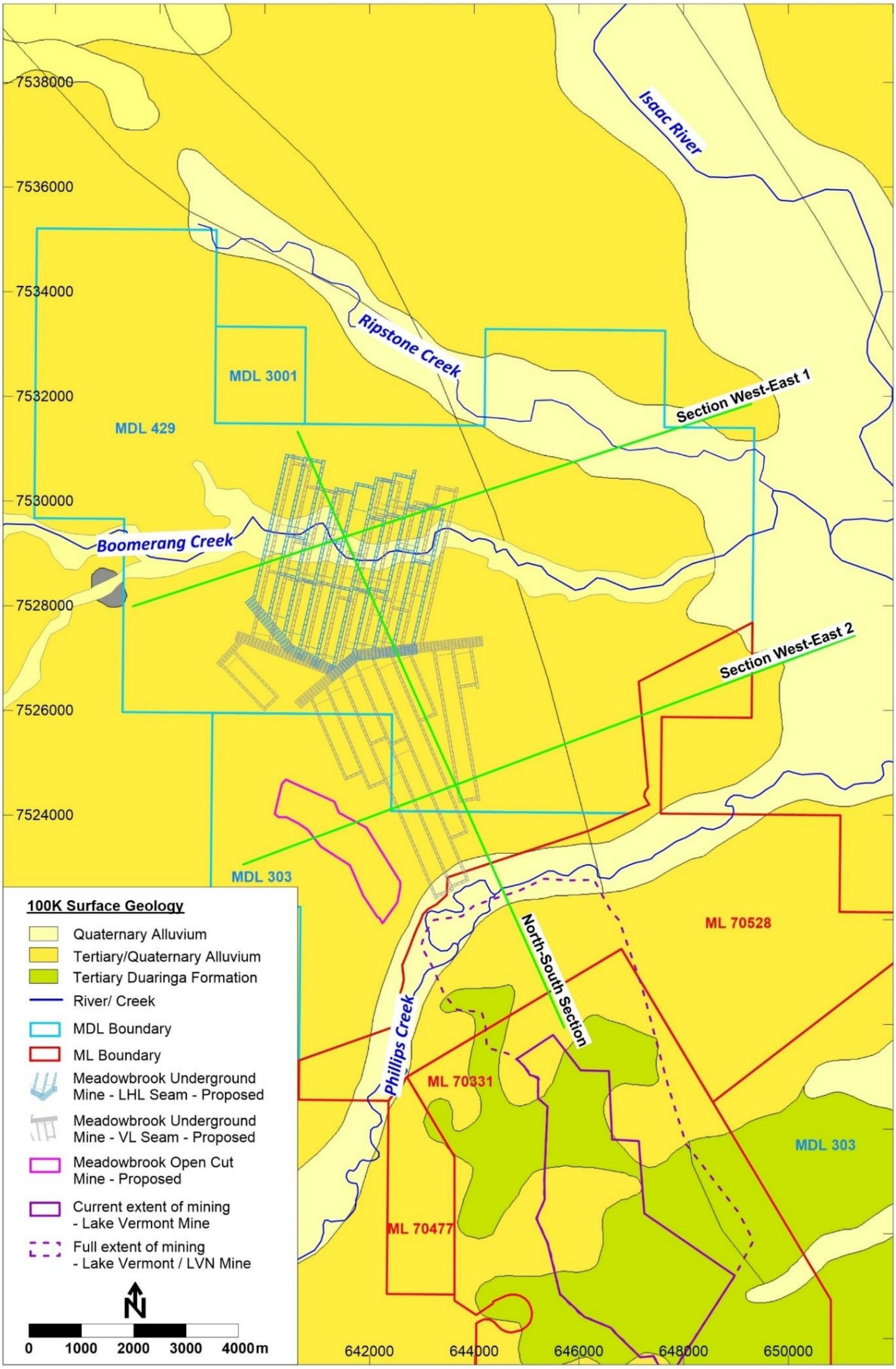

Figure 21.13: Surface geology of the Project site

Figure 21.12 and Figure 21.13 also identify the locations of geological cross-sections that have been undertaken for the Project (with two west–east sections oriented across strike and one north–south section that has been oriented through the central area of the proposed underground mining). The west–east sections are shown in Figure 21.14, with the north–south section shown in Figure 21.15. These sections have been prepared to assist the understanding of stratigraphic and structural relationships of the Project geology.

21.1.4.5 Exploration history and coal resource

The Lake Vermont Meadowbrook Project mining area is covered by closely spaced drill holes undertaken as part of successive exploration drilling programs. Exploration drilling has recorded the geological sequence of the overburden and coal seams, as well as the sediments immediately below the target seams. Geophysical logs are also available for the majority of boreholes and provide additional data on rock and coal seam properties. Both 2D and 3D seismic surveys have been carried out across the Project area, with the most recent 3D seismic survey conducted in 2020. The exploration program provides a high level of confidence in the geological variables within the Project area.

Economic coal seams at the Project occur within the Rangal Coal Measures, a sub-group of the Late Permian aged Blackwater Group. These coal seams are persistent, thick coal horizons with the following descending stratigraphic sequence:

- the Leichardt Seam and Leichardt Lower Seam; and
- the Vermont Seam and Vermont Lower Seam.

The Vermont Lower Seam extends across the Project underground mining area, while the Leichhardt Lower Seam is limited to the northern half of the underground mining area. Open-cut mining of the satellite pit will target the Vermont Lower Seam, Vermont Seam and Leichardt Seam.

The underground mining area is limited to the west due to increasing seam gradients as the target seams dip more steeply approaching the western sub-crop, reaching gradients of approximately 1:6. A limiting seam gradient of approximately 1:8 has been adopted to limit the western boundary of the underground footprint. The dip progressively flattens across the underground mining area towards the east to typical gradients of 1:20. This flattening of the seam with depth away from the sub-crop is characteristic of other deposits in the Rangal Coal Measures.

In the underground mining area, the thickness of the Vermont Lower Seam is typically between 3.0 m and 4.8 m, and the thickness of the Leichhardt Lower Seam is typically between 3.0 m and 5.0 m. The seams to be mined by open-cut methods typically range in thickness from 1.5 m to 4.0 m. The Project coal seams provide high-quality hard coking coal, PCI coal and an industrial coal product.

21.1.5 Background to the development of the action

21.1.5.1 Commonwealth requirements

A reconciliation of each of the Commonwealth MNES requirements listed within the Project Terms of Reference (ToR), as per Appendix 3 of the ToR, are provided for the Project, and where each requirement is addressed within this EIS is provided in Attachment 4, Matters of National Environmental Significance Reconciliation Table.

Reconciliation of the ‘Independent Expert Scientific Committee (IESC) Information Guidelines’ is provided in Attachment 3, Independent Expert Scientific Committee Guidelines Reconciliation Table.

21.1.5.2 Relationship to Lake Vermont Mine

The Lake Vermont Mine is an existing open-cut mining operation. The Project is a metallurgical coal development that provides for the continuation and extension of the Lake Vermont Mine, to the north of the existing operations, within the proposed MLA area (refer Figure 21.3 and Figure 21.10).

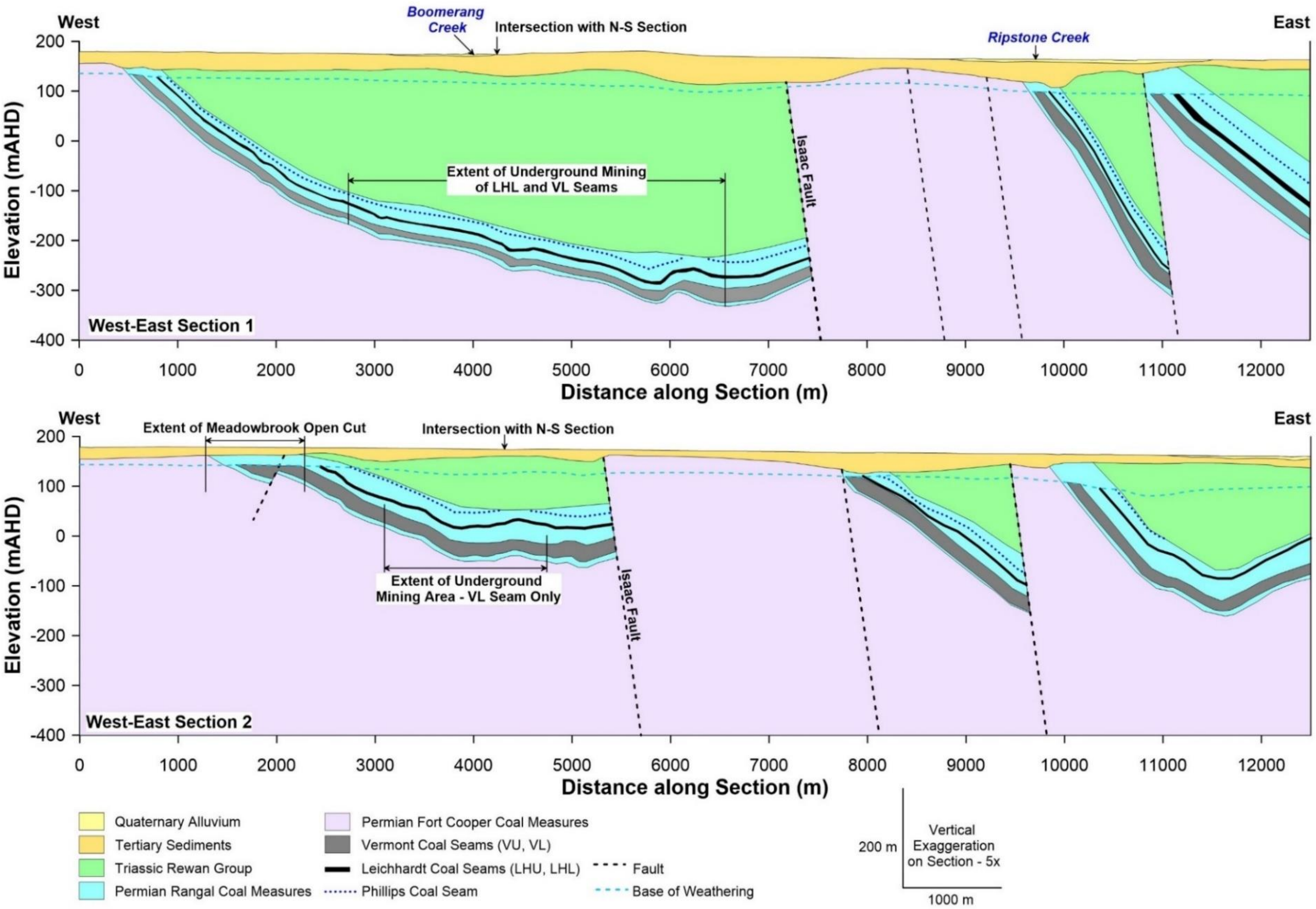

Figure 21.14: West–east geological cross-sections of the Project site

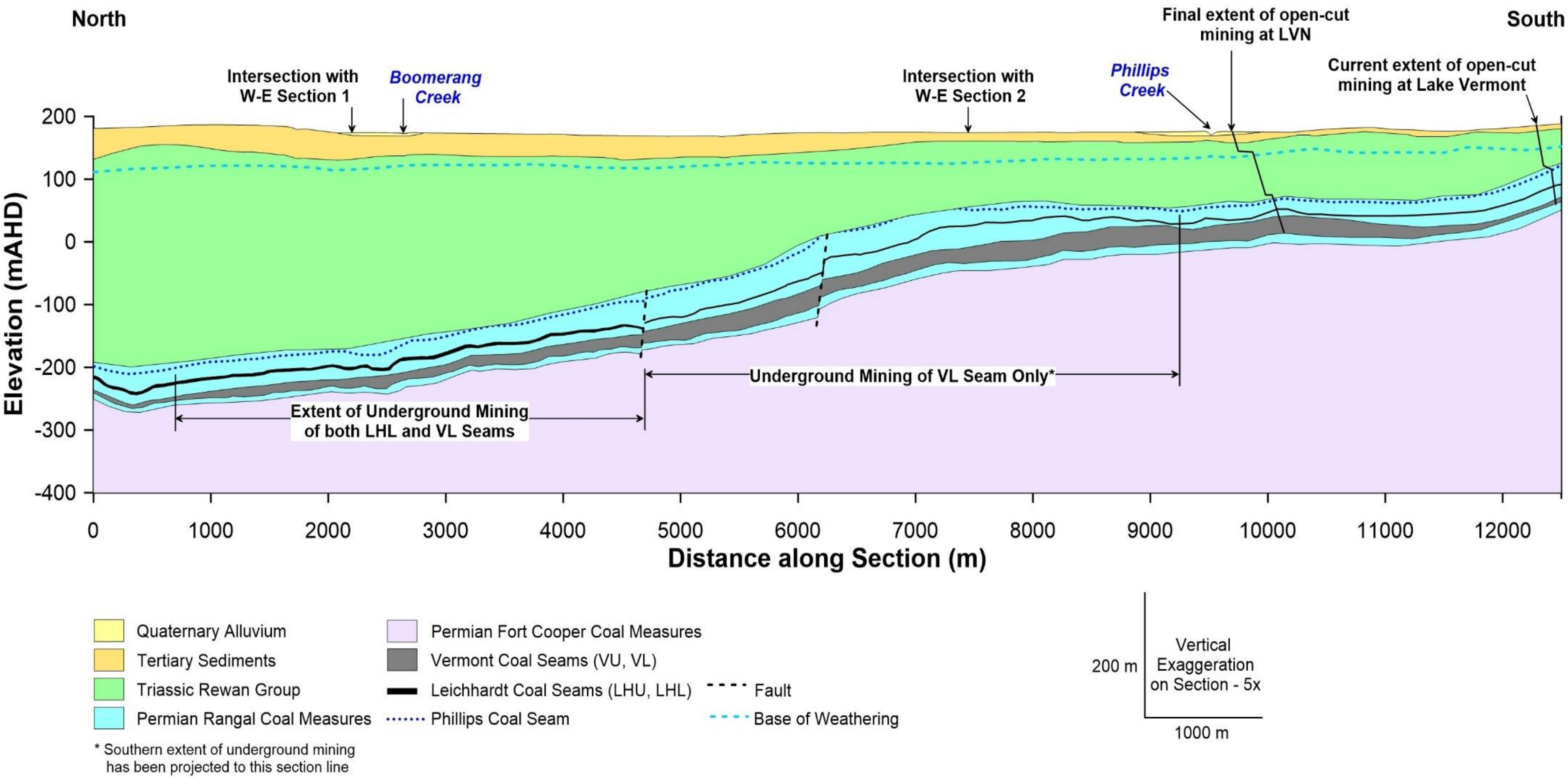

Figure 21.15: North–south geological cross-sections of the Project site

Approved open-cut mining operations at the existing Lake Vermont Mine will occur concurrently with the development and operation of the Project. The Project addresses the forecast reduction in coal production that will occur at the Lake Vermont Mine, by combining output from the existing open-cut operations and the Project extension. This will enable total coal production to be maintained at the currently approved output for an extended period (of approximately 20 years) while also increasing the existing mine life by approximately 30 years. Proposed Project mining and production rates are detailed in Section 21.2.1.

The Project is ideally positioned to efficiently meet the market demands for metallurgical coal, having access to the Lake Vermont Mine's existing infrastructure. The Project will maximise the use of this existing infrastructure to minimise environmental impacts from additional infrastructure. Existing infrastructure that will be utilised includes the Lake Vermont Mine CHPP, coal handling facilities, train load-out facilities, product coal stockpiles, co-disposal coal reject facilities and other supporting infrastructure.

21.1.5.3 Relationships of other mining projects

Existing (i.e. approved) and proposed nearby major resource projects include (Figure 21.3):

- Saraji Mine approximately 5 km to the west;
- Saraji East Project (proposed) on land adjoining the western boundary of the Project;
- Olive Downs approximately 2 km to the north and Olive Downs North approximately 40 km to the north;
- Winchester South Project (proposed) approximately 8 km to the north-northwest;
- Eagle Downs approximately 13 km to the north-west;
- Vulcan Complex approximately 20 km to the north-west;
- Peak Downs approximately 25 km to the north-west;
- Daunia approximately 35 km to the north;
- Caval Ridge approximately 45 km to the north-west;
- Poitrel approximately 35 km to the north;
- Millennium approximately 40 km to the north;
- Isaac Downs approximately 40 km to the north-west;
- Moranbah South approximately 45 km to the north-west; and
- Isaac Plains East and Isaac Plains East expansion approximately 50 km to the north-west.

21.1.6 Environmental impact assessment process

In July 2019, Bowen Basin Coal applied to the Department of Environment and Science (DES) under sections 70 and 71 of the EP Act for approval to voluntarily prepare an EIS. This application was supported by the preparation of an Initial Advice Statement, outlining the resource, operations and infrastructure of the proposed Project. Under section 72 of the EP Act, DES approved the application on 26 August 2019.

On 22 November 2019, the now Commonwealth Department of Agriculture, Water and the Environment (DAWE) determined the Project (EPBC Referral 2019/8485) to be a controlled action under the EPBC Act, with the controlling provisions being sections 18 and 18A (listed threatened species and communities), sections 20 and 20A (listed migratory species) and sections 24D and 24E (a water resource, in relation to coal seam development and large coal mining development). At this time, the DAWE also established that the Project assessment could proceed under the bilateral assessment agreement process. To support this, the DAWE provided specific requirements which were included within the final ToR established by the DES.

21.1.6.1 Terms of reference

The ToR for the Project were finalised on 30 April 2019. A three-month extension to the EIS submission period was granted on 14 April 2022, prior to the expiry of the initial two-year EIS submission period. This has provided for an EIS submission timeframe of no later than 01 August 2022.

The ToR is provided in full in Attachment 1, Terms of Reference of this EIS. A detailed reconciliation table indicating where the ToR are addressed in the EIS is provided as Attachment 2, Terms of Reference Reconciliation Table.

21.1.6.2 EIS preparation

This EIS has been prepared to ensure that sufficient information is provided to the DES (and the DAWE) 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.

Technical assessments 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, the information provided throughout these assessments will be utilised to support secondary approvals, such as water licences.

A flowchart of the Queensland EP Act EIS process (and linkages to the parallel Mining Lease application process) is provided in Figure 21.16.

21.1.6.3 Public consultation process

Public consultation has been undertaken in accordance with the ToR and in consideration of the Queensland 'Preparing an environmental impact statement: Guideline for proponents' (Department of State Development, 2020). Public consultation is described in Section 21.16.

21.1.6.4 Other approvals and conditions

The primary approvals required for the Project include:

- an amendment of the existing site-specific EA for the Lake Vermont Mine, as an outcome of the EIS, which identifies the applicable 'Environmentally Relevant Activities' (ERAs) that will be authorised to be conducted on-site under the EP Act;
- approval of the Project as a 'controlled action' under the EPBC Act; and
- the granting of the required ML(s) for the Project under the *Mineral Resources Act 1989* (MR Act).

The EA is issued by the DES and is required before operations may commence, ensuring that the proponent has taken measures to avoid, minimise and/or mitigate potential environmental impacts. The EA will regulate construction, operation and closure requirements, which must be adhered to throughout the conduct of the approved activities.

A ML is also required to authorise the Project. In Queensland a ML approval is issued by the Department of Resources (DoR) under the MR Act and the Mineral Resources Regulation 2013 (Qld). The granting of a ML entitles the holder to machine-mine specified minerals and carry out activities associated with, or promoting, mining activities. The ML application process is linked to the EA application process, as shown in Figure 21.16.

Beyond these key statutory approvals, there is also a broad network of legislation and regulation which govern the Project's development and operation. Relevant legislation identified for the Project at the time of EIS preparation is provided in Table 21.2.

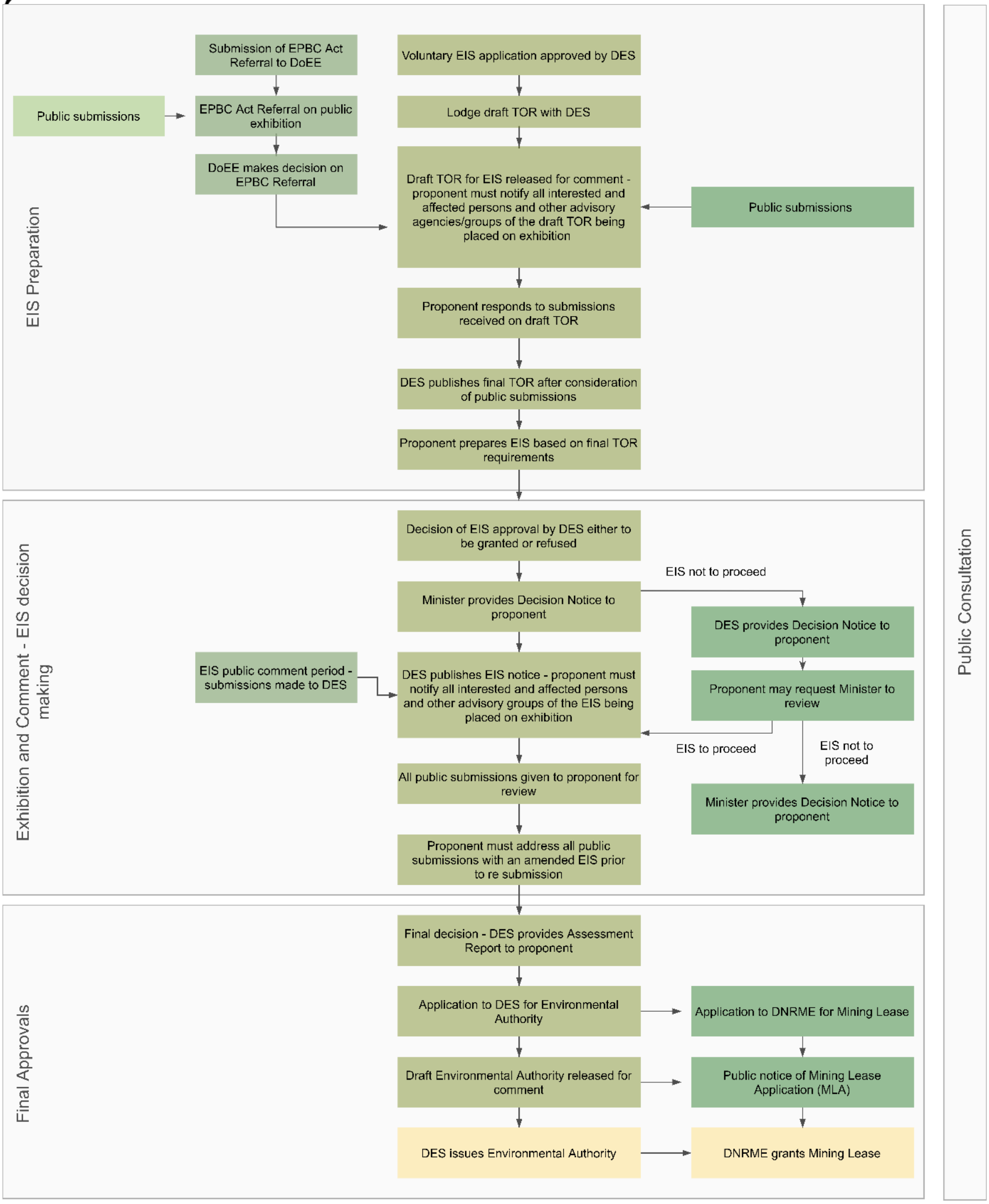

Figure 21.16: EIS process flowchart

Table 21.2: Relevant Commonwealth and State government legislation and policies

Relevant area	Administering Authority	Legislation relevant to the Project
Commonwealth legislation		
Environmental values	DCCEEW	*Environment Protection and Biodiversity Conservation Act 1999*
Emissions reporting	DCCEEW	*National Greenhouse and Energy Reporting Act 2007*
Cultural heritage	NNTT	*Native Title Act 1993*
Queensland legalisation and associated subordinate legislation		
Environmental values	DAF	*Biosecurity Act 2014*
	DES	*Environmental Offsets Act 2014* Environmental Offsets Regulation 2014 Queensland Environmental Offsets Policy Significant Residual Impact Guidelines
	DES	*Environmental Protection Act 1994* Environmental Protection Regulation 2019 Environmental Protection (Air) Policy 2019 Environmental Protection (Noise) Policy 2019 Environmental Protection (Water and Wetland Biodiversity) Policy 2019
	DAF	*Fisheries Act 1994*
	DES	*Nature Conservation Act 1992* Nature Conservation (Protected Areas) Regulation 1994 Nature Conservation (Animals) Regulation 2020 Nature Conservation (Plants) Regulation 2020
	DoR	*Soil Conservation Act 1986*
	DoR	*Vegetation Management Act 1999*
	DRDMW	*Water Act 2000* Water Plan (Fitzroy Basin) 2011 Fitzroy Basin Resource Operations Plan 2011 Fitzroy Basin Water Management Protocol June 2018
Cultural heritage	DES	*Queensland Heritage Act 1992*
	DSDSATSIP	*Aboriginal Cultural Heritage Act 2003*
Development and planning	DEPW	*Building Act 1975*
	DEPW	*Electricitity Act 1994*
	DEPW	*Planning Act 2016*
	DEPW	*Plumbing and Drainage Act 2018*
	DSDILGP	*Regional Planning Interests Act 2014*

Relevant area	Administering Authority	Legislation relevant to the Project
	Coordinator-General/DSDILGP	*State Development and Public Works Organisation Act 1971*
	DSDILGP	*Strong and Sustainable Resource Communities Act 2017*
	DTMR	*Transport Infrastructure Act 1994*
	DTMR	*Transport Operations (Road Use Management) Act 1995* Transport Operations (Road Use Management—Dangerous Goods) Regulation 2018
	DES	*Waste Reduction and Recycling Act 2011*
Natural resources	Resources Safety and Health Queensland	*Explosives Act 1999* Explosives Regulation 2017
	DAF/DES	*Forestry Act 1959*
	DoR	*Mineral and Energy Resources (Common Provisions) Act 2014*
		Mineral Resources Act 1989 Mineral Resources Regulation 2013
	Queensland Treasury	*Mineral and Energy Resources (Financial Provisioning) Act 2018* Mineral and Energy Resources (Financial Provisioning) Regulation 2019
Human health and wellbeing	Resources Safety and Health Queensland	*Coal Mining Safety and Health Act 1999* Coal Mining Safety and Health Regulation 2017
	Department of Education	*Electrical Safety Act 2002*
	QFES	*Fire and Emergency Service Act 1990*
	Department of Education	*Work Health and Safety Act 2011*
Land and government	DoR	*Land Act 1994*
	DoR	*Land Title Act 1994*
	DSDILGP/Isaac Regional Council	*Local Government Act 2009*
Native title	DoR	*Native Title Queensland Act 1993*
Human rights	Queensland Human Rights Commission	*Human Rights Act 2019*

21.2 Description of the action

21.2.1 Project overview

The Lake Vermont Meadowbrook Project represents an extension of mining activities at the existing Lake Vermont Mine, involving underground longwall mining and open-cut mining activities and supporting infrastructure.

The key components of the Project include:

- underground longwall mining of the Leichhardt Lower Seam and Vermont Lower Seam; the depth and thickness of the coal seams in the Project area means the coal resource can be extracted using underground mining methods;
- an open-cut pit to mine the Leichhardt Lower Seam, Vermont Seam and Vermont Lower Seam;
- development of a Mine Infrastructure Area (MIA);
- development of a new infrastructure corridor linking the MIA to existing infrastructure at the Lake Vermont Mine;
- extensions of existing infrastructure supplying electricity and water supplies;
- construction of drifts and portal to provide access to underground operations; and
- development of other supporting infrastructure and associated activities.

The Project involves the extraction of up to 7 Mtpa of ROM coal, equivalent to approximately 5.5 Mtpa of metallurgical product coal (for the export market). The Project addresses the forecast reduction in coal output that will occur at the Lake Vermont Mine, by combining output from the existing, approved open-cut operations and the Project extension. This will enable total coal production to be maintained at the currently approved output for an additional period of up to 20 years, over a total mine life of approximately 53 years (including final rehabilitation).

The Project maximises the use of Bowen Basin Coal owned land and Infrastructure at the Lake Vermont Mine to minimise the environmental impacts from additional infrastructure and provide Project efficiencies.

The Lake Vermont Accommodation Village in Dysart is proposed to be expanded to support the Project's construction and operational stages. The accommodation village expansion requires local government development approval, which is being sought from the Isaac Regional Council.

21.2.2 Project timing

Construction and mine development activities are scheduled to commence subject to and following the approval of the proposed amendments to the environmental authority (EA) and granting of the ML.

Project Years are referenced throughout this environmental impact statement (EIS) in preference to relating milestones to calendar years. This facilitates uncertainties associated with future approval timings—in other words, should the Project commence later than anticipated, Project Years will remain relevant, whereas calendar years will not.

For consistency throughout this EIS, construction for the underground extension is forecast to commence in fiscal Year 2024 (being Project Year -1) and will continue for a period of approximately 24 months (throughout Project Year -1 and Project Year 0). Details of proposed construction activities are provided in Section 21.2.3.

In-seam development of the underground headings up to the commencement of longwall extraction will be undertaken in Project Year 1 and Project Year 2, with the commencement of longwall mining operations commencing in Project Year 3.

Mining of the Project open-cut satellite pit will not commence until Year 20, and will have a life of 11 years.

The combined underground and open-cut resource areas will support a production life of approximately 30 years—commencing in Year 1 (indicatively 2026) and completing in Year 30 (indicatively 2055). Details of the proposed schedule of operations, including production quantities, mining progression and stage plans, are provided in Section 21.2.4.1.

Progressive rehabilitation will occur throughout the life of the Project, with final rehabilitation and achievement of a stable post-mining land use (grazing) anticipated in Project Year 53 (indicatively 2078). Further details of the rehabilitation and closure of the Project is provided in Chapter 6, Rehabilitation.

21.2.3 Construction

The Project has been designed to integrate with the existing Lake Vermont Mine infrastructure to maximise mine efficiency and minimise environmental impacts.

Key Project construction activities include the development of:

- an infrastructure corridor to provide for site access, coal haulage, power supply, water supply and telecommunications;
- an MIA;
- underground mine access portals, drifts and ventilation shafts and fans;
- an ROM coal conveying and handling system;
- infrastructure for electricity supply;
- infrastructure for water supply; and
- mine water management infrastructure.

A description of the key components of the construction/development activities is provided in the following Sections.

21.2.3.1 Infrastructure corridor

An infrastructure corridor will be constructed to connect the Project MIA to the existing infrastructure at the Lake Vermont Mine. The infrastructure corridor will enable the delivery of electricity, water and telecommunications to the Project, provide personnel and materials access and facilitate the delivery of ROM coal to the ROM pad at the Lake Vermont Mine.

The infrastructure corridor will include the following constructions:

- a haulage road for personnel, materials and coal haulage;
- watercourse crossings at Phillips Creek and One Mile Creek;
- an overhead 66kV electricity transmission line (ETL);
- a raw water supply pipeline;
- two laydown areas to support construction activities; and
- telecommunications infrastructure.

Various route options for the infrastructure corridor have been assessed in consideration of safety, environmental and existing Lake Vermont Mine operational requirements and are described in detail in Section 21.8.4. The proposed alignment of the infrastructure corridor has been selected to minimise disturbance to remnant vegetation, Phillips Creek and One Mile Creek, and to allow for the integration of ROM coal haulage with the existing operations. Consideration of the floodplain extent has also been afforded to the final alignment proposed, with the haul road construction anticipated to slightly modify the local flooding profile (as detailed in Section 21.10.7). The proposed infrastructure corridor is shown in Figure 21.10. The infrastructure corridor is 45 m wide.

Construction of the access/coal haulage road and associated stream crossings within the infrastructure corridor are described in Section 21.2.3.2.

Construction of the proposed 66kV ETL and raw water supply pipeline is described in Section 21.2.3.7 and Section 21.2.3.8, respectively. Telecommunications infrastructure is described in Section 21.5.

21.2.3.2 Access/Coal haulage roads

The primary external access to the Project site will be *via* the existing Lake Vermont Mine Access Road. This access will be used for personnel, equipment and material deliveries.

Construction of the internal Project access/haulage road within the 45 m wide infrastructure corridor will be one of the first construction activities to commence, to facilitate the subsequent construction of the underground drifts and portal.

The internal Project access/haulage road will be a sealed bitumen road to support haulage of ROM coal from the MIA to the existing Lake Vermont Mine ROM stockpiles (*via* road-train). This sealed haulage road will also facilitate access to the Project for personnel and materials (Figure 21.10). The coal haulage road design will incorporate a loop at the MIA ROM coal stockpile area and a loop at the existing Lake Vermont Mine ROM pad to facilitate ROM coal loading and unloading.

Conceptual cross-sections of the Project access/haulage road (representing both fill and cut sections) are provided in Figure 21.17.

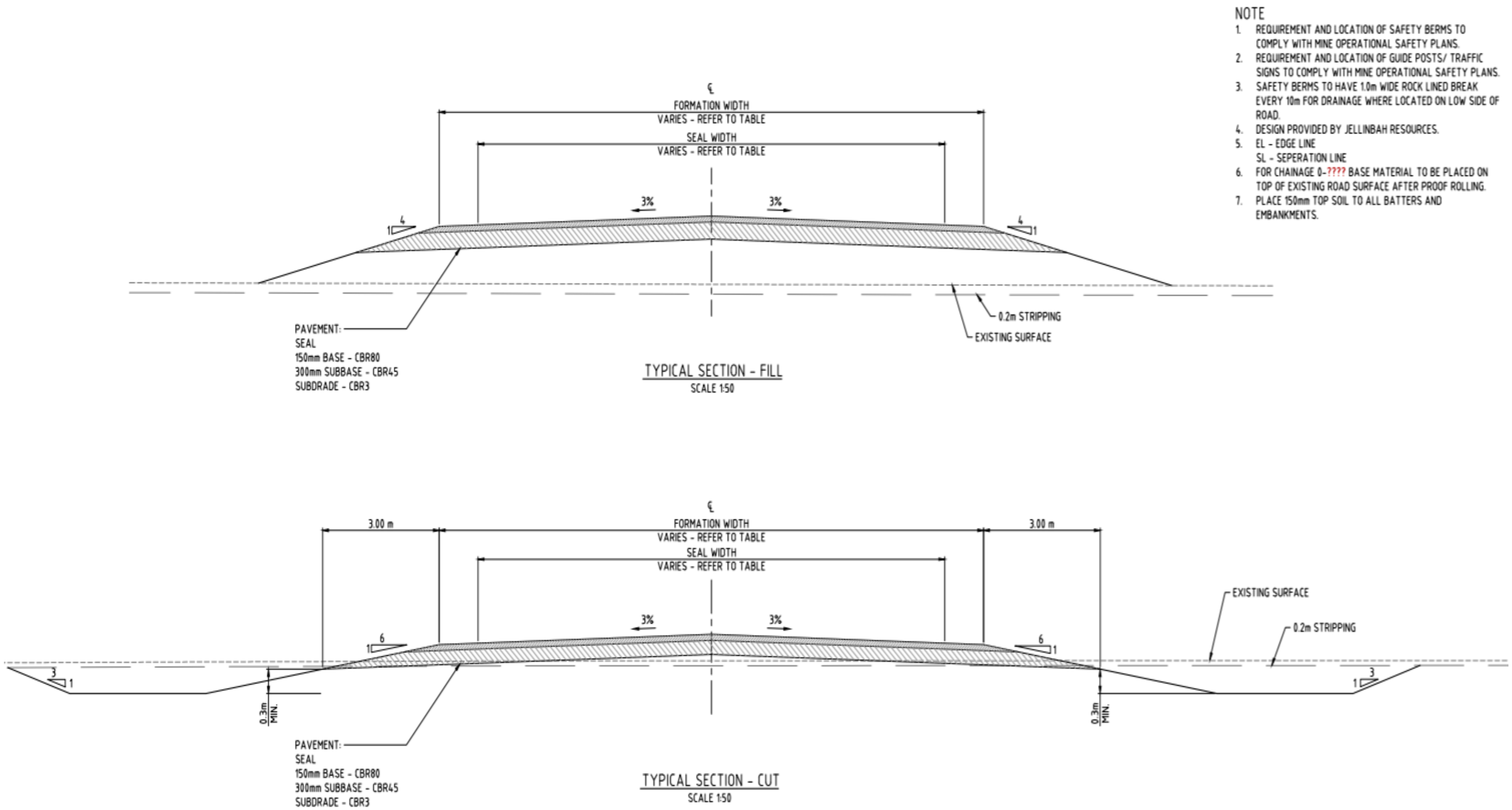

Figure 21.17: Conceptual cross-sections of the Project access/haulage road

21.2.3.3 Stream Crossings

Construction of the access/coal haulage road will require stream crossings of Phillips Creek and One Mile Creek (Figure 21.10). Stream crossings will be constructed as causeways with appropriately-sized culverts to pass low flows. Conceptual design plans for the Phillips Creek and One Mile Creek crossings are shown in Figure 21.18.

Causeways are anticipated to be under water for approximately five days per annum. The vertical alignment has been designed for a maximum of 300 mm overtopping in a minor flow of 50% Annual Exceedance Probability (AEP)–Q2. This level of outage of the haul road is considered an acceptable impact to operations.

The causeway length for the One Mile Creek crossing will be approximately 164 m. It will be a concrete construction, with an underlying box culvert 750 mm wide x 600 mm high (Figure 21.18). The causeway length for the Phillips Creek crossing will be approximately 17.5 m. It will be a concrete construction, with two underlying box culverts 3600 mm wide x 1800 mm high (Figure 21.18). The sizing differences of these two causeways is representative of the different channel and bed structures of the two watercourses, as well as the respective flow regimes.

It is noted that the disturbance required to support construction of the Phillips Creek crossing will be approximately 100 m wide. This width is primarily required to facilitate excavation and grading of the channel bed to maintain existing flow velocities through this section of the stream (including the proposed culverts). Revegetation works will be undertaken as part of culvert construction activity, with causeways and culverts to remain post-mine closure. Construction activities will be undertaken during the dry season to minimise erosion and sediment mobilisation and ensure time to generate stability prior to wet season flows.

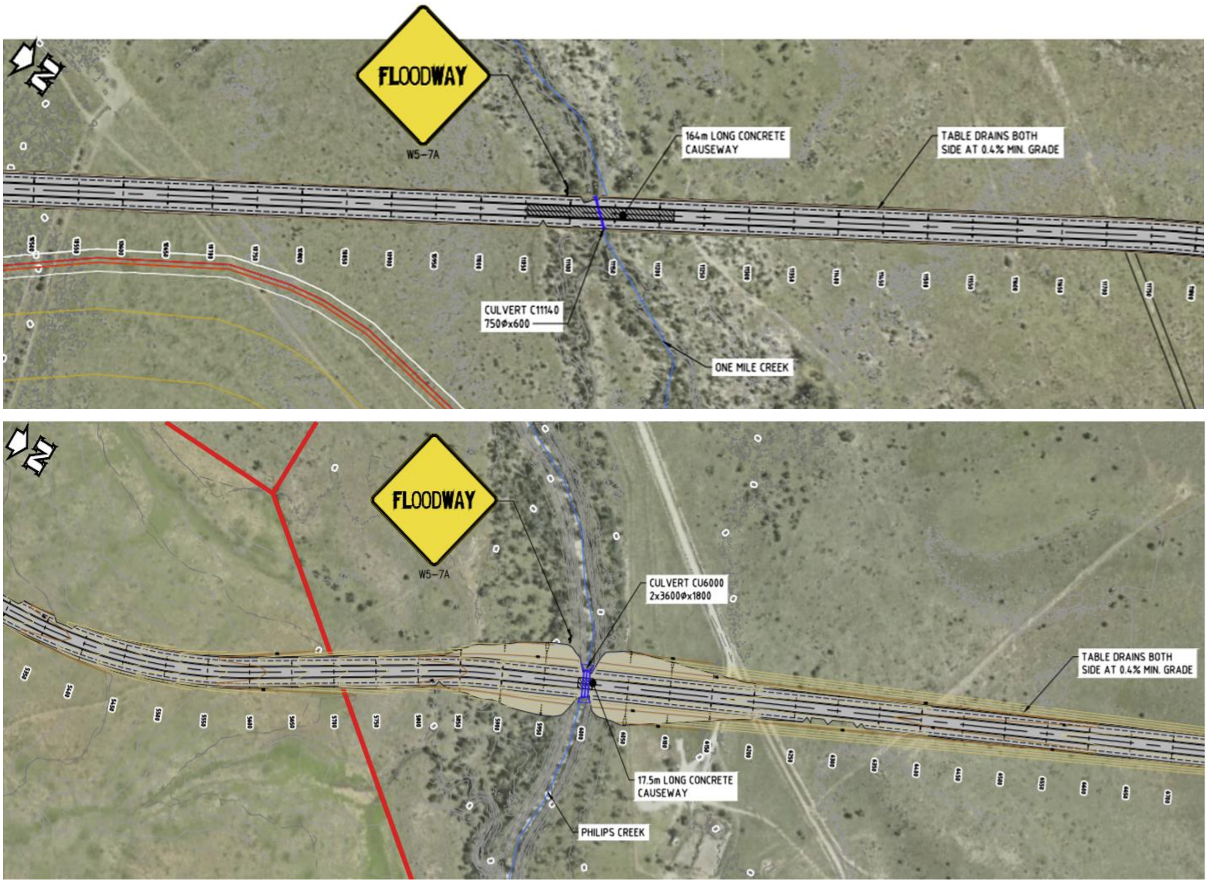

Figure 21.18: Conceptual designs of the Phillips Creek and One Mile Creek Crossings

21.2.3.4 Mine infrastructure area

The MIA will be constructed within the footprint shown in Figure 21.10 and include the following key components:

- mine administration and operations buildings, including crib room, ablution, first aid and emergency management facilities;
- bathhouse facilities;
- warehouse and stores compound;
- equipment hardstand and laydown areas;
- equipment maintenance workshop and service bays;
- diesel storage and refuelling bay;
- underground transport mustering area;
- underground portal access to a personnel and transport drift, as well as a conveyor drift;
- ROM coal stockpile and associated infrastructure, including coal haulage loading area;
- raw water and mine water dams;
- flood protection levee;
- electricity distribution infrastructure;
- diesel backup generator;
- main surface fan installation;
- potable water treatment plant;
- sewage treatment plant (STP) and effluent irrigation areas; and
- other associated minor ancillary infrastructure.

The location for the MIA has been chosen in consideration of proximity and access to the underground mining area and the open-cut pit to ensure appropriate clearance for blasting operations and minimise disturbance to remnant vegetation and environmentally sensitive areas.

It is noted that the entire footprint of the MIA is assumed to be disturbed for the purposes of impact assessment. While it is unlikely that the entire MIA will be subject to ground disturbance, this conservative assessment approach enables some flexibility in final placement of infrastructure within the MIA footprint.

The proposed layout of the MIA is shown in Figure 21.19. As the MIA site is relatively flat, limited earthworks will be required. A levee is proposed to be constructed around the perimeter of the MIA (for flood protection). Levee design is based on protecting infrastructure within the MIA during flooding events (1:1,000 AEP), including protection of water ingress into the underground mine. MIA levee construction is discussed further in Section 21.10.6.1.

21.2.3.5 Underground drifts and portal

Two underground drifts and associated portals (providing the surface entrance to the underground drift tunnels) are proposed to be constructed within the MIA (Figure 21.19). One drift will provide underground access for the transportation of personnel, mining equipment and materials, while the other drift will house the main coal clearance conveyor to convey ROM coal from underground to the ROM coal stockpile within the MIA.

A number of surface-to-seam boreholes will be developed vertically above the pit bottom area for the purposes of providing key materials to the underground (e.g. concrete supplies, stonedust, etc.). Additionally, three surface-to-seam boreholes will be developed at this location to deliver power to the underground. These boreholes will all be within the substation footprint, as shown in Figure 21.10.

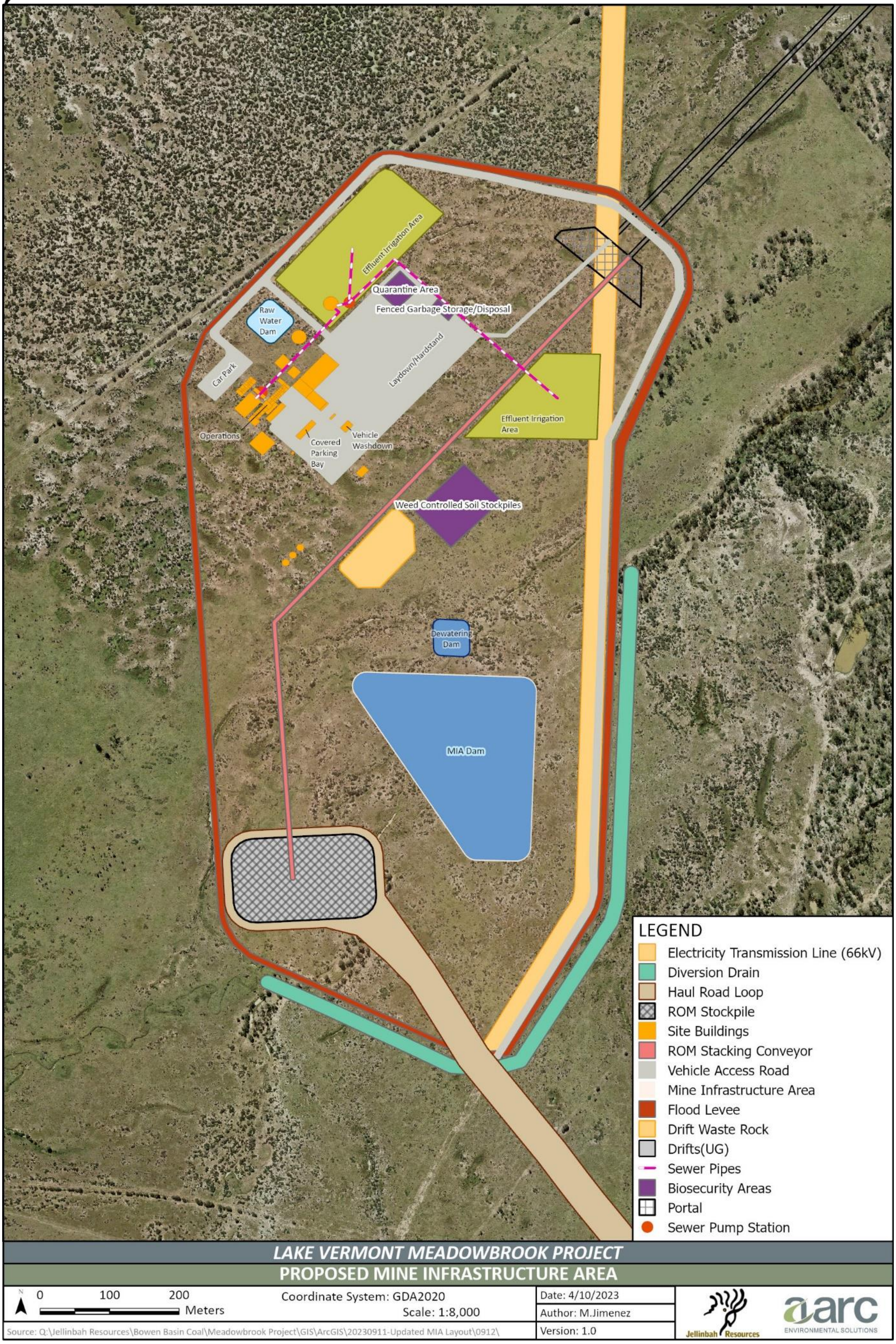

Figure 21.19: Proposed layout of the mine infrastructure area

Due to the long lead time involved in constructing the underground drifts (i.e. approximately 24 months), development of the portals and drifts will commence as soon as the infrastructure corridor construction enables the transport of materials and heavy equipment to the site. Construction of the water pipeline and electricity infrastructure will immediately follow the corridor development to deliver power and water to the MIA.

To enable equipment access to the portal construction site and to establish the working area for the construction of the portal, ground disturbance will be required. Impacts to ecological values resultant of clearing for MIA development (including the drift portal) are detailed in Section 21.12.

Portal establishment will involve the following steps:

- developing a drift construction pad;
- excavating the portal area to establish a highwall;
- pouring a concrete roadway floor and installing pre-formed concrete portal culvert structures and grouting these to the highwall;
- backfilling the portal excavation and re-topsoiling;
- installing temporary construction ventilation fans and temporary conveyors; and
- installing temporary diesel-powered generator(s) adjacent to the portal.

Diesel-powered generators adjacent to the portal will be used to supply the electricity demand of the drift construction equipment prior to the site electricity infrastructure being developed. Temporary ventilation fans will be installed to maintain suitable air quality at the working face of the drifts.

A road header will be used to excavate the drifts. Temporary conveyors will be operated to transport waste rock material from the road header to the surface where it will be deposited in the temporary stockpile near the portal entrance.

Over the 24 months of drift construction, it is estimated that 100,000 m^3 of waste rock will be produced. This waste rock material will be stockpiled within the MIA (close to the portal entrance) and be utilised for Project construction activities (e.g. for the laydown areas at the MIA). Waste rock material that cannot be utilised on-site for construction and development activities will be disposed of in the Project open-cut pit (as part of backfilling operations).

The indicative layout of the underground drifts once the portal has been established is shown in Figure 21.19. The underground drifts will be approximately 4.7 m high by 6.5 m wide and 2,000 m in length. Both drifts will be constructed with a gradient of 1:8 and intersect the Vermont Lower Seam at a depth of approximately 240 m (pit bottom).

The underground drifts and portal will be designed and constructed in accordance with the 'Coal Mine Safety and Health Regulation 2017'.

21.2.3.6 Ventilation systems

An upcast ventilation shaft will be sunk to intersect the pit bottom area at a depth of approximately 240 m. The shaft will be sunk using blind bore technology, be concrete lined and constructed in parallel with the drift construction.

The main mine ventilation fans will be positioned on the shaft collar and provide a ventilation capacity of approximately 250 cubic metres per second. The fans will be commissioned once an initial pit bottom underground roadway is driven to link the drifts to the base of the shaft. The pit bottom shaft and fans will provide sufficient ventilation capacity for the initial years of in-seam development and early longwall operation. Additional ventilation shafts will be sunk, and fan relocations will occur during the life of the underground mine to ensure adequate ventilation is maintained. Ventilation shafts will be located adjacent to existing tracks to minimise the ground disturbance required. Indicative locations of ventilation shafts are provided in Figure 21.10.

Approximately 2,500 cubic metres of in situ rock material will be excavated from the construction of each ventilation shaft, with excavated material to be used to build the site pad and/or bunding around the ventilation shafts. At mine closure, waste rock will be utilised to backfill ventilation shafts.

A range of equipment will be required to construct the ventilation shaft and fan assembly, including a blind bore rig and support vehicles, front-end loader and various other light and heavy vehicles.

21.2.3.7 Electricity supply infrastructure

As described in Section 21.2.3.1, a 66 kV ETL will be constructed within a 20 m easement within the infrastructure corridor. The 66 kV ETL will be constructed from the existing Lake Vermont substation at the Lake Vermont Mine (adjacent to the CHPP) to a new 66 kV/22 kV electrical substation to be located above pit bottom, as shown through Figure 21.10. As required, the new electrical substation will distribute power around the MIA by above and below ground 22 kV ETLs.

The electricity supply from the electrical substation will be stepped down via a transformer to power the ventilation fan (6.6 kV) and supply electrical demand to the underground mine operations via 11 kV cables down surface-to-seam boreholes. Underground electricity supply will generally be stepped down to 3,300 V for the longwall face machinery and 1,000 V for development face machinery for other mining activities.

Diesel-powered generators and/or solar power units will be used during construction to supply electricity prior to the electricity infrastructure being developed.

21.2.3.8 Water supply and management infrastructure

Raw water supply pipeline

A raw water supply pipeline will be constructed within the infrastructure corridor, co-located with the ETL in a 20 m wide easement. The raw water supply pipeline will connect to the existing raw water supply pipeline at the Lake Vermont Mine that sources water from the Eungella Water Pipeline Southern Extension. The raw water supply pipeline, approximately 12 km long, will transfer raw water to a Raw Water Dam within the MIA, from which water will be pumped to a water treatment plant. Water demands for construction will be met by the capture of incidental rainfall and runoff within the Project water management system, as well as from water truck transfers from the existing Lake Vermont Mine. Water management infrastructure is described in detail in Section 21.7.

Water treatment plant

A water treatment plant will be constructed at the MIA to provide potable water for the Project. The water treatment plant will be constructed in accordance with the National Health and Medical Research Council's (NHMRC) 'Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy' (NHMRC 2018) and will be developed in accordance with the Queensland Water Resources Commission (QWRC) 'Guidelines for Planning and Design of Urban Water Supply Schemes' (QWRC 1989) and relevant Australian Standards. The water treatment plant will have the capacity to provide up to approximately 30 kL/day and up to approximately 11 ML/year. Raw water will be pumped from the Raw Water Dam to the water treatment plant for treatment. Treated water will be stored in 100 kL capacity potable water tanks adjacent to the plant. Effluent from the water treatment plant will be captured and stored in a Mine Water Dam and used for dust suppression.

During construction and until the water treatment facility (and raw water supply pipeline) is operational, potable water will be trucked to the site by a local potable water supplier.

Water management infrastructure

Water management infrastructure proposed to be developed during Project construction includes the Raw Water Dam, the Dewatering Dam and the MIA Dam. These dams are proposed to be located as shown in Figure 21.19, with dam details provided in

Table 21.3. Operation of these dams is discussed in Section 21.7.2.

Table 21.3: MIA Dam sizing

Storage name	Storage type	Maximum catchment area (ha)	Storage capacity (ML)
Raw Water Dam	Raw water	0.4	20
Dewatering Dam	Mine affected water	0.4	20
MIA Dam	Mine affected water	73	440

Water management infrastructure for the construction phase will include development of a flood protection levee around the perimeter of the MIA, as shown in Figure 21.19. The MIA flood protection levee is designed to protect infrastructure within the MIA from a 0.1% AEP flooding event. A further flood protection levee is proposed to be constructed as part of the satellite open-cut pit development (during the Project operational phase), located as shown in Figure 21.10. Levee design and construction is discussed in Section 21.10.6.1.

A diversion drain is also proposed to be developed during the construction phase to support the diversion of clean water around the southern extent of the MIA levee (Figure 21.19). An additional diversion drain is also proposed to be constructed during the Project operational phase (indicatively Project Year 20; refer Section 21.2.4.1) to divert clean water around the southern extent of the open-cut pit levee. Diversion drain design and construction is discussed through Section 21.10.6.2.

21.2.3.9 Construction materials and equipment

The Project will support local and regional suppliers and manufacturers, when possible, for the supply of construction materials and equipment.

Construction materials required for the Project will include:

- bitumen;
- concrete;
- haul road base (gravel);
- pre-cast concrete structures;
- prefabricated buildings;
- structural steel and steel reinforcing;
- oversized special items; and
- other miscellaneous items.

The majority of infrastructure components (e.g. MIA buildings) will be manufactured off-site and transported to the site for assembly and installation. Delivery of construction materials to the Project will be via the Lake Vermont Mine Access Road and infrastructure corridor access road.

Large items that cannot be divided into smaller components will be transported on state roads under permit. When necessary, these vehicles will be accompanied by safety escorts. Equipment and fuel deliveries are anticipated to come from Moranbah or Mackay via Saraji Road, Golden Mile Road and the Lake Vermont Mine Access Road.

The Project construction period is expected to require approximately 115,000 m^3 of road base gravel and fill for construction of the infrastructure corridor haulage road, upgrades to existing mine roads, internal access roads (e.g. at the MIA) and hardstand areas.

If suitable material for construction (such as road base gravels, clay and rock materials) is identified on-site (e.g. from the underground box-cut spoil or drift construction) it will be used for the construction of roads or lay down areas. The local Tay Glen borrow pit (south-west of the Saraji Mine), which has provided construction aggregate for the Lake Vermont Mine, will also be utilised to meet Project construction requirements. Access to the Tay Glen borrow pit is proposed *via* existing private roads and tracks under consent with relevant landowners.

The equipment fleet anticipated to be used during construction include excavators, haul trucks, dozers, drills, graders, scrapers, front-end loaders, cranes/Frannas and water trucks. The initial underground mining equipment will also be delivered to the Project during the construction stage.

21.2.3.10 Construction disturbance area

Construction activities will require some vegetation clearance and/or land disturbance. The location of mining infrastructure has been selected to minimise vegetation clearance. Vegetation clearance procedures have been developed for the Project and are described in Section 21.12. Approximate disturbance areas associated with the construction development footprint are provided in Table 21.4.

Table 21.4: Approximate disturbance areas associated with construction

Construction component	Disturbance area (ha)
Infrastructure corridor and laydown areas (excluding MIA)	58.4
MIA (including levee, diversion drain and assuming 100% disturbance within MIA footprint)	73.6
ETL, substation and vehicle access (excluding MIA and infrastructure corridor)	8.8
Ventilation shafts	1.1

The locations of infrastructure corridor crossings at Phillips Creek and One Mile Creek have been selected by utilising existing light vehicle crossings to minimise damage to the bed and banks of the watercourses. No diversions of watercourses are proposed for the Project.

21.2.4 Operations

21.2.4.1 Mine resource, schedule and sequence

The Project mine layout, sequencing and mining methods have been designed or selected to maximise resource extraction and minimise resource waste, resource sterilisation and environmental impacts. The Project coal reserve will be mined using underground and open-cut mining methods.

The proposed mine schedule for the Project underground and open-cut mining operations is presented in Table 21.5. The recoverable coal reserve in the underground mining area is approximately 108.6 Mt and approximately 13.3 Mt in the open-cut mining area (Table 21.5). This provides a total recoverable ROM coal resource of approximately 122 Mt.

The Project will operate in parallel with the existing Lake Vermont Mine operations. The provisional mine schedule and sequence is based on maintaining a total Lake Vermont Mine Complex product coal output of approximately 9 Mtpa. However, Project timing may ultimately vary to consider factors such as localised geological features, market conditions or mining economics.

Table 21.5: Provisional mine schedule–- annual coal and waste production

Year	Underground mining			Open-cut mining (Satellite pit)			
	ROM coal (t)	Product (t)	CHPP rejects (t)	ROM coal (t)	ROM waste (bcm)	Product (t)	CHPP rejects (t)
1 (2026)	120,599	104,829	15,770	—	—	—	—
2	407,558	373,109	34,449	—	—	—	—
3	3,854,215	3,403,760	450,455	—	—	—	—
4	6,389,931	5,733,715	656,216	—	—	—	—
5	6,707,875	6,056,206	651,669	—	—	—	—
6	6,928,790	6,234,064	694,726	—	—	—	—
7	6,340,317	5,688,199	652,118	—	—	—	—
8	5,337,080	4,725,249	611,831	—	—	—	—
9	5,356,817	4,468,218	888,599	—	—	—	—
10	4,868,204	4,059,046	809,158	—	—	—	—
11	5,446,513	4,498,854	947,659	—	—	—	—
12	3,931,421	3,282,333	649,088	—	—	—	—
13	4,861,426	4,108,503	752,923	—	—	—	—
14	5,377,038	4,539,002	838,036	—	—	—	—
15	5,931,230	5,049,339	881,891	—	—	—	—
16	4,490,033	3,928,561	561,472	—	—	—	—
17	4,739,102	4,181,096	558,006	—	—	—	—
18	5,065,826	4,458,430	607,396	—	—	—	—
19	4,577,298	4,006,933	570,365	—	—	—	—
20	4,733,743	4,085,390	648,353	258,707	13,532,224	200,436	58,271
21	5,725,404	4,820,442	904,962	1,066,768	15,963,723	844,570	222,198
22	4,410,978	3,594,433	816,545	1,321,576	17,578,874	1,072,284	249,292
23	2,965,948	2,322,704	643,244	1,276,587	17,621,022	1,063,526	213,061
24	—	—	—	1,401,996	17,074,784	1,136,094	265,902
25	—	—	—	1,488,154	17,249,295	1,157,223	330,931
26	—	—	—	1,442,902	17,832,792	1,034,341	408,561
27	—	—	—	1,316,800	17,822,767	956,998	359,802
28	—	—	—	1,451,066	17,108,187	1,148,838	302,228
29	—	—	—	1,924,539	12,755,867	1,577,244	347,295
30 (2055)	—	—	—	395,669	1,106,802	324,386	71,283
Total	**108,567,347**	**93,722,417**	**14,844,931**	**13,344,763**	**165,646,337**	**10,515,939**	**2,828,824**

Underground mining schedule and sequencing

The planned mining sequence for the underground mining area is shown in Figure 21.20. The primary underground target seam is the Vermont Lower Seam that extends across the whole underground mining footprint. Underground mining of coal reserves will commence in the Vermont Lower Seam in Project Year 1 (indicatively 2026) and continue for approximately 23 years. The overlying Leichhardt Lower Seam, which is a secondary underground target seam, is only present across the northern half of the underground footprint.

The Vermont Lower Seam occurs at depths ranging from approximately 150 m in the south-west of the underground mining footprint to approximately 500 m in the north-east. The Leichhardt Lower Seam occurs at depths ranging from approximately 250 m in the west of the underground mining footprint to approximately 500 m in the far north-east of the mining area.

The development of the underground main headings and gate roads is anticipated to commence in Project Year 1 after construction of the drifts has been completed. Figure 21.20 shows the progression of development roadways and mining over the life of the mine. Continuous miner units will be utilised to drive the in-seam access headings to enable longwall operations to commence. Approximately 22 months of initial in-seam development using continuous miners is planned before the longwall commences operation.

It is planned to extract the southern longwall panels first by progressing from west to east (Figure 21.20). As the longwall completes the southern panels in the Lower Vermont Seam, in-seam development work will commence in the northern panels in the overlying Leichhardt Lower Seam. Access from the Vermont Lower Seam up to the Leichhardt Lower Seam will be via inter-seam drifts. Upon completing extraction of the southern Vermont Lower Seam panels, the longwall will commence mining the northern Leichhardt Lower Seam panels. Once the northern Leichhardt Lower Seam panels have been extracted, mining will recommence in the Vermont Lower Seam to extract the northern Vermont Lower Seam panels. The general mining sequence and annual mining progress plots are shown on Figure 21.20.

During Project feasibility studies, a number of underground mining alternatives have been assessed prior to defining the final longwall layout. Project alternatives are discussed in Section 21.8.

Open-cut pit mining schedule and sequencing

The planned mining sequence for the open-cut pit is shown in Figure 21.21. Coal reserves in the open-cut pit will be mined for approximately 11 years (Table 21.5) (i.e. starting in Project Year 20 and finishing in Project Year 30). Open-cut mining of coal reserves from the Leichhardt Lower, Vermont and Vermont Lower Seams will occur within the satellite open-cut pit.

The open-cut will be a terrace mining operation that will initially commence in the south and progress north to the centre of the mining area (Figure 21.21). Mining will then relocate and commence in the north and progress to the south (Figure 21.21). This mining sequence and associated backfilling will result in the final rehabilitated pit landform providing a post-mining land use of grazing (consistent with the pre-mining land use). This progression also ensures that no pit void is retained post-mine closure. Rehabilitation of the Project will be provided for through a PRC Plan, as required under Queensland legislation and the ToR for the Project EIS.

Lake Vermont Meadowbrook Complex Schedule

Figure 21.22 shows the life of mine production profile for the Lake Vermont Meadowbrook Complex (i.e. the existing Lake Vermont Mine and the Lake Vermont Meadowbrook Project). As illustrated by this figure, the Project addresses the forecast reduction in coal production that will occur at the existing Lake Vermont Mine by combining output from the existing open-cut operations and the Project extension.

Without the Project, mining activity at the existing Lake Vermont Mine will gradually decline from 2024, with further sharp decreases (to approximately 4 Mtpa and less) from 2028 (Project Year 3) until the end of the mine life. The Project proposes to provide additional product coal to augment the reduced open-cut output and maintain production levels at approximately 9 Mtpa from Project Year 3 (indicatively 2026) through to Project Year 22 (indicatively 2048).

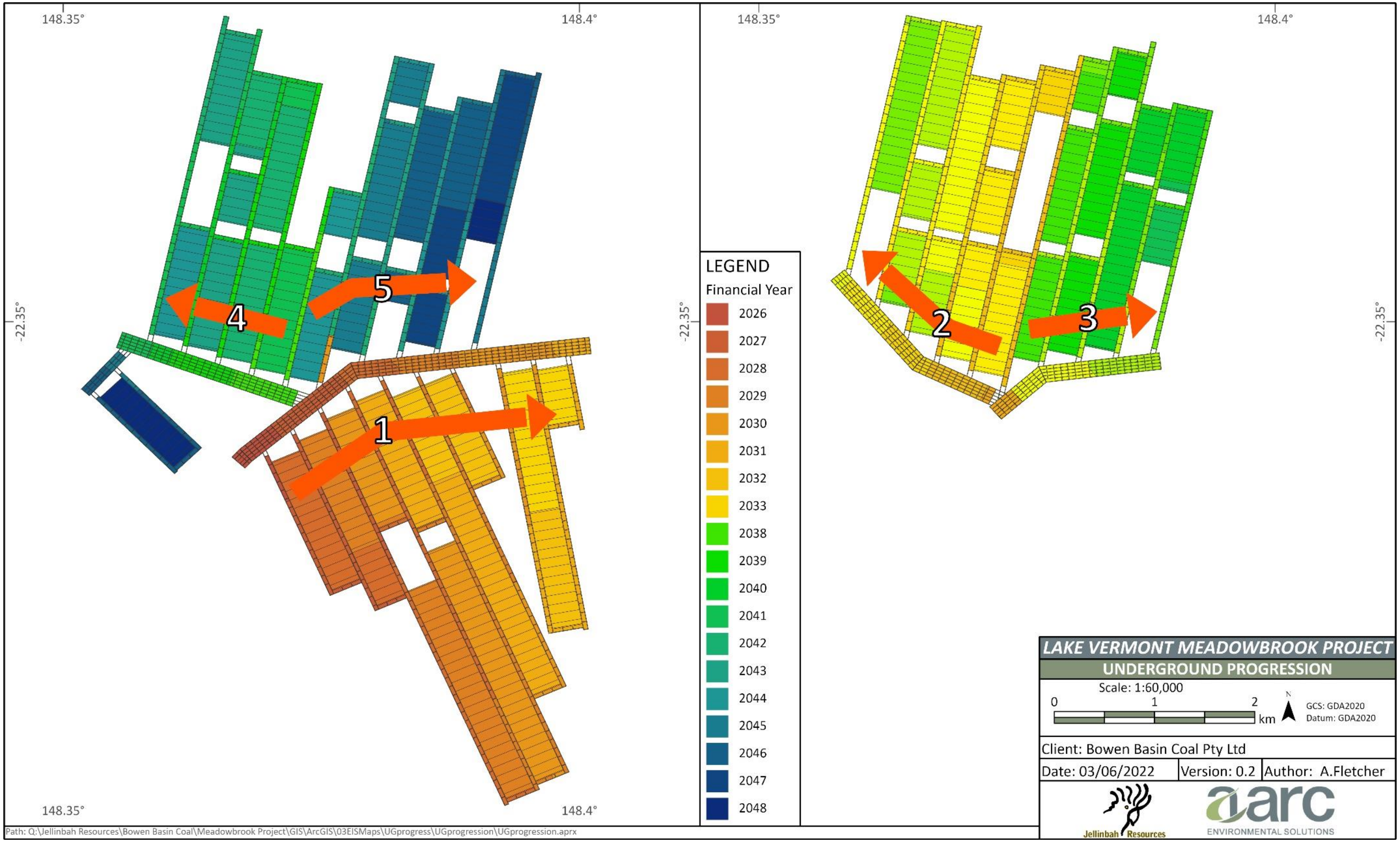

Figure 21.20: Indicative mine progression plan— underground mining

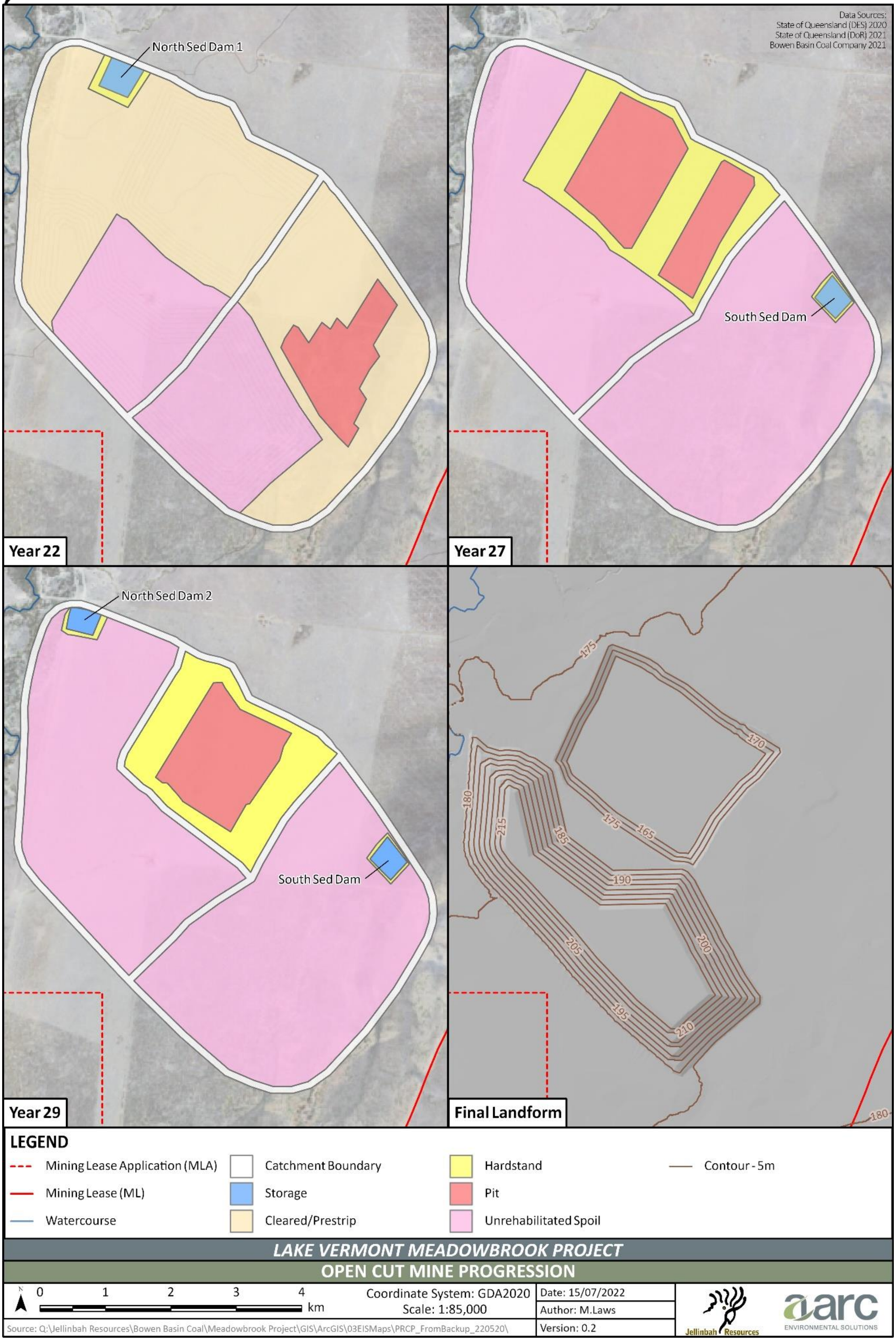

Figure 21.21: Indicative mine progression plan – open-cut pit mining

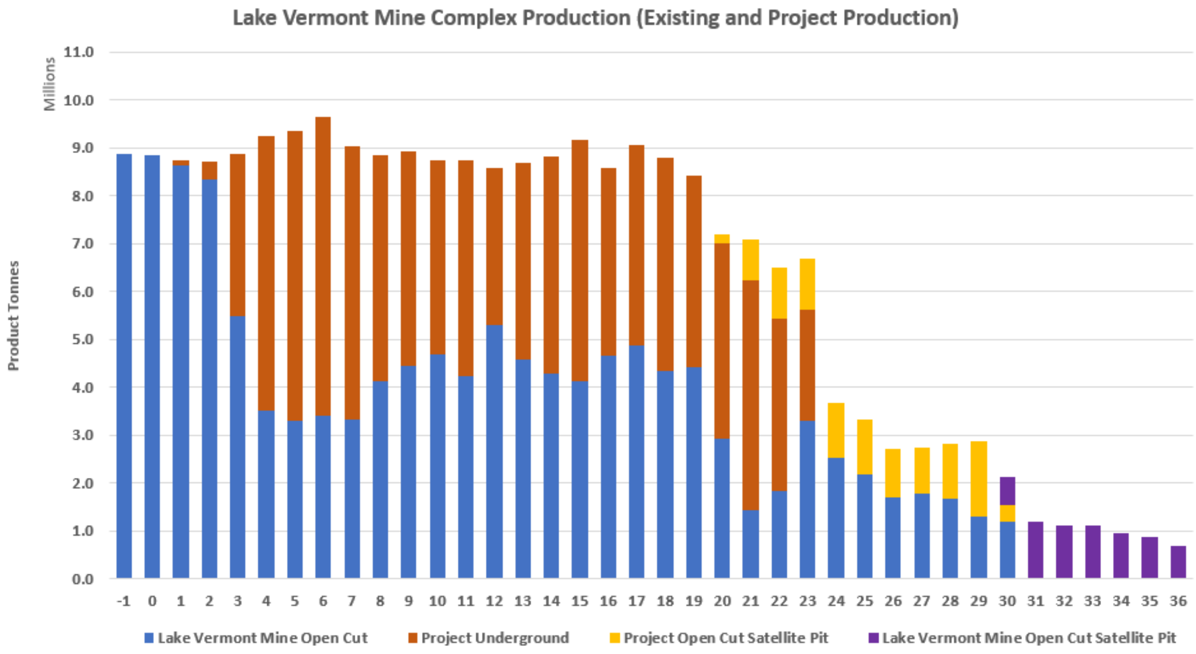

Figure 21.22: Lake Vermont Meadowbrook Complex–- Life of Mine Production Profile

As the Project underground extension reaches its final years, the proposed open-cut satellite pit will commence (in Project Year 20), further supplementing existing operations, albeit with production levels continuing to tail off until Project mining completion (in Project Year 30). Mining at the existing Lake Vermont Mine will continue for approximately six years following completion of the proposed Project through the mining of the (already approved) Lake Vermont Mine open-cut satellite pit.

While progressive rehabilitation will occur throughout the life of the Project, final rehabilitation and mine closure will occur in conjunction with final mining. Backfilling of the open-cut pit is scheduled to be completed in Year 35 (indicatively 2060), with achievement of a stable post-mining land use (grazing) anticipated in Year 53 (indicatively 2078). Further details of the rehabilitation and closure of the Project are provided through the Project PRCP (Appendix B, Progressive Rehabilitation and Closure Plan).

Figure 21.23 to Figure 21.28 show the general arrangement of the Project in Project Years 2, 7, 12, 17, 22 and 27, and at end of mining, together with the progress of the existing Lake Vermont Mine. It is noted that Project Year 7 (as one of the peak underground production years) and Project Year 22 (as a year involving overlap of both the underground and open-cut developments) are the years that have been selected for the modelling of potential impacts on environmental values, such as air quality and noise.

Mine access and development works

Access to the underground will be via the main drifts located within the MIA (Figure 21.19). The MIA has been located in an area that enables efficient access to both the proposed underground and open-cut developments.

Construction of the underground drifts and portal is described in Section 21.2.3.5. Following the completion of portal/drift construction, underground access roadways will be developed using continuous miners. Underground main roads (main headings) will be developed towards the east and run through the approximate centre of the underground mining area. The main headings will provide the primary access, ventilation and roadways for housing the main trunk coal conveyors (Figure 21.10). Each longwall panel will be formed by developing gate roads (the tail gate and main gate roads) that extend from the main heading to the limits of the mine footprint. The gate roads will consist of two parallel roadways driven using continuous miners (Figure 21.30), with each roadway being approximately 5.0 m wide and 3.2 m in height. The headings will be connected approximately every 100 m by driving a cut-through from one heading to the other. This will leave a series of coal pillars along the length of the gate road that will support the overlying strata (Figure 21.30).

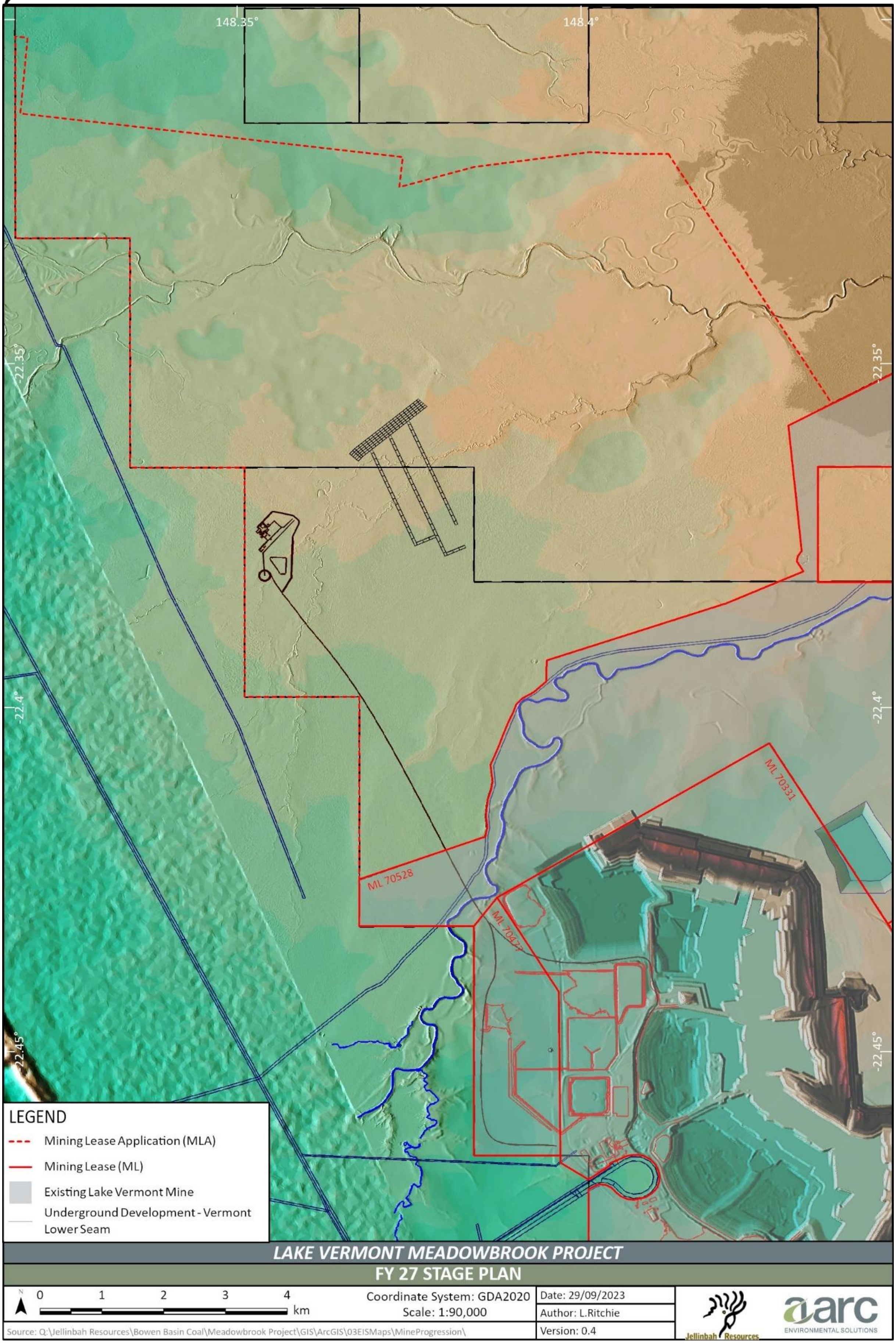

Figure 21.23: Mine stage plan – Project Year 2

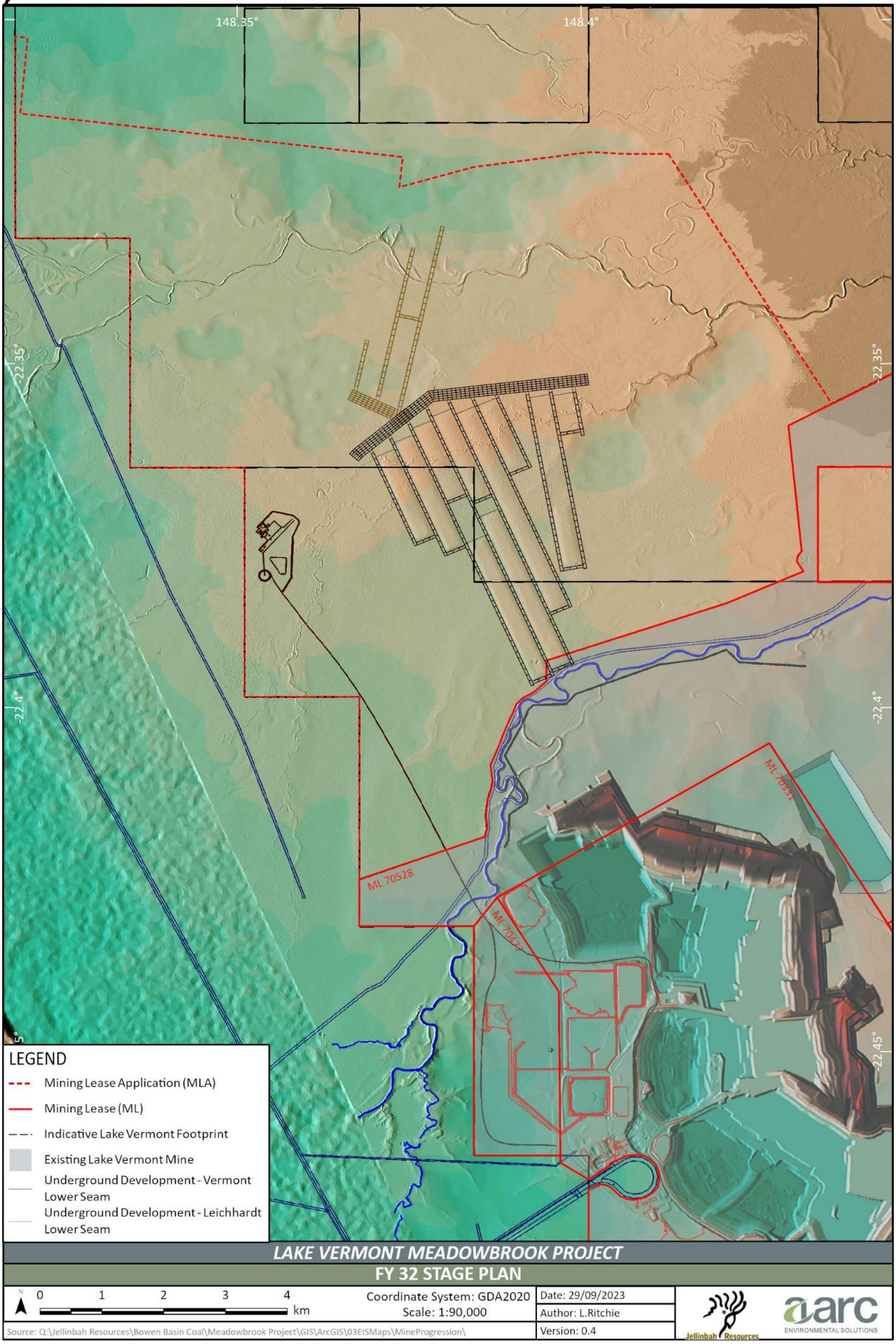

Figure 21.24: Mine stage plan – Project Year 7

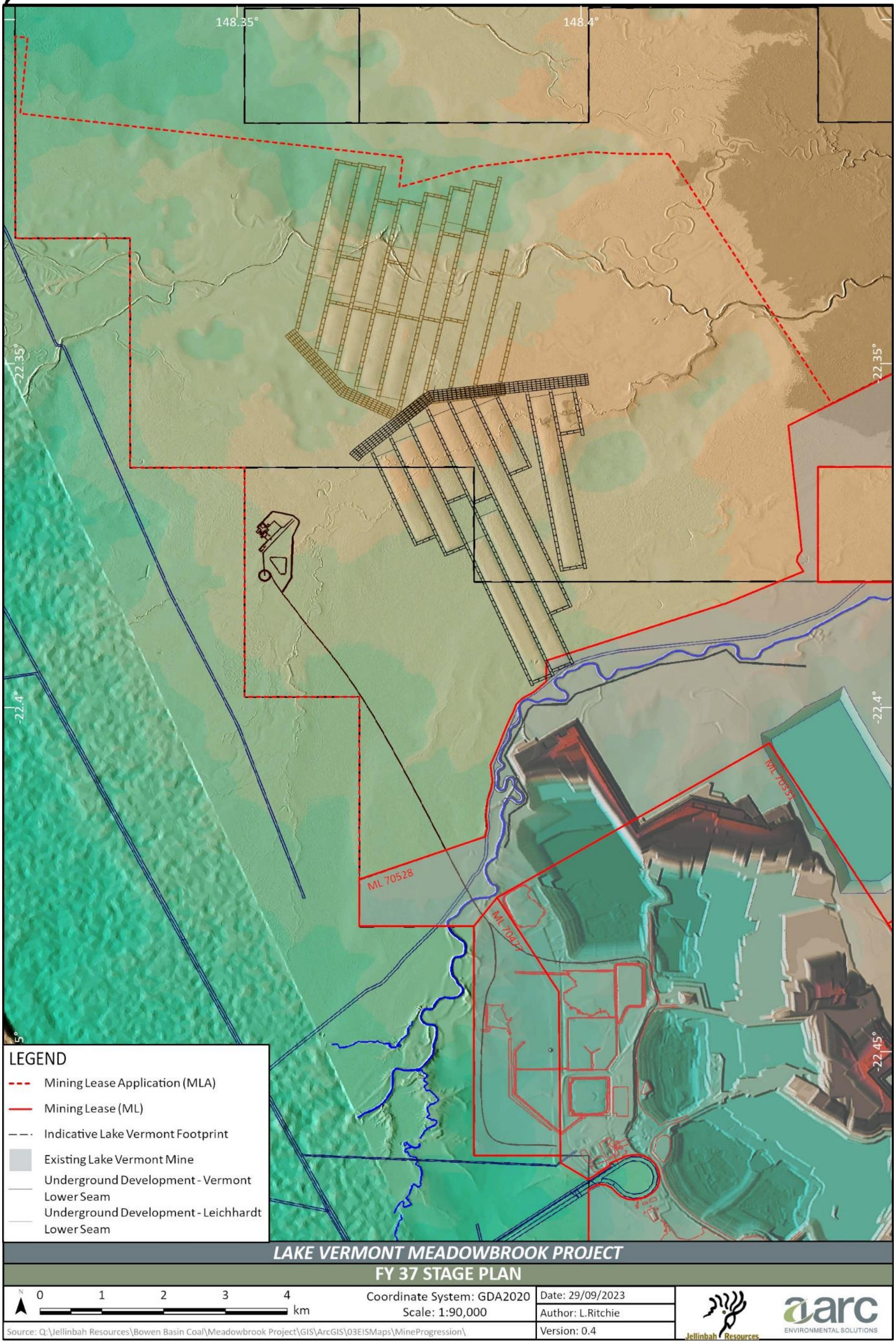

Figure 21.25: Mine stage plan – Project Year 12

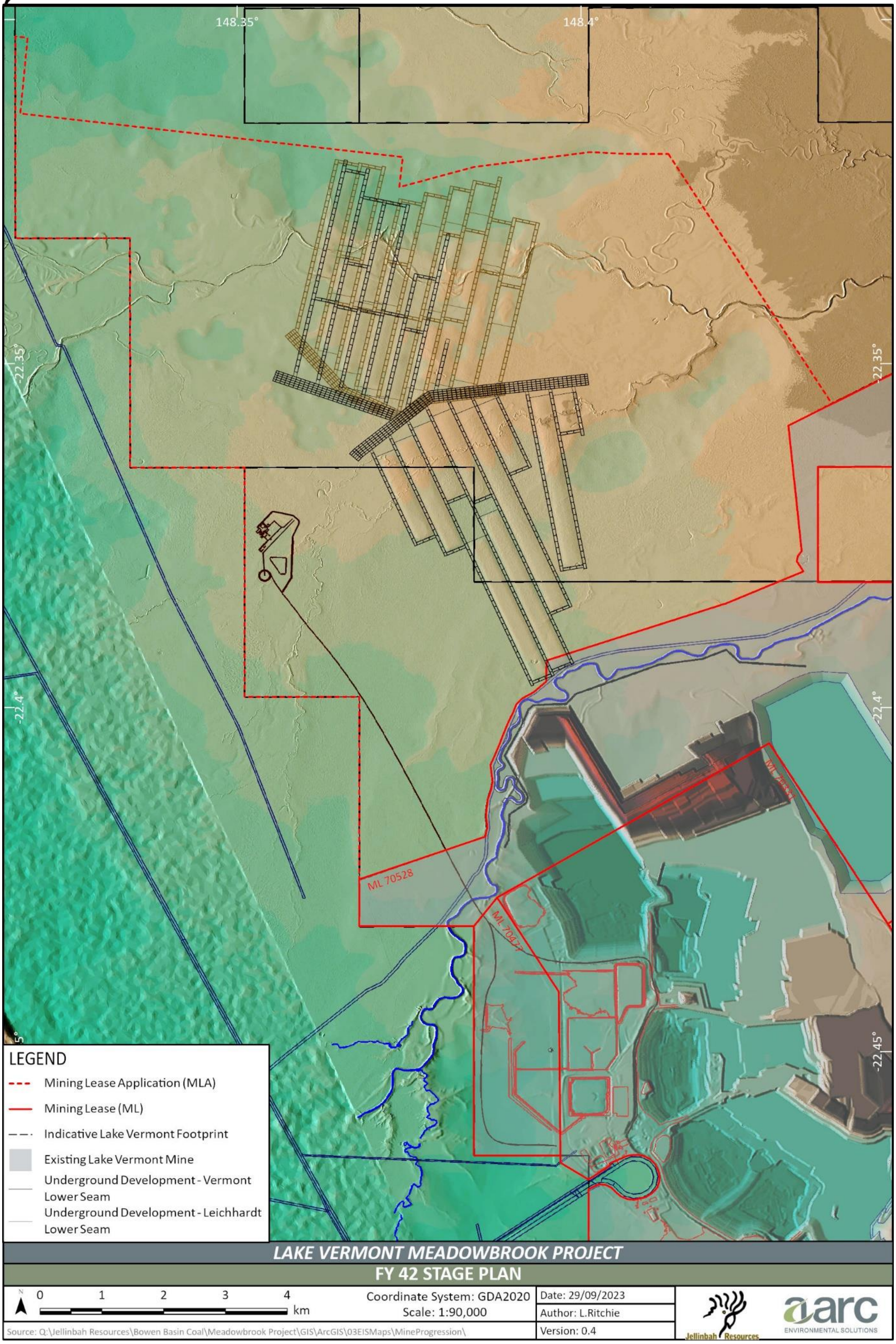

Figure 21.26: Mine stage plan – Project Year 17

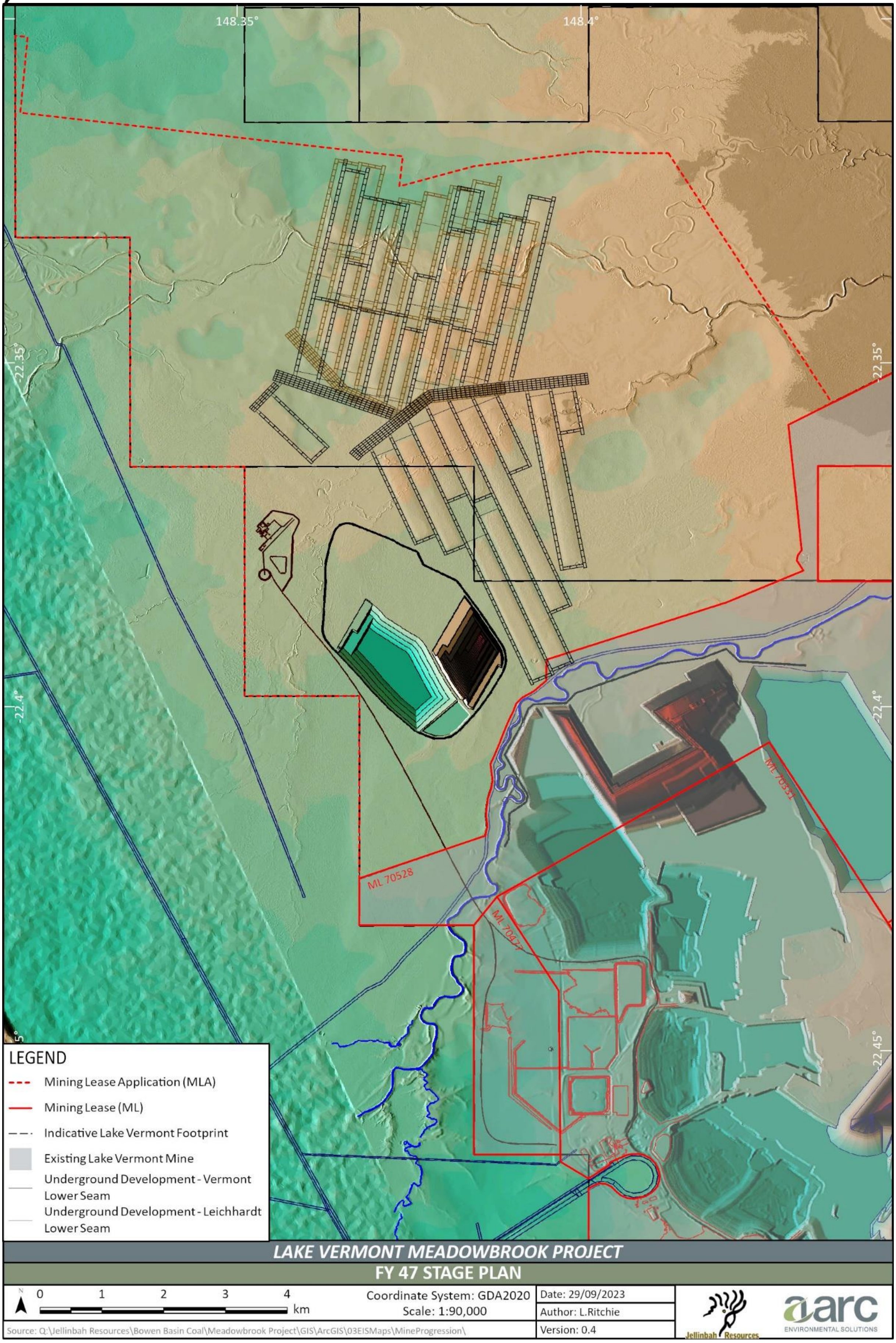

Figure 21.27: Mine stage plan – Project Year 22

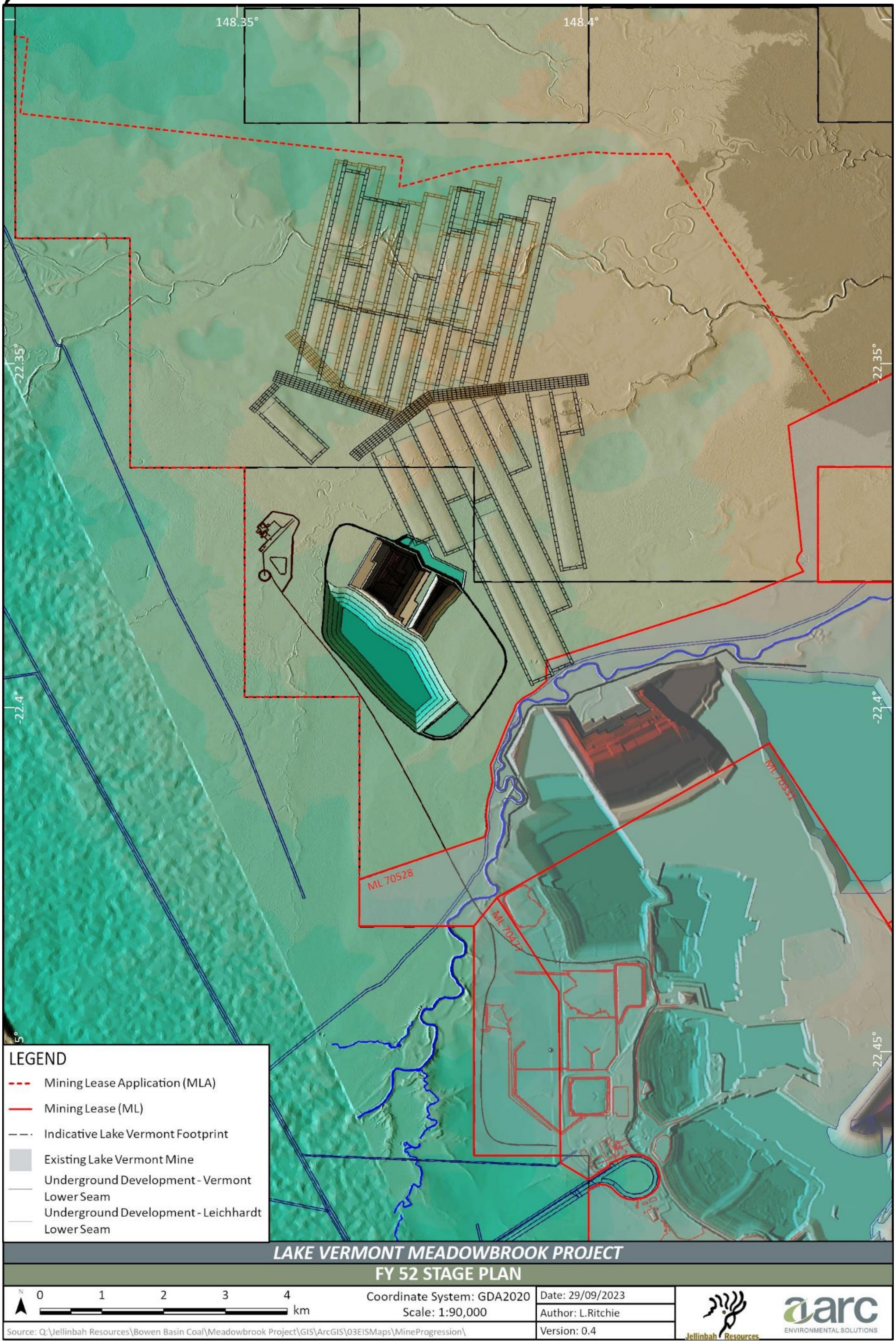

Figure 21.28: Mine stage plan – Project Year 27

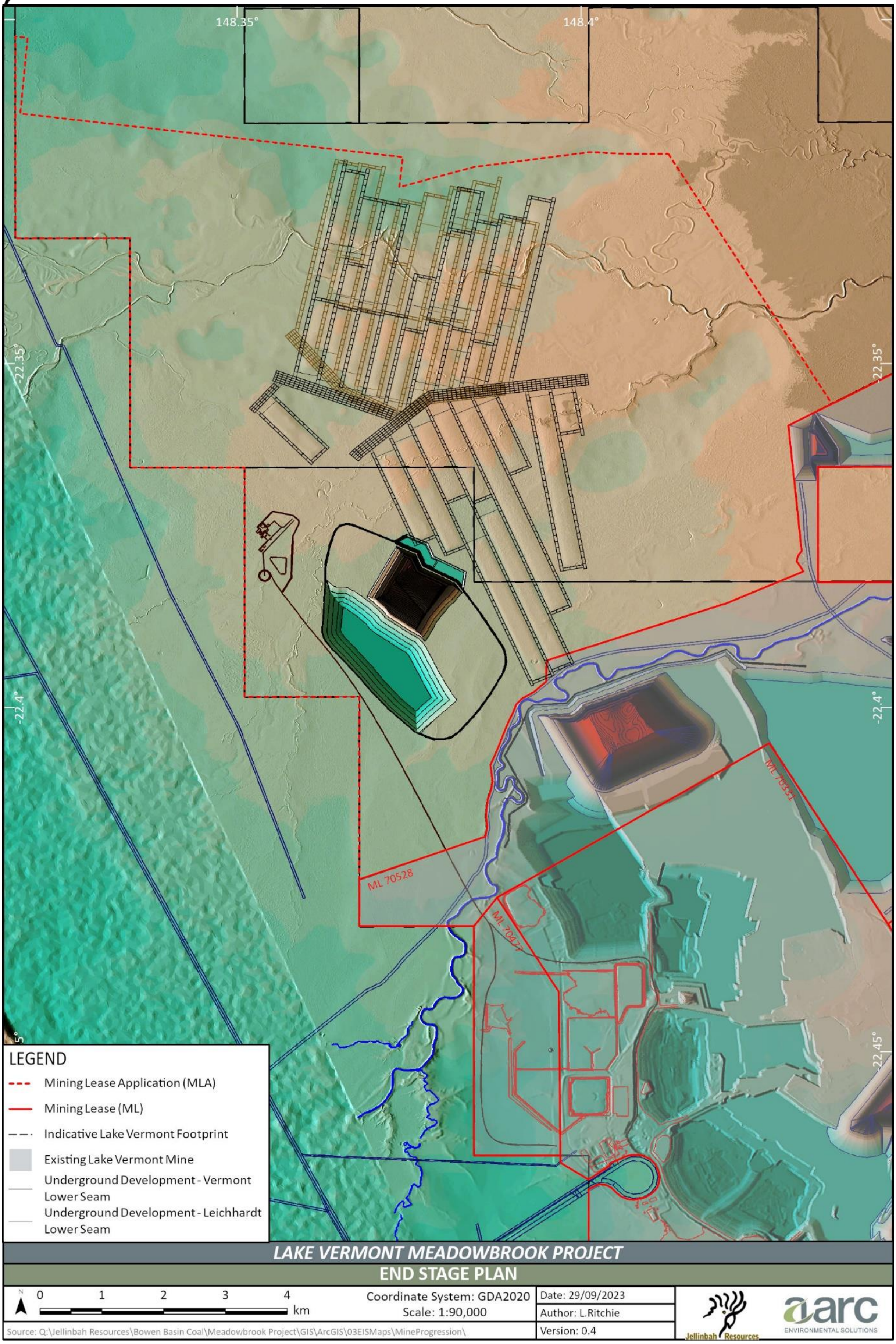

Figure 21.29: Mine stage plan – end of all mining

Figure 21.30: Longwall mining schematic

The development of the underground main headings and gate roads is anticipated to commence in Project Year 1 after construction of the drifts has been completed. Figure 21.20 shows the progression of the development roadways and mining over the life of the mine.

Longwall mining operation

Conventional longwall coal mining methods will be used to extract coal from the underground mining area.

Longwall extraction has been planned for the Vermont Lower Seam and the overlying Leichhardt Lower Seam. Longwalls in the Vermont Lower Seam have been designed with a solid coal face length of approximately 300 m. In the shallower area south of the main headings, the width of the gate road chain pillars will vary from between 35 m to 40 m (solid). In the deeper area north of the main headings, the solid dimension of the chain pillars will vary between 45 m to 50 m. The extraction height of the longwall will range between approximately 3 m to 4.8 m for the Vermont Lower Seam and increase from west to east.

Longwalls in the Leichhardt Lower Seam will also have face lengths of up to approximately 300 m (solid). Three panels have been narrowed to 270 m wide (solid) to maximise recovery between faults. The gate road chain pillars in the Leichhardt Lower Seam are 45 m wide (solid). The extraction height of the Leichhardt Lower Seam will be approximately 3.0 m to 4.8 m.

The longwall unit will utilise a shearer to progressively cut a slice of coal from the coal face, and the broken coal will then be transferred to the main gate conveyor via an armoured face conveyor. The longwall unit will utilise a series of hydraulically powered roof supports to provide a safe working environment for the shearer and the machine operators. Once each slice of coal is removed from the longwall face, the hydraulic roof supports will be progressively advanced allowing the immediate overlying roof strata to collapse behind the rear shields of the longwall supports (referred to as forming the 'goaf') (Figure 21.20).

Figure 21.20 illustrates the development of the roadways prior to mining and the longwall mining method. To start each new longwall panel, the longwall unit is disassembled and recovered from the take-off position of the previous longwall and transported to and re-assembled along the installation roadway of the next panel. This longwall relocation process takes approximately one month.

ROM coal extracted by the longwall unit will be conveyed along the gate road via the main gate conveyor and transferred onto the trunk conveyor system that will run the length of the main headings and conveyor drift. On reaching the surface, the ROM coal will be conveyed directly to the ROM coal stockpile in the MIA. ROM coal handling and processing is described in Section 21.2.5.

Major underground equipment and mobile fleet

The major underground equipment and mobile fleet anticipated to be required for the Project's underground mining operations is provided in Table 21.6.

Table 21.6: Major underground equipment and mobile fleet

Description	Estimated quantity
Longwall face unit	1
Development face units	3
Load haul dump (LHD) transporters	8
Man transporters	12
UG grader	1
UG mine dozer	1
Main ventilation fan system	1
Mains conveyor system to surface	1
Gate road conveyor systems	3
CAT992 loader (MIA ROM coal stockpile and new ROM pad at Lake Vermont Mine)	2
CATD11 dozer (MIA ROM coal stockpile and new ROM pad at Lake Vermont Mine)	1
Service truck (for maintenance of surface equipment)	1
Road trains (for transport of ROM coal from ROM coal stockpile area to new ROM pad at Lake Vermont Mine)	5
Light vehicle	25

Coal seam gas management

Incidental coal seam gas is present in the Rangal Coal Measures, and gas drainage will be required to reduce the in-seam gas contents to below outburst thresholds to ensure safe mining conditions. A Gas Drainage Management Plan will be developed prior to construction that will include the following operating and management details:

- the legislative requirements of the management plan;
- personnel roles and responsibilities;
- description of the gas drainage options (including the pre-drainage of the coal seams prior to underground mining, dilution of methane via the mine ventilation system throughout mine operations; and post-drainage of goaf areas following longwall extraction);
- measures to mitigate predicted gas drainage impacts (including flaring);

- the rehabilitation of gas drainage sites (including the topsoil and erosion and sediment controls, surface preparation and decommissioning procedures); and
- monitoring and reporting requirements.

Temporary vegetation/habitat disturbance above the underground mining area will be undertaken for the deployment of gas drainage wells. Surface disturbance works to support the conduct of gas drainage activities will be sited to minimise the amount of vegetation disturbance required. Management measures for areas of disturbance required above the underground mining area will be provided in the Gas Drainage Management Plan and will include:

- The use of existing tracks to access sites, to minimise vegetation clearing, disturbance of soils and creation of new tracks.
- Restricting vegetation clearance to the slashing of vegetation (i.e. leaving the lower stem and roots in-situ to maximise the potential for natural regrowth) where practicable.
- Lopping of branches, rather than the removal of trees, where practicable.
- Limiting the amount of soil disturbance to the minimum required for the mobilisation, placement and operation of equipment, and for maintaining access to equipment.

As part of the feasibility studies, the Proponent has undertaken an initial assessment of the gas reservoir characteristics to understand the extent of the gas drainage and mine ventilation options.

Gas pre-drainage will include the use of surface-to-seam (SIS) as well as 'underground in-seam' (UIS) drainage drilling. Gas drainage is intended to reduce the in-seam gas content to below outburst thresholds and to a level where the mine ventilation system can adequately dilute the residual gas levels. Once coal mining operations commence, UIS pre-drainage will form the primary pre-drainage strategy.

SIS gas drainage

SIS gas pre-drainage involves the use of gas drainage wells that are connected from the surface to the underground coal seam. The use of lateral and vertical wells are used in combination as part of the Project SIS drainage program (Figure 21.31). Lateral wells are drilled along the coal seam and intersect vertical wells at the end hole. The vertical well, in connection with the lateral well, is used to collect gas from the intersected coal seam and deliver it to the surface (Figure 21.31).

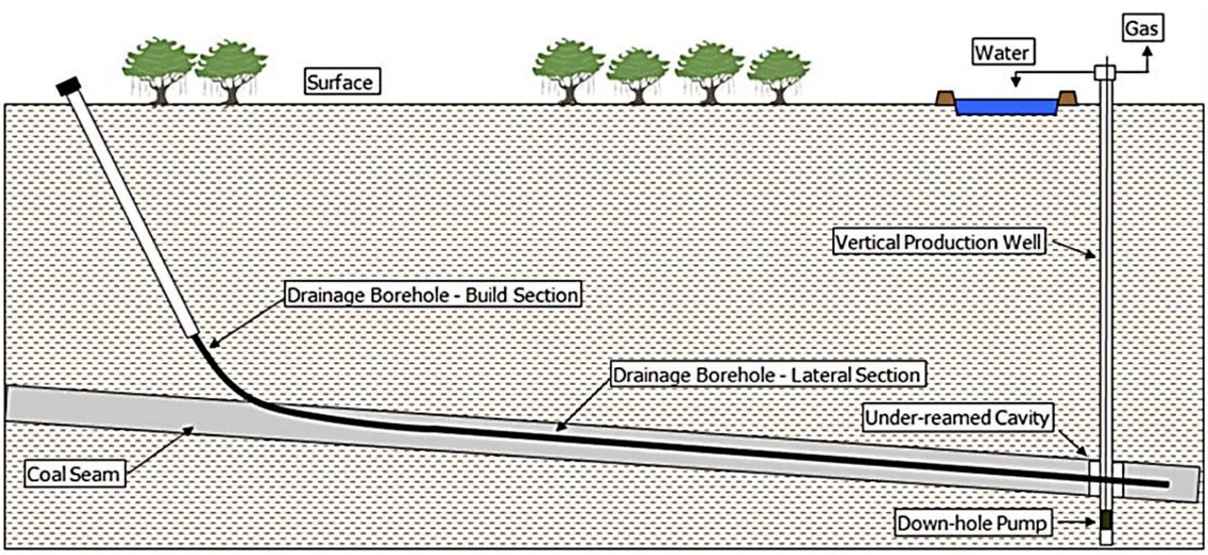

Figure 21.31: SIS gas drainage underground installation example

Gas drainage wells will be developed over each panel as mining progresses through the underground area, with relocatable surface control equipment to be transported to new locations as required. On the surface, the SIS gas drainage well head will be sealed; this is where the water and gas are then separated using a separation unit. The water will be separated and distributed to the Dewatering Dam within the MIA via cross surface pipelines. The groundwater extracted as part of the SIS gas drainage process forms part of the overall underground water inflows estimates, as included within the site water balance model. Gas will flow into monitoring equipment and control equipment that will generally consist of flame arrestors, non-return valves, filter boxes, control boxes and fire suppressors positioned on a relocatable skid (Figure 21.32). Once the gas has flowed through the control and monitoring equipment, it can be piped to its final destination. This may be via several methods, such as venting, flaring or on-site power generation.

Figure 21.32: Example SIS gas drainage relocatable skid

UIS gas drainage

UIS gas pre-drainage will generally include a borehole riser drilled from the surface down to the coal seam. It is connected at the bottom of the hole to the underground gas infrastructure that consists of gas/water separators and gas pipelines.

On the surface, the UIS gas riser is typically set-up in a similar configuration to the SIS gas drainage equipment. This includes monitoring equipment and control equipment that generally consists of flame arrestors, non-return valves, filter boxes, control boxes and fire suppressors positioned on a relocatable skid, with the addition of a venturi to assist in the extraction of gas. Figure 21.33 shows a typical UIS venturi surface skid.

Placement of the UIS drainage vertical risers depends on underground workings and mining schedules. Generally, the risers would be positioned along the panel roadways and advanced as mining progresses.

Management of mine gas

Once gas drainage and mining operations commence, sufficient site-specific gas well operational performance data will be obtained to assess the viability of on-site power generation as an alternative to flaring. Any potential future uses of mine gas will be discussed with the holder of the overlapping petroleum tenure.

It is proposed that gas captured via pre- and post-drainage systems will be flared. Flaring incidental mine gas significantly reduces greenhouse gas emissions. Project greenhouse gas emissions are considered in detail in Chapter 13, Air Quality.

Flaring stacks are typically situated at a set distance away from gas drainage equipment and infrastructure where they will be connected via gas pipelines to pre- or post-gas drainage skids. An example of a flaring stack proposed to be used by the Project is shown in Figure 21.34.

Figure 21.33: Example venturi skid equipment

Figure 21.34: Example flare installation

Ventilation air methane

As a standard requirement in underground coal mines, ventilation systems will be installed at the commencement of the mine and will progress with the mine as it develops. Due to residual coal seam gas following pre-drainage, the ventilation system will generate ventilation air methane that will be vented to the atmosphere. Project greenhouse gas emissions are considered in detail in Chapter 13, Air Quality.

Post-mine gas drainage

The roof behind the longwall will collapse after the coal has been mined, forming the goaf. In the goaf, there may be remnant coal remaining, or upon fracture of the surrounding strata after the roof has collapsed, it may connect to additional coal seams. This will cause goaf gas to build up behind the longwall. Post-mining gas drainage may, therefore, be required to ensure that gas levels are controlled and remain within regulated limits in the longwall ventilation circuit. Post-mine gas drainage will utilise UIS drainage infrastructure and not require additional surface disturbance.

The gas can be drained via vertical gas wells that are drilled into the strata above the coal seam that does not form part of the goaf. As the goaf is formed and roof fractures are created, the gas will drain via the vertical gas wells to the surface infrastructure. An installation example of the vertical goaf gas wells is detailed in Figure 21.35.

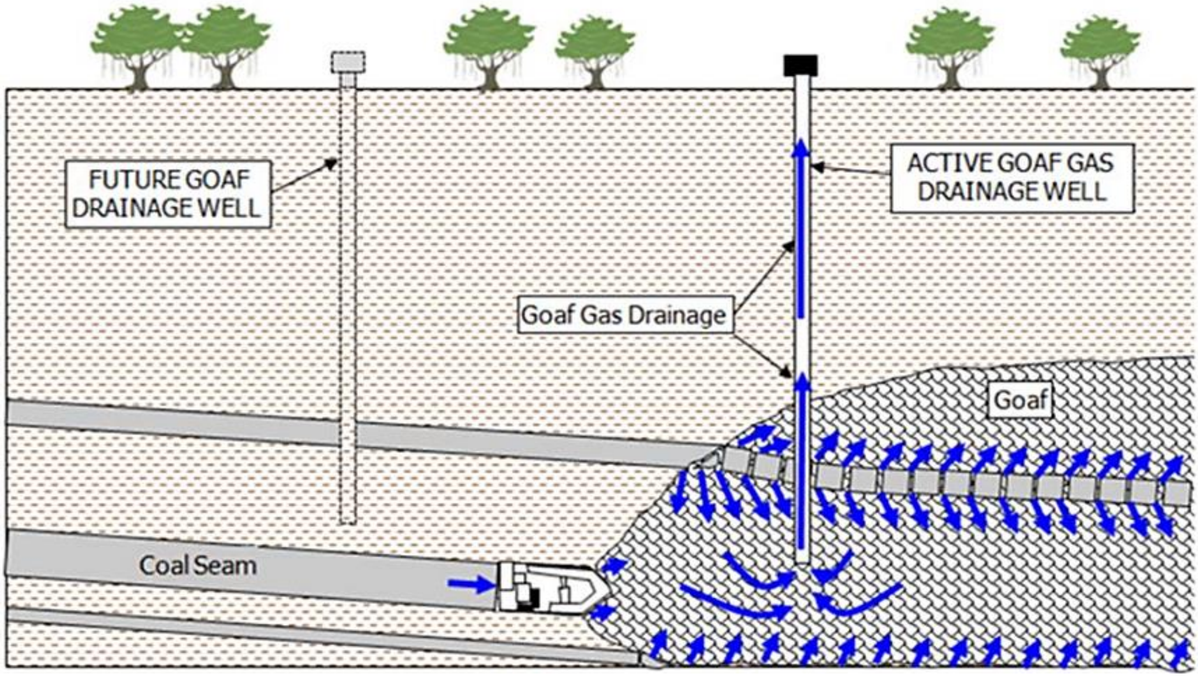

Figure 21.35: Vertical goaf gas wells–- example installation

Surface disturbance for gas drainage

Surface disturbance will be required to facilitate SIS gas drainage activities. Access to the surface of each longwall panel will be required here, with this predominantly achieved through the existing track network that exists across the Project site. Additional track access will be required, however, to support access to panels in the north-west of the underground mining area. One new track is proposed to facilitate this access, which is included in the proposed disturbance for the Project (Figure 21.10). Further access via the existing and proposed track network will be achieved by slashing (as opposed to blade clearance) without new ground disturbance.

At any one time, however, small areas (<2 ha) are likely to be disturbed for drilling and gas control equipment establishment and operation. Gas drainage will avoid areas of Brigalow TEC, Poplar Box TEC and areas of conservation of significant fauna habitat and vegetation in proximity to watercourses.

There is some flexibility with the location of gas pre-drainage infrastructure, with wells generally able to be situated to avoid ecologically sensitive areas. The location of gas post-drainage infrastructure and wells are not quite as flexible, as they need to be placed along the edge of mining panels. However, a degree of latitude will exist when locating boreholes to minimise environmental impacts. The footprint of gas drainage activities will, therefore, be consistent with typical exploration disturbance while also being temporary (short-term).

Decommissioning and rehabilitation

Once mining has advanced beyond the location of a gas drainage vertical well or borehole, that hole will be decommissioned and rehabilitated within three months. The decommissioning and rehabilitation process will involve:

- disconnecting and removing all surface and downhole equipment;
- plugging/capping the hole so that there is no connection with the surface atmosphere;
- removing any protruding casing/piping to below ground level;
- ensuring the surveyed location of the hole is recorded; and

- rehabilitating the site in accordance with the Project PRCP (Appendix B, Progressive Rehabilitation and Closure Plan).

After wells are decommissioned, general rehabilitation practices will utilise vegetation and topsoil previously set aside from site clearing. Each pre-drainage surface borehole site will be active for a few years as the drainage operation periodically relocates with the progressive advancement of the mining faces. After this time, they will be progressively rehabilitated. Post-drainage goaf holes will be rehabilitated more frequently and align with the completion of each longwall block. The goaf holes will be decommissioned, capped and rehabilitated as part of the requirements of the longwall sealing management procedures.

21.2.4.2 Mine dewatering

Groundwater that drains from coal seams and the surrounding rock mass will accumulate in the underground workings prior to being pumped to the surface via the access drifts. While local groundwater resources are notably of poor quality (i.e. highly saline), water pumped to the surface will be significantly diluted from the raw water sent underground for dust suppression. Modelled water quality is, therefore, indicative of a suitable salinity to utilise this water for dust suppression and processing activities. Notwithstanding this, the proposed water management system will include a Dewatering Dam (Figure 21.19). From here, water may be pumped into the adjoining MIA Dam (for further dilution) and utilised for dust suppression or sent back to the Lake Vermont Mine to support processing requirements. Any excess water may also be stored within existing (approved) voids at the Lake Vermont Mine. Further details of the Project water management system are provided in Section 21.7.2.

21.2.4.3 Open-cut satellite pit

The Project's open-cut satellite pit is north of Phillips Creek and south of One Mile Creek in the area south-west of the MIA (Figure 21.10). Initially, three open-cut satellite pits were considered for the Project; however, as discussed in Section 21.8, two have been discounted based on environmental considerations.

The proposed open-cut satellite pit seeks to mine the Vermont Lower, Vermont and Leichhardt Seams. The width and length of the open-cut pit is approximately 800 m by 3,100 m, respectively. An overall average strip ratio of 14 (bcm waste rock): 1 (t ROM coal) is estimated for the open-cut satellite pit. Given the relatively steep floor grade, the pit has been designed as a terrace mining operation. The extent of the pit lies within the flood plain of Phillips Creek in the south and One Mile Creek in the north. Consequently, mining operations will commence at the southern and northern extremities of the defined mining area and progress towards the centre of the pit, with progressive backfilling ensuring no void is retained within a floodplain. The rehabilitated pit area will achieve a post-mining land use. Project rehabilitation is addressed in detail in Chapter 6, Rehabilitation.

Open-cut batters will generally have slopes of 63 degrees (2V:1H). The maximum depth of the open-cut will be approximately 130 m in the central area of the open-cut pit. After backfilling, however, the landform will have a total depth of approximately 33 m.

The placement of the initial box-cut and mine sequencing has been determined by the need to:

- utilise a terrace mining technique to manage the steep floor grades;
- locate the final void in a location outside of the floodplain; and
- minimise the haul distance to overburden dumps to reduce noise and air emissions.

The open-cut mining schedule is provided in Table 21.5 and described in Section 21.2.4.1. Progress plots are shown in Figure 21.21. General arrangements for the open-cut satellite pit that match the schedule of the Lake Vermont Meadowbrook Complex are shown in Figure 21.27 and Figure 21.28 (Project Year 22 and Project Year 27, respectively).

21.2.4.4 Open-cut water management

A temporary flood levee will be constructed around the open-cut pit area to protect infrastructure from floodwater ingress. The flood levee is proposed to be constructed in advance of open-cut mining operations (indicatively Project Year 20).

The open-cut flood levee will provide protection for a maximum 0.1% AEP design flood event and will be considered a regulated structure. Flood levee design and construction is discussed in Section 21.10.6.1.

A diversion drain will be constructed around the south-eastern corner of the open-cut footprint to divert clean water (from a minor drainage line) around the disturbed area (refer Figure 21.10). This diversion drain will be constructed in parallel with the open-cut pit levee (indicatively Project Year 20). A conceptual diversion drain cross-section is shown in Figure 21.36.

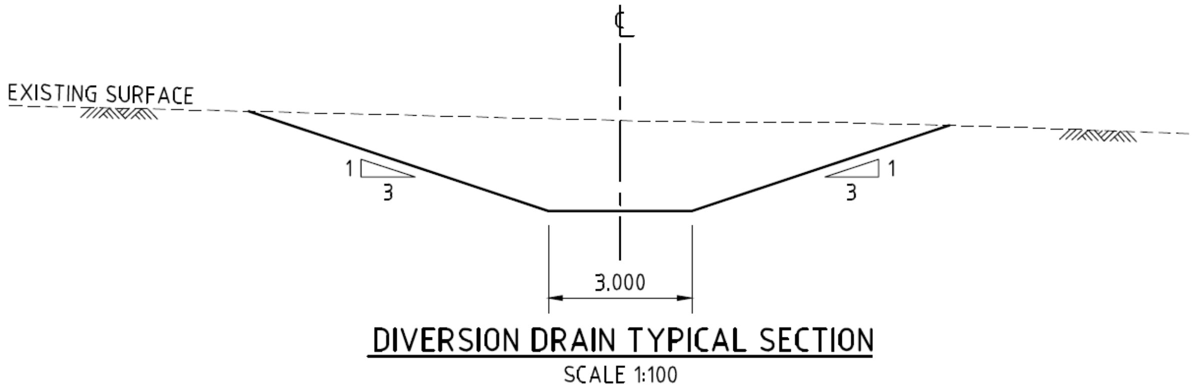

Figure 21.36: Conceptual diversion drain cross-section

Sediment dams will be constructed within the open-cut satellite pit footprint to assist in managing runoff within this area (including from waste rock emplacements) (Figure 21.21). As runoff is expected to be relatively benign, sediment dams will be designed to discharge to the environment (after the settlement of suspended sediment), with minimal impact to downstream water quality or the receiving environment expected. Sediment dams will be constructed to contain a 1 in 10-year ARI 24-hour rainfall event. All sediment dams will be removed and rehabilitated as part of mine closure. Design and operation of sediment dams is discussed in Section 21.10.6.4.

The final landform design for the Project prevents water ingress into the final rehabilitated pit landform (which will present as a surface depression) in the event of a 0.1% AEP flooding event. The post-closure flood model indicating the location of the rehabilitated pit landform is shown in Figure 21.37.

21.2.4.5 Mining method

Due to the steeply dipping geology of the open-cut pit coal resource, conventional hydraulic excavators and rear dump trucks will be used in a terrace style mining operation. The terrace mining method, with advancing in-pit dumps, is an established mining method. Terrace mining utilises horizontal mining benches (flitches) that are removed by excavator/truck fleets. Coal and waste are removed as they are encountered, with mining progressing down and across benches. The overburden (waste) is placed in out-of-pit waste rock emplacements or used to backfill the void behind the advancing operations.

Working benches 200 m wide will provide room across the pit width to have multiple coal mining faces exposed at any one time. A main 50 m wide sidewall haul-back road is proposed to be constructed along the western wall. Other haul-back roads will be on the floor of the deposit and along the natural surface level. The face ramp design will be repeated every 200 m, with face ramps connecting to the sidewall road to provide continuous access to the pit bottom for coal and waste haulage. The mining flitches are expected to be 3 m to 5 m deep. In steeper areas, extra equipment, such as D10 dozers or small backhoes, will be utilised to move material onto the floor to allow efficient excavation of the waste/coal interface and minimise coal loss.

Waste will be hauled to out-of-pit waste emplacements, while coal will be hauled to the ROM coal stockpile.

A summary of typical open-cut mining activities and sequences is provided below:

- **Vegetation clearing**: Most of the disturbance footprint that is associated with the open-cut pit and flood levee is clear of remnant or high-value regrowth vegetation and is characterised by cleared grazing land. Remnant vegetation in the north of the disturbance footprint will be removed in accordance with specific vegetation clearance procedures to be developed for the Project.
- **Topsoil stripping and handling**: When 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 waste rock emplacements. Conventional drill and blast techniques using standard rotary drills will be used for the blasting 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, ammonium nitrate and fuel oil (ANFO).
- **Coal mining and ROM coal handlin**g: Coal mining will involve excavators loading ROM coal into haul trucks for haulage to the ROM coal stockpile.

21.2.4.6 Waste rock management

Approximately 186 Mbcm of waste rock material is anticipated to be generated during open-cut mining. The development of waste rock emplacements for Project Year 22 and Project Year 27 are shown in Figure 21.27 and Figure 21.28, respectively.

Two out-of-pit waste rock emplacements adjacent to the proposed open-cut pit will be required to support mining operations (Figure 21.10). The more prominent waste rock emplacement, with elevations up to 40 m above the existing surface, will be created to the west of the open-cut pit, while a smaller, temporary waste rock emplacement will be formed on the eastern boundary of the open-cut pit. As operations progress, waste rock materials (also referred to as spoil) will be placed back into the mined pit. Waste rock temporarily stockpiled in the eastern waste emplacement area will be placed back into the pit following the completion of mining.

For both the western and eastern out-of-pit emplacements, rehabilitated slopes have been designed not to exceed a grade of 1 in 7, with slope lengths at a maximum of 70 m. The final pit landform (internal) is comprised of relatively level areas and occasional short, stepped slopes of up to 1 in 7. Rehabilitation strategies and final landform details for the mine waste rock emplacements are presented in Chapter 6, Rehabilitation.

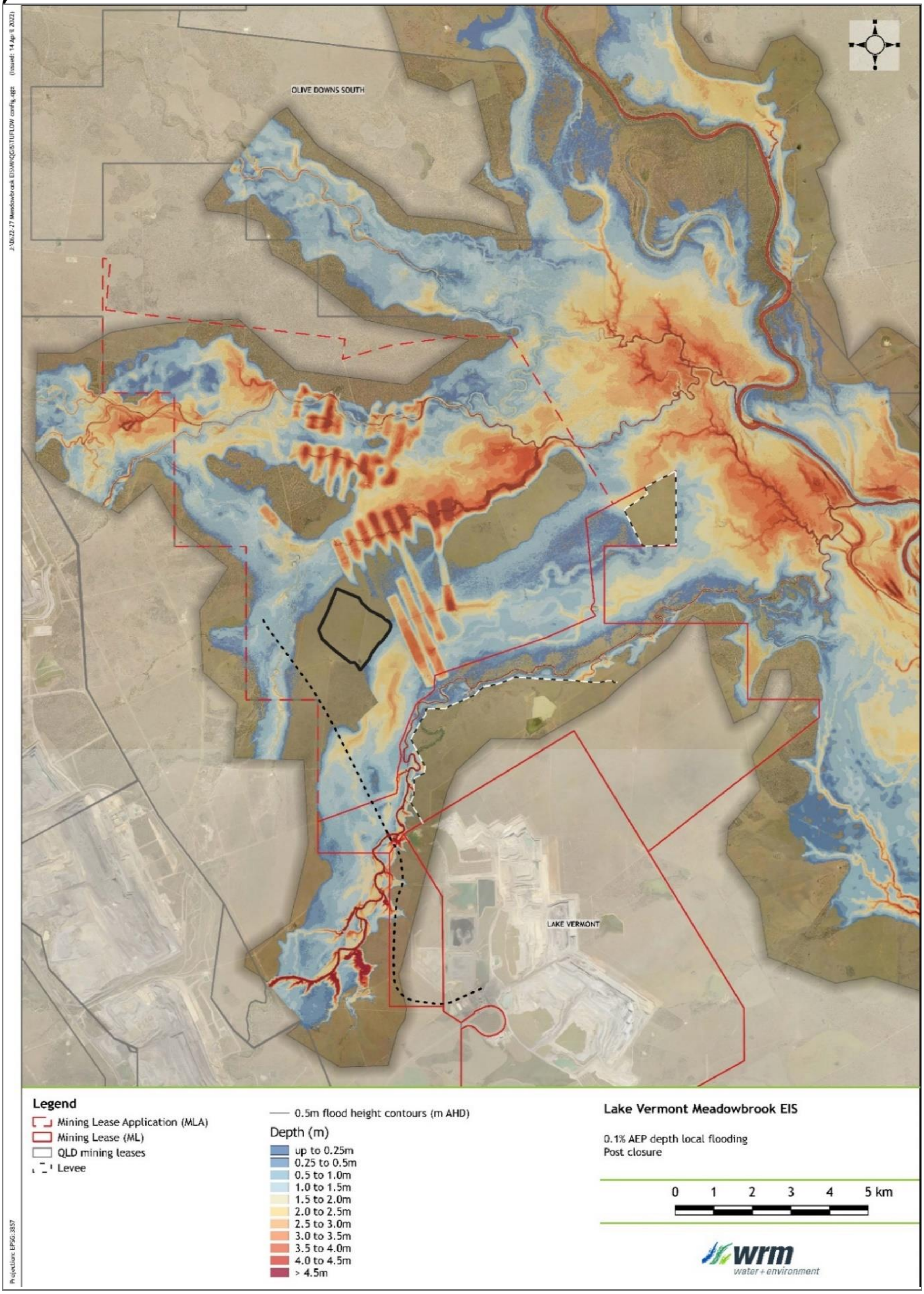

Figure 21.37: Post-closure flood model in relation to open-cut infrastructure

A Geochemical Assessment has been undertaken by RGS Environmental (2021) of the overburden and interburden materials (Appendix D, Geochemical Assessment). Overburden and interburden waste rock materials are geochemically similar to those materials currently produced at the existing Lake Vermont Mine. In summary, the assessment confirmed that:

- there is negligible risk of acid mine drainage;
- the salinity and sodicity of mine overburden and interburden is typical of the Rangal Coal Measures; and
- the waste rock materials are amenable to revegetation as part of rehabilitation activities.

With the implementation of the proposed management and mitigation measures described in Chapter 15, Waste Management, the waste rock produced by the Project presents a low risk of environmental harm.

21.2.4.7 Mining equipment

A provisional mine equipment fleet and estimated quantity required for Project open-cut operations is provided in Table 21.7. Makes and models of equipment are representative only of the classes and sizes of equipment proposed, and the final selection will depend on financial analysis at the time of purchase.

Table 21.7: Major open-cut mining equipment list

Unit type	Make/model	Application	Estimated quantity
Blast hole drill	Ingersoll Rand DR460	Overburden drilling	1
Excavator –600 t	Liebherr LH 9600	Overburden excavation/loading, coal mining/loading	1
Excavator –400 t/350 t	Liebherr LH 9400/ LH 9350	Coal mining/loading	2
Haul truck—220 t	Caterpillar 793	Waste and coal haulage	6
Haul truck—180 t	Caterpillar 789	Waste and coal haulage	5
Dozer	Caterpillar D10	Dump maintenance	2
Dozer	Caterpillar D11	Face clean-up, dump maintenance, ROM coal stockpile	3
Wheel dozer	Caterpillar 854	-	2
Grader	Caterpillar 18M	Overburden contouring/road grading	2
Water cart	Caterpillar 777	Dust suppression	2
Loader	Caterpillar 992	Coal loading	2
Service truck	-	-	1
Road-train	-	Haulage of ROM coal from stockpile to new ROM pad	1
Light trucks	-	-	4
Light vehicles	-	-	22

21.2.5 ROM coal handling and processing

21.2.5.1 ROM coal handling

ROM coal from the underground mining operations will be conveyed by the underground drift conveyor directly to a 100,000 tonne ROM coal stockpile pad located in the MIA. ROM coal from the open-cut mining operations, later in the mine life, will be hauled from the open-cut pit to a ROM coal stockpile pad at the top the southern pit ramp.

ROM coal will be loaded from the ROM coal stockpiles onto double or triple road trains by front-end loaders. Haulage will be via the sealed road to the existing Lake Vermont ROM pad (Figure 21.10). The ROM coal will be fed into one or both of the two existing CHPP ROM coal hoppers, noting that one hopper is adjacent to each of the two existing CHPP modules.

Dozers will be used in conjunction with front-end loaders at the two ROM coal pads to manage the stockpiles.

21.2.5.2 ROM coal reclaim and preparation

ROM coal reclaim and preparation will follow existing processes at the Lake Vermont Mine. The CHPP modules comprise a range of components to process the coal and separate coal reject materials, including:

- crushers;
- screens;
- dense medium cyclones;
- flotation cells;
- separators;
- filters; and
- thickeners.

The CHPP was developed with two processing modules having the capability to produce two product coals—hard coking coal and PCI coal. However, in 2016, analysis of the plant reject stream identified that a scalping reprocess of the rejects could yield additional volumes of a higher ash industrial coal, thereby reducing the volume of reject material and maximising overall resource recovery and value. As such, in 2017, a third plant module was constructed and retrofitted to the existing plant, which has enabled a third product stream of industrial coal to be scalped. The additional industrial coal retrieved equates to approximately 10% to 15% of the total product coal produced.

The primary two CHPP modules, in tandem, can process a ROM coal feed of up to 11.2 Mtpa and produce approximately 9 Mtpa of product coal. No additional CHPP capacity is required to support the proposed Project, as the current authorised limit of 12 Mtpa of ROM coal is sufficient to support the proposed Project.

The CHPP will continue to operate up to 24 hours a day, seven days a week, with a combined design capacity of approximately 800 tonnes per hour (tph) of ROM feed. A description of the operation of the CHPP modules is provided below and illustrated in Figure 21.38.

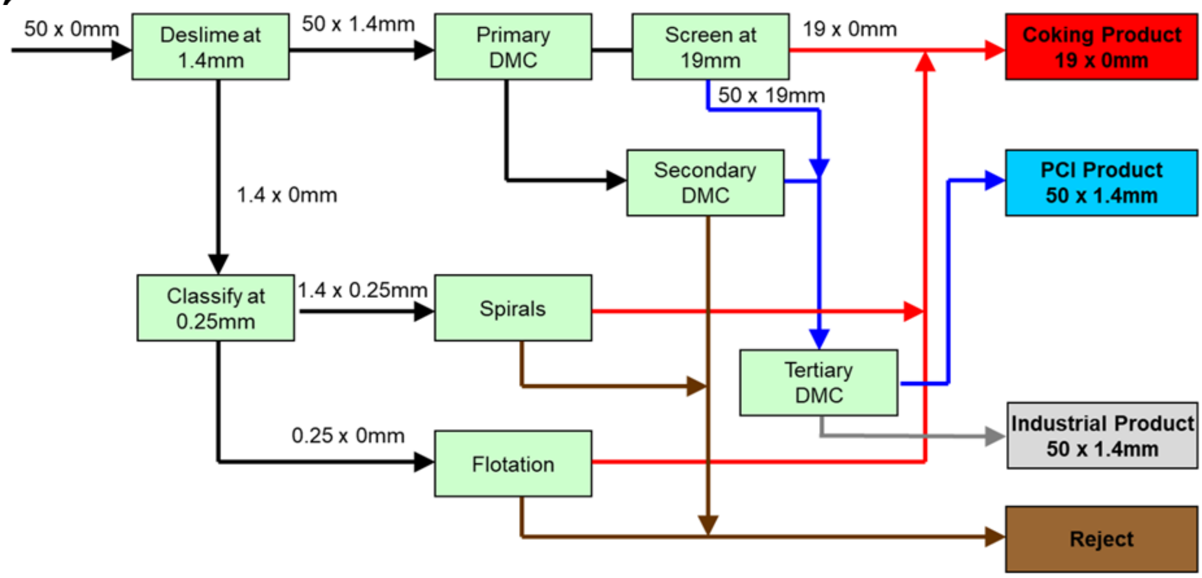

Figure 21.38: CHPP module schematic

Each ROM coal hopper dumps the ROM coal into a primary crusher with a top particle size output of 300 mm. ROM coal from the primary crusher is conveyed to secondary and tertiary crushers with top particle size outputs of 150 mm and 50 mm, respectively. Crushed coal from the tertiary crushers is fed into the raw coal surge bins. From the raw coal surge bins, the ROM coal is fed into a desliming screen with 1.4 mm aperture. Screen overflow (>1.4 mm) is fed into the coarse coal circuit, while screen underflow (<1.4 mm) is fed into the fine coal circuit.

Coal screened into the coarse coal circuit is pump fed into dense medium cyclones for separation. Metallurgical grade magnetite is used as the dense medium in the coarse coal circuit[1]. Product coal from the dense medium cyclones is screened at 19 mm prior to being fed into the clean coal centrifuge before it is transferred onto the product conveyor.

Product coking coal more than 19 mm is conveyed to the coking coal stockpile to be reclaimed by the train loading system. Product coal less than 19 mm is fed into the tertiary dense medium cyclone to produce PCI product coal, which is conveyed to the PCI coal stockpile to be reclaimed by the train loading system.

Coarse rejects from the underflow of the dense medium cyclones will be conveyed to the reject crusher where they will be crushed to less than 32 mm. The coarser waste fractions (i.e. the waste from the cyclones) typically comprise up to 70% to 75% of the total coal reject stream.

Coal screened into the fine coal circuit is fed into classifying cyclones with a 0.25 mm aperture screen. Fractions more than 0.25 mm are fed into spiral concentrators, while fractions less than 0.25 mm are fed into Jameson flotation cells for fine coal beneficiation (Figure 21.38). The reagents added to the fine coal circuit have the effect of generating fine bubbles that attract the coal particles while suppressing any general tendency for the mineral matter present to attach itself to the rising bubbles. Methyl Isobutyl Carbinol and diesel are used in the flotation process[2]. Product coal from the spiral concentrators and flotation cells is fed into the clean coal centrifuge and then onto the coking coal product conveyor. Process water from the spiral concentrators and flotation cell circuits (containing fine rejects) is pumped as a slurry to the tailings thickener. Management of coarse rejects from the reject crusher and fine rejects from the tailings thickener is described in Section 21.2.7.

21.2.6 Product coal handling and transport

[1] While magnetite is routinely recovered with 99.99% efficiency from wash water in the product coal and rejects circuit, some magnetite remains in the product coal and waste streams. Any magnetite in the waste circuit will end up in the co-disposal facilities, while material lost to the product stockpile will contribute to the mineral matter content of the product coal.

[2] Most reagents are recovered with recycled water, with any losses confined to the fine coal product and tailings circuits. Any reagents entrained in the wastes are retained within the co-disposal facilities where microorganisms degrade the organic chemicals present.

As described above, once washed in the CHPP, the coal products will continue to be conveyed to the coal stockpiles west of the CHPP and adjacent to the train load-out facility (Figure 21.39). From the product coal stockpiles, coal will be conveyed to the train load-out bin. The train load-out facility comprises a four valve reclaim tunnel and reclaim conveyor capable of dispatching coal from the site at 4,250 tph. No additional infrastructure or modifications to the existing product coal handling processes are required for the Project. The transport of Project product coal via rail to port is described in Section 21.3.

Once washed in the CHPP, the coking coal and PCI coal products will continue to be conveyed to the coking coal and PCI coal stockpiles located west of the CHPP and adjacent to the train load-out facility (). From the product coal stockpiles, coal will be conveyed to the train load-out bin. The train load-out facility comprises a four valve reclaim tunnel and reclaim conveyor capable of dispatching coal from site at 4,250 tph. No additional infrastructure or modifications to the existing product coal handling processes are required for the Project. The transport of Project product coal via rail to port is described in Section.

21.2.7 Reject management

Approximately 14.8 Mt of coal reject material will be generated from underground mining activities and approximately 2.8 Mt from open-cut mining activities, which will produce a total volume of approximately 17.7 Mt of coal rejects. Annual coal reject volumes are provided in Table 21.5. A Geochemical Assessment has been undertaken by RGS Environmental (2021) of the potential coal reject materials (Appendix D, Geochemical Assessment). A description of the coal reject geochemical and physical characteristics is provided in Chapter 15, Waste Management. The results of the geochemical test work indicate that the characteristics of potential coal reject material will:

- be non-acid forming;
- be slightly alkaline to alkaline;
- have a relatively low-level of salinity; and
- have no significant metal/metalloid enrichment.

This is consistent with the characteristics of coal reject material at the existing Lake Vermont Mine.

Figure 21.39:   Lake Vermont Mine Infrastructure

Coal reject management procedures utilised at the existing Lake Vermont Mine will be adopted for the proposed Project. A co-disposal system (i.e. the simultaneous disposal of coarse and fine reject material) will continue to be used to manage rejects. This will commence with the Project utilising existing, approved co-disposal cell capacity at the existing Lake Vermont Mine from Project Year 1. Prior to capacity being reached within existing cells, further approval will be sought to construct additional cells adjacent to those already existing at Lake Vermont Mine. Beyond this, additional reject disposal capacity is available within approved residual voids at the Lake Vermont Mine. In-pit disposal of coal rejects may, therefore, be considered in future, subject to independent approvals.

The crushed coarse rejects (from the reject crusher) will be mixed with process water (i.e. tailings thickener underflow containing fine rejects) and pumped as a slurry to an active co-disposal facility where it will be sub-aerially deposited. The co-disposal process will result in a single homogenous mixture that, once dewatered, will form a stable solid mass that can be readily rehabilitated. The process water will be separated as decant and recycled to the CHPP. Raw water introduced to the CHPP and recycled process water from the co-disposal facilities will be routinely treated by the addition of flocculants.

The existing co-disposal facilities are regulated structures and have been designed and certified by a suitably qualified and experienced person (RPEQ) in accordance with the relevant government regulations. Lake Vermont Mine also currently operates under a Tailings Disposal Plan in accordance with existing EA conditions. This Tailings Disposal Plan will be updated to detail the procedures for the management of coal rejects generated during operation of the Project.

21.2.8 Ongoing resource definition and exploration activities

The Project resource has been defined through exploration drilling and seismic surveys. During the life of the Project, exploration activities will continue to be undertaken within Bowen Basin Coal owned tenements. This will include in-seam drilling and surface-to-seam drilling to investigate geological structures, coal quality and seam morphology. Disturbance due to exploration activities in areas not authorised to be mined will be rehabilitated in accordance with the ‘Eligibility criteria and standard conditions for exploration and mineral development projects’ (DEHP 2016).

21.2.9 Hazardous substances

The hazardous materials and chemicals to be used for the Project are listed in Table 21.8. Further information on hazardous materials and chemicals is provided in Chapter 16, Hazards and Safety.

Table 21.8: Indicative list of hazardous substances

Hazardous substance	DG class[1]	UN number[2]	Packing group[3]	Purpose/use
Acetone	3	1090	II	Degreasing agent and paint thinner
Ammonium nitrate	1.1D	0241	N/A	Explosive (for blasting)
Acetylene	2.1	1001	N/A	Welding and cutting
Chlorine	2.3 (5.1, 8)	1017	N/A	Water treatment
Diesel	3	1202	III	Fuel for vehicles and equipment, CHPP and explosives use
Liquefied petroleum gas	2.1	1075	N/A	Fuel for forklifts
Lubricant oils, grease and waste oil	9	3082	III	Transmission oils, hydraulic oils, engine oils, drive oils
Oily rags	4.2	1856	N/A	Waste product
Methyl Isobutyl Carbinol	3	2053	III	CHPP

Hazardous substance	DG class[1]	UN number[2]	Packing group[3]	Purpose/use
Sodium hydroxide (caustic soda)	8	1823	II	Degreasing agent and sewage treatment
Paint	3	1263	I	Painting

1 DG Class: Dangerous Goods class means the hazard class of the dangerous goods as stated in the Australian Code for the Transport of Dangerous Goods by Road and Rail Edition 7.7, 2020.

2 UN numbers: A number that identifies hazardous substances and articles (such as explosives, flammable liquids, toxic substances, etc.) in the framework of international transport. UN numbers are assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods.

3 Packaging Group: Assigned to dangerous goods (other than Classes 1, 2 and 7) according to the degree of risk the goods present (I = great danger, II = medium danger and III = minor danger)

21.2.10 Operations disturbance areas

Forecast disturbance resultant of the Project operational phase is outlined in Table 21.9. This includes disturbance associated with:

- subsidence-induced ponding;
- drainage management measures to mitigate subsidence impacts;
- gas drainage management activities; and
- open-cut mining activity.

Table 21.9: Approximate disturbance areas associated with operations

Operations component	Approximate disturbance (ha)
Subsidence-induced ponding impacts (post-drainage mitigation works)	213.0
Drainage management measures to mitigate subsidence impacts	8.3
Gas drainage management activities (new track construction)	0.5
Open-cut mining (including the flood levee and diversion drain) footprint	666.4

As described in Section 21.2.3, the location of mining infrastructure has been selected to minimise vegetation clearance. Vegetation clearance procedures have been developed for the Project and are described in Section 21.12.

An assessment of subsidence-induced impacts on watercourses is considered in 21.9.6.8. Impacts on environmental values resultant from subsidence is described in Section 21.12 and Section 21.13

21.3 Infrastructure

21.3.1 Transport

21.3.1.1 Road Transport

Vehicle access to the Project will primarily be *via* Dysart utilising the Golden Mile Road (council-controlled road) and the privately owned Lake Vermont Mine Access Road (Figure 21.40). It is acknowledged, however, that access to the Project may also be *via* an alternative route from Mackay, which is expected to be used by a minority of Project traffic. This route includes the Golden Mile Road (east of the intersection with the Lake Vermont Mine Access Road) *via* the Fitzroy Developmental Road.

The Lake Vermont Accommodation Village is in Dysart at the intersection of Queen Elizabeth Drive and the Dysart Bypass Road. The village is proposed to be refurbished and extended to provide additional rooms and alleviate ongoing car parking congestion. These proposed works on the existing accommodation village will be subject to separate approval under the Queensland *Planning Act 2016*.

Stantec (Appendix R, Transport Impact Assessment, Section 5) has assessed the existing road transport infrastructure and potential impacts of the Project on the existing road network. No additional infrastructure requirements or upgrades are considered to be required as a result of the proposed Project. The impact assessment and proposed mitigation measures are described in Chapter 20, Transport.

21.3.1.2 Rail Transport and Port Operations

The existing Lake Vermont Mine has a spur line and rail loop branching off the Norwich Park Branch Railway (Goonyella Railway System) (Figure 21.10).

As the Project does not increase the annual product coal output from the Lake Vermont Mine Complex (beyond currently approved levels), there is no requirement for new rail infrastructure at the Lake Vermont Mine. Product coal from the Project will be loaded onto trains using the existing train load-out facility at the Lake Vermont Mine for transportation to port.

Based on the current capacity of coal trains, the Lake Vermont Complex will continue to require an average of 15–20 train movements per week.

Project coal will be transported via port facilities connected to the Aurizon Goonyella Rail system. The rail system interconnects to port facilities, including Abbott Point Coal Terminal north of Bowen, RG Tanna Coal Terminal in Gladstone and the Dalrymple Bay Coal Terminal in Mackay. The existing Lake Vermont Mine product coal is transported to these port facilities for shipping to international markets.

21.3.1.3 Air Transport

Mackay and Emerald Airports are the nearest major regional airports servicing the region, while Moranbah is the nearest regional airport in the vicinity of the Project. The Project workforce will utilise the existing regional air infrastructure as required.

The Project workforce will be predominantly local to the region, so the number of staff using airport facilities will not impact airport operations. Therefore, airport facilities and operations are not expected to be affected as a result of the Project.

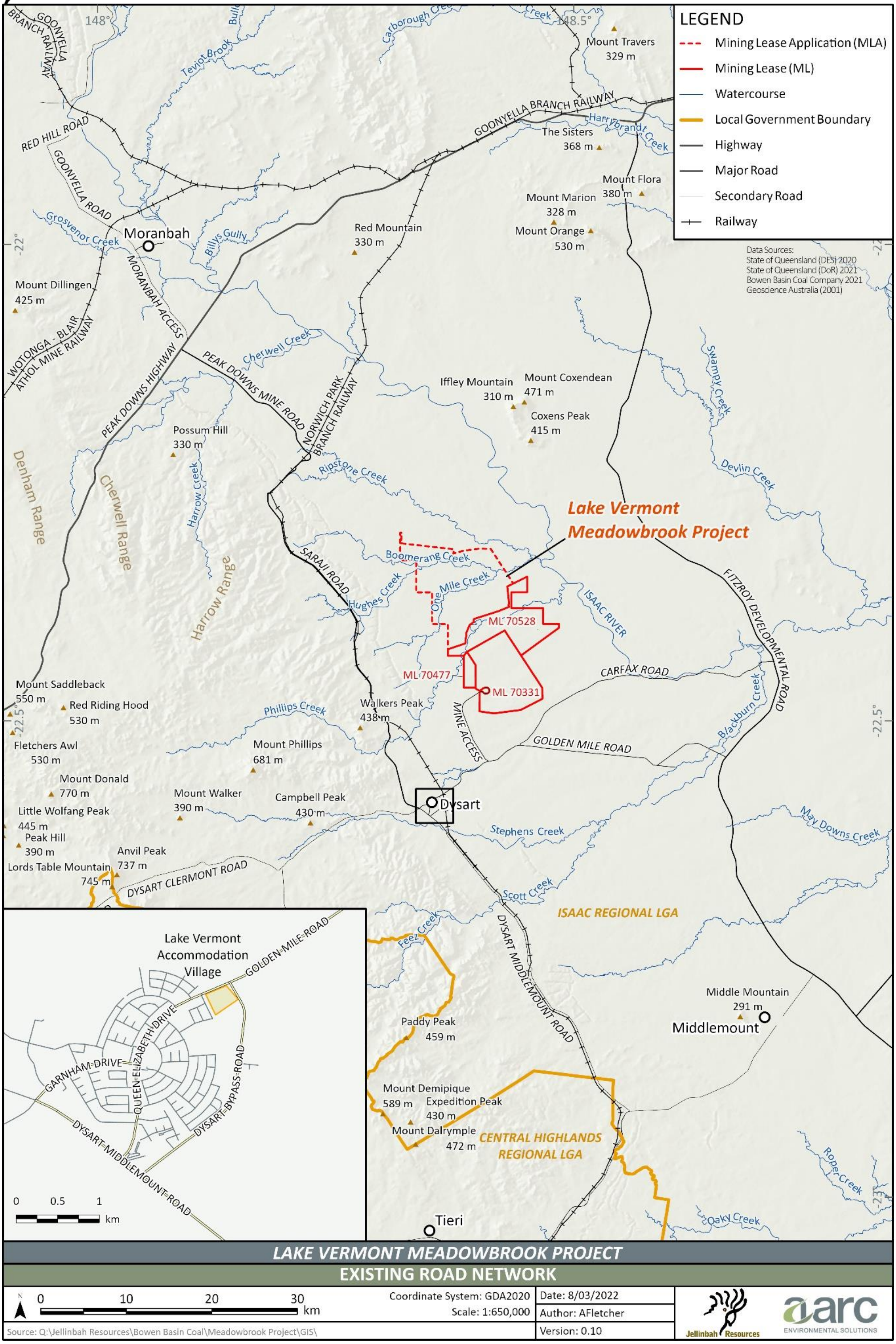

Figure 21.40: Existing road network

21.4 Energy

21.4.1 Electricity Supply

In summary, the Dysart substation, which is jointly owned by Powerlink and Ergon Energy, provides electricity to the Lake Vermont Mine via a 66 kV ETL. The Ergon Energy Vermont substation is adjacent to Lake Vermont Mine's CHPP.

As described in Section 21.2.3.7, additional electricity infrastructure is required to provide power to the Project, including a 66 kV ETL, electrical substation, 22 kV ETL distribution network within the MIA and cables to provide electricity supply to the underground via surface-to-seam boreholes.

The peak permanent power demand during the Project operational period is estimated to be approximately 27 MW. The Dysart substation has sufficient capacity to supply this requirement.

Diesel-powered generators and/or solar power units will be used during the construction phase to supply electricity prior to the electricity infrastructure being developed.

21.4.2 Fuel Supply

A diesel storage facility capable of storing up to approximately 120 kL will be established at the MIA for the refuelling of mining support and transport vehicles. All fuel storage facilities will be constructed and operated in accordance with Australian Standard (AS) 1940 'The Storage and Handling of Flammable and Combustible Liquids'. Diesel will be transported to the site by road tanker from Moranbah or Mackay.

21.5 Telecommunications

Telecommunications for the Project will be provided by an extension of the existing communications systems at the Lake Vermont Mine. A fibre-optic or microwave telecommunications cable will extend telecommunications from the Lake Vermont Mine to the Project MIA within the proposed infrastructure corridor. The telecommunications cable will be co-located with the proposed water and power infrastructure.

An existing telecommunications tower is located at the existing Lake Vermont Mine, with a further telecommunications tower anticipated to be constructed within the proposed MIA.

An underground phone and radio communication system will be controlled and monitored through the mine office control room.

21.6 Sewage treatment

During the construction phase, a primary sewage treatment process will be installed for use until the STP is operational. Septic tanks will collect liquid and sludge waste products, which will be routinely transported off-site to a local council STP for further processing and disposal. The waste sludge is expected to be removed every 12–18 months by a regulated waste contractor for disposal at a licensed facility.

An STP will be constructed within the MIA for operations. Sewage generated at the MIA will be pumped to a package STP by underground sewage pump stations and underground rising mains. The STP will have a secondary treatment capability and the ability to produce Class C effluent for irrigation. The collection system will 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 will be located in a control room at the MIA. Wet weather storage will be located adjacent to the plant, with a capacity to ensure that irrigation of saturated soil is avoided during wet weather periods.

The 'Model for Effluent Disposal Using Land Irrigation' (MEDLI) software has been used by Cardno (Appendix S, Land- Based Effluent Disposal Assessment, Section 8) to model the proposed irrigation of treated effluent to land. MEDLI modelling is discussed in Chapter 15, Waste Management, and the MEDLI modelling report is provided as Appendix S, Land Based Effluent Disposal Assessment (Section 8). Through MEDLI modelling, it has been conservatively estimated that a maximum of 200 workers will be on-site at any one time and that each worker will generate their entire wastewater volume (equating to one equivalent person) of 200 L/day of effluent in accordance with the' Environmental Protection Regulation 2019'.

The proposed irrigation area for treated effluent is shown in Figure 21.19. The area has been proposed as an effluent irrigation area because:

- it is on high ground, well away from waterways (protected by the MIA levee);
- it is close to and at a similar elevation to the primary source of wastewater; therefore, pumping requirements are minimised;
- there is sufficient space to allow for the placement of the irrigation area while maintaining adequate buffers from sensitive receptors, such as waterways, ecosystems, groundwater users and the public; and
- the area has previously been cleared and used for grazing purposes resulting in lower ecological value.

MEDLI modelling determined that an area of approximately 3.6 ha will be sufficient for irrigation, given the site characteristics, soils and vegetation of the area assessed. Treated wastewater from the STP will be disposed of using low height sprays in the designated irrigation area. The effluent disposal system will incorporate an appropriate buffer to comply with guideline requirements, and warning signs complying with 'Australian Standard AS 1319' will be erected.

Treated effluent will not be used for irrigation immediately prior to expected rainfall or if pooling of water is evident at the site to reduce the potential for runoff from the irrigation area. During these periods, treated effluent will be stored in wet weather storage tanks at the MIA. Sewage treatment and management is addressed in Chapter 15, Waste Management.

21.7 Water supply and management

21.7.1 Water supply

Bowen Basin Coal holds a water supply agreement with Sunwater's Eungella Water Pipeline Pty Ltd for the supply of up to 1,500 ML of water per annum to the Lake Vermont Mine. Bowen Basin Coal also has an on-supply contract with Peabody to transfer Peabody's 1,000 ML per year water allocation to the Lake Vermont Mine.

There is sufficient capacity available from within the current water supply agreements to meet the anticipated requirements of the Project. Detailed water balance modelling has been undertaken for the Project and is provided in Section 0 and Appendix F, Site Water Balance and Water Management (section 7).

21.7.2 Water management

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 the water demands of the Project.

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

- drainage diversions of clean catchment runoff around mine infrastructure and other disturbed land;
- capture and treatment of disturbed runoff in sediment basins and other sediment control infrastructure;
- containment of mine affected water in dedicated storages; and
- protection and mitigation of flood flows by the construction of a flood protection levee.

The major components of the Project water management system are described below.

21.7.2.1 MIA and open-cut pit levees

The MIA and open-cut pit are proposed to be protected by levee structures (0.1% AEP) that will be supported by diversion drains to pass clean water around disturbed areas.

The MIA levee structure will be developed during the initial Project construction phase and remain in place until mine closure. At this stage, the levee will be removed and the area rehabilitated. Details on the MIA levee construction is provided in Section 21.10.6.1.

The open-cut pit levee structure will also be temporary—required only once open-cut mining commences in Project Year 20 (indicatively 2045) up until the final overburden profile is achieved and the associated permanent landform is established. Details on the open-cut pit levee construction is provided in Section 21.10.6.1.

21.7.2.2 Raw water supply pipeline

An extension to the existing raw water supply pipeline will be constructed within the infrastructure corridor from the existing Lake Vermont Mine (that sources water from the Eungella Water Pipeline Southern Extension) to the proposed MIA. The proposed 12 km raw water supply pipeline will transfer raw water to a Raw Water Dam at the MIA. Raw water will then be treated through a water treatment plant for use underground.

21.7.2.3 Underground mine dewatering system

Water accumulating within the underground workings (groundwater inflows, excess dust suppression water and washdown water) will be pumped to the surface and into a turkey's nest dam (the Dewatering Dam) within the MIA. Underground dewatering is anticipated to cease in Project Year 23 (indicatively 2048) at the completion of underground operations.

21.7.2.4 Open-cut mine dewatering system

Local runoff and groundwater seepage accumulating within in-pit sumps in the open-cut mining pit will be pumped to the Dewatering Dam (replacing inflows from the underground operations).

21.7.2.5 Return water pipeline

Inflows to the underground operations and associated water management system will exceed demands for mine water within the Meadowbrook operation. The return water pipeline will be used to transfer excess mine affected water via the infrastructure corridor to environmental dams at the existing Lake Vermont Mine. The return water pipeline will be located within the proposed infrastructure corridor for the Project.

21.7.2.6 Potable water supply

The water treatment plant will be located within the MIA and have the capacity to treat raw water from the Raw Water Dam and pipeline are a rate of up to approximately 11 ML/year. Treated water will be stored in 150 kL capacity potable water tanks adjacent to the plant.

Wastewater produced from the water treatment plant will be captured and stored within the mine affected water system and used for dust suppression.

21.7.2.7 Sewage treatment

Sewage generated at the MIA will be pumped to a package STP by underground sewage pump stations and underground rising mains. The STP will have secondary treatment capability and the ability to produce Class C effluent for irrigation. It is conservatively estimated that effluent will be produced at a rate of approximately 40kL/day (based on 200 workers each generating 200 L/day of effluent on-site each day). Wet weather storage will be located adjacent to the plant, with irrigation of treated effluent proposed to occur within the MIA.

21.7.2.8 Raw water dam

The Raw Water Dam will be within the MIA and will temporarily store raw water for use when relatively high-quality water is required—for example, within the underground operations, in equipment requiring clean water for cooling, and feed water for the potable water treatment plant. The Raw Water Dam will be sized to provide continuation of supply in the event of reasonably foreseeable equipment failure (e.g. pump or pipeline failure).

21.7.2.9 MIA dam

Runoff from disturbed areas within the MIA will be contained within the levee system and directed into the Mine Infrastructure Area Dam (MIA Dam), which is proposed for the low area to the east of the ROM stockpile. Runoff captured in the MIA Dam could include runoff from the ROM stockpile, laydown areas, and workshop areas. For this assessment, it has been conservatively assumed that the MIA Dam will capture runoff from the entire area within the MIA levee. In the detailed design, the site drainage system will be configured to minimise the area captured and direct clean runoff from undisturbed parts of the MIA away from the dam.

21.7.2.10 Dewatering dam

The Dewatering Dam will be located within the MIA and store water transferred from the underground and open-cut mining operations. As overviewed in Section 21.2.4.2, water from the Dewatering Dam will be pumped into the adjoining MIA Dam (for management or storage), utilised for dust suppression or sent back to the Lake Vermont Mine to support processing requirements.

The Dewatering Dam will be operated to avoid any overflows; however, emergency overflows via the spillway will be captured within the MIA footprint as a result of the levee system.

21.7.2.11 Sediment dams

During open-cut mining operations, catchment runoff from overburden dumps will be captured in three sediment dams (referred to as the Southern Sediment Dam, Northern Sediment Dam 1 and Northern Sediment Dam 2). Sediment dams will be designed and operated in accordance with the 'Department of Environment and Heritage Protection Guideline—Stormwater and environmentally relevant activities' (DEHP 2017). This guideline states that:

- *For events up to and including a 24-hour storm event with an ARI of 1 in 10 years, the following must be achieved:*
  - *a sediment basin must be designed, constructed and operated to retain the runoff at the site(s) approved as part of the ERA application; and*
  - *the release stormwater from these sediment basins must achieve a total suspended solids (TSS) concentration of no more than 50mg/L for events up to and including those mentioned above. For events larger than those stated above, all reasonable and practical measures must be taken to minimise the release of prescribed contaminants.*

Proposed sediment dams will, therefore, be constructed to contain a 1 in 10-year ARI 24-hour rainfall event. Northern Sediment Dam 1 will be initially constructed by pre-excavating overburden material near the northern corner of the open-cut pit levee. Once the existing ground surface is mined out, sediment dams will be formed into localised depressions north and south of the open-cut pit (refer Figure 21.21). All sediment dams will be removed and rehabilitated as part of mine closure.

21.8 Feasible alternatives and consequence of not proceeding

Project objectives and rationales are described in Section 21.1.3. The Project addresses the decline in coal output that will occur from the existing Lake Vermont Mine operations and secure the long-term future of the Lake Vermont Mine by mining the coal reserves that occur to the immediate north. The Project will enable the Lake Vermont Mine Complex to maintain its current production output of approximately 9 Mtpa for approximately 20 years over a total mine life of approximately 53 years (including final rehabilitation). This will enable the Lake Vermont Mine to continue to be a significant contributor to employment, the Dysart community, the surrounding region and state revenues.

This section describes the alternatives considered in the development of the Project. Assessment of the Project alternatives has focused on maximising resource recovery while avoiding or minimising potential environmental and social impacts.

21.8.1 Mining method

Coal deposits are mined using either open-cut mining methods or underground mining methods dependent on both technical and economic parameters. The Lake Vermont Mine operations currently utilises open-cut mining methods to extract coal from the Vermont and Leichhardt Seams due to the favourable low strip ratio. Both underground and open-cut mining methods are proposed for the Project, which are described below.

21.8.1.1 Open-cut mining

An initial assessment was made to map the economic open-cut limits beyond the approved ML boundaries but within the MDL tenements. Up to three potential small areas amenable to open-cut mining have been identified within the Project area that could operate as 'satellite' pits to the main Lake Vermont Mine. The environmental values and constraints have been assessed, and it has been determined that two of the potential open-cut areas will not be viable due to their locations within flood plain areas and the risk this may present to downstream water users in the Isaac River catchment area. The costs to completely backfill these relatively small pits will make these areas economically unviable.

However, one small open-cut area lies largely outside of flood plains and other environmentally sensitive areas and provides a longer-term extension that can be mined towards the end of the Lake Vermont open-cut mine life. This area provides an additional 13 million tonnes of potentially recoverable coal resource (Table 21.5). The seams within the identified open-cut footprint, however, are relatively steeply dipping.
Given the dip of the seams and the small resource base, dragline methods are considered unsuitable. Based on the seam dips, terrace mining has been deemed the most applicable mining methodology. This resource has, therefore, been proposed for mining and is identified as the Project's open-cut satellite pit.

21.8.1.2 Underground mining

Within the underground resource area, two target seams have been identified that provide a working section thickness amenable to underground mining. As identified in Section 21.2.4.1, the Vermont Lower Seam extends across the whole underground footprint, whereas the Lower Leichhardt Seam only extends across the northern half of the underground area. Within the limits of the underground footprint, the seams range in depth from approximately 150 m to 500 m.

Both Bord and Pillar and Longwall mining methods have been assessed from a technical and economic standpoint.

Utilising longwall mining, it is possible to extract the Vermont Lower Seam and Lower Leichhardt Seam in the northern section of the proposed underground mine.

Bord and pillar

First workings only bord and pillar mining methods were considered. Full pillar extraction was dismissed primarily due the elevated potential underground safety risks and the Queensland regulatory restrictions pertaining to these potential safety implications.

Economic Bord and Pillar mining relies heavily on maintaining high productivity, which is achieved by maximising face cutting time and minimising interruptions to the coal cutting process. The primary interruption to coal cutting is the requirement to install roof and roadway support. A cutting method, known as Cut and Flit or Place Changing, enables the coal cutting sequence to be divorced from the roof support sequence and thereby maintain high productivity. The method is reliant on the temporary self-supporting nature of the immediate face area. As depth increases, the required support density increases, which ultimately requires immediate roof support that reduces the time available for cutting. Typically, economic Bord and Pillar mining is generally limited to depths less than 250 m to 300m.

Based on using a 250 m depth limitation across the underground resource area within the Project, only the southern, shallower portion of the Vermont Lower Seam can be accessed by Bord and Pillar mining. Applying appropriate pillar and roadway dimensions based on geotechnical assessment, the total recoverable coal using this mining methodology will equate to approximately 12 million ROM tonnes. A nominal sized Bord and Pillar operation utilising two to three continuous miner units could produce between approximately two to three million ROM tonnes per annum. This will equate to an underground mine life of between four to five years. This alternative does not provide the annual production volume required or a suitable mine life extension. It also results in a very low resource recovery and potentially sterilises significant underground resources.

Longwall

A longwall mining system allows for the extraction of both the underground target seams across the full depth range within the identified underground mining footprint.

Based on the structural geology, geotechnical and other key mining parameters, plus recognising the overall environmental values and constraints, a range of longwall mine layouts and mining sequence options have been evaluated. The outcomes from this evaluation process are summarised below:

- Seam access from a completed open-cut highwall at the southern extremity of the underground footprint is not practical and results in constraints on future underground output.
- A seam access point centrally located along the western boundary of the underground footprint results in an optimal, lowest operating cost mine layout, and provides for a surface MIA located clear of flood plains and sensitive environmental constraints.
- Extraction of the two underground target seams is technically and economically viable and enables maximum resource recovery and maximum mine life.
- Maintaining production capacity by supplementing reduced open-cut production with underground production and utilising the existing CHPP and train load-out facilities will significantly reduce the magnitude of the overall future environmental impact.

21.8.2 Longwall mining layout and alternatives

During Project feasibility studies, various longwall mine layouts and scheduling alternatives have been evaluated taking due consideration of structural geology, geotechnical aspects, key mining parameters, predicted subsidence and potential impacts on environmental values. The steps included:

- preliminary subsidence modelling to identify potential subsidence effects resulting from various layout options and the interactions from mining both the Vermont Lower Seam and Leichhardt Lower Seam;
- preliminary hydrologic and hydraulic assessment of the various options to identify the potential extent and magnitude of impacts on surface water flows (e.g. identifying whether the impacts resulting from alternative panel orientations is material);
- adoption of a mine layout that minimises impacts on environmental values; and
- maximising resource recovery, production output and economic return.

The preliminary subsidence and hydrological assessments indicated that an underground mining longwall layout with an approximate north–south orientation will minimise subsidence effects and impacts on key environmental values (particularly watercourses). This general panel orientation will provide good alignment with respect to the structural geology and geotechnical characteristics. The assessments also indicated that subsidence impacts on Phillips Creek will be minimised if the longwall panels that extend to the south in the underground mining area are offset from this watercourse.

Assessment of options to mitigate areas of residual ponding (post-subsidence) was also undertaken, resulting in the mitigation drains and bunds proposed for the Project. The proposed mitigation works will minimise the duration of any residual ponding by draining the ponded water away as soon as downstream water levels allow.

The underground roadway design, panel orientation and seam access for the Project also included consideration of the following key parameters:

- structural geology and coal quality;
- ground control (i.e. geotechnical stability and characteristics of the underground mining area);
- optimisation of roadway development to longwall extraction tonnes;
- personnel and materials management (i.e. access to/from the underground mining area);
- ventilation and gas management; and
- mining sequence.

The overall assessment process showed that a centrally located set of main headings oriented east to west with a longwall panel oriented approximately north to south either side of the main headings will provide the most effective mine layout with minimum environmental impact.

21.8.3 Open-cut mining layout and sequence

The location of the Project is primarily defined by the existing Lake Vermont Mine and the coal reserves within MDL 429 and MDL 303. At the time of the Initial Advice Statement for the Project (AARC 2019), the mining of three open-cut satellite pits was proposed. Two of the satellite pits were subsequently removed from the proposed Project in consideration of environmental and economic impacts. Removing the two satellite pits from the Project has resulted in a reduction in the amount of remnant vegetation proposed to be cleared.

An assessment of various open-cut pit layout and sequence options have been undertaken for the remaining open-cut satellite pit to minimise environmental impacts. Option analysis has indicated the satellite pit could be mined in such a way (initially from the south, and then from the north) that the partially backfilled pit could be located outside of the floodplain post-mining. Options assessed for the layout of the open-cut pit also indicated the open-cut pit could be mined to largely avoid the requirement to clear remnant or high regrowth vegetation. Amendments to the open-cut pit layout have been made to the original pit extent to minimise potential impacts. Potential impacts of the open-cut pit on ecological values are assessed in Section 21.12 and Section 21.13.

Mined material that does not contain economic coal is termed waste rock. Waste rock is usually disposed of in the open-cut void and/or waste rock emplacements and progressively rehabilitated. Options considered for disposal of Project waste rock from the open-cut include:

- disposal of mine waste rock material in permanent out-of-pit waste rock emplacements;
- storage of mine waste rock material in temporary out-of-pit mine waste rock emplacements followed by rehandling of mine waste rock to backfill the open-cut; or
- a combination of permanent out-of-pit mine waste rock emplacements and temporary out-of-pit mine waste rock emplacements, together with open-cut backfilling.

The final option has been selected for the Project, as it allows for the overall disturbance footprint to be minimised, while also allowing for progressive rehabilitation of mine landforms.

21.8.4 Infrastructure corridor alignment

Various alignment options for the infrastructure corridor have been assessed in consideration of safety, environmental and existing Lake Vermont Mine operational requirements. The raw water and mine water pipelines, the ETL and telecommunications infrastructure have been co-located with site access to the MIA to reduce the cumulative surface disturbance that will occur with individual alignments.

Alignment options considered include:

- the location at which the infrastructure corridor traverses Phillips Creek and One Mile Creek in consideration of the floodplain and required stream crossing design;
- whether the proposed infrastructure corridor will extend to the CHPP reclaim hoppers or to a new ROM pad area further north at the Lake Vermont Mine (and thereafter be transported via the existing haul road to the CHPP reclaim bins);
- the location of the western access road in consideration of site topography and existing Lake Vermont Mine operational requirements; and
- various configurations for access to the MIA area in consideration of existing infrastructure and Project requirements such as power, water and telecommunications.

The proposed alignment of the infrastructure corridor has been selected to:

- minimise the crossing length and proposed disturbance to Phillips Creek and One Mile Creek;
- traverse higher ground to minimise the extent of the infrastructure corridor traversing the floodplain;
- minimise the amount of remnant vegetation required to be disturbed;
- minimise disturbance to environmentally sensitive areas (such as habitat for threatened species and communities) in consideration of infrastructure requirements within the MIA area (e.g. power supply from the infrastructure corridor to the proposed electrical substation); and
- facilitate the integration of ROM coal haulage with the existing operations.

The location of the proposed infrastructure corridor is shown in Figure 21.10.

21.8.5 Infrastructure and MIA

The primary objective of the Project is to maintain currently approved production levels at the Lake Vermont Mine and address the future marked decline in output from the existing operation. The Project maximises the use of current infrastructure, which will minimise the additional infrastructure that is required. This will provide environmental and economic benefits by reducing the overall footprint of the proposed extension and the capital expenditure.

The existing infrastructure at the Lake Vermont Mine that will be utilised includes:

- existing roads/mine haul roads;
- CHPP;
- rejects co-disposal cells;
- train loading facilities;
- rail loops; and
- connections to raw water, power and telecommunications.

No additional CHPP capacity will be required, as with the current authorised limit of 12 Mtpa of ROM coal, the plant will have sufficient capacity to support the proposed Project. Similarly, no additional rail or port capacity is required, as the volume of coal to be transported via the rail network will be within existing commercial arrangements.

The location of the MIA has been chosen to:

- avoid the sterilisation of coal resources;

- be proximate to underground and open-cut mining activities;
- be at an appropriate distance from open-cut pit blasting activities.
- avoid the clearing of remnant vegetation or, where this is not practicable, it must minimise the clearance of remnant vegetation as much as possible;
- avoid disturbing the habitat of threatened species and threatened ecological communities known to occur or have the potential to occur or, where this is not practicable, it must minimise the area required to be disturbed as much as possible;
- avoid or minimise exposure of infrastructure to flooding; and
- have a relatively flat topography to minimise the earthworks required.

Threatened ecological communities and species known to occur include the:

- Poplar Box Threatened Ecological Community;
- Brigalow Threatened Ecological Community;
- Ornamental Snake;
- Squatter Pigeon;
- Koala; and
- Greater Glider.

Detailed mapping of these communities and species' habitats has also been considered in all aspects of mine planning. This has maximised the potential to avoid and/or minimise disturbance to these habitats.

In light of these considerations, the most appropriate location of the MIA is ultimately considered to be on the western boundary of the Project site, as shown in Figure 21.10.

21.8.6 Workforce Accommodation

Workforce accommodation options for the Project include:

- self-accommodation (i.e. live locally in their own home);
- rental accommodation;
- utilisation of existing accommodation villages in Dysart; and
- utilisation of the existing Lake Vermont Mine Accommodation Village.

Local communities are defined as including communities located within a one-hour drive of the Project. This represents locations where the potential workforce might reside locally, having regard to limitations on travel distances and fatigue management requirements. Dysart is the only town located within an hours' drive of the Project site.

Bowen Basin Coal initially considered an expansion of the Lake Vermont Accommodation Village to accommodate both the construction and operational workforces. However, this will require a significantly higher number of rooms to be constructed than will ultimately be required for operational years. Instead, the Project proposes to utilise the existing commercial accommodation village facilities in Dysart for the construction workforce. The construction workforce will be accommodated in either the commercial Civeo accommodation village or the Stayover by Ausco accommodation village in Dysart, both of which have sufficient capacity to provide for the Project construction workforce. The use of existing villages in Dysart for the construction workforce has been selected to minimise the potential environmental, social and economic impacts of the Project.

The accommodation strategy for the Project has been developed to encourage workers to live locally. Consultation with the IRC has indicated the Lake Vermont Mine Accommodation Village in Dysart is the preferred location to continue to accommodate the operational workforce for the Lake Vermont Mine Complex (i.e. the workforce from Project Year 1 onwards) who do not choose to live locally. Jellinbah Group (a related entity of Bowen Basin Coal) has acquired land adjacent to the Lake Vermont Accommodation Village to enable the village to be extended by up to an additional 100 rooms with additional car parking. The extension will facilitate a progressive refurbishment of the existing facilities and ease congestion issues at the current village.

21.8.7 Not proceeding with the Project

In accordance with the ToR, an assessment of the consequences of not proceeding with the Project has been conducted. Were the Project not to proceed, the following consequences are inferred:

- The output from the existing Lake Vermont Mine will markedly decline beyond 2028 and result in a direct loss of approximately 410 workers over a period of 20 years. This will result in flow-on impacts (both direct and indirect) to the local Dysart community and the surrounding regional economy.
- Alterations to current land use practices will not occur.
- Approximately 122 Mt of ROM coal will not be mined, resulting in a loss of mining royalties.
- There will be a loss of State and Federal tax revenue. Over its life, the Project is estimated to provide approximately $1,919.4 million of additional tax revenues to the Australian Government, and approximately $1,334.5 million to the Queensland Government as compared to what will occur without the Project.

21.9 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). The context, baseline characteristics and water quality objectives of water resources are presented in Sections 21.9.1 to 21.9.5. Potential Project impacts to water resources and avoidance and mitigation measures are presented in Sections 0 to 21.9.7, with a summary assessment of significant impacts in Section 21.9.9. An independent review of the Project geomorphology modelling and assessment was proactively commissioned by Bowen Basin Coal, having been undertaken by Rohan Lucas of Alluvium. An independent review of the Project site water balance modelling and assessment was proactively commissioned by Bowen Basin Coal, having been undertaken by Tony Marszalek of Hydro Engineering and Consulting Pty Ltd. The Project surface water peer review reports are provided as Attachment 7 and Attachment 8 to this EIS.

21.9.1 Context and conceptualisation

21.9.1.1 Environmental values

Environmental values (EVs) are defined as the qualities of water that make it suitable for supporting aquatic ecosystems and human water use (DES 2018). The Project is located within the Isaac-Connors sub-catchment of the greater Fitzroy Basin (Figure 21.5) and within the western upland tributaries of the Isaac River Sub-basin. The waterways in the vicinity of the Project (Phillips Creek, Boomerang Creek, One Mile Creek and Ripstone Creek) are located within the Isaac western upland tributaries region of the Isaac River Sub-Basin (WQ1301).

The Isaac River, and a small portion of the study area, lies within the Isaac and lower Connors River main channel subcatchment of the Isaac River Sub-basin.

The EVs for surface water are presented in Appendix F Surface Water Assessment (section 3). In summary, the key EVs for water that are to be protected for the Project are:

- physical, chemical and biological integrity of the watercourses within the catchment and their amenity as potential water sources for human use and to support aquatic ecosystems;
- the qualitive and quantitative integrity of local groundwater as a potential water source for agriculture or other suitable uses; and

- the integrity of raw water supplies and associated infrastructure in the region.

21.9.1.2 Regional hydrology

The Project is within the Isaac-Connors sub-catchment of the greater Fitzroy Basin. The Isaac River is the main watercourse in the vicinity and flows in a south-easterly direction to the east of the Project area.

The Isaac River catchment commences at the Denham Range approximately 97 km to the north of the Project. The Isaac River flows in a south-westerly direction through the Carborough and Kerlong Ranges before turning to a south-easterly direction near the Goonyella Riverside Mine. The Isaac River converges with the Connors River and then the Mackenzie River 150 km downstream of the Project. Ultimately, the Mackenzie River joins the Fitzroy River, which flows initially north and then east towards the east coast of Queensland before flowing into the Coral Sea south-east of Rockhampton, near Port Alma. Figure 21.5 shows the location of the Project and the Isaac-Connors sub-catchment.

The greater Isaac-Connors sub-catchment area is approximately 22,364 km2 (to the Mackenzie River confluence), out of a total Fitzroy River catchment of 142,665 km2; equivalent to approximately 15% of the overall Fitzroy River catchment.

The catchment area of the Isaac River upstream of the Project is approximately 410,000 ha. This represents 2.9% of the overall Fitzroy River catchment and 18.3% of the Isaac-Connors sub-catchment.

The maximum Project disturbance footprint is approximately 7000 ha and represents 0.05% and 0.3% of the overall Fitzroy River and Isaac-Connors sub-catchment areas, respectively.

The Isaac River is a seasonally flowing watercourse, typically with surface flows in the wetter months from November to March, reducing to little or no flow from about April to October. All waterways and drainage lines in the vicinity of the Project area are ephemeral and experience flow only after sustained or intense rainfall in the catchment. Stream flows are highly variable, with channels drying out during winter to early spring when rainfall and runoff is historically low, although some pools hold water for extended periods. Consequently, stream physical attributes, water quality and the composition of aquatic flora and fauna communities tend to be highly variable.

The Isaac River catchment upstream of the Project comprises mainly scattered to medium dense bushland and grazing land and includes the township of Moranbah. There are several existing coal mines in the Isaac River catchment, including:

- Burton;
- North Goonyella;
- Goonyella Riverside;
- Broadmeadow;
- Broadlea North;
- Isaac Plains;
- Moranbah North;
- Millennium;
- Daunia;
- Poitrel;
- Grosvenor;
- Peak Downs;
- Saraji;
- Norwich Park; and

- Lake Vermont.

In addition, Pembroke Resources' Olive Downs Project is an approved mine currently under construction to the north (Figure 21.3).

21.9.1.3 Local hydrology

The Project area drains to the Isaac River via tributaries of Phillips Creek (to the south) and Boomerang Creek (to the north) shown on Figure 21.41.

The waterways passing through the Project area originate in the Harrow Range, where they are confined in narrow valleys by hillslopes and bedrock. Downstream of the range, they intersect the Saraji Mine, where they are diverted via narrow corridors between open-cut pits. A description of the various waterways in the vicinity of the Project is as follows:

- Ripstone Creek commences approximately 20 km to the north-west of the Project area and traverses in a south-easterly direction north of the Project area before draining into Boomerang Creek approximately 0.5 km to the east of the Project area. Ripstone Creek has a catchment area of approximately 30,300 km^2 to the confluence with Boomerang Creek, of which 12% is within the Project area. Ripstone creek will not be impacted by the Project.
- Boomerang Creek catchment begins approximately 21 km to the west of the Project area and discharges into the Isaac River approximately 4 km east of the Project area. The Boomerang Creek catchment to its confluence with Isaac River is approximately 79,600 ha and comprises the sub-catchments of Ripstone Creek, Plumtree Creek, East Creek, Hughes Creek, Barrett Creek, East Creek, One Mile Creek and Spring Creek. The Project area covers approximately 9550 ha, or 12% of the Boomerang Creek catchment.
- Hughes Creek commences approximately 25 km west of the Project area and drains in an easterly direction to its confluence with Boomerang Creek near the upstream boundary of the Project area. Hughes Creek has a catchment area of 17,500 ha, of which 0.2% is within the Project area. Barrett Creek drains into Hughes Creek upstream of Saraji Mine.
- One Mile Creek commences approximately 15 km south-west of the Project area and drains in a north-easterly direction through the Project area to Boomerang Creek. The channel and catchment of One Mile Creek have been significantly modified where it intersects the Saraji Mine. One Mile Creek has a catchment area of approximately 13,200 ha, of which 2.7% is within the Project area. Spring Creek drains into One Mile Creek approximately 0.6 km upstream of the Project area.
- Phillips Creek runs west to east into the Isaac River south of the Project area. It has a catchment area of approximately 51,400 ha to its confluence with the Isaac River. The Project area covers an area of approximately 2450 ha, or 4.8% of the Phillips Creek catchment. Phillips Creek will not be impacted by the Project.

The proposed underground mining operations underly sections of Boomerang Creek and One Mile Creek and parts of the floodplain of Phillips Creek. The proposed open-cut operations are between Phillips Creek and One Mile Creek. Phillips Creek and Hughes Creek/Boomerang Creek and One Mile Creek are defined watercourses under the Water Act 2000 (Qld).

Land uses within these catchments include cattle grazing and open-cut mining. Mining activities upstream at Peak Downs and Saraji Mine have altered flow paths, with major diversions of Ripstone Creek, Boomerang Creek, East Creek, Hughes Creek, One Mile Creek, Spring Creek and Phillips Creek (Figure 21.42). Upstream tributaries have also been diverted (Figure 21.42). Lake Vermont Resources has approval for a proposed diversion of Phillips Creek adjacent to the Project area; Pembroke Resources has approval for a diversion of Ripstone Creek, neither of which has yet been constructed (Figure 21.42). Existing diversions upstream of the project extend 31 km.

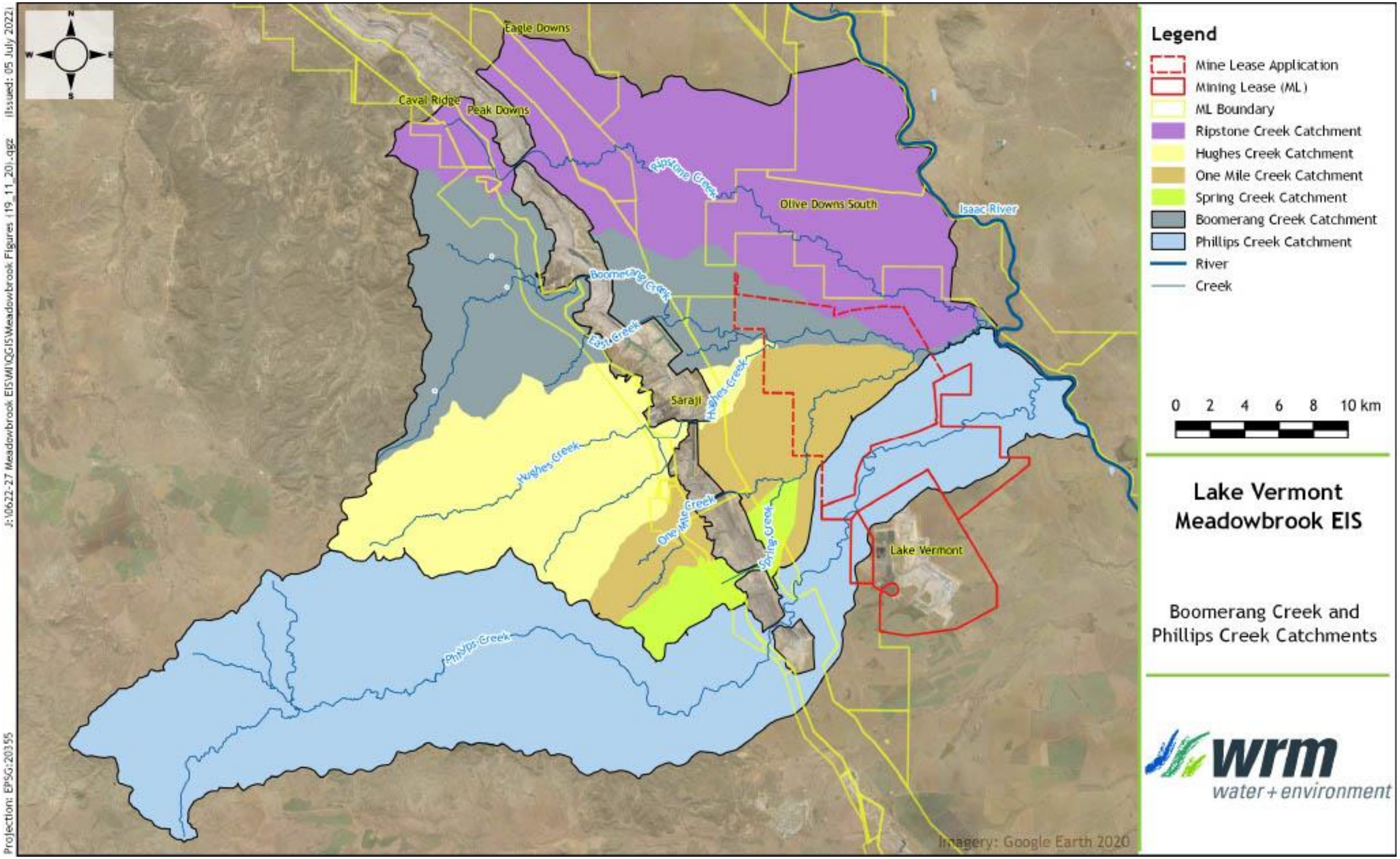

Figure 21.41: Catchments draining through the Project area

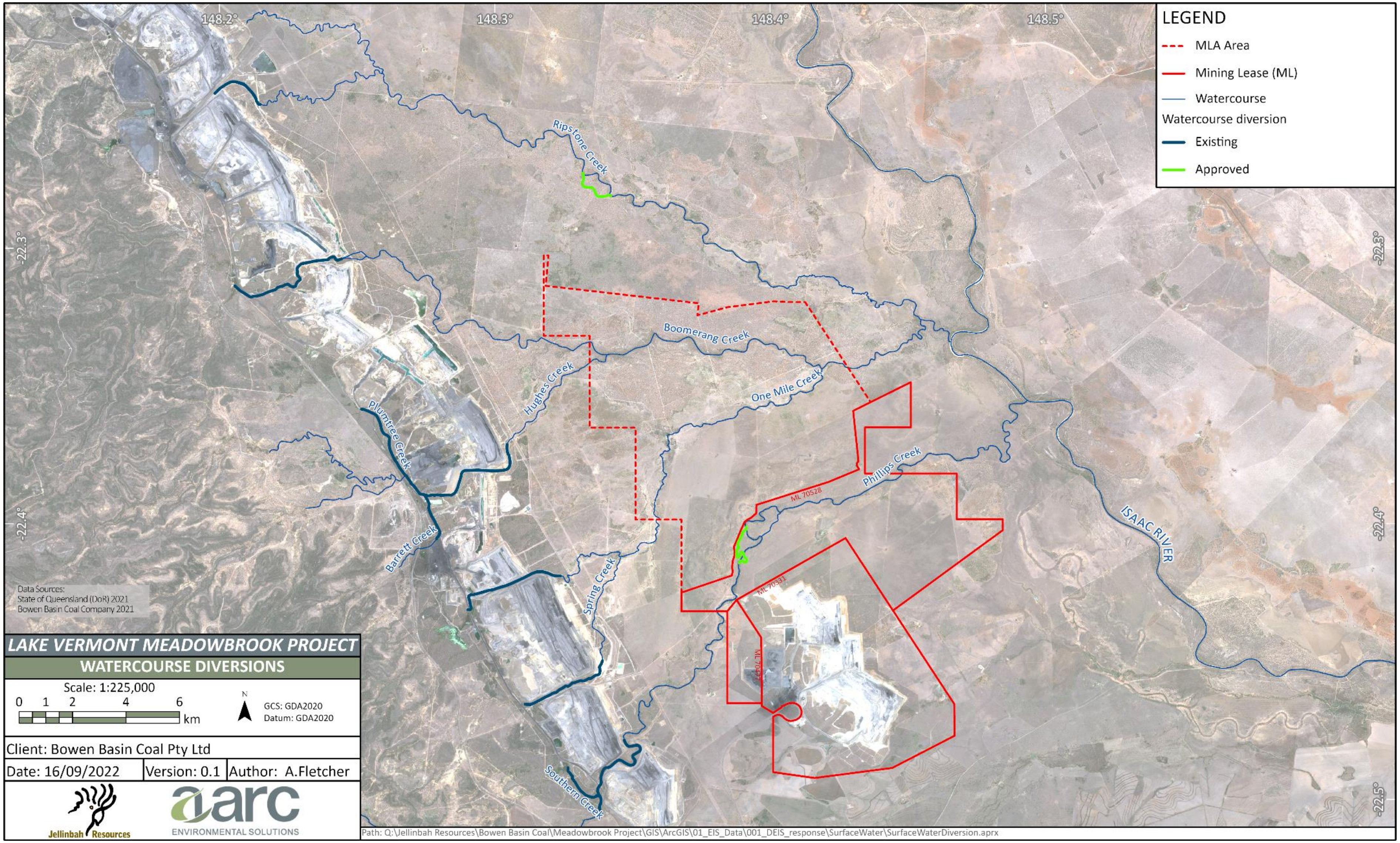

Figure 21.42: Existing and approved watercourse diversions

21.9.1.4 Existing uses

There is currently minimal use of surface water from the Isaac River downstream of the Project, with water use limited to mining, irrigation and stock watering. The Lower Fitzroy and Fitzroy Barrage Water Supply Schemes are located 250 km downstream of the confluence with the Isaac River.

A search of the Queensland Government 'Water Entitlement Viewer' did not identify any surface water users on either One Mile Creek or Boomerang Creek, downstream of the project.

There are five (5) licences to take water from the Isaac River downstream of the Project, which have been issued for mining, irrigation, stock watering, domestic supply and water harvesting. Detailed information regarding individual licences for Isaac River surface water users was obtained through analysis of water licence data provided by the Department of Resources. Some limitations in the dataset include the absence of names of water users, and in some cases, allocated volumes for water licenses due to privacy restrictions. The nearest downstream water entitlement is for a property located on the Isaac River approximately 25 km downstream of the Project.

There are also several historical riparian water access notifications along the Isaac River which authorise stock and domestic supplies only. Section 96 of the Water Act states that an owner of land adjoining a watercourse may take water for domestic and stock purposes without the need for a permit or licence. Details of the volume, source and purpose of the licences are included in Appendix F, Surface Water Assessment (Section 4.4).

21.9.2 Baseline surface water characteristics

21.9.2.1 Streamflow regime

The Queensland Government's Department of Regional Development, Manufacturing and Water operates a nearby surface water monitoring site on the Isaac River at Deverill (GS 130410). Water monitoring data is also available from Phillips Creek at the Tayglen gauge (GS 130409), which was operational from 1968 to 1988. The data available shows flows occur in Phillips Creek approximately 25% of the time. Daily flow records from the Tayglen gauge are shown in Figure 21.43. Surface water monitoring data is also available from monitoring stations on Phillips Creek, operated by Lake Vermont Resources. Locations of these monitoring stations are provided in Appendix F, Surface Water Assessment (section 4.5).

The Tayglen gauge is located at the upstream extent of the Phillips Creek Quaternary alluvium. While very low flows will be observed at that location, they will seep into the deep sandy bed of the downstream reaches of Phillips Creek and not reappear as surface flow. This is consistent with field observations during water sampling and post-flood water level measurements at Lake Vermont, which indicate Phillips Creek typically ceases to flow within 24 hours of the cessation of rainfall. The natural flow regime of One Mile Creek and Boomerang Creek will be similar to the characteristics of Phillips Creek. Flows in One Mile Creek are significantly affected by upstream mining activities.

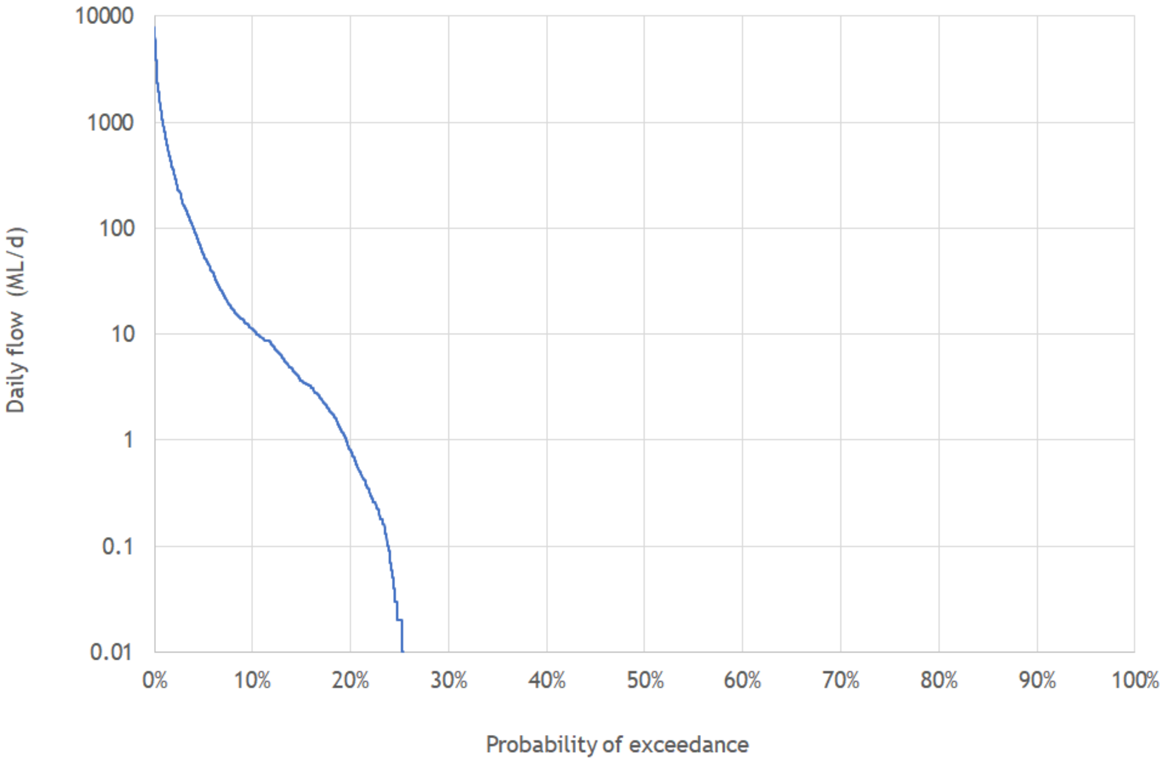

Figure 21.43: Frequency of daily flows recorded at Phillips Creek at Tayglen

21.9.2.2 Flood hydrology

Hydrological and hydraulic models of the Isaac River and local creek catchments have been developed, validated and calibrated to estimate the 50%, 10%, 2%, 1% and 0.1% AEP peak design discharges, as well as the PMF for a range of durations up to 48 hours. Rainfall data (rainfall depths, areal reduction factors and temporal patterns) have been applied in accordance with ensemble event procedures in Australian Rainfall & Runoff (Bell et al. 2019).

The existing-case flood model development and results are discussed in detail in Section 21.10.

Further details regarding current flooding behaviour, flood mapping and flood model development are described in Appendix F, Surface Water Assessment (Section 4.7) and Appendix Z, Flood Modelling.

21.9.2.3 Baseline water quality data

Surface water and stream sediment quality assessments, including physico-chemical sampling, have been conducted to characterise the baseline conditions of the Project and its receiving environment. To perform these assessments, water samples have been tested regularly since January 2021 at the locations shown in Figure 21.44. The figure also shows the locations where water monitoring is being undertaken for nearby projects, the data from which has been used to establish background water quality and to develop site-specific guidelines when sufficient suitable data is available. The methods and results of baseline monitoring are presented in full in Appendix F, Surface Water Assessment (Section 4.6) and discussed in Appendix H, Aquatic Ecology Assessment (Section 6.2). This assessment includes a comparison of WQOs for Upper Isaac River catchment waters published for the Isaac River Sub-basin (DEHP 2011) and ANZECC 'Guidelines for Freshwater and Marine Water Quality' (95% protection). Characterisation of the baseline water quality is as follows:

- Physico-chemical parameters:
  - Dissolved Oxygen (DO) values were outside the WQOs (85–110%) at all sites except for MA1, MA5, MA8, and MA13 in 2020, and MA6 and MA11 in 2021.
  - Electrical conductivity (EC) values exceeded WQO (720 µS/cm) at sites MA3, MA5, MA6, MA12, and MA13 in 2020, and at site MA3 in 2021.

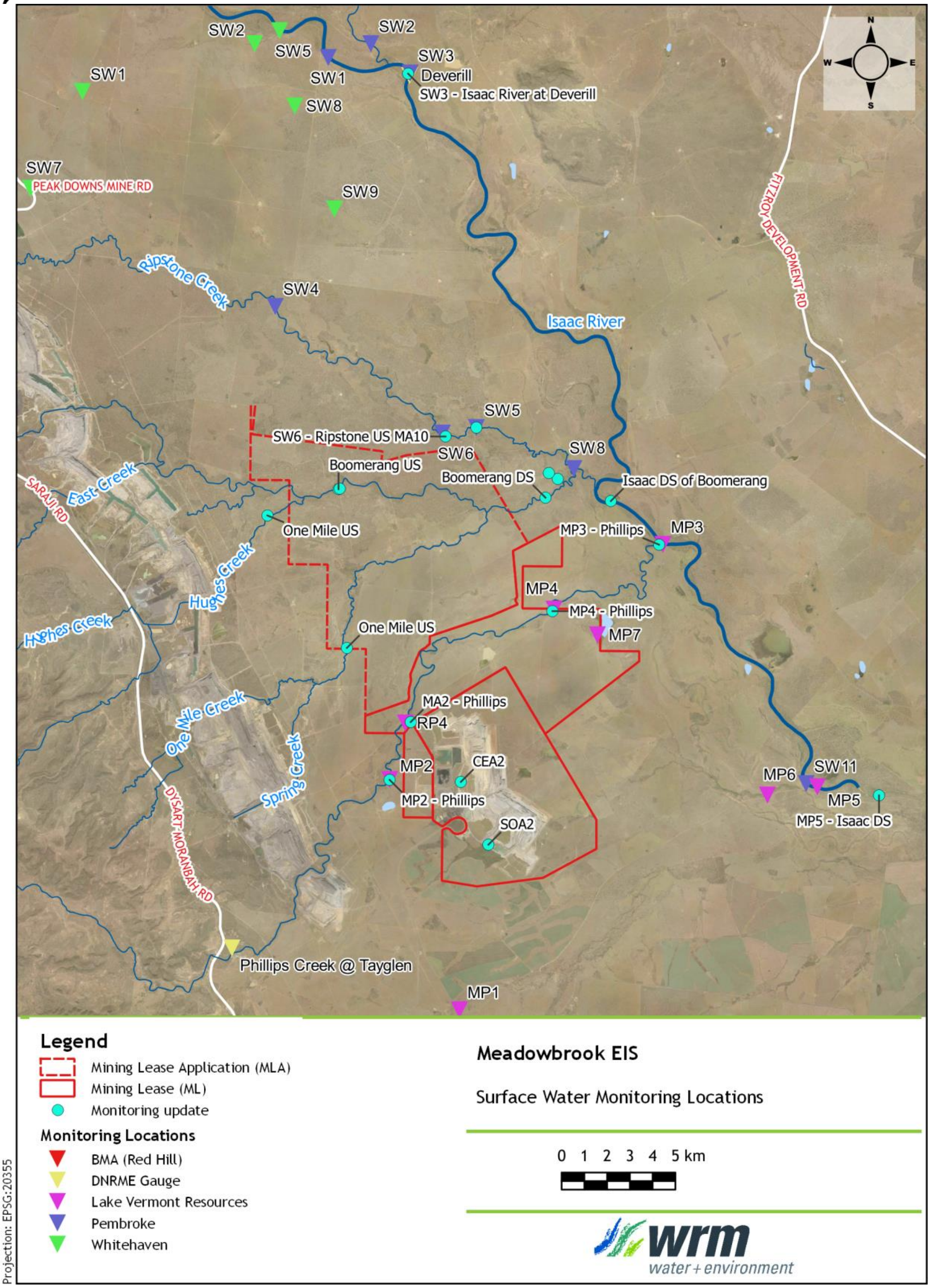

Figure 21.44: Map of monitoring locations used in collection of baseline data

  - The waters of the study area are neutral to alkaline, with pH values outside the WQO range (6.5–8.5) at sites MA3 and MA4 in 2020.
  - Turbidity levels at each site exceeded the WQO for aquatic ecosystems (50 NTU) except for sites MA6 and MA8 in 2021.
  - Suspended solids (SS) exceeded the WQO value (55 mg/L) at sites MA3, MA5 and MA6 in 2020, and sites MA3 and MA12 in 2021.
  - Ammonia levels exceeded the WQO value (0.02 mg/L) at many sites; MA2, MA3, MA5, MA6, and MA12 in 2020, and sites MA6 and MA12 in 2021.
  - Total nitrogen WQO values were not exceeded in 2020 however, it should be noted the 2021 samples were not analysed for total nitrogen.
  - Total phosphorus exceeded the WQO value (0.05 mg/L) at all sites except MA13 in 2020. The 2021 samples were not analysed for total phosphorus.
  - Sulphate exceeded the WQO value (25 mg/L) at all sites except MA8 in 2020, and sites MA6, MA8, and MA11 in 2021.
- Dissolved metal values outside WQO or guideline values were infrequent across all sites. Only zinc exceeded the ANZECC value (0.008 mg/L) at sites MA6 and MA8 in 2020.
- Total metals outside WQO or guideline values have been recorded for several metals across various sites:
  - Aluminium exceeded the ANZECC value (0.055 mg/L) across all sites;
  - Cadmium exceeded the ANZECC value (0.002 mg/L) at site MA12 in 2021;
  - Copper exceeded the ANZECC value (0.0014 mg/L) across all sites. The WQO value (1 mg/L, cattle) was exceeded at sites MA3, MA6, MA8, MA11, and MA12 in 2021;
  - Lead exceeded the ANZECC value (0.0034 mg/L) at sites MA6 in 2020, and MA12 in 2021;
  - Nickel exceeded the ANZECC value (0.011 mg/L) at site MA12 in 2021; and
  - Zinc exceeded the ANZECC value (0.008 mg/L) at sites MA3, MA5, MA6, and MA8 in 2020 and MA3, MA12, and MA13 in 2021.
- Petroleum hydrocarbon exceedances were infrequent across monitored sites:
  - C15–C28 fraction exceeded the ANZECC value (100 µg/L) at site MA8 in 2020.
  - C16–C34 fraction exceeded the ANZECC value (100 µg/L) at site MA8 in 2020.

Several factors such as direct access of cattle to the watercourses and mining activities upstream of the Project (Saraji Mine and Saraji East Project) are likely to influence water quality results and may have resulted in a number of baseline water quality samples not meeting the default guideline values. Nevertheless, water quality in the Project area is considered typical of the slightly to moderately disturbed aquatic ecosystem in this region that this area represents.

Regional Isaac River water quality is presented in Appendix F, Surface Water Assessment (section 4.6.1), the water quality is described to be at or above some regional default guidelines.

21.9.3 Controlled releases

The mine affected water system which will manage runoff and groundwater inflows from the underground, open-cut pit, ROM stockpile and MIA is a closed system designed to prevent any releases of mine affected water to the environment. No provision for controlled releases is included within the water management system.

21.9.4 Surface water quality objectives

The indicators and water quality guidelines relevant to the relevant eVs are described in the Queensland Water Quality Guidelines and ANZG (2018). The conditions of waterways located in the vicinity of the Project are classified as slightly to moderately disturbed ecosystems under the QWQ.

The WQOs relevant to the identified eVs are provided in Table 21.10 and are generally based on the trigger values or Default Guideline Values nominated in the Queensland Water Quality Guidelines and the Australian and New Zealand 'Guidelines for Fresh and Marine Water' (ANZECC & ARMCANZ 2000). Where EVs have multiple WQOs or default guideline value, the lowest value has been adopted.

Table 21.10: EPP (Water) guideline values adopted for the upper Isaac River catchment waters

Parameter	Water Quality Objective	Relevant environmental value
Ammonia N	< 0.02 mg/L	Aquatic ecosystem[b]
Oxidised N	< 0.06 mg/L	Aquatic ecosystem[b]
Organic N	< 0.42 mg/L	Aquatic ecosystem[b]
Total nitrogen	< 0.5 mg/L	Aquatic ecosystem[b]
Filterable Reactive Phosphorus (FRP)	< 0.02 mg/L	Aquatic ecosystem[b]
Total Phosphorus	< 0.05 mg/L	Aquatic ecosystem[b]
Chlorophyll a	< 0.005 mg/L	Aquatic ecosystem[b]
Dissolved oxygen	85-110% saturation > 4 mg/L at surface	Aquatic ecosystem[b] Drinking water[c]
Turbidity	< 50 NTU	Aquatic ecosystem[b]
Suspended solids	< 55 mg/L	Aquatic ecosystem[b]
pH	pH 6.5-8.5	Aquatic ecosystem[b]
Conductivity (EC) baseflow	< 720 µS/cm	Aquatic ecosystem[b]
Conductivity (EC) high flow	< 250 µS/cm	Aquatic ecosystem[b]
Sulphate	< 25 mg/L	Aquatic ecosystem[b]
Total Dissolved Solids	< 2000 mg/L	Stock watering[d]
Colour	50 Hazen Units	Drinking water[c]
Total Hardness	150 mg/L as CaCO3	Drinking water[c]
Sodium	< 30 mg/L	Drinking water[c]
Aluminium	< 20 mg/L < 5 mg/L < 0.055 mg/L (pH > 6.5)	Irrigation[g,e] Stock watering[f] Aquatic ecosystem[a]
Arsenic	2.0 mg/L 0.5 mg/L up to 5 mg/L < 0.013 mg/L	Irrigation[g,e] Stock watering[f] Aquatic ecosystem[b]
Beryllium	< 0.5 mg/L	Irrigation[g,e]

Parameter	Water Quality Objective	Relevant environmental value
Boron	< 5 mg/L < 0.94 mg/L	Stock watering[f] Aquatic ecosystem[k]
Cadmium	< 0.01 mg/L < 0.0002 mg/L	Stock watering[f] Aquatic ecosystem[a]
Chromium	< 1 mg/L < 1 mg/L < 0.001 mg/L	Irrigation[g,e] Stock watering[f] Aquatic ecosystem[a]
Cobalt	< 0.1 mg/L < 0.0014 mg/L	Irrigation[g,e] Aquatic ecosystem[h]
Copper	< 5 mg/L < 1 mg/L < 0.0014 mg/L	Irrigation[g,e] Stock watering (cattle)[f] Aquatic ecosystem[a]
Fluoride	< 2 mg/L	Irrigation[g,e]
Iron	< 10 mg/L < 0.18 mg/L	Irrigation[g,e] Aquatic ecosystem[l]
Lead	< 5 mg/L < 0.1 mg/L < 0.0034 mg/L	Irrigation[g,e] Stock watering[f] Aquatic ecosystem[a]
Lithium	< 2.5 mg/L	Irrigation[g]
Manganese	< 10 mg/L < 1.9 mg/L	Irrigation[g,e] Aquatic ecosystem[a]
Mercury	< 0.002 mg/L < 0.0006 mg/L	Irrigation[g] Aquatic ecosystem[a,i]
Molybdenum	< 0.05 mg/L < 0.034 mg/L	Irrigation[g,e] Aquatic ecosystem[h]
Nickel	< 2 mg/L < 1 mg/L < 0.011 mg/L	Irrigation[g,e] Stock watering[f] Aquatic ecosystem[a]
Selenium	< 0.05 mg/L < 0.02 mg/L < 0.005 mg/L	Irrigation[g,e] Stock watering[f] Aquatic ecosystem[a]
Silver	< 0.00005 mg/L	Aquatic ecosystem[a]
Uranium	< 0.1 mg/L < 0.0005 mg/L	Irrigation[g,e] Aquatic ecosystem[i]
Vanadium	< 0.5 mg/L < 0.006 mg/L	Irrigation[g,e] Aquatic ecosystem[i]

Parameter	Water Quality Objective	Relevant environmental value
Zinc	< 5 mg/L < 0.008 mg/L	Irrigation[g,e] Aquatic ecosystem[a]
Nitrate as N	< 1.1 mg/L	Stock watering[j]
Zinc	< 5 mg/L < 0.008 mg/L	Irrigation[g,e] Aquatic ecosystem[a]
Nitrate as N	< 1.1 mg/L	Stock watering[j]

a Table 3.4.1 of ANZECC & ARMCANZ (2000): trigger values for slightly-moderately disturbed systems (95% level of protection)
b Table 2 of Isaac River Sub-Basin eVs and WQOs: Aquatic ecosystem – moderately disturbed
c Table 4 of Isaac River Sub-Basin eVs and WQOs: Drinking water EV
d Table 10 of Isaac River Sub-Basin eVs and WQOs: Stock watering EV: salinity
e short-term trigger value
f Table 11 of Isaac River Sub-Basin eVs and WQOs: Stock watering EV: heavy metals and metalloids
g Table 9 of Isaac River Sub-Basin eVs and WQOs: Irrigation EV: heavy metals and metalloids
h Section 8.3.7 of ANZECC & ARMCANZ (2000): low reliability guideline
i Based on Limit of Reporting (LOR) for ICPMS/CV FIMS analytical methods
j Based on ambient WQGs for total nitrogen –standard trigger value for contemporary environmental authorities in Bowen Basin
k Based on 95% level of protection in Toxicant default guideline values for aquatic ecosystem protection: Boron in fresh water (ANZG, 2018)
l Based on 95% level of protection in Toxicant default guideline values for aquatic ecosystem protection: Total iron in fresh water (ANZG, 2018)
m Based on (ANZG, 2018) aquatic ecosystems
Note: All WQOs stated in this Table for metals are for dissolved metals

21.9.5 Sediment quality objectives

Baseline levels of metals in sediments are important to investigate the accrual of any pollutants. Stream sediment quality objectives for the Project are adopted from the 'Interim Sediment Quality Guideline (ISQG) values' (ANZECC & ARMCANZ 2000) Table 21.11.

Table 21.11: ISQG Values adopted for the Meadowbrook Project

Contaminant	ISQG Value – Low (mg/kg)	ISQG Value – High (mg/kg)
Arsenic	20	70
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Nickel	21	52
Mercury	0.15	1
Zinc	200	410

21.9.6 Potential impacts

21.9.6.1 Surface water quality

The potential drivers of impacts to water quality due to the Project are detailed in Appendix H, Aquatic Ecology Assessment (section 9.2.6), and are summarised as follows:

- erosion and sedimentation (see Chapter 5, Land Resources);
- uncontrolled water releases;
- mine drainage from waste rock emplacements (see Chapter 6, Rehabilitation);
- final rehabilitated pit landform seepage and overflow (see Section 21.9.6.7); and
- litter, waste and spills (see Chapter 15, Waste Management).

No controlled releases will be used to manage stored site inventories and consequently, there will be no impacts to surface water quality through controlled releases. The impacts to water quality through failure to contain waters in the water management system are assessed through the preliminary consequence category assessment conducted within the site water balance model presented in Section 0 and Appendix Y, Site Water Balance and Water Management Report (section 6).

21.9.6.2 Site water balance conceptual model

A conceptual model of water levels in the residual depression following pit rehabilitation is presented in Appendix X, Rehabilitated Landform Water Balance Report (section 3.1). The key components of the conceptual model are:

- rainfall;
- evaporation from the rehabilitated pit;
- evapotranspiration and runoff generation from catchments;
- outflows to regional groundwater; and
- salt fluxes in each flow component.

A diagrammatic representation of the conceptual model is provided through Figure 21.45.

It is noted that following rehabilitation, the landform would be configured to mostly shed water away from the depression, with some rainfall infiltrating through the in-pit waste rock. Infiltration through the waste rock would seep vertically until it reaches the underlying groundwater surface. Groundwater inflows to the backfilled pit were modelled separately as part of the groundwater impact assessment studies which included allowance for enhanced infiltration through the waste rock. The landform was designed on the basis of the groundwater modelling to ensure there would be no groundwater inflows to the residual depression after levels recover.

Outflows are limited to evaporation and seepage losses to the surrounding aquifer. Water accumulating in the pit depression would also infiltrate into the adjacent waste rock, creating additional water storage in this ‘spoil aquifer’. The rehabilitated pit shell storage vs elevation curve was modified to include additional spoil storage based on a spoil storage vs elevation relationship for the pit shell provided by JBT consulting, assuming the porosity of the adjacent spoil would be 25%.

The focus of the water quality assessment is the potential for salt accumulation within the residual depression (or final pit landform). Sources of salt include catchment runoff. It is anticipated that excess water and dissolved salt would seep from the proposed landform into the spoil under and adjacent to the pit landform. Seepage to the groundwater results in the removal of salt from the surface water system, and thus, if seepage outflow rates are sufficiently high, salts would not accumulate in surface water over time.

In principle, for an initially empty depression, water is expected to accumulate until evaporative losses from the wetted surface area balance the combined influence of catchment runoff, rainfall and groundwater interception. Where catchment inflows are limited, over a sufficiently long timescale, water levels are expected to reach a nominal steady state, with some variation about the steady state level during prolonged periods of wet or dry climate bias. This principle works in reverse for any depression that is filled (e.g. by pumping) above the steady state level prior to relinquishment; water levels will reduce due to evaporation.

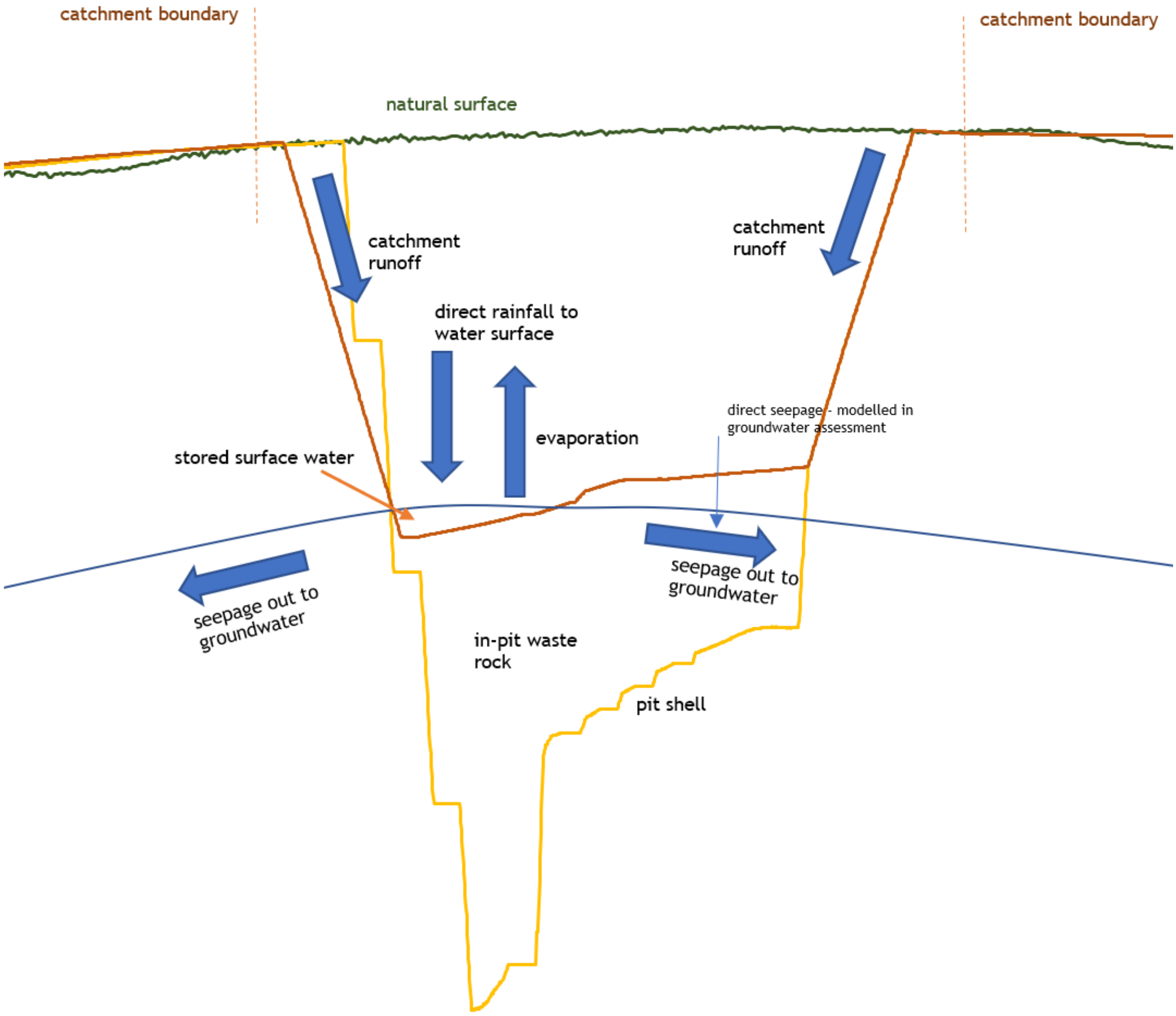

Figure 21.45: Diagrammatic representations of the conceptual surface water model of the rehabilitated pit landform

21.9.6.3 Site water balance numerical model

A GoldSim water balance model has been developed for the Project water management system and for the rehabilitated pit landform. The model incorporates the 'Australian Water Balance Model' to estimate daily runoff from daily rainfall, this model is a saturated overland flow model allowing for variable source areas of surface runoff. The potential effects of climate change were assessed using climate-change adjusted climate data developed as part of the Consistent Climate Scenarios. The model components described in Section 21.9.6.2 and applied methods and model conditions are supported by relevant research from comparable environments. Multiple model scenarios were modelled to account for uncertainty in model parameters and the methodology, configuration, operating parameters and modelled water balance results are presented in Appendix Y, Rehabilitated Landform Water Balance Report (section 5).

The water balance model predicts that the average annual demand for water is estimated to be up to approximately 1,390 ML/year.

The results of the water balance model show:

- The need for imported water from the raw water supply pipeline is expected to decrease from a peak of nearly 1,500 ML/a around Year 5 to less than 200 ML/a in the last 5 years of open-cut operations. The available pipeline water allocation is sufficient to maintain supplies.

- The adopted MIA Dam storage capacity is sufficient to contain inflows throughout the Project life without overflow.
- In-pit water volumes would generally be maintained at relatively low volumes which would not interrupt mining operations. Pumping to the Dewatering Dam would ensure the pit is empty prior to the following wet season.
- During underground operations, the average annual quantity of water returned to the existing Lake Vermont operation would be approximately 1,000 ML/year (ranging from 518 ML/year to 1595 ML/year). During open cut operations, the average would reduce to approximately 404 ML/year (but could range from 0 ML/year to 3,078 ML/year depending on the prevailing weather conditions). Water delivered from Meadowbrook would offset Lake Vermont mine's use of pipeline water. The Lake Vermont Mine water management system has significant potential storage capacity available, and water transferred from Meadowbrook following wet periods could be accommodated within the existing capacity.
- The model results show sediment dam overflows will only be expected in the wettest 10% of historical climate periods. The largest modelled total sediment dam release during open-cut operations was 1,038 ML from North Sediment Dam under very wet climate conditions. Median total project releases are expected to be much smaller – less than 140 ML from each dam over the total project life. The maximum modelled salinity of sediment dam releases was 691 mg/L at the North Sediment Dam.

21.9.6.4 Sediment dams

Sediment dams will be designed to avoid releases and overflow events under most circumstances and in accordance with the Department of Environment and Heritage Protection Guideline - Stormwater and environmentally relevant activities (DEHP 2017). The likelihood and magnitude of sediment dam overflows, as well as the predicted salinity of sediment dam overflows, have been derived from a Project water balance model (Appendix Y, Mine Water Balance, Section 5.4). The water balance model has indicated that overflows from sediment dams will only be expected from 10th percentile wet conditions or greater. The median total overflow volumes have been modelled to be less than 140 ML from any sediment dam over the total Project life. Modelled maximum overflow salinities range from 518 mg/L to 691 mg/L, with maximum downstream salinities during sediment dam overflows of up to 377 mg/L in One Mile Creek and 253 mg/L in Phillips Creek. Increases of this magnitude will have minimal impact on downstream environmental values (Appendix Y, Mine Water Balance, Section 5.4).

21.9.6.5 Mine water dams

To manage any excess Project water, a return water pipeline will be utilised to transfer water to the mine water system at the existing Lake Vermont Mine. The return water pipeline will be located within the infrastructure corridor.

Predictions of the required stored water volume for the MIA Dam have been derived from the site water balance model (Appendix Y, Mine Water Balance Section 5.4.1). The MIA Dam adopted storage capacity has been sized to be sufficient to manage dewatering inflows and outflows to the return water pipeline without overflow throughout the Project life.

21.9.6.6 Open-cut pit

Predictions of inundation of the open-cut pit have been derived from the site water balance model (Appendix Y, Mine Water Balance, Section 4.4). The 90th percentile in-pit inventory has been modelled to be always less than 365 ML. In very wet years, up to 1,063 ML of water could be stored in the open-cut pit at the 1% confidence level. Pit water will be managed by pumping it into the Dewatering Dam.

21.9.6.7 Rehabilitated pit landform

The open-cut pit will be progressively rehabilitated during operations and, on completion of mining, will be partially backfilled with spoil. The design of the final pit area landform is premised on achieving a final elevation above the anticipated recovered groundwater level. A water balance model was developed to assess the behaviour of the rehabilitated pit landform under various climate scenarios (Appendix X, Rehabilitated Landform Water balance Report, section 4.1).

Runoff from the surrounding out-of-pit waste rock emplacement areas post-closure will be directed away from the central pit area to limit the catchment area flowing into the depression to principally that of the depression itself (i.e. an area of approximately 185 ha). The modelled long-term behaviour in the Meadowbrook rehabilitated pit landform shows that due to the relatively large surface of the rehabilitated pit floor, water levels in the depression are expected to rapidly reach equilibrium level and fluctuate within a 1.2 m range above the floor level, well below the overflow level of the rehabilitated pit landform. All climate scenarios yield very similar water levels. The results of the modelling showed the modelled water levels were not sensitive to the seepage rate.

Salinity of water in the rehabilitated pit is modelled to result in fluctuating moderate salinity with median total dissolved solids salinity range of 270 (mg/L) to 465 (mg/L). The maximum salinity of water intermittently within and seeping from the rehabilitated pit landform is predicted to be less than 950 mg/L under the high salinity scenario modelled. This is below the low risk drinking water guideline for beef cattle (ANZG 2018). Further details of the modelled water quality of the rehabilitated pit landform is provided in Appendix X, Rehabilitated Landform Water balance Report (section 4.2)

21.9.6.8 Geomorphology

The potential impacts of the Project on geomorphology of floodplains and streams of the Project area are described in detail in Appendix W, Geomorphological Assessment Report (section 3). The proposed longwall panels underly and will cause subsidence in Boomerang Creek, One Mile Creek and their floodplains, was well as part of the Phillips Creek floodplain to the south.

The channel and floodplain of Boomerang Creek will see a maximum subsidence depth of up to 4.0 m. Maximum subsidence depths in the floodplain between One Mile Creek and Boomerang would be over 4.5 m in localised areas. Maximum subsidence depths on the One Mile Creek channel and southern floodplain will be up to 3.0 m. Maximum subsidence depths on the Phillips Creek northern floodplain will be up to 3.0 m. Hydraulic models have been used to assess the potential flood and geomorphic impacts of the Project.

Hydraulic models were used to assess the potential flood and geomorphic impacts of the Project.

Boomerang Creek

Due to the relatively flat natural ground slopes and the depth of the proposed subsidence, the extent and depth of undrained depressions in the floodplain would significantly increase. These depressions would partially fill with local rainfall and runoff and slowly evaporate or seep into the local soils. The duration of ponding in these depressions would depend on the depth and duration of rainfall, but based on water balance modelling, they would be unlikely to fill completely, and would be expected to store more than 1 m of water less than 10% of the time. However, based on modelling of the 50% AEP flood, the depressions would be expected to fill with Boomerang Creek floodwater at least every few years. The ponded water would then persist until it evaporated or seeped into the underlying soil. In the absence of seepage, depending on their depth, the ponds could then be expected to persist for several months post filling.

In small floods, the proposed subsidence would result in an increase in the amount of Boomerang Creek floodwater flowing towards One Mile Creek. Velocity increases of 0.25 m/s to 0.5 m/s are predicted over a broad area where Boomerang Creek floodwater approaches One Mile Creek. However, the increased velocities would be insufficient to erode the floodplain except in localised areas as it drains into subsidence troughs.

The proposed subsidence would result in a series of troughs in the channel bed due to the interaction of the differential settlement across the nine longwall panels and the intervening unmined pillars in each of the two overlying coal seams. These areas would see decreases in channel velocity, bed shear and stream power, causing reductions in sediment transport capacity in each trough, and promoting further aggradation of the bed (relative to the top of bank level) in these areas. The subsidence troughs in Boomerang Creek are expected to rapidly aggrade sediment during flow events from the abundant sediment present within the catchment. Notwithstanding the expected rapid in-filling of troughs, changes to stream morphology will be monitored according to the Subsidence Management Plan and include monitoring for erosion with demonstrable impact on channel form (refer Chapter 5, Section 5.5.1 for further detail). Where these impacts occur, bank protection measures will be applied and are expected to be effective in securing stream banks and prevent the development of streambank erosion.

There would be increased channel velocity, bed shear and stream power as the channel drains into the mine subsidence zone at Ch 9,250. The deep bed sediments in these reaches are expected to erode relatively quickly as the channel morphology changes to reflect the higher bed grade. This may also lead to marginal increases in bank erosion as the channel capacity increases.

Channel velocity, bed shear and stream power would also increase as flow enters the second and fourth subsidence troughs (Ch 10,200, and Ch 11,700 to Ch 12,000). The bed sediments on the downstream side of these localised elevated sections of the stream bed are expected to scour and headward erosion may potentially occur to the extent that this elevated section of stream bed will be eroded down to the upstream and downstream bed levels (which will rise as the bed aggradation occurs). The expected aggradation relative to the bank levels could accelerate the potential abandonment of the existing Boomerang Creek channel. It should be emphasised that given the number of remnant channels and abundant sediment supplies in the catchment, a new Boomerang Creek channel could form in the absence of the proposed subsidence. Hydraulic modelling of earlier stages of underground operations indicated that the avulsion risk would be greatest in Year 17 prior to the development of the easternmost panels.

During initial flows, local incision and bank erosion can be expected over the pillars between subsidence troughs. However, given the abundant sediment supplies in Boomerang Creek, the sand bedload will infill the troughs such that the bed grade should revert to approaching the pre-mining grade over time. The expected aggradation relative to the bank levels could accelerate the potential abandonment of the existing Boomerang Creek channel. It should be emphasised that given the number of remnant channels and abundant sediment supplies in the catchment, a new Boomerang Creek channel could form in the absence of the proposed subsidence.

It should be noted that Alluvium (2019) found that depending on the timing of flows and mining and the infilling of subsidence at the proposed Saraji East underground mine through Hughes and Boomerang Creek would potentially cause downstream bedload starvation for a period and this could impact the timing of infilling of the bed at the Meadowbrook Project.

One Mile Creek

The proposed subsidence would result in a series of 8 main troughs in the channel bed due to the differential settlement across the longwall panels and the intervening unmined pillars in the one overlying coal seam which are aligned approximately perpendicular to the channel.

All troughs associated with the One Mile Creek floodplain would be directly connected to the main channel – and during flood flows, water would flow laterally into the subsidence areas. The north-flowing reaches of the One Mile Creek floodplain would also experience minor impact from the construction of the temporary levee proposed around the northern end of the open cut pit mining area. At the completion of open cut mining, the levee would be decommissioned, and the One Mile Creek floodplain would be restored to pre-mining levels through the placement of in-pit overburden in the final landform.

Within the subsidence zone, peak flood levels would be reduced by up to approximately 1.3 m and 1.5 m in the 50% AEP and 2% AEP floods respectively. In floods larger than the 2% AEP event, the impact of subsidence on downstream flows would be minimal.

Parts of the channel within subsidence troughs would see decreases in channel velocity, bed shear and stream power, causing reductions in sediment transport capacity in each trough, and promoting further aggradation of the bed (relative to the top of bank level) in these areas.

There would be increased channel velocity, bed shear and stream power as the channel drains into the mine subsidence zone. Velocities in this area would remain less than guidelines values but given the relatively fine sediment in this area and the apparent limitation in sediment supply, these reaches are expected to erode as the channel morphology changes to reflect the higher bed grade. This may also lead to increases in bank erosion as the channel capacity increases.

Channel velocity, bed shear and stream power also increase as flow enters the second to fifth subsidence troughs. The bed sediments on the downstream side of these localised elevated sections of the stream bed are expected to scour and headward erosion would occur through this elevated section of stream bed.

The subsidence troughs in Boomerang Creek are expected to rapidly aggrade sediment during flow events from the abundant sediment present within the catchment. Notwithstanding the expected rapid in-filling of troughs, changes to stream morphology will be monitored according to the Subsidence Management Plan and include monitoring for erosion with demonstrable impact on channel form (refer Chapter 5, Section 5.5.1 for further detail). Where these impacts occur, bank protection measures will be applied and are expected to be effective in securing stream banks and prevent the development of streambank erosion.

For the subsidence impacted areas of the land adjacent to One Mile Creek, minor drainage channels are proposed to drain the subsidence panels where practicable, ponding of runoff captured in the floodplain between Boomerang and One Mile Creeks would effectively reduce the local catchment draining to One Mile Creek by approximately 900 ha (6.9%). During open-cut operations, water which would normally flow to One Mile Creek would be intercepted by the proposed mine water management system within the levees protecting the mine pit and sediment dams. During the period of peak open-cut mining disturbance, the temporary maximum additional reduction in catchment area to One Mile Creek would be approximately 300 ha (i.e. a total of 1,200 ha in catchment reduction). At the completion of mining and rehabilitation of the final landform, this would reduce by approximately 150 ha (i.e. a total catchment loss of 1,050 ha - 8%).

This catchment loss would impact the downstream 4 km to 6 km reach of One Mile Creek in minor runoff events, (which has been impacted by historical mining activities in the upper catchment) but would not significantly further alter the flow regime. The impacts of the catchment loss would be minimal downstream of the confluence, where it would make up 1.8% of the 48,900 ha total catchment.

Phillips Creek

The main channel of Phillips Creek will not be impacted by the proposed subsidence. However, four underground panels crossing the northern Phillips Creek floodplain will impact flooding and drainage. The proposed temporary levee around the south-eastern end of the open-cut mining area will also impact flood flows until it was decommissioned, and pre-mining ground levels restored at the end of mining.

A minor drainage channel will be constructed around the toe of the levee to ensure the floodplain is free draining. Drainage channels will be cut through the pillars separating the subsidence troughs to allow free drainage of catchment runoff through the subsidence zone. Small embankments are also proposed across the subsidence panels to restrict the flow of water from Phillips Creek to One Mile Creek.

21.9.6.9 Reductions in streamflow

The Project has the potential to reduce streamflow in streams local to the Project area. Potential impacts to streamflow are discussed in Appendix W, Geomorphological Assessment Report, as well as summarised as follows.

Residual post-subsidence depressions

Ponding of runoff captured in the floodplain between Boomerang and One Mile Creeks will result in reductions in localised streamflow, that would otherwise be available to the downstream receiving environment.

It is estimated that subsidence depressions will reduce the local catchment draining to One Mile Creek by approximately 9 km2 (or 6.9%). This catchment loss would impact the downstream 4 km reach of One Mile Creek in minor runoff events (which has been impacted by historical mining activities in the upper catchment) but would not significantly further alter the flow regime. The impact of this catchment loss would be minimal downstream of the confluence of One Mile Creek and Boomerang Creek, where it would make up 1.8% of the 489 km2 total catchment. (Appendix W, Geomorphological Assessment Report, Section 3.3.4.1).

This catchment loss is noted as being an overestimate, as following prolonged rainfall, the volume of local overland flow would be sufficient to fill and overflow subsidence depressions. The volume of overland flow captured in the main floodplain depressions was estimated using a daily timestep surface water balance model (as per Appendix W, Geomorphological Assessment Report, Section 3.3.4.1).

Water balance modelling of the overland flow into the One Mile Creek depressions shows their median stored volume would total only 20 ML, but they could intercept approximately 283 ML/a of catchment runoff on average (median 96 ML/a). (Appendix W, Geomorphological Assessment Report, Section 5.3). As noted above, this is likely to be an overstatement of volumes due to limitations / challenges in modelling such scenarios.

Notwithstanding this, significant commitments have been made by the proponent to limit the volume of overland flow that may be trapped within subsidence depressions. These mitigations include the proposed construction of:

- mitigation bunds: to prevent surface water ingress into subsided areas; and
- mitigation drains: to facilitate water egress from subsided areas (where topography allows).

These mitigations are discussed in detail through Chapter 9, Flooding & Regulated Structures, Section 9.4.4.3.

Further, since the time of the public notification of the EIS, an additional commitment has now been made to limit the volume of water retained in subsided depressions (as part of the final submitted EIS). Specifically, the proponent proposes to use pumping equipment to further reduce the total volume of overland flow captured, by pumping water out of subsided depressions into downstream flow paths, when accumulated volumes become significant.

Pumps will be located at the deepest sections of each subsidence depression and deliver water to the pre-mining overland flow path. The effectiveness of pumping out each of the depressions at a nominal rate of 50 L/s (4.3 ML/d) when water depth exceeds 0.5 m above the lowest point, was tested using the water balance model. The results show that pumping reduces the volume captured in the depressions to 11% of the total runoff draining to the depressions (Appendix W, Geomorphological Assessment Report, Section 3.3.4.1).

It is noted that no works are proposed by the Project, for the purposes of capturing overland flow. Indeed, proposed works are only designed to limit the accumulation of overland flow. As such, a licencing requirement under the Fitzroy Water Plan is not considered to arise for the Project. Nonetheless, an assessment of impacts to overland flows has been provided as part of this EIS, to ensure consideration of the full range of potential impacts.

Post mining, it is expected that subsidence depressions will naturally refill with sediment. Based on estimated average sediment supply rates to the catchment, in the absence of significant depletion of sediment in the reach of Boomerang Creek between the two projects, it is expected to take 15 to 45 years for the Meadowbrook subsidence depressions to refill with sediment (post-mining). Complete replenishment of residual sediment loss attributable to the Saraji East project could take a similar time, however large floods occurring after the completion of mining could significantly reduce these timeframes. (Appendix W, Geomorphological Assessment Report, Section 3.3.4.1).

Mitigations such as the backfilling of subsidence depressions was considered as part of Project studies, however this option was discounted as a result of the more significant impact it presents to environmental values in these areas. Indeed, it is preferable to maintain ecosystem function within subsided areas, as opposed to presenting a greater impact within these footprints (resultant of building a new overlying landform). Further, there is also some argument that ponded areas arising as a result of subsidence will support increased habitat availability for some locally present threatened species (eg ornamental snake, squatter pigeon and greater glider).

Environmental impact assessment has not been reconsidered in respect of this new commitment, meaning ponding impacts are overstated. With catchment losses downstream of the Once Mile Creek and Boomerang Creek confluence representing just 1.8% of the 489 km2 total catchment, minimal impact to streamflow is therefore expected as a result of subsidence depressions. Further, water retained in subsidence depressions will remain available to the environment, supporting local habitat value and providing a source of replenishment for localised alluvium.

Potential loss in the open-cut mining area

During open cut operations, water which would normally flow to One Mile Creek and Phillips Creek would be intercepted by the proposed mine water management system within the levees protecting the mine pit and sediment dams. The construction of the sediment dams would be staged, and in large rainfall events they could overflow. However, during the period of peak open cut mining disturbance, the temporary maximum additional reduction in catchment area draining to the downstream 6 km reach of One Mile Creek would be approximately 300 ha. At the completion of mining and rehabilitation of the final landform, this would reduce to approximately 150 ha (i.e. a total catchment loss of 1,050 ha – 8%).

At Phillips Creek, there would be a corresponding 30 ha temporary loss of catchment during operations and a loss of 3 ha after rehabilitation of the final landform. These losses are insignificant in terms of impacts to the flow regime of Phillips Creek and its floodplain.

Potential loss to underground workings

Maximum depth of continuous subsurface subsidence cracking above the workings predicted from site conditions and observations at similar operations is predicted in Appendix A, Subsidence Assessment (Section 5.1.5). Cracking is not predicted to extend from the underground workings to ground surface and no potential loss of surface water to underground workings is predicted.

Potential loss to surface cracking

Surface subsidence cracks will develop in the proposed longwall mining areas and are predicted to extend to a maximum depth of 15 m, with the majority less than 1 m deep (Appendix A, Subsidence Assessment, Section 5.2.2.3). Cracks of this depth would not result in the loss of water from the alluvium associated with the watercourses overlying the underground workings and will not result in the loss of surface water to underground workings (Appendix F, Surface Water Assessment, Section 7.6.4). Indeed, there is no connectivity of cracking expected between the surface and the coal seams targeted for mining (Appendix A, Subsidence Assessment, Section 7.6).

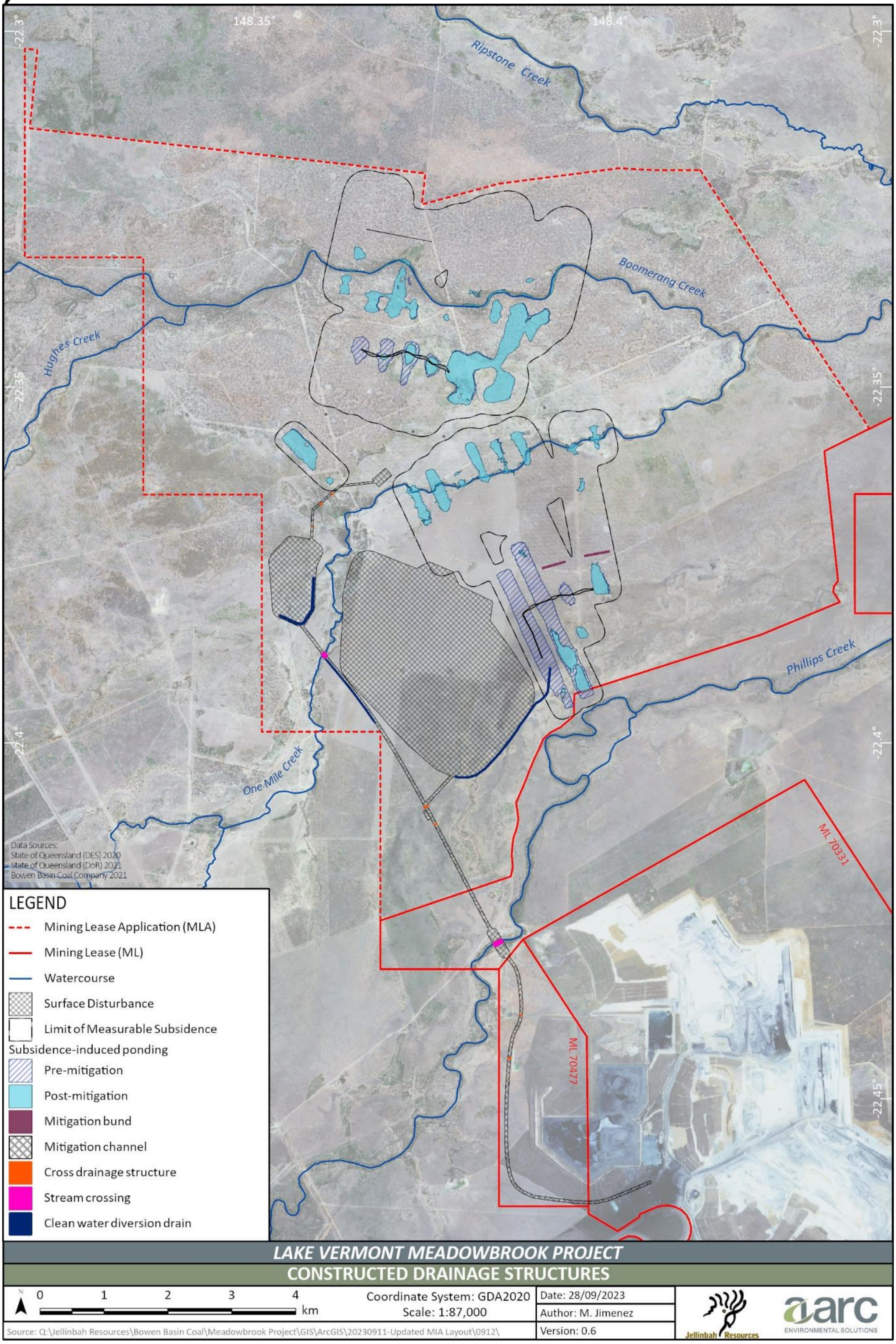

Figure 21.46: Maximum subsidence extent and depth

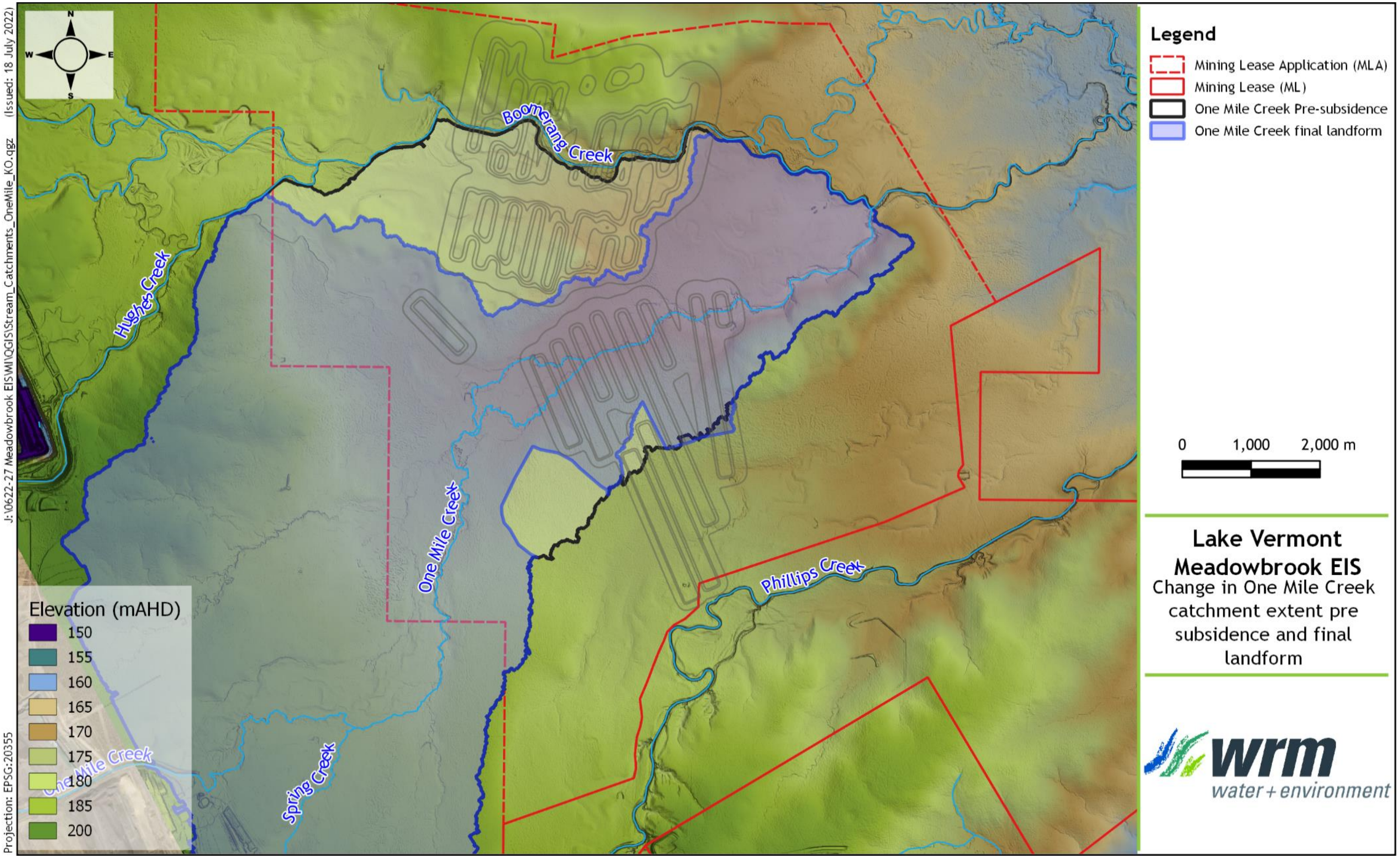

Figure 21.47: Changes in One Mile Creek catchment

21.9.6.10 Flooding impacts

Flood hydrology was modelled for the Project area in in accordance with the most recent ensemble event procedures in Australian Rainfall & Runoff (Appendix F, Surface Water Assessment, Section 7.3 and Appendix Z, Flood Modelling, Section 1.1). The assumptions, limitations and risks associated with this model are described at Section 7.2, Appendix F, Surface Water Assessment. Potential flooding impacts associated with the Project are addressed in Section 21.10.

21.9.6.11 Site water demand

During underground operations, the average annual demand for water is estimated to be up to approximately 1,390 ML/year. The principal water demand would be for raw water for underground operations which would become mine affected water after use in the underground operation. Minor quantities of water captured in the water management system would be used for washdown and dust suppression in the surface operations.

During open cut operations (and after the cessation of underground mining), the average annual water demand would be significantly reduced (to approximately 180 ML/year). While the infrastructure corridor linking the new MIA to the existing operation will include sealed access and coal haulage roads (which will not require watering for dust suppression during operations), water would be used for dust suppression on haul roads in the active mining area.

If on-site supplies are insufficient during dry periods, they would be supplemented with additional imported raw water. However, there will generally be an excess of water on-site, particularly during underground operations, and excess water would be returned to the existing Lake Vermont Mine for reuse within the site water management system via a pipeline along the infrastructure corridor.

Water pipeline supply and transfer volume

Predictions of water pipeline supply and transfer volumes have been derived from the site water balance model (Appendix Y, Site Water Balance and Water Management, section 5.6) The need for raw water supply is expected to decrease from a peak of almost 1,500 ML per year to less than 200 ML per year in the last five years of operations. Mean transfer volume requirements are expected to peak at Project Year 5 at 1,320 ML per year. Modelled very wet conditions (99th percentile) during open-cut pit mining predicts transfer volumes of 3,000 ML per year.

21.9.6.12 Regional water availability

The Project will source water from a raw water supply pipeline constructed within the infrastructure corridor. The raw water supply line will connect to the existing raw water supply pipeline at the Lake Vermont Mine that sources water from the Eungella Water Pipeline Southern Extension. Bowen Basin Coal holds a water supply agreement with Eungella Water Pipeline Pty Ltd for the supply of up to 1,500 ML of water per annum and an on-supply contract with Peabody to transfer 1,000 ML per year of their water allocation to the Lake Vermont Mine. There is sufficient capacity available from the current water supply agreements to meet the anticipated requirements of the Project. The Project will not require any licensed allocation of water from the Isaac River and will not impact existing licence allocation holders.

Water demands for construction will be met by the capture of incidental rainfall and runoff within the Project water management system, as well as water truck transfers from the existing Lake Vermont Mine. A diversion drain is proposed to be developed during the construction phase to divert clean water around the southern extent of the MIA levee. And additional diversion drain is also proposed to be constructed during the Project operational phase to divert clean water around the southern extent of the open-cut pit levee. Diversion drain design and construction is discussed in Section 21.10.6.2.

21.9.6.13 Wetlands

No wetlands or watercourses identified as high ecological value waters are located within the study area or surrounds. The Project will not result in any direct disturbance to HES wetlands or HES wetland protection areas. However, HES wetlands could be impacted indirectly through changes to hydrogeological or hydrological flows.

The water management system has been designed to minimise potential impacts on HES wetlands. The Project will not result in a significant impact on prescribed wetlands. The assessment of potential impacts on prescribed wetlands, including HES wetlands, is detailed in Section 21.12, Section 21.13, and Section 21.15.

21.9.6.14 Cumulative impacts

Assessments of cumulative impacts on water resources are detailed in:

- Appendix E (section 6.2.5), Groundwater Assessment;
- Appendix F (section 7.7), Surface Water Assessment;
- Appendix H (section 9.3), Aquatic Ecology Assessment; and
- Appendix Z, Flood Modelling Assessment Report.

No controlled releases of mine-affected waters are predicted to occur and no provision for an authorised release point is proposed. Consequently, no impacts to surface water quality or cumulative impacts to surface water quality as a result of mine-affected water releases are predicted to occur. Hydrological and hydrogeological modelling conducted to assess impacts on water resources has included all current and known future coal mining and gas extraction operations and no cumulative impacts to surface water environmental values were identified from geomorphology, reductions to streamflow or the rehabilitated pit landform.

Regional flood modelling has determined that cumulative flooding impacts of the Project and the approved Olive Downs project will extend onto the Isaac River floodplain downstream of the Project. However, the flooding impacts of the Project will be minor, and the cumulative impact of the Project and the Olive Downs project will also be minimal.

A full assessment of the cumulative impacts on surface water is provided at Appendix F, Section 7.7.3, an assessment of cumulative impacts on groundwater is detailed in Chapter 7, and Groundwater and the cumulative impact assessment of flood modelling is presented in Chapter 9, Flooding and Regulated Structures.

The assessment of cumulative impacts on groundwater is detailed in Section 21.11 and the cumulative impact assessment of flood modelling is presented in Section 21.10.

21.9.7 Avoidance, mitigation, management measures and monitoring

21.9.7.1 Water management system

The water management system for the Project has been developed to minimise potential water quality impacts on the receiving environment and achieve the environmental objectives for water quality that are to be met under the EP Act; namely, to protect the environmental values of waters, wetlands and GDE, groundwater and any associated surface ecological systems. Numerical modelling demonstrates the water management system would be adequate to minimise impacts on water resources and water dependent assets.

The water management system will be centred within the Project MIA shown in Figure 21.10. The infrastructure corridor linking the new MIA to the existing Lake Vermont Mine will include the water supply and return water pipelines as shown on Figure 21.10. The layout of the proposed water management system features within the MIA is shown in Figure 21.19.

The water management system will manage water in separate types based on likely water quality characteristics, as described below.

Mine affected water

The mine affected water system will manage runoff from the open-cut pit, ROM stockpile and MIA and groundwater inflows from the underground mine. It will be a closed system designed to prevent releases of mine affected water to the environment.

Inflows to the mine-affected water system will be primarily from groundwater seepage into the underground mine and open-cut pit. Groundwater quality is described in Section 21.11. Water management system modelling was based on an approximately equivalent representative TDS concentration of 17,000 mg/L for groundwater inflows (Appendix F, Surface Water Assessment, section 5.1), and included all waters defined as mine affected water by DES (2017).

The mine affected water system will manage runoff from the open-cut waste rock dumps, which is to be directed to sediment dams managed under a sediment and erosion control plan. Overburden runoff quality is expected to be benign, and sediment dams have been sized to achieve a high-level of sediment containment. Stored water will be returned to the MIA Dam for blending with mine-affected water before reuse.

Clean catchment water

Clean water from undisturbed areas will be diverted around areas of disturbance by drains including a diversion drain proposed to be developed during the construction phase to support the diversion of clean water around the southern extent of the MIA levee. An additional diversion drain is also proposed to be constructed during the Project operational phase to divert clean water around the southern extent of the open-cut pit levee. Diversion drain design and construction is discussed in Section 21.10.6.2.

Watercourse diversions and crossings

The Project does not propose to divert the course of any Water Act 2000 (Qld) watercourses; or any watercourses identified as “yet to be mapped” on the Queensland ‘Watercourse Identification Mapping’.

Haul road crossings of Phillips Creek and One Mile Creek are proposed, with potential flooding impacts of these works discussed through Section 21.10.7; and potential aquatic ecology impacts discussed through (Section 21.13.3).

It is noted that the Project haul road is proposed to be constructed above existing ground level to ensure all-weather access during mine operation. Therefore, the proposed haul road construction is anticipated to provide some obstruction to floodplain and channel flows, locally increasing upstream flood levels. These risks are proposed to be mitigated through the design of the road embankment and associated cross-drainage structures, as identified through Section 21.10.6. Locations of cross-drainage structures for the Project are shown in Figure 21.46. Stream crossings will be constructed as causeways with appropriately sized culverts to mitigate impacts to channel flows. Impacts to aquatic ecology values resultant of stream crossings is discussed through Section 21.13.3 while flooding impacts are considered within Section 21.10.7.

The electricity transmission line and light vehicle access to the substation and bore holes also transits channel flows at three locations with cross-drainage structures to mitigate upstream flood levels and downstream flow reductions (Figure 21.46).

Two channel flow diversions are proposed at the southern ends of the mine infrastructure area (1 km) and open cut (2.3 km) (Figure 21.46). Water diverted by these channels is returned to One Mile and Phillips Creeks respectively. The Stage 2 ponding mitigation channel returns almost all channel flow to the natural channel that joins Phillips Creek 6km east of the Project eastern boundary.

A small amount of overland flow (60 ha) will be redirected by the Project haul road to join One Mile Creek immediately upstream of the One Mile Creek crossing (Figure 21.46).

Raw water

The proposed infrastructure corridor will include a pipeline to deliver raw water, via the Lake Vermont Mine, sourced from the Eungella Water Pipeline Southern Extension as described in Section 21.9.6.12. Raw water will be delivered to a dedicated Raw Water Dam at the Meadowbrook MIA which will supply the mining operations and the potable water treatment plant (Figure 21.19).

Potable water and sewage water

Potable water and sewage water will be managed on-site within the MIA. A water treatment plant will be constructed within the MIA as described in Section 21.6. Treated water will be stored in 100 kL tanks adjacent to the plant and effluent from the water treatment plant will be stored in the Mine Water Dam.

An STP will be constructed within the MIA to treat sewage generated during operations phase. The STP will have secondary treatment capability and produce Class C effluent for land based irrigation disposal. Effluent disposal using land irrigation is proposed, based on modelling of effluent disposal undertaken as described in Chapter 15, Waste Management. The modelling determined that an area of 3.6 ha will be sufficient for irrigation given site characteristics and the proposed effluent irrigation areas are within the MIA contained catchment area. The sewage treatment system and management measures will be regulated under the Project EA (administered by DES).

21.9.7.2 Water management system components

The components of the water management system and their connectivity are presented in Figure 21.48 and the components located within the MIA are shown in Figure 21.19.

MIA and open-cut pit levees

The MIA and open-cut pit will be protected by levees and associated minor drainage systems to exclude clean water runoff from Phillips Creek and One Mile Creek and their minor tributaries in the 0.1% AEP design flood. The levees will be 'regulated structures' and will be designed, constructed, operated and decommissioned in accordance with the 'Manual for assessing consequence categories and hydraulic performance of structures' (DES 2016) and the 'Guideline, Structures which are dams or levees constructed as part of environmentally relevant activities' (DES 2022).

The MIA levee structure will be developed during the initial Project construction phase, remaining in place until mine closure, at which point the levee will be removed and the area rehabilitated. The open-cut pit levee structure will also be temporary, required only once open-cut mining commences in Project Year 20 (indicatively 2045) until the final overburden profile is achieved and the associated permanent landform established. Details on the MIA levee and open-cut pit levee construction is provided in Section 21.10.6.1.

Raw water supply pipeline

An extension to the existing raw water supply pipeline will be constructed within the infrastructure corridor. It will connect to the existing raw water supply pipeline at the Lake Vermont Mine (that sources water from the Eungella Water Pipeline Southern Extension) to the proposed MIA. The proposed 12 km raw water supply pipeline will transfer raw water to a Raw Water Dam at the MIA. Raw water will then be treated by a water treatment plant for ablutions use and use underground.

Underground mine dewatering system

Water accumulating within the underground workings (groundwater inflows, excess dust suppression water and washdown water) will be pumped to the surface to the Dewatering Dam to be located in the MIA. Underground dewatering is anticipated to cease at the completion of underground operations.

Open-cut mine dewatering

Local runoff and groundwater seepage accumulating within in-pit sumps in the open-cut mining pit will be pumped to the Dewatering Dam.

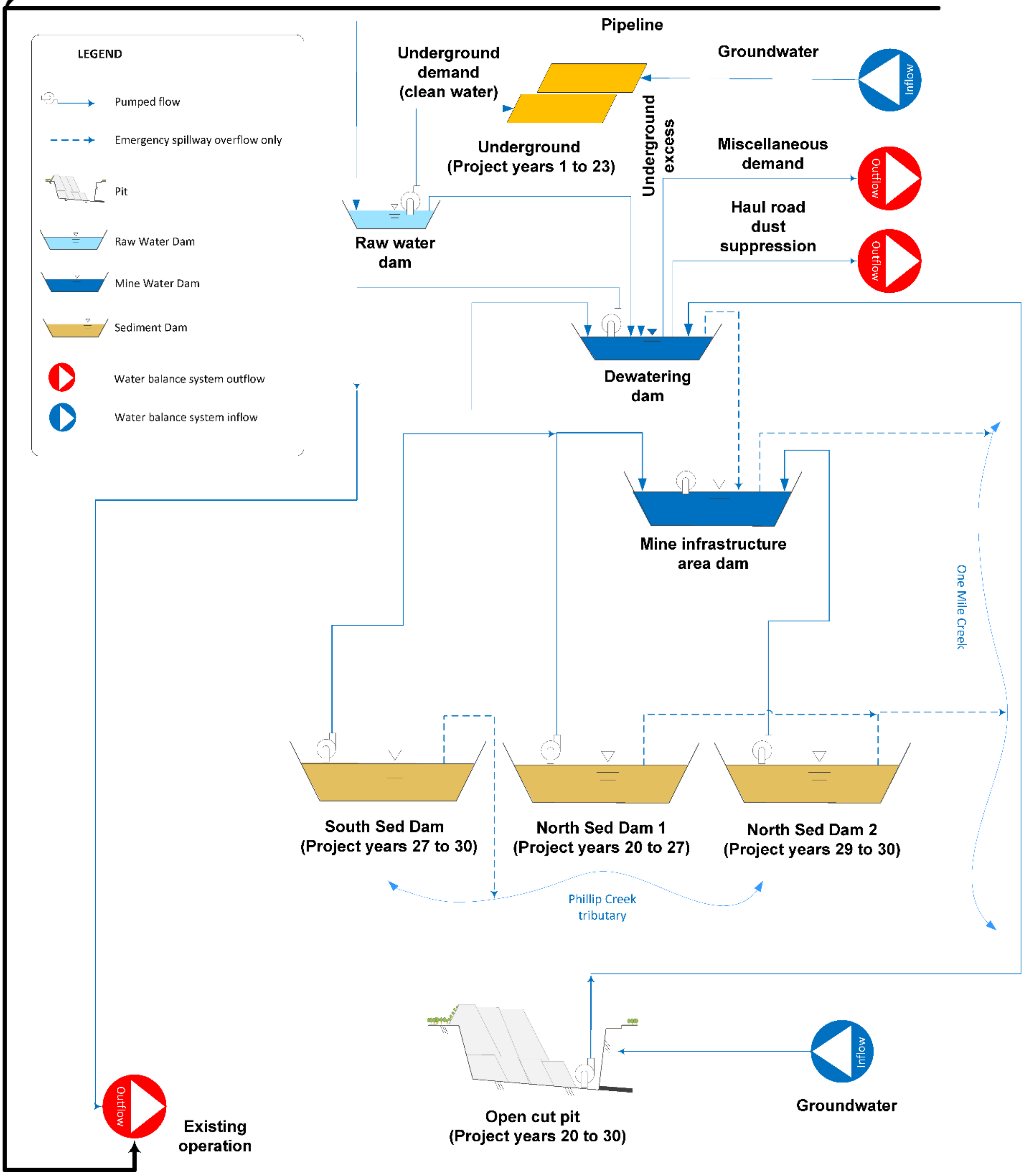

Figure 21.48: Water management system schematic

Return water pipeline

Inflows to the underground operations and associated water management system are expected to exceed demands for mine water within the Meadowbrook operation. The return water pipeline will be used to transfer excess mine-affected water via the infrastructure corridor to environmental dams at the existing Lake Vermont Mine. The return water pipeline will be located within the proposed infrastructure corridor for the Project.

Potable water supply

The water treatment plant will be located within the MIA and have the capacity to treat raw water from the Raw Water Dam and pipeline at a rate of up to 10 ML/year. Treated water will be stored in 180 kl capacity potable water tanks adjacent to the plant.

The minor volumes of effluent from the water treatment plant will be captured and stored within the mine-affected water system and used for dust suppression or returned to the Lake Vermont water management system.

Sewage treatment

Sewage generated at the MIA will be pumped to a package STP. The STP will have secondary treatment capability and the ability to produce Class C effluent for irrigation, as defined in the Queensland Public Health Regulation 2018. It is conservatively estimated that effluent will be produced at a rate of approximately 40 kl/day (based on 200 workers each generating 200 L/day of effluent on-site each day). Wet weather storage will be located adjacent to the plant. Irrigation of treated effluent is proposed to occur within the MIA. Details of the proposed effluent treatment and disposal system are provided in Appendix S, Land-Based Effluent Disposal Assessment (Section 3).

Raw Water Dam

The Raw Water Dam will be located within the MIA and will temporarily store raw water for use where relatively high-quality water is required—for example, within the underground operations, in equipment requiring clean water for cooling and feed water for the potable water treatment plant. The Raw Water Dam will be sized to provide continuity of supply in the event of reasonably foreseeable equipment failure (e.g. pump or pipeline failure).

Mine infrastructure area dam

Runoff from disturbed areas within the MIA will be contained within the catchment area and directed via a series of drains to the MIA Dam which is proposed to be located in the low area to the east of the ROM stockpile. Runoff captured in the MIA Dam will include runoff from the ROM stockpile, laydown areas, workshop areas. For the impact assessment, it has been conservatively assumed that the MIA Dam will capture runoff from the entire area within the MIA levee. In detailed design, the site drainage system may be configured to minimise the area captured and to direct clean runoff from undisturbed parts of the MIA away from the dam.

Dewatering Dam

The Dewatering Dam will be located within the MIA and store water transferred from the underground and open-cut mining operations. Water stored in the Dewatering Dam will be reused for dust suppression of the surface operations.

Excess water will be transferred via the return water pipeline to the existing Lake Vermont Mine for reuse within the site water management system and to offset water otherwise imported via the raw water pipeline. The Dewatering Dam will be operated to avoid any overflows; however, emergency overflows via the spillway will be captured within the MIA Dam..

Sediment dams

During open-cut mining operations, catchment runoff from overburden dumps will be captured in three sediment dams (referred to as Southern Sediment Dam, Northern Sediment Dam 1 and Northern Sediment Dam 2 as shown in Figure 21.49 to Figure 21.51.

Sediment dams will be designed and operated in accordance with the 'Guideline - Stormwater and environmentally relevant activities' (DES 2021). This guideline states that:

> *For events up to and including a 24 hour storm event with an ARI of 1 in 10 years, the following must be achieved:*
>
> – *a sediment basin must be designed, constructed and operated to retain the runoff at the site(s) approved as part of the ERA application;*

– *the release stormwater from these sediment basins must achieve a total suspended solids (TSS) concentration of no more than 50mg/L for events up to and including those mentioned above.*

For events larger than those stated above, all reasonable and practical measures must be taken to minimise the release of prescribed contaminants.

Sediment dams will be constructed to contain a 1 in 10-year ARI 24-hour event and will be operated in accordance with 'Guideline – Stormwater and environmentally relevant activities' (DES 2021). Sediment dam catchment areas and proposed storage capacities are provided in Chapter 9, Flooding and Regulated Structures.

The Northern Sediment Dam 1 will be initially constructed by pre-excavating overburden material near the northern corner of the open-cut pit levee. Once the existing ground surface is mined out, sediment dams will be formed into localised depressions north and south of the open-cut pit.

21.9.7.3 Sediment and erosion control

The existing Lake Vermont Water Management Plan will be updated in accordance with erosion and stability management measures proposed in Chapter 5, Land Resources, Section 5.5.3. Management plans will be developed by an appropriately qualified person prior to mining commencement and be implemented for the duration of mining activities. The Plan will be implemented during Project construction, operations and rehabilitation phases to minimise erosion and sediment generation from disturbed areas and maintain water quality in downstream water systems.

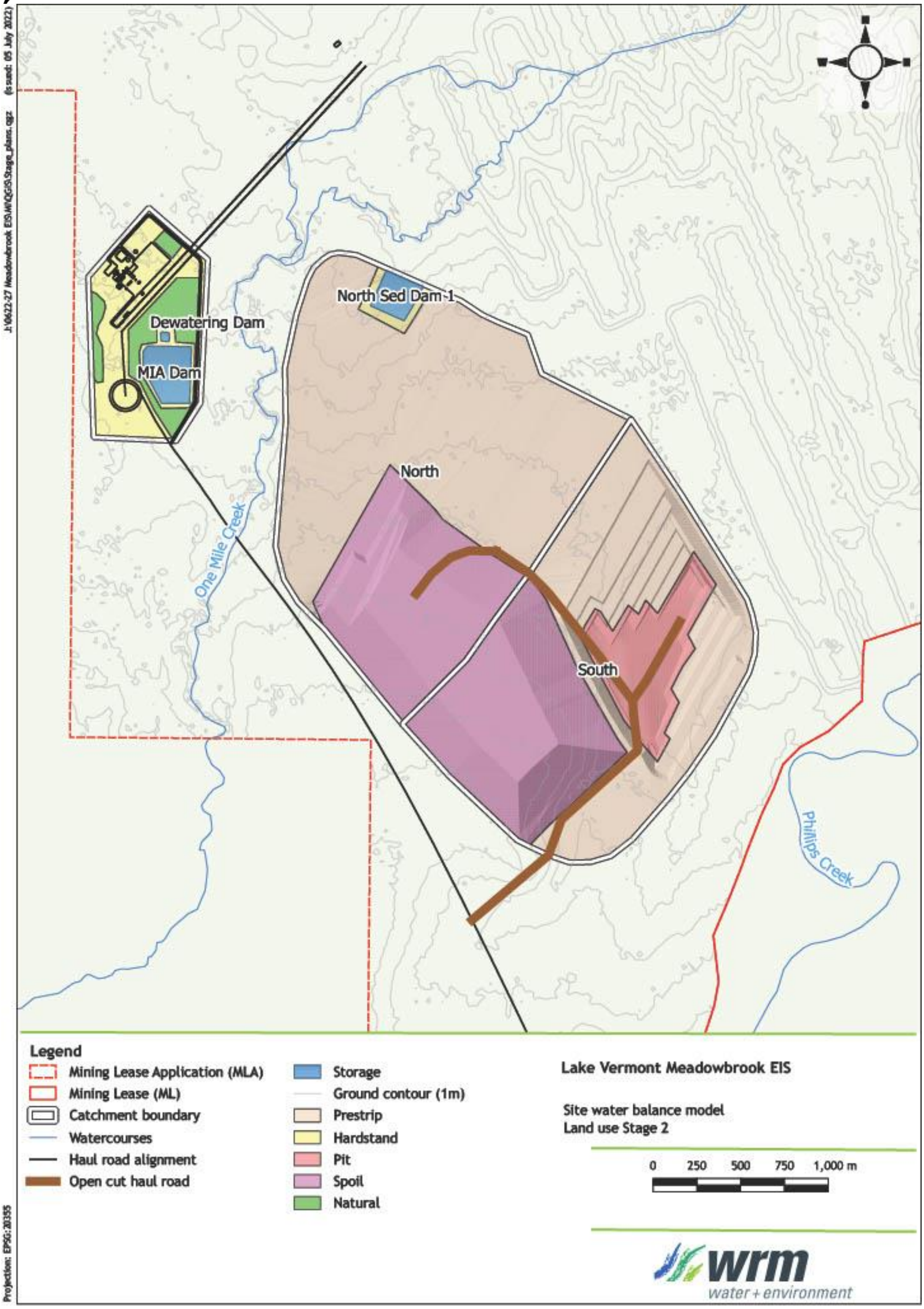

Figure 21.49: Proposed catchment and land use boundaries (Project Year 20–26)

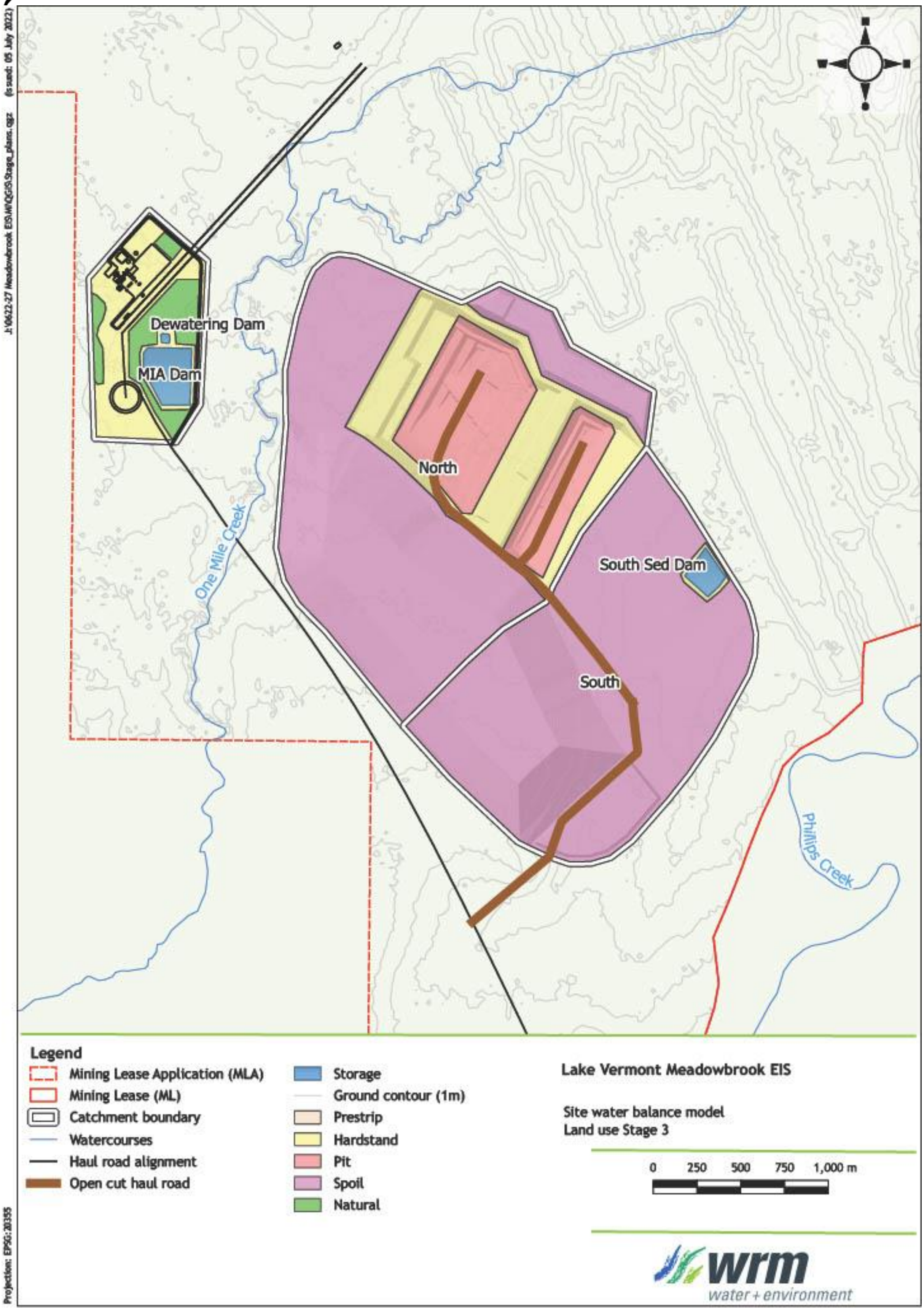

Figure 21.50: Proposed catchment and land use boundaries (Project Year 27–28)

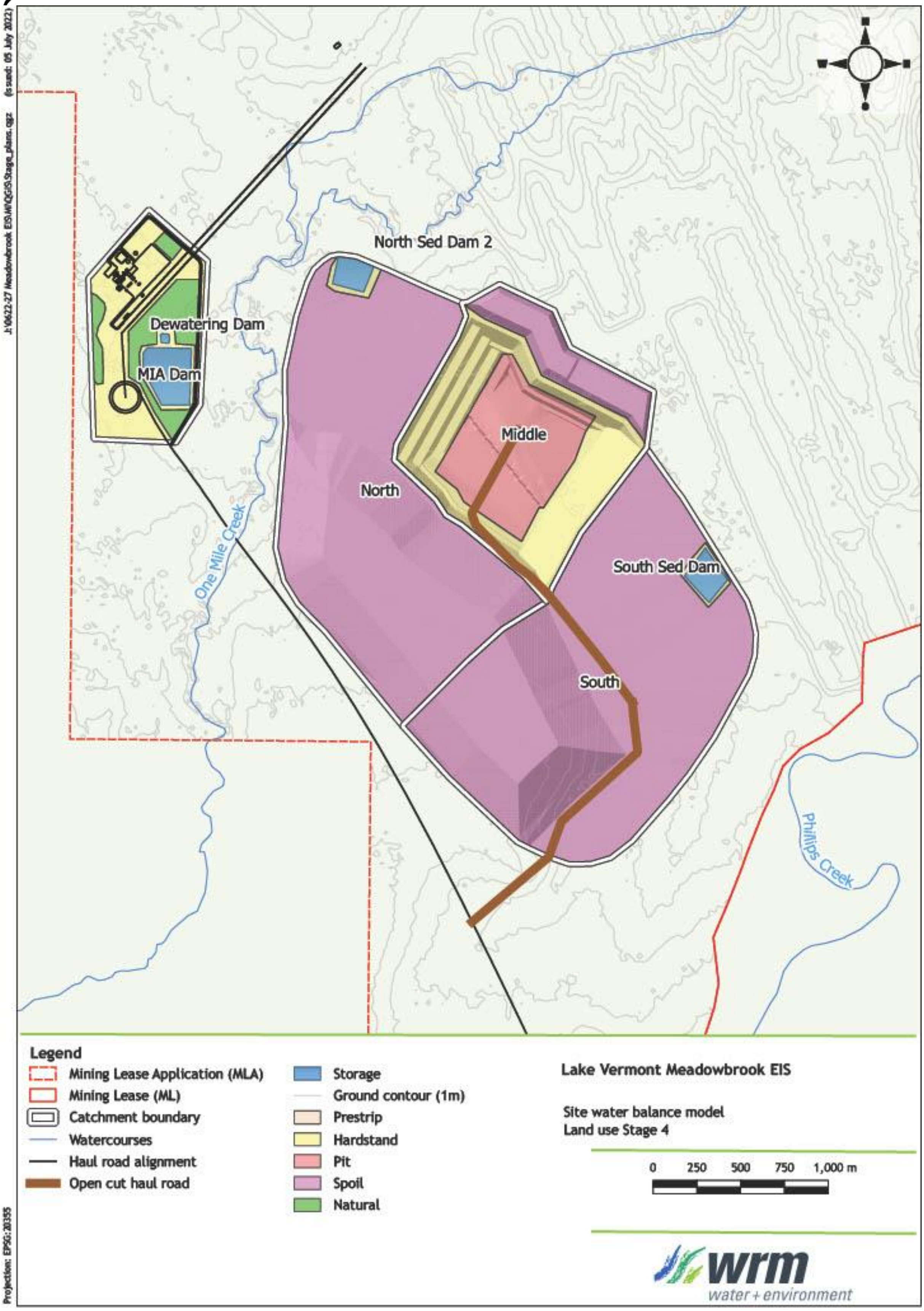

Figure 21.51: Proposed catchment and land use boundaries (Project Year 29–30

21.9.7.4 Water Management Plan

The existing Lake Vermont Mine Water Management Plan will be updated to incorporate the management of water resources for the Project. It will include:

- a description of the potential sources of contaminants that could impact on water quality;
- a description of the water balance model;
- a description of the water management system;
- a program for the pumping of excess water captured within subsidence depressions (to minimise the capture of overland flow);
- a program for the monitoring and review of the Water Management Plan's effectiveness and adequacy of water mitigation measures; and
- corrective actions and contingency procedures for emergencies.

The Water Management Plan will be updated progressively to reflect changing water management requirements. The update process will identify risks associated with the water management system and enable feedback on infrastructure and operational management improvements. Once additional data is collected, site-specific water guidelines incorporating seasonal variation may be developed if necessary.

Emergency and contingency planning

The existing Lake Vermont Mine Water Management Plan will be updated to include proactive management measures for flood, drought and severe weather events, as they might apply to the Project. Emergency and contingency planning for the Project water management system will be designed to protect the values of receiving waters in accordance with the Project EA. Contingency planning and wet weather preparedness will include:

- managing water in accordance with this plan, including creating air space in storages ahead of each wet season;
- details on compliance with the site's EA;
- maintaining water management infrastructure, including ensuring dams, drains, pipes, pumps, monitoring equipment and other water management infrastructure are serviceable in advance of each wet season;
- reviewing the Water Management Plan and associated water management procedures annually and after each wet season to capture lessons learned from that wet season; and
- ensuring relevant personnel are trained in the Water Management Plan and associated procedures.

21.9.7.5 Water quality management and monitoring

Surface water quality monitoring program

There are no proposed release points for the Project and therefore no expected mine affected water impacts to the sensitive receiving environment. The Lake Vermont Mine Water Management Plan will be updated to include monitoring requirements for the Project. When water quality monitoring is undertaken, it will be by trained personnel and in accordance with the 'Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009' (DES 2018).

21.9.7.6 Receiving environment monitoring program (REMP)

There are no proposed release points for the Project and, therefore, no sensitive receiving waters that will potentially be directly affected by an authorised release of mine-affected water. However, the overflow from sediment dams will have the potential to impact the sensitive receiving environment. The existing REMP design document will be updated to include monitoring of One Mile Creek to identify any potential impact of sediment dam overflow on ecotoxicological values, as outlined in Chapter 23, Proposed Environmental Authority Conditions. The location of REMP monitoring points on One Mile Creek will be determined subject to a REMP design process, however, are likely to be at the assessment monitoring locations MA3 and MA12 shown in Figure 21.101.

The REMP design document will also be updated to provide for monitoring of the receiving environment of Boomerang Creek, Phillips Creek and the Isaac River, such as to identify any potential impacts associated with subsidence induced geomorphological changes. As per proposed EA Condition C21 (Chapter 23, Proposed EA Conditions) the receiving environment for the Project is stated to include the waters of One Mile Creek, Boomerang Creek, Phillips Creek and the Isaac River.

The REMP design document that addresses the requirements of the REMP will be updated, and reports outlining the findings of the REMP (including all monitoring results and interpretations) will be prepared annually and made available to the administrating authority.

To ensure the ongoing adequacy of the water management system, reviews will include the Project water balance. 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;
- water quality monitoring of the water storages and sediment dams;
- pumped flow water meter data for major transfer and water demand offtakes;
- aerial surveys of the mine topography to review catchment area and land use development; and
- daily rainfall.

The update and review of the model will be used to assess validity of the model inputs and assumptions

21.9.7.7 Corrective actions

As described in Section 21.9.7.2 to Section 21.9.7.4, water quality monitoring within the area of potential impact by the Project will be conducted in accordance with the Water Management Plan, and the REMP. The results of the water quality monitoring programs will:

- provide information on the performance of the water management system; and
- facilitate adaptive management through early detection of any impacts and the implementation of appropriate corrective actions.

When monitoring identifies a potential impact, further sampling and analysis may be undertaken and a direct toxicity assessment if required to verify and characterise the potential impact and identify feasible corrective actions. Potential corrective actions may include:

- maintaining and/or managing sediment and erosion controls when inspections indicate the controls are not operating effectively;
- implementing additional erosion control measures;
- implementing additional waste rock management measures;
- conducting water management system audits;
- modifying the water management system;
- increasing the frequency of monitoring or including additional sampling locations to inform the nature of the impacts and the effectiveness of the corrective actions implemented; and/or
- following up inspections and/or monitoring.

21.9.7.8 Annual review

An annual review of surface water quality trends and groundwater quality trends will be conducted by a suitably 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.

21.9.8 IESC checklist

Reconciliation of the IESC Information Guidelines is provided as Attachment 3 to this EIS.

21.9.9 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 criteria (DoE 2013). 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:

a) changes in the water quantity, including the timing of variations in water quantity;

b) changes in the integrity of hydrological or hydroecological connections, including substantial structural damage (e.g. large scale subsidence); or

c) changes in the area or extent of a water resource.

The significant impact criteria provides guidance that a significant impact on changes to water quality may occur where, as a result of the action:

a) there is a risk that the ability to achieve relevant local or regional water quality objectives will be materially compromised, and as a result of the action:

    i) creates risks to human or animal health or to the condition of the natural environment as a result of the change in water quality;

    ii) 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;

    iii) causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment;

    iv) seriously affects the habitat or lifecycle of a native species dependent on a water resource, or;

    v) 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, or;

b) there is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives), or;

c) 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 (DoE 2013) is presented in Sections 21.9.9.1 and 21.9.9.2.

21.9.9.1 Potential impacts to hydrological characteristics

Assessment of Project impacts, according to guidance provided by the significant impact criteria (DoE 2013), to watercourses and floodplains is shown in Table 21.12.

Table 21.12: Assessment of significant impact on changes to hydrological characteristics

Significant impact guidance	Assessment of significance
Changes in the water quantity, including the timing of variations in water quantity;	The mine affected water system will be a closed system designed to prevent any releases of mine affected water to the environment, with no provision for controlled releases, and thereby no provision for the Project to change water quantity in watercourses from releases (refer Section 21.9.3). Impacts to streamflow from geomorphological change were assessed (refer Section 21.9.6.8). Residual post-subsidence depressions are predicted to not significantly alter flow regime. The open-cut pit mining area will result in temporary reduction in catchment of up to 3 km^2, and at final landform completion a 1.5 km^2 or 8% reduction of catchment to One Mile Creek. This will impact One Mile Creek for approximately 6 km in minor runoff events, with impacts minimal at the confluence with Boomerang Creek (equivalent to a 1.8% reduction in catchment). There is no predicted significant movement of surface water to underground workings through subsurface or surface cracking caused by subsidence. 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 hydroecological connections, including substantial structural damage (e.g. large scale subsidence); or	Impacts to watercourses and floodplains as a result of geomorphological changes caused by the Project were assessed (refer Section 21.9.6.8). Subsidence will result in the formation of intermittently ponded depressions (potentially holding water for a maximum of several months every few years) in floodplains and troughs across the watercourses of Boomerang Creek and One Mile Creek, from which ponded water will evaporate or seep from, within months following filling. Watercourse troughs are predicted to resolve through bed aggradation and erosion monitoring and mitigation measures will be implemented to effectively manage watercourse erosion (Section 21.9.7.3). Watercourse velocities are predicted to remain below guideline values where watercourses enter subsidence affected areas of trough formation. Significant changes to hydrological and hydroecological connections throughout the Project area of influence are considered unlikely to occur.
Changes in the area or extent of a water resource.	Potential impacts to the area of extent of watercourses were assessed (refer Section 21.9.6.8). Underground mining subsidence is predicted to result in the formation of troughs across Boomerang Creek and One Mile Creek, which will be inundated in flow conditions. Sediment aggradation is predicted within Boomerang Creek, resulting in the infilling of these troughs. One Mile Creek is anticipated to take longer to self repair (having a sediment deficiency) and may therefore require management measures to be implemented (such as infilling of troughs). Troughs in both watercourses will be monitored through a Project Subsidence Management Plan, which will provide measures for adaptive management. 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 hydroecological connections indicate the Project is unlikely to have a significant impact on hydrological characteristics.

21.9.9.2 Potential impacts to receiving water quality

Assessment of impacts to local watercourses (Boomerang Creek, One Mile Creek, Phillips Creek) and regional receiving waters quality (Isaac River; being a tributary of the Fitzroy River which flows into the Coral Sea and

Great Barrier Reef Marin Park (GBRMP)) has been undertaken according to guidance provided by the significant impact criteria (DoE 2013) is shown in Table 21.13.

Table 21.13: Assessment of significant impact on changes to water quality

Significant impact guidance	Assessment of significance
There is a risk that the ability to achieve relevant local or regional water quality objectives will be materially compromised, and as a result of 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, or;	The mine affected water system will be a closed system designed to prevent any releases of mine affected water to the environment, with no provision for controlled releases, and thereby no provision for the Project to change water quality from releases (refer Section 21.9.3). Overflows from sediment dams will be expected for 10th percentile (1 in 10yr, 24hr event) wet conditions or greater (refer Section 21.9.6.4). Modelled downstream salinities in sediment dam overflow events are expected to have minimal impact on downstream salinity, or EVs. No risks to health or the natural environment condition, as a result of change in water quality, are predicted. There is minimal current use of surface water from the Project area watercourses and Isaac River downstream of the Project (Section 21.9.1.4) and the Project will not substantially reduce the amount of surface water available for use (Section 21.9.6.9). Given zero releases of mine affect water are proposed, the Project is not expected to cause persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment (Section 21.9.6.7). Sediment dams are also designed to overtop only in high rainfall scenarios, where significant dilution capacity will exist. The Project is not expected to affect the habitat or lifecycle of a native species dependent on a water resource (Section 21.13.4). The Project is not expected to cause the establishment of an invasive species that is harmful to ecosystem function or water resources (Section 21.12.3). The Project is unlikely to materially compromise the local or regional water quality objectives.
There is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives), or;	Water quality in the Project area is considered typical of a 'slightly to moderately disturbed aquatic ecosystem' in the region that this area represents. Baseline water quality conditions have been impacted by agricultural activities and historic and current upstream mining activities (Section 21.9.2). The mine affected water system will be a closed system designed to prevent any releases of mine affected water to the environment with no provision for controlled releases, and thereby no provision for the Project to change water quality from releases (refer Section 21.9.3). Overflows from sediment dams will be expected in 10th percentile wet conditions or greater (refer Section 21.9.6.4). Modelled downstream salinities in sediment dam overflow events are expected to have minimal impact on downstream salinity levels, or EVs. 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.	The mine affected water system will be a closed system designed to prevent any releases of mine affected water to the environment. 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.

21.10 Flooding

21.10.1 Flood characteristics and context

In undertaking an assessment of the Project's flooding risks, the following sections identify existing values relevant to flooding and regulated structures.

21.10.1.1 Nearby water resources

The Project is within the Isaac Connors Sub-catchment of the greater Fitzroy Basin catchment and near to the main watercourse of the Isaac River (Figure 3.4). Ground elevations to the west of the Project are marginally higher in elevation (approximately 10 mAHD), with the Project generally draining west to east towards the Isaac River. The surface between Phillips Creek and Boomerang Creek is a broad, flat floodplain that slopes gently to the east from approximately 180 mAHD in the west to around 170 mAHD in the east (Figure 21.11).

The Project is on the floodplains of Phillips Creek, One Mile Creek, Boomerang Creek and Ripstone Creek, which are tributaries of the Isaac River. Phillips Creek traverses the proposed infrastructure corridor and meanders to the south of the Project's underground mining area and into the Isaac River. Ripstone Creek (north of the Project) flows eastward before flowing into Boomerang Creek (east of the Project area) and shortly after into the Isaac River (Figure 21.11).

Hughes Creek traverses the MLA and converge with Boomerang Creek and One Mile Creek. The confluence of Hughes Creek and Boomerang Creek occur in the west of the Project, with One Mile Creek flowing into Boomerang Creek in the east of the Project area (Figure 21.11).

21.10.1.2 Land uses and regional context

The Project is on the floodplain of tributaries of the Isaac River, which is some of the land mapped as an 'Important Agricultural Area' by the 'Queensland Agricultural Land Audit' (Figure 21.8).

The Project contains a small area mapped as potential SCL under the RPI Act (referred to as the SCL trigger area on Figure 21.7). The land within the MLA is currently used for beef cattle grazing and resource exploration activities.

21.10.1.3 Proximity to infrastructure

The Project is located near existing and proposed coal mining operations of the Bowen Basin (Figure 21.3).

Golden Mile Road, which crosses the Isaac River on the south-east floodplain, runs between the Project site and Dysart.

21.10.2 Flood modelling

21.10.2.1 Regional hydrological modelling

An XP-RAFTS hydrological model of the Isaac River catchment has been developed to assess the current flood risk and the potential impacts of the Project on flooding. Details of the model are provided in Appendix Z, Flood Modelling (Section 1.2).

The Isaac River catchment regional model extends downstream to the confluence of Phillips Creek with the Isaac River and includes 248 sub catchments (Figure 21.52). Separate XP-RAFTS runoff-routing models of the Isaac River catchment have been used to estimate the 50%, 10%, 2%, 1% and 0.1% AEP peak design discharges and the Probable Maximum Flood (PMF) for a range of durations up to 48 hours. Rainfall data (rainfall depths, areal reduction factors and temporal patterns) have been applied in accordance with ensemble event procedures in 'Australian Rainfall & Runoff' (Ball et al. 2019). Design peak flows from the regional Isaac River model have been reconciled against the flood frequency analysis of the peak annual flow series at the Queensland Government Deverill gauge (130410A) (Appendix Z, Flood Modelling, Section 1.2.5).

A comparison of the Isaac River design rainfall intensities has been made at the southern, western, centroid, and eastern boundaries for the 1% AEP event across all durations. Due to small variations in design rainfall estimates over most of the catchment, a uniform spatial rainfall distribution has been adopted across the model (Appendix Z, Flood Modelling, Section 1.2.3).

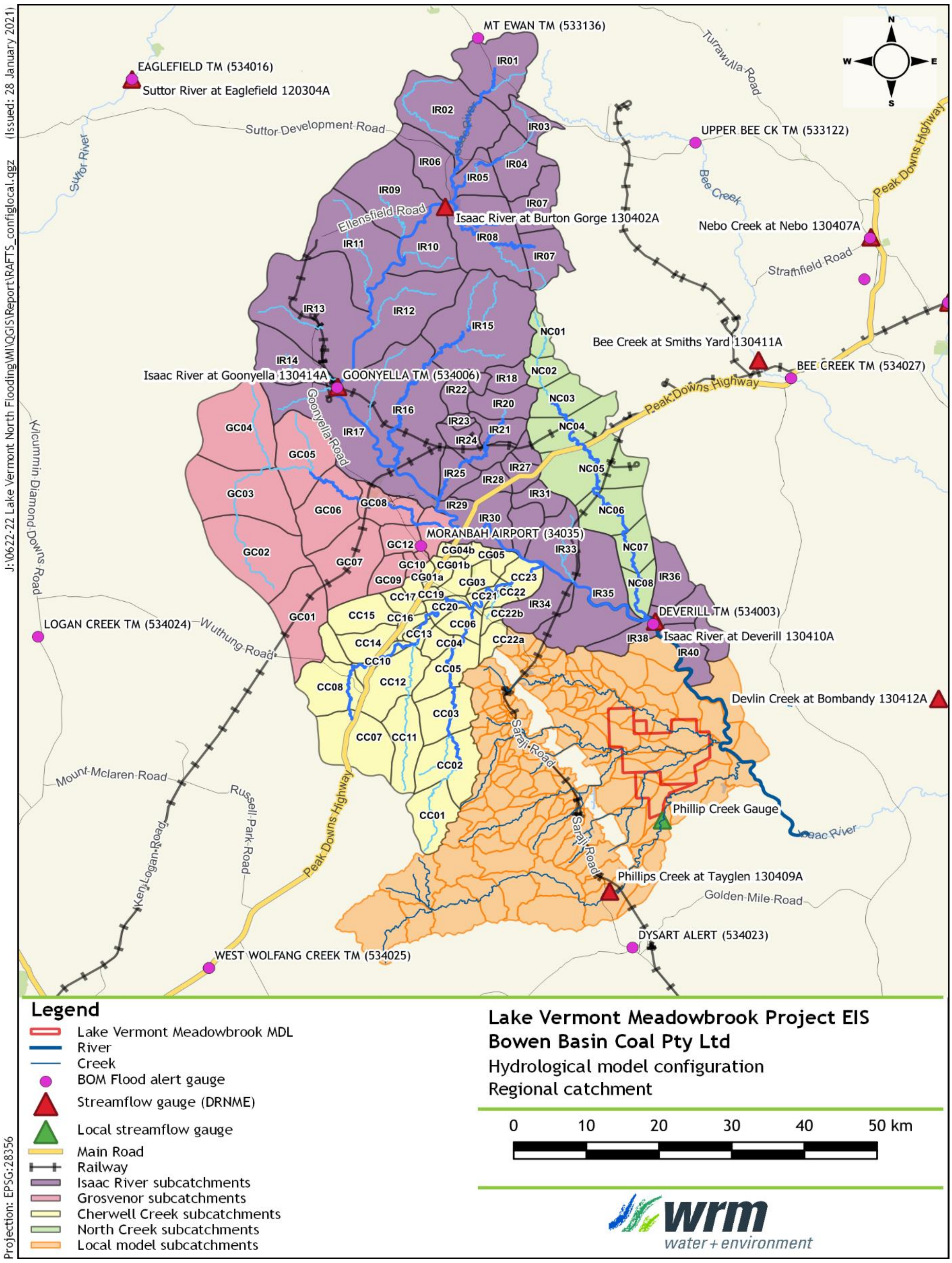

Figure 21.52: Isaac River catchment regional model (XP-RAFTS regional configuration)

21.10.2.2 Local hydrological model

An XP-RAFTS model of the local creek system was developed as the basis of the present hydrological analysis for local flooding conditions. The local creek hydrological model (Figure 21.53) includes the catchments of

Boomerang, Ripstone, One Mile and Phillips Creeks and extends to the confluence of Phillips Creek with the Isaac River (Appendix Z, Flood Modelling Assessment Report, section 1.3).

The model of the local creek system was calibrated to flows recorded at Lake Vermont Mine Phillips Creek streamflow gauge during the Cyclone Debbie flood event. Design peak flows in Phillips Creek were reconciled against the flood frequency analysis of the peak annual flow series of historical flow data recorded at the Tayglen gauging station (130409A) (Figure 21.52 and Figure 21.53). The local model was used to determine creek inflows for the 50%, 10%, 2%, 1%, 0.1% AEP and PMF design events. Due to small variations in design rainfall estimates over most of the catchment, a uniform spatial rainfall distribution was adopted across the model. Further details of the model are provided in Appendix Z, Flood Modelling Assessment Report, section 1.3.7.

21.10.2.3 Hydraulic model

A hydrodynamic model has been developed by WRM (Appendix Z, Flood Modelling Assessment Report, section 2.2) using TUFLOW software to assess the flow behaviour of the Isaac River, Ripstone Creek, Boomerang Creek, Hughes Creek, One Mile Creek and Phillips Creek in the vicinity of the Project including flood extents, depths and velocities. The flood model also forms the basis of a more localised assessment of the impact of the project on flow conditions in the mine lease area (Appendix W, Geomorphological Assessment Report, section 4.2).

The hydraulic model has been used to simulate flood conditions under:

- approved site conditions (base case);
- operational conditions (with full longwall mining subsidence)
- post-closure conditions; and
- cumulative impact scenarios.

The scenario and event combinations for the hydraulic models are further described as follows:

- Pre-mining approved conditions, which assume the already approved Lake Vermont Mine pits and final landform and the already approved Phillips Creek diversion, are in place for:
    - local flooding: 50%, 10%, 2%, 1%, 0.1% AEP and PMF; and
    - regional flooding: 1%, 0.1% AEP and PMF.
- Developed conditions (Project Year 2051), (indicating mine site conditions) for local and regional flooding (approved condition flood AEP and PMF events) represent the greatest amount of disturbance to the floodplain with:
    - mine subsidence at its full extent;
    - earthworks and cross-drainage for the haul road;
    - levees around the MIA;
    - levees around the full extent of the open-cut operation; and
    - the implementation of channels and bunds to mitigate the extent of subsidence-induced ponding.
- Post-closure scenarios for local flooding (1%, 0.1%, and PMF) includes:
    - removal of all operational site activities (with the exception of the haul road which will remain post-closure);
    - presence of a rehabilitated pit landform with constructed elevation designed to prevent ‘extreme flood’ inflows into the rehabilitated pit landform (depression), and a rehabilitated waste rock emplacement; and
    - residual mine subsidence areas with bunds and drainage across subsided panels to mitigate subsidence-induced ponding.

- Cumulative impact scenarios, with all levees in place associated with the proposed Olive Downs Project, have been run for both Project Year 26 mine site conditions (indicatively 2051) and post-closure conditions.

Further details of the model are provided in Appendix Z, Flood Modelling (Section 2).

21.10.3 History of flooding

WRM (2019) has conducted a pre-mining flood study for the Project to provide initial planning advice on existing flood conditions of watercourses crossing the proposed mining area. The hydrological and hydraulic model for this study was developed using XP-RAFTS software.

The methodology for the hydrological model of the Isaac River, Boomerang Creek and Phillips Creek catchments involved calibration with the discharge hydrographs recorded at three recent historical flood events at the Deverill and Goonyella (GS130414A) gauging stations (Figure 21.52). The three historical flood events were in February 2008, December 2010 and March 2017, and have been calibrated against available sub-daily rainfall and stream flow data from the nearest rainfall stations:

- Isaac River at Deverill (130410A);
- Isaac River at Goonyella (130414A);
- Isaac River Bridge (534026);
- Moranbah WTP (34038); and
- Moranbah Airport (34035) (Figure 21.52).

Details of the historical flood events in the Isaac River catchment, including event duration and recorded peak discharge (m3/s), are provided in Table 21.14 (WRM 2019).

WRM (2019) also recorded observations for modelling at three storage dams during the 2017 event. They included Burton Gorge Dam, Teviot Dam and Lake Elphinstone. Burton Gorge Dam had a spill event with a recorded peak discharge of about 235 m3/s at the Burton Gorge Dam gauging station compared to a peak discharge of 215 m3/s in the XP-RAFTS model. Lake Elphinstone and Teviot Dam were not observed to spill during the event or in the XP-RAFTS model.

Table 21.14: Historical (calibration) flood events, Isaac River catchment

Historical flood event	Start date	Event duration (days)	Recorded peak discharge (m^3/s) - Goonyella	Recorded peak discharge (m^3/s) - Deverill
February 2008	09/02/2008	9	1,070	2,142
December 2010	18/01/2010	15	91	1,827
March 2017	27/03/2017	7	199	1,614

As discussed in Section 21.10.2.3, Local hydrological model, the Lake Vermont Mine Phillips Creek streamflow gauge recorded flows from the Cyclone Debbie flood event in March 2017. Local sub-daily rainfall data was also recorded on-site and provided by Lake Vermont Mine. The rainfall event began at midnight on 28 March 2017 and continued for approximately two days, with a total cumulative rainfall of 169 mm. The peak recorded discharge volume was 428 m3/s (Appendix Z, Flood Modelling, Section 1.3.4).

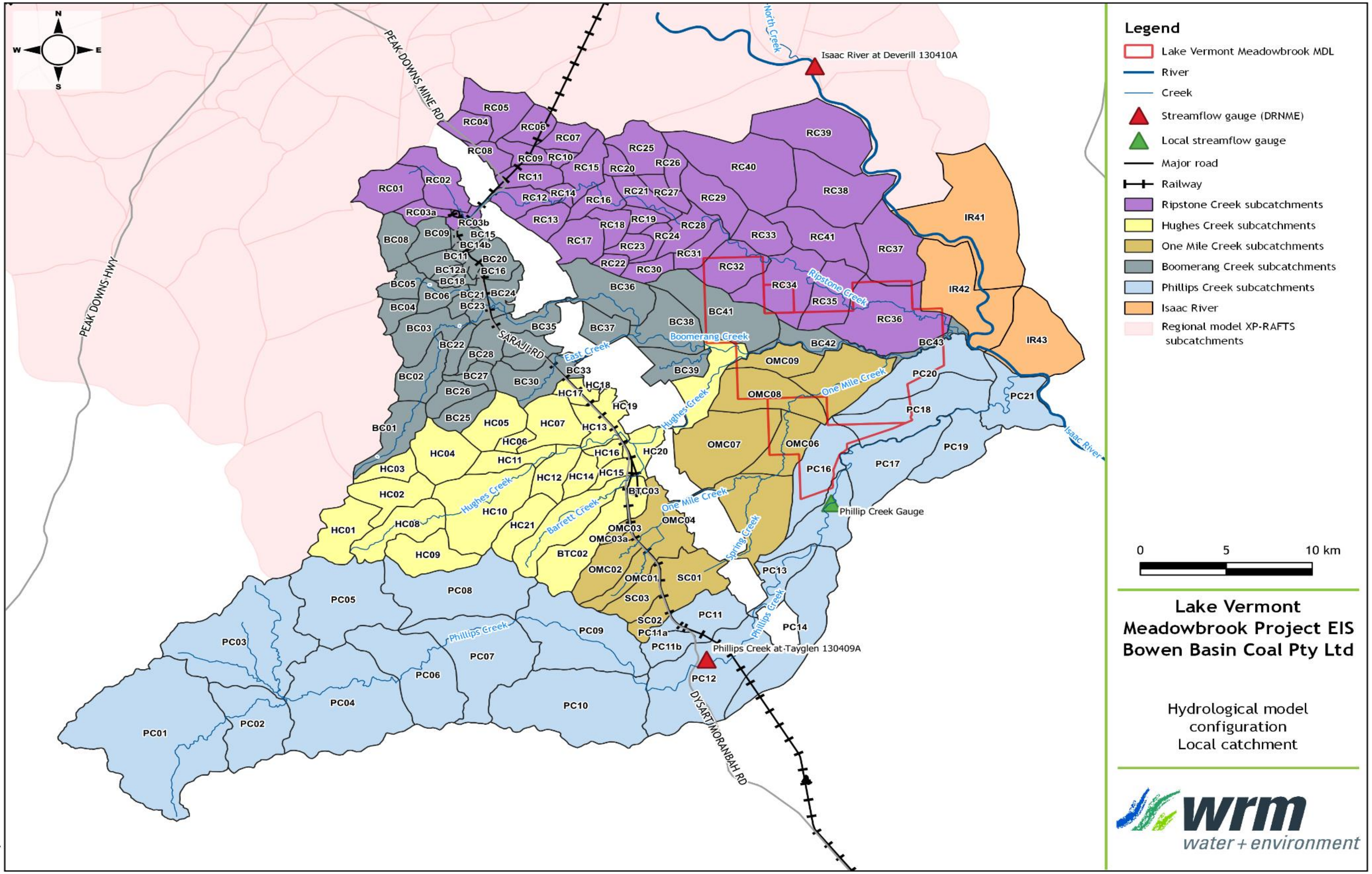

Figure 21.53: Local creeks catchment model (XP-RAFTS local configuration)

21.10.4 Current flood risk

The Flood Modelling Assessment contained in Appendix Z, Flood Modelling Assessment Report (section 1.3.1), outlines the current local flood risk for 50%, 10%, 2%, 1%, 0.1% AEP and PMF flood events, and regional flood risks of the Isaac River for 1%, 0.1% AEP and PMF events.

The depth of the Isaac River floodplain flow is significantly greater than for local creek flooding, however, this does not significantly impact flood levels in the project area. As provided by WRM (Appendix Z, Flood Modelling Assessment Report, section 3.2.2):

> *the absence of large local creek flows, breakouts flowing overland from the Phillips Creek northern floodplain to One Mile and Boomerang Creeks are not evident in flows less than the 0.1% AEP.*

The baseline flood mapping (approved conditions) for flood depths, heights, and velocity for 0.1% and 1% AEP, is provided in Appendix Z, Flood Modelling Assessment Report (section 3.2). The 0.1% AEP modelled flood heights were used as the basis for designing protection works around the surface operations at the MIA and open-cut pit. The 0.1% AEP mapping shows the extent of flooding, for which the flood protection levee is required to be designed, in accordance with the Manual (DES, 2016) to ensure flood events do not interact with mining operations.

The baseline flood mapping for flood depths, heights, and velocity for 50%, 10%, 2% AEP and PMF flood events are provided in Appendix Z, Flood Modelling Assessment Report (section 3.2). In summary:

- Phillips Creek has a much greater channel capacity compared to the northern streams (Ripstone Creek, One Mile Creek, and Boomerang Creek) which is confined within-bank during the 50% AEP flood event. However, during the 10% AEP event, minor out-of-bank flows from the channel upstream of the Project area connect to a drainage line further downstream on the northern Phillips Creek floodplain. This breakout in the 2% AEP event becomes fully developed and forms a continuous flow path parallel to Phillips Creek before re-joining the main channel upstream of its confluence with the Isaac River.
- The catchment boundary of One Mile Creek extends to a natural levee along the southern bank of Boomerang Creek. In the 50% AEP flood, two breakouts direct Boomerang Creek flow into the local drainage system, draining overland and joining One Mile Creek further downstream. In the 2% AEP event the One Mile Creek floodplain joins with Boomerang Creek due to these breakouts becoming more significant flow paths.
- Further upstream of Phillips Creek, in large flows approaching the 1% AEP, floodwater begins to overflow from the Phillips Creek floodplain through the proposed underground mining area towards One Mile Creek. These flow paths become fully engaged in the 0.1% AEP event
- Point channel velocities in the 50% AEP event range between 1.3 and 1.8 m/s. One Mile Creek flow velocities are lower than other streams at typically less than 0.5 m/s.
- 1% AEP event flow velocities in Phillips Creek are up to 2.5 m/s but are below 1 m/s along One Mile Creek. Flow breaking out over the Phillips Creek northern floodplain at velocities up to 1.2 m/s. Boomerang Creek velocities range between 1.3 to 1.5 m/s, and at one of the breakouts flowing across to One Mile Creek velocities are up to 1.5 m/s.

21.10.5 Geomorphology

A geomorphology assessment has been undertaken by WRM (as a component of the Project Surface Water Assessment) to assess the potential impacts of the Project on the geomorphology of streams crossing the Project area. The geomorphology assessment is based on the results of the detailed hydraulic modelling undertaken by WRM and is provided in Appendix W, Geomorphological Assessment Report. A summary of the drainage characteristics of the Isaac River floodplain is provided in section 21.10.5.1, and a summary of the existing flooding characteristics is provided in section 21.10.5.2.

21.10.5.1 Drainage characteristics

The most significant watercourse in proximity to the Project is the Isaac River to the east of the Project, which flows in a south-easterly direction. The Isaac River is a seasonally flowing watercourse, typically with surface flows in the wetter months from November to April, reducing in the drier months from May to October. All waterways in the vicinity of the Project are ephemeral and experience flow only after sustained or intense rainfall within the catchment (Appendix W, Geomorphological Assessment Report, Section 2.2).

Waterways passing through the Project area drain into the Isaac River via tributaries of Phillips Creek (to the south) and Boomerang Creek (to the north) (Figure 21-1). The waterways originate in the Harrow Range, where they are confined within narrow valleys by hillslopes and bedrock (Appendix F, Surface Water Assessment, Section 4.3). Local hydrology is described in Section 21.7 and Section 21.9.

Long-term deposition of sediment over the Boomerang Creek channel banks during flooding has resulted in the formation of natural levees along the southern bank of Boomerang Creek, such that it is perched above the adjacent floodplain. As a result, runoff from out-of-bank areas immediately to the south of the channel drain independently of the Boomerang Creek channel to One Mile Creek. One Mile Creek is a tributary of Boomerang Creek, and they share the same floodplain. The floodplain across the Project area is elevated (with several gilgai features) between the Boomerang and One Mile Creek channels. Floodwater frequently ponds in existing gilgai, meander cutoffs and remnant channels in the very flat floodplain between the two waterways (Appendix F, Surface Water Assessment, Section 4.8).

The Boomerang Creek channel has a breadth of 30 m and is typically 1.5 m to 2.5 m deep, with a sandy bed. Its capacity is relatively low, with floodwater flowing over the southern bank at several locations after a 50% AEP flood via two shallow south-easterly flow paths to One Mile Creek. One Mile Creek has a much smaller catchment than Boomerang Creek, and the channel is shallower (typically 0.75 m to 1.5 m deep) and narrower (around 15 m wide) (Appendix F, Surface Water Assessment, Section 4.8).

21.10.5.2 Existing flooding characteristics

Flood modelling for the Project has focused on storm event durations causing the largest flood peaks in the waterways crossing the Project area (Appendix F, Surface Water Assessment, Section 4.7.2).

Local catchment flooding has been considered more important when assessing the geomorphic response of waterways in the Project area compared to the Isaac River, which has a minor impact on flood levels in the eastern part of the Project area only (Appendix F, Surface Water Assessment, Section 4.7.2).

The 'existing conditions' modelling assumes that the Phillips Creek diversion has been constructed in accordance with the approved functional design, and there is no infrastructure across Boomerang Creek or One Mile Creek catchments (Appendix F, Surface Water Assessment, Section 4.7.2). The results of flood modelling for the 'existing conditions' scenario have been used in the geomorphology assessment to characterise hydraulic conditions of relevance to the floodplain geomorphology, including velocity, bed shear stress and stream power (Appendix F, Surface Water Assessment, Section 4.8). The assessment included the following scenarios:

- A 50% AEP flood event represented the behaviour of the creek channels at bank full flow conditions:
  - Bank full flow is the maximum flow that the channel can carry before it overflows onto the adjacent floodplain.
  - Bank full flow is often considered to be the stream forming flow, as it often exerts the greatest influence on channel geometry (Appendix F, Surface Water Assessment, Section 4.8).
- A 2% AEP flood event represented behaviour of the creeks and associated floodplains during large floods (Appendix F, Surface Water Assessment, Section 4.8).

In summary, the modelling results for the 50% AEP flood event indicate:

- Flows are confined within Ripstone Creek upstream of the Project, but then lose definition with a low carrying capacity downstream of the Project area.

- Flows would be contained in-bank in Phillips Creek, with local catchment runoff contributing all flow in its northern floodplain.
- Apart from some localised areas where overbank flows are concentrated, floodplain flow velocities are relatively low (less than 0.5 m/s).
- Boomerang Creek downstream of the overflow path to the One Mile Creek confluence drains independently of the floodplain flows, with the remaining 50% AEP flows contained in-bank.
- One Mile Creek has low channel capacity, with the 50% AEP flows draining along several channels and as shallow overbank flows.
- One Mile Creek receives Hughes Creek overflows, and then Boomerang Creek overflows to effectively become the primary flow path during flood flows (Appendix F, Surface Water Assessment, Section 4.7.3).

In summary, the modelling results for the 2% AEP flood event indicate:

- The south-east-flowing overflow paths from Boomerang Creek to One Mile Creek are significantly wider and deeper, but the perched Boomerang Creek channel downstream of the overflow paths continues to drain independently of the floodplain.
- Flooding along One Mile Creek becomes wider. Downstream of the flow path from Boomerang Creek, flow depths increase beyond 4 m but, with the exception of relatively short sections of the main channel, velocities are less than 1 m/s.
- Flows escape the channel of Phillips Creek just upstream of the Project area and run north along a drainage path within the western Phillips Creek floodplain before turning east. The Phillips Creek channel is perched with a wide levee of naturally deposited material separating the independently flowing channel from its floodplain.

In their lower reaches, the Ripstone Creek, Boomerang Creek, One Mile Creek and Phillips Creek floodplains combine and merge with the Isaac River floodplain (Appendix F, Surface Water Assessment, Section 4.7.3).

21.10.6 Proposed structures

Key water management infrastructure proposed to manage the Project flooding risk includes:

- flood protection levees;
- diversion drains;
- mine dewatering infrastructure; and
- sediment dams.

These infrastructure items are discussed as follows.

21.10.6.1 Flood protection levees

Two flood protection levees are proposed to be constructed with 0.1% AEP design event flood protection, to protect the MIA and open-cut area from potential inundation. The flood protection levee will be constructed around the MIA at the start of the Project to protect infrastructure (Figure 21.19). A second flood protection levee will be constructed around the open-cut mining area before commencing open-cut mining in Project Year 20 (Figure 21.10). Levees will be designed to withstand the predicted velocities during operations (Appendix Z, Flood Modelling, Section 3.3.3). A conceptual levee design is provided in (Figure 21.54).

Project levees are proposed to have a 5 m wide crest (sufficient for a light vehicle to traverse), with external batters constructed at a grade of 1 in 3 and internal batters constructed at a grade of 1 in 3.5. As the proposed levee structures are required to protect infrastructure from a 0.1% AEP flood event, they will be considered regulated structures (Appendix F, Surface Water Assessment, Section 7.3.

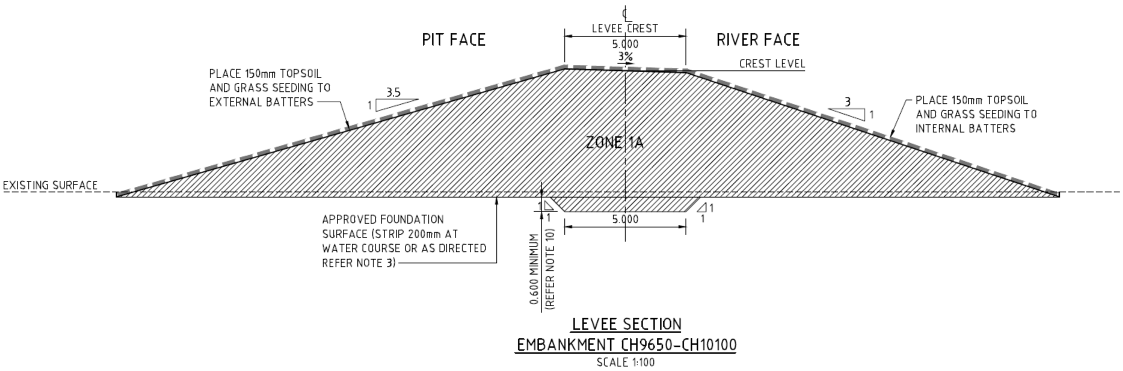

Figure 21.54: Conceptual levee cross-section

Project flood levees will be constructed using nondispersive, low permeability, engineered fill. The batters and surrounding disturbed areas will be revegetated with grasses to stabilise the levee structure and prevent sediment runoff. The flood levee crest level and design freeboard allowances will be reviewed and certified as part of the future detailed design for the proposed levee structure. Model EA conditions for regulated structures (i.e. levees) will also require the development of certified design drawings prior to the commencement of levee construction.

The proposed crest elevations for the levees will allow for a 0.50 m freeboard. The maximum crest of the proposed MIA levee is 3.11 m above ground level (178.9 mAHD) in the south-western corner of the MIA (Chainage 228) (Figure 21.55). The average height of the MIA levee will be 1.74 m (178.23 mAHD) with a minimum construction height of 0.64 m (Chainage 1,700) (Figure 21.55).

The maximum crest of the proposed open-cut mining area levee is 5.18 m above ground level (181.96 mAHD) in the south-eastern section adjacent to Phillips Creek (Chainage 1703) (Figure 21.56). The average height of the levee in this area will be approximately 2.35 m (179.64 mAHD). In the north-western area of the levee and adjacent to One Mile Creek, the maximum crest height will be 2.64 m (at Chainage 7183) (Figure 21.56). A minimum crest height of 0.50 m is assumed for areas of higher topography.

The 2051 developed conditions with mitigations scenario model (Appendix Z, Flood Modelling, Section 3.3) produced results indicating that the levees around the open-cut operation and MIA would locally reduce floodplain conveyance and storage. This would have the effect of locally increasing upstream flood levels and redistributing downstream flow to the opposite floodplains until the levees are decommissioned, and the floodplain landform is returned to pre-mining levels (Appendix Z, Flood Modelling, Section 3.3).

Detailed levee designs will incorporate appropriate erosion protection measures such as rock armouring where velocities are sufficient to erode the compacted earth embankment. Velocities adjacent to the MIA levee and northern open cut levee are predicted to be less than 1.5 m/s in the 1 in 1000 AEP flood, and erosion protection works are therefore unlikely to be required in these areas. The southern open cut levee would likely require erosion protection works near the southern and north-eastern corners. (Appendix Z, Flood Modelling, Section 3.3).

Modelled mapping of peak flood depth and extent for the developed conditions (2051 conditions with mitigation) for the 0.1% AEP and PMF flood events are shown in Z, Flood Modelling, Section 2.3. These modelling outputs demonstrate that the operational flood levees provide 0.1% AEP flood protection to mining infrastructure. Modelling also demonstrates that post-mining, the rehabilitated pit depression will be located outside areas affected by flood levels up to and including the PMF flood level. The final landform design includes elevation to ensure water ingress into the final rehabilitated pit area is prevented in the event of a 0.1% AEP flood event. Surface water interactions with the rehabilitated pit depression are discussed in Chapter 6, Rehabilitation and Chapter 8, Surface Water.

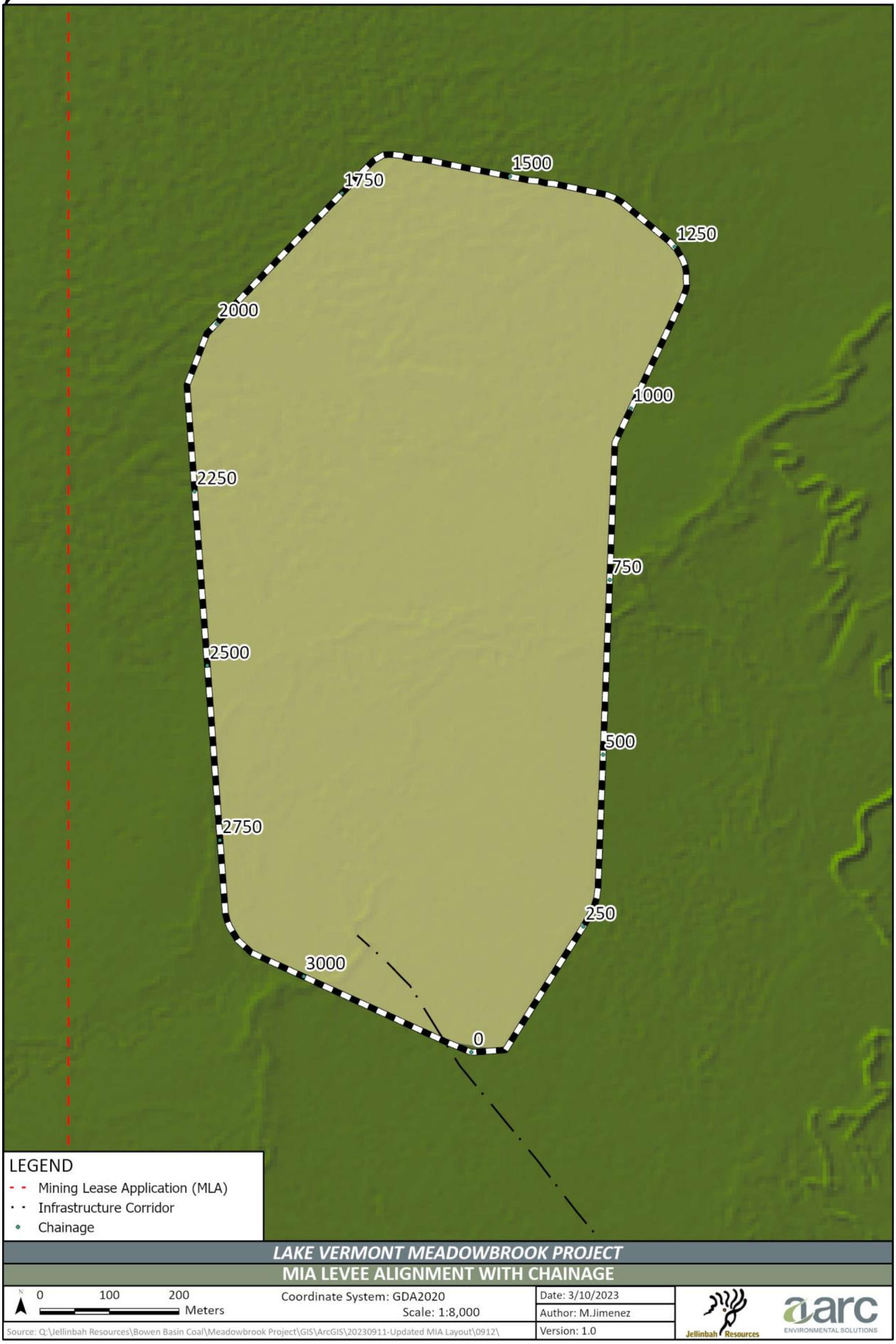

Figure 21.55: Proposed MIA levee alignment with chainage in metres

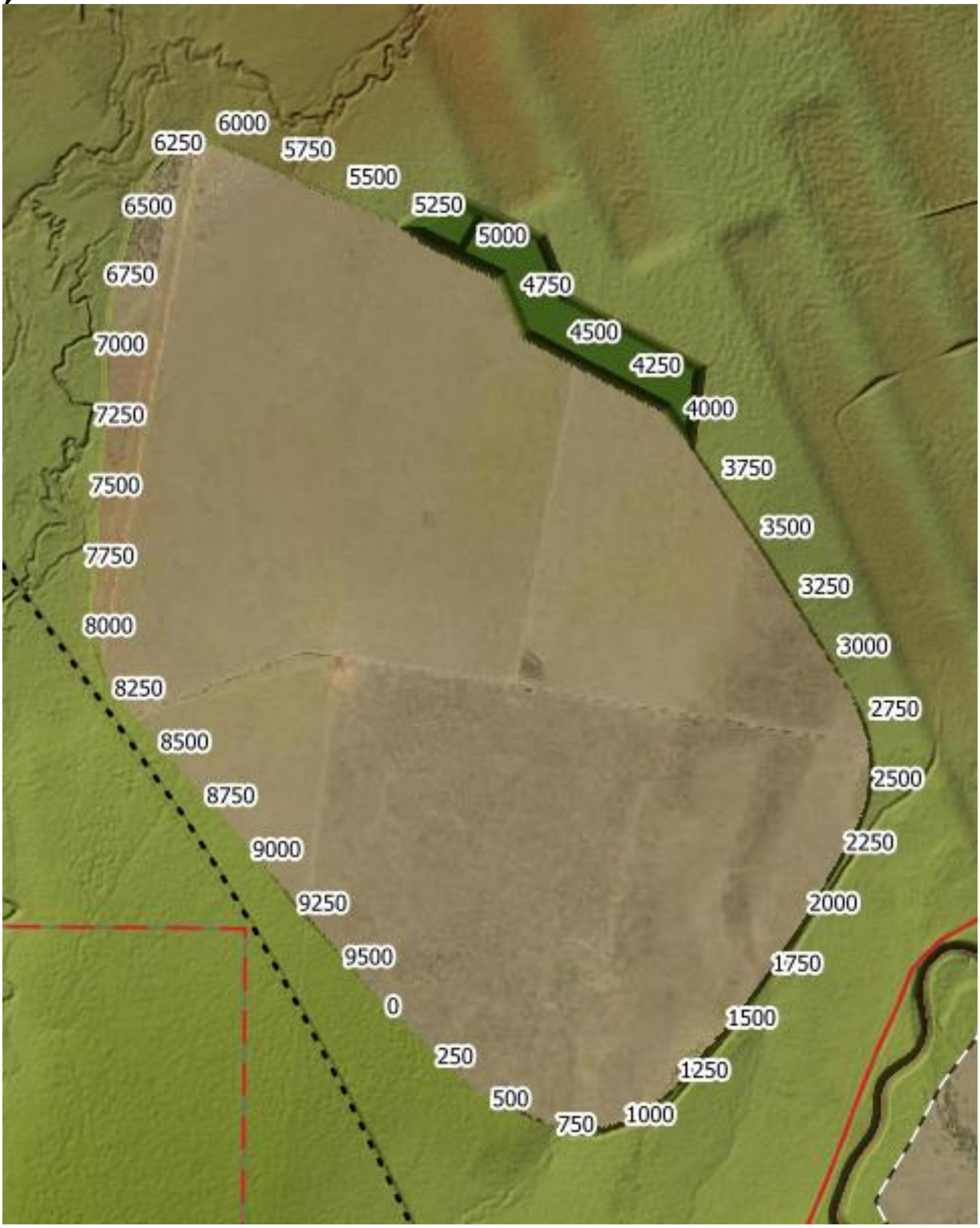

Figure 21.56: Proposed open-cut mining area levee alignment with chainage in metres

21.10.6.2 Diversion drains

A diversion drain is proposed to be developed during the construction phase to support the diversion of clean water around the southern extent of the MIA levee (Figure 21.19). An additional diversion drain is proposed to be constructed during the Project operational phase (indicatively Project Year 20) to divert clean water around the southern extent of the open-cut pit levee (Figure 21.10).

Both of these diversion drains have been designed to facilitate the passage of overland flow, which would otherwise be impeded by levee construction.

A conceptual cross-section of the proposed Project diversion drains is provided in Figure 21.57. Diversion drains will have an approximate 3 m channel base and channel walls constructed at a grade of 1:3. The MIA diversion drain will be constructed in parallel with the MIA levee construction, while the open-cut diversion drain will be constructed in parallel with the open-cut pit levee construction (circa Project Year 20).

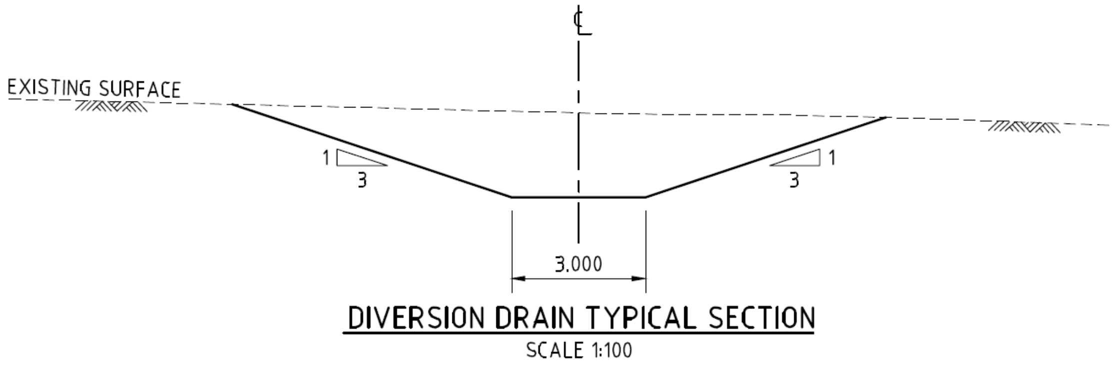

Figure 21.57: Conceptual diversion drain cross-section

21.10.6.3 Underground mine dewatering infrastructure

To manage groundwater ingress into the underground mine workings, mine dewatering will occur. Underground mine dewatering will involve pumping water from the underground workings to the surface infrastructure within the MIA.

Dewatering infrastructure proposed to be developed during Project construction includes the Dewatering Dam and the MIA Dam. A raw water dam (for storage of clean, raw water) will also be constructed within the MIA. These dams will be located as shown through Figure 21.19. Further details of these proposed dams is provided in Table 21.15, with operation of these dams detailed in Section 21.7.

Table 21.15: MIA Dam sizing

Storage name	Storage type	Maximum catchment area (ha)	Storage capacity (ML)
Raw Water Dam	Raw water	0.4	20
Dewatering Dam	Mine affected water	0.4	20
MIA Dam	Mine affected water	73	440

Water pumped from the underground will initially be transferred to the Dewatering Dam (a Turkey's nest dam) within the MIA. From here, water may be pumped into the adjoining MIA Dam (for further dilution), utilised for dust suppression or pumped back to the Lake Vermont Mine to support processing requirements. While local groundwater resources are notably of poor quality (i.e. highly saline), water pumped to the surface from the underground will be significantly diluted by the volume of raw water sent underground for dust suppression (estimated to be a ratio of three parts pipeline water to one part groundwater).

A consequence assessment has been completed for the dams identified in Table 21.15 in accordance with the 'Manual for assessing consequence categories and hydraulic performance of structures' (DES 2016) and the 'Structures which are dams or levees constructed as part of environmentally relevant activities'(DES 2022b). Each dam is assigned a 'Consequence Category' of High, Significant or Low depending on its potential to cause harm (DES 2016). A structure categorised as a Significant or High consequence is referred to as a regulated structure. Such structures must comply with hydraulic performance objectives (DES 2016). A summary of the Consequence Category assessment of Project dams is provided in Section 21.10.7.5.

21.10.6.4 Sediment dams

Sediment dams will be constructed within the proposed open-cut mining area to assist in managing rainfall and runoff. During open-cut mining operations, catchment runoff from overburden dumps will be captured in three sediment dams, namely; the:

1) Southern Sediment Dam;
2) Northern Sediment Dam 1; and
3) Northern Sediment Dam 2.

Locations of these sediment dams are provided in Figure 21.21. Sediment dams will be designed to contain a one in 10-year ARI 24-hour rainfall event and will be operated in accordance with the DES Guideline 'Stormwater and environmentally relevant activities' (DES 2021c). Sediment dam catchment areas and proposed storage capacities are provided in Table 21.16.

Table 21.16: Sediment dam sizing

Storage name	Storage type	Maximum catchment area (ha)	Storage capacity (ML)
Northern Sediment Dam 1	Sediment dam	327	240
Northern Sediment Dam 2	Sediment dam	223	155
Southern Sediment Dam	Sediment dam	256	180

During rainfall events exceeding dam design capacity, the Northern Sediment Dams would overtop to One Mile Creek, while the Southern Sediment Dam would overtop to Phillips Creek (*via* an existing drainage line). Environmental risks related to sediment dams are discussed in Section 21.9.6.4.

The Northern Sediment Dam 1 would be initially constructed by pre-excavating overburden material near the northern corner of the open-cut pit levee. Once the existing ground surface is mined out, sediment dams would be formed into localised depressions, both north and south of the open-cut pit (Site Water Balance and Water Management System Report, Section 2.2.11). Sediment dam locations are provided in Figure 21.21, Chapter 3, Project Description. All sediment dams will be removed and rehabilitated as part of mine closure.

21.10.6.5 Other infrastructure

Additional infrastructure that may have an impact on flood behaviour include:

- the haul road:
  - located within the infrastructure corridor;
  - connects the existing Lake Vermont Mine and the proposed MIA;
  - includes crossings at Phillips Creek, the Phillips Creek northern floodplain and One Mile Creek; and
  - requires several cross-drainage structures; and
- a rehabilitated waste rock emplacement area.

21.10.7 Potential impacts

21.10.7.1 Flood depth and afflux impacts

Flood depth and extent for all scenarios described in Section 21.10.2.3 is provided through Appendix Z, Flood Modelling Assessment Report (section 3.2.1), for each AEP flood event (50%, 10%, 2%, 1%, 0.1%) and the PMF flood events. Flood depth mapping shows the difference between the scenarios modelled for each flood event assessed. As an example, the modelled peak flood depths for the existing conditions and developed conditions for the 1% AEP flood event are shown in Figure 21.58 and Figure 21.59, respectively.

Flood afflux mapping for 2051 conditions minus approved conditions (local and regional) is provided in Appendix Z, Flood Modelling Assessment Report (Section 3.3) for each flood event assessed. Figure 21.59 shows the 1% AEP afflux local flooding.

The flood impact assessment for the modelled scenarios indicates:

- Underground mine subsidence will locally reduce flood levels but increase the depth and extent of flooding.
- Subsidence will increase floodplain storage, which has the effect of reducing downstream flood flows, levels and extents for 50% and 10% AEP flood events on Phillips Creek, One Mile Creek and Boomerang Creek, of between 50 and 100 mm.
- For the 10% AEP event, over the subsidence panels on the Phillips Creek floodplain downstream of the open-cut mine, reductions in flood level are up to two metres in some areas. In larger events reductions in level are smaller, and within the range of 700 mm to 850 mm.
- For the subsidence areas on One Mile Creek, reductions in level range from one metre to 700 mm.
- Along Boomerang Creek some flood levels have reduced by much as three metres in the 10% AEP event to 2.5 metres in the PMF in the most affected locations.
- Afflux downstream of the mine lease area is negative for all events - ranging from a 600 mm reduction at the Isaac River in the 50% AEP to 300 mm in the 10% AEP. Reductions in the floodplain of the Isaac River in the larger events from the 2% AEP to the PMF range from 60 to 100 mm.
- In the 0.1% AEP and PMF events there is also some positive afflux in the vicinity of the confluence of the Boomerang and Isaac Rivers of approximately 30 to 50 mm.
- In the 1% AEP event, for regional flooding conditions, off-lease impacts are limited to the Phillips Creek northern floodplain with reductions of up to 100 mm just to the south of the Satellite pit and small increases of 30 mm to the western side of the Satellite pit.
- In the 0.1% AEP flood event, reductions downstream in the Phillips Creek northern tributary are approximately 150 mm.

Project impacts to flooding depth and afflux are relatively minor, localised, limited in duration (for the period of levee existence), do not present impacts to other water users, and are not considered to present a significant impact on the hydrological characteristics of water resources.

21.10.7.2 Flood velocity impacts

Flood velocity mapping for all scenarios described in Section 21.10.2.3 is provided in Appendix Z, Flood Modelling Assessment Report, section 3.3.3, for each flood event assessed. The modelled 1% AEP flood velocities for the 2051 operations scenarios are shown in Figure 21.60 and Figure 21.61. The modelled changes in velocity for the 2051 mine site conditions compared with approved conditions for the 1% AEP event is shown in Figure 21.62.

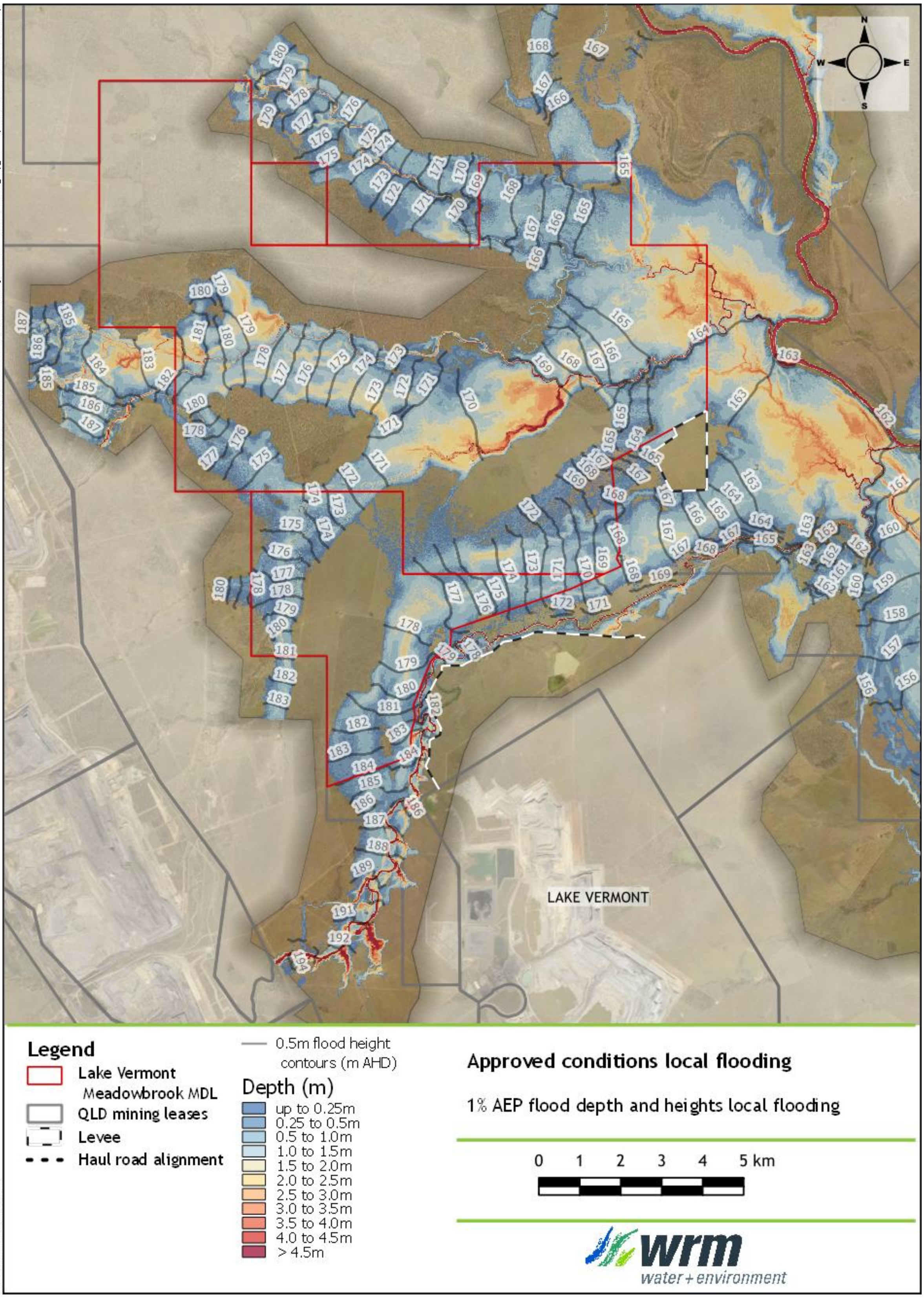

Figure 21.58: 1% AEP approved conditions local flood depths and heights

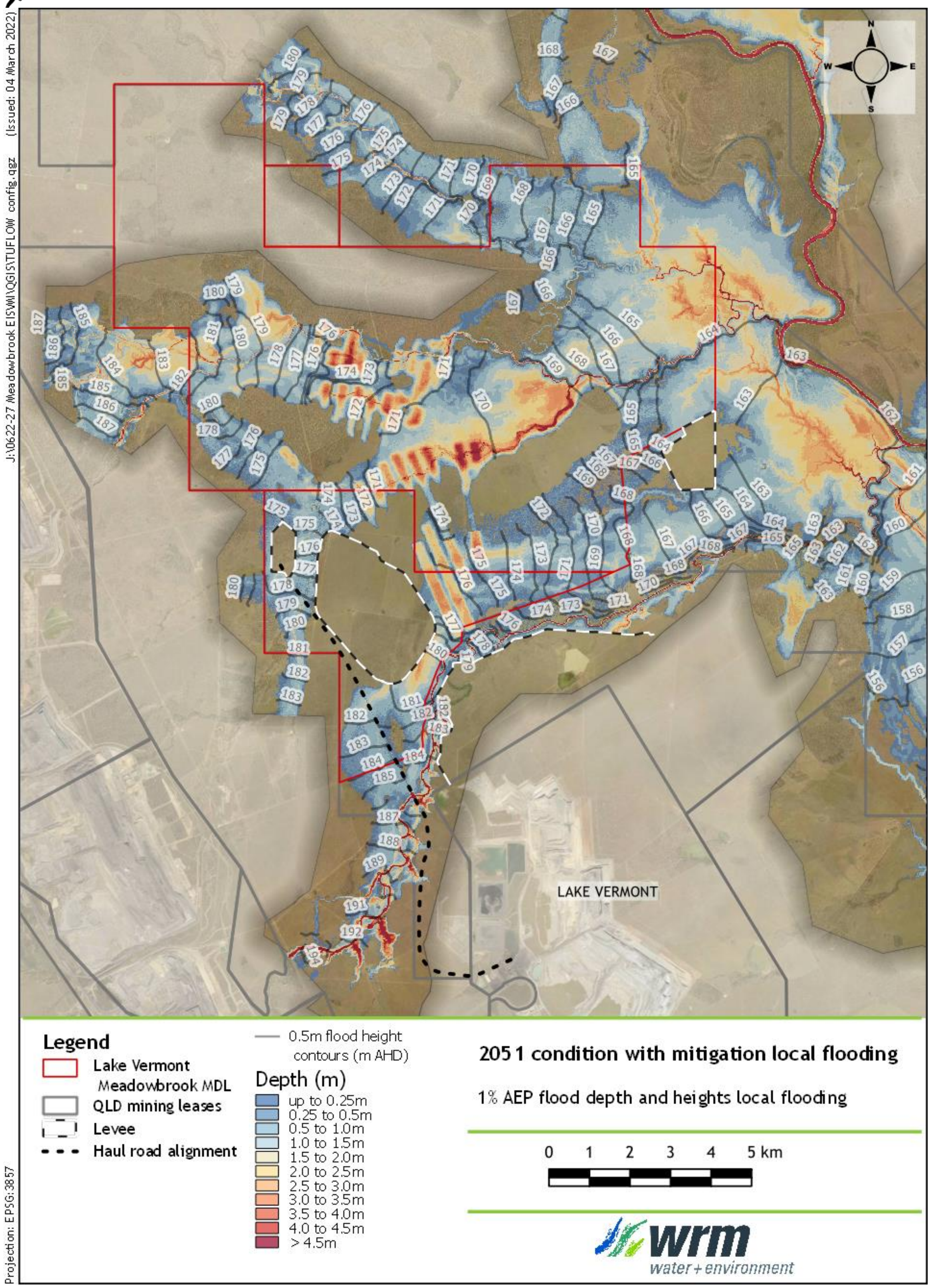

Figure 21.59: 1% AEP developed condition flood depth and heights local flooding

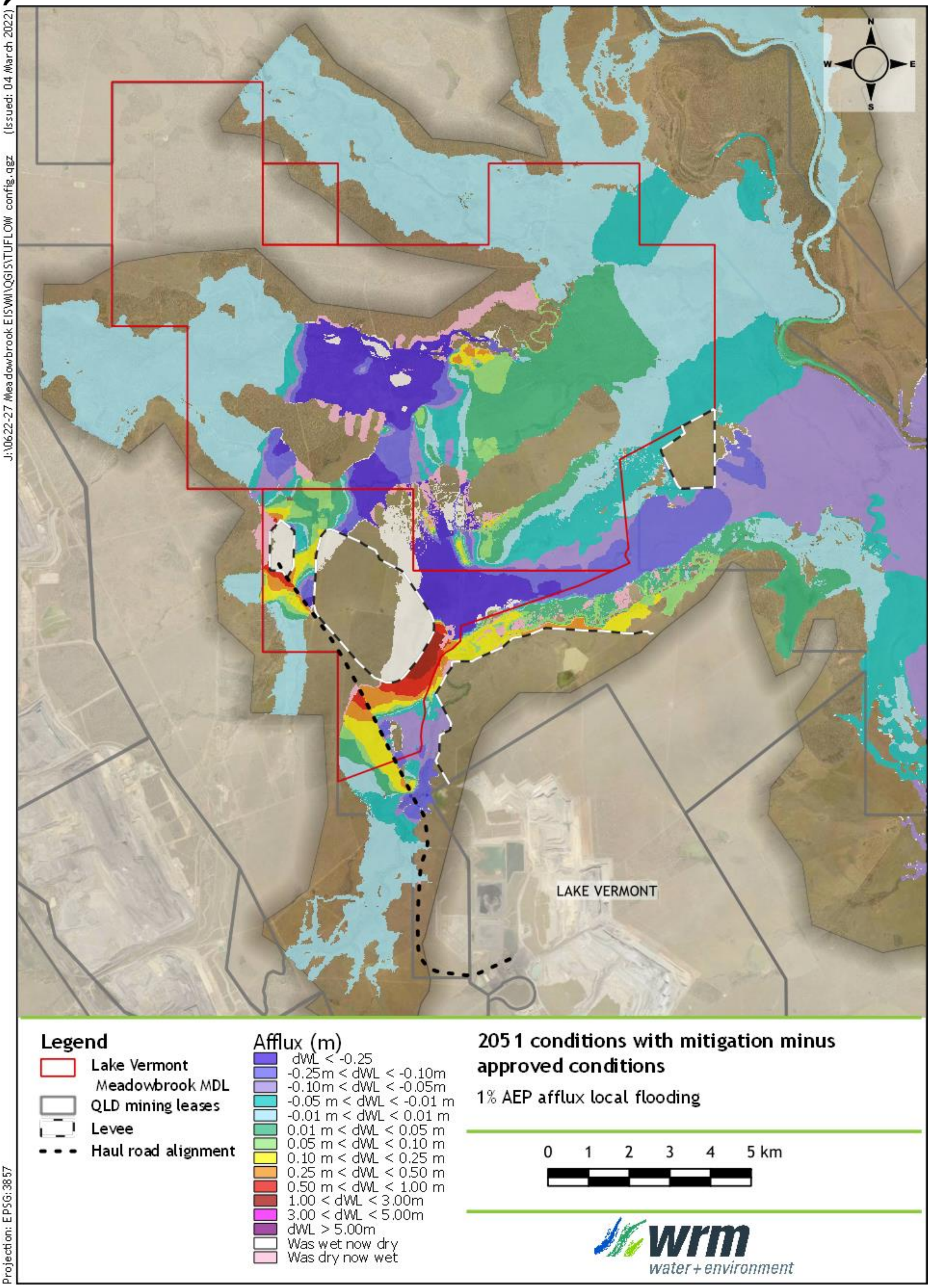

Figure 21.60: 1% AEP afflux (2051 conditions minus approved conditions)

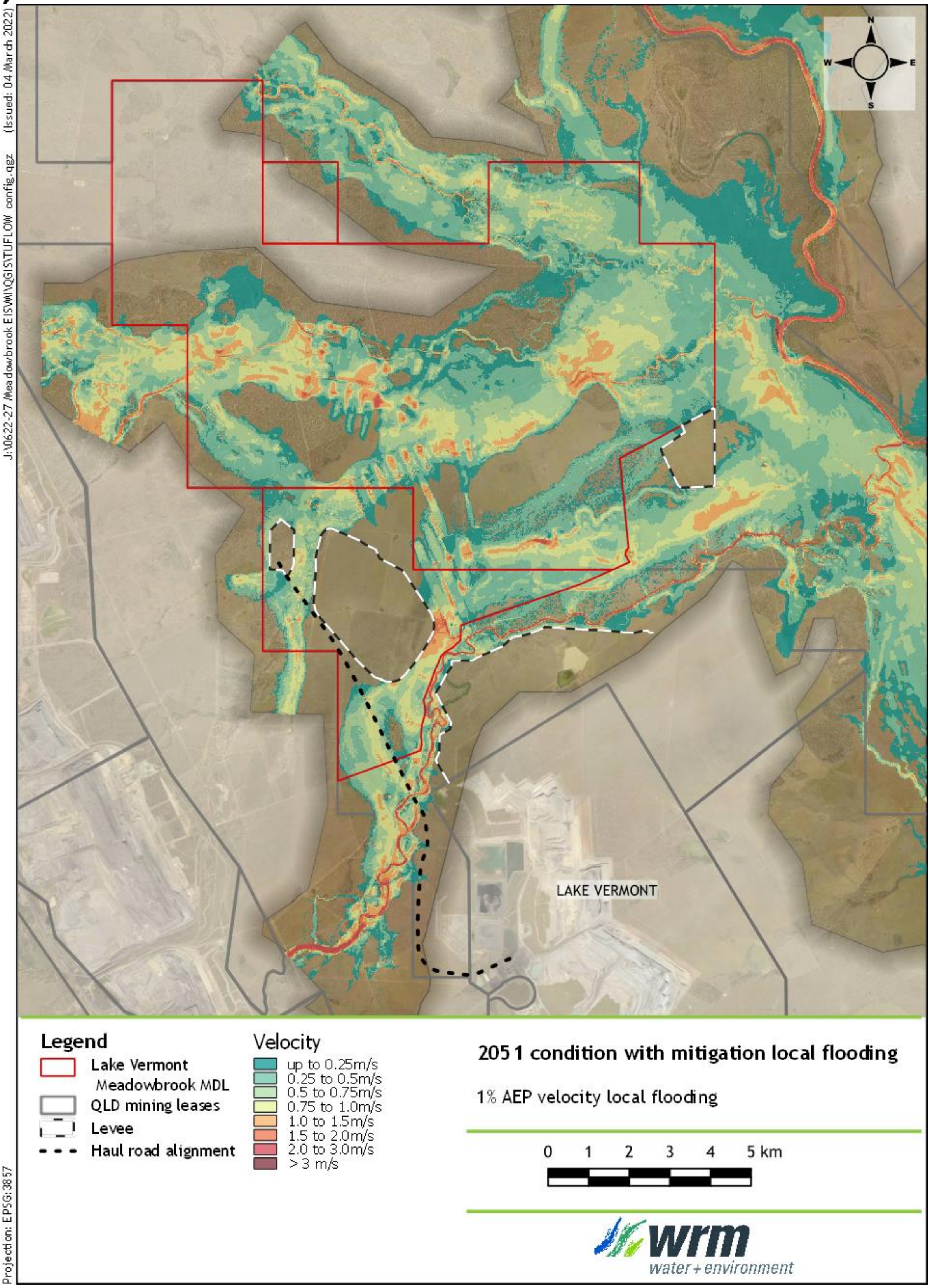

Figure 21.61: 1% AEP 2051 conditions local flood velocity

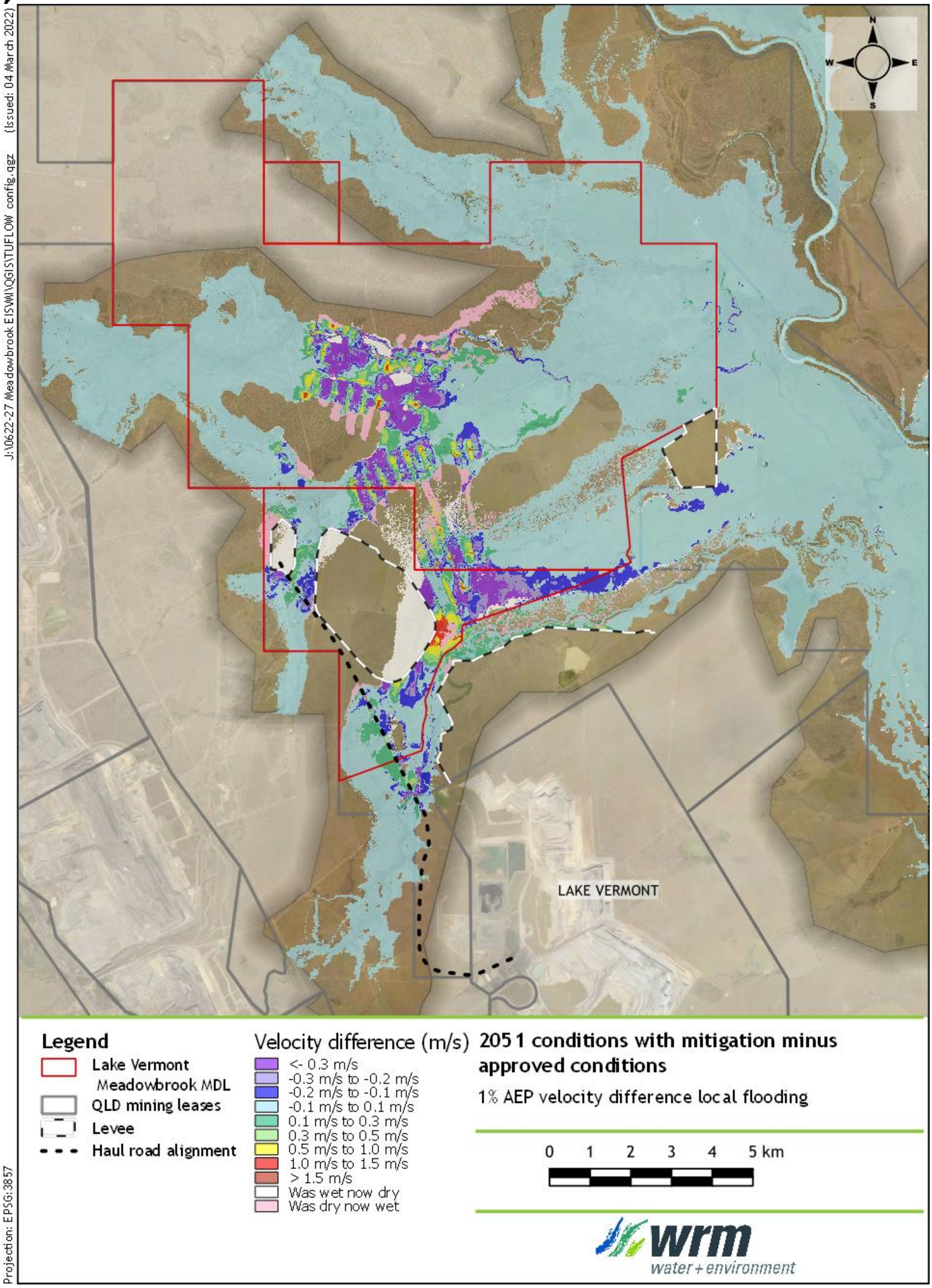

Figure 21.62: 1% AEP 2051 velocity difference (2051 conditions minus approved conditions)

A detailed assessment of velocity impacts is provided in Appendix Z, Flood Modelling Assessment Report , section 3.3.1. An overview of the Flood Impact Assessment for flood velocity indicates that:

- There are no significant changes in velocity downstream of the mine lease area in design flood events.
- Across the range of events, the subsidence panels will typically experience velocity reductions of up to 0.5 m/s, and velocity increases between the panels of up to 0.7 m/s (with some areas experiencing increases up to 1.2 m/s).
- The Phillips Creek floodplain near the south-eastern corner of the open-cut mine is predicted to experience the greatest velocity increases. Modelled point velocity increases range from 0.8 m/s in the 10% AEP event to approximately 1.3 m/s in the 2% and 1% AEP events, and up to 1.5 m/s in the 0.1% AEP event. These velocity increases will be temporary until the operational pit protection levee was decommissioned.
- In the 2% and 1% AEP events, increases of 0.2 m/s will occur upstream of the haul road in the channel of Phillips Creek and increases of 0.1 to 0.2 m/s along the haul road on the Phillips Creek northern floodplain.
- Minimal upstream velocity impacts are predicted for the 50% and 10% AEP floods. Minimal increases in velocity are predicted in the 0.1% AEP event.

Project impacts to flood velocities are therefore relatively minor, localised, primarily limited in duration (for the period of levee existence), do not present impacts to other land or water users, and are not considered to present a significant impact on the hydrological characteristics of water resources.

21.10.7.3 Geomorphology impacts

An assessment of the 2051 development conditions of the Project has been undertaken to model potential effects on geomorphological behaviour of the channels and floodplains of Boomerang Creek and One Mile Creek, for the 50% and 2% AEP events (Appendix W, Geomorphological Assessment Report, section 4.5 and 4.6). The results are outlined as follows, for floodplain morphology and channel morphology.

The geomorphology assessment undertaken by WRM, Appendix W, Geomorphological Assessment Report (section 3) also considers predicted direct subsidence impacts on floodplain drainage. Flood level impacts from subsidence are provided in Appendix Z, Flood Modelling Assessment Report, section 3.3.1.

Floodplain morphology

Impacts on floodplain morphology for the proposed 2051 development conditions have been outlined in detail in Appendix W, Geomorphological Assessment Report (section 4.4). In summary, the Project has the potential to have the following affects on flow velocities:

- Reduced flow velocities across much of the floodplain will occur as water is stored in the subsided areas. This will promote the deposition of sediment in these areas and the surrounding floodplain. Long-term impacts will result in the gradual accretion of floodplain depressions.
- Increased velocities in areas where overbank floodwater drains into subsidence troughs (Figure 4.7 and Figure 4.8 of Appendix W, Geomorphological Assessment Report, section 4.4) including:
    - a 50% AEP event that will initiate:
        - increases of more than 0.5 m/s in small areas of the floodplain, with the potential to cause localised erosion initially;
        - increases of 0.25 m/s to 0.5 m/s where the additional floodplain water from Boomerang Creek drains into One Mile Creek.
    - A 2% AEP event that will allow:
        - velocities to remain mostly below 1 m/s, with significant alterations to floodplain morphology considered unlikely.

Channel morphology

The results of flood modelling of the Boomerang Creek and One Mile Creek floodplains for the 2051 development conditions have been used to assess impacts on channel morphology, including changes to flood velocities, bed shear and stream power. The results have been modelled from 50% and 2% AEP events (Appendix W, Geomorphological Assessment Report, Section 4.5). The key findings of the assessment are detailed below. Appendix W, Geomorphological Assessment Report (Section 4.5) should be referred to for the locations of drainage references shown in the sections below.

Boomerang Creek

- Subsidence results indicate a series of six main troughs in the bed due to the interaction of the differential settlement across the longwall panels and the intervening unmined pillars in the two overlying coal seams. The subsidence troughs above each longwall panel cause decreases in channel velocity, bed shear and stream power, as the channel drains out of each subsidence trough and traverses the adjoining chain pillar.
- Increase in channel velocity, bed shear and stream power will occur as the channel drains into the mine subsidence zone at Ch 9,250. The deep bed sediments in these reaches are expected to erode relatively quickly as the channel morphology changes to reflect the higher bed grade. Potentially, this will lead to an increase in bank erosion as the channel capacity increases.
- Increase in channel velocity, bed shear and stream power will occur as flow enters the second and fourth subsidence troughs (Ch 10,200, and Ch 11,700 to Ch 12,000). The observed volumes of sediment in the overall system are significant enough to indicate expected aggradation of the bed, resulting in the post-subsidence channel velocity, bed shear and stream power reverting towards pre-mining conditions.

One Mile Creek

- The predicted subsidence troughs (eight main troughs in the bed) above each longwall panel significantly decrease channel velocity, bed shear and stream power as the channel drains out of each subsidence trough and traverses the adjoining chain pillar. This will cause a major reduction in sediment transport capacity in each trough and promote aggradation of the bed in these areas.
- Increase in channel velocity, bed shear and stream power will occur as the channel drains into the mine subsidence zone at Ch 9,750. Velocities in this area would remain less than guideline values but, given the relatively fine sediment in this area and the apparent limitation in sediment supply, these reaches are expected to erode as the channel morphology changes to reflect the higher bed grade. This may also lead to increases in bank erosion as the channel capacity increases.
- Increase in channel velocity, bed shear and stream power will occur as flow enters the second to fifth subsidence troughs (working west to east). The bed sediments on the downstream side of these localised elevated sections of the stream bed are expected to scour, and headward erosion would occur through this elevated section of stream bed.

As part of mitigation and monitoring measures outlined in section 21.10.8, a subsidence monitoring program will be implemented to assess the extent of the channel changes, including changes in bed levels and the impact of increased localised sedimentation. Bank protection measures will be considered if monitoring indicates that the increase in erosion is having a demonstratable impact on the channel form.

21.10.7.4 Subsidence impacts

Flood level impacts near the subsidence zone and the predicted direct subsidence impacts were modelled by WRM and are provided in Appendix W, Geomorphological Assessment Report (Section 3). The predicted direct impact results consider the depth and extent of subsidence and the impacts of subsidence on floodplain drainage, as discussed below.

Flood level impacts

The most significant reductions in flood levels tend to be localised around the subsidence areas and are of a similar magnitude to the predicted subsidence depths (Appendix Z, Flood Modelling Assessment Report, Section 3.3.1). The WRM assessment made the following conclusions:

- Over the subsidence panels on the Phillips Creek floodplain downstream of the open-cut mine, reductions in flood levels are up to 2 m in some areas in the 10% AEP event.
- In the 50% and 10% AEP events, there is a reduction in the wetting of the floodplain downstream of the subsidence.
- For the subsidence areas on One Mile Creek, reductions in levels range from 1 m to 700 mm. Along Boomerang Creek, some flood levels have reduced by as much as 3 m in the 10% AEP event and 2.5 m in the PMF in the most affected locations.
- The increase in flood storage in subsided areas results in a reduction of 50% and 10% AEP flood levels further downstream at Phillips Creek, One Mile Creek and Boomerang Creek of between 50 mm and 100 mm.
- For the 2% AEP and larger flow events, reductions in flow along the tributary of Phillips Creek that lies on the subsided floodplain become more significant (i.e. between 100 mm and 250 mm) as flow is diverted along the subsidence panels and joins One Mile Creek. This effect would be mitigated by the construction of bunds across the subsidence panels, thereby limiting afflux in the One Mile Creek and Boomerang Creek floodplains to 50 mm to 100 mm. The subsidence would result in a small reduction in flood levels downstream of the subsidence zone.
- Afflux downstream of the mine lease area is negative for all events and ranges from a 600 mm reduction at the Isaac River in the 50% AEP to 300 mm in the 10% AEP. Reductions in the floodplain of the Isaac River in the larger events from the 2% AEP to the PMF range from 60 mm to 100 mm.
- In the 0.1% AEP and PMF events, there is some positive afflux in the vicinity of the confluence of the Boomerang and Isaac Rivers of approximately 30 mm to 50 mm.
- Within the subsidence zone of Boomerang Creek, peak flood levels would be reduced by up to approximately 3.5 m in the 50% AEP and approximately 3.0 m in the 2% AEP flood. The extent of inundation would be increased slightly by backwater flowing up the subsidence troughs. During small flood events, additional flood storage would significantly reduce the peak flow rate and peak flood levels in downstream reaches of Boomerang Creek by as much as 0.3 m to 0.5 m (Geomorphological Assessment Report, Section 5.2).
- Within the subsidence zone of One Mile Creek, peak flood levels would be reduced by up to approximately 1.3 m in the 50% AEP flood and approximately 1.5 m in the 2% AEP flood (Appendix W, Geomorphological Assessment Report, Section 5.3).

Depth and extent of subsidence

The maximum depth of predicted subsidence varies with location around the proposed operation, with impacts greater where two seams are mined (Appendix W, Geomorphological Assessment Report, Section 3.2). Subsidence depths relevant to flooding impacts are considered as follows:

- The channel of Phillips Creek would not be directly affected by subsidence. Maximum subsidence depths on the Phillips Creek northern floodplain would be up to between 2.5 m and 3.0 m.
- Maximum subsidence depths on the One Mile Creek channel and southern floodplain would be up to between 2.5 m and 3.0 m.
- Maximum subsidence depths in the floodplain between One Mile Creek and Boomerang Creek would be over 4.5 m in localised areas.
- The channel and floodplain of Boomerang Creek would see maximum subsidence depths of up to 4.0 m (Appendix W, Geomorphological Assessment Report, Section 3.2).

Impacts of subsidence on floodplain drainage

Changes to local topography resulting from predicted subsidence would increase the number and extent of areas not free draining (i.e. residual ponding areas). Residual ponding areas are primarily located directly above longwall panels, with the surface area of the panel subsiding as the underlying coal strata is removed.

Bowen Basin Coal has undertaken work to identify and mitigate the extent of residual ponding areas. This can be achieved in some areas by:

- constructing bunds to prevent surface water ingress into subsided areas; or
- constructing drains to facilitate water egress from subsided areas.

This work has resulted in the development of proposed 'mitigation bunds' and proposed 'mitigation drains'. Figure 21.63 shows both the unmitigated and mitigated ponding footprints in conjunction with the proposed locations of mitigation bunds and mitigation drains.

On the northern Phillips Creek floodplain, a mitigation drain is proposed to drain the four subsided panels downstream via an existing drainage line (Figure 21.63). The proposed earthworks would extend for approximately 2.5 km from the deepest point of the westernmost panel. The channel would be up to 2.8 m deep at the peak of each pillar and would have a base width of approximately 5 m, consistent with the existing floodplain channel in the area (Appendix W, Geomorphological Assessment Report, Section 3.3.2).

On the floodplain between One Mile Creek and Boomerang Creek, a mitigation drain is proposed to drain four subsided panels (Figure 21.63). The proposed earthworks would extend for approximately 1.4 km from the deepest point of the westernmost panel. The channel would be up to 3 m deep at the peak of each pillar and would have a base width of approximately 5 m (Appendix W, Geomorphological Assessment Report , Section 3.3.2).

Two mitigation bunds are also proposed to be constructed across the panels in the Phillips Creek floodplain (Figure 9.13). These mitigation bunds are designed to maintain flows in the minor drainage paths during flood conditions and reduce the potential for Phillips Creek floodwater to be diverted to One Mile Creek in minor floods. Mitigation bunds will be constructed to a maximum height of approximately 2.7 m (at the deepest point of the subsided ponds) and a maximum width up to approximately 27 m (based on a 1:5 slope at the maximum height). The length of each mitigation bund is up to a maximum of approximately 350 m.

With proposed ponding mitigation works, it is noted that it has not been possible to drain the residual ponding areas in the north-eastern part of the One Mile Creek and Boomerang Creek floodplains, due to relative elevations (Appendix W, Geomorphological Assessment Report, Section 3.3.3). Nonetheless, significant reductions in ponding areas would be achieved through the proposed mitigation bunds and mitigation drains. This works to significantly reduce the impact to ecological values. Ecological impacts from residual ponding are discussed in Chapter 10, Terrestrial Ecology, and Chapter 11, Aquatic Ecology.

It should also be noted that the residual ponding areas shown in Figure 9.13 provide the 'worst-case' scenario, as this representation assumes subsided areas are full of water, which will rarely be the case (Appendix W, Geomorphological Assessment Report , Section 3.3.1). Residual ponding areas would nonetheless form after rainfall and flood events. Under the 50% AEP flood event, residual ponds created by subsidence are predicted to be inundated by flooding at least every few years on average (Appendix W, Geomorphological Assessment Report, Section 3.3.3). Ponding areas may also be pumped from the deepest ponding areas when depths exceed 0.5m (Appendix W, Geomorphological Assessment Report, Section 3.3.4).

21.10.7.5 Water management infrastructure risk

As described in Section 21.10.6.1, temporary flood protection levees with 0.1% AEP design event flood protection will be constructed around the MIA and open-cut pit prior to operations.

The MIA levee is predicted to cause some minor additional off-lease inundation to depths of up to 150 mm adjacent to One Mile Creek. This is expected to increase to 200 mm in a (0.1%) AEP event (Appendix Z, Flood Modelling Assessment Report, Section 3.3.2). These depth increases would be temporary until the open-cut mining area levee is decommissioned (Appendix Z, Flood Modelling Assessment Report, Section 3.3).

The open-cut mining area levee is predicted to induce floodplain flow velocity increases. Under the developed conditions (2051 scenario), the Phillips Creek floodplain near the south-eastern corner of the open-cut mining area is predicted to experience the greatest velocity increase. Modelled point velocity has increased the range from 0.8 m/s in the 10% AEP event to approximately 1.3 m/s in the 2% and 1% AEP events and up to 1.5 m/s in the 0.1% AEP event. These velocity increases would be temporary until the open-cut mining area levee is decommissioned (Appendix Z, Flood Modelling Assessment Report, Section 3.3.3).

Post closure conditions

Post-closure conditions for local creek flooding have been modelled for a 0.1% AEP and PMF flood event. However, the proposed rehabilitated pit is outside the 0.1% AEP (approved conditions) flood extent, and the surrounding land would be shaped to mitigate the risk of inundation of the rehabilitated pit from floods not exceeding the 0.1% AEP flood event (Appendix Z, Flood Modelling Assessment Report, Section 3).

The depth and velocity results for the 0.1% AEP flood event are shown in Figure 21.64 and Figure 21.65. The results of the analysis of the PMF under post-closure conditions is provided in Appendix Z, Flood Modelling Assessment Report, Section 3.4

Consequence category assessments

Proposed Project levees (MIA levee and open-cut mining area levee) are designed to protect infrastructure from a 0.1% AEP flood event. As such, these levees will be considered ‘regulated structures’ (Appendix F, Surface Water Assessment, Section 5.3.1). Project levees have been conceptually designed in accordance with the ‘Manual for assessing consequence categories and hydraulic performance of structures’ (DES 2016) and the ‘Structures which are dams or levees constructed as part of environmentally relevant activities’ (DES 2022b). Model EA conditions for regulated structures will require the development of certified design drawings prior to the commencement of levee construction.

A consequence category assessment has also been completed for all dams proposed for the Project in accordance with the ‘Manual for assessing consequence categories and hydraulic performance of structures’ (DES 2016), which sets out the requirements of the administering authority for consequence category assessment and certification of the design of regulated structures.

Each dam is assigned a Consequence Category of High, Significant or Low depending on its potential to cause harm. A structure categorised as a Significant or High consequence is referred to as a regulated structure. Such structures must comply with hydraulic performance objectives (DES 2016).

DES (2016) requires an assessment of the potential for harm under the following failure event scenarios:

- **Failure to contain – seepage**—spills or releases to ground and/or groundwater *via* seepage from the floor and/or sides of the structure;
- **Failure to contain – overtopping**—spills or releases from the structure that result from a loss of containment due to overtopping of the structure; and
- **Dam break** — collapse of the structure due to any possible cause.

For each failure event scenario, a consequence category is assigned depending on the potential to cause harm to humans and/or wildlife or general economic loss or general environmental harm. Assessment of the consequence category of Project dams is discussed as follows.

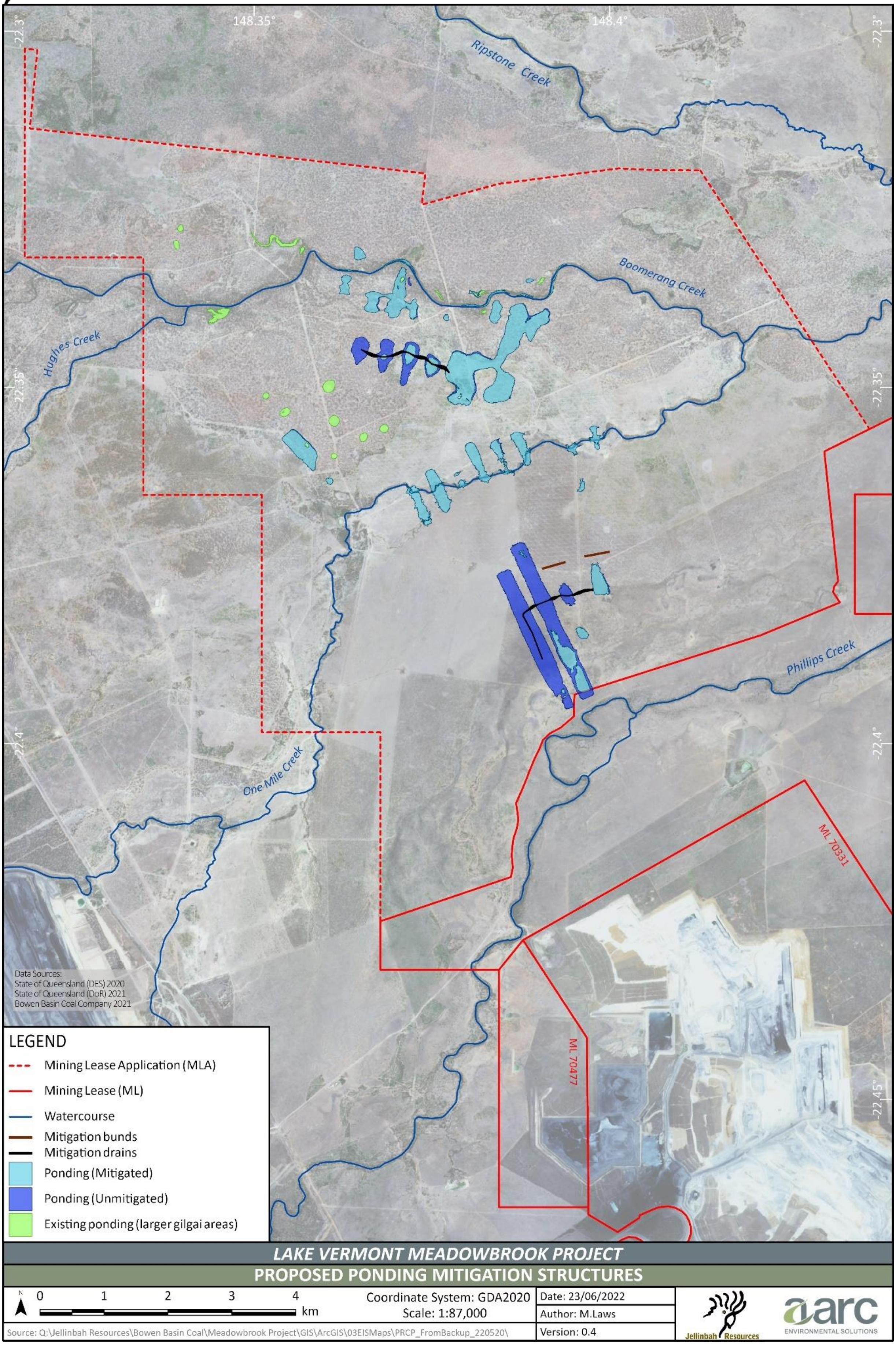

Figure 21.63: Residual ponding areas and proposed mitigations

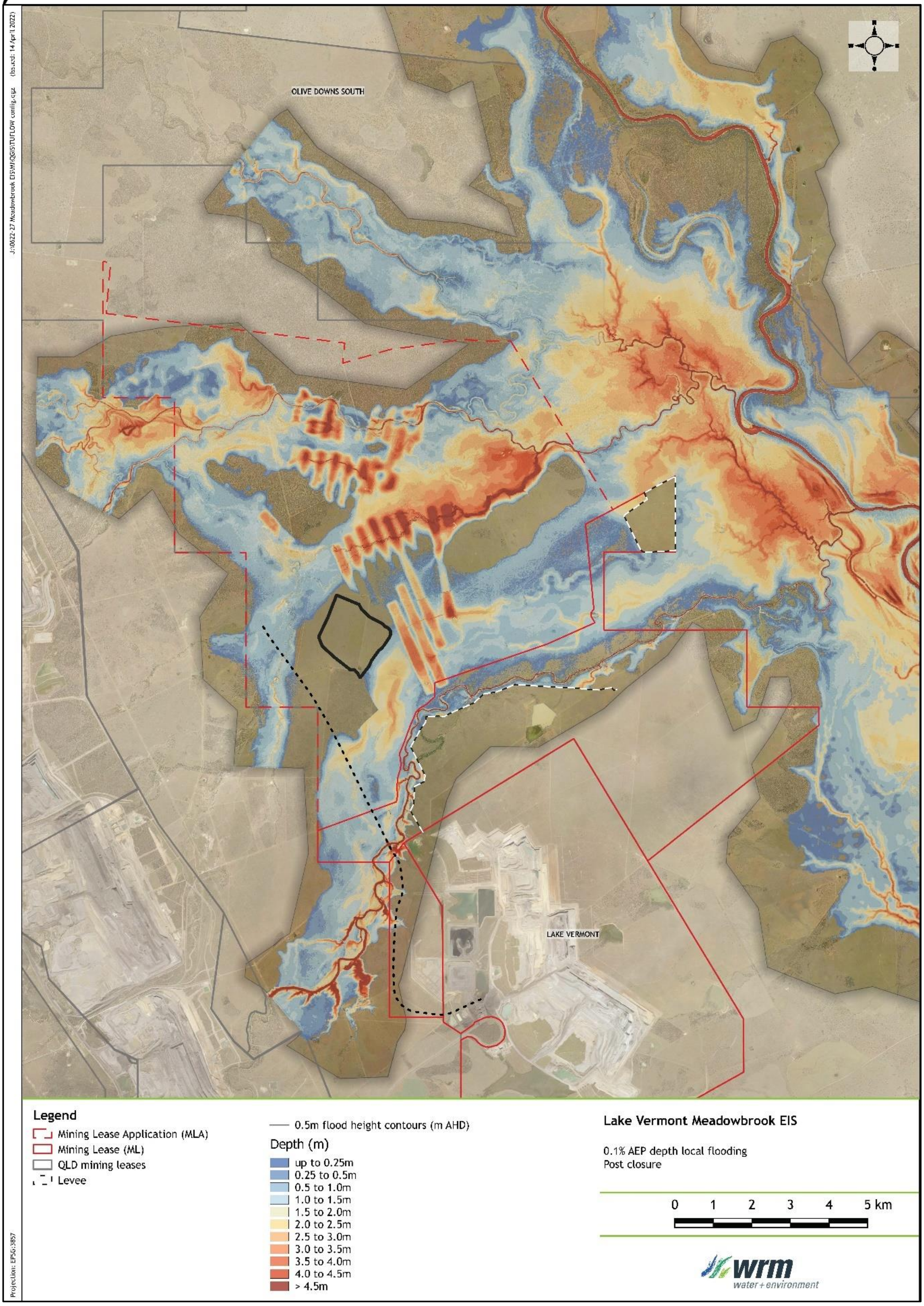

Figure 21.64: Post closure conditions 0.1% AEP depth

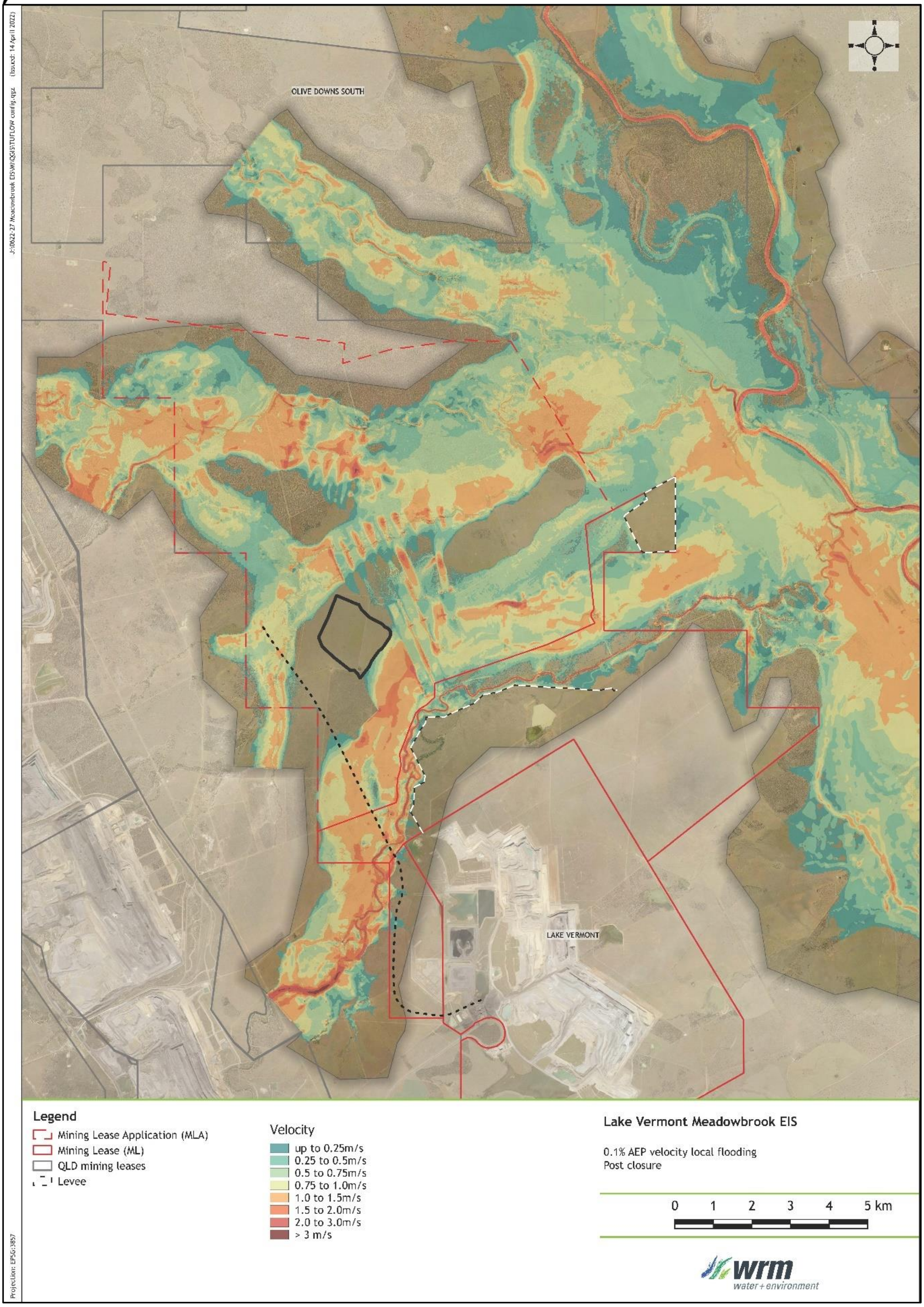

Figure 21.65: Post closure conditions 0.1% AEP velocity

Failure to contain – seepage

Seepage risks from Project dams are considered to be low. While seepage from the Dewatering Dam and MIA Dam may have the potential to impact ecological values of One Mile Creek and its tributaries, any such impact would be limited in extent (Appendix Y, Site Water Balance and Water Management, Section 6.1.3).

The expected water quality of excess water pumped from the underground operation is considered to present a low risk of seepage impact, effectively being diluted by a ratio of three parts raw water to one part groundwater prior to dewatering. The Dewatering Dam and MIA Dam have, therefore, been assigned to the Low Consequence Category. However, it is recommended that this is reviewed once the detailed engineering and design of Project water storage infrastructure is finalised.

Failure to contain – overtopping

DES (2016) states that a dam is to have a Significant Consequence Category if it meets the following criteria:

- *Location such that contaminants may be released so that adverse effects…would be likely to be caused to Significant Values—and at least one of the following:*
    - *i) loss or damage or remedial costs greater than $10,000,000 but less than $50,000,000; or*
    - *ii) remediation of damage is likely to take more than 6 months but less than 3 years; or*
    - *iii) significant alteration to existing ecosystems; or*
    - *iv) the area of damage (including downstream effects) is likely to be at least 1 km2 but less than 5 km2 (DES, 2016).*

Given the relatively small volume and concentrations of contaminants within Project dams, it is unlikely that remedial measures would meet these criteria (Appendix Y, Site Water Balance and Water Management, Section 6.1.3).

The Dewatering Dam and MIA Dam are located within an area surrounded by a levee structure (the MIA levee) further preventing the passage of overtopping water to the receiving environment. Project sediment dams are designed to overtop and function effectively as sediment dams. Overtopping risks from Project dams are, therefore, considered to be in the Low Consequence Category.

The nearest known town water supply systems are on the Fitzroy River, and they would not be materially affected by discharge from any of the dams at the Project due to the total stored volume being less than 500 ML and the very large dilution potential during wet season flows (Appendix Y, Site Water Balance and Water Management, Section 6.1.2.1).

Dam break

Due to the sparse population in the region, there are no workplaces or dwellings in the potential failure impact zone of the site water dams. In accordance with 'Manual for assessing consequence categories and hydraulic performance of structures' (DES 2016), site personnel are not considered in the dam break assessment. All dams are located such that people are not routinely present in the potential failure path if an embankment were to fail (Appendix Y, Site Water Balance and Water Management, Section 6.1.2.1).

In respect of general economic loss, it is noted that there are no significant commercial operations in the immediate downstream reaches of the Isaac River or its tributaries likely to be affected by contamination under any of the potential failure impact scenarios (Appendix Y, Site Water Balance and Water Management, Section 6.1.2.2).

Similarly, the potential damage caused by a dam break of the MIA Dam embankment is likely to be limited due to its limited height (planned to be less than 5 m) and storage capacity (Appendix Y, Site Water Balance and Water Management, Section 6.1.2.2). The proposed MIA levee will also work to mitigate a dam break scenario at the Dewatering Dam and the MIA Dam.

With respect to the potential for environmental harm resultant from a dam break, it is noted that stored water quality in the Dewatering Dam and the MIA Dam are likely to be similar to mine water dams at other Central Queensland mine sites (e.g. elevated salinity and pH and some dissolved metals). As there are no High

Environmental Value (HEV) zones identified in the downstream receiving environment, there is limited potential to cause harm to Significant Environmental Values (Appendix Y, Site Water Balance and Water Management, Section 6.1.2.3). As such, Project dams are assessed as being in the Low Consequence Category for dam break.

The assessment outcomes (consequence categories) for proposed Project dams are provided in Table 21.17.

Consequence category assessments will require review and revision once the detailed engineering and design of the water infrastructure is finalised (Appendix Y, Site Water Balance and Water Management, Section 6). Once this occurs, certifications for any regulated structures will be provided.

Table 21.17: Summary of consequence category assessment (dams)

	Dewatering Dam	**MIA Dam**	**Raw Water Dam**	**Sediment Dams**
Failure to contain - seepage				
Harm to humans	L^	L	L	L
General environmental harm	L	L	L	L
General economic loss/damages	L	L	L	L
Failure to contain - overtopping				
Harm to humans	L	L	L	L
General environmental harm	L	L	L	L
General economic loss/damages	L	L	L	L
Dam break				
Harm to humans	L	L	L	L
General environmental harm	L	L	L	L
General economic loss/damages	L	L	L	L
Overall Consequence Category assessment rating				
Requires DSA/MRL*	N	N	N	N
Requires engineered spillway	Y	Y	Y	Y
Requires clay lining (unless detailed groundwater investigation indicates risks are low)	Y	Y	N	N

^L=Low consequence; S=Significant consequence. *DSA=Design Storage Allowance; MRL=Mandatory Reporting Level.

21.10.7.6 Haul road and watercourse crossings

The proposed haul road construction will obstruct floodplain and channel flow, locally increasing upstream flood levels (Appendix Z, Flood Modelling Assessment Report, Section 3.3). However, vertical alignment and cross-drainage structures have been designed to mitigate upstream impacts and preserve downstream flow distribution. In events greater than 50% AEP, the proposed haul road would increase upstream, off-lease flood levels within the channel of Phillips Creek by less than 60 mm (Appendix Z, Flood Modelling Assessment Report, Section 3.3.2).

Immediately upstream of the haul road crossing at One Mile Creek, the haul road causes a local afflux of approximately 400 mm in the 1% AEP flood. However, the afflux does not extend significantly off-lease. In the 10%, 2% and 1% AEP events, the low-level crossing at Phillips Creek becomes drowned out, and the afflux is reduced so that off-lease flood levels upstream of the haul road are not increased by the Project. The 0.1% AEP and PMF flood events show no afflux in Phillips Creek upstream of the haul road crossing (Appendix Z, Flood Modelling Assessment Report, Section 3.3.2).

21.10.7.7 Waste rock emplacements

The rehabilitated waste rock emplacement area (that will remain post-mine closure) is outside the defined 0.1% AEP flood area and will not impact flooding profiles or be impacted by flooding.

Coal reject management procedures utilised at the existing Lake Vermont Mine will also be adopted for the Project. Specifically, the existing coal-disposal facilities will be used to manage Project coal reject. These facilities are regulated structures that have been designed and certified by a Registered Professional Engineer of Queensland in accordance with government regulations. Rehabilitation of the co-disposal facilities is described in Chapter 6, Rehabilitation.

21.10.7.8 Cumulative impacts

The Flood Impact Assessment has considered existing structures and nearby projects that may affect flood behaviour. Cumulative impact conditions include all levees associated with the proposed Olive Downs Project. Flood impacts of the Project and proposed Olive Downs Project would potentially interact due to the Willunga and Olive Downs South domains of the Olive Downs Project that extend onto the Isaac River floodplain downstream and upstream of the Lake Vermont Meadowbrook Project.

Cumulative impact modelling has included two scenarios representing combined impact by the Project. The two scenarios are:

1) 2051 mine site conditions with mitigation measures (plus other projects); and

2) post-closure conditions of the Project (plus other projects).

A cumulative impact assessment has been undertaken for a 0.1% AEP regional flood event (Appendix Z, Flood Modelling Assessment Report, Section 4).

The results indicate that cumulative flooding outside the Project area is caused by relatively large impacts on Isaac River floodplains by other approved projects.

The impacts of the Lake Vermont Meadowbrook Project are relatively minor, with little cumulative interaction between the Project and the impacts of other proximate projects.

The cumulative impact scenario of all known proposed floodplain developments near the Isaac River floodplain is increased water levels within the Project area by 60 mm post-closure (Appendix Z, Flood Modelling Assessment Report, section 5).

21.10.7.9 Sensitivity assessments

An assessment of the Project's vulnerability to climate change has been undertaken in Chapter 4, Climate. This assessment has been conducted according to projections generated by the 'Coupled Model Intercomparison Project Phase 5' and information contained in the 'Queensland Future Climate Dashboard, Qld 2021'.

In summary:

- The average annual rainfall is projected to decrease slightly by 2050, continuing to decrease until 2070.
- Seasonal rainfall projections indicate that spring rainfall will decrease slightly by 2050, continuing to decrease until 2070, while summer rainfall will increase by 2070.
- The intensity of extreme rainfall events is expected to decrease between 2050 and 2070.
- Average and maximum daily temperatures are considered likely to increase over the life of the mine due to climate change.

- Evaporation is expected to increase with the projected increased temperatures.

An impact assessment for climate change on peak flows for the 50%, 10%, 2% and 1% AEP flooding events was also undertaken. This assessment was based on the Representative Concentration Pathway (RCP) 8.5 scenario for 2060 (Appendix Z, Flood Modelling Assessment Report, Section 1.3.12). RCP8.5 corresponds to a worst-case scenario. The ARR datahub provides a Climate Change Factor (CCF) for each RCP for each decade from 2030 up to 2090. As the Project finishes sometimes between 2050 and 2060, the year 2060 was selected for this assessment. According to the ARR Datahub the increase in rainfall intensity for RCP8.5 at the location of the Project for 2060 is 11.5%. The rainfall intensity for the selected flood events was therefore factored up by 1.115 and new discharges derived at the key locations (Appendix Z, Flood Modelling Assessment Report, Section 1.3.12).

Based on this, under modelled climate change conditions in the vicinity of the project disturbance, flood maps would be representative of flow conditions in more frequent events, as described below:

- the 50% AEP map would have an AEP of about 56%;
- the 10% AEP map would have an AEP of about 17%;
- the 2% AEP map would have an AEP of about 3.8%;
- the 1% AEP map would have an AEP of about 1.8%; and
- the 0.1% AEP map would have an AEP of about 0.3%.

Overall therefore, modelled climate changes are not anticipated to increase the risk of harm to environmental values, resultant of the Project.

21.10.8 Mitigation, management measures and monitoring

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

21.10.8.1 Flood protection levees

While conceptual flood levee designs have been developed for this EIS (per Section 21.10.6.1), detailed levee designs will be developed prior to construction in accordance with 'Manual for assessing consequence categories and hydraulic performance of structures' (DES 2016) and the 'Guideline, Structures which are dams or levees constructed as part of environmentally relevant activities' (DES 2022b).

To best manage risks associated with levee construction, Bowen Basin Coal is committed to:

- review flood levee crest levels and the design freeboard as part of detailed design works;
- develop and submit certified design drawings (and supporting documentation) prior to the commencement of levee construction in accordance with the requirements prescribed by DES (2016);
- use only non-dispersive, low permeable, engineered fill for levee construction;
- revegetate batters and surrounding areas with grasses to stabilise the structure and prevent sediment runoff; and
- decommission and rehabilitate levees in accordance with the Project PRCP (Appendix B, Progressive Rehabilitation and Closure Plan, Section 3.5.5.2).

With flood protection levees proposed to be regulated structures, they will be inspected by a suitably qualified and experienced person in advance of the wet season each year. In addition, following major flood events, a visual inspection of levees will be conducted by site personnel to identify any potential issues with erosion, settlement or slumping.

Two diversion drains will be constructed to support the management of surface water drainage around the proposed levee structures. These drains will be at the southern extent of the MIA levee and the southern extent of the open-cut mining area levee (Appendix Z, Flood Modelling Assessment Report, Section 2.3). Conceptual design details for these diversion drains are provided in Section 21.10.6.2.

21.10.8.2 Ponding mitigation drains and bunds

Mitigation measures to limit the extent of residual ponding due to subsidence will include:

- construction of a 2.5 km long mitigation drain (with a 5 m channel base) to alleviate the extent of ponding within the subsidence panels immediately to the north of Phillips Creek (refer Figure 21.63);
- construction of a 1.4 km long mitigation drain (with a 5 m channel base) to alleviate the extent of ponding in the subsidence panels to the south of Boomerang Creek (refer Figure 21.63); and
- construction of two earthen mitigation bunds across these subsidence panels to prevent floodwater flowing north and into One Mile Creek (Appendix Z, Flood Modelling Assessment Report, Section 2.3).

Detailed design drawings will be prepared for this infrastructure, to support construction. The proposed disturbance from this infrastructure has also been considered within the Project assessment of impacts (refer Section 21.12 and 21.13).

A further flood bund is proposed as part of the final landform for the Project to prevent water ingress into the final rehabilitated pit in a major flood event. A post-closure flood model showing a 0.1% AEP flood depth is provided in Figure 21.64. Construction of the proposed final rehabilitated pit landform will be located within the disturbance footprint of the open-cut mining area as part of the final earthworks. The landform will be designed to prevent water ingress into the rehabilitated pit during major flood events, supporting a post-mining land use for grazing. Post-mining land uses are detailed in Chapter 6, Rehabilitation.

21.10.8.3 Sediment dams

Sediment dams will be constructed within the proposed open-cut mining area to assist in managing rainfall and runoff. During open-cut mining operations, catchment runoff from overburden dumps will be captured in three sediment dams (referred to as the Southern Sediment Dam, the Northern Sediment Dam 1 and the Northern Sediment Dam 2).

To mitigate risk, sediment dams will be designed to contain a 1 in 10 year ARI 24 hour rainfall event and will be operated in accordance with the ‘DES Guideline: Stormwater and environmentally relevant activities’ (DES 2021c). Sediment dam catchment areas and proposed storage capacities are provided in Table 21.16.

The existing ‘Sediment and Erosion Control Plan’ for the Lake Vermont Mine will be updated to detail the management of proposed sediment dams prior to their construction and operation.

21.10.8.4 Haul road drainage

The proposed haul road construction is anticipated to obstruct floodplain and channel flows, locally increasing upstream flood levels (Appendix Z, Flood Modelling Assessment Report, Section 5).

These risks are proposed to be mitigated through the design of road embankment and associated cross-drainage structures. It is noted that prior to construction, the haul road design will be refined, with the vertical profile and cross-drainage structure details chosen to ensure impacts do not exceed those in the preliminary design. For the purposes of this study, the preliminary design and the indicative number and sizing of cross-drainage structures along the haul road have been adopted (Appendix Z, Flood Modelling Assessment Report, Section 2.3).

21.10.8.5 Receiving environment monitoring

Boomerang Creek is anticipated to experience increases in channel velocity, bed shear and stream power as the channel drains into mine subsidence zones (Appendix F, Surface Water Assessment, Section 7.4.1). The deep bed sediments in these reaches are expected to erode relatively quickly as the channel morphology changes to reflect the higher bed grade. This may also lead to an increase in bank erosion as the channel capacity increases.

The existing 'Receiving Environment Monitoring Plan' will, therefore, be updated prior to the commencement of underground mining to include additional sites to enable monitoring of potential impacts as a result of the proposed Project. Incidental management measures may also be implemented if monitoring indicates that an increase in erosion is having a demonstrable impact on the Boomerang Creek channel (Appendix F, Surface Water Assessment, Section 7.4.4).

21.10.8.6 Subsidence monitoring

As per the findings in the geomorphology assessment, the Project will implement a subsidence monitoring plan as part of ongoing monitoring and mitigation measures (Appendix F, Surface Water Assessment, Section 7.4.4).

The subsidence monitoring plan will facilitate monitoring to assess the extent of channel changes, including changes in bed levels and the impact of increased localised sedimentation. Incidental management measures, including bank protection, will also be considered if monitoring indicates that an increase in erosion is having a demonstrable impact on the Boomerang Creek channel.

21.10.8.7 Adaptation strategies

The risk to the Project posed by climate change has been assessed as low, with adaptation strategies proposed to include:

- development of infrastructure designed to meet local cyclone protection standards;
- construction of levies to protect key infrastructure areas from flooding and extreme rainfall events; and
- development of a PRC Plan (that considers climate hazards and climate change risks within rehabilitation strategies).

21.11 Groundwater

21.11.1 Context and conceptualisation

The Project Groundwater Impact Assessment has been undertaken by JBT Consulting Pty Ltd and is presented as Appendix E, Groundwater Impact Assessment. Preliminary 3D numerical groundwater modelling has been conducted by SLR and is presented within Appendix E, Groundwater Impact Assessment (Appendix A). An independent review of the Project groundwater modelling and assessment has been also proactively commissioned by Bowen Basin Coal, having been undertaken by Dr Noel Merrick of HydroAlgorithmics Pty Ltd. The Project groundwater peer review report is provided as Attachment 6 to this EIS.

21.11.1.1 Geology

The Project area is located in the western limb of the Bowen Basin, a north–south trending retro-arc basin that extends more than 250 km north to south and up to 200 km west to east. The Project lies at the eastern end of the Collinsville Shelf, which is characterised by a thin accumulation of sediments, gentle easternly dips and minor structural deformation. The eastern boundary of the Collinsville Shelf occurs at the Isaac Fault, a major thrust fault which has throws of 150 to 400 m in the Project area.

The stratigraphic sequence within the Project area comprises of the following:

- Cainozoic (Quaternary and Tertiary) sediments;
- Triassic Rewan Group;
- late Permian blackwater group sediments (and coal measures); and

- middle Permian.

The stratigraphy of the Project area and surrounds is summarised in Table 21.18. Within the Project area, the Permian and Triassic-age sediments of the Bowen Basin are overlain by a veneer of unconsolidated to poorly consolidated Tertiary and Quaternary sediments. The surface geology for the Project is shown in Figure 21.13 which indicates areas where Cainozoic sediments and basalt (to the west of the Project area) overlay the Permo-Triassic Bowen Basin sediments. The solid geology of the Project is shown in Figure 21.12 which shows the strata underlying Cainozoic cover sediments and presents the faulted relationship between the underlying Permian and Triassic strata. The stratigraphic and structural relationships of the geologic units illustrated in the west–east section Figure 21.14 and north–south section Figure 21.15.

The hydrogeological units of the Project area are identified in Appendix E, Groundwater Impact Assessment (section 3.2) and summarised below.

Table 21.18: Stratigraphy of the Project area and surrounds

Age	Stratigraphic unit		Description	Occurrence
Cainozoic Quaternary	Alluvium		Alluvial sands, clayey sands and clays, with a basal layer in some locations of sand and gravel.	Covers Project area with widely varying thickness of between 2 - 80 m. Due to the sandy sediments, the interface between Quaternary and Tertiary sediments could not be determined. The Cainozoic sediments were generally thicker in the north of the Project area and thinned moving south.
Cainozoic Tertiary	Alluvium Main Range Basalt Duaringa Formation			
Triassic	Rewan Group	Sagittarius Sandstone	Greyish-green sandstone, siltstone and mudstone.	Occurs beneath Cainozoic sediments over much of the Project area.
		Arcadia Formation	Reddish-brown mudstones, and greyish-green sandstone and siltstone.	Upper part of the Rewan Group is absent over most of the Project area due to weathering.
Late Permian	Blackwater Group	Rangal Coal Measures	Coal bearing sediments that contain the Phillips, Leichhardt Lower and Vermont Lower seams.	The dip of the coal seams is relatively steep (approximately 5-10°) within THE MLA before flatting out to the west.
		Fort Cooper Coal Measures	Sandstone, siltstone, mudstone, carbonaceous shale and coal. Contains the Girrah seam which has a number of groundwater monitoring bores.	Underlies the Rangal Coal Measures and subcrops beneath Tertiary sediments within the Project area due to the dip of the strata or faulting.
		Moranbah Coal Measures	Sandstone, siltstone, mudstone and coal.	-
Middle Permian	Back Creek Group	Ingelara Formation	Conglomeratic sandy siltstone, mudstone and sandstone.	-

Cainozoic (Quaternary and Tertiary) sediments

Cainozoic sediments occur across the entirety of the Project area. The thickness of Cainozoic sediments is highly variable, ranging from 2 m to 80 m and averaging 26 m. The Cainozoic sediments mainly comprise alluvial sands, clayey sands and clays, with a basal layer in some locations of sand and gravel. The Cainozoic sediments are thinnest in the south within the MLA and gradually thicken moving north through the MLA (the area generally to the south of Boomerang Creek) to 35 to 45 m. The Cainozoic sediments are thickest (more than 60 m) in the northern area of the MLA (the area generally to the north of Boomerang Creek).

The Cainozoic sediments in proximity to Boomerang Creek were found to be relatively sandy and the boundary between recent Quaternary alluvium and the older Tertiary alluvium difficult to delineate. The Tertiary sediments were observed to generally be sandier (and therefore have higher hydraulic conductivity) in the area within the MLA (and the vicinity of Boomerang Creek) than the area to the south (the area within ML 70528 and adjacent to Phillips Creek). The Quaternary alluvium associated with Phillips Creek tends to be greater in thickness and extent than the Quaternary alluvium associated with Boomerang Creek.

The regional water table is generally developed in the Tertiary sediments, below the base of alluvium. The alluvium is likely to be seasonally saturated following direct rainfall recharge, and flow events in Boomerang Creek. The only location where the alluvium is permanently saturated is in the Isaac River.

Of the Project groundwater monitoring bores, there are two screened in quaternary alluvium at 12 m depth, and seven screened in Tertiary sediments ranging between 20-60 m depth.

Triassic Rewan Group

The Sagittarius Sandstone is the basal formation of the Rewan Group and occurs beneath Cainozoic sediments over much of the Project area. The unit is up to 300 m thick and comprises of greyish-green sandstone, siltstone and mudstone.

The Sagittarius Sandstone can be differentiated from the underlying Rangal Coal Measures by the greenish tinge of the sediments, as well as the presence of a dark mudstone 1 m to 3 m thick, with a high natural gamma count. The Arcadia formation makes up the upper part of the Rewan Group. However, it is absent over most of the Project area (due to weathering).

Rangal Coal Measures

The Late Permian Rangal Coal Measures are coal-bearing sediments that contain the target coal seams for the Meadowbrook Project (Leichhardt Lower and Vermont Lower seams). The coal seam dips relatively steeply at approximately 5° to 10° in the east, flattening out to the west, as shown in Figure 21.12. In descending stratigraphic order, the coal seams comprise:

- Phillips Seam, which generally comprises < 1 m thickness of inferior coal, but which is useful as a stratigraphic marker;
- Leichhardt Seam, which thins and deteriorates north of Phillips Creek;
- Leichhardt Lower Seam, which appear as two thin, clean coal seams that coalesce to the north to form one seam of 2.5 to 4 m thickness; and
- Vermont / Lower Vermont seam.

The Vermont Seam comprises two relatively minor upper plies, which have split away from the two plies of the Vermont Lower Seam, where the thickness of the two seams combined within the proposed Project area is in the order of 3 m. The Vermont Seam occurs at a depth of approximately 100 m in the southwest of the mining area where the seams subcrop but deepens significantly to the northeast of the underground area where the depth to the base of the Vermont lower seam ply occurs at a depth of approximately 500 m.

The Rangal Coal Measures truncate against the Isaac Fault, which forms an eastern limit to underground mining.

Fort Cooper Coal Measures

The Late Permian Fort Cooper Coal Measures stratigraphically underlie the Rangal Coal Measures. The unit subcrops beneath Tertiary sediments within the Project area due to either the dip in the strata (western area of the Project) or to faulting (e.g. east of the Isaac Fault). The uppermost coal seam in the Fort Cooper Coal

Measures within the Project is the Girrah seam, which subcrops to the west of the Rangal Coal Measures subcrop line. Four Meadowbrook Project groundwater monitoring bores are screened within the Girrah seam.

21.11.2 Baseline groundwater characteristics

21.11.2.1 Groundwater levels and flows

The groundwater levels across the Project area were assessed in Appendix E, Groundwater Impact Assessment (section 4.2.1), from data collected at the Meadowbrook and Lake Vermont North monitoring bore networks shown in Figure 21.66. The groundwater level contours for the tertiary sediments, Leichardt coal seam and Vermont coal seam are presented in Figure 21.67, Figure 21.68 and Figure 21.69. The groundwater levels were identified as consistent with little water level variation that could be attributed to extraction activities, discharge to Lake Vermont pit or recharge.

The groundwater flow direction within the Tertiary sediments and Permian coal seams is generally from west to east, following the general topography towards the Isaac River. Flows in the coal seams are truncated by faults, such as the Isaac Fault; however, groundwater flows are driven laterally at these features or over these features to continue the general flow direction.

The existing Lake Vermont Mine is acting as a sink for groundwater flow within the coal seams, and there is a component of groundwater flow that is southwards towards the Lake Vermont open pit.

Recharge is predominately through rainfall and downward seepage from ephemeral creeks. This occurs directly to the Tertiary and Quaternary groundwater units. The Permian coal measures are preferentially recharged where coal seams subcrop beneath Tertiary or Quaternary sediments. Recharge to the coal seams appears to be enhanced where creeks flow over the subcrop area.

21.11.2.2 Hydraulic properties

Hydraulic conductivity of each hydrogeological unit has been determined through falling head testing and packer testing (Appendix E, Groundwater Impact Assessment, section 4.4.4). The hydraulic properties indicate that a decrease in permeability with depth is apparent for the coal seams, Permian interburden and Rewan Group sediments.

There is a difference between the hydraulic conductivity from bores in the Meadowbrook area and bores in the Lake Vermont North area, with bores in the Meadowbrook area generally recording a higher hydraulic conductivity. The hydraulic conductivity for hydrogeological units is shown in Table 21.19.

Table 21.19: Hydraulic conductivity summary statistics

Groundwater unit	Number of samples	Hydraulic conductivity (m/day)		
		Minimum	**Maximum**	**Arithmetic mean**
Quaternary alluvium	2	9.80×10^{-3}	4.74×10^{-2}	2.86×10^{-2}
Tertiary sediments	9	2.73×10^{-3}	1.37	3.16×10^{-1}
Rewan group	13	3.28×10^{-5}	5.58×10^{-2}	7.71×10^{-3}
Permian coal measures < 130 m depth	25	1.52×10^{-3}	9.92×10^{-1}	2.21×10^{-1}
Permian coal measures > 130 m depth	25	8.64×10^{-7}	9.14×10^{-2}	8.05×10^{-3}
Permian coal measures (all)	50	8.64×10^{-7}	9.92×10^{-1}	1.14×10^{-1}

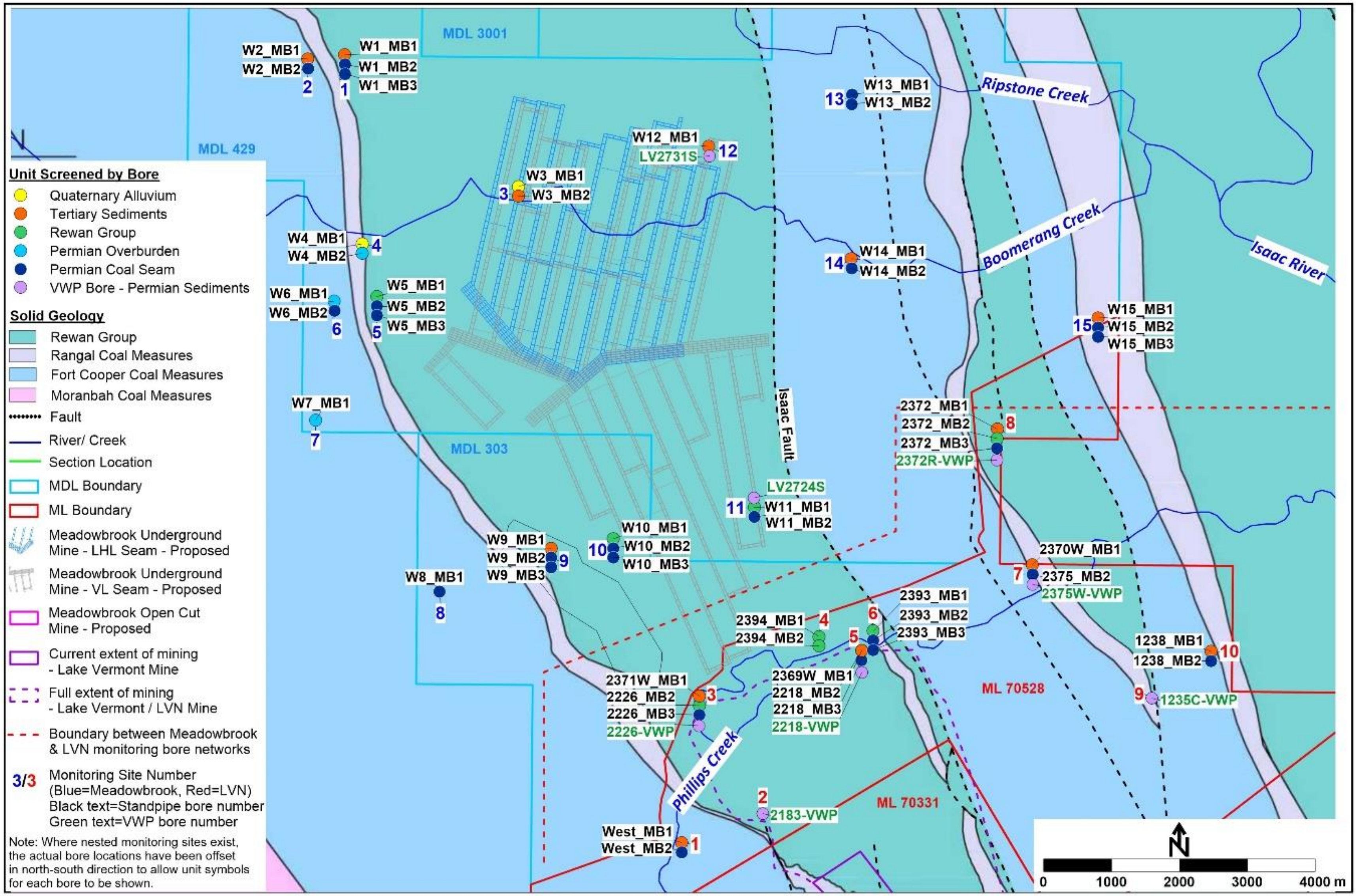

Figure 21.66: Project groundwater monitoring bores

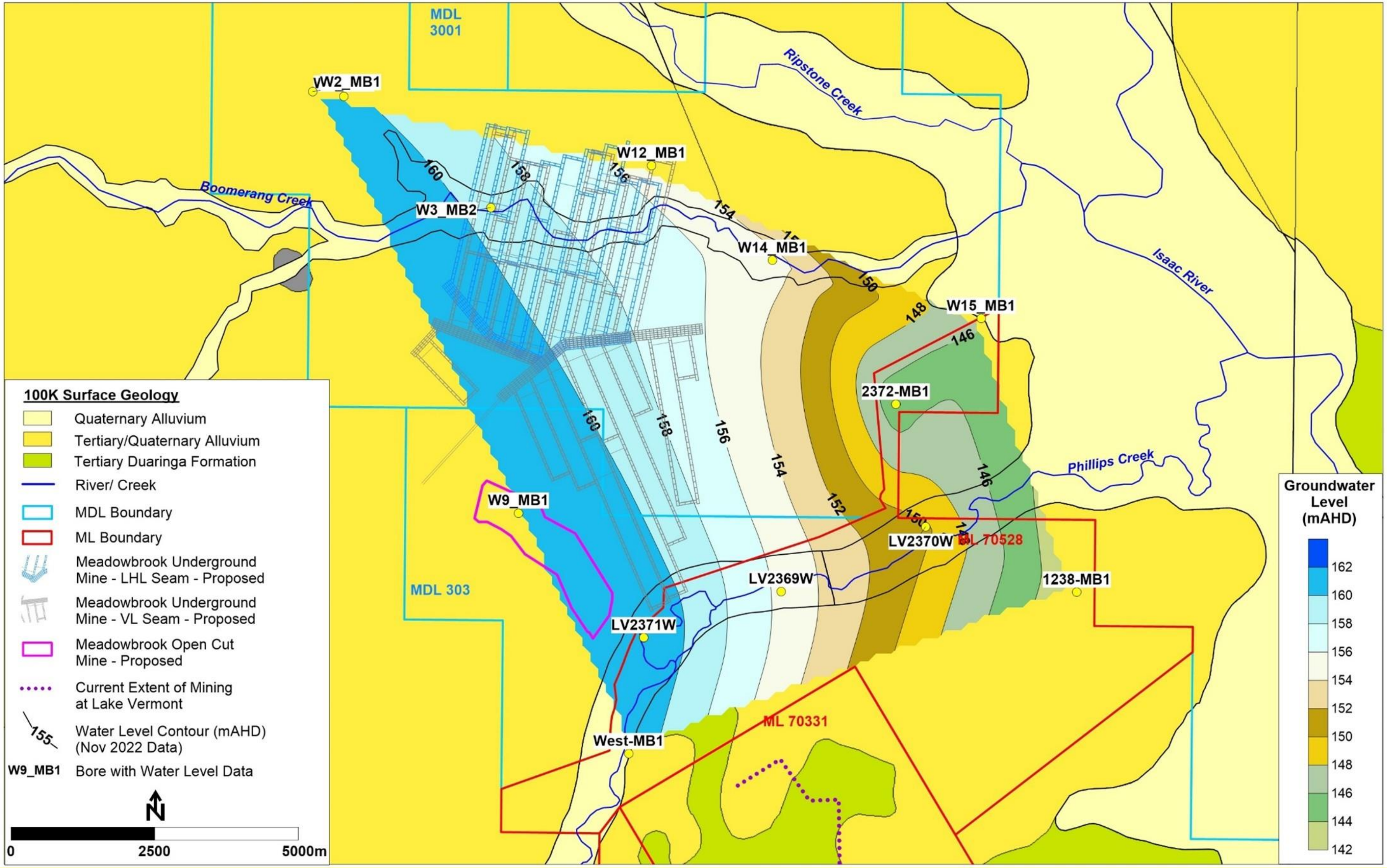

Figure 21.67: Groundwater levels for tertiary sediments

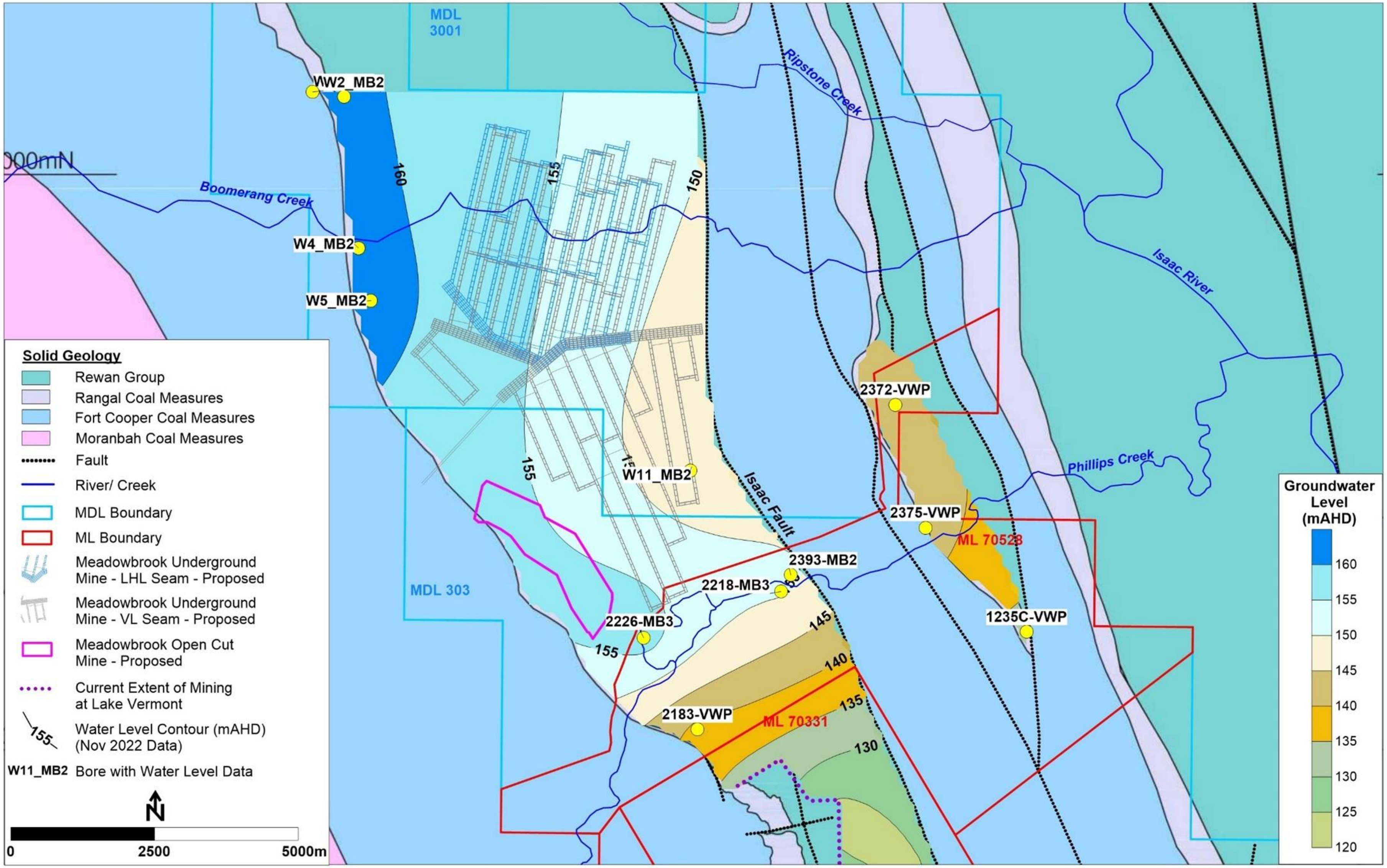

Figure 21.68: Groundwater levels for Leichhardt coal seam

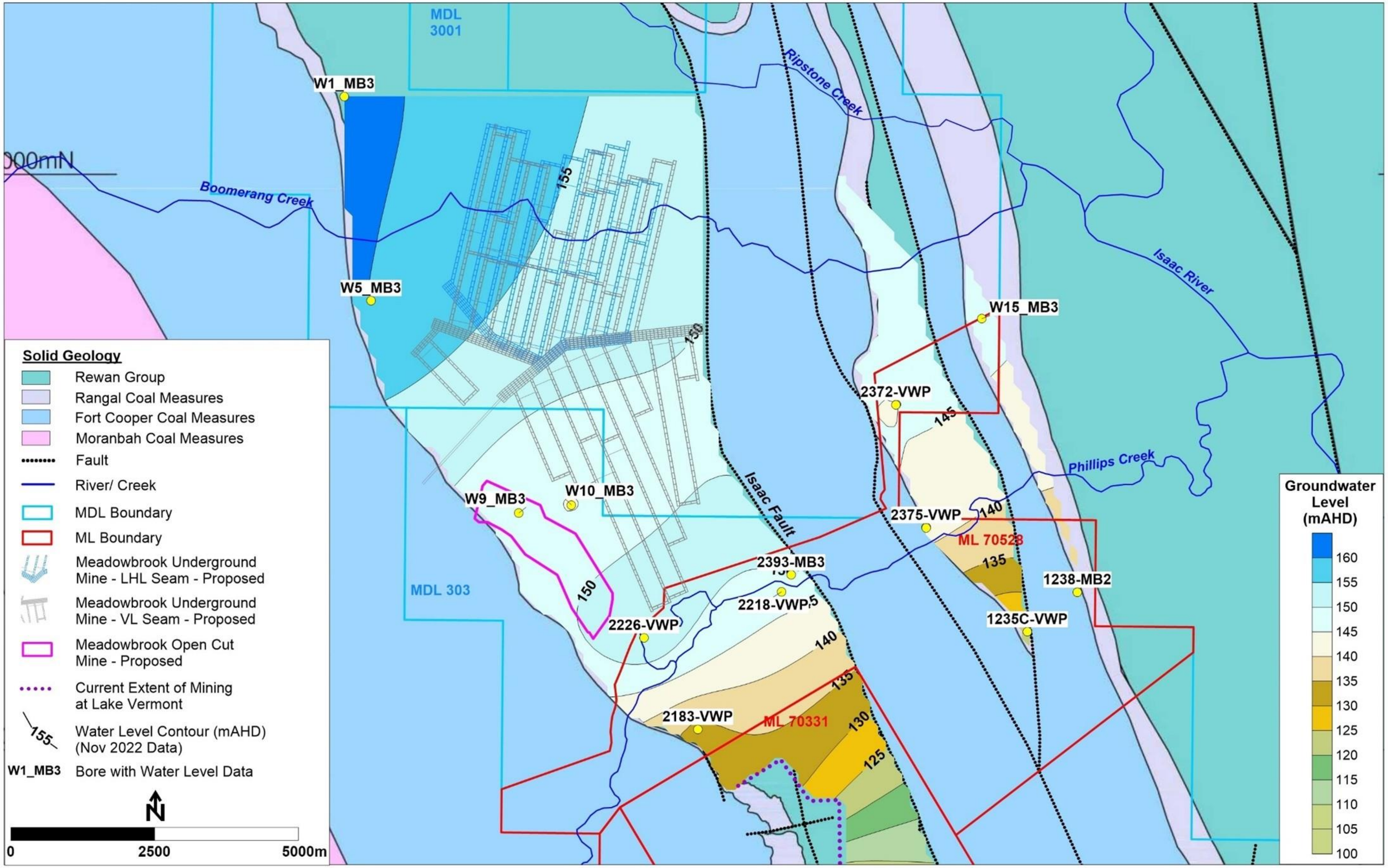

Figure 21.69: Groundwater levels for Vermont coal seam

21.11.2.3 Groundwater quality

The mean values of the groundwater quality have been determined from 13 monitoring events between October 2020 and November 2021. Parameters assessed include pH, EC and major ions (sodium, calcium, magnesium, potassium, chloride, sulphate, alkalinity), total and dissolved metals/metalloids (aluminium, arsenic, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, uranium, vanadium, zinc) and total petroleum hydrocarbons (TPH).

- pH;
- electrical conductivity and major ions:
  - sodium;
  - calcium;
  - magnesium;
  - potassium;
  - chloride;
  - sulphate;
  - alkalinity;
- total and dissolved metals/metalloids:
  - aluminium;
  - arsenic;
  - boron;
  - cadmium;
  - chromium;
  - cobalt;
  - copper
  - iron;
  - lead;
  - manganese;
  - nickel;
  - selenium;
  - silver;
  - uranium;
  - vanadium;
  - zinc; and
- total petroleum hydrocarbons (TPH).

The mean pH, EC and major ions results are summarised in Table 21.20. The maximum, minimum and mean groundwater metal concentrations are available in Table 21.21. Appendix E, Groundwater Impact Assessment (section 4.3.1) provides all available electrical conductivity data, illustrating seasonal and climatic changes in quality and summarised groundwater quality results over the past two years at Meadowbrook monitoring bore sites and four years for Lake Vermont North monitoring bore sites. Appendix E, Groundwater Impact Assessment (Annexure C) provides the data for all the groundwater quality parameters, not just EC, over the past two years at Meadowbrook monitoring bore sites and four years for Lake Vermont North monitoring bore sites.

Table 21.20: Mean groundwater quality data - pH, electrical conductivity, major ions

Groundwater Unit	No. of Samples	pH (Field)	EC (field)*	Ca*	Mg*	Na*	K*	Cl*	SO_4*	Alk.*
			µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Meadowbrook Groundwater Monitoring Bores										
Tertiary	69	6.49	17518	278	470	3277	33	6342	846	435
Rewan	29	6.75	23197	489	472	4261	27	8132	888	486
Permian	278	6.84	29995	656	788	5455	30	10803	1059	396

Groundwater Unit	No. of Samples	pH (Field)	EC (field)*	Ca*	Mg*	Na*	K*	Cl*	SO_4*	Alk.*
			µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Lake Vermont North (Lake Vermont North) Groundwater Monitoring Bores										
Tertiary	75	6.59	21338	450	865	3420	4	6465	1550	1189
Rewan	115	6.70	19744	345	501	3360	7	6451	449	695
Permian	151	6.63	15051	293	334	2517	9	4836	296	596
Combined Meadowbrook & Lake Vermont North Monitoring Bores										
Tertiary	144	6.55	19508	365	670	3350	19	6404	1203	817
Rewan	144	6.71	20439	375	495	3549	12	6804	551	651
Permian	429	6.77	24746	533	634	4461	23	8786	790	463

*EC = Electrical Conductivity, Ca = Calcium, Mg = Magnesium, Na = Sodium, K = Potassium, Cl = Chloride, SO4 = Sulphate, Alk. = Total Alkalinity

For monitoring sites at Meadowbrook, the mean electrical conductivity is greater than 20,000 µS/cm at most monitoring bores. South of the Project area at the Lake Vermont North monitoring bores, the mean electrical conductivity is greater than 10,000 µS/cm. Sites influenced by recharge from Philips Creek exhibit lower electrical conductivity.

The Tertiary sediments recorded high electrical conductivity values, indicating the unit is variably saturated and has poor hydraulic connection with the underlying sediments.

Mean major ion data shows bicarbonate anion water chemistry is present in some locations and is associated with low electrical conductivity water quality. The bicarbonate anion groundwater chemistry indicates high carbonate content of recharge waters. High sulphate anion groundwater has also been recorded in some Tertiary bores, likely caused by oxidation of sulphide minerals in shallow groundwater and indicative of groundwater recharge.

Groundwater in the Project area is generally neutral to very slightly acidic across all units. Metal concentrations are generally below the limit of reporting (Table 21.21).

Table 21.21: Groundwater quality data - metals

Statistic	Al	As	B	Cd	Cr	Co	Cu	Fe	Pb	Mn	Hg	Mo	Ni	Se	Ag	U	V	Zn
	mg/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Tertiary Sediments																		
Sample no.	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146
Min (mg/L)[a]	0.010	0.001	0.060	0.0001	0.001	0.001	0.001	0.050	-	0.006	0.0001	0.001	0.001	-	0.001	0.001	0.010	0.005
Max (mg/L)	0.090	0.034	2.440	0.0003	0.007	0.027	0.122	5.700	-	0.920	0.0002	0.027	0.590	-	0.009	0.258	0.060	0.122
Mean (mg/L)b	-	-	0.784	-	-	0.005	-	0.921	-	0.182	-	-	0.040	-	-	0.035	-	-
Rewan Group																		
Sample no.	143	143	143	143	143	143	143	143	143	143	143	143	143	143	143	143	143	143
Min (mg/L) [a]	0.010	0.001	0.150	0.0002	0.001	0.002	0.001	0.060	-	0.010	-	0.001	0.001	-	0.003	0.001	-	0.005
Max (mg/L)	0.060	0.010	1.340	0.0002	0.011	0.045	0.300	6.150	-	1.340	-	0.058	0.420	-	0.003	0.022	-	0.291
Mean (mg/L)[b]	-	-	0.547	-	-	-	-	2.058	-	0.471	-	0.007	0.027	-	-	0.008	-	0.037
Permian Sediments																		
Sample no.	431	431	431	431	431	431	431	431	431	431	431	431	431	431	431	431	431	431
Min (mg/L) [a]	0.010	0.001	0.050	0.0001	0.001	0.001	0.001	0.050	-	0.005	-	0.001	0.001	-	0.001	0.001	-	0.005
Max (mg/L)	0.130	0.044	2.260	0.0005	0.084	0.029	0.647	7.320	-	1.780	-	0.109	0.153	-	0.006	0.060	-	0.531
Mean (mg/L)[b]	-	-	0.597	-	-	-	-	1.707	-	0.308	-	-	-	-	-	-	-	-

a The minimum value is the minimum value recorded above the LOR. As shown from the difference between the total number of samples for each parameter and the number of samples > LOR, the majority of samples for most parameters are < LOR

b The mean and median of the data have only been calculated for values > LOR, and only for parameters where the number of samples > LOR is approximately 50% or greater

21.11.3 Water dependent assets

Primary groundwater use within the region includes;

- livestock watering; and
- domestic use.

No domestic use of groundwater has been identified to occur within the Project area (Appendix E, Groundwater Impact Assessment, Section 8.2). Other possible types of groundwater uses have also been considered as relevant to the Project Groundwater Impact Assessment, including use by:

- groundwater dependent ecosystems;
- stygofauna; and
- wetlands.

These groundwater uses are described below.

21.11.3.1 Agricultural groundwater users

Landowner bores within the Project area use the Isaac River alluvium, Tertiary and Permian sediment groundwater units. The bore locations and water quality descriptions of registered bores in the potential impact area have been taken from the State of Queensland Department of Resources Groundwater Database (version current to October 2021) and are summarised in Table 21.22.

A bore census has also been undertaken by BBC (via a mail-out to all potentially affected landholders within the Project's maximum predicted drawdown area) as part of efforts to identify other bores (including unregistered bores) that may be in existence and potentially impacted by the Project. No responses to BBC's bore census request were received.

Table 21.22: Summary of groundwater bore information

RN	Easting (AGD84)	Northing (AGD84)	Aquifer	Screened Interval (mbgl)	Water Quality*	Drilled Date	Original Bore Name
67216	655250	7526106	Isaac River Alluvium	3.66 - 4.57	Good	Jun-1996	Black Tank Spear
67217	656650	7522490	Isaac River Alluvium	0 - 3.3	Good	Oct-1984	Red Spear
67218	658515	7521249	Isaac River Alluvium	0 - 3.3	-	Oct-1984	Blue Spear
97180	654580	7527016	Isaac River Alluvium	15.24 - 16.4	Good	Jun-1996	Top bore
97181	656320	7523808	Isaac River Alluvium	17.37 - 18.29	Good	Jun-1996	Cutter Bore
97182	657833	7521659	Isaac River Alluvium	17.37 - 18.29	Good	Jun-1996	5 Blue Pump
97183	657305	7522099	Isaac River Alluvium	17.68 - 18.29	Good	Jun-1996	8 Blue Pump
122458	644869	7526590	Permian Sediments	38.5 - 50.5	4000	Mar-2006	-
132627	649450	7524848	Duaringa Formation	35 - 40	-	Apr-2007	-
132628	648106	7523872	Permian Sediments	85 - 95	-	Apr-2007	-
132631	635326	7527999	Permian Sediments	316 - 325	7290	Jan-2007	-
136689	635754	7528054	Permian Sediments	316 - 325	7290	Jan-2007	-
165975	634482	7525801	Quaternary-Undefined	6.5 - 9.5	-	Oct-2019	-

RN	Easting (AGD84)	Northing (AGD84)	Aquifer	Screened Interval (mbgl)	Water Quality*	Drilled Date	Original Bore Name
165976	631380	7530499	Quaternary-Undefined	6.5 - 9.5	6217	Oct-2019	-
165977	635771	7527621	Permian Sediments	231 - 237	Brackish	Oct-2019	-
165978	635831	7527462	Quaternary-Undefined	7.2 - 10.2	6172	Oct-2019	-
165979	635640	7527466	Permian Sediments	27.5 - 36.5	5596	Oct-2019	-

* Water quality descriptions are from the DoR Groundwater Database. In some cases only a description such as “Good” or “Brackish” is provided. Where a numerical value is provided, the value is EC in units of µS/cm

For the majority of bores screened within the Isaac River alluvium, the Department of Resources Groundwater Database describes the water quality simply as “good”. For bores within the Permian sediments, the EC values of the groundwater ranges from 4,000 µS/cm to 7,290 µS/cm, and as a result, has marginal value for livestock watering use. It is noted that only electrical conductivity is used to describe the water quality of registered bores in the Department of Resources Groundwater Database. However, the values provided tend to be lower than those encountered in the same groundwater units at the Project site, except for groundwater monitoring bores that are close to creeks where it is interpreted that groundwater recharge is occurring.

21.11.3.2 Groundwater dependent ecosystems

Description and assessment of GDE values of the Project site is described in Section 21.15.

21.11.3.3 Wetlands

There are no HES wetlands located within the proposed Project area. However, there are HES wetlands located within the potential impact area of the Project. These HES wetlands (located near the Project boundary) are ephemeral and contain water only following significant rainfall or surface flow events. These wetlands are not associated with the groundwater system.

There are 10 HES wetlands identified near to the Project area which are identified in Figure 21.70, numbered 1 to 10. Five of these wetlands are located within the potential drawdown impact area, including:

- Wetland 2, associated with a distinct oxbow (prior meander channel);
- Wetland 7, located on the eastern boundary of the existing Lake Vermont Mine (ML70528);
- Wetlands 8 and 9, associated with flood channels that occur near the confluence of Boomerang Creek and Ripstone Creek; and
- Wetland 10, associated with an unnamed surface drainage system that drains to Ripstone Creek.

Figure 21.71, identifies gilgai wetland systems, these features are not groundwater features and therefore there is no predicted groundwater related impacts to gilgai wetlands.

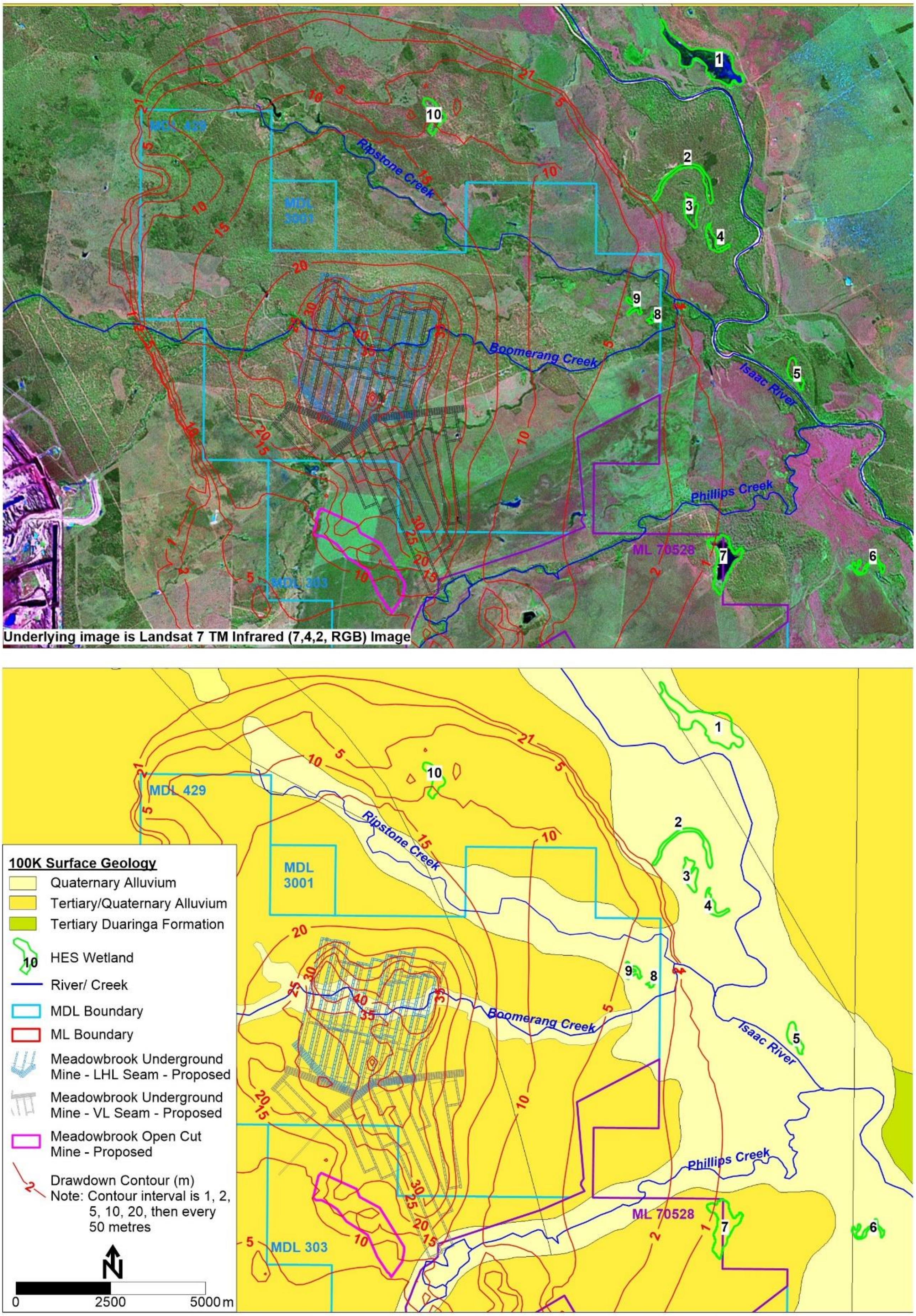

Figure 21.70: Location of HES wetlands and Tertiary sediment drawdown

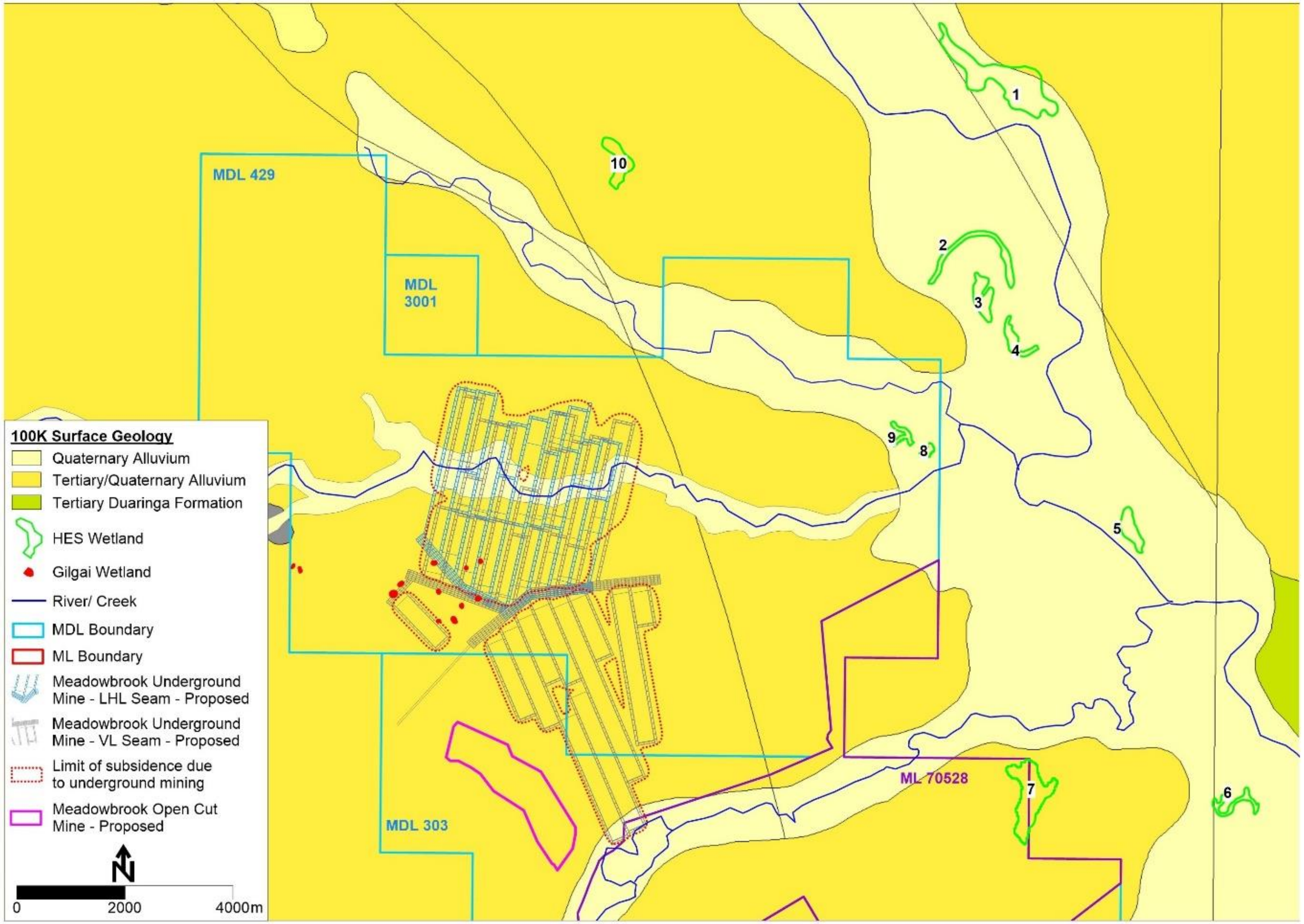

Figure 21.71: Subsidence impacts on surface features

21.11.3.4 Stygofauna

Description and assessment of stygofauna values of the Project site is described in Section 21.14.

21.11.3.5 Drinking water

The average electrical conductivity of groundwater recorded at monitoring bores in the Project area ranges from 17,518 µS/cm to 29,995 µS/cm and is, therefore, considered unsuitable as drinking water.

21.11.4 Potential impacts

The assessment of potential impacts on groundwater resources has been informed by modelling of the groundwater system of the Project region. A description of the modelling undertaken is provided through Section 21.11.4.1.

21.11.4.1 Model methodology

Conceptual groundwater model

A conceptual hydrogeological model of the groundwater regime at the Project has been developed, informed by site conditions (Appendix E, Groundwater Impact Assessment, section 4.7). The model is presented through Figure 21.72.

The surface geology comprises Tertiary age alluvium (poorly consolidated sand silt and clay) with recent Quaternary alluvium (sand silt and clay) associated with the current location of some surface water features. The surface sediments are underlain by generally low permeability sediments of the Triassic Rewan Group and low permeability Permian sediments that are overburden and interburden to higher permeability coal seams that act as groundwater conduits within the Permian strata. Recharge to the groundwater system occurs as either direct recharge in the Quaternary and Tertiary groundwater units or via diffuse downward recharge from overlying units. Groundwater recharge to Permian coal seams occurs preferentially where coal seams subcrop beneath Tertiary sediments. Groundwater movement generally follows surface topography. Hydraulic conductivity decreases slightly with the depth of coal seams, Permian interburden and Rewan Group sediments.

Groundwater quality is generally poor, the majority of monitoring bores recorded groundwater EC greater than 10,000 µS/cm and often greater than 20,000 µS/cm. Lower EC is recorded at locations near features such as Phillips Creek and Boomerang Creek indicating areas of groundwater recharge.

Numerical model

Three-dimensional numerical groundwater modelling has been undertaken for the Project by SLR Consulting Australia Pty Ltd and is included in Appendix E, as Attachment A - Groundwater Modelling and Technical Report.

The modelling was undertaken using the Olive Downs Project foundational model (Hydrosimulations 2018), which has been expanded over time to include the:

- Moorvale South Project (SLR 2019);
- Winchester South Project (SLR 2020); and
- Caval Ridge Expansion Project (SLR 2021

Detailed information on hydrogeological units, hydraulic properties and groundwater levels was available for each of these projects, which enabled the construction of a regional groundwater model that includes the major mining projects in the vicinity of the Project, thus allowing assessment of cumulative impacts from mining operations.

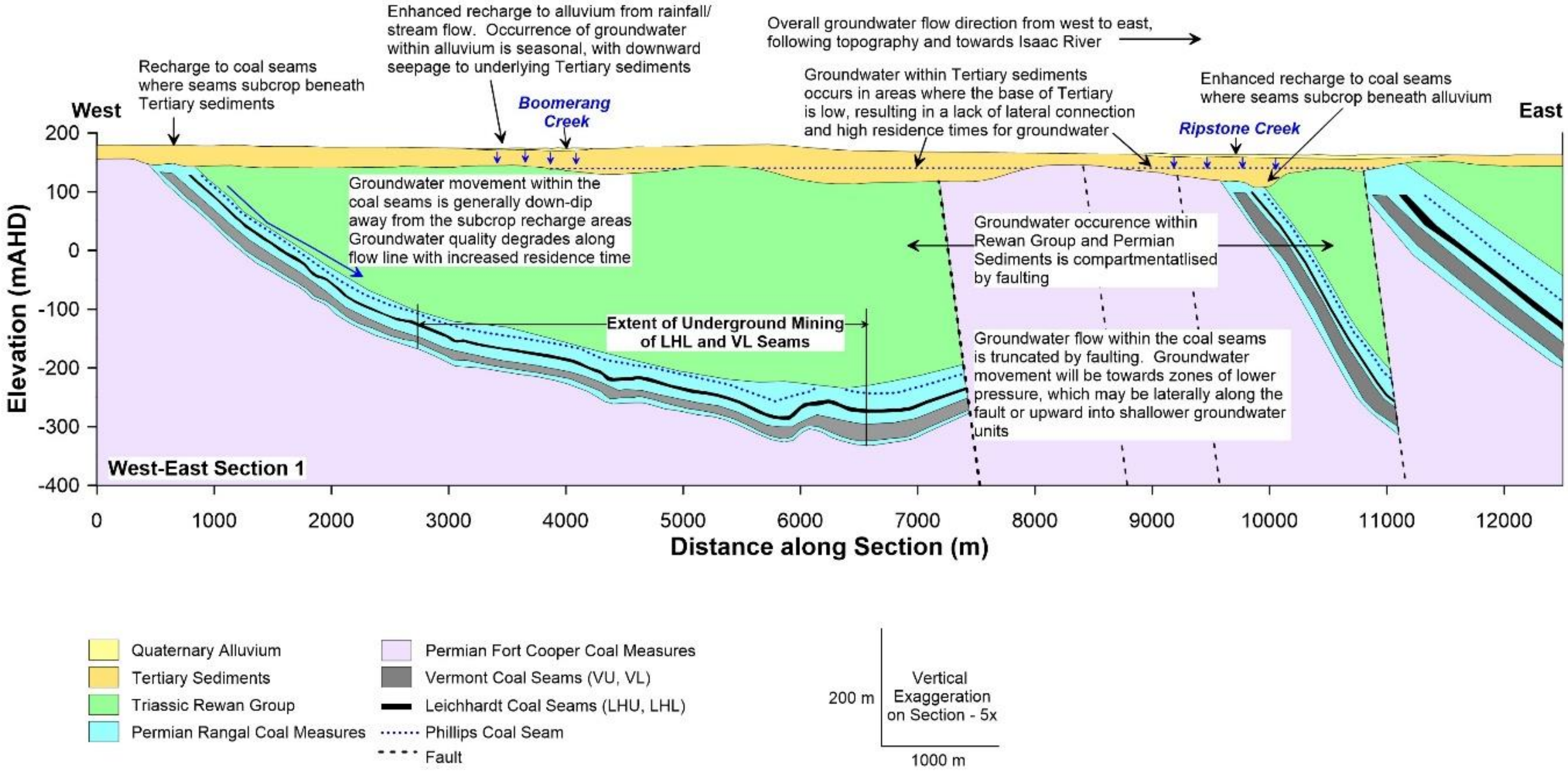

Figure 21.72: Conceptual groundwater model

In addition to the projects discussed above, the Project groundwater model includes:

- enhanced geological detail (groundwater unit occurrence, elevations, and faulting) in the area of the Project and the Lake Vermont Mine;
- details of all known mining operations within the model area; including:
    - Caval Ridge Mine;
    - Eagle Downs Underground Mine;
    - Poitrel Open Pit;
    - Daunia Open Pit;
    - Moorvale South Project;
    - Peak Downs Mine;
    - Olive Downs South Domain;
    - Saraji Open Pit Mine;
    - proposed Saraji Underground Mine; and
    - Willinga Station and Lake Vermont Mine.

The model also includes assessment of the potential cumulative impacts from the Arrow Energy Coal Seam Gas borefield (Bowen Gas Project). The impacts of the Arrow operation are included as a sensitivity scenario in the modelling undertaken by SLR and provided as part of Appendix E, through Attachment A, Groundwater Modelling and Technical Report (Section 6).

The Project groundwater model includes 19 layers, as listed in Table 21.23. The main units that are present in the Project area are represented by Layers 1 to 11.

Table 21.23: Model layers and thickness

Model Layer	Formation	Unit	Average Thickness (m)	Comment
1	Alluvium, colluvium, Tertiary basalt	Surface cover	6.5	-
2	Tertiary sediments, Tertiary basalt	Tertiary and minor Triassic Clematis, weathered Permian, Tertiary basalt	16.5	-
3	Rewan Group	Triassic	139.0	-
4	Rangal Coal Measures	Leichhardt overburden	36.0	-
5		Leichhardt seam	4.9	Coal seam mined at Meadowbrook
6		Interburden	36.5	-
7		Vermont seam	4.0	Coal seam mined at Meadowbrook
8		Vermont underburden	26.5	-
9	Fort Cooper Coal Measures	Fort Cooper overburden	61.5	-
10		Fort Cooper seams (combined)	61.5	-
11		Fort Cooper underburden	60.0	-
12		Q Seam	1.5	-

Model Layer	Formation	Unit	Average Thickness (m)	Comment
13	Moranbah Coal Measures	Interburden	17.0	-
14		P Seam	2.5	-
15		Interburden	41.0	-
16		H Seam	4.5	-
17		Interburden	65.5	-
18		D Seam	8.5	-
19		Interburden	100.0	-

Model calibration

An automated calibration utility of parameter estimation and uncertainty analysis (Doherty 2010) and manual calibration have been used to match the available transient water level data. Groundwater levels at 400 bores within the model area recorded between January 2008 to December 2020 were used for the model calibration.

Model calibration statistics are within suggested values (Middlemis et al. 2001), and model mass balance errors are low (Appendix E, Attachment A - Groundwater Modelling and Technical Report, Section 9).

Model sensitivity and uncertainty analysis

Sensitivity analysis and uncertainty analysis have been carried out on the numerical groundwater model, with details provided in Appendix E, Attachment A - Groundwater Modelling and Technical Report (Section 5). The composite sensitivity values were calculated during the Parameter Estimation and Uncertainty Analysis calibration. The model is determined to have a relatively low sensitivity to most parameters, including all the storage and recharge parameters.

The uncertainty analysis results for mine inflows shows that the calibrated prediction model aligns with the 50th percentile results and is therefore considered appropriate to use as a most likely case for assessing the impacts.

Additional sensitivity scenario – fracturing to surface

An additional sensitivity scenario of worst-case continuous fracturing to a surface (resulting from subsidence) has been modelled and compared to the base-case drawdown (Appendix E, Groundwater Impact Assessment, Section 5.5). The extent of drawdown is similar for each modelled scenario, with the majority of drawdown observed in the area above the mining panels.

Model limitations/uncertainty minimisation

Sufficient input data was available to enable model development and calibration. As part of the ongoing groundwater monitoring program, additional site-specific hydraulic information will continue to be collected. Ongoing data collection will enable the validity of the model calibration to be assessed. Additional site-specific data is expected to reduce uncertainty bounds for model prediction results (Appendix E, Attachment A - Groundwater Modelling and Technical Report, Section 6.3.

Predicted mine inflows uncertainty

The underground mine inflow rate has been adjusted for the purpose of water balance modelling to cater for a worst-case inflow estimate. The modelled hydraulic conductivity of the goaf zone was limited to two orders of magnitude above the unfractured hydraulic conductivity.

These model conditions have been applied while maintaining consistency with industry standards and industry-standard assumptions, with the conditions predicted by the subsidence fracturing. Details are provided in Appendix E, Groundwater Impact Assessment (Section 5.5).

Assessment of the potential impacts to groundwater values is provided in Sections 21.11.4.2 to 21.11.4.5.

21.11.4.2 Predicted groundwater impacts

Groundwater impacts from the base case Project due to inflows into the Project mining operations have been assessed using the numerical groundwater flow model described in Appendix E, Groundwater Impact Assessment (section 5).

Post-mining conceptual groundwater model

A conceptual hydrogeological model of the post-mining groundwater regime at the Project has been developed (Appendix E, Groundwater Impact Assessment, section 5.8) with the model presented as Figure 21.73.

The post mining conceptual groundwater model exhibits a zone of enhanced permeability due to goafing and caving into the underground workings. Groundwater drawdown due to mining will occur, with the drawdown limits constrained to the west by the 'pinching-out' of the coal bearing strata of the Rangal Coal Measures and to the east by truncation of aquifer strata by the Isaac fault.

The Project open-cut satellite pit is included in the conceptual model, where the water level in the rehabilitated pit landform remains below the base of the tertiary sediments in the final landform area (rehabilitated pit floor).

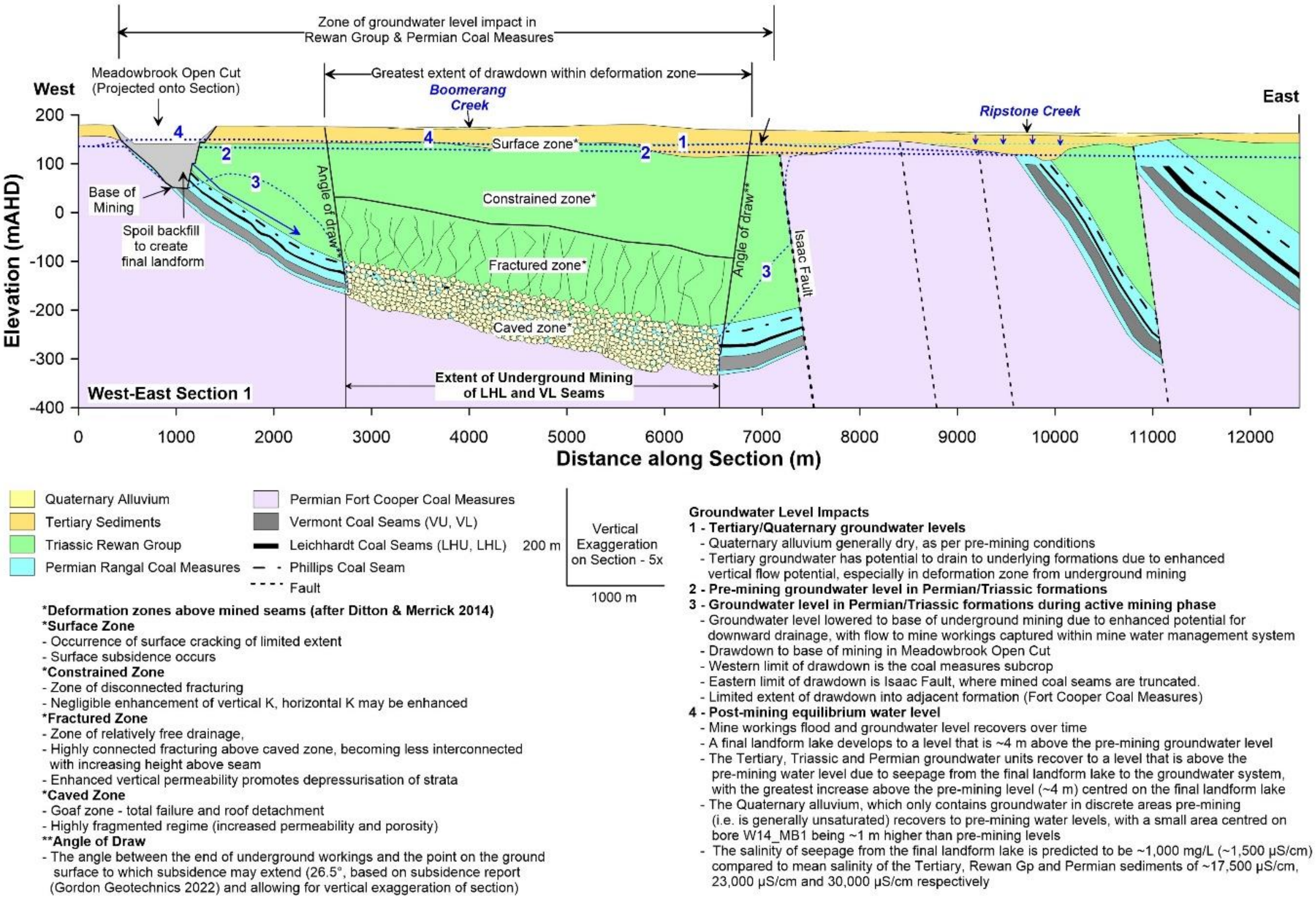

Figure 21.73: Post-mining conceptual groundwater model

Predicted groundwater inflow rates to underground workings

Further refining of the groundwater model has been undertaken in relation to the rate of mine inflows into the proposed underground workings. The most appropriate model of inflows is determined to be a sensitivity scenario that was run in the numerical groundwater model (SLR 2022), where the increase in vertical hydraulic conductivity for the goaf zone above the underground workings was limited to two orders of magnitude above the unfractured hydraulic conductivity (Appendix E, Groundwater Impact Assessment Section 5.8).

The calculated inflow rates for the two-order of magnitude vertical hydraulic conductivity increase are presented in Table 21.24.

Table 21.24: Predicted and design allowance inflow rates to underground workings

Project Year	Vertical K - 2 Order of Magnitude Limit (litres per second)	Project Year	Vertical K - 2 Order of Magnitude Limit (litres per second)
1 (2026)	0.0	15	7.4
2	0.4	16	7.2
3	1.7	17	6.6
4	4.4	18	5.9
5	7.1	19	5.8
6	7.1	20	5.8
7	5.9	21	5.9
8	7.2	22	6.2
9	7.1	23	6.5
10	7.7	24	7.3
11	8.8	25	6.5
12	9.9	26	5.6
13	9.8	27 (2052)	0.0
14	8.4		

Average groundwater inflows to the underground workings are estimated at 6 litres per second, with a maximum of 10 litres per second and a minimum of 0.4 litres per second predicted over the Project life.

These rates can inform the groundwater take for an Associated Water Licence under section 1283 of the Water Act 2000. The volume of groundwater predicted to be taken over the life of the underground mine is 5,110 ML, with an average of approximately 204 ML per year.

Predicted groundwater inflow rates to the open-cut pit

Net groundwater inflows to the Project open-cut pit (including evaporation) for the period of active mining, are shown in Table 21.25 and Figure 21.74.

Table 21.25: Predicted inflows to the open-cut pit

Project year	Net Pit Inflow (litres per second)
19*	0.0
20	0.4
21	0.9
22	0.7
23	1.6
24	3.4
25	2.7
26	5.1
27	4.8

*Project Year 19 is indicatively calendar year 2044

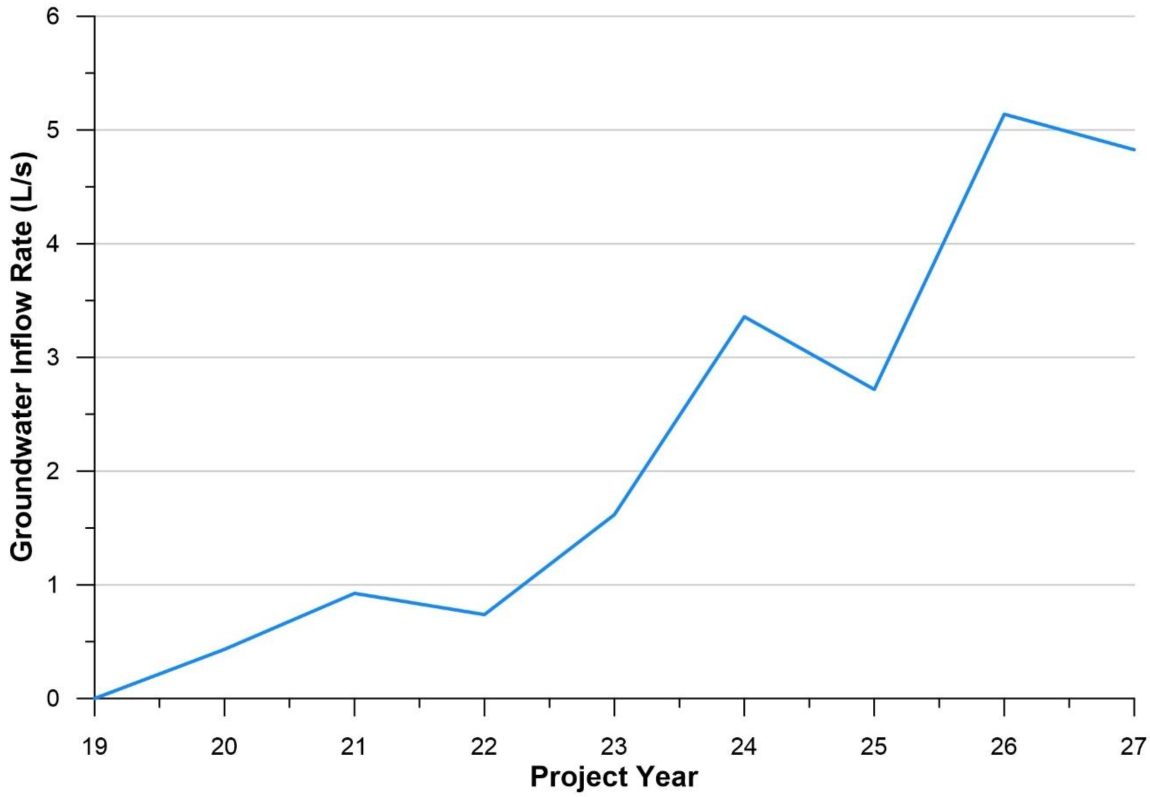

Figure 21.74: Groundwater inflow rate to Meadowbrook open-cut

Average net groundwater inflow for the life of the Project open-cut, including evaporation, is predicted to be 2.45 litres per second, with a maximum inflow of 5.1 and a minimum inflow of 0.4 litres per second. The total volume of water removed from the formation during the active phase of mining is calculated at 2,086 ML, and allowing for evaporation, the total predicted net pit inflow over the active period of mining is 623 ML (Appendix E, Groundwater Impact Assessment, section 5.6.2).

The Project open-cut satellite pit will be progressively backfilled, with the final rehabilitated pit landform presenting a shallow depression in the central mining area. The design of the final pit-area landform is premised on achieving a final elevation above the pre-mining groundwater level (and above the anticipated recovered groundwater level). As such, surface water ponded within the rehabilitated pit depression will have a seepage pathway to the underlying formations. Further details on rehabilitation of the Project open-cut satellite pit is provided in Chapter 6, Rehabilitation.

Predicted groundwater drawdown

The potential impact of the Project on groundwater drawdown has been extracted from the numerical groundwater model. The drawdown, in five model layers, is discussed in the following sections.

Quaternary alluvium

Contours of predicted drawdown in the Quaternary alluvium is shown through Figure 21.75.

The impact on drawdown within the Quaternary sediments is predicted to be minor, as the strata is only seasonally saturated, and the modelled drawdown likely represents an interaction of the difficult to define boundary between the Quaternary alluvium and Tertiary sediment.

At the maximum extent of drawdown, an area of drawdown is predicted at the confluence of Boomerang Creek and Ripstone Creek. The Quaternary sediments of Boomerang Creek and Ripstone Creek are likely to be only seasonally saturated with seepage, resulting in dry alluvium for most of the year, with predicted drawdown impacts limited to periods where the alluvium would have been saturated. The post-mining equilibrium drawdown will be less than 1 m, and a small area of 1 m raised groundwater level is predicted in the vicinity of Boomerang Creek.

Tertiary sediments

Contours of predicted drawdown at the end of mining, maximum lateral extent of drawdown and post-mining equilibrium in the Tertiary sediments are shown in Figure 21.76. At the end of mining, a 20 m drawdown contour will be centred on the area of the underground mining. This depth will be the approximate thickness of the Tertiary sediments, indicating that the Tertiary sediments have been drained in this area.

At the maximum extent of drawdown, 20 m of drawdown is predicted to occur over most of the underground mining area, and 1 m of drawdown is predicted to extend east to the confluence of Boomerang Creek and Ripstone Creek. At post-mining equilibrium, a groundwater mound of 4 m above the pre-mining groundwater level is predicted to occur in the area of the rehabilitated pit landform, and 1 m of mounding is expected to extend to the north-east extent of the underground mining.

Rewan Group

Contours of predicted drawdown at the end of mining, maximum lateral extent of drawdown and post-mining equilibrium in the Rewan Group are shown in Figure 21.77.

Drawdown is expected to crop out to the west due to the dip in the strata and terminate at the Isaac Fault west of the Project mining area. Drawdown will, therefore, be restricted within the western and eastern extents of the formation.

Predicted drawdown at the end of mining will be greatest at the central area of the underground mining and the maximum extent of drawdown centred on the northern underground panels. The post-mining equilibrium groundwater level is predicted to be approximately 4 m above the pre-mining groundwater level, with the raised groundwater centred on the rehabilitated pit landform.

Leichhardt coal Seam

Contours of predicted drawdown at the end of mining, maximum lateral extent of drawdown and post-mining equilibrium in the Leichhardt seam are shown in Figure 21.78. Drawdown at the end of mining and post-mining equilibrium will be centred on the underground panels where mining of the Leichhardt seam occurs.

At post-mining equilibrium, the water level in the Leichhardt seam is predicted to recover, and a groundwater mound 4 m above the pre-mining groundwater level is predicted to be centred on the rehabilitated pit landform.

Vermont Coal Seam

Contours of predicted drawdown at the end of mining, maximum lateral extent of drawdown and post mining equilibrium in the Vermont coal seam is shown in Figure 21.79.

Drawdown at the end of mining and maximum extent of drawdown is predicted to be similar to that observed for the Leichhardt seam. At post-mining equilibrium, the groundwater level is predicted to recover, and a groundwater mound of approximately 4 m above the pre-mining level is predicted to be centred on the rehabilitated pit landform.

Recovery to underground workings and rehabilitated pit

Above the northern longwall panels, the groundwater level is predicted to recover to approximately 95% of final equilibrium after 270 years. The final predicted equilibrium groundwater elevation in this area is approximately 1.5 m above the pre-mining water level for both the Leichhardt and Vermont Seams.

Above the southern longwall panels, the groundwater level is predicted to recover to approximately 95% of the final equilibrium level after 135 years. The final predicted equilibrium groundwater elevation in this area is approximately 2.3 m above the pre-mining water level for both the Leichhardt and Vermont Seams.

The Project open-cut satellite pit will be progressively backfilled during the operational and rehabilitation phases of the Project. The final rehabilitated pit landform will present with a shallow depression in the central mining area, with a floor elevation approximately 15 m below the natural surface. The design of the final pit-area landform is premised on achieving a final elevation above the pre-mining groundwater level and the anticipated recovered groundwater level. As such, surface water that periodically ponds within the rehabilitated pit depression will have a seepage pathway to the underlying formations.

Due to the limited size of the catchment area, it is likely that the central rehabilitated pit depression will be subject to intermittent periods of ponding; however, it is not expected to be a permanent water body. The water balance model outcomes indicate that water quality will not accumulate salts over time due to losses to groundwater. Further details on predicted surface water behaviour within the rehabilitated pit is provided in Section 21.9.6.7.

Drawdown impacts on groundwater bore users

There is one bore screened in Cainozoic sediments within the 2 m drawdown area of the Tertiary strata. The impacted bore (132627) is to the east of the Project area on the “Lake Vermont” property (Lot 3, SP260662) owned by BMA. BBC proposes to undertake discussions with BMA to establish whether a make good agreement will be required to address the potential impacts on this bore.

There are no bores screened in the consolidated sediments of the Rewan Group and Permian coal measures within the 5 m drawdown area of the relevant strata.

There is potential to impact unregistered private bores to the east or north of the Project area in the Tertiary aquifer or consolidated strata. A bore census was undertaken by BBC (*via* a mail-out to all potentially affected landholders within the Project’s maximum predicted drawdown area) to identify other bores (including unregistered bores) that may be in existence and potentially impacted by the Project. No responses to BBC’s bore census request was received.

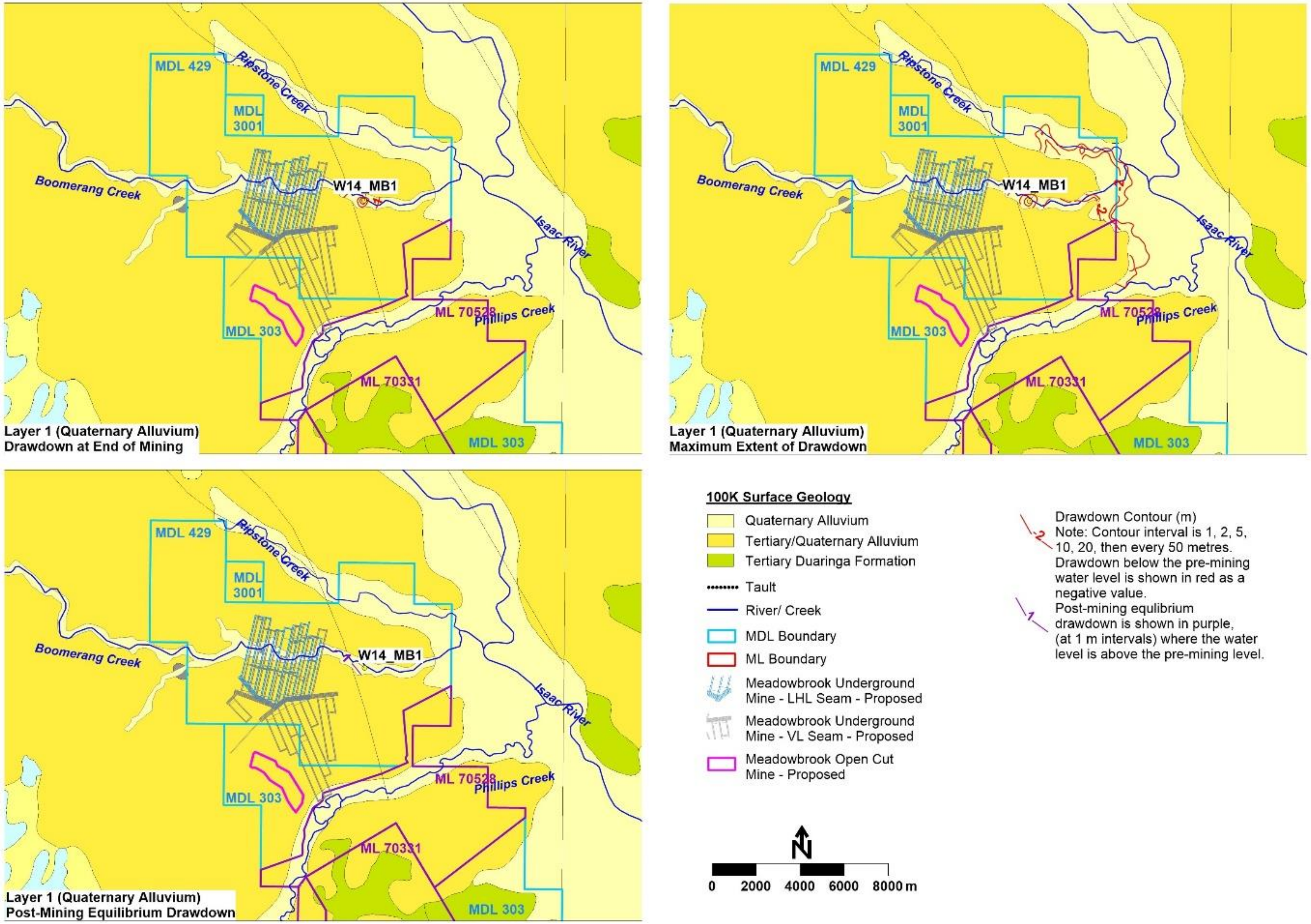

Figure 21.75: Predicted maximum Quaternary alluvium drawdown

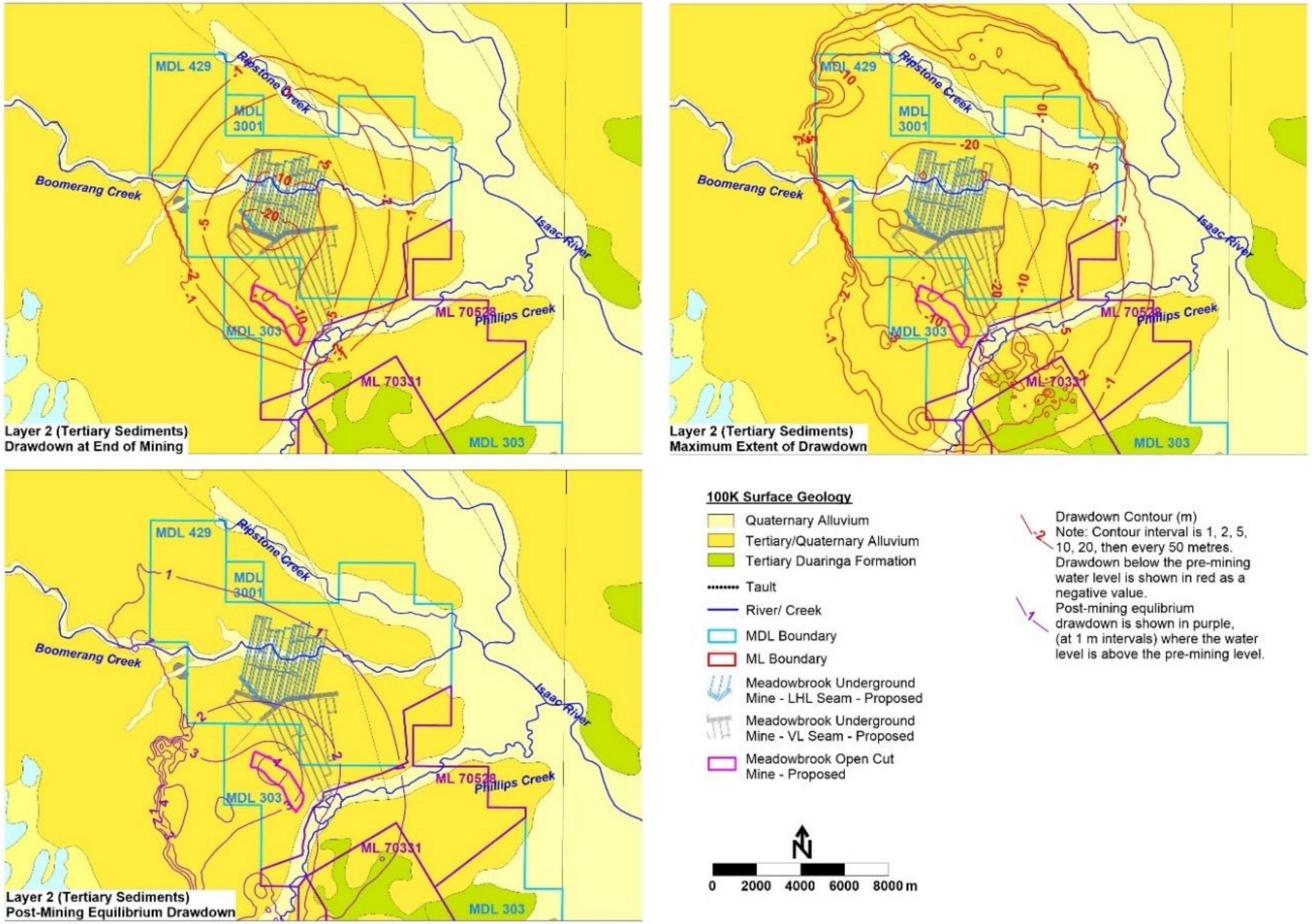

Figure 21.76: Predicted water level drawdown and recovery for Tertiary sediments

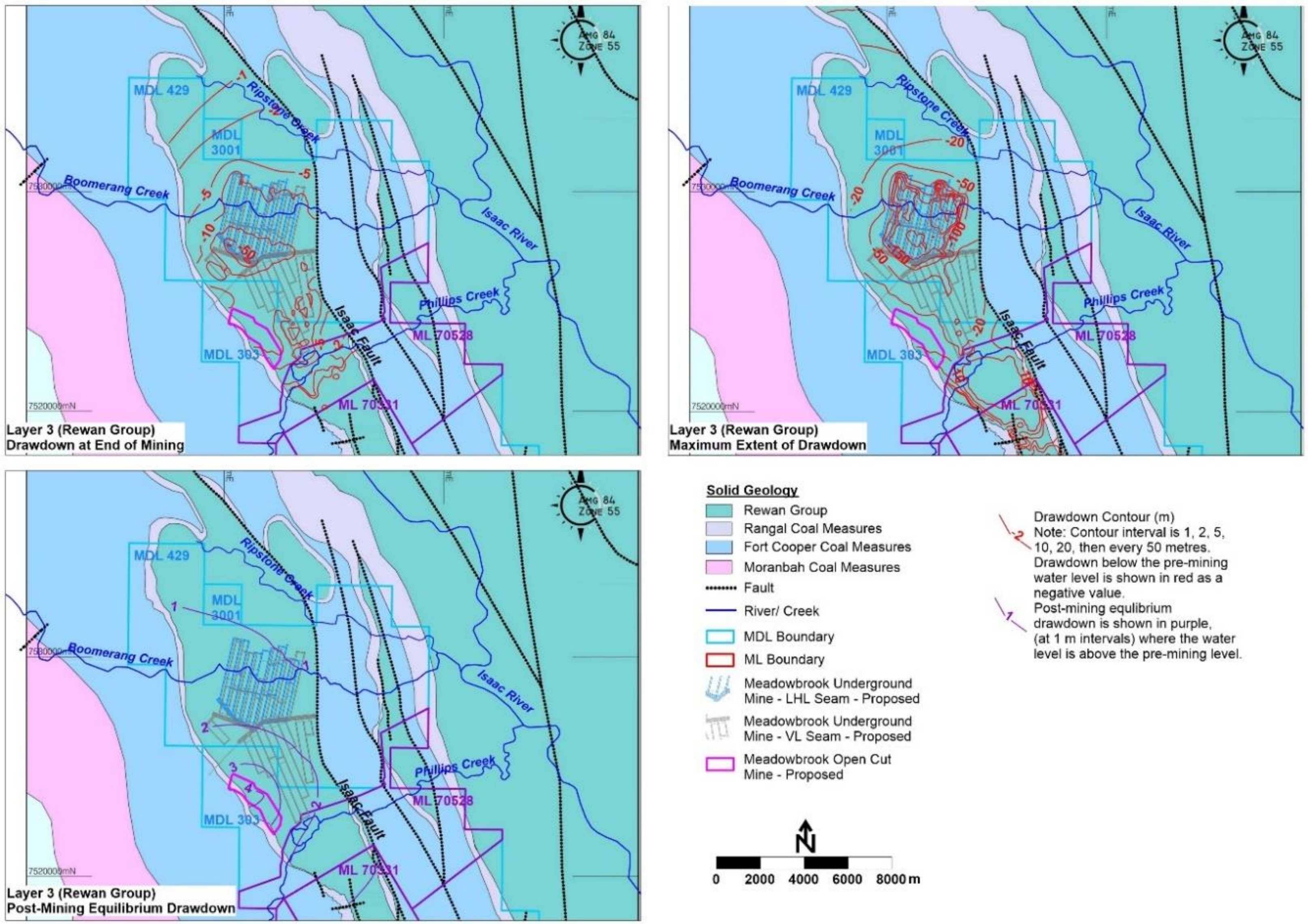

Figure 21.77: Predicted water level drawdown and recovery for Rewan group

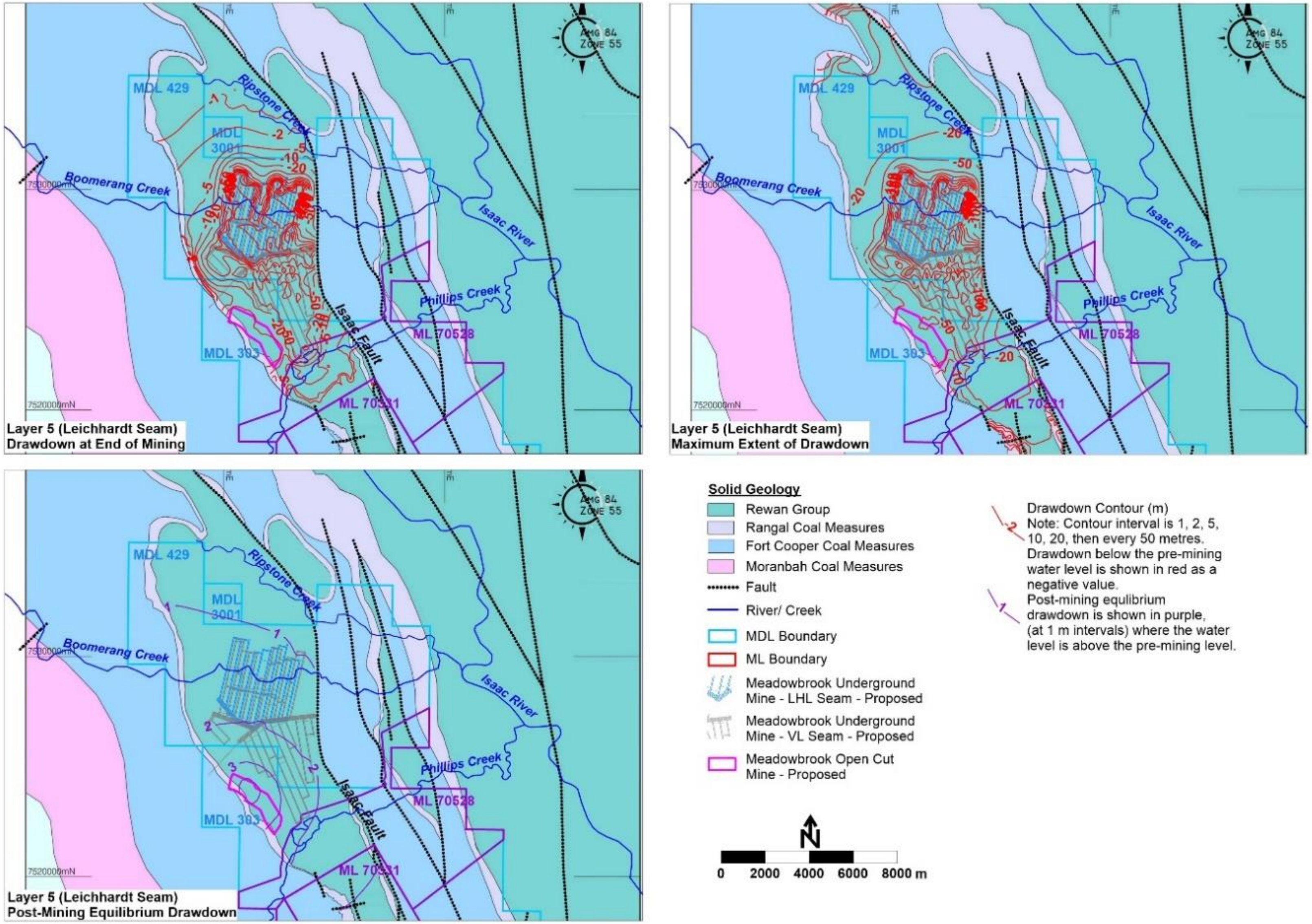

Figure 21.78: Predicted water level drawdown and recovery for Leichhardt coal seam

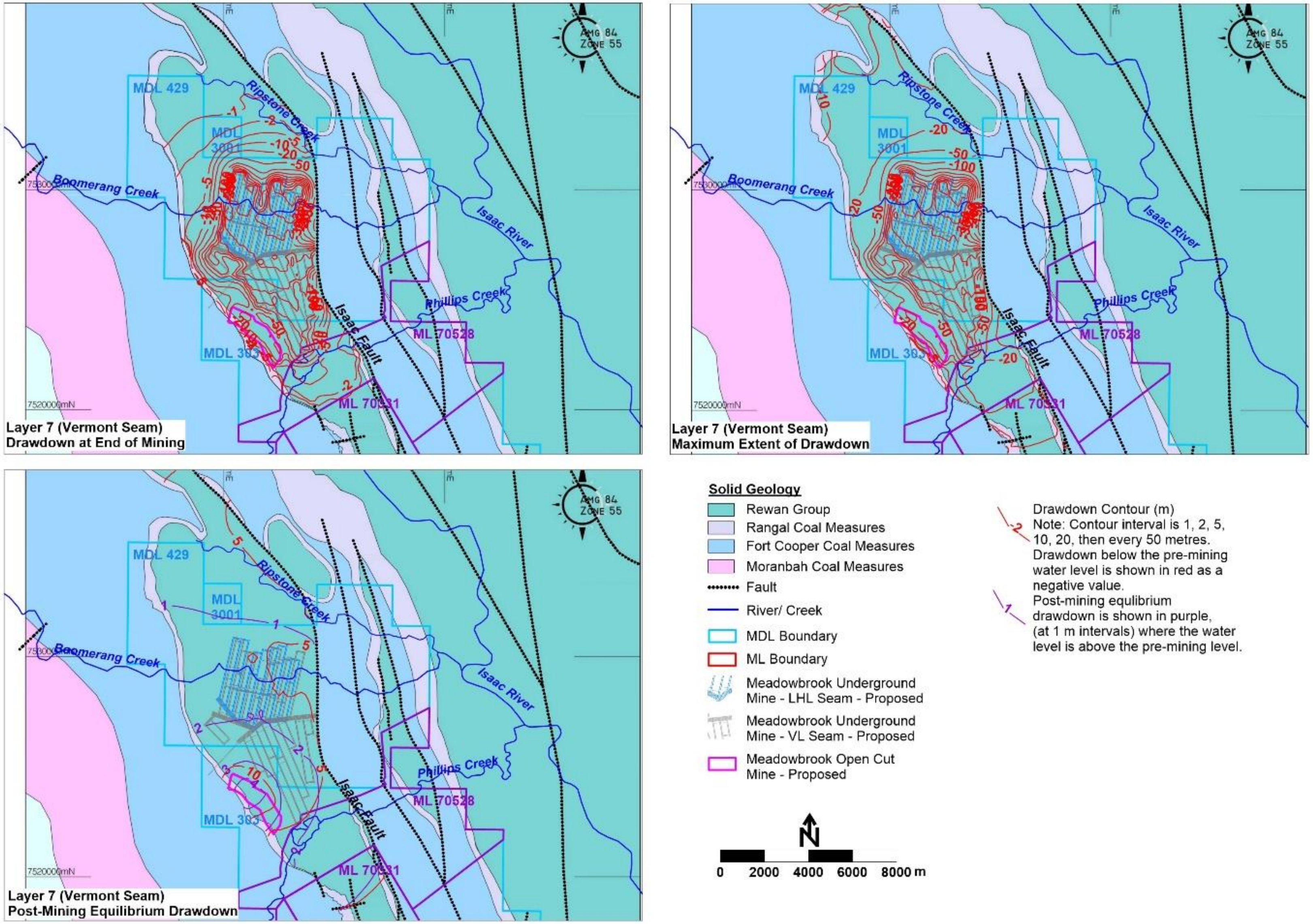

Figure 21.79: Predicted water level drawdown and recovery for Vermont coal seam

Subsidence related impacts

Subsidence-related impacts on groundwater levels have been predicted by groundwater modelling described at Section 21.11.4.1 and through the Groundwater Modelling Technical Report (Appendix E, Attachment A).

Subsidence is likely to cause fracturing of the geological strata overlying the coal seam. The SLR base-case model (SLR 2022) assumed height of fracturing scenarios from the Meadowbrook subsidence prediction report (Appendix A, Subsidence Assessment) as follows:

- For a single-seam mining scenario (e.g. areas where only the Vermont Lower Seam is extracted), a zone of continuous fracturing extending to approximately 120 m above the extracted seam; and,
- For a dual-seam mining scenario (e.g. areas where bore the Vermont Lower and Leichhardt Lower seams are extracted), zone of continuous fracturing extending to approximately 180 m above the extracted seam.

Over most of the mining area, the above scenarios resulted in the extension of continuous fracturing through the coal seams and Leichhardt overburden and into the basal portion of the Rewan Group. However, a worst-case sensitivity assumption of continuous fracturing to surface was included in the numerical groundwater model. The difference in drawdown in the fracturing to surface scenario compared to the base-case drawdown scenario is illustrated through Figure 21.80, Figure 21.81 and Figure 21.82.

It is noted that the extent of drawdown (as defined by the 1 m drawdown contour) is similar for both the base case and fracturing to surface scenario, indicating fracturing does not significantly increase drawdown. The majority of additional drawdown for the fracture-to-surface scenario is observed in the area directly above the mining panels, as would be reasonably expected.

21.11.4.3 Great Artesian Basin impacts

The Great Artesian Basin boundary is located approximately 150 km from the Project. Based on modelled extent of groundwater impacts, it is concluded that there will be no impact by the Project on groundwater within the Great Artesian Basin (Appendix E, Groundwater Impact Assessment, section 1.2.2).

21.11.4.4 Groundwater quality

The impacts to groundwater quality is assessed within Appendix E, Groundwater Impact Assessment (Section 6.2.7). Modelling predicts that a groundwater mound will develop to 4 m above the pre-mining groundwater level at the location of the surface depression within the open-cut rehabilitated pit landform. Seepage of surface water is predicted to occur from the rehabilitated pit landform to the underlying groundwater formations. The electrical conductivity of this seepage is predicted to be approximately 1,500 µS/cm which is much less than the mean EC of the groundwater system (Section 21.11.2.3). Seepage of water from the rehabilitated pit landform is therefore assessed to be unlikely to present a significant risk to groundwater quality.

21.11.4.5 Cumulative impacts

The numerical groundwater modelling for the Project has used a regional model that includes the major mining projects in the vicinity, including the approved Bowen Gas Project, as a sensitivity analysis. This model, therefore, has facilitated an assessment of cumulative impacts from mining operations.

The cumulative impact of the proposed Project and other projects is discussed in Appendix E, Groundwater Impact Assessment (Section 6.2.8). The assessment has included all current and known future coal and gas operations with potential to impact groundwater in the area, as presented in Section 21.11.4.1. The assessed cumulative impacts to hydrogeological units (with the exception of the Quaternary alluvium) are described below. The cumulative impact to Quaternary alluvium is not assessed due to the unit being generally dry in the Project area, with little to no drawdown predicted as a result of the Project, including to the Isaac River alluvium.

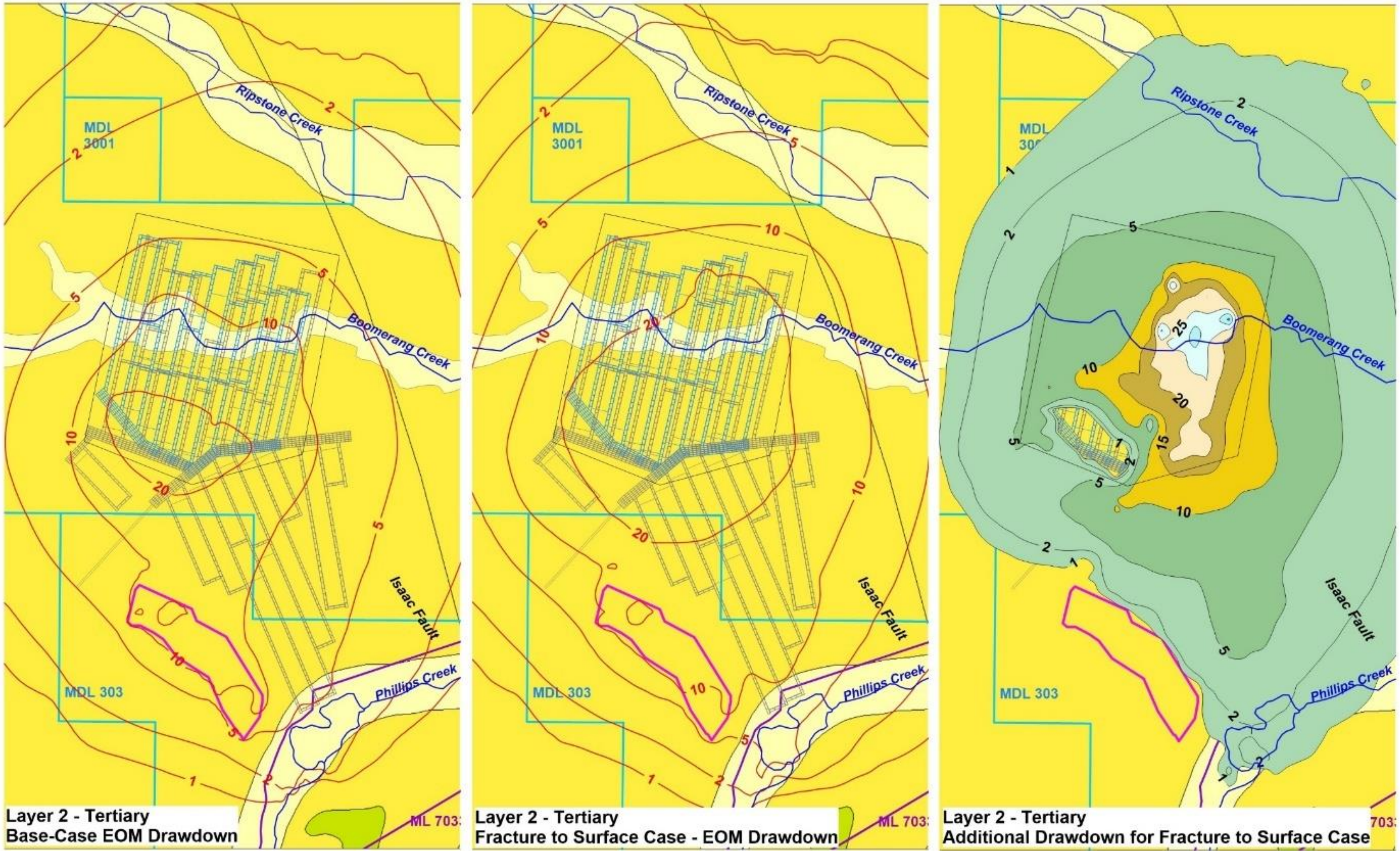

Figure 21.80: Difference Between Base-Case and Fracture to Surface Drawdown - Layer 2

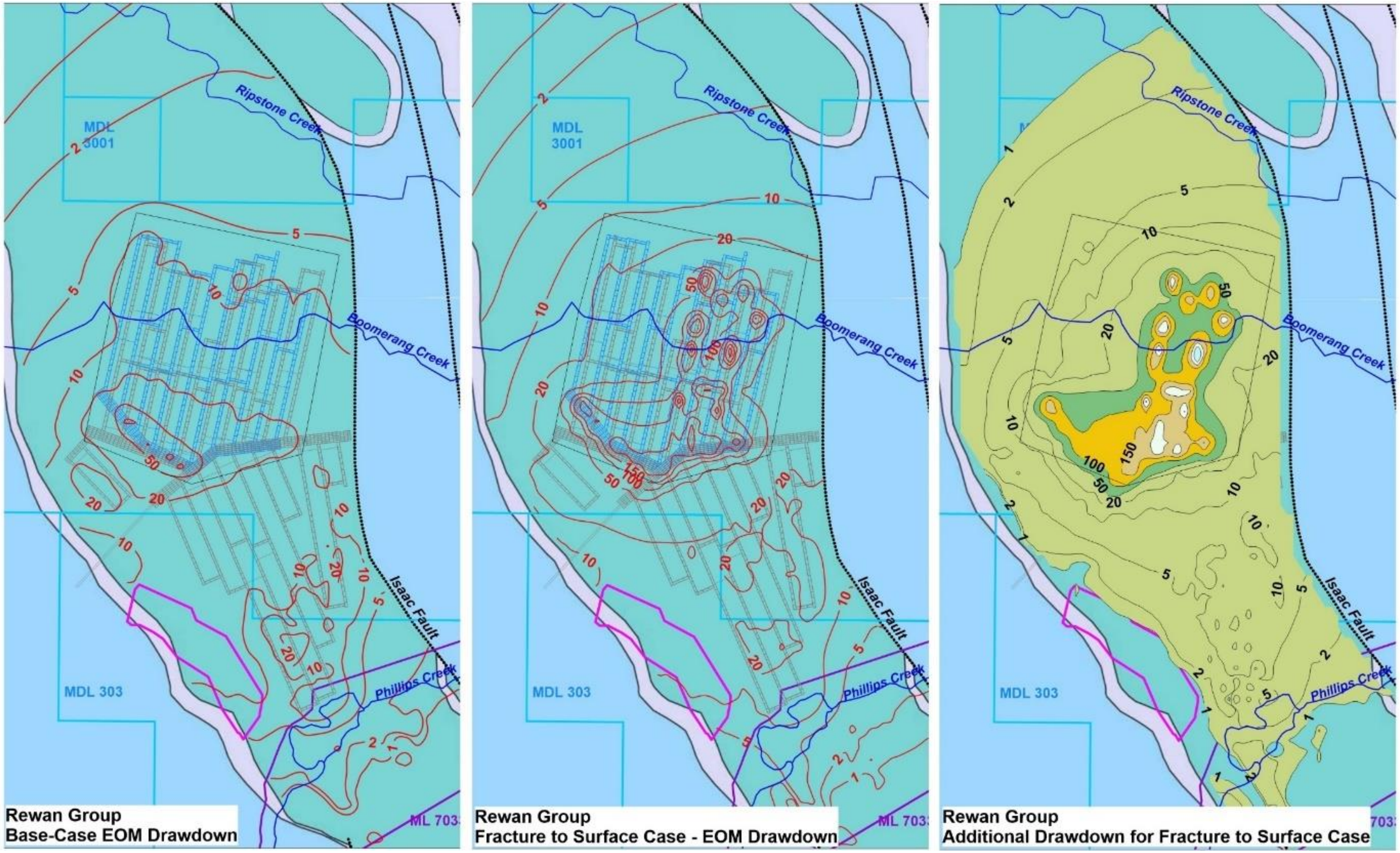

Figure 21.81: Difference Between Base-Case and Fracture to Surface Drawdown - Rewan Group

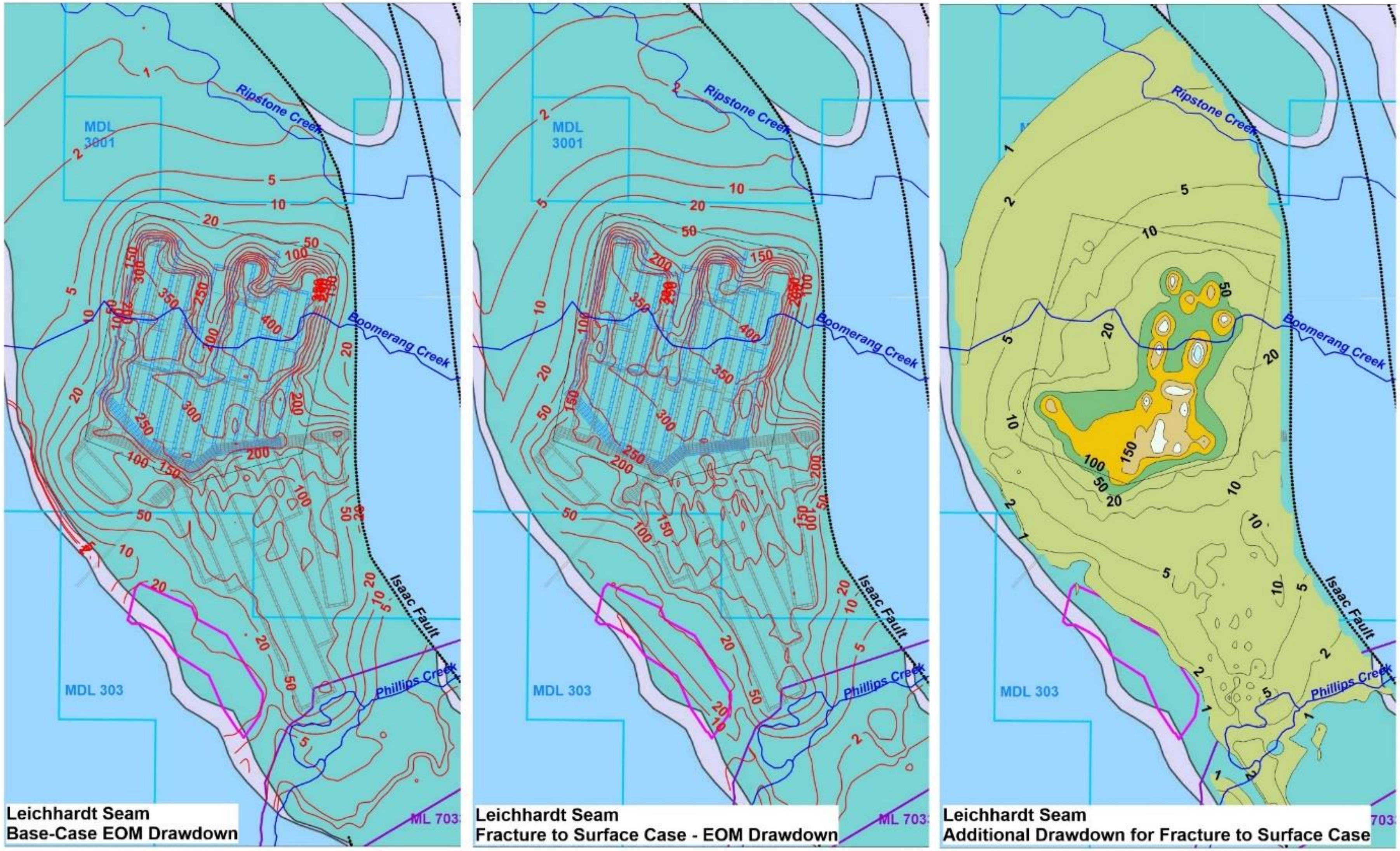

Figure 21.82: Difference Between Base-Case and Fracture to Surface Drawdown - Leichhardt Seam

Tertiary Sediments

Cumulative drawdown from Olive Downs South and Eagle Downs extends southward to coalesce with the drawdown from the Project, resulting in an additional 2 m to 10 m of drawdown beneath Boomerang Creek and an additional 2 m to 15 m of drawdown beneath Ripstone Creek.

Cumulative drawdown contours from the operations at Olive Downs South and Willunga extend beneath the Isaac River. None of the drawdown beneath the Isaac River is attributable to the Project.

Rewan Group

To the north of the Project underground mining area, the drawdown contours from Eagle Downs and Olive Downs South coalesce with the drawdown from the Project, which increases the drawdown in this area by 5 m to 50 m.

The drawdown observed in the eastern block of the Rewan Formation is attributable to Olive Downs South and Willunga. Mining at the Project will not contribute to this drawdown, as the Rewan Group sediments are truncated to the east of the Project mining area by the Isaac Fault.

Leichhardt Seam

Drawdown to the north of the Project underground mining area increases by 10 m to 50 m, which is attributable to mining at Eagle Downs and Olive Downs South.

The drawdown observed in the eastern block of Permian coal measures is attributable to Olive Downs South and Willunga. Mining at the Project will not contribute to this drawdown, as the Rangal Coal Measures are truncated to the east of the Project mining area by the Isaac Fault.

Vermont Seam

Drawdown to the north of the Project underground mining area increases by 10 m to 50 m, which is attributable to mining at Eagle Downs and Olive Downs South.

The drawdown that is observed in the eastern block of Permian coal measures is attributable to Olive Downs South and Willunga. Mining at the Project will not contribute to this drawdown, as the Rangal Coal Measures are truncated to the east of the Meadowbrook mining area by the Isaac Fault.

21.11.5 Mitigation, management measures and monitoring

21.11.5.1 Impacted groundwater bore management

BBC proposes to undertake discussions with BMA to establish whether a make good agreement will be required to address the potential impacts to registered bore 132627. The bore is screened in Cainozoic sediments within the 2 m drawdown area of the Tertiary strata.

21.11.5.2 Groundwater monitoring program

Groundwater monitoring of the Project area commenced in October 2020, following construction of site monitoring bores in March–April 2020. This monitoring extends on the groundwater monitoring network already in operation for the existing Lake Vermont Mine.

Monthly monitoring of groundwater will continue at the Project site, building on the existing baseline dataset. Groundwater quality trigger levels and limits will be established as the dataset grows, and once established, they will be incorporated into the existing Water Management Plan for Lake Vermont Mine (and the Lake Vermont Mine EA). It is proposed that groundwater monitoring will occur at quarterly intervals for the duration of the Project. Monitoring methods will be in accordance with the 'Queensland Monitoring and Sampling

Manual Water Sampling Guidelines—Part 11 Guidance on groundwater' (ANZS 1998), and the Australian Governments Groundwater Sampling and Analysis—A Field Guide' (Sundaram et al. 2009).

The proposed monitoring parameters include the following :

- laboratory and field pH and EC;
- major ions (sodium, calcium, magnesium, potassium, chloride, sulphate, alkalinity);
- total and dissolved metals/metalloids (aluminium, arsenic, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, uranium, vanadium, zinc); and,
- total petroleum hydrocarbons.

Groundwater monitoring has been conducted at, and will continue at the Project monitoring locations and the Lake Vermont Mine monitoring locations, as shown in Table 21.26, Table 21.27 and Figure 21.66.

Table 21.26: Meadowbrook Project groundwater monitoring bores

Bore ID	Groundwater Unit	Easting (AGD84)	Northing (AGD84)
W1_MB1	Tertiary sediments	637914	7531373
W1_MB2	Leichhardt Lower Seam	637916	7531372
W1_MB3	Vermont Seam	637919	7531372
W2_MB1	Tertiary sediments	637368	7531452
W2_MB2	Girah 1 Seam	637370	7531452
W3_MB1	Quaternary alluvium	640470	7529435
W3_MB2	Tertiary sediments	640468	7529435
W4_MB1	Quaternary alluvium	638172	7528735
W4_MB2	Permian overburden	638169	7528735
W5_MB1	Rewan Group	638387	7527823
W5_MB2	Leichhardt Lower Seam	638385	7527820
W5_MB3	Vermont Seam	638384	7527817
W6_MB1	Permian overburden	637758	7527892
W6_MB2	Girah 1 Seam	637761	7527893
W7_MB1	Permian overburden	637484	7526145
W8_MB1	Girah 1 Seam	639306	7523618
W9_MB1	Tertiary sediments	640953	7524117
W9_MB2	Vermont Upper Seam	640953	7524119
W9_MB3	Vermont Lower Seam	640952	7524121
W10_MB1	Rewan Group	641869	7524259
W10_MB2	Vermont Upper Seam	641869	7524259
W10_MB3	Vermont Lower Seam	641869	7524261
W11_MB1	Rewan Group	643941	7524860

Bore ID	Groundwater Unit	Easting (AGD84)	Northing (AGD84)
W11_MB2	Leichhardt Seam	643943	7524861
W12_MB1	Tertiary sediments	643268	7530165
W13_MB1	Vermont Lower Seam	645381	7530927
W13_MB2	Girah 1 Seam	645379	7530927
W14_MB1	Tertiary sediments	645373	7528515
W14_MB2	Permian Coal Seam	645375	7528515
W15_MB1	Tertiary sediments	649009	7527504
W15_MB2	Vermont Upper Seam	649009	7527504
W15_MB3	Vermont Lower Seam	649009	7527504

Table 21.27: Lake Vermont North groundwater monitoring bores

Bore ID	Groundwater Unit	Easting (AGD84)	Northing (AGD84)
West-MB1	Tertiary	642872	7519929
West-MB2	Permian Coal Measures	642873	7519932
2183-VWP*	Permian coal measures	644068	7520358
2371W-MB1	Tertiary	643131	7521947
2226-MB2	Rewan Group	643134	7521947
2226-MB3	Permian (Leichhardt Seam)	643133	7521950
2226-VWP*	Rewan Group, Permian coal measures	643129	7521950
2394-MB1	Tertiary	644898	7522962
2394-MB2	Rewan Group	644895	7522962
2369W-MB1	Tertiary	645524	7522752
2218-MB2	Rewan Group	645526	7522756
2218-MB3	Permian (Leichhardt Seam)	645523	7522754
2218-VWP*	Rewan Group, Permian coal measures	645526	7522753
2393-MB1	Tertiary	645696	7523043
2393-MB2	Permian (Leichhardt Seam)	645694	7523043
2393-MB3	Permian (Vermont Seam)	645691	7523043
2370W-MB1	Tertiary	648037	7523878
2375-MB2	Permian (Vermont Seam)	648042	7523874
2375W-VWP*	Permian coal measures	648040	7523865
2372-MB1	Tertiary	647520	7526012

Bore ID	Groundwater Unit	Easting (AGD84)	Northing (AGD84)
2372-MB2	Rewan Group	647519	7526010
2372-MB3	Permian (Vermont Seam)	647518	7526008
2372R-VWP*	Permian coal measures	647515	7526007
1235C-VWP*	Permian coal measures	649799	7522054
1238-MB1	Tertiary	650671	7522741
1238-MB2	Permian (Vermont Seam)	650670	7522744

21.11.5.3 Groundwater trigger levels and limits

Groundwater trigger levels and limits have been developed by a suitably qualified person for both groundwater level and quality, utilising data from the baseline dataset. The proposed trigger levels are provided in Appendix A7, Groundwater Triggers. The trigger levels are derived from the 95th percentile of baseline data, or ANZG (2018) guideline value for 95% freshwater ecosystem protection. The proposed groundwater quality trigger levels are summarised in Table 21.28. The proposed groundwater level trigger thresholds for each groundwater unit is shown in Table 21.29, with the calculated values based on the following:

- For each bore location, the starting water level is the lowest water level from the data record that is assessed to be related to climatic conditions;
- The end of mining drawdown is the water level prediction for each groundwater unit (for the fracture to surface case) from modelling that was undertaken (Appendix E, Groundwater Assessment); and
- The level trigger threshold (mAHD) is calculated as the starting water level (mAHD) minus the end of mining drawdown (m).

Table 21.28: Proposed groundwater quality trigger levels

Parameter	Unit of Measurement		Groundwater Unit – Limit		Figure
		Alluvium	Rewan Group	Permian	
Field pH	pH Unit	5.84 – 6.79 (1)	6.44 – 7.17 (1)	6.24 – 8.66 (1)	A-1
Field Electrical Conductivity (EC)					
All bores*	(µS/cm)	30422 (2)	24581 (2)	41567 (2)	A-2
W14_MB1	(µS/cm)	1205 (3)	-	-	A-2
Sulphate (mg/L)					
All bores*	mg/L	1250	-	1760	A-3
W14_MB1	mg/L	163 (3)	-	-	A-3
W5_MB1	mg/L	-	1696 (3)	-	A-3
W1_MB1	mg/L	-	165 (3)	-	A-3
W1_MB2	mg/L	-	-	20 (6)	A-3
W1_MB3	mg/L	-	-	20 (6)	A-3
Dissolved Metals/Metalloids					

Parameter	Unit of Measurement	Groundwater Unit – Limit			Figure
		Alluvium	Rewan Group	Permian	
Aluminium	mg/L	0.055 (4)	0.055 (4)	0.055 (4)	A-4
Chromium	mg/L	0.005 (3)	0.005 (3)	0.006 (3)	A-5
Cobalt	mg/L	0.008 (3)	0.005 (3)	0.024 (3)	A-6
Copper	mg/L	0.008 (3)	0.008 (3)	0.153 (3)	A-7
Manganese	mg/L	1.9 (4)	1.9 (4)	1.9 (4)	A-8
Molybdenum	mg/L	0.034 (4)	0.047 (3)	0.070 (3)	A-9
Nickel	mg/L	0.223 (3)	0.410 (3)	0.075 (3)	A-10
Selenium	mg/L	0.01 (5)	0.01 (5)	0.01 (5)	A-11
Zinc	mg/L	0.107 (3)	0.066 (3)	0.13 (3)	A-12

* Limit for all bores in groundwater unit, with the exception of any individual bores where separate limit is proposed

(1) 5th and 95th Percentile of data for groundwater unit

(2) 95th Percentile of data for groundwater unit

(3) 95th Percentile of data for individual bore

(4) ANZG (2018) Aquatic ecosystem protection for moderately disturbed system (95% protection)

(5) LOR of IC-PMS

(6) Low value above the maximum LOR recorded for each bore

Table 21.29: Modelled drawdown and groundwater level trigger threshold

Monitoring Location	Groundwater Unit	Starting Water Level (mAHD)	End of Mining Drawdown (m)	Level Trigger Threshold (mAHD)	Monitoring Frequency
W1_MB1	Tertiary sediments	160.4	2	158.4	Quarterly
W1_MB2	Leichhardt Lower Seam	160.84	2.3	158.54	Quarterly
W1_MB3	Vermont Seam	160.87	1.8	159.07	Quarterly
W3_MB2	Tertiary sediments	159.1	17	142.1	Quarterly
W4_MB2	Permian overburden	161.07	11.6	149.47	Quarterly
W5_MB1	Rewan Group	160.97	9.1	151.87	Quarterly
W5_MB2	Leichhardt Lower Seam	161.84	15.4	146.44	Quarterly
W5_MB3	Vermont Seam	159.82	4.3	155.52	Quarterly
W9_MB2	Vermont Upper Seam	147.12	50.8	96.32	Quarterly
W9_MB3	Vermont Lower Seam	148.81	50.8	98.01	Quarterly
W10_MB3	Vermont Lower Seam	144.33	13.6	130.73	Quarterly

Monitoring Location	Groundwater Unit	Starting Water Level (mAHD)	End of Mining Drawdown (m)	Level Trigger Threshold (mAHD)	Monitoring Frequency
W11_MB1	Rewan Group	145.14	29.9	115.24	Quarterly
W11_MB2	Leichhardt Seam	143.99	130	13.99	Quarterly
W12_MB1	Tertiary sediments	154.75	16.4	138.35	Quarterly
W14_MB1	Tertiary sediments	153.34	7.5	145.84	Quarterly

21.11.5.4 Groundwater management plan

Project groundwater trigger levels and limits will ultimately be maintained and managed through updates to the existing Lake Vermont Mine Water Management Plan. The groundwater management and monitoring measures within this plan will continue for the life of the Project, be updated as required and will include commitments for:

- the continuation of groundwater monitoring from the current Project monitoring bores (with locations as identified in Table 21.26 and Table 21.27). The monitoring bore list may be modified during updates to the Water Management Plan and finalisation of the Project's EA;
- installation of additional groundwater monitoring bores within the Quaternary and Tertiary sediments at the confluence of Ripstone and Boomerang Creeks, at sites that are adjacent to the identified HES wetlands;
- the replacement of monitoring bores if and as required (e.g. if bores are destroyed or become unserviceable for any reason);
- an assessment of adequacy of the groundwater network when assessed necessary and expansion of monitoring network as required; and
- the procedure for assessment of data via groundwater level and quality trigger levels and subsequent reporting.

21.11.5.5 Future groundwater modelling

Changes in water level will be assessed on an annual basis against model predictions, by a suitably qualified person, as part of the Annual Return. The numerical groundwater model will be re-run every five years, if required (e.g. if the actual vs predicted water level variation is assessed as being significant by a suitably qualified person).

21.11.5.6 Adaptive Management

Groundwater mitigation measures will be presented in the updated Water Management Plan and will be adaptively developed in the event that investigations were to conclusively attribute Project impacts on existing groundwater values including:

- impacts from mine-affected water on groundwater;
- impacts on existing groundwater users; and
- impacts on GDEs.

21.11.6 IESC checklist

Reconciliation of the IESC Information Guidelines is provided in Attachment 3.

21.11.7 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 criteria (DoE 2013). The significant impact criteria provides guidance on when a significant impact to the hydrological characteristics of a water resource may occur.

An assessment of Project impacts, according to guidance provided by the significant impact criteria (DoE 2013), to geohydrological characteristics is provided in Section 21.11.7.1 and to ground water quality in Section 21.11.7.2.

21.11.7.1 Potential impacts to geohydrological characteristics

Assessment of Project impacts, according to guidance provided by the significant impact criteria (DoE 2013), to aquifers is shown in Table 21.30.

Table 21.30: Assessment of significant impact on geohydrological characteristics

Significant impact guidance	**Assessment of significance**
Changes in the water quantity, including the timing of variations in water quantity;	Inflows to underground mine and open-cut pit workings will result in drawdown of groundwater resources. Predicted inflow rates and descriptions of predicted drawdowns are presented in Section 21.11.4.2. At the end of mining, recovery of groundwater resources to 95 % of final equilibrium is predicted to occur after 270 years (above the northern longwall panels) and 135 years above the southern longwall panels, as described in Section 21.11.4.2. Groundwater drawdown is predicted to impact one potential groundwater bore and a make good arrangement with the owner will be arranged as required. No Project impacts to the Great Artesian Basin will occur. Changes in the quantity of local groundwater availability are not expected to be significant.
Changes in the integrity of hydrological or hydroecological connections, including substantial structural damage (e.g. large scale subsidence); or	Connections between aquifers and the recovery of groundwater levels is described in Section 21.11.4.2. Groundwater recovery is predicted to occur in as identified above. Impacts on groundwater hydroecological connections are assessed in Section 21.14.5 and 21.15.3. No impacts to GDEs are predicted, with ongoing monitoring proposed to validate assessment outcomes. Subsidence-induced surface cracking will occur as a result of the Project, however, no connectivity of cracking will exist between the surface and seam. Significant changes to hydrological and hydroecological 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 21.10.4.2. Changes to groundwater are not predicted to impact groundwater dependent ecosystems (refer Section 21.14.5 and 21.15.3) with ongoing monitoring proposed to validate assessment outcomes. Significant changes in the area or extent of groundwater resources are considered unlikely to occur.
Conclusion	The predicted changes to groundwater quantity, extents of aquifers and aquifer connections, groundwater drawdown and recoveries indicate the Project is unlikely to have a significant impact on groundwater hydrological characteristics.

21.11.7.2 Potential impacts to groundwater quality

Assessment of impacts to local and regional groundwater according to guidance provided by the significant impact criteria (DoE 2013) is shown in Table 21.31.

Table 21.31: Assessment of significant impact on changes to groundwater quality

Significant impact guidance	Assessment of significance
There is a risk that the ability to achieve relevant local or regional water quality objectives will be materially compromised, and as a result of 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, or;	The Project is not predicted to impact groundwater quality. During operation, groundwater will inflow to the underground mine and open-cut pit (described Section 21.11.4.2) with this water to be managed within the Project water management system described in Section 21.9.7). The rehabilitated open-cut pit final landform will be subject to intermittent ponding but will not be a permanent water storage, nor salt accumulating feature, and is therefore not expected to impact groundwater quality (refer Section 21.11.4.2). The Project is therefore unlikely to materially compromise local or regional water quality objectives.
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 local water quality is comparable to regional water quality objectives (Section 21.11.2). The Project is not predicted to impact local groundwater quality (refer Section 21.11.4.2). A significant worsening of local water quality is therefore unlikely to occur as a result of the Project.
High quality water is released into an ecosystem which is adapted to a lower quality of water.	The Project water management system will be a closed system designed to prevent any releases of mine affected water to the receiving environment. Similarly, no high-quality water will be released by the Project, such as into an ecosystem which is adapted to a lower quality of water.
Conclusion	The predicted groundwater quality and ability of groundwater to continue to meet WQOs indicate the Project is unlikely to have a significant impact on groundwater hydrological characteristics.

21.12 Terrestrial ecology

21.12.1 Methodology

21.12.1.1 Study area

The terrestrial ecology study area comprises the MLA area for the Project, being a portion of MDL 303 and MDL 429 (Figure 21.10) and an area of land to the south of the MLA within the existing Lake Vermont Mine (within ML 70477 and ML 70528). The land within the MLA is owned by the proponent and is the proposed location of the mining activity, with the land within the existing MLs the proposed location for a section of the infrastructure corridor. The MLA is used for grazing and maintained partially as cleared agricultural areas and vegetated woodland.

21.12.1.2 Desktop assessment

A desktop assessment has been undertaken to identify and present the ecological values mapped to exist within the terrestrial ecology study area. The desktop assessment included a review of Commonwealth and State databases and mapping, literature reviews, ecology assessments from the existing Lake Vermont operations, ecological assessment from surrounding projects and aerial photographs. Searches were undertaken within a 50 km buffer on the EPBC Act Protected Matters Search Tool and the DES Wildlife Online search and WildNet Wildlife Records. The results of the desktop assessment (described in Appendix G, Terrestrial Ecology Assessment, section 6) informed the field survey design and methodology.

Threatened ecological communities

In Australia, three categories exist for the listing of Threatened Ecological Communities (TECs) under the EPBC Act; they are:

- Critically Endangered;
- Endangered; and
- Vulnerable.

Five communities listed as Endangered under the EPBC Act have been identified as potentially occurring within the study area or surrounds, namely:

1) Brigalow (*Acacia harpophylla* dominant and co-dominant) Endangered Ecological Community (EEC);
2) Poplar Box Grassy Woodland on Alluvial Plains EEC;
3) Natural grasslands of the Queensland Central Highlands and northern Fitzroy Basin EEC;
4) Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions EEC; and
5) Weeping Myall Woodlands EEC.

No TECs listed as Critically Endangered or Vulnerable have been identified within the study area or surrounds.

A number of REs mapped by the Queensland Government within the study area potentially represent TECs. RE 11.3.1, RE 11.4.8 and RE 11.4.9 have the potential to represent the Brigalow EEC while RE 11.3.2 has the potential to represent the Poplar Box EEC or the Weeping Myall Woodlands EEC.

The following REs are known to be associated with the Natural Grasslands EEC: RE 11.3.21, RE 11.4.4, RE 11.4.11, RE 11.8.11, RE 11.9.3, RE 11.9.12 and RE 11.11.17 (TSSC 2009). While none of these REs are mapped by the Queensland Government within the study area, the TEC has been mapped as occurring at the Winchester South Project to the north and within the Saraji East study area to the west.

The following REs are known to be associated with the Semi-evergreen Vine Thickets EEC: RE 11.2.3, RE 11.3.11, RE 11.4.1, RE 11.5.15, RE 11.8.3, RE 11.8.6, RE 11.8.13, RE 11.9.4, RE 11.9.8 and RE 11.11.18 (DAWE 2021). None of these REs are mapped by the Queensland Government within the study area, and the desktop assessment of ecological studies have not recorded this TEC as being present.

As described in Section 21.12.1.3, field surveys have been conducted to ground-truth and assess the vegetation of the study area to determine the presence and extent of any TECs.

Threatened flora and fauna species

Four flora and 12 fauna species listed as Critically Endangered, Endangered or Vulnerable under the EPBC Act have been identified by the desktop assessment as having known records within the region (50 km search area) (Table 21.32, Figure 21.83 and Figure 21.84).

Table 21.32: EPBC Act listed Threatened flora and fauna species known records

Family	Scientific Name	Common Name	EPBC Act Status[1,2]
Flora			
Myrtaceae	*Eucalyptus raveretiana*	Black Ironbox	V
Poaceae	*Aristida annua*	Annual Wiregrass	V
Poaceae	*Dichanthium queenslandicum*	King Bluegrass	E
Poaceae	*Dichanthium setosum*	Bluegrass	V
Fauna			
Reptiles			
Elapidae	*Denisonia maculata*	Ornamental Snake	V
Scincidae	*Lerista allanae*	Allan's Lerista	E
Birds			
Accipitridae	*Erythrotriorchis radiatus*	Red Goshawk	V
Apodidae	*Hirundapus caudacutus*	White-throated Needletail	V, Mi
Columbidae	*Geophaps scripta scripta*	Squatter Pigeon (Southern)	V
Falconidae	*Falco hypoleucos*	Grey Falcon	V^
Rostratulidae	*Rostratula australis*	Australian Painted Snipe	E
Mammals			
Dasyuridae	*Dasyurus hallucatus*	Northern Quoll	E
Phascolarctidae	*Phascolarctos cinereus*	Koala	V
Pseudocheiridae	*Petauroides volans*	Greater Glider	V
Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat	V
Vombatidae	*Lasiorhinus krefftii*	Northern Hairy-nosed Wombat	CE

1 CE= Critically Endangered; E = Endangered; V = Vulnerable; Mi = migratory

2 Known records within 50 km of the study area (refer Appendix G, Terrestrial Ecology Assessment, Appendix A and B)

^ The Grey Falcon was listed as threatened under the EPBC Act after the Controlled Action decision for the Project

While not known to be recorded within 50 km of the study area, the Project ToR for MNES (Appendix 3 of the ToR) identified a number of additional threatened flora and fauna species requiring consideration and assessment. A description of each threatened flora and fauna species' distribution, habitat, and ecology, and an assessment of their likelihood of occurrence is provided in Likelihood of occurrence tables for flora and fauna, appendices of the Terrestrial Ecology Assessment (Appendix G, Terrestrial Ecology Assessment, Appendix D and E).

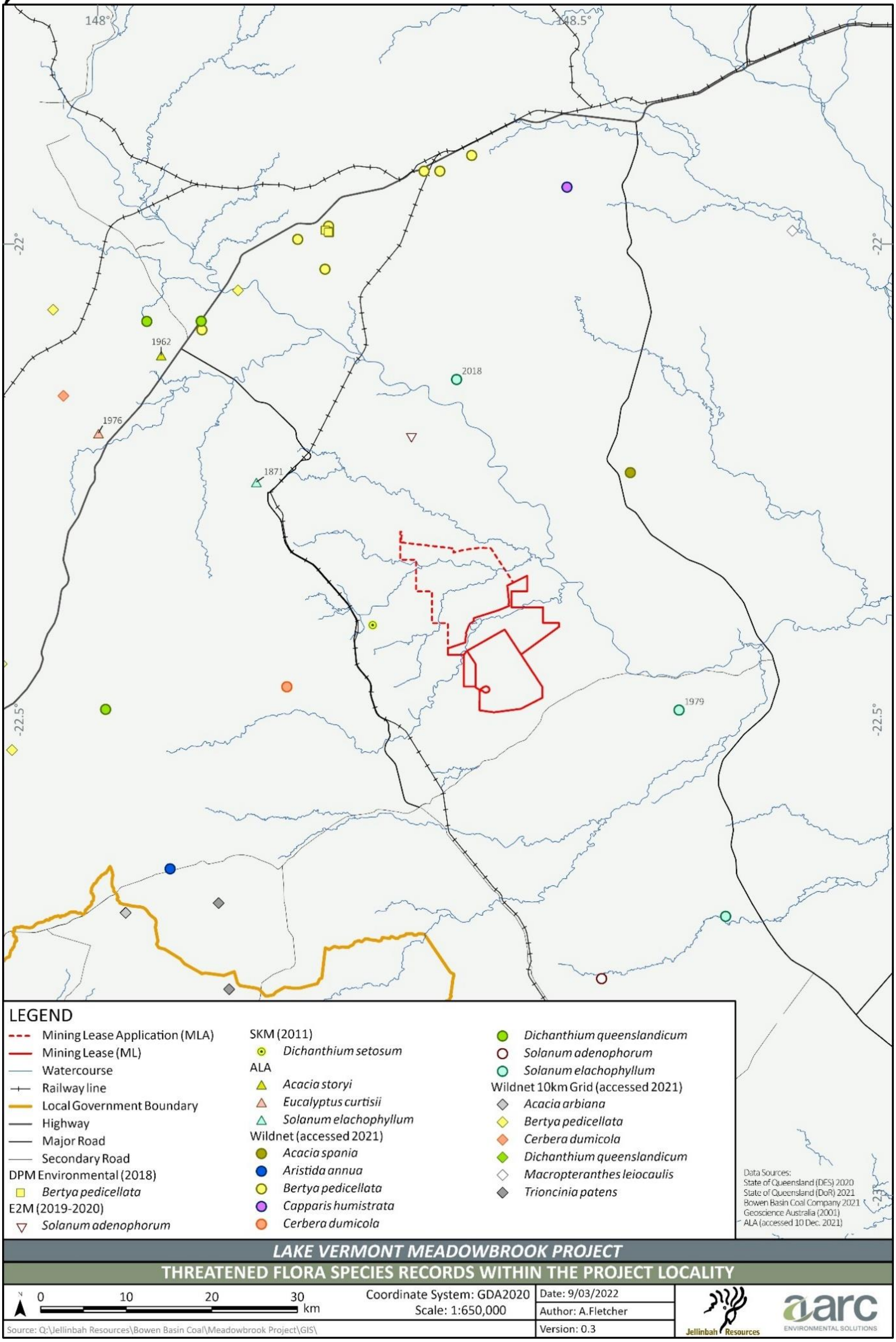

Figure 21.83: Threatened flora species records within the Project locality

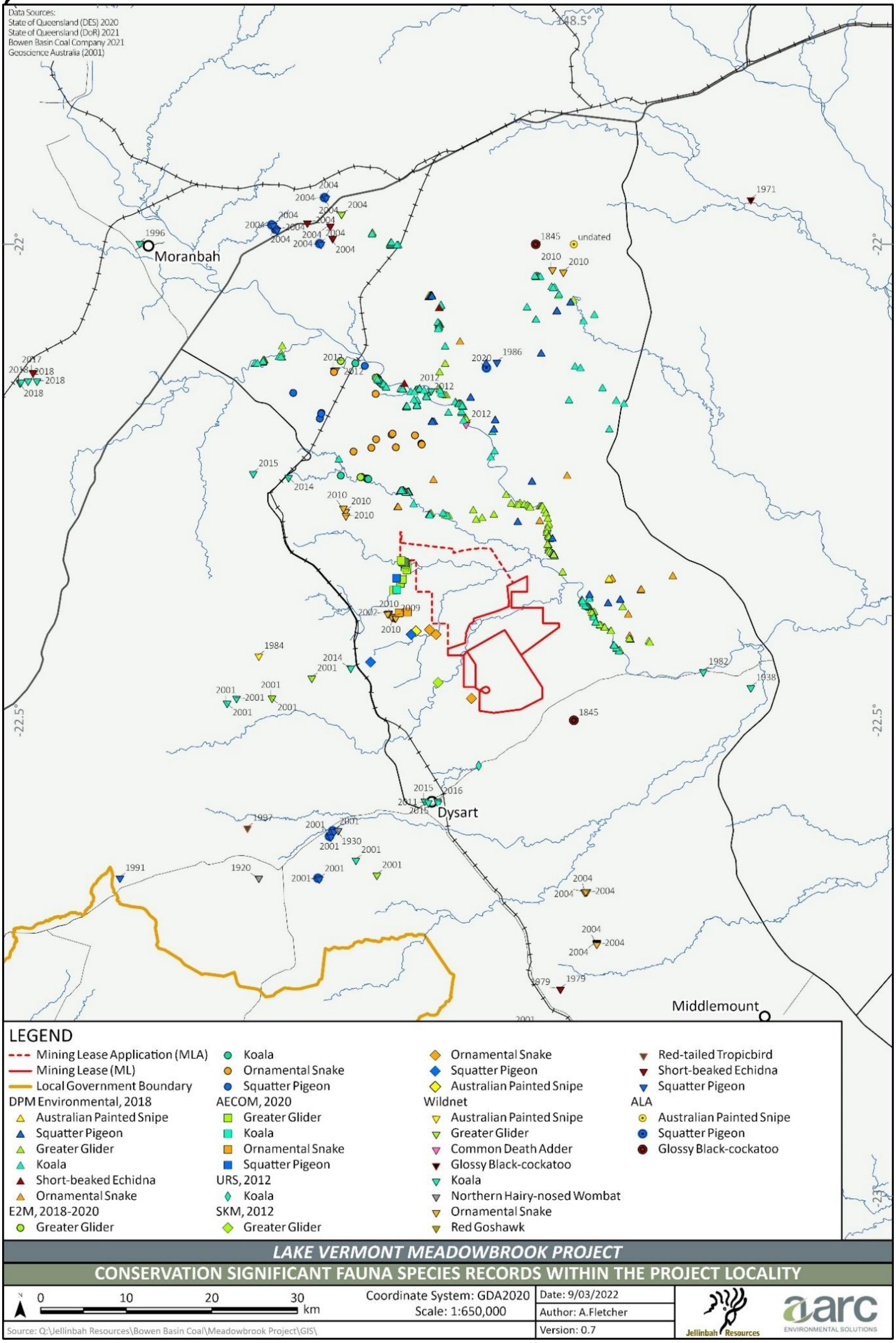

Figure 21.84: Conservation significant fauna species records within the Project locality

Migratory species

Eighteen species listed as migratory under the EPBC Act have been identified by the desktop assessment as having known records within the wider region (50 km search area) (Table 21.33 and Figure 21.85).

Table 21.33: EPBC Act listed migratory species known records

Family	Scientific Name	Common Name	EPBC Act Status[1,2]
Birds			
Accipitridae	*Pandion cristatus*	Eastern Osprey	Mi
Apodidae	*Apus pacificus*	Fork-tailed Swift	Mi
Apodidae	*Hirundapus caudacutus*	White-throated Needletail	V, Mi
Laridae	*Gelochelidon nilotica*	Gull-billed Tern	Mi
Laridae	*Hydroprogne caspia*	Caspian Tern	Mi
Monarchidae	*Monarcha melanopsis*	Black-faced Monarch	Mi
Monarchidae	*Symposiachrus trivirgatus*	Spectacled Monarch	Mi
Muscicapidae	*Myiagra cyanoleuca*	Satin Flycatcher	Mi
Phaethontidae	*Phaethon rubricauda*	Red-tailed Tropicbird	Mi
Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail	Mi
Rostratulidae	*Rostratula australis*	Australian Painted Snipe	E, Mi
Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	Mi
Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper	Mi
Scolopacidae	*Calidris ruficollis*	Red-necked Stint	Mi
Scolopacidae	*Gallinago hardwickii*	Latham's Snipe	Mi
Scolopacidae	*Tringa nebularia*	Greenshank	Mi
Scolopacidae	*Tringa stagnatilis*	Marsh Sandpiper	Mi
Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis	Mi

1 V = Vulnerable; E = Endangered, Mi = migratory

2 Known records within 50 km of the study area (refer Appendix G, Terrestrial Ecology Assessment, Appendix A and B)

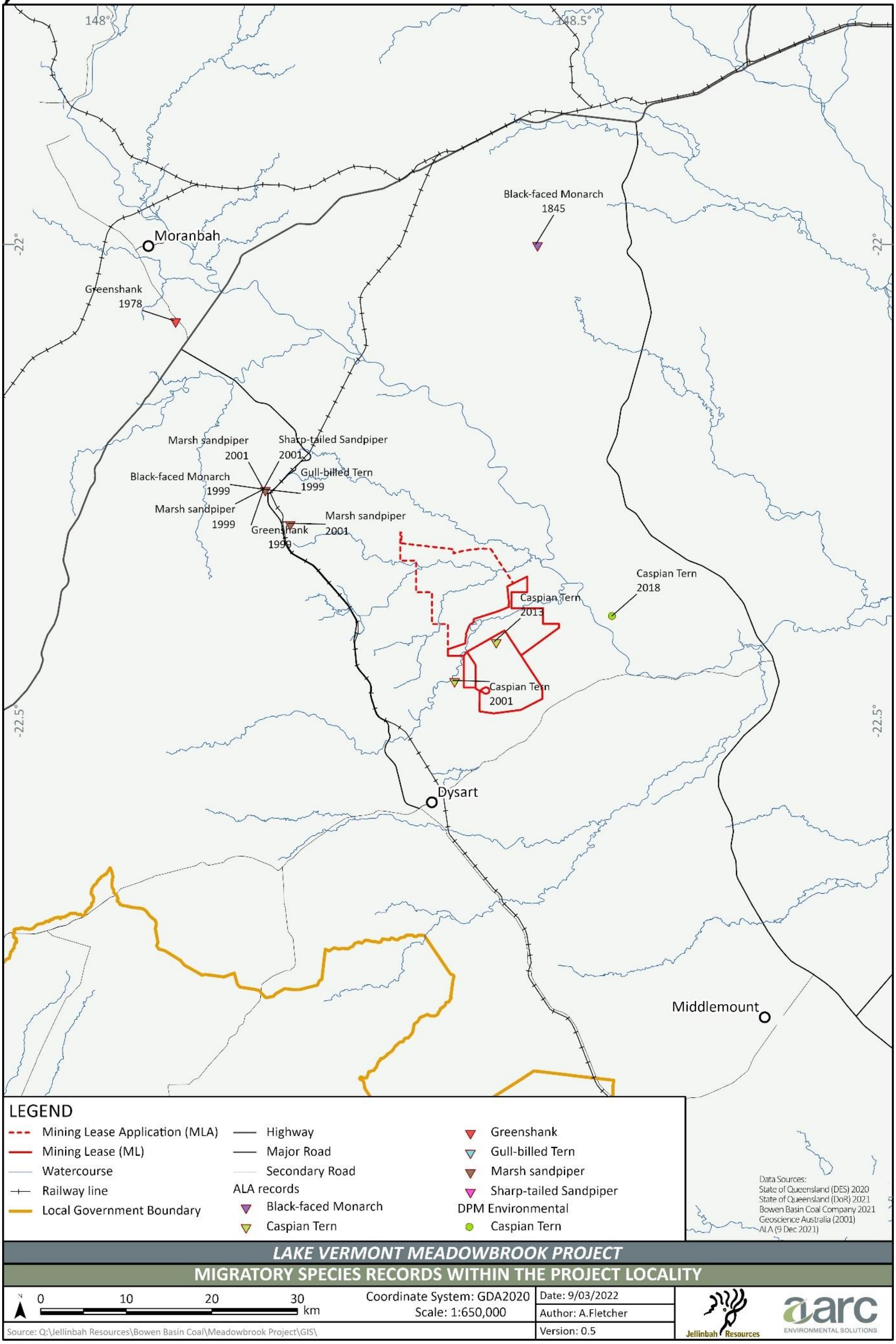

Figure 21.85: Migratory species records within the Project locality

While not known to be recorded within 50 km of the study area, the Project ToR for MNES (Appendix 3 of the ToR) identified four additional migratory species requiring consideration and assessment, namely the:

- Oriental Cuckoo;
- Yellow Wagtail;
- Curlew Sandpiper; and
- Pectoral Sandpiper.

A description of each migratory species' distribution, habitat, ecology and an assessment of their likelihood of occurrence is provided in Appendix G, Terrestrial Ecology Assessment (section 6.2.2).

Conservation significant species likelihood of occurrence

Conservation significant species identified by the desktop assessment have been assigned a likelihood of occurrence based on the criteria provided in Table 21.34. The likelihood assessment is based on the knowledge of ecologists, species' distribution, potential habitat suitability, known records and scientific literature and is provided in Table 21.35 (flora) and Table 21.36 (fauna).

Table 21.34: Criteria adopted for likelihood of occurrence determination

Likelihood of occurrence	Criteria
Known	There are confirmed species records within the study area*.
Likely	Preferred habitat occurs within the study area. There are confirmed species records in the nearby surrounds; however, the species is not yet confirmed as occurring within the study area.
Potential	Potential habitat may occur within the study area, and the species is known to occur in the wider surrounds.
Unlikely	Due to a lack of suitable habitat within the study area and/or the absence of records from the wider surrounds, the species is considered to have a low likelihood of occurring within the study area.

*Note: The likelihood assessment has been conducted in consideration of the desktop assessment and prior to the field survey.

Conservation significant flora and fauna species identified by the desktop assessment and assessed for likelihood of occurrence informed the design of the Project field surveys.

Table 21.35: Flora species of conservation significance likelihood of occurrence

Species	Status		Description	Desktop Likelihood of Occurrence
	NC Act[1]	EPBC Act[2]		
Cerbera dumicola	NT	–	**Distribution** *C. dumicola* occurs across a range of habitats in central coastal and sub-coastal Queensland with a few populations in central Queensland. The northern populations are located 23 km south-west of Charters Towers and the most southern population occurs at Baralaba (Queensland Government 2019). **Habitat** Associated vegetation and species include: sandstone hills in open *Eucalyptus umbra subsp. carnea*; on plateaus, in woodland of *Acacia shirleyi* with *Corymbia dolichocarpa*; acidic soils in mine rehabilitation area; woodland of *A. catenulata* and *A. shirleyi* with *E. thozetiana* on a slope of sand/clay soil; semi-deciduous notophyll-microphyll vine forest of *Brachychiton australis, Gyrocarpus americanus, Flindersia australis, Pleiogynium timorense, Drypetes deplanchei* and *Sterculia quadrifida* on rhyolite hillslopes; open woodland of *E. melanophloia* with occasional *Acacia shirleyi, E. populnea* and *E. brownii;* semi-evergreen vine thicket with *Corymbia citriodora* and *Corymbia aureola* emergents; woodland of *A. rhodoxylon* on brown, sandy loam; and in *Corymbia tessellaris - Acacia aneura* open woodland (Queensland Government 2019). **Ecology** This species has been recorded flowering in October (Queensland Government 2019).	<u>Potential</u> Potential habitat may occur within the study area and there are records for the species within 50 km.
Peak Downs Daisy *Trioncinia patens*	CE	–	**Distribution** This species is known only from three locations, all locations are on the toe-slopes of peaks in and near the Peak Range National Park between Claremont and Dysart in central Queensland (Queensland Government 2019). **Habitat** *T. patens* occurs in Eucalypt woodland (*Eucalyptus orgadophila, E. crebra, E. melanophloia* and *Corymbia erythrophloia*) on basalt-derived dark-grey to red-brown clays or clay loams, often with some surface gravel (Queensland Government 2019). **Ecology** This species has been recorded flowering and fruiting in January and February (Queensland Government 2019).	<u>Unlikely</u> Potential habitat (basalt-derived dark-grey to red-brown clays or clay loams) unlikely to occur, and given this species' restricted distribution, is unlikely to be present within the study area.

Species	Status		Description	Desktop Likelihood of Occurrence
	NC Act[1]	EPBC Act[2]		
Capparis humistrata	E	—	**Distribution** *C. humistrata* is endemic to central-eastern Queensland and occurs between Marlborough and Bouldercombe (Queensland Government 2019). This species has also been recorded further north near Dingo in Central Queensland (Queensland Government 2019). **Habitat** This species is known to occur in Eucalypt woodlands with a shrubby understorey, on stony hard ridges and serpentinite soil (Queensland Government 2019). **Ecology** Flowers have been recorded in March, May and December, and fruits have been recorded in November and December.	Unlikely Potential habitat (i.e. stony hard ridges and serpentinite soils) is unlikely to occur within the study area.
Marlborough Blue# *Cycas ophiolitica*	E	E	**Distribution** Marlborough Blue is endemic to Queensland, occurring from Marlborough to Rockhampton in central-eastern Queensland (DoEE 2019c). **Habitat** It inhabits eucalypt open forest and woodland communities with a grassy understorey (Queensland Government 2019). The species occurs on hill tops or steep slopes, at altitudes of 80 to 620 m above sea level, growing on infertile, shallow, stony, red clay loams or sandy soils (Queensland Government 2019, DoEE 2019c). It occurs in association with *Corymbia dallachiana, C. erythrophloia, C. xanthope* and *Eucalyptus fibrosa* (DoEE 2019c). **Ecology** Marlborough Blue occurs in areas that are subjected to periodic fires of varying intensities, with hot, humid summers and mild, dry winters (DoEE 2019c). It is pollinated by small beetles (DoEE 2019c, Queensland Government 2019), and seeds may be dispersed by mammals such as possums, rodents or fruit bats (DoEE 2019c). This species has a limited dispersal ability due to seed toxicity and the lack of vertebrate dispersers within its range (DoEE 2019c).	Unlikely Potential habitat unlikely to occur and there are no records for this species within 50 km of the study area.

Species	Status		Description	Desktop Likelihood of Occurrence
	NC Act[1]	EPBC Act[2]		
Macropteranthes leiocaulis	NT		**Distribution** This species is known from Central East Queensland, and from Mingela Bluff south of Townsville to Binjour Plateau west of Maryborough (ANBG 2019). **Habitat** *M. leiocaulis* is known to occur in dry rainforest and vine thicket communities (ANBG 2019). This species has been collected in semi-evergreen vine thickets and vine scrub (AVH 2019). **Ecology** This species occurs as a small shrub or tree up to 25 m high (ANBG 2019). This species is deciduous and has been recorded with prostrate coppiced growth (ANBG 2019). Fruit has been recorded from April through to September, with flowers recorded in September (AVH 2019).	Unlikely Potential habitat (semi-evergreen vine thickets and vine scrub) unlikely to occur within the study area.
Bertya pedicellata	NT	—	**Distribution** This species is confined to central and south-east Queensland, from near Aramac eastwards to Rockhampton and south to near Biggenden (Queensland Government 2019), with an isolated record from the Warwick district. **Habitat** *B. pedicellata* grows on rocky hillsides in range of community types, including Eucalypt forest or woodland, *Acacia* woodland or shrubland and open heathland or vine thicket communities (Queensland Government 2019). The soils on which this species grow on are mainly skeletal to shallow sandy, sandy clay or clay loams overlaying rhyolite, trachyte or sandstone substrates (Queensland Government 2019). **Ecology** This species has been recorded flowering from March to November and fruits from August to November (Queensland Government 2019).	Potential Potential habitat may occur within the study area, and there are records for the species within 50 km. This species has been recorded by surveys conducted for the Olive Downs Project and Isaac Plains East Project.

Species	Status		Description	Desktop Likelihood of Occurrence
	NC Act[1]	EPBC Act[2]		
Tony's Wattle *Acacia arbiana*	NT	-	**Distribution** Restricted to the summits of several mountains within the Peak Range (Ropers and Scotts Peak), and potentially on other peaks of the Peak Range east of Clermont, Queensland (World Wide Wattle 2019). **Habitat** This species has been recorded in trachyte outcrops in heath-like vegetation. Tony's Wattle has been found among heath-like vegetation communities growing in rocky soils (ALA 2019). **Ecology** Flowering for this species occurs from July to August (World Wide Wattle 2019).	Unlikely Potential habitat unlikely to occur and given this species' restricted distribution, is unlikely to occur within the study area.
Western Rosewood *Acacia spania*	NT	-	**Distribution** This species has been recorded from 68 km north of Aramac to as far south as Roma (Queensland Government 2019). This species has been recorded within the Idalia National Park and the Bundoora State Forest, and within remnant vegetation and non-remnant vegetation. **Habitat** This species grows mostly on rocky sandstone ridges and hills in sandy to loamy soils in Eucalypt or *Acacia* dominated woodland communities (Queensland Government 2019). Altitudinal range from 400 to 600 m (Queensland Government 2019). **Ecology** Flowering occurs in August-September (Queensland Government 2019).	Unlikely Potential habitat unlikely to occur and the study area is not within the typical altitude and range of this species.
Blackdown Wattle *Acacia storyi*	NT	-	**Distribution** Majority of populations of this species occur within the Blackdown Tablelands National Park (Queensland Government 2019). Three populations occur outside of the Blackdown Tablelands National Park in Rockland Spring, upper Davy Creek at the foot slopes of Expedition Range, 30 km north-east of Woorabinda (Queensland Government 2019).	Unlikely Potential habitat (sandstone plateaus and sandy/shallow skeletal soils over sandstone) unlikely to occur within the study area.

Species	Status		Description	Desktop Likelihood of Occurrence
	NC Act[1]	EPBC Act[2]		
			Habitat This species grows on sandstone plateaus, and on sandy and shallow skeletal soils over sandstone (Queensland Government 2019). Blackdown Wattle occurs in open forests or within tall open forests. This species occurs in association with *Eucalyptus tereticornis* and *Aristida spp.; E. hendersonii, E. cloeziana, E. melanoleuca* and *E. propinqua* (Queensland Government 2019). **Ecology** This species has been recorded flowering from April to September and maturing pods from August to December (Queensland Government 2019).	
Black Ironbox *Eucalyptus raveretiana*	LC	V	**Distribution** This species occurs in scattered and disjunct populations in central coastal and sub-coastal Queensland (Queensland Government 2019). It has been recorded from Charters Towers and Ayr and south to Rockhampton (Queensland Government 2019). **Habitat** Occurs on alluvial soils, loams, light clays or cracking clays in open forests and woodlands along watercourses and occasionally on river flats (Queensland Government 2019). Associated alluvial soils include sands, loams, light clays, and cracking clays (Queensland Government 2019). This species prefers areas with moderately fertile soil and suitable sub-soil moisture levels (Queensland Government 2019). **Ecology** This species has been recorded flowering from December to March (Queensland Government 2019). Black Ironbox is considered a fast-growing species (Queensland Government 2019).	<u>Potential</u> Potential habitat may occur within the study area and there are records for the species within 50 km.
Annual Wiregrass *Aristida annua*	V	V	**Distribution** Annual Wiregrass is restricted to Emerald and Springsure districts within central Queensland (DoEE 2019c, DoE 2014c). It occurs within the Brigalow Belt North and Brigalow Belt South IBRA Bioregions (DoE 2014c). **Habitat** This species is restricted to Eucalypt woodland on black clay and basalt soils, and possible disturbed sites (DoEE 2019c, DoE 2014c). It is known to occur within the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin ecological community (DoEE 2019c, DoE 2014c).	<u>Potential</u> Potential habitat may occur within the study area and there are records for the species within 50 km.

Species	Status		Description	Desktop Likelihood of Occurrence
	NC Act[1]	EPBC Act[2]		
			Ecology Annual Wiregrass flowers between March and June (DoEE 2019c).	
King Bluegrass *Dichanthium queenslandicum*	V	E	**Distribution** King Bluegrass is endemic to Queensland, occurring from Dalby north to approximately 90 km north of Hughenden and to Clermont in the west, in three disjunct populations (Queensland Government 2019, DSEWPaC 2013b). **Habitat** This species occurs on black cracking clay soils in tussock grasslands mainly in association with other species of Bluegrasses (TSSC 2013a, Queensland Government 2019). It is mostly confined to natural bluegrass grasslands of central and southern Queensland (TSSC 2013a). Other communities where King Bluegrass can be found include *Acacia salicina* thickets in grassland and eucalypt woodlands in association with *Corymbia dallachiana, C. erythrophloia, E. orgadophila* (Queensland Government 2019). **Ecology** Flowering occurs throughout the year, particularly in March (Queensland Government 2019).	<u>Potential</u> Potential habitat may occur within the study area and there are records for the species within 50 km.
Bluegrass *Dichanthium setosum*	LC	V	**Distribution** Bluegrass has been reported from inland New South Wales and Queensland (DoEE 2019c). In Queensland, it has been recorded from the Leichhardt, Morton, North Kennedy and Port Curtis regions (DoEE 2019c). **Habitat** Occurs in grassy woodland and open forests usually dominated by *Acacia* or Eucalypt species. Bluegrass is associated with heavy basaltic black soils and stony red-brown hard-setting loam with clay subsoil. It is found in moderately disturbed areas, such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture (DoEE 2019c, Queensland Government 2019). **Ecology** This plant commences growing in spring, flowers in summers and becomes dormant in late autumn (DoEE 2019c).	<u>Potential</u> Potential habitat may occur within the study area, and the species has been recorded by studies conducted for the Saraji Mine and the Caval Ridge Coal Mine.

Species	Status		Description	Desktop Likelihood of Occurrence
	NC Act[1]	EPBC Act[2]		
Quassia# *Samadera bidwillii*	V	V	**Distribution** Quassia is endemic to Queensland occurring in several localities between Scawfell Island, near Mackay, and Goomboorian, north of Gympie (DoEE 2019c). This species occurs within the Burnett Mary, Fitzroy, Mackay Whitsunday, and Burdekin Natural Resource Management Regions (DoEE 2019c). **Habitat** This species occurs in lowland rainforest often in association with *Araucaria cunninghamii* or on rainforest margins, also commonly found in areas adjacent to both temporary and permanent watercourses (Queensland Government 2019, DoEE 2019c). It can also be found in open forest and woodland in locations up to 510 m in altitude (DoEE 2019c). Spotted Gum (*Corymbia citriodora*), Grey Gum (*Eucalyptus propinqua*), White Mahogany (*E. acmenoides*), Forest Red Gum (*E. tereticornis*), Pink Bloodwood (*C. intermedia*), Ironbark (*E. siderophloia*), Gum Topped Box (*E. moluccana*), Gympie Messmate (*E. cloeziana*) and Broad-leaved Ironbark (*E. fibrosa)* are commonly associated tree species that occur in association with Quassia in open forest/woodland habitat types (Queensland Government 2019). **Ecology** Flowering occurs from November – March (DoEE 2019c).	<u>Unlikely</u> Based on habitat requirements, potential habitat unlikely to occur, and there are no records of the species within 50 km of the study area.
Solanum adenophorum	E	—	**Distribution** This species is endemic to the Dingo/Nebo/Clermont area in central-eastern Queensland. **Habitat** *S. adenophorum* occurs mostly in Brigalow woodland and on very gently inclined slopes (Queensland Government 2019). It also occurs in Gidgee (*Acacia cambagei*) scrub on deep cracking clay soils (Queensland Government 2019). **Ecology** *S. adenophorum* flowers in October with mature fruit recorded in May, September and October (Queensland Government 2019).	<u>Potential</u> Potential habitat may occur within the study area and there are records for the species within 50 km.

Species	Status		Description	Desktop Likelihood of Occurrence
	NC Act[1]	EPBC Act[2]		
Solanum elachophyllum	E	—	**Distribution** This species has been recorded in areas from south-west of Mackay to south-west of Gladstone (Queensland Government 2019). **Habitat** *S. elachophyllum* grows on fertile cracking clay soils in open forest of *Eucalyptus thozetiana, Acacia harpophylla*, with understorey of *Geijera parviflora*, *Casuarina cristata, Macropteranthes leichhardtii, E. cambageana*, or woodland of *E. creba* and *E. tenuipes* (Queensland Government 2019). **Ecology** This species has been recorded flowering in February, March, July and September and mature fruits have been recorded in March to May, July and September to October (Queensland Government 2019).	Potential Potential habitat may occur within the study area and there are records for the species within 50 km.
Daviesia discolor	V	V	**Distribution** This species is known from three widely disjunct localities in Queensland, near Blackwater on the Blackdown Tableland, in the Mount Walsh area near Biggenden (Crisp 1991) and north of Mount Playfair within Carnarvon National Park. **Habitat** *Daviesia discolor* occurs from coastal hills to mountain slopes and ridges, 50–1100 m in altitude, mostly on fine-textured soils, which may be derived from acid volcanic or metamorphic rocks. On the Blackdown Tableland, *D. discolor* occurs on sandy soil derived from sandstone and on lateritic clay, at altitudes of 600 to 900 m, in open eucalypt forest dominated by species such as Blackdown Stringybark (*E. sphaerocarpa*) and Black Stringybark (*E. nigra*). In the Mount Walsh area, *D. discolor* grows in very tall open forests of Bloodwood (*Corymbia trachyphloia*) and White Mahogany (*E. acmenoides*) on hillcrests and slopes at 500 to 580 m altitude on well drained, shallow sandy loam to sandy clays. The population in Carnarvon National Park occurs on brown sandy loam of creek banks, in mixed shrubland with scattered *Triodia sp*. hummocks and *Angophora sp*. trees (DoEE 2019c). **Ecology** This species has been recorded flowering from August to October (DoEE 2019c).	Unlikely Based on habitat requirements and known distribution of this species, potential habitat is unlikely to occur within the study area.

Table 21.36: Fauna species of conservation significance likelihood of occurrence

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	**NC Act[3]**		
Reptiles				
Common Death Adder *Acanthophis antarcticus*	—	V	**Distribution** This species is known to occur from central Queensland through New South Wales to the southern parts of South Australia and Western Australia (Queensland Government 2019). It is found over a large area of Queensland from Brisbane to Cooktown, with most records held within the south-east (Rowland and Ferguson 2012). **Habitat** Areas that are well drained with a deep leaf litter layer, including wet sclerophyll forests and rainforests, woodland, shrublands, grasslands and coastal heathlands are preferred habitat types for this species (Queensland Government 2019, Rowland and Ferguson 2012). **Ecology** The Common Death Adder is highly cryptic, spending most of its time sitting motionless hiding under low foliage, leaf litter or loose sand. It is active during the day and night but is mostly active during the night when moving between shelter sites (Queensland Government 2019). This species prefers areas that contain a dense groundcover layer (leaves, foliage, sand) to lure in its prey (insects, frogs, lizards, birds, and small mammals). It is an ambush predator waiting until its prey are in range before striking (Queensland Government 2019). Breeding occurs in spring with live young born between February and March every second year (Queensland Government 2019). It is not known to have specific breeding habitat requirements. The Common Death Adder is a sedentary terrestrial snake (Queensland Government 2019). It is most active during the breeding season (September to March) (Queensland Museum 2019), in the warmer months of the year and at night when moving between shelter sites (Rowland and Ferguson 2012).	Potential A dead specimen of the Common Death Adder has been recorded by surveys conducted for the Arrow Bowen Gas Project in 2011 (and reported in the Olive Downs Coking Coal Project EIS). However, none of the recent extensive nearby fauna surveys (Olive Downs, Saraji East, Winchester South) have recorded this species.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
Ornamental Snake *Denisonia maculata*	V	V	**Distribution** This species is sparsely distributed throughout its range and is known only from the Brigalow Belt North and parts of the Brigalow Belt South biogeographical regions (DoE 2014a, DoEE 2019c). The drainage system of the Fitzroy and Dawson Rivers are core areas associated with this species distribution (DoEE 2019c). **Habitat** The Ornamental Snake's preferred habitat is within, or close to, habitat that is preferred by its prey (frogs) (DoEE 2019c). This species is known to prefer woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions in Queensland Regional Ecosystem Land Zone 4, as well as lake margins and wetlands (DoEE 2019c). The vegetation communities associated with this species habitat include Brigalow (*Acacia harpophylla*), Gidgee (*Acacia cambagei*), Blackwood (*Acacia argyrodendron*) or Coolibah (*Eucalyptus coolabah*), or grassland associated with gilgais (DoEE 2019c). In Queensland, it has been recorded in Queensland Regional Ecosystems 11.4.3, 11.4.6, 11.4.8 and 11.4.9, 11.3.3 and 11.5.16 (DoEE 2019c). This species has been recorded in abundance at sites that contain the following microhabitat features; in shallow water where some aquatic vegetation is present or in flooded gilgais where the fringing groundcover has been inundated, where there is a diverse range of gilgai size and depth, in soils of high clay content and deep cracking, ground debris, and in habitat patches greater than 10 ha in area connected to or within large areas of remnant vegetation (DoEE 2019c). **Ecology** The Ornamental Snake seeks refuge within soil cracks within gilgai mounds during dry periods. This species is nocturnally active predominantly in early summer throughout the wet season (DoEE 2019c), foraging in areas where burrowing frogs are abundant, with frogs being the main food source (DoEE 2019c). It is not known to have specific breeding or dispersal habitat requirements (DoEE 2019c).	Likely Preferred habitat occurs within the study area. This species has been recorded by a number of surveys conducted for Projects in the nearby surrounds (Olive Downs Project, Saraji, Winchester South) and wider region (e.g. Caval Ridge and Isaac Plains East) (Appendix G, Terrestrial Ecology Assessment, section 9.2.2).
Dunmall's Snake[#] *Furina dunmalli*	V	V	**Distribution** This species occurs from near the Queensland border throughout the Brigalow Belt South and Nandewar bioregions, and as far south as Ashford in New South Wales (DoEE 2019c). In Queensland, the Dunmall's Snake is primarily found in the Brigalow Belt region approximately 200-500m asl (DoEE 2019c, DoE 2014e).	Unlikely Potential habitat may occur; however, there are no records for this species within 50 km of the study area

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Habitat The Dunmall's Snake can occur in a broad range of habitat types, including forests to woodlands on black alluvial cracking clay/clay loams (DoEE 2019c). Dominant vegetation associated with these habitat types include Brigalow (*Acacia harpophylla*), Wattles (*A. burowii*, *A. deanii, A. leioclyx*), native Cypress (*Callitris spp*.) or Bull-oak (*Allocasuarina luehmannii*), *Corymbia citriodora*, *Eucalyptus crebra, E. melanophloia* and *Callitris glaucophylla* (DoEE 2019c). This species has been found sheltering beneath litter and fallen timber and may use cracks in the alluvial clay soils (DoEE 2019c, DSEWPaC 2011a). **Ecology** The Dunmall's Snake is an inconspicuous, terrestrial snake that is difficult to detect (DoEE 2019c). It is nocturnally active between sheltering sites at night, with peak activity likely to occur in early summer through to the wet season (DSEWPaC 2011a). This species eats small skinks and geckos.	
Yakka Skink[#] *Egernia rugosa*	V	V	**Distribution** The Yakka Skink has a highly fragmented distribution, limited to Queensland (DoE 2014d, DoEE 2019c). The known distribution of this species extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland (DoEE 2019c, DSEWPaC 2011a), including portions of the Brigalow Belt (North and South), South-east Queensland, Mulga Lands, Einasleigh Uplands, Cape York Peninsula and Wet Tropics Biogeographical Regions (DoEE 2019c). **Habitat** The core habitat for this species is within the Brigalow Belt South and Mulga Lands Bioregions (DoEE 2019c). It occurs in a wide variety of vegetation types including open dry sclerophyll forest, woodland, and scrub (DoEE 2019c). It is known to prefer areas which contain partly buried rocks, logs or tree stumps, root cavities or abandoned animal burrows within these vegetation types, where it occupies burrows and cavities beneath these features (DoEE 2019c, DoE 2014d, DSEWPaC 2011a, Queensland Government 2019, Ferguson and Mathieson 2014). It is not generally found in trees or rocky habitats (DoEE 2019c, Ferguson and Mathieson 2014) and is known to occur in Queensland Regional Ecosystem 11.3.2 (DoEE 2019c). This species is known to take refuge around deep gullies, tunnel erosion/sinkholes, rabbit warrens, raked log piles, sheds and loading ramps in areas where its habitat has been cleared (DoEE 2019c, DoE 2014d, DSEWPaC 2011a).	<u>Unlikely</u> Potential habitat may occur; however, there are no records of the species within 50 km of the study area

<table>
<tr><th rowspan="2">Species</th><th colspan="2">Status</th><th rowspan="2">Description</th><th rowspan="2">Desktop likelihood of occurrence</th></tr>
<tr><th>EPBC Act[1,2]</th><th>NC Act[3]</th></tr>
<tr><td></td><td></td><td></td><td>Ecology

The Yakka Skink is a secretive, terrestrial skink that quickly retreats into its burrow shelter sites if it detects movement or disturbance (Queensland Government 2019, DSEWPaC 2011a). This species is limited in its capacity to disperse from a colony site, and active burrows can be identified by scat piles near the entrance (DoEE 2019c, Queensland Government 2019). It is active during the morning and dusk, through to the early evening (DoEE 2019c), feeding on soft plant materials, fruits and a wide variety of invertebrates that venture into, or near the burrow entrance (DoEE 2019c). It is not known to have specific breeding or dispersal habitat requirements.</td><td></td></tr>
<tr><td>Allan’s Lerista
Lerista allanae</td><td>E</td><td>E</td><td>Distribution

This species is found in three localities in central Queensland comprising of Retro, Logan Downs, and Clermont, based on 13 museum specimens (DoEE 2019c).

Habitat

Only known to occur in the Brigalow Belt North Biogeographic Region on black soil downs (undulating plains formed on basalt, shale, sandstone and unconsolidated sediments) (DoEE 2019c). Earlier records suggest that this species has been found under the surface of black-red soil, under tussocks of grass on farmland (DoEE 2019c) in association with Mountain Coolibah (Eucalyptus orgadophila)/Red Bloodwood (E. erythrophloia) open woodlands and Black Tea-tree (Melaleuca bracteata) closed scrub to low closed-forest gravely hills, ridges and gullies (DoEE 2019c). Recent records are from leaf litter and friable soils beneath trees and shrubs (DSEWPaC 2011a), associated with Queensland Regional Ecosystems 11.8.5 and 11.8.11 (DoEE 2019c).

Ecology

No information is available about the life cycle, reproductive behaviour, movement, diet or feeding habits of the Allan’s Lerista (DoEE 2019c). This species is thought to be nocturnally active, feeding on termites as its primary food source (DoEE 2019c).</td><td><u>Unlikely</u>

There are known records of the species within 50 km of the study area near Clermont; however, based on habitat requirements, potential habitat is unlikely to occur within the study area.</td></tr>
<tr><td colspan="5">Birds</td></tr>
<tr><td>Red Goshawk
Erythrotriorchis radiatus</td><td>V</td><td>E</td><td>Distribution

Endemic to Australia, the Red Goshawk is sparsely dispersed across coastal and sub-coastal Australia, from western Kimberley Division to north-eastern New South Wales, and occasionally on continental islands (DoEE 2019c, TSSC 2015a).</td><td><u>Potential</u>

Potential habitat occurs within the study area, and there are records for the species within 50 km.</td></tr>
</table>

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Three recently confirmed sightings of dispersive individuals suggest that this species also occurs in central Australia, across South-east Queensland to the western slopes of the Great Dividing Range (DERM 2012, DoEE 2019c). **Habitat** The Red Goshawk prefers forest and woodland with a mix of vegetation types, including eucalypt woodland, tall open forest, gallery rainforest, swamp sclerophyll forest, and at the edge of rainforest (DoEE 2019c). In partly cleared areas of eastern Queensland, it is associated with gorge and escarpment country (TSSC 2015a). *E. radiatus* avoids very dense or very open habitats and prefer areas where large prey populations (birds) and permanent water exist (DoEE 2019c). **Ecology** Forests of intermediate density or ecotones between habitats of differing densities (e.g. between rainforest and eucalypt forest, between gallery forest and woodland) are preferred for foraging (DoEE 2019c). This species ambushes its prey when hunting, feeding on medium to large birds (DoEE 2019c). Nests are located within large trees within 1 km of permanent water (DoEE 2019c). Nest trees have been noted to be significantly taller (>20m) than surrounding trees, with larger crown diameters and greater girth at breast height (approx. 2.9m) (DoEE 2019c, TSSC 2015a, DERM 2012, DEWHA 2010a). Movement patterns of the Red Goshawk are poorly known (DoEE 2019c). They have been observed individually, in pairs and in family groups (DEWHA 2010a).	
Osprey *Pandion cristatus* **Pandion haliaetus*	Mi	SLC	**Distribution** The breeding range of the Eastern Osprey extends around the northern coast of Australia (including many offshore islands) from Albany in Western Australia to Lake Macquarie in New South Wales, with a second isolated breeding population on the coast of South Australia (DoEE 2019c). The total range (breeding plus non-breeding) around the northern coast is more widespread and is continuous around this region, except for Eighty Mile Beach (DoEE 2019c). **Habitat** Predominantly occupies coastal and littoral habitats as well as terrestrial wetlands of tropical and temperate Australia and offshore islands. They visit a variety of wetland habitats, including coastal cliffs, beaches, estuaries, inshore waters, reefs, bays, broad rivers, reservoirs, large lakes, and mangrove swamps (DoEE 2019c).	<u>Unlikely</u> Due to a lack of suitable habitat, the Osprey is unlikely to occur within the study area.

<table>
<tr><th rowspan="2">Species</th><th colspan="2">Status</th><th rowspan="2">Description</th><th rowspan="2">Desktop likelihood of occurrence</th></tr>
<tr><th>EPBC Act[1,2]</th><th>NC Act[3]</th></tr>
<tr><td></td><td></td><td></td><td>Ecology

The Eastern Osprey is mostly resident or sedentary around breeding territories, and forage widely outside breeding periods although continue to make intermittent visits to breeding grounds in the non-breeding season (DoEE 2019c). The species occupy large territories that are used for breeding and at least some foraging (DoEE 2019c).

Foraging

The Eastern Osprey require extensive areas of open fresh, brackish or saline water for foraging, which mostly occurs during the day (DoEE 2019c). They mainly feed on fish, diving directly into the water to obtain their prey (DoEE 2019c). This species does not have specific breeding habitat requirements and are known to nest on a variety of natural and artificial sites (trees, cliffs, rocky headland, jetties, lighthouses cranes for example). Eastern Osprey's occupy large territories that are used for breeding and at least some foraging (DoEE 2019c). They forage more widely, continuing to visit their breeding grounds in the non-breeding season (DoEE 2019c).

Dispersal

There is evidence of movement of the species along the Murray River and extensions of range in north-western Western Australia and north-eastern Queensland in autumn and an extension of range inland in north-western Queensland in winter (DoEE 2019c).

*Note: Taxonomy is controversial, with one taxonomic arrangement recognising a single species, Pandion haliaetus, with four subspecies. However, three of the four subspecies (haliaetus, carolinensis and cristatus) proposed as full species based on differences in distribution, morphology and genetics.

The NC Act recognises Pandion cristatus as a full species. The EPBC Act recognises Pandion cristatus, also as a full species, however its listings as Marine and Migratory are linked to Pandion haliaetus.</td><td></td></tr>
<tr><td>Fork-tailed Swift
Apus pacificus</td><td>Mi</td><td>SLC</td><td>Distribution

The Fork-tailed Swift is a non-breeding visitor to all states and territories of Australia (DoEE 2019c). It is widespread throughout Queensland, with sightings common from February to March (DoEE 2019c).

Habitat

This species does not have specific habitat requirements and is found across a range of habitats, from inland open plains to wooded and coastal areas, where it is exclusively aerial (DoE 2015a).</td><td><u>Likely</u>

Potential habitat is likely to occur within the study area. The species has been recorded by nearby studies conducted for the Saraji East Project and Winchester South Project and others in the wider region (e.g. Caval Ridge Coal Mine.)</td></tr>
</table>

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Ecology The Fork-tailed Swift does not breed in Australia, however migrates annually for its non-breeding season (DoEE 2019c). It is thought that this species roosts aerially but are occasionally observed to land (DoEE 2019c). **Foraging** The Fork-tailed Swift forages aerially, up to hundreds of meters above the ground (DoEE 2019c). They often occur in areas of updraughts and along the edges of low-pressure systems eating small bees, wasps, termites and moths (DoEE 2019c). **Dispersal** The Fork-tailed Swift leaves its breeding grounds in Siberia from August -September and arrives in Australia around October (DoEE 2019c). Within Australia large flocks precede or follow low pressure systems as they cross the country in search of food. The species leaves southern Australia from mid-April and departs Darwin by the end of April (DoEE 2019c).	
White-throated Needletail *Hirundapus caudacutus*	V, Mi	V	**Distribution** The White-throated Needletail migrates to Australia during the non-breeding season around September/October (DoEE 2019c, TSSC 2019). During this time, this species is widespread across eastern and south-eastern Australia (DoEE 2019c, TSSC 2019). In eastern Australia, it has been recorded in all coastal regions of Queensland, extending inland to the western slopes of the Great Divide and occasionally onto adjacent inland plains (DoEE 2019c). **Habitat** Primarily an aerial species, this species is known to occur across a variety of habitats, including wooded areas, open forests, and rainforests (DoEE 2019c). Large tracts of native vegetation, particularly forest, is considered likely to be a key habitat requirement for this species (DoE 2015a). It has been observed flying over farmland, typically over partially cleared pasture or within remnant vegetation at the edge of paddocks (DoEE 2019c). **Ecology** The White-throated Needletail does not breed in Australia and forages aerially while in the country. The species is sometiles preyed upon by raptors (DoEE 2019c).	Likely Potential habitat is likely to occur within the study area. The closest record for this species is from studies conducted for the Lake Vermont Mine.

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<tr><td></td><td></td><td></td><td>Foraging

This species predominantly forages aerially at heights up to 'cloud level', along the edges of low-pressure systems (DoEE 2019c). This species is also known to forage much closer to the ground (still aerial) in open habitats or recently disturbed areas (DoE 2019p) feeding on a wide variety of insects (DoEE 2019c). It prefers to roost in forest and woodlands, both among dense foliage in the canopy or in tree hollows, as well as on bark or rock faces, and maybe aerially on occasion (DoEE 2019c, DoE 2015a).

Dispersal

The White-throated Needletail breeds in Asia and makes passage through south-east Asia to spend the non-breeding season in Australia and occasionally New Guinea and New Zealand during September and October (DoEE 2019c). While in Australia the species disperses south along both sides of the Great Divide in QLD and NSW and arrives in the southern parts of their range (Victoria and Tasmania) in November. The species leaves for its migration to breeding grounds between March and April.</td><td></td></tr>
<tr><td>Glossy Black-cockatoo (Northern) Calyptorhynchus lathami erebus</td><td>—</td><td>V</td><td>Distribution

The Glossy Black-cockatoo is known to occur in Queensland, New South Wales, and Victoria (Hourigan 2012). Within Queensland, the distribution of this species ranges from the Dawson-Mackenzie-Isaac Rivers basin, north to the Connors-Clarke Ranges, south to Dawes and Many Peaks Ranges, and inland to the Expedition, Peak and Denham Ranges, including the Blackdown Tableland (Hourigan 2012).
Habitat

This species prefers woodland areas dominated by She-oak Allocasuarina or open sclerophyll forests and woodlands with a stratum of Allocasuarina beneath Eucalyptus, Corymbia or Angophora (Hourigan 2012). It has also been observed in mixed vegetation communities consisting of Allocasuarina, Casuarina, Cypress (Callitris) and Brigalow (Acacia harpophylla) (Hourigan 2012).
Ecology

Feeding exclusively on the seeds of nine Allocasuarina and Casuarina species, the Glossy Black-cockatoo shows a strong preference to certain feed trees, returning to selected trees over consecutive years (Hourigan 2012). It feeds within these trees, dropping the chewed remains of seed cones, twigs and leaves beneath when feeding (Hourigan 2012).

Nesting sites occur in areas that contain large old trees (living or dead) usually in eucalyptus trees for breeding (Hourigan 2012). It is an obligate hollow nester, requiring hollows that are usually between 10-20 m above ground, in vertical or near vertical branches, stems, and spouts, or in trunk cavities</td><td><u>Potential</u>

Potential habitat may occur within the study area, and there are records for the species within the wider surrounds.</td></tr>
</table>

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			(Hourigan 2012). They will often nest near other breeding pairs, using the same nest over consecutive years during the breeding season (Hourigan 2012). Outside the breeding season, the Glossy Black-cockatoo will roost communally in groups of up to 40 individuals in live trees (Hourigan 2012). Seasonal movements might occur more frequently in areas where resources (feeding and breeding requirements) are more dispersed, or in response to dry conditions (Hourigan 2012). The peak breeding season occurs from March to August in South-east Queensland (Hourigan 2012).	
Squatter Pigeon (Southern) *Geophaps scripta scripta*	V	V	**Distribution** The southern sub species for the Squatter Pigeon occurs on the inland slopes of the Great Dividing Range. Its range extends from the Burdekin-Lynd Divide in central Queensland in the southern region of Cape York Peninsula to the Border Rivers region of northern New South Wales, and from the east coast to Hughenden, Longreach and Charleville in Queensland (DoEE 2019c, TSSC 2015b). **Habitat** Defined as open forests to sparse, open-woodlands and scrub, this species inhabits the grassy understory of open eucalypt woodland (TSSC 2015b, DEWHA 2010a). Sandy areas separated by gravel ridges, which have open and short grass cover allowing easier movement, are preferred (TSSC 2015b). Important microhabitat features include vegetation that is within 3 km of water bodies or courses, within remnant, regrowth or partly modified vegetation communities and areas that are mostly dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species within the overstorey (DoEE 2019c). **Ecology** Natural foraging habitat for this species occurs in any remnant or regrowth open forest to sparse, open woodland or scrub dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species (DoEE 2019c). It prefers landscapes with well-draining, sandy or loamy soils on low, gently sloping, flat to undulating plains and foothills (DoEE 2019c). Access to water is important and foraging habitat is usually within 3 km of a suitable, permanent, or seasonal waterbody (DoEE 2019c). Typically, the ground covering vegetation layer is patchy consisting of native, perennial tussock grasses or a mix of perennial tussock grasses and low shrubs or forbs (DoEE 2019c), rarely exceeding 33% of the ground area. The remaining ground cover is areas of bare soil and light leaf litter/coarse woody debris (DoEE 2019c). Breeding habitat occurs on stony rises occurring on sandy or gravelly soils, within 1 km of a suitable, permanent waterbody. The ground covering vegetation layer is consistent with foraging habitat (DoEE 2019c).	Likely Potential habitat for this species is likely to occur within the study area. This species has been recorded by studies conducted for the Lake Vermont Mine, Saraji Mine, Saraji East Project, Olive Downs Coking Coal Project and Winchester South Project and others.

Species	Status		Description	Desktop likelihood of occurrence
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			Any forest or woodland occurring between patches of foraging or breeding habitat which facilitates movement between patches of foraging habitat, breeding habitat and/or waterbodies, as well as areas of cleared land less than 100 metres (m) wide linking areas of suitable breeding and/or foraging habitat are important for dispersal (DoEE 2019c). Dispersal habitat typically occurs on non-alluvial clays (Queensland RE Land zone 4) where the ground vegetation layer has been thinned through current land use practices (cattle grazing) (DoEE 2019c).	
Grey Falcon *Falco hypoleucos*	V^	V	**Distribution** The species occurs in arid and semi-arid Australia, including the Murray-Darling Basin, Eyre Basin, central Australia and Western Australia. The species is mainly found where annual rainfall is less than 500 mm, except when wet years are followed by drought, when the species might become marginally more widespread, although it is essentially confined to the arid and semi-arid zones (TSSC 2020). **Habitat** The species frequents timbered lowland plains, particularly acacia shrublands that are crossed by tree-lined water courses. The species has been observed hunting in treeless areas and frequents tussock grassland and open woodland, especially in winter (TSSC 2020). **Ecology** The Grey Falcon occurs at low densities across inland Australia. While breeding, the species feeds almost exclusively on birds. Prey species include doves, pigeons, small parrots and cockatoos, and finches, but a variety of other bird prey species has been recorded. Breeding occurs from June to November. Eggs are laid in the old nests of other birds, particularly those of other raptors or corvids. The nests chosen are usually in the tallest trees along watercourses, particularly River Red Gum (*Eucalyptus camaldulensis*) and Coolibah (*E. coolabah*), but falcons also nest in telecommunication towers (TSSC 2020).	<u>Potential</u> Potential habitat for this species is likely to occur within the study area. This species has been recorded by studies conducted for the Saraji East Project.
Oriental Cuckoo[#] *Cuculus optatus*	Mi	SLC	**Distribution** Distributed throughout the northern parts of Western Australia, Northern Territory and Queensland, as well as along the Queensland and New South Wales coastline (DoEE 2019c). **Habitat** Nonbreeding habitat occurs within rainforest margins, monsoon forest, vine scrubs, riverine thickets, wetter, densely canopied eucalypt forests or open *Casuarina, Acacia or Eucalyptus* woodlands (DoE 2015a).	<u>Unlikely</u> Preferred habitat (i.e. more humid habitats, such as monsoon forest, wet eucalypt forest, river margins and near mangroves) do not occur, and there are no records for this species within 50 km of the study area.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Ecology The Oriental Cuckoo breeds in the northern hemisphere migrates for its non-breeding season to Australia and south-east Asia. The species typcally inhabits forests, but can inhabit open woodlands, forest edges, and clearings. The Oriental Cuckoo is a cpyptic species with secretive behaviours. The species is a brood parasite, but does not breed in Australia. **Foraging** The Oriental Cuckoo forages for insects in the trees and ground of forested areas. **Dispersal** The Oriental Cuckoo breeds across northern Eurasia. It migrates for the non-breeding season to Australia and south-east Asia and has been recorded along the eastern and northern portions of Australia.	
Star Finch[#] *Neochmia ruficauda ruficauda*	E	E	**Distribution** The eastern sub species for the Star Finch is known to occur in Central Queensland only (DoEE 2019c). Its distribution extends north to Bowen, west to beyond Winton and, south to near Wowa (DoEE 2019c, DEWHA 2008c), within the Desert Channels, Burdekin and Fitzroy Natural Resource Management Regions (DoEE 2019c). **Habitat** The Star Finch occurs in damp grasslands, sedgelands and grassy woodlands, near permanent water, and often in or near suburban areas (DoEE 2019c, DEWHA 2008d). Common species associated with these areas include *Eucalyptus coolabah, E. tereticornis, E. tessellaris, Melaleuca leucadendra, E. camaldulensis* and *Casuarina cunninghamii* (DoEE 2019c). **Ecology** Little is known about the foraging ecology of this species (DoEE 2019c). It has been seen eating insects in fig trees and is said to forage in the shade of *Eucalyptus* trees (DoEE 2019c). This species predominantly eats seeds taken from a range of grasses including *Arundinella, Brachyachne, Chloris, Chrysopogon, Digitaria, Echinochloa, Heterachne, Iseilema, Oryza, Panicum, Setaria, Sorghum, Themeda* and *Urochloa* (DoEE 2019c). Nests are bottle-shaped made from grass, often placed in trees 3–9m above the ground, in a shrub or tree or among grass, sedges or reeds (DoEE 2019c).	<u>Unlikely</u> Potential habitat may occur; however, there are no records for this species within 50 km of the study area.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			The Star Finch is sedentary or resident species that may undertake some local dispersal at the completion of the breeding season. This species is not known to have specific dispersal requirements (DoEE 2019c).	
Gull-billed Tern *Gelochelidon nilotica*	Mi	SLC	**Distribution** This species occurs on all continents except Antarctica (BirdLife Australia 2019a). **Habitat** Gull-billed Terns are found in coastal environments consisting of, freshwater swamps, brackish and salt lakes, beaches and estuarine mudflats, floodwaters, sewage farms, irrigated croplands, and grasslands (BirdLife Australia 2019a). **Ecology** Little is known on the ecology of this species. The breeding season for this species is flexible and can change depending on the location (BirdLife Australia 2019a). Their nests usually occur in shallow depressions scraped in sand or mud, lined with some vegetation, and they feed on the surface of the water (BirdLife Australia 2019a). **Foraging** The Gull-billed Tern forages for a varied diet of small fish, reptiles, amphibians, crustaceans, small mammals, and insects in freshwater swamps, brackish/salt lakes, beaches, estuarine mudflats, floodwaters, sewage farms, irrigated land and grassland (BirdLife Australia 2019a)s. **Dispersal** The species inhabits a range of freshwater and wet area habitats. Breeding occurs across a wide partion of its range, though is generally not north of 25° south (BirdLife Australia 2019a).	<u>Potential</u> Potential habitat may occur within the study area, and there are records for the species within 50 km. However, it is only likely to be present when climatic conditions are suitable.
Caspian Tern *Hydroprogne caspia*	Mi	SLC	**Distribution** The Caspian Tern has a widespread occurrence and can be found in both coastal and inland habitat within Australia (DoEE 2019c). Within Queensland it occurs in coastal regions from the southern Gulf of Carpentaria to the Torres Strait, and along the eastern coast (DoEE 2019c). It has also been recorded in western parts of Queensland, including the Lake Eyre Drainage Basin, north-west to the Gulf Country, north of Mt Isa and Cloncurry (DoEE 2019c).	<u>Likely</u> Potential habitat may occur within the study area. This species has been recorded by studies conducted for the Lake Vermont Mine, Olive Downs Coking Coal Project and Caval Ridge Coal Mine.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Habitat It is predominantly found in sheltered coastal embayments, near coastal, inland, or artificial terrestrial wetlands in varying levels of salinity (DoEE 2019c). Areas that contain sandy or muddy margins is preferred (DoEE 2019c). Habitat types include harbours, lagoons, inlets, bays, estuaries, river deltas, lakes, waterholes, reservoirs, rivers, creeks, sewage ponds and saltworks (DoEE 2019c). Large numbers may shelter along the coast, behind coastal sand-dunes or coastal lakes during rough weather and have been observed inland after inclement weather (DoEE 2019c). **Ecology** Breeding occurs in select locations within Queensland, including the Wellesley Islands, south-east Gulf of Carpentaria, islands off the far north coast from Bird Island south to Three Isles, and from islands around Shoalwater Bay (DoEE 2019c). Breeding locations include low islands, cays, spits, banks, ridges, beaches of sand or shell, terrestrial wetlands and stony or rocky islets or bank (DoEE 2019c). Nests may be among low/sparse vegetation or in the open (DoEE 2019c). Roosting occurs on bare exposed sand or shell spits, banks or shores of coasts, lakes, estuaries, coastal lagoons and inlets (DoEE 2019c). **Foraging** Usually foraging in open wetland (including lakes and rivers), the Caspian Tern prefers sheltered shallow water near the margins (DoEE 2019c). It can also be found in open coastal waters, and in coastal inlets they may prefer to forage in tidal channels or over submerged mudbanks (DoEE 2019c). Their diet consists of fish, eggs/young from other birds, carrion, aquatic invertebrate, flying insects and earthworms (DoEE 2019c), foraging diurnally. **Dispersal** In Australia, the Caspian Tern is a resident and present throughout the year at sites, where breeding occurs year-round (DoEE 2019c). Some birds may move from coastal breeding colonies to inland non-breeding areas. They might follow watercourses inland, and their occurrence at small lakes suggest that at least some movement occurs overland (DoEE 2019c). Foraging diurnally, this species may venture up to 60 km from their nesting site in search of food (DoEE 2019c).	

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
Painted Honeyeater[#] *Grantiella picta*	V	V	**Distribution** The Painted Honeyeater is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory (DoE 2015c). Breeding records are west of the dividing range in Queensland, whereas non-breeding records also occur in coastal areas along the eastern seaboard (Rowland 2012). **Habitat** This species occurs in eucalyptus forests/woodlands, which consist of E*ucalyptus, Melaleuca, Casuarina, Callitris* and A*cacia* species (Queensland Government 2019, DoE 2015d, Rowland 2012). It prefers woodlands, containing a higher number of mature trees, with flowering and fruiting mistletoe and flowering eucalypts (Queensland Government 2019, Rowland 2012). **Ecology** The diet of the Painted Honeyeater primarily consists of the fruit of mistletoes (*Amyema sp*), and occasionally nectar and insects (Queensland Government 2019, Rowland 2012). The nesting locations are within the vicinity of abundant fruiting mistletoes, or within the mistletoe itself (Rowland 2012). Breeding occurs from October to March when mistletoe fruits are most available (DoE 2015c). Dispersal habitat requirements for this species are not known; however, its movements are in response to mistletoe flowering and fruiting (Queensland Government 2019, Rowland 2012, DoE 2015c).	<u>Unlikely</u> Potential habitat may occur; however, there are no records for this species within 50 km of the study area despite extensive fauna surveys for projects nearby and in the wider region.
Black-faced Monarch *Monarcha melanopsis*	Mi	SLC	**Distribution** Widespread in eastern Australia and throughout Queensland (DoEE 2019c). It is known to occur on the eastern slopes of the Great Divide and occasionally further inland within this Queensland range (DoEE 2019c). **Habitat** The Black-faced Monarch mainly occurs in rainforest ecosystems (semi-deciduous vine thickets, vine forest, warm temperate rainforest, dry (monsoon) rainforest for example) (DoEE 2019c). It may also occur in regrowth rainforest, open eucalypt forests, in dry sclerophyll forests and woodlands, gullies in mountain areas or coastal foothills (DoEE 2019c), and occasionally in suburban parks/ gardens or among mangroves (DoEE 2019c).	<u>Unlikely</u> Preferred habitat (rainforest ecosystems) does not occur in the study area and this species is unlikely to occur.

<table>
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Breeding occurs in select locations, including the Atherton Region (Julatten south to the Paluma Range), inland to the Atherton Tableland and in south-eastern Queensland to Lakes Entrance, Victoria (DoEE 2019c). This species breeds in rainforest habitat, and generally nests near the top of trees with large leaves, in the tops of small saplings, or in lower shrubs (DoEE 2019c). Tree and shrub species used as nest sites include Daisy bushes (Olearia spp.), Lilly Pilly (Acmena smithii), Yellow Sassafras (Doryphora sassafras), wattles (Acacia spp.), Coachwood (Ceratopetalum apetalum), Grey Myrtle (Backhousia myrtifolia) and Turpentine (Syncarpia glomulifera) (DoEE 2019c).

Foraging

The Black-faced Monarch feeds mostly in rainforest but also in open eucalypt forest within the mid-upper canopy (DoEE 2019c). They feed on spiders, wasps, insects, moths/caterpillars aerially and from the foliage (DoEE 2019c).

Dispersal

In Queensland, the Black-faced Monarch migrates between February and May, where a large proportion leaves Australia during winter (DoEE 2019c). There is no specific dispersal habitat requirements for this species; however, it can occur in 'marginal' habitats during winter or during passage (migration) (DoEE 2019c).</td><td></td></tr>
<tr><td>Spectacled Monarch
Symposiachrus trivirgatus</td><td>Mi</td><td>SLC</td><td>Distribution

The Spectacled Monarch is found in coastal north-eastern and eastern Australia; from Cape York, Queensland to Port Stephens, New South Wales (BirdLife Australia 2019b).

Habitat

This species inhabits dense rainforests and moist Eucalyptus forests. The Spectacled Monarch is known to also inhabit areas of mangroves and other dense vegetation including areas of thick understory in rainforests, wet gullies, and waterside vegetation (BirdLife Australia 2019b).

Ecology

This species forages mostly below the canopy in foliage and on tree trunks and vines. The Spectacled Monarch feeds on insects and is known to call persistently while foraging (BirdLife Australia 2019b).</td><td><u>Unlikely</u>

Preferred habitat (dense rainforests and moist Eucalypt forests) does not occur in the study area. This species is unlikely to occur.</td></tr>
</table>

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Foraging The Spectacled Monarch feeds on insects, foraging mostly below canopy foliage and on tree trunks or vines (BirdLife Australia 2019b). **Dispersal** The Spectacled Monarch is found in coastal north-eastern and eastern Australia from Cape York to Port Stephens. It also occurs in Papua New Guinea, the Moluccas and Timor (BirdLife Australia 2019b).	
Satin Flycatcher *Myiagra cyanoleuca*	Mi	SLC	**Distribution** The Satin Flycatcher is widespread in eastern Australia. In Queensland, it is widespread and scattered in the east, mostly in coastal areas but also on the Great Divide and occasionally further west (DoEE 2019c). **Habitat** This species Inhabits vegetated gullies in eucalypt forests, often near wetlands or watercourses (DoEE 2019c). It also occurs in eucalypt woodlands with open understorey and grass ground cover, and in tall wet sclerophyll forest. This species is generally absent from rainforest (DoEE 2019c, DoE 2015a). **Ecology** Satin Flycatchers prefer to nest in a fork of outer branches of trees, such as paperbarks, eucalypts, and banksias (DoEE 2019c). They show a preference for eucalypt forest and woodlands, at high elevations during the breeding season from November to early January (DoE 2015a, DoEE 2019c). They nest in the same locality each year, and sometimes in the same tree (DoEE 2019c). **Foraging** Not known to have specific foraging habitat, the Satin Flycatcher forages high in the mid to upper canopy in trees, usually sallying for prey in the air or picking prey (mainly insects) from foliage and branches of trees (DoEE 2019c). **Dispersal** On migration the Satin Flycatcher occurs in coastal forests, woodlands, mangroves and drier woodlands and open forests (DoEE 2019c). They are inconspicuous when on passage, because movements are thought to be made singly or in pairs, or small loose groups through the tree-tops at night (DoEE 2019c). The departure and arrival time varies between different regions, moving through Queensland late August–November (DoEE 2019c).	<u>Likely</u> Potential habitat may occur within the study area and there are records for the species from studies conducted for the Olive Downs Coking Coal Project, Caval Ridge Coal Mine, Isaac Plains East Project and Winchester South Project.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
Rufous Fantail *Rhipidura rufifrons*	Mi	SLC	**Distribution** Within Australia, the Rufous Fantail occurs in coastal and near coastal districts, which is consistent with its distribution throughout Queensland (DoEE 2019c). **Habitat** In east and south-east Australia, the Rufous Fantail mainly occupies wet sclerophyll forests, and gullies dominated by eucalyptus species with a dense shrubby understory (DoEE 2019c, DoE 2015a). The Rufous Fantail has also been recorded from parks and gardens when on passage (DoEE 2019c). In north and northeast Australia, *R. rufifrons* often occurs in tropical rainforest and monsoon rainforests, including semi-evergreen mesophyll vine forests, semideciduous vine thickets or thickets of *Melaleuca spp*. (DoEE 2019c). **Ecology** This species does not have specific breeding habitat requirements (DoEE 2019c). **Foraging** The Rufous Fantail forages mainly in the low to middle strata of forests, sometimes in/below the canopy or on the ground (DoEE 2019c). It forages aerially at lower levels in the wet season compared to the dry season, eating insects (DoEE 2019c). **Dispersal** Some population of the Rufous Fantail in east Australia are migratory, populations in north Queensland move altitudinally, however other populations may be migrate from south-east Queensland in winter (March to April) to north Queensland and Torrest Strait, returning in August to December (DoEE 2019c).	<u>Potential</u> Potential habitat may occur within the study area; however, it is unlikely to be preferred habitat.
Red-tailed Tropicbird *Phaethon rubricauda*	Mi	V	**Distribution** The Red-tailed Tropicbird is solitary, highly pelagic, and may be seen hundreds of kilometres from land (Marchant and Higgins 1998). In Australia this species has a discontinuous distribution and has been recorded in all states (Marchant and Higgins 1998). The majority of records from northern Australia (Marchant and Higgins 1998).	<u>Unlikely</u> Potential habitat does not occur in the study area for this species and is unlikely to occur.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Habitat The Red-tailed Tropicbird breeds in loose colonies in inaccessible areas on small remote islands or the south-west coats of Australia and adults are found in the vicinity of colonies all year round (BirdLife Australia 2019b). **Ecology** The species is known to stay closer to land during breeding seasons. The Red-tailed Tropicbird is known to breed in Tropical and Subtropical Zones, on volcanic and other islands, stacks, atolls, cays; usually far from mainland (Marchant and Higgins 1998). The Red-tailed Tropicbird is monogamous, maintaining bonds from year to year (Marchant and Higgins 1998). The species is solitary at sea and breeds solitary or in loose colonies (Marchant and Higgins 1998). Species predominantly roots at sea, with only the incubating or brooding adult remaining on land at night (Marchant and Higgins 1998). **Foraging** The Red-tailed Tropicbird feeds mostly on fish, especially flying-fish, squid and crustaceans and the species catches prey by plunge diving (BirdLife Australia 2019b). **Dispersal** The Red-tailed Tropicbird is a dispersive or migratory species; adults and juveniles appear to disperse widely (Marchant and Higgins 1998). Primarily feeds on fish and cephalopods and is known to dive into water up to depths of 50 m. Feeding chiefly occurs during the day (Marchant and Higgins 1998).	
Australian Painted Snipe *Rostratula australis*	E	E	**Distribution** Known to occur within wetlands within all states of Australia (DoEE 2019c). This species is most common in eastern Australia, where it has been recorded throughout much of Queensland, New South Wales, Victoria, and south-eastern South Australia at scattered locations (DoEE 2019c).	<u>Potential</u> Potential habitat is likely to occur within the study area; however, the condition and extent of the habitat requires assessment. This species was recorded by studies conducted for the Olive Downs Coking Coal Project, Saraji East Project and Winchester South Project.

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<tr><th>EPBC Act[1,2]</th><th>NC Act[3]</th></tr>
<tr><td></td><td></td><td></td><td>Habitat

The Australian Painted Snipe generally inhabits shallow freshwater (sometimes brackish) wetlands, including temporary and permanent lakes, swamps and claypans (DoEE 2019c). It has also been known to occupy inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains (DoEE 2019c). These areas usually include emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia, Canegrass or Tea-tree (Melaleuca) (DoEE 2019c). Areas lined with trees, or that have some scattered fallen or washed-up timber are sometimes also used (DoEE 2019c).

Ecology

This species generally remains in dense cover when feeding, although may forage over nearby mudflats and other open areas such as ploughed land or grassland (DoEE 2019c). This species requires suitable wetland areas even in drought conditions (DoEE 2019c).

Breeding habitat requirements are specific: shallow wetlands with areas of bare wet mud and both upper and canopy cover (low and sometimes tall and dense) nearby (DoEE 2019c). This species may breed in response to wetland conditions rather than during a season (DoEE 2019c).

Most nest records are from or near small islands in freshwater wetlands, which contain a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover (DoEE 2019c).

The Australian Painted Snipe is possibly dispersive or migratory (DoEE 2019c). Dispersive movements have been attributed to local conditions: moving to flooded areas; moving from drying to permanent wetlands; moving away from areas affected by drought (DoEE 2019c).

This species is mainly crepuscular (active at dawn and dusk) and highly cryptic (DoEE 2019c).</td><td></td></tr>
</table>

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
Common Sandpiper *Actitis hypoleucos*	Mi	SLC	**Distribution** The Common Sandpiper is widespread in small numbers. It is known to occur along all coastlines in Australia, and in many areas inland (DoEE 2019c). In Queensland, this species has been recorded in South-eastern Gulf of Carpentaria and Cairns Foreshore (DoEE 2019c). It migrates to Australia during the non-breeding season, migrating to Queensland from August (DoEE 2019c). **Habitat** The Common Sandpiper can occur in a broad range of coastal and inland wetlands with varying levels of salinity (DoEE 2019c). It is mostly found around muddy margins or rocky shores, which may be narrow and or steep (DoEE 2019c). Rarely found on mudflats (DoEE 2019c). **Ecology** Roost sites are typically on rocks or in roots/ branches of vegetation, especially mangroves (DoEE 2019c). **Foraging** The Common Sandpiper forages on bare soft mud at the edges of wetlands in shallow water, often in areas where objects protrude from the substate (rocks or pneumatophores) (DoEE 2019c). Sometimes the Common Sandpiper will venture into grassy areas adjoining wetlands in search of food for extensive periods (molluscs, bivalves, crustaceans and a variety of insects) (DoEE 2019c). **Dispersal** The southern migration passage is said to be mostly diurnal, whereas the northern passage mainly occurs by night (DoEE 2019c).	<u>Potential</u> Potential habitat may occur within the study area when climatic conditions are suitable.
Sharp-tailed Sandpiper *Calidris acuminata*	Mi	SLC	**Distribution** The Sharp-tailed Sandpiper is a non-breeding visitor to all states and territories of Australia (DoEE 2019c). It is widespread throughout Queensland, arriving in large numbers in September (DoEE 2019c). **Habitat** This species prefers fresh or saltwater shallow wetlands with muddy edges (DoEE 2019c), with the presence of inundated or emergent sedges, grass, saltmarsh, or other low vegetation (DoEE 2019c). This includes swamps, lakes, lagoons, and pools near the coast, and waterholes, soaks, dams, bore drains and	<u>Potential</u> Potential habitat may occur within the study area when climatic conditions are suitable.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			bore swamps, saltpans, and hypersaline salt lakes inland (DoEE 2019c). Sometimes they occur on rocky shores and rarely on exposed reefs (DoEE 2019c). **Ecology** Roosting occurs at edges of shallow wetlands, on wet open mud or sand, or in short sparse vegetation, such as grass or saltmarsh (DoEE 2019c). Mangroves and on rocks in water are some other locations this species has been seen roosting (DoEE 2019c). **Foraging** The Sharp-tailed Sandpiper forages at the edge of the water of wetlands or intertidal mudflats, either on bare wet mud or sand, or in shallow water (DoEE 2019c). This species can also forage among inundated vegetation of saltmarsh, grass, or sedge, eating seeds, worms, molluscs, crustaceans, and insects (DoEE 2019c). **Dispersal** Movements occur during the non-breeding period, moving to temporary or flooded wetlands and leaving them when they dry (DoEE 2019c).	
Curlew Sandpiper# *Calidris ferruginea*	CE, Mi	E	**Distribution** Widespread in small numbers, this species is known to occur around coasts in Australia and in many areas inland during the non-breeding season (DoEE 2019c). In Queensland, this species has been recorded in the Gulf of Carpentaria, with widespread records along the coast, south of Cairns (DoEE 2019c). **Habitat** Inhabiting wetland environments, the Curlew Sandpiper mainly occurs on intertidal mudflats in sheltered coastal areas, (estuaries, bays, inlets and lagoons), as well as around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms (DoE 2015d). Small numbers have been recorded living inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand (DoE 2015d).	Unlikely Potential habitat may occur in suitable climatic conditions; however, there are no records of this species within 50 km of the study area.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Ecology Roosting occurs on bare dry shingle, shell, or sand beaches, sandspits and islets in or around coastal or near coastal lagoons and other wetlands (DoEE 2019c). Occasionally roosting occurs in dunes during very high tides and sometimes in saltmarsh (DoEE 2019c). **Foraging** Curlew Sandpipers forage on mudflats and nearby shallow water at the edge of shallow pools, wading through water 15–60 mm deep (DoEE 2019c). At high tide, they forage among low sparse emergent vegetation, such as saltmarsh, and sometimes forage in flooded paddocks or inundated salt flats (DoEE 2019c). **Dispersal** Substantial numbers of Curlew Sandpipers remain in northern Australia throughout the nonbreeding season, arriving around September (DoE 2015d).	
Pectoral Sandpiper[#] *Calidris melanotos*	Mi	SLC	**Distribution** The Pectoral Sandpiper occurs around Cairns in Queensland (DoEE 2019c). There are scattered records elsewhere, mainly from east of the Great Divide between Townsville and Yeppoon (DoEE 2019c). A few inland records have also been recorded at Mount Isa, Longreach, and Oakley (DoEE 2019c). **Habitat** This species prefers shallow wetlands with varying levels of salinity, in coastal or near coastal habitat (DoEE 2019c). It is sometimes found further inland in the following habitat types, coastal lagoons, swamps, lakes, inundated grasslands, estuaries, bays, saltmarshes, river pools, creeks, floodplains, and artificial wetlands (DoEE 2019c). Its preferred habitat is wetlands that have open fringing mudflats and low, emergent, or fringing vegetation, such as grass or samphire (DoEE 2019c). It has also been recorded in swamp overgrown with lignum (DoEE 2019c). **Ecology** The Pectoral Sandpiper breeds in northern Russia and North America. It is not known to have specific dispersal or roosting habitat requirements, and this species is found in Australia from September to June (DoEE 2019c).	<u>Unlikely</u> Potential habitat may occur when climatic conditions are suitable; however, there are no records of this species within 50 km of the study area.

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<tr><td></td><td></td><td></td><td>Foraging
Foraging occurs in shallow water or soft mud at the edge of wetlands where they consume algae, seeds, crustaceans, arachnids, and insects (DoEE 2019c).
Dispersal
The species is transient through Central America and the Caribbean while on route to the non-breeding areas in South America. In the tropical Pacific, there are scattered records from Hawaii, Polynesia, Micronesia and Australasia. The species occurs in small numbers through east Asia.</td><td></td></tr>
<tr><td>Red-necked Stint
Calidris ruficollis</td><td>Mi</td><td>SLC</td><td>Distribution
The Red-necked Stint is distributed along most of the Australian coastline (DoEE 2019c). This species has been found inland in all states when conditions are suitable and is known from the coastlines of all states (DoEE 2019c).
Habitat
This species is found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores (DoEE 2019c). It can also occur along ephemeral or permanent shallow wetlands near the coast or inland, including lagoons, lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in salt flats. The Red-necked Stint has also been known to use flooded paddocks or damp grasslands; and have been recorded in areas with little or no perennial vegetation (Higgins & Davies 1996).
Foraging
The Red-necked Stint forages on bare wet mud on intertidal mudflats or sandflats, or in very shallow water (DoEE 2019c). The species is also known to forage in non-tidal wetlands during high tides; including areas of flooded paddocks (DoEE 2019c). This species is omnivorous.
Ecology
This species is a non-breeding visitor to Australia, it is known to breed in Siberia and sporadically in north and west Alaska (DoEE 2019c). The Red-necked Stint roosts on sheltered beaches, spits, banks or islets, of sand, mud, coral or shingle, sometimes in saltmarsh or other vegetation (DoEE 2019c).</td><td><u>Potential</u>
Potential habitat may occur within the study area when climatic conditions are suitable.</td></tr>
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Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Dispersal The Red-necked Stint spends winter in Australasia, mostly in Australia for its non-breeding season (DoEE 2019c). The species begins to arrive in Australia from August, with the majority arriving from early September (DoEE 2019c). The Red-necked Stint leaves Australia from late February/ March through to April, with a few individuals remaining as late as May (DoEE 2019c).	
Latham's Snipe *Gallinago hardwickii*	Mi	SLC	**Distribution** The Latham's Snipe is a non-breeding visitor to south-eastern Australia, and a passage migrant through northern Australia (DoEE 2019c). In Queensland, their range extends inland over the eastern tablelands in south-eastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range (DoEE 2019c). **Habitat** This species prefers open freshwater permeant and ephemeral wetlands, typically with low dense vegetation (DoEE 2019c). It can be found in a variety of vegetation communities including but not limited to tussock grasslands, coastal and alpine heathlands, tea-tree scrub and open forests (DoEE 2019c). **Ecology** Latham's Snipe is dispersive during its stay in Australia, arriving from July to November. The snipe is thought to disperse in response to rainfall and the availability of food (DoEE 2019c). **Foraging** The foraging habitat of the Latham's Snipe consist of areas of mud (exposed or beneath very shallow water) with low, dense vegetation present (DoEE 2019c). They roost near their foraging sites, in areas that provide some shelter (clumps of vegetation, in drainage ditches, among boulders, or in shallow water if cover is not available) (DoEE 2019c). **Dispersal** Latham's Snipe is a migratory species that breeds in Japan and Russia and migrates to Australia where is remains for the duration of the northern winter. Once in Australia the species move slowly southward along the coastal regions and most individuals end up south of the Richmond River in NSW (DoEE 2019c).	<u>Likely</u> Potential habitat may occur within the study area when climatic conditions are suitable. The species has been recorded by nearby studies including the Olive Downs Coking Coal Project, Saraji East Project and Winchester South Project.

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<tr><td>Greenshank
Tringa nebularia</td><td>Mi</td><td>SLC</td><td>Distribution
This species distribution is widespread in the Gulf country and eastern Guld of Carpentaria (DoEE 2019c). This species is recorded in most coastal regions. There have been few records south of a line near Dalby to Mt Guide, with sparsely scattered records elsewhere (DoEE 2019c).
Habitat
The Greenshank occurs in all types of wetlands and is described as having the widest distribution of any shorebird in Australia (DoEE 2019c). This species in habits a wide variety of inland wetlands and sheltered coastal habitats (varying salinity) (DoEE 2019c). Habitats include; embankments, harbours, river estuaries, deltas and lagoons but can also include tidal pools, rock-flats, and rock-platforms (DoEE 2019c). Sheltered coastal habitat features include; large mudflats, saltmarsh, mangroves, and seagrass (DoEE 2019c). The Greenshank utilises both permanent and ephemeral systems including; swaps, lakes, rivers, creeks, dams, billabongs, waterholes, and inundated floodplains, claypans and salt flats (DoEE 2019c). This species will also inhabit artificial waterbodies including; sewage farms, saltworks dams, inundated rice crops and bores (DoEE 2019c).
Foraging
The Greenshank is known to forage in soft mud on mudflats, in channels or in shallows around the edge of water and on the edges of wetlands, often in areas of sparse emergent or fringing vegetation (DoEE 2019c).
Ecology
This species is a non-breeding visitor to Australia. The Greenshank roosts and loafs around wetlands and in shallow pools and puddles or on slightly elevated rocks, sandbanks or small muddy islets (DoEE 2019c). An important roost site for this species during the non-breeding season occurs on an inland claypan near Roebuck Bay in Western Australia (DoEE 2019c).
Dispersal
The Greenshank arrives in Australia from August, primarily in Western Australia (DoEE 2019c). By November, the Greenshank appears to disperse across Australia from Western Australia (DoEE 2019c). This species numbers slowly increase during August and September with some larger increases at some sites in October and November. The Greenshank begins its Northward migration from March, but primarily occurs in April (DoEE 2019c).</td><td><u>Potential</u>
Potential habitat for the Greenshank may occur within the study area and there is potential for this species to occur.</td></tr>
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Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
Marsh Sandpiper *Tringa stagnatilis*	Mi	SLC	**Distribution** The Marsh Sandpiper is found on coastal and inland wetlands throughout Australia and is widespread in coastal Queensland (DoEE 2019c). This species is also recorded in all regions of New South Wales and is found in coastal Victoria (DoEE 2019c). Scattered records of this species have been found across Western Australia, Northern Territory and South Australia (DoEE 2019c). **Habitat** This species lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats (DoEE 2019c). The species is less often found at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes (DoEE 2019c). **Foraging** The Marsh Sandpiper usually forages in shallow water at the edge of wetlands. They probe wet mud of mudflats or feed among marshy vegetation (Higgins & Davies 1996). This species is carnivorous and has been recorded eating insects, molluscs, and crustaceans (DoEE 2019c). **Ecology** This species is a non-breeding visitor to Australia and is known to breed from eastern Europe to eastern Siberia (DoEE 2019c). This species has been recorded potentially roosting on tidal mudflats, near low saltmarsh, and around inland swamps (Higgins and Davies 1996). **Dispersal** This species is known to arrive in Australia from September and disperse across Australia from September to December (DoEE 2019c). The Marsh Sandpiper begins to migrate north in March and April, with temporary influxes of populations occurring at some sites along the eastern coast (DoEE 2019c).	<u>Potential</u> Potential habitat for the Marsh Sandpiper may occur within the study area, and there is potential for this species to occur.
Glossy Ibis *Plegadis falcinellus*	Mi	SLC	**Distribution** Within Australia, the Glossy Ibis is generally located east of the Kimberley in Western Australia and Eyre Peninsula in South Australia (DoEE 2019c). This species is known to breed in select locations, which include the Channel Country in Queensland (DoEE 2019c).	<u>Likely</u> Potential habitat is likely to occur within the study area, and there are nearby records for the species by studies conducted for the Olive Downs

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Habitat Fresh water marshes at the edges of lakes and rivers, lagoons, floodplains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation are the preferred foraging and breeding habitats for this species. They are also occasionally found in coastal locations such as estuaries, deltas, saltmarshes and coastal lagoons (DoEE 2019c). It is known to occur in large densities in drying Top End grass/sedge swamps and Channel Country grass/forb meadows (DoEE 2019c). **Foraging** The species feeds in very shallow water, probing the water/mud in search of its preferred food source (aquatic invertebrates/insects) (DoEE 2019c). Preferred foraging habitat mentioned above. **Roosting/Breeding** Australian breeding habitat types include wooded and shrubby swamps in the semi-arid and arid regions, including the Channel Country in Queensland (DoEE 2019c). Glossy Ibis roost in trees or shrubs usually near water bodies (DoEE 2019c). The breeding season is from mid-spring to the end of summer; however, reproduction may extend to September to April if persistent food resources are available at breeding sites (DoEE 2019c). **Dispersal** Within Australia, the species moves in response to good rainfalls, expanding its range (DoEE 2019c). It often moves north in autumn, then return south to the main breeding areas in spring and summer (DoEE 2019c).	Coking Coal Project and Winchester South Project.
Yellow Wagtail[#] *Motacilla flava*	Mi	SLC	**Distribution** This species may occur throughout Australia during the non-breeding season (DoEE 2019c).	<u>Unlikely</u> There are no known records for this species within 50 km of the study area.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Habitat The Yellow Wagtail prefers mostly well-watered open grasslands and the fringes of wetlands, it roosts in mangroves and other dense vegetation (DoE 2015a). **Ecology** The Yellow Wagtail occupies a range of damp or wet habitats with low vegetation, from damp meadows, marshes, waterside pastures, sewage farms and bogs to damp steppe and grassy tundra. The species breeds from April to August (BirdLife Australia 2019b). **Foraging** The Yellow Wag Tail feeds on a range of invertebrates and plant material, particularly seeds (BirdLife Australia 2019b). **Dispersal** The Yellow Wagtail has an extremely large range, extending from Europe to West Asia and south to Egypt (BirdLife Australia 2019b).	
Mammals				
Northern Quoll *Dasyurus hallucatus*	E	LC	**Distribution** The Northern Quoll occurs in five regional populations across Queensland, the Northern Territory and Western Australia both on mainland and on offshore islands (DoEE 2019c). In Queensland, it is known to occur as far south as Gracemere and Mt Morgan, south of Rockhampton, as far north as Weipa in Queensland and as far west into central Queensland to the vicinity of Carnarvon Range National Park (DoEE 2019c). **Habitat** This species does not have highly specific habitat requirements, living in a range of open woodland and open forest types preferring rocky areas (DoEE 2019c, Hill and Ward 2010). They have also been recorded in vine forest, vegetation along creek lines, adjacent to mangroves, around urban areas and on beaches (DSEWPaC 2011b). In central Queensland, the Northern Quoll is also known to occupy non-rocky lowland habitats such as beachscrub communities. Northern Quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging	<u>Unlikely</u> Potential habitat for this species is unlikely to occur within the study area.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			and dispersal (DAWE 2021). Important factors in the landscape include shallow soils, large cover of rocks including outcropping rock, distance to permanent water and time since last fire (DSEWPaC 2011b). **Ecology** Day time den sites occur in a wide range of areas including rock overhangs, tree hollows, hollow logs, termite mounds, goanna burrows and human structures (DSEWPaC 2011b), generally including some form of rocky area for denning purposes (DoEE 2019c). Their greatest breeding success is known to occur at sites near water (DoEE 2019c), and they are active at night and twilight (DSEWPaC 2011b). Little is understood about the characteristics of foraging or dispersal habitat for the Northern Quoll (DoE 2016). Current knowledge is that foraging/dispersal habitat is recognised to be any land comprising predominantly of native vegetation in the immediate area (i.e. within 1 km) of shelter habitat (DoE 2016).	
Coastal Sheathtail Bat *Taphozous australis*	—	NT	**Distribution** Known to occur along a narrow coastal zone in Queensland (Shoalwater Bay to Cape York), extending a few kilometres inland (Queensland Government 2019, Hourigan 2011b). **Habitat** The Coastal Sheathtail Bat depends on coastal roosts (Queensland Government 2019, Hourigan 2011b). This species can roost in disused mines, boulder piles, rock fissures, concrete bunkers and building, although sea caves and rocky clefts are preferred (Queensland Government 2019, Hourigan 2011b). In central Queensland coast bioregion, it occupies airy boulder sea caves with multiple openings located on rocky foreshore of peninsulas, < 50 m of the Highest Astronomical Tide (Queensland Government 2019, Hourigan 2011b). **Ecology** Foraging at night <3km of the ocean, these bats forage in sand dune scrub, mangroves, melaleuca swamps, coastal heathlands, open eucalypt forest grasslands, lowlands, and foothills (Queensland Government 2019, Hourigan 2011b). Roost conditions may vary from warm (26–28°C) and humid (84–92%), roosting individually or in small groups. This species can commute up to 15km up or down the coast from their roost (Queensland Government 2019, Hourigan 2011b).	Unlikely Potential habitat for this species is unlikely to occur within the study area.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
Ghost Bat# *Macroderma gigas*	V	E	**Distribution** The Ghost Bat is endemic to Australia, occurring in Queensland, northern Pilbara and Kimberley in Western Australia, and the top end of the Northern Territory (TSSC 2016a, Hourigan 2011a). In Queensland, this species is currently distributed in 4-5 highly disjunct populations along the coast and inland from the McIlwraith Range in Cape York to Rockhampton, with the biggest colony occurring at Mount Etna (Hourigan 2011a). Habitat modelling studies suggest that the Ghost Bat is a geographically relictual species in southern, arid landscapes, present only because caves provide suitable roost microclimates (TSSC 2016a). **Habitat** This species occupies a variety of habitats ranging from arid Pilbara to tropical savanna woodlands and rainforests. During the daytime they roost in caves, rock crevices and old mines. (TSSC 2016a). **Foraging** Foraging areas are approximately 60 ha in size (TSSC 2016a). Their diet consists of large insects, small mammals, reptiles, birds and bats, and prey availability is thought to influence foraging habitat for this species (Hourigan 2011a). **Roosting/Breeding** Roost sites consist of caves, rock crevices and disused mine adits (TSSC 2016a). Permanently used roost sites are generally deep natural caves or disused mines with a relatively stable temperature of 23°−28°C, with a moderate to high relative humidity of 50−100% and the ceiling at least 2 m above the floor (TSSC 2016a, Hourigan 2011a). Individuals aggregate in these maternity roosts during spring and summer (Hourigan 2011a). **Dispersal** Ghost Bats usually require several caves to move between seasonally or as dictated by weather conditions (TSSC 2016a). It is known to forage up to 2 km from its daytime roost area and will use the same foraging area each night (TSSC 2016a, Hourigan 2011a).	<u>Unlikely</u> There are no known records for this species within 50 km of the study area. Given the extensive surveys that have occurred nearby and in the wider region, this species is considered unlikely to occur within the study area.

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<tr><th>EPBC Act[1,2]</th><th>NC Act[3]</th></tr>
<tr><td>Koala
Phascolarctos cinereus</td><td>V</td><td>V</td><td>Distribution
The Koala is endemic to Australia, ranging from north-eastern Queensland to the south-east corner of South Australia, across coastal and inland areas (DoEE 2019c). Biogeographic regions of Queensland where Koalas have been recorded include; the Einasleigh Uplands, Wet Tropics, Desert Uplands, Central Mackay Coast, Mitchell Grass Downs, Mulga Lands, Brigalow Belt, South-eastern Queensland and Channel Country. South-eastern Queensland contains the highest density of Koalas (DoEE 2019c, TSSC 2012a).
Habitat
Koalas occupy a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the Eucalyptus genus or related genera (including Corymbia and Angophora species), as well as Lophostemon and Melaleuca species (DSEWPaC 2012a, DoEE 2019c, TSSC 2012a).These habitat types are largely influenced by land elevation, annual temperature and rainfall patterns, soil types and the available soil moisture and fertility (DoEE 2019c, TSSC 2012a, DSEWPaC 2012a, DSEWPaC 2012a). Preferred food and shelter trees are naturally abundant on fertile clay soils, and there is a tendency to find the highest densities of Koalas along creek lines (DoEE 2019c, TSSC 2012a, DSEWPaC 2012a).
Ecology
Koalas are leaf-eating specialists, occupying a range of vegetation communities; dominated by Eucalyptus species, or related genera (including Corymbia and Angophora species), as well as Lophostemon and Melaleuca species usually along watercourses (DSEWPaC 2012a, TSSC 2012a). The Koala is also known to supplement its diet with other genera at times, including Leptospermum and Melaleuca (DoEE 2019c, TSSC 2012a). The species is known to have quite specific foraging habitat requirements, as Koalas have been known to show a strong preference between individual trees within species (DoEE 2019c, TSSC 2012a), and individual Koalas usually obtain most of their nutrition from one or a few species present at a site (DoEE 2019c, TSSC 2012a).
This species tends to move little under most conditions, changing trees only a few times each day (DoEE 2019c). Dispersing individuals, mostly young males, may occasionally cover distances of several kilometres over land with little vegetation (DoEE 2019c).
Koala’s often change trees at night, as preferred food trees may be several hundred metres apart, they spend a considerable amount of time on the ground (Van Dyck & Strahan 2008).</td><td><u>Likely</u>
Potential habitat for this species is likely to occur within the study area, and the species has been recorded by nearby studies including the Olive Downs Coking Coal Project and Saraji East Project</td></tr>
</table>

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
Grey-headed Flying-fox# *Pteropus poliocephalus*	V	LC	**Distribution** Australia's only endemic flying fox, The Grey-headed Flying fox occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria (DoEE 2019c, DEWHA 2010b). Only a small proportion of this range is used at any one time, as the species selectively forages where food is available (DoEE 2019c). **Habitat** This species requires foraging and roosting sites (DoEE 2019c). It utilises a range of habitat types including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and Banksia woodlands, in search of its flowering and fruiting trees (DoEE 2019c, Queensland Government 2019). **Foraging** They primarily eat nectar and pollen from *Eucalyptus* and related genera (*Corymbia* and *Angophora*), as well as from *Melaleucas* and *Banksias* (DoEE 2019c). In some areas they have also been known to eat a wide range of rainforest fruits (DoEE 2019c). They will also feed on cultivated fruit trees in gardens and orchards (DEWHA 2010b). Flying fox camps form in response to the location and timing of local flowering and fruiting events. An area will be occupied for a few weeks to several months until the food resource is exhausted (DEWHA 2010b). **Roosting/Breeding** The Grey-headed Flying fox roosts in groups of various sizes (few individuals to over 70,000) on exposed branches during the day (DoEE 2019c, DEWHA 2010b). These roost sites are generally in proximity to water (rivers, lakes on the coast), and can include stands of *Melaleuca,* mangroves, riparian vegetation, and rainforest patches of vegetation (DoEE 2019c). Flying fox colonies can also use highly modified vegetation in urban and suburban areas for roost sites (DoEE 2019c). **Dispersal** Flying-foxes typically commute within 15 km of their day roost site to daily foraging areas (DoEE 2019c). They are capable of nightly flights of up to 50km from their roost to different feeding areas, as different plant species flower and fruit (DoEE 2019c, Queensland Government 2019, DEWHA 2010b). The national population is fluid and highly mobile, moving up and down the east coast in search of food (DoEE 2019c).	<u>Unlikely</u> Potential habitat may occur; however, there are no records for this species within 50 km of the study area despite the extensive surveys conducted nearby and in the wider region.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
Greater Glider (southern and central) *Petauroides volans*	V	V	**Distribution** The Greater Glider (*Petauroides volans*) is restricted to eastern Australia, occurring from Proserpine in QLD through to central Victoria, with an elevational range from sea level to 1200 m above sea level (TSSC 2016b, DCCEEW 2022). **Habitat** Largely restricted to eucalypt forests and woodlands, the Greater Glider's preferred habitat consists of taller, montane, moist eucalypt forests with relatively old trees and abundant hollows. It also favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species (TSSC 2016b, DCCEEW 2022). **Ecology** This species is primarily folivorous, with a diet mostly comprising of eucalypt leaves, and occasionally flowers (TSSC 2016b, DCCEEWW 2022). It is an arboreal nocturnal marsupial, sheltering in den trees (large hollows in large, old trees) during the day (TSSC 2016b, DCCEEW 2022). Home ranges of the Greater Glider are typically relatively small (1 to 4 ha) but are larger in lower productivity forests and more open woodlands (up to 19 ha) (TSSC 2016b, DCCEEW 2022). Due in part to the Greater Gliders relatively small home range, and due to its low dispersal ability, this species disperses poorly across vegetation that is not native forest (TSSC 2016b, DCCEEW 2022).	<u>Likely</u> Potential habitat for this species is likely to occur within the study area. The species has been recorded by studies conducted for the Lake Vermont Mine and other nearby projects.
Short-beaked Echidna *Tachyglossus aculeatus*	—	SLC	**Distribution** The Short-beaked Echidna is found in almost all Australian environments and is present is all Australian states (Van Dyck and Strahan 2008). This species is known from a variety of habitat types including open forests, grasslands and heavily vegetated woodlands. Distributions in arid regions is generally sparse. **Habitat** This species has no particular habitat requirements outside of the supply of ants and termites for its diet (Van Dyck and Strahan 2008). This species generally seeks shelter under thick bushes, in hollow logs, in debris and has been known to occasionally shelter in rabbit or wombat burrows (Van Dyck and Strahan 2008).	<u>Likely</u> Potential habitat for this species is likely to occur within the study area, and the species has been recorded from studies conducted for the Lake Vermont Mine and other nearby projects.

Species	**Status**		**Description**	**Desktop likelihood of occurrence**
	EPBC Act[1,2]	**NC Act[3]**		
			Ecology Adults have no significant predators; however, juveniles are known to be predated upon by goannas (Van Dyck and Strahan 2008). The Short-beaked echidna is a solitary species, with overlapping homes ranges with no fixed nesting sites (Van Dyck and Strahan 2008). **Foraging** In arid regions the species is known to forage at night to avoid high temperatures (Van Dyck and Strahan 2008). In temperate regions the pattern of activities varies depending on temperatures, the species typically forages around dusk and dawn (Van Dyck and Strahan 2008).	
Large-eared Pied Bat *Chalinolobus dwyeri*	V	V	**Distribution** Records exist from Shoalwater Bay, north of Rockhampton, through to the vicinity of Ulladulla, NSW in the south, however, this species current distribution is also poorly known (DoEE 2019c, TSSC 2012b). In Queensland, further records are known from sandstone escarpments in the Carnarvon, Expedition Ranges, Blackdown Tableland and in the Scenic Rim near the border (DoEE 2019c, TSSC 2012b). **Habitat** This species occurs in areas with extensive cliffs and caves. Suitable habitat consists of sandstone gorges in tall, open, moist eucalypt forest with a rainforest sub-canopy, wet and dry sclerophyll forests and woodlands, rainforest edges, wet sclerophyll forest and *Callitris* or pine dominant forest (DoEE 2019c, DEWHA 2010b). **Ecology** The species requires a combination of sandstone cliff/escarpment to provide roosting habitat, adjacent to higher fertility sites, particularly woodland valley or river/rainforest corridors which are used for foraging (DoEE 2019c). Roosting has also been recorded in caves, overhangs, disused Fairy Martin (*Hirundo ariel*) nests and mine shafts, and potentially in tree hollows (DoEE 2019c, DEWHA 2010b, TSSC 2012b, DERM 2011). The structure of primary nursery roosts is specific, including arch caves with dome roofs with indentations in the roof (TSSC 2012b, DoEE 2019c, DERM 2011). These characteristics are not very common in the landscape and therefore a limiting factor (DoEE 2019c). This species forages for insects at night around roost sites for up to several kilometres (DoEE 2019c).	<u>Unlikely</u> Potential habitat for this species (areas with extensive cliffs and caves) is unlikely to occur within the study area, and the distribution of this species is to the south of the study area.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
Corben's Long-eared Bat# *Nyctophilus corbeni*	V	V	**Distribution** This species is found across semi-arid southern Australia, where it is patchily distributed in southern central Queensland, central western New South Wales, north-western Victoria, and eastern South Australia (TSSC 2015d). In Queensland, approximately 30% of its distribution is within the Brigalow Belt South Bioregion (TSSC 2015d). **Habitat** Known to occur in a range of inland woodland vegetation types, including Bulloke woodlands, Brigalow woodland, Belah woodland, Smooth-barked Apple woodland, River Red Gum forest, Black Box woodland (TSSC 2015d). Corben's Long-eared Bat is more common in box / ironbark / cypress-pine vegetation, with a distinct tree canopy and a dense, cluttered understorey layer (TSSC 2015d). **Foraging** Foraging appears concentrated around patches of trees, with many individuals from different species of bat sharing the same foraging area (TSSC 2015d). This bat feeds on insects in flight, by gleaning vegetation and during ground foraging (TSSC 2015d). **Roosting Breeding** Corben's Long-eared Bat roosts solitarily in tree hollows, crevices, under loose bark and possibly under dense foliage (DoEE 2019c, DEWHA 2010b, TSSC 2015d). **Dispersal** Most roost sites are used just for a single day and large distances are travelled at night, with consecutive roost sites generally within 4 km (TSSC 2015d).	<u>Unlikely</u> Potential habitat may occur; however, there are no records within 50 km of the study area, and the study area is located to the north of the known distribution of this species.
Northern Hairy-nosed Wombat *Lasiorhinus krefftii*	CE	CE	**Distribution** Only remaining population occurs in the Epping Forest National Park, along the Belyando River system (DoEE 2019c).	<u>Unlikely</u> Given the known distribution of this species and the extensive surveys conducted nearby for other projects, this species is unlikely to occur. The records that occur within 50 km of the study area are historic records.

Species	Status		Description	Desktop likelihood of occurrence
	EPBC Act[1,2]	NC Act[3]		
			Habitat Within Epping Forest National Park, the vegetation is dominated by Brigalow and Gidgee (*Acacia harpophylla* and *A. cambagei*) scrub, intersected by a gully with deep sandy soils supporting mixed eucalypt woodland (DoEE 2019c, TSSC 2018). Dominant native grasses are *Aristida spp*. and *Enneapogon spp.* Buffel Grass (*Cenchrus ciliaris*) is increasing in abundance (DoEE 2019c). **Ecology** Deep sandy soils are required for burrow construction, occurring along the banks of a single wide gully within Epping Forest National Park (DoEE 2019c). Burrows are located close to trees, specifically Native Bauhinia (*Lysiphyllum hookeri*) providing shade and support in the soft, sandy soil (DoEE 2019c, TSSC 2018). The Northern Hairy-nosed Wombat is strictly nocturnal, feeding at night and only when it is not too cold or too hot and dry (DoEE 2019c, TSSC 2018).	

21.12.1.3 Field survey

The terrestrial ecology surveys were undertaken by suitably qualified ecologists in accordance with all required permits and approvals. Seasonal surveys were undertaken within the Project area over a total of 46 days in autumn 2019 (11-21 March), spring 2019 (6-19 November), autumn 2020 (23-25 March and 1-8 April), autumn 2021 (16-25 April), and spring 2021 (6-10 September).

The field assessments were conducted in accordance with the following survey guidelines:

- Commonwealth Guidelines:
  - 'Survey guidelines for Australia's threatened reptiles' (DSEWPaC 2011a).
  - 'Survey guidelines for Australia's threatened birds' (DEWHA 2010a).
  - 'Survey guidelines for Australia's threatened mammals' (DSEWPaC 2011b).
  - 'Survey guidelines for Australia's threatened bats' (DEWHA 2010b).
  - 'EPBC Act Referral Guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)' (DoE 2014a).
  - 'Draft Referral guidelines for the nationally listed Brigalow Belt reptiles' (DSEWPaC 2011c).
  - 'Draft referral guideline for 14 migratory birds listed under the EPBC Act' (DoE 2015a).
  - 'Species Profile and Threats Database' outlined survey requirements for EPBC Act listed species likely or with potential to occur.
- State Guidelines:
  - 'Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland (V5.0)' (Neldner *et al.* 2019).
  - 'Flora Survey Guidelines - Protected Plants (V2.01)' (DES 2019).
  - 'Management of endangered plants' (Cropper 1993).
  - 'Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (V3.0)' (Eyre *et al.* 2018).
  - 'Targeted species survey guidelines: Common death adder *Acanthophis antarcticus*' (Rowland and Ferguson 2012).
  - 'Targeted species survey guidelines: Glossy black-cockatoo *Calyptorhynchus lathami*' (Hourigan 2012).
- This report uses nationally accepted taxonomy for flora from the Australian Plant Census (APC 2020) and the nomenclature for fauna follows the Australian Biological Resources Study Faunal Directory (ABRS 2020).

The total flora survey effort included:

- A total of 54 secondary sites were surveyed
- A total of 245 quaternary sites were sampled
- Rapid flora observations at approximately 500 locations

The total fauna survey effort summary is provided in Table 21.37. The location of flora and fauna survey sites is presented in Figure 21.86 and Figure 21.87 respectively. The complete details of all field assessment methodologies available in Appendix G, Terrestrial Ecology Assessment (section 7).

Table 21.37: Summary of fauna survey effort

Survey method	Survey effort					Total survey effort
	Autumn survey 2019	Spring survey 2019	Autumn survey 2020	Autumn survey 2021	Spring survey 2021	
Systematic fauna site						
Elliott trapping	4 sites (MF01 - MF04) x 20 traps x 4 nights = 320 trap nights	6 sites (MF05 - MF10) x 20 traps x 4 nights = 480 trap nights	1 site (MF14) x 20 traps x 4 nights = 80 trap nights	-	-	880 total trap nights
Pitfall trap lines	4 sites (MF01 - MF04) x 4 pitfalls x 4 nights = 64 trap nights	6 sites (MF05 - MF10) x 4 pitfalls x 4 nights = 96 trap nights	1 site (MF14) x 4 pitfalls x 4 nights = 16 trap nights	-	-	176 total trap nights
Funnel trapping	4 sites (MF01 - MF04) x 6 funnels x 4 nights = 96 trap nights	6 sites (MF05 - MF10) x 6 funnels x 4 nights = 144 trap nights	1 site (MF14) x 6 funnels x 4 nights = 24 trap nights	-	-	264 total trap nights
Automated camera trapping	4 sites (MF01 - MF04) x 1 camera x 4 nights = 16 trap nights	9 sites (MF05 - MF13) x 1 camera x 4 nights = 36 trap nights	1 site (MF14) x 1 camera x 4 nights = 4 trap nights	-	-	56 total trap nights
Bird surveys	2 person hours per site (MF01 - MF04) = 8 person hours	Minimum 1 person-hour per site (MF05 - MF13) = 12 person hours at fauna sites	2 person hours per site (MF14) = 2 person hours	-	-	22 total person hours
Spotlight searches	1 person-hour per site (MF01 - MF04) = 4 person hours	1 person-hour per site (MF05 - MF13) = 9 person hours at fauna sites	2 person hours per site (MF14) = 2 person hours	-	-	15 total person hours
Call playback sessions	2 sessions per site (MF01 - MF04) = 8 sessions	2 sessions per site (MF05 - MF10) + 1 session per site (MF11 - MF13) = 15 sessions	2 sessions per site (MF14) = 2 sessions	-	-	25 sessions
Habitat searches	2 person hours per site (MF01 - MF04) = 8 person hours	Minimum 1 person-hour per site (MF05 - MF13) = 11 person hours at fauna sites	1 person-hour per site (MF14) = 1 person-hour	-	-	20 total person hours

Survey method	Survey effort					Total survey effort
	Autumn survey 2019	Spring survey 2019	Autumn survey 2020	Autumn survey 2021	Spring survey 2021	
Echolocation call detection	(2 sites [MF01, MF02] x 1 bat detector x 3 nights) + (2 sites [MF03, MF04] x 1 bat detector x 4 nights) = 14 detection nights	8 sites (MF05 - MF08, MF10 - MF13) x 1 bat detector x 3 nights = 24 detection nights	1 site x 1 bat detector x 3 nights = 3 detection nights	-	-	41 total detection nights
Supplementary micro bat survey sites						
Harp trapping	-	-	6 sites (MH01-MH06) x 1 trap x 5 nights = 30 trap nights	-	-	30 total trap nights
Mist netting	-	-	4 sites (MH01, MH05, MH06, MF14) x 1 mist nets x 1 hour = 4 trap hours	-	-	4 total trap hours
Echolocation call detection	-	-	3 sites (MH02 - MH04) x 1 bat detector x 3 nights = 9 detection nights	-	-	9 total detection nights
Spotlight searches	-	-	2 person hours at 3 sites (MH01, MH05, MH06) = 6 person hours	-	-	6 total person hours
Supplementary surveys						
Bird surveys	20 person hours of bird surveying	30 person hours of bird surveying	10 person hours of bird surveying	-	-	60 total person hours
Spotlight searches	4 person hours of spotlighting	6 person hours of spotlighting	5 person hours of spotlighting	35mins per site x 2 persons per site (MSS01, MSS02, MSS03 and MSS04) + 7 person hours of opportunistic spotlighting = 11.6 person hours	11 person hours of spotlighting	37.6 total person hours

Survey method	Survey effort					Total survey effort
	Autumn survey 2019	**Spring survey 2019**	**Autumn survey 2020**	**Autumn survey 2021**	**Spring survey 2021**	
Habitat searches	20 person hours of habitat searching	30 person hours of habitat searching	5 person hours of habitat searching	-	-	55 total person hours
Habitat assessment	-	-	-	-	20 Koala and Greater Glider sites, 11 Ornamental Snake sites, 20 water body assessments for Squatter Pigeon and Australian Painted Snipe	

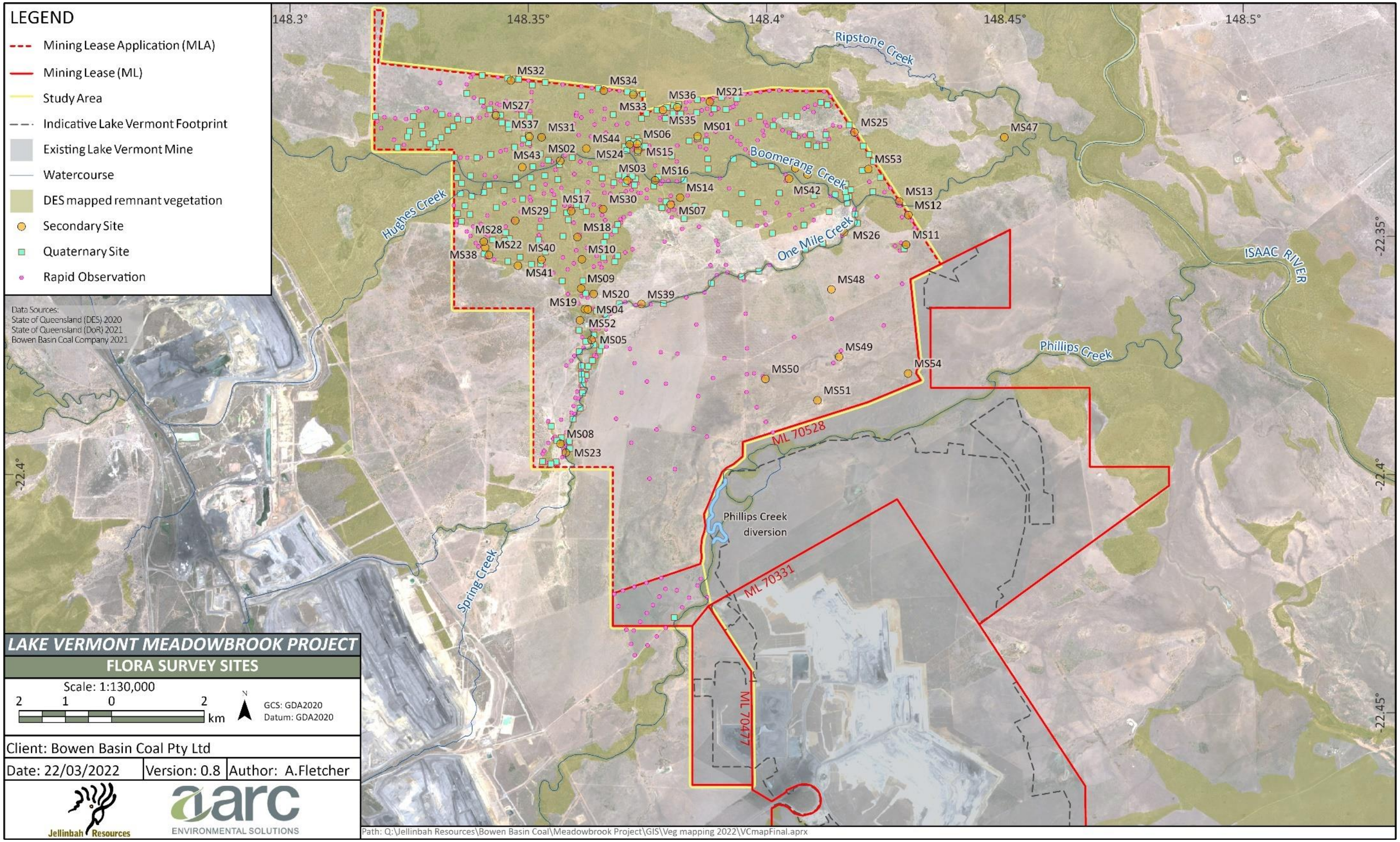

Figure 21.86: Flora survey sites

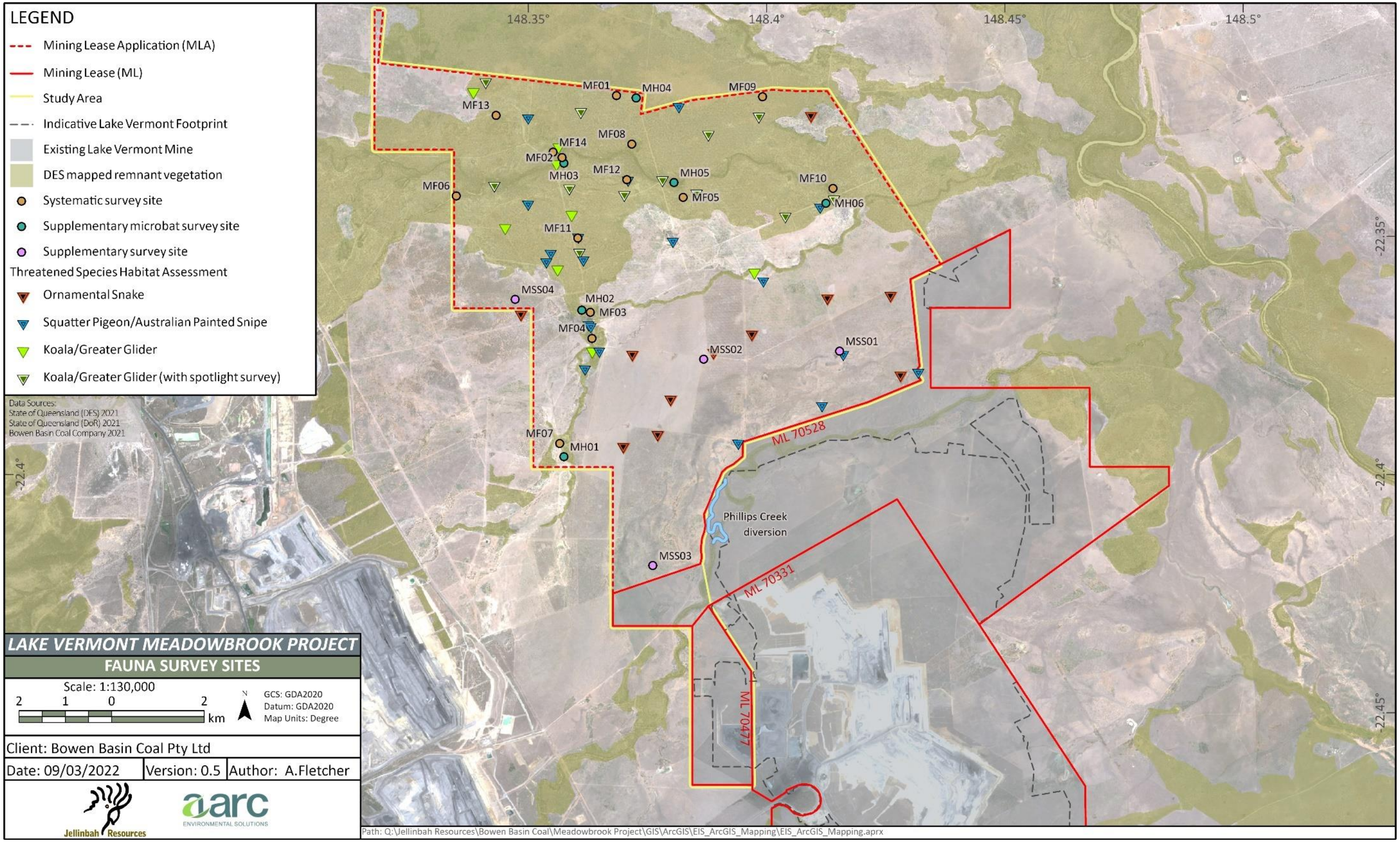

Figure 21.87: Fauna survey sites

21.12.2 Terrestrial ecology values

21.12.2.1 Regional Ecosystems

A total of 15 remnant REs were identified within the study area (Figure 21.88), comprising four ‘Endangered’ REs, three ‘Of Concern’ REs, and eight ‘Least Concern’ REs under the VM Act biodiversity status and four ‘endangered’, three ‘of concern’ and eight ‘least concern’ VM Act status REs. Cleared agricultural areas occupied the majority of the study area (5,431 ha) and high value regrowth has been identified. The descriptions of REs identified is presented in Table 21.38.

Table 21.38: Ground-truthed vegetation communities within the study area

Map unit	Vegetation community	Associated RE	VM Act status[1]	BD status[2]
1: Brigalow Woodlands				
VC 1a	Remnant Brigalow woodland on alluvial plains.	11.3.1	Endangered	Endangered
VC 1b	Remnant Dawson Gum woodland with Brigalow on undulating Cainozoic clay plains.	11.4.8	Endangered	Endangered
VC 1c	Remnant Brigalow with Yellowwood woodland with occasional Dawson Gum on Cainozoic clay plains.	11.4.9	Endangered	Endangered
VC 1d	High value regrowth Brigalow.	—	—	—
2: Eucalypt Woodlands				
VC 2a	Remnant Poplar Box woodland on alluvial plains.	11.3.2	Of Concern	Of Concern
VC 2b	Remnant Coolibah woodland on alluvial plains.	11.3.3	Of Concern	Of Concern
VC 2c	Remnant Eucalypt and Bloodwood spp. woodland on alluvial plains.	11.3.4	Of Concern	Of Concern
VC 2d	Remnant Poplar Gum and Clarkson’s Bloodwood woodland on floodplains.	11.3.9	Least Concern	No Concern at Present
VC 2e	Remnant Poplar Box with occasional Clarkson’s Bloodwood and Silver-leaved Ironbark woodland on sand plains.	11.5.3	Least Concern	No Concern at Present

Map unit	Vegetation community	Associated RE	VM Act status[1]	BD status[2]
VC 2f	Remnant Poplar Gum woodland on Cainozoic sand plains.	11.5.8c	Least Concern	No Concern at Present
VC 2g	Remnant Narrow-leaved Red Ironbark woodland on Cainozoic sand plains.	11.5.9c	Least Concern	No Concern at Present
VC 2h	Remnant Clarkson's Bloodwood and Poplar Gum woodland, often with a dense low tree layer dominated by Paperbark Tea-tree.	11.5.12	Least Concern	No Concern at Present
3: Riparian Woodlands				
VC 3a	Remnant River Red Gum or Blue Gum woodland fringing drainage lines.	11.3.25	Least Concern	Of Concern
4: Vegetation Associated with Wetlands				
VC 4a	Remnant River Red Gum, Poplar Gum and/or Blue Gum fringing lacustrine wetlands.	11.3.27b	Least Concern	Of Concern
VC 4b	Remnant Coolibah open woodland fringing palustrine wetlands.	11.3.27f	Least Concern	Of Concern
VC 4c	Palustrine swamp with fringing Blue Gum woodland in depressions on Cainozoic sand plains and remnant surfaces.	11.5.17	Endangered	Endangered

[1] Endangered; Of Concern; Least Concern
[2] Endangered; Of Concern; No Concern at Present

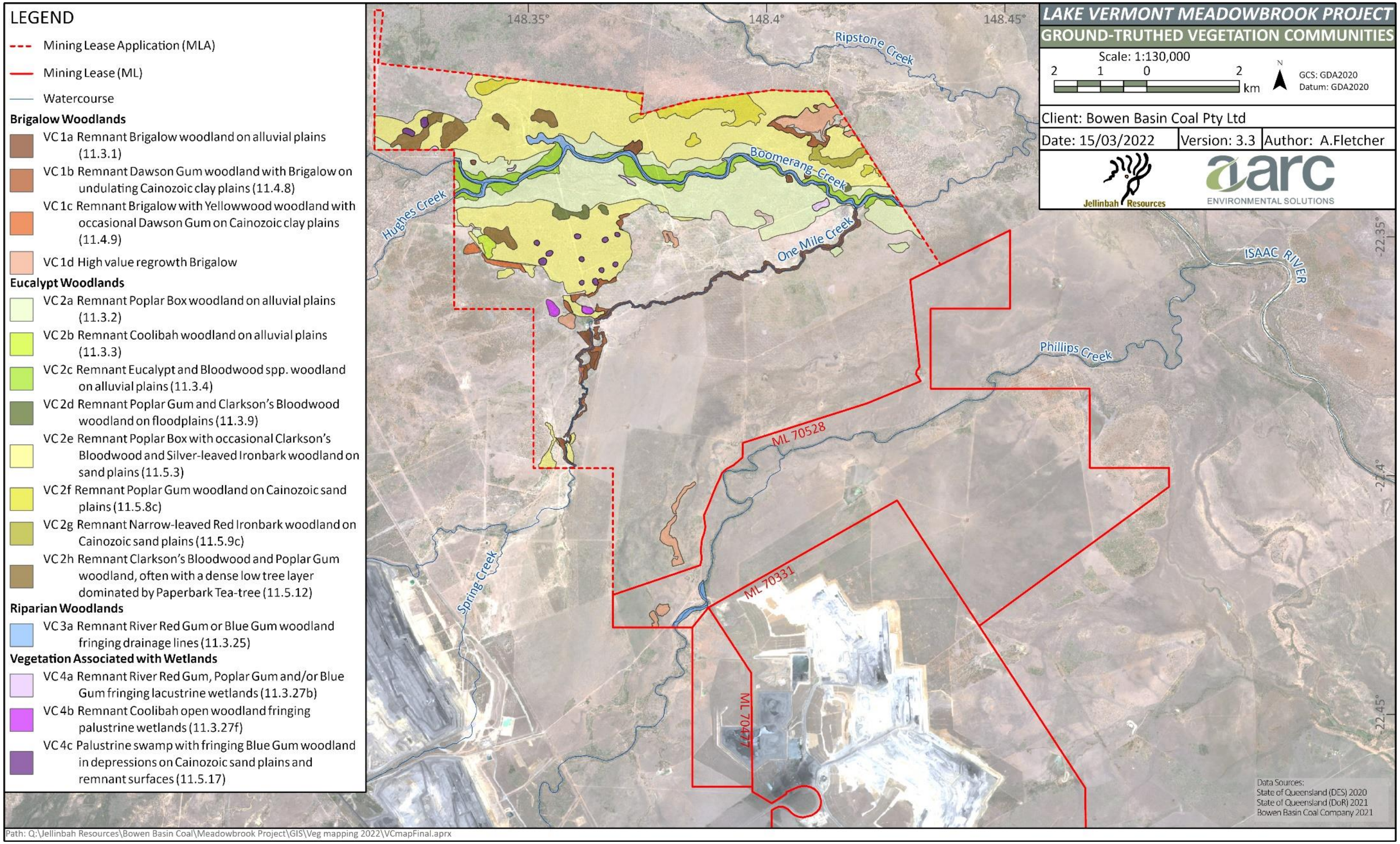

Figure 21.88: Ground-truthed vegetation communities within the study area

21.12.2.2 Threatened Ecological Communities

Two TECs defined under the EPBC Act were identified through as present within the terrestrial ecology study area, being:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC (Brigalow TEC); and
- Poplar Box Grassy Woodland on Alluvial Plains TEC (Poplar Box TEC).

These TECs are listed as endangered under the EPBC Act.

Brigalow (Acacia harpophylla dominant and co-dominant) TEC

Areas of Brigalow vegetation were recorded within the study area and many of these areas met the condition thresholds of the EPBC Act listed endangered Brigalow TEC. A total of 154.5 ha of Brigalow TEC occurring over 23 patches were identified and are shown on Figure 21.89.

The Brigalow TEC vegetation recorded at the study area is comprised of vegetation representing RE 11.3.1, RE 11.4.8 and RE 11.4.9.

Poplar Box Grassy Woodland on Alluvial Plains TEC

Areas of Poplar Box woodland vegetation were recorded within the study area and many of these areas met the Class B, good quality condition thresholds of the EPBC Act listed Poplar Box TEC. A total of 656.6 ha of Poplar Box TEC occurring over eight patches were identified and are shown on Figure 21.89.

The Poplar Box TEC vegetation recorded at the study area is comprised of vegetation representing RE 11.3.2.

21.12.2.3 Flora species of conservation significance

No conservation significant flora species were recorded within the study area.

21.12.2.4 Fauna species of conservation significance

Five fauna species listed as threatened under the EPBC Act and NC Act were identified during the field surveys, namely, the Ornamental Snake, Squatter Pigeon (Southern), White-throated Needletail, Koala and Greater Glider (Table 21.39). All of these species were listed as Vulnerable under the EPBC Act and NC Act at the time of the controlled action decision for the Project.

Since the time of the controlled action decision for the Project, it is noted that some changes have occurred to the listing status of some of these five species. Specifically, the EPBC Act listing status for the Koala and the Greater Glider has changed from Vulnerable to Endangered (during 2022). With this change occurring after the controlled action decision for the proposed Project was made, this assessment considers the impacts to these species as EPBC Act Vulnerable species.

The Short-beaked Echidna, listed as a non-migratory Special Least Concern species under the NC Act has also been recorded during the surveys.

An additional threatened species, the Australian Painted Snipe, has also been considered to have a moderate likelihood of occurring within the Project area.

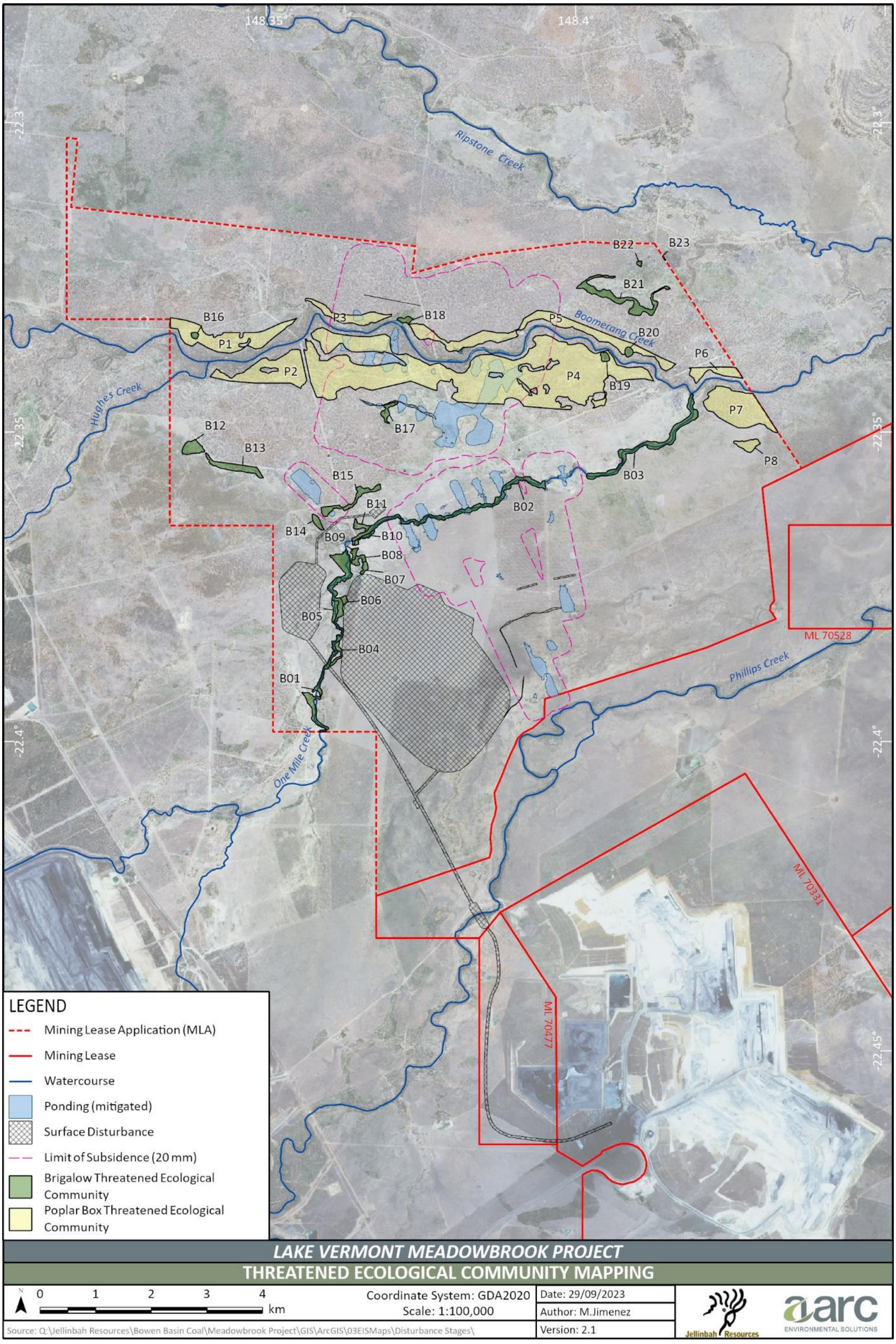

Figure 21.89: Threatened Ecological Communities within the study area

Table 21.39: Conservation significant fauna species recorded within the study area

Family	Scientific Name	Common Name	NC Act Status[1]	EPBC Act Status[2]
Reptiles				
Elapidae	*Denisonia maculata*	Ornamental Snake	V	V
Birds				
Apodidae	*Hirundapus caudacutus*	White-throated Needletail	V, SLC	V, Mi
Columbidae	*Geophaps scripta scripta*	Squatter Pigeon (Southern)	V	V
Laridae	*Thalasseus bergii*	Crested Tern	SLC	Mi
Mammals				
Phascolarctidae	*Phascolarctos cinereus*	Koala	V	V
Pseudocheiridae	*Petauroides volans*	Greater Glider	E	V
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	SLC	-

1 NC Act conservation status: E – Endangered, V – Vulnerable, SLC - Special Least Concern
2 EPBC Act conservation status: V - Vulnerable; Mi - migratory

21.12.2.5 EPBC Act listed migratory species

Two species listed as migratory under the EPBC Act and as Special Least Concern (migratory) species under the NC Act were recorded by the surveys, the White-throated Needletail (also listed as Vulnerable) and Crested Tern (*Thalasseus bergii*) (Table 21.39).

21.12.3 Potential impacts to terrestrial ecology values

The proposed Project development can be split into four Project stages, each with identifiable impacts. The areas impacted by each stage are presented in Figure 21.90, with the activities of the four stages including:

- Stage 1–project construction—occurs over approximately 2 years (Project Year -1 to Project Year 0);
- Stage 2–mining of the southern longwall panels—occurs over approximately 8 years (Project Year 1 to Project Year 8);
- Stage 3–mining of the northern longwall panels—occurs over approximately 15 years (Project Year 9 to Project Year 23); and
- Stage 4–open-cut pit—occurs over approximately 11 years (Project Year 20 to Project Year 30).

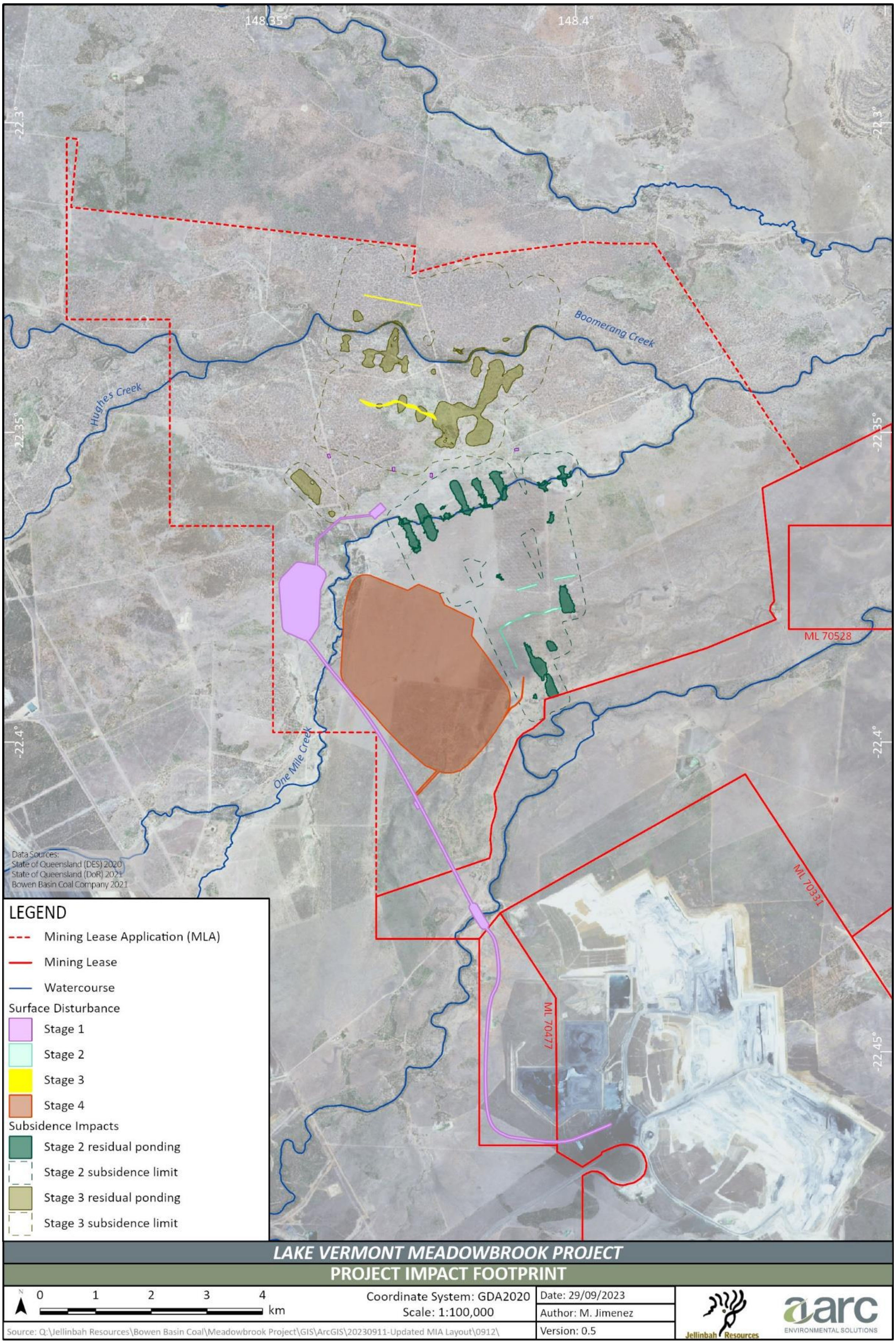

Figure 21.90: Project impact footprint

The potential impacts of the Project on terrestrial flora and fauna and their habitats will occur under each Project stage, including:

- direct impacts through vegetation clearance and habitat disturbance;
- indirect impacts including;
    - mine subsidence effects (e.g. changes to surface water hydrology, residual ponding post mining);
    - changes to surface or groundwater hydrology (e.g. groundwater drawdown);
    - fragmentation and edge effects;
    - weeds and pests;
    - noise and vibration;
    - dust;
    - artificial lighting; and
    - bushfires.
- cumulative impacts; and
- facilitated impacts.

The potential impacts of the Project and the measures developed to avoid, mitigate and manage impacts on terrestrial flora and fauna are described in Sections 21.12.3.2 to 21.12.3.15. Section 21.12.4 describes the potential impacts and avoidance, mitigation and management measures specific to MNES and MSES and assesses the significance of the impacts on these matters.

21.12.3.1 Vegetation clearance and habitat disturbance

Project infrastructure has been sited to avoid or minimise disturbance to remnant vegetation when possible. However, all four Project stages will include some direct vegetation clearance and habitat disturbance:

- Stage 1 includes the majority of clearance for Project infrastructure development.
- Stages 2 and 3 include some surface works for subsidence ponding mitigation and access for gas drainage.
- Stage 4 includes some vegetation clearance for the open pit development.

Details of the direct disturbance and vegetation removal for the Project stages are outlined below.

Stage 1

Stage 1 of the Project is the construction phase, which commences in Project Year -1 (indicatively 2024) with completion in Project Year 0 (indicatively 2025). Direct disturbance will occur in stage 1 including vegetation removal for the construction of the infrastructure corridor, MIA, ETL and supporting infrastructure. Whenever possible, infrastructure has been located so as to minimise the clearance of vegetation.

Stage 2 and 3

Stage 2 represents the mining of the underground longwall panels located south of the main headings (Figure 21.90). Stage 2 of the Project commences in Project Year 1 (indicatively 2026) and runs through to Project Year 8 (indicatively 2033). Stage 3 represents the underground mining of the longwall panels located north of the main headings (Figure 21.90) and involves mining of two laterally located coal seams. Stage 3 of the Project commences in Project Year 9 and runs through to Project Year 23 (indicatively 2048). Stage 2 and 3 involve some vegetation clearance for the construction of subsidence-induced ponding mitigation works as well as an additional access track to support gas drainage activities.

Proposed ponding mitigation works include the proposed construction of 'mitigation drains' and 'mitigation bunds' (Figure 21.63). Mitigation drains are designed to drain water away from areas of subsidence-induced ponding, while mitigation bunds are designed to prevent water moving into subsided areas. Both mitigation mechanisms are designed to reduce the extent of residual ponding. The proposed 'mitigation channels' and 'mitigation bunds' involve additional direct disturbance, however, substantially reduce the otherwise unmitigated ponding footprint. The proposed drainage works are located to minimise disturbance to Brigalow and Poplar Box TECs.

Areas of residual subsidence-induced ponding will be subject to intermittent periods of inundation, being estimated to retain water for a maximum period of several months, every few years, subject to the volume of inflow and soil permeability conditions (Appendix W, Geomorphological Assessment Report, section 3.3.3). For the purposes of this ecological assessment, areas of periodic ponding are considered to undergo impacts equivalent to the loss of existing vegetation. This is a conservative approach (as ponding areas will provide an ecological function similar to existing gilgais). Potential impacts of surface subsidence and periodic ponding is described in further detail in Section 21.12.3.6.

Vegetation clearance will also occur in Stage 3 for an access track, to allow surface access to the western longwall panels (to support proposed gas drainage activities) (Figure 21.10). This area of the Project site is currently not connected to existing access tracks. The proposed access track is located to minimise impacts to Brigalow and Poplar Box TEC. Stages 2 and 3 will result in surface subsidence from underground mining activities, and changes to surface water hydrology resulting in the creation of residual ponding areas post mining.

The potential impacts of surface subsidence and periodic ponding are described in further detail in Section 21.12.3.6.

Stage 4

Stage 4 involves the disturbance of vegetation for the satellite open-cut pit; this includes:

1) the pit levee construction;
2) development of waste rock emplacements;
3) sediment dams; and
4) mining disturbance (Figure 21.10).

Stage 4 is located predominantly within the cleared agricultural areas, although the north end of the pit will involve some clearance of remnant vegetation. Stage 4 has been designed to minimise the clearance of vegetation and avoid disturbance to watercourses.

21.12.3.2 Vegetation clearance

A total of 12.2 ha of remnant vegetation will be cleared and 96.9 ha impacted by predicted periodic ponding as a result of the Project, resulting in 109.1 ha of remnant vegetation disturbed by the Project. This represents some 3.2% of remnant vegetation within the study area.

Table 21.40 details the proposed clearance of each vegetation community identified within the study area.

The vegetation within the study area provides terrestrial fauna with opportunities for foraging, breeding, nesting, predator avoidance and movement between areas, facilitates dispersal/migration and promotes genetic diversity. These opportunities could potentially be reduced for fauna by clearance activities associated with the Project. Notwithstanding this, ponding areas induced by subsidence will create additional (seasonal) water sources for fauna not completely dissimilar to local gilgai functionality. Where practicable, Project infrastructure has been sited within cleared agricultural areas. The majority of disturbance associated with the proposed open-cut satellite pit will be to cleared agricultural land. Table 21.41 details the proposed clearance of each major habitat type identified in the study area.

Table 21.40: Proposed disturbance of vegetation communities

Map unit	Vegetation community	Associated RE	Extent within study area (ha)	Area of disturbance (ha)		
				Stages 1,2,3 clearing	Stage 2 and 3 residual ponding	Stage 4 clearing
1: Brigalow Woodlands						
VC 1a	Remnant Brigalow woodland on alluvial plains.	11.3.1	106.2	0.3	8.2	3.6
VC 1b	Remnant Dawson Gum woodland with Brigalow on undulating Cainozoic clay plains.	11.4.8	51.4	0.3	0.1	3.5
VC 1c	Remnant Brigalow with Yellowwood woodland with occasional Dawson Gum on Cainozoic clay plains.	11.4.9	19.4	0.0	0.0	0.0
VC 1d	High value regrowth Brigalow.	—	110.3	1.0	5.1	2.2
2: Eucalypt Woodlands						
VC 2a	Remnant Poplar Box woodland on alluvial plains.	11.3.2	960.2	0.0	58.3	0.0
VC 2b	Remnant Coolibah woodland on alluvial plains.	11.3.3	12.2	0.0	0.0	0.0
VC 2c	Remnant Eucalypt and Bloodwood spp. woodland on alluvial plains.	11.3.4	178.0	0.0	4.9	0.0
VC 2d	Remnant Poplar Gum and Clarkson's Bloodwood woodland on floodplains.	11.3.9	22.8	0.3	0.0	0.0
VC 2e	Remnant Poplar Box with occasional Clarkson's Bloodwood and Silver-leaved Ironbark woodland on sand plains.	11.5.3	1,593.8	2.6	17.7	0.0
VC 2f	Remnant Poplar Gum woodland on Cainozoic sand plains.	11.5.8c	126.5	0.0	0.0	0.0
VC 2g	Remnant Narrow-leaved Red Ironbark woodland on Cainozoic sand plains.	11.5.9c	28.0	0.0	0.0	0.0
VC 2h	Remnant Clarkson's Bloodwood woodland often with a dense low tree layer dominated by Paperbark Tea-tree.	11.5.12	94.5	0.0	0.0	0.0
3: Riparian Woodlands						
VC 3a	Remnant River Red Gum or Blue Gum woodland fringing drainage lines.	11.3.25	135.8	1.5	5.2	0.0

Map unit	Vegetation community	Associated RE	Extent within study area (ha)	Area of disturbance (ha)		
				Stages 1,2,3 clearing	Stage 2 and 3 residual ponding	Stage 4 clearing
4: Vegetation Associated with Wetlands						
VC 4a	Remnant River Red Gum, Poplar Gum and/or Blue Gum fringing lacustrine wetlands.	11.3.27b	10.6	0.0	2.4	0.0
VC 4b	Remnant Coolibah open woodland fringing palustrine wetlands.	11.3.27f	11.1	0.1	0.0	0.0
VC 4c	Palustrine swamp with fringing Blue Gum woodland in depressions on Cainozoic sand plains and remnant surfaces.	11.5.17	21.3	0.0	0.0	0.0

Table 21.41: Proposed disturbance of major habitat types within the study area

Major habitat type	Extent within study area (ha)	Area of disturbance (ha)		
		Stage 1,2,3 clearing (ha)	Stage 2 and 3 residual ponding (ha)	Stage 4 clearing (ha)
Brigalow woodlands	287.3	1.7	13.4	9.3
Eucalypt dry woodlands	2,825.7	2.9	76.0	0.0
Eucalypt open forest to woodlands on floodplains	326.0	1.5	10.2	0.0
Freshwater wetlands	43.0	0.1	2.4	0.0
Cleared agricultural areas	5,446.7	138.2	111.7	656.2

Temporary disturbance for gas drainage

The drainage of in-seam gas will be undertaken *via* a system of wells and control equipment located on a relocatable skid. Access to the surface of each panel for gas drainage will be gained predominantly *via* the existing track network. Additional access will be required to panels in the west end of the Stage 3 underground mining area, which is currently isolated from existing tracks. One track is therefore proposed to provide access for the movement of gas drainage equipment, which is included in the stage 3 direct disturbance footprint and shown on Figure 21.10. Further access from the existing and proposed track network (to support gas drainage activity) will be achieved without ground disturbance, with slashing of access tracks proposed (as opposed to blade clearing) of any additional tracks.

Gas drainage wells will be developed over each panel as mining progresses through the underground area, with the relocatable control equipment transported on the surface to new locations as required.

Temporary disturbance created for the deployment of drilling vehicles and gas control equipment will be progressively rehabilitated. Previously disturbed areas will be in stages of regeneration and rehabilitation and in the order of two hectares at any one time. Gas drainage activities will preferentially avoid areas of Brigalow TEC, Poplar Box TEC, areas of fauna habitat of conservation significance and vegetation in proximity to watercourses.

Gas drainage activity will also avoid any disturbance to the bed and banks of watercourses. Clearing of mature trees will also be avoided, with lopping of branches rather than removal of trees to occur if necessary. Gas drainage sites will therefore present minimal, temporary areas of disturbance, consistent with that of exploration activity. Disturbance to be rehabilitated upon the completion of each site. Given the nature and extent of this disturbance, gas drainage activities are unlikely to result in a significant impact on the distribution and abundance of wildlife in the Project locality.

21.12.3.3 Vegetation clearance protocols

The following management measures will be implemented where vegetation clearance is necessary:

- Clearing activities will be undertaken progressively in accordance with the mine schedule and Project requirements and not before.
- Vegetation/habitat adjoining proposed clearance areas will be delineated and clearly marked to prevent accidental damage through a ‘Permit to Disturb’ process.
- Areas to be cleared will be inspected to identify fauna at direct risk from clearing activities.
- Vegetation will be felled in the direction of the clearance zone to avoid impacts to adjoining retained vegetation and habitat.

- Clearing operations will be managed to maximise the reuse of cleared vegetative material. This will include the salvage and reuse of select habitat resources from the cleared vegetation (e.g. logs) for habitat enhancement either in the rehabilitation program, proposed offset areas located on Bowen Basin Coal land or elsewhere on-site.

As described in Section 21.12.3.2, temporary vegetation/habitat disturbance above the underground mining area will be undertaken for the deployment of gas drainage wells. These surface works will be sited to minimise the amount of vegetation disturbance required (e.g. the positioning of infrastructure and vehicle access routes to avoid the removal of trees or the siting of infrastructure in previously disturbed areas, such as adjacent to existing tracks). Management measures for areas of disturbance required above the underground mining area include the following criteria:

- Existing tracks will be used to access sites to minimise the disturbance of soils and creation of new tracks.
- Vegetation clearance will be restricted to the slashing of vegetation (i.e. leaving the lower stem and roots in situ to maximise the potential for natural regrowth), where practicable.
- Branches will be lopped, rather than removing trees, where practicable.
- The amount of soil disturbance will be limited to the minimum required for the mobilisation, placement and operation of equipment and for maintaining access to equipment.
- Rehabilitation measures will be implemented in the event that natural regeneration is considered not to be progressing (e.g. weed control measures or active planting). Details of proposed rehabilitation measures are provided in the Project PRC Plan.

21.12.3.4 Clearing Management Program

A Clearing Management Program will be prepared for the Project by a suitably qualified ecologist in accordance with guidelines prior to Project clearance activities.

The Clearing Management Program will include the following criteria:

- Measures will be implemented to minimise disturbance and salvage and reuse of select habitat features in accordance with the vegetation clearance protocols.
- Protocols will be implemented to handle fauna encountered prior to or during clearing activities, including their relocation as necessary to suitable habitat.
- An appropriately qualified fauna spotter/catcher will be present during clearing.
- Specific measures will be implemented to minimise impacts to threatened species, including the Ornamental Snake, White-throated Needletail, Squatter Pigeon, Koala and Greater Glider.
- Protocols will be implemented to handle injured wildlife, including emergency euthanasia.

21.12.3.5 Rehabilitation

Land disturbed by mining activities will be rehabilitated progressively as it becomes available. Details of the proposed rehabilitation program are provided in Chapter 6, Rehabilitation and Appendix B, Progressive Rehabilitation and Closure Plan (section 3.5). In accordance with the Queensland government's policy objectives defined in the 'Mined land rehabilitation policy' (Queensland Government 2018), the general rehabilitation goals for the Project are to leave an area that is safe and stable, does not cause environmental harm and is able to sustain the post-mining land use approved in the PRCP.

21.12.3.6 Subsidence effects and residual ponding

Surface cracking

Some surface soil cracking is also predicted as a result of subsidence. Tension cracks are expected to develop and close after short periods, as the transient tensile strain passes above the retreating longwall. Longer lasting tension cracks can develop in areas of residual tensile strain, which generally occur along the perimeter of longwall panels.

Maximum surface crack widths of 200 mm are predicted above the shallower underground mining areas, with a maximum of 50 mm crack widths above the deeper underground mining areas. Cracking depths are predicted to be predominantly less than 1 m up to a potential maximum of 15 m, with no connective cracking from the surface to the mined seams.

Soils affected by cracking are predominantly expected to self-ameliorate through wetting/drying cycles, particularly in areas with shrink swell vertosols which are dominant in the stage 2 underground mining subsidence area and the southeast portion of the stage 3 underground mining subsidence area (Appendix C, Soils and Land Assessment, section 10.2.2). Soil cracks that do not resolve are expected to be amenable to small scale crack rehabilitation involving excavation and backfilling. Excavation will be reserved as a last resort to repair residual cracking, to minimise additional disturbance.

Surface cracking is not expected to result in impacts to vegetation, however if surface cracking creates conditions which allow soil erosion to develop, vegetation could be impacted as a result of erosion. Ongoing monitoring and management of surface cracking is proposed to avoid erosion developing.

Surface crack rehabilitation

Crack rehabilitation works will be initiated in consideration of locations of conservation significant species and ecosystems, with work to be undertaken without machinery where possible. The Subsidence Management Plan will integrate an adaptive soil crack monitoring and management approach, such that, where unpredicted subsidence impacts and environmental consequences occur, previously approved processes will be considered to prevent their reoccurrence. Crack rehabilitation will include the following:

- surveys for persistent surface cracking;
- scarifying or ripping of minor cracks using light machinery;
- removal of topsoil from cracked areas, excavation and backfilling, and re-spreading topsoil to affected areas;
- natural regeneration through soil seed bank, rootstock material and recruitment; and
- post rehabilitation monitoring.

Rehabilitation works is expected to be limited to areas three meters wide and will not require the removal of trees. Livestock will be excluded from areas undergoing active subsidence and will not be present in areas subject to crack rehabilitation.

Predicted impacts from surface cracking

Tension cracks may form around the perimeter of each longwall panel and the nature and persistence of cracks will be dependent on the depth of cover, panel and pillar width, geology and soil properties. Where persistent soil cracks develop, crack rehabilitation will be conducted in accordance with the Subsidence Management Plan. The rehabilitation of soil cracks will not require any routine clearing of vegetation and will only be conducted where cracks fail to self-ameliorate and the risk of erosion develops. Trees will not be removed for crack rehabilitation. Crack rehabilitation works will be conducted with light machinery and targeted to affected areas in an approach that avoids clearing of understory vegetation. Where targeted understory vegetation removal is required for crack rehabilitation, the site will be immediately remediated, and re-vegetation will be started. Rehabilitated areas will remain under observation to allow monitoring of success of the approaches used.

Where soil cracks are temporary and self ameliorating, they are not expected to cause any significant impacts to vegetation and fauna habitat quality. The remediation of soil cracks is expected to adequately rehabilitate persistent cracking and the rehabilitation works are not expected to result in significant impact to terrestrial ecology values.

Subsidence and ponding area impact

The surface water assessment has identified the areas of subsidence footprint that will develop potential for residual ponding (post-mining). Mitigation measures to minimise ponding by facilitating drainage in the subsidence footprint have been designed and incorporated into the Project design to minimise the extent of subsidence-induced ponding (WRM 2022). Areas subject to predicted residual ponding which cannot be mitigated by drainage works are predicted to experience ponding during flooding events for a maximum period of several months in every few years. Ponding extent will typically be less than the maximum modelled extent and duration shorter than worst-case scenario predicted, pumping of ponding areas may also be undertaken when depth exceeds 0.5m at the deepest location, further reducing ponding extent and duration. Notwithstanding these predictions, a conservative assessment approach has been taken and the ponding areas changed hydrological regime is considered to be potentially deleterious to the existing vegetation communities particularly ecological values associated with tree species (Section 21.12.3.1).

Outside of predicted ponding areas, the broader subsidence footprint is expected to demonstrate no material changes to the surface landform, with impacts to have a short duration (i.e. land movement once the panel is mined). Subsidence-induced changes to the surface landform are not expected to impact ecological values, outside of areas where residual ponding is resultant or disturbance for mitigation works is proposed.

Monitoring results from similar mining operations in the Bowen Basin have demonstrated that subsidence from underground mining has no broad patterns of impact on vegetation. An assessment of subsidence impacts on vegetation for comparable operations has identified that there would be no change in woodland canopy height or projected foliar cover over the entire longwall panel area (Eco Logical Australia 2015), including the most subsided areas that are likely to be inundated with ponding. Subsidence monitoring of additional existing underground mining projects in the Bowen Basin indicates that subsidence impacts can be minor and non-damaging to the viability and habitat provision of open Eucalypt Woodland and riverine woodland vegetation. At the Grosvenor project, monitoring of impacts on vegetation demonstrates that subsidence-affected areas show no substantial deleterious impact on vegetation conditions in areas of Eucalypt Woodlands (including areas of Poplar Box vegetation, RE 11.3.2) and Brigalow Woodlands (including RE 11.4.9). This is based on an assessment of:

- habitat continuity;
- vegetation cover;
- dominance of natives;
- debris; and
- other indicative features (Engeny 2020).

At the Moranbah North project, monitoring demonstrates that the condition of vegetation impacted by subsidence and waterway diversion is comparable to control sites (Engeny 2021).

Notwithstanding this, for the purposes of the Project terrestrial ecology assessment, the impact to vegetation from residual ponding is considered to be equivalent to the clearance of tree species and as a result, habitat values dependent on trees. This represents a conservative assessment of the potential subsidence impacts and it is possible that the Subsidence Management Plan measures will avoid and mitigate potential impact. The habitat values provided by cleared agricultural areas are considered to be retained, despite residual ponding development because the pre-mining conditions of these areas involve intermittent ponding of gilgai depressions which will continue post-subsidence and the pre-mining conditions do not include presence of tree species that are expected to be susceptible to impacts from intermittent ponding. The areas of ponding impact on vegetation communities is presented in Table 21.40, impacts to major habitat types are presented in Table 21.41 The portions of the subsidence footprint not predicted to undergo ponding are expected to retain viability and continue provision of habitat values and are, therefore, considered not to be subject to any substantial impacts resulting from subsidence. Subsidence footprint areas excluding ponding areas is presented in Table 21.42.

Table 21.42: Vegetation within subsidence footprint excluding ponding areas

Map unit	Vegetation community	Associated RE	Extent within study area (ha)	Area within unponded subsidence footprint (ha)
1: Brigalow Woodlands				
VC 1a	Remnant Brigalow woodland on alluvial plains	11.3.1	106.2	25.0
VC 1b	Remnant Dawson Gum woodland with Brigalow on undulating Cainozoic clay plains	11.4.8	51.4	7.1
VC 1c	Remnant Brigalow with Yellowwood woodland with occasional Dawson Gum on Cainozoic clay plains	11.4.9	19.4	0.0
VC 1d	High value regrowth Brigalow	—	110.3	1.6
2: Eucalypt Woodlands				
VC 2a	Remnant Poplar Box woodland on alluvial plains	11.3.2	960.2	313.2
VC 2b	Remnant Coolibah woodland on alluvial plains	11.3.3	12.2	0.0
VC 2c	Remnant Eucalypt and Bloodwood spp. Woodland on alluvial plains	11.3.4	178.0	61.0
VC 2d	Remnant Poplar Gum and Clarkson's Bloodwood woodland on floodplains	11.3.9	22.8	10.2
VC 2e	Remnant Poplar Box with occasional Clarkson's Bloodwood and Silver-leaved Ironbark woodland on sand plains	11.5.3	1,593.8	496.7
VC 2f	Remnant Poplar Gum woodland on Cainozoic sand plains	11.5.8c	126.5	32.2
VC 2g	Remnant Narrow-leaved Red Ironbark woodland on Cainozoic sand plains	11.5.9c	28.0	0.0
VC 2h	Remnant Clarkson's Bloodwood woodland often with a dense low tree layer dominated by Paperbark Tea-tree	11.5.12	94.5	0.0
3: Riparian Woodlands				
VC 3a	Remnant River Red Gum or Blue Gum woodland fringing drainage lines	11.3.25	135.8	35.0
4: Vegetation Associated with Wetlands				
VC 4a	Remnant River Red Gum, Poplar Gum and/or Blue Gum fringing lacustrine wetlands	11.3.27b	10.6	<0.1
VC 4b	Remnant Coolibah open woodland fringing palustrine wetlands	11.3.27f	11.1	0.0
VC 4c	Palustrine swamp with fringing Blue Gum woodland in depressions on Cainozoic sand plains and remnant surfaces	11.5.17	21.3	4.5

Subsidence Management Plan

During development of areas predicted to be subject to subsidence impacts, monitoring will be undertaken to assess the occurrence and severity of any potential impacts. An adaptive management approach will be adopted, with management measures implemented as necessary. This approach to the management of subsidence impacts will be detailed through the development of a SMP and a draft SMP has been prepared for the Project (Appendix A2).

The Project SMP will:

- Provide a description of the topography of the area to be affected by subsidence, including:
  - soils and geology of the area;
  - ecological values;
  - surface water values; and
  - groundwater values.
- Provide the predictions of the magnitude of subsidence for the mining area, including:
  - predicted subsidence from mining of each longwall panel;
  - predicted geomorphic changes to watercourses; and
  - predicted surface cracking.
- Provide the predictions of the magnitude of flora and fauna impacts from subsidence, including:
  - predicted areas of decline in tree vegetation resulting from ponding; and
  - predicted areas of in-stream subsidence troughs.
- Provide a risk assessment that will include the likelihood and consequence of each of the impacts and priority of actions to be implemented in the mitigation process.
- Provide a description of measures to minimise and remediate impacts, including;
  - the exclusion of grazing cattle from the active subsidence affected area;
  - describe the adaptive management approach to potential subsidence impacts;
  - outline approach for rehabilitation of persistent soil cracks; and
  - outline bank protection measures for potential stream bank erosion impacts.
- Provide the detail of the ongoing subsidence monitoring program, including;
  - condition monitoring of watercourses in subsidence affected areas;
  - monitoring for soil cracks impacts; and
  - monitoring of vegetation condition impacts.
- Provide the detail of the process for determining when active management (rehabilitation) is required to address surface cracking, erosion, geomorphological changes, or other unexpected impacts that may arise. Provide the process for determining the most applicable rehabilitation method to be adopted to address these impacts, to both minimise further disturbance and ensure protection of environmental values present within the area of impact.

The subsidence monitoring program will provide data to assist with the management of associated risks, validate subsidence predictions and analyse the relationship between subsidence effects and impacts on the surrounding environment. A trigger action response plan as well as contingency plans will be described in the SMP whenever there are variations with respect to predicted subsidence.

21.12.3.7 Hydrological changes

Surface water

The predicted changes to watercourses as a result of the Project are identified in Appendix W, Geomorphological Assessment Report (section 4.5). A summary of the predicted changes with reference to potential impacts to terrestrial ecology values is presented as follows.

Boomerang Creek

The predicted subsidence will result in a series of six small troughs in the Boomerang Creek channel bed (Figure 21.90). In these troughs which will be limited to the stream channel, channel velocity will be decreased, and aggradation of sediment into the stream bed will be promoted in these areas. Where the creek drains into the subsidence zone, increased channel velocity is predicted, with potential for marginal increase in bank erosion. The pillars between the subsidence troughs are expected to undergo initial bank erosion during the initial flows after subsidence; however, the grade is expected to revert to pre-mining grade as troughs infill with the sediment that is abundant upstream in Boomerang Creek.

The predicted subsidence troughs in the Boomerang Creek channel are not expected to represent an impact to terrestrial ecology values. The channel is an unvegetated sandy stream substrate and, therefore, does not contain any conservation significant vegetation or fauna habitat value. The marginal risk of increased bank erosion where the creek enters the first subsidence trough is not expected to result in an impact to the vegetation adjoining the creek (Appendix W, Geomorphological Assessment Report, section 5.2).

One Mile Creek

The predicted subsidence will result in a series of eight main troughs in the channel bed aligning perpendicularly to the channel (Figure 21.90). The troughs will align with residual ponding areas extending laterally from the watercourse. During floods, water will flow laterally and inundate the subsidence troughs. Where the channels intersect with subsidence troughs, channel velocity is expected to decrease, and sediment transport capacity will drop promoting sediment aggradation. Where the channel enters the subsidence zone, channel velocity will increase, and some channel erosion is expected. Bank erosion may also potentially occur. Some localised channel bed erosion is also expected where the channel enters the second to fifth subsidence troughs (working downstream). The infilling of these troughs is expected to require more time than the troughs in Boomerang Creek, due to less availability of sediment in the watercourse. The temporary levee proposed for the open-cut pit will also cause a minor impact to flow in One Mile Creek.

The predicted subsidence troughs within the channel of One Mile Creek and the associated lateral areas connected to the channel ponds are considered to represent areas of direct impact to the existing vegetation. The troughs are predicted to extend into adjacent riparian vegetation, including riparian Brigalow TEC vegetation and the impacts to this vegetation is assessed in Section 21.12.4.1. The surface water assessment has identified that some creek bank erosion may occur where the creek enters the subsidence zone; however, this erosion is predicted to be minor and will be subject to monitoring as part of the proposed Subsidence Management Plan. Management measures are available should this impact occur (Appendix W, Geomorphological Assessment Report, section 5.3).

Phillips Creek

Phillips Creek channel is not predicted to be impacted by any subsidence. The predicted subsidence and open-cut pit levee within the Phillips Creek flood plain may cause some minor impact on flooding and drainage. The drainage works in the subsidence area and design of drainage around the open-cut pit levee are expected to maintain the flow of water through the subsidence zone and prevent the drainage of water from the Phillips Creek floodplain into One Mile Creek.

The Project is not expected to have any substantial impact on the catchment or stream channel of Phillips Creek. No terrestrial ecology values are expected to be impacted by hydrological changes in this stream.

Surface water impacts summary

The Subsidence Management Plan will include measures for the monitoring of creek morphology and stream bed and bank impacts. Where erosion of stream banks with demonstrable impact on channel form is identified bank protection measures will be considered (Appendix W, Geomorphological Assessment Report, section 4.5). The bank protection measures are expected to be effective in securing stream banks from erosive processes and prevent the impact to terrestrial ecology values including riparian vegetation along subsidence affected watercourses. Notwithstanding this, it should be noted that the predicted ponding areas include the subsidence troughs in Boomerang Creek and One Mile Creek and these predicted ponding areas are considered to be subject to impacts to vegetation comparable to the removal of vegetation (refer Section 21.12.3.6).

21.12.3.8 Flooding

Across the Project area during flood events, the extent of inundation is predicted to be increased at the margins of subsided areas. A summary of the predicted changes within the floodplain of the Project area with reference to terrestrial ecology values is presented below.

- Boomerang Creek meanders across a broad floodplain. The undrained depressions on the floodplain will substantially increase after the predicted subsidence and partially fill with local rainfall and runoff. The extent of the depressions that remain undrained after flooding will be reduced by the proposed ponding drainage mitigation, but areas of residual ponding are predicted to remain. During flood events, the extent of inundation is predicted to be increased by the proposed project as a result of back water flowing up subsidence troughs. Peak flood levels within the subsidence zone are predicted to be reduced during flood events, and flow velocities will significantly reduce as water is stored in subsided areas.
- One Mile Creek shares a floodplain with Boomerang Creek. Within the subsidence zone, peak flood levels will be reduced during flood events of approximately 2% AEP and smaller. For flood events larger than 2% AEP, the impact of predicted subsidence on peak flood levels will be minimal.
- The Phillips Creek floodplain is the location of the open-cut pit and a portion of the underground mine panels, which all have the potential to impact flood hydrology. Proposed drainage mitigation measures are predicted to allow the movement of flood waters to be consistent with pre-mine conditions.

Flow velocities are predicted to be reduced in portions of the floodplain as water is stored in subsided areas; and increase in areas where overbank floodwater drains into subsidence troughs (Appendix W, Geomorphological Assessment Report, section 4.4). The increased velocities are predicted to generally remain below 0.75 m/s for the 50% AEP event and 1 m/s for a 2% AEP event, which are predicted to be unlikely to significantly alter floodplain morphology (Appendix W, Geomorphological Assessment Report, section 4.4).

Changes to flood hydrology are therefore not predicted to result in any significant impacts on terrestrial ecology values. The function of flood regimes is expected to be retained for vegetation and habitat features, including areas of gilgai features that undergo inundation in periodic flood conditions.

21.12.3.9 Habitat fragmentation and connectivity

Vegetation clearing has the potential to fragment vegetation remnants and impact on the continuity of corridors. As described in Section 21.12.3.1, the majority of vegetation clearance for the Project will occur in the MIA, infrastructure corridor and open-cut mining area. The landscape within which these components are proposed to be situated is already fragmented from nearby areas of woodland vegetation.

The northern portion of the study area contains a large contiguous area of remnant vegetation that provides fauna with significant dispersal opportunities. The relatively small (and temporary) areas of disturbance associated with temporary Project activities (such as gas wells) and residual ponding are unlikely to limit the opportunities for faunal dispersal through the woodland habitats.

Riparian corridors associated with Boomerang Creek, Hughes Creek, One Mile Creek and Phillips Creek provide east–west fauna movement opportunities through the landscape. The riparian vegetation along these streams is mapped as regionally significant (Boomerang Creek, Hughes Creek, One Mile Creek) or state significant (Phillips Creek) corridors connecting to state significant riparian vegetation along the Isaac River. The riparian corridors associated with these streams provide species with opportunities for movement and dispersal, in particular the Koala and Greater Glider. While the Project infrastructure corridor primarily traverses cleared agricultural areas, it will also traverse the riparian corridors of Phillips Creek and One Mile Creek. The proposed infrastructure corridor will fragment the riparian vegetation at these locations and may impact on species' ability to disperse along the riparian corridors. The predicted residual ponding on One Mile Creek may impact on species' ability to disperse through the ponding areas. However, although the assessment conservatively considers these areas to be significantly impacted, vegetation will not be cleared, no Project infrastructure will be constructed in riparian subsidence areas to inhibit dispersal and ponding will be infrequent (some extent of ponding expected every few years and lasting for up to a few months) and therefore no significant impacts to connectivity are expected to result from this predicted ponding.

The avoidance, mitigation and management measures that have been described for direct vegetation clearance/habitat disturbance are also relevant to minimising habitat fragmentation and impacts on connectivity.

21.12.3.10 Weeds and pests

Many introduced flora species are effective competitors for resources and have the potential to reduce the floristic structure and diversity of native plant communities.

Thirty-five introduced flora species have been recorded within the Study area. Seven flora species recorded are listed as restricted matters under the Biosecurity Act (Qld) and/or as WONS:

1) Harissia Cactus (*Harrisia martini*);
2) Balloon Vine (Cardiospermum grandiflorum);
3) Parthenium (Parthenium hysterophorus);
4) Lantana (Lantana camara);
5) Rubber Vine (Cryptostegia grandiflora);
6) Velvety Tree Pear (*Opuntia tomentosa*); and
7) Common Prickly Pear (*Opuntia stricta*).

Activities that could introduce or spread weeds include soil disturbance and vehicle movements. Vegetation clearing can also result in 'edge effects', when the clearing activities cause modifications to the interface with natural habitats. Areas to be directly disturbed by the Project are predominantly associated with cleared agricultural areas where introduced plants (such as Buffel Grass) dominate the ground layer. Parthenium is the most common Biosecurity Act (Qld)/WONS weed species recorded throughout the study area and occurs in higher densities within cleared agricultural areas.

Nine introduced fauna species that present risk to native fauna and their habitat have been recorded in the study area:

1) Cane Toad (Rhinella marina);
2) European Cattle *(Bos taurus);*
3) Wild Dog (Canis familiaris);
4) European Red Fox *(Vulpes vulpes);*
5) Red Deer (Cervus elaphus);
6) Feral Cat (*Felis catus*);
7) House Mouse (*Mus musculus*);

8) Rabbit (Oryctolagus cuniculus); and

9) Feral Pig (*Sus scrofa*).

Relative to these introduced species, the following are listed as key threatening processes under the EPBC Act[3]:

- biological effects, including lethal toxic ingestion, caused by Cane Toads;
- predation by the European Red Fox.
- predation by Feral Cats.
- predation, habitat degradation, competition and disease transmission by Feral Pigs.
- competition and land degradation by rabbits.

The provision of scavenging areas (e.g. discarded food scraps and other rubbish) has the potential to increase populations of introduced fauna species in and around the Project area.

The Lake Vermont Mine Pest and Weed Management Plan will be reviewed and revised when appropriate to incorporate pest and weed management measures for the Project. The existing Laker Vermont pest and weed management plan currently includes flora and fauna pest management strategies. These are detailed below:

Weed management:

- list of weeds identified on the project site
- management strategies to minimise spread of pre-existing weed and preventing the introduction of new species; and
  - monitoring of weeds by site personnel;
  - recording of major site infestations;
  - treating identified weeds as per the Department of Natural Resources and Water (DNRW) Pest Fact sheets as soon as possible;
  - treated weeds to be monitored on a regular basis; and
  - areas of disturbance minimised to prevent establishment of weed species.
- weed control methods specific to each identified species.

Fauna pest management:

- list of faunal pests that occur on the Project site; and
- management strategies.
  - domestic waste to be stored appropriately and located in areas in accessible to feral animals;
  - waste to be disposed of in deep land fill on a regular basis; and

landfill sites to be regularly covered to reduce the occurrence of feral cats, pigs and nuisance birds.

The existing Pest and Weed Management Plan for the Lake Vermont Mine complex will be updated to include:

- inspections within the mining lease to identify areas requiring weed management to be implemented;

[3] A threatening process is defined as a key threatening process under the EPBC Act if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.

- weed management measures (e.g. mechanical removal and application of approved herbicides) in consideration of weed control strategies outlined by the Department of Agriculture and Fisheries and the 'Isaac Regional Biosecurity Plan 2020–2023' (Isaac Regional Council 2020);
- requirements for follow up inspections to assess the effectiveness of the weed management measures implemented and requirement for any additional management measures;
- requirements for maintenance of a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by introduced fauna;
- requirements for storage of domestic waste in appropriate receptacles and locations;
- feral animal control strategies in consideration of pest control strategies outlined by the Department of Agriculture and Fisheries, 'Isaac Regional Biosecurity Plan 2020–2023' (Isaac Regional Council 2020) and Threat Abatement Plans applicable to the EPBC Act listed key threatening processes; and
- requirements for minimisation of the period that areas remain in disturbed and or unvegetated condition.
- legislative changes relating to the Biosecurity Act, the policies of the Biosecurity Plan (IRC 2020) and Threat Abatement Plans applicable to the EPBC Act 'Key Threatening Processes';
- invasive species recorded in the Project area;
- proposed management measures;
- establishment of a monitoring program to identify introduction and establishment of invasive species and for the evaluation of success achieving objectives of the Management Plan;
- description of the personnel roles and responsibilities for implementation of the Management Plan; and
- establishing a review process for the Management Plan.

It is considered unlikely that the Project will increase the occurrence or diversity of weeds or feral pests with the given management measures proposed to be implemented.

21.12.3.11 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.

Potential sources of noise or vibration in the proposed underground mining area include the ventilation shafts, vehicle movements and the operation of equipment (e.g. haulage trucks, loaders, dozers, drill rigs, compressors and other drilling-related equipment). The potential for noise and vibration generation in the proposed underground mining area is expected to be low. Construction related noise generating activities in the underground mining area will typically be localised and of short duration and may induce small movements of fauna species.

The indirect noise impacts on the woodland and other habitats from the open-cut mining activities proposed to be undertaken in the latter stages of the Project or from vehicle movements on the haul road, will be localised and minor given fauna often readily habituate to continuous noise. While sudden noise (e.g. blasting activities) has the potential to startle native fauna, animals are likely to adapt to the disturbance and/or move to similar habitats in the surrounding landscape.

21.12.3.12 Dust

Studies have shown that excessive dust generation from construction works can impact the health and viability of surrounding vegetation. The potential for dust generation in the proposed underground mining area is expected to be low and limited to short-term construction activities (e.g. MIA, infrastructure corridor,) or vehicle movements.

Recent studies on the impacts of dust from unsealed roads on vegetation and fauna (Cumberland Ecology 2015; Jones *et al.* 2016) found no evidence that dust has any detrimental impacts on vegetation or fauna abundance. Notwithstanding, personnel and contractors will be required to observe speed limits when driving on access tracks within the underground mining area and surrounds to minimise the generation of dust.

Air quality modelling for the Project has been undertaken, and predictions of dust deposition rates comply with the model mine condition limits at all sensitive receptors (Appendix L, Air Quality and GHG Assessment, section 3.6). Roads within the Project infrastructure corridor will be sealed to minimise the generation of dust. Open-cut mining operations and exposed surface areas (e.g. windblown emissions from ROM stockpiles) have the greatest potential to result in the generation and dispersion of atmospheric dust. Dust control measures will be employed, including watering of potential dust generating surfaces and progressive rehabilitation of disturbance areas (such as mine waste rock emplacements) to minimise dust emissions. Given the predicted dust deposition associated with the Project (Appendix L, Air Quality and GHG Assessment, section 3.6), the health and viability of surrounding vegetation will not be deleteriously affected.

The Project will not result in an increase in total coal production, and a range of dust control measures will continue to be employed at the Lake Vermont Mine including the watering of potential dust generating surfaces.

21.12.3.13 Artificial lighting

Artificial lighting will be established in the Project area including within the MIA and infrastructure corridor. Project lighting has the potential to affect behavioural patterns of some species. Some bird and bat species, for example, are attracted to insects around lights and could become prey for larger predators (e.g. owls). Artificial lighting can also attract predators and invasive pests, both of which may pose a threat to native fauna (DoEE 2020).

The exterior lighting will be designed to provide a safe working environment. Australian Standard AS/NZS 4282:2019 'Control of the obtrusive effects of outdoor lighting' recognises the impact of artificial light on biota (DoEE 2020). To minimise potential impacts of artificial lighting, the placement, configuration and direction of lighting for the Project will be implemented in consideration of AS 4282:2019 'Control of the obtrusive effects of outdoor lighting' (Standards Australia 2019).

21.12.3.14 Vehicle strike

The movement of vehicles has the potential to increase the incidence of fauna mortality *via* vehicular strike. Ground-dwelling fauna are most susceptible to this potential impact. The risk of injury or mortality from vehicle strike is greatest where roads cross fauna movement corridors. The Project infrastructure corridor primarily traverses cleared agricultural areas; however, it will also traverse the riparian corridors of Phillips Creek and One Mile Creek.

Contributing risk factors for vehicle strike are the speed of vehicles on roads and tracks, and limiting speed can reduce the threat of vehicle strike to fauna species such as Koala (DES 2019b). Speed limits will be imposed on roads and tracks within the Project area to reduce the risk of vehicle strike on native fauna. Safe driving procedures will also be incorporated into site inductions to increase awareness of the risk of vehicle strike.

21.12.3.15 Bushfire

While plants and animals have a range of mechanisms to survive individual fires, accidental bushfires could potentially occur if mine activities are not appropriately managed. Bushfire prevention and management measures will be implemented for the Project, and fire awareness will be included in the induction of personnel and contractors to minimise the risk of bushfire. Given the implementation of management measures, the Project is unlikely to increase the bushfire potential within the surrounding landscape.

21.12.3.16 Erosion and sedimentation

The Project has the potential to result in erosion of disturbed areas and sedimentation of waterways through the following:

- clearing of vegetation for the development of open-cut pits;

- construction of haul roads and other infrastructure;
- erosion facilitated by soil cracking resultant of surface subsidence; and
- hydrological changes to watercourses due to subsidence.

Vegetation clearance protocols and erosion and sediment control measures will be implemented to minimise potential impacts, as described in Section 21.12.3.3. Potential erosion resulting from subsidence and soil cracking and erosion of watercourses is considered in section 21.12.3.6.

21.12.3.17 Facilitated impacts

Facilitated impacts relate to impacts from other Projects (including by third parties) which 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), when that development will 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 the development of any other Projects. Mining operations will not facilitate the development of any other Projects that could not already be developed. Proposed electrical, water supply and telecommunications infrastructure will link to existing infrastructure at the Lake Vermont Mine and does not facilitate the development of other future projects.

Post mining, it is expected that, when possible, the Project area will be reinstated to grazing land at a similar suitability to that existing prior to mining. When this cannot be achieved, an alternative land use that can provide a similar value to pre-mining or can provide long-term ecological value to the region will be established. It is not considered that the return of lands to an agricultural land use or an alternative land use that provides similar value will facilitate the development of other projects that will 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.

21.12.3.18 Cumulative impacts

Cumulative impacts can be defined as the total impact on the environment that result from the incremental impacts of the action (the Project) added to other past, present and reasonably foreseeable future actions. Cumulative impacts include direct and indirect impacts on the environment.

Resource developments (approved and proposed) that occur within 50 km of the Project are provided in Section 21.1.5.3. The majority of developments identified in Section 21.1.5.3 have been approved, with the most recent being the Olive Downs Coking Coal Project (in 2020) and the Vulcan Project (September 2021). Other developments currently subject to government assessment include the Saraji East Project (BMA 2021) and the Winchester South Project (Whitehaven Coal 2021).

- The Project provides for the continuation and extension of the existing Lake Vermont Mine which is authorised for impacts to prescribed Environmental matters including the following (regulated vegetation for REs occurring within a defined distance of a relevant watercourse or wetland);
    - RE 11.3.25 within defined distance of relevant watercourse – 28.4 ha;
    - RE 11.3.27 within defined distance of relevant wetland – 3.9 ha; and
- protected wildlife habitat for the Squatter Pigeon – 39.2 ha.

Based on publicly available information, an assessment has been undertaken of the potential cumulative impact of the Project on ecosystem resilience. Ecosystem resilience is the capacity of an ecosystem to respond to changes and disturbances yet retain its basic functions and structures. For ecosystems to be resilient to threats, they need a healthy diversity of individuals, species and populations. The cumulative impact assessment has considered the species present (species diversity, abundance and dynamics), patterns of species distribution (the communities and ecosystem present that encompass all species), broad habitat types (the ecological niches for the range of species present) and ecosystem processes.

The Project is located within the Brigalow Belt Bioregion (Figure 21.4) and within the Isaac-Comet Downs subregion. The Brigalow Belt Bioregion has experienced considerable modification, particularly over the last 70 years due to agriculture and mining (DES 2018). Remnant vegetation cover has been reduced, with communities on the more fertile soils being the most affected (DES 2018). Habitat loss, fragmentation, inappropriate fire regimes, invasive plants and feral animals are relevant threats to the biodiversity values of the bioregion. The current extent of remnant vegetation in the Brigalow Belt Bioregion has been estimated by the Queensland Herbarium as being approximately 15,039,386 ha or 41.2% of the pre-clearing cover (Accad *et al.* 2021). The pre-clearing cover for the Isaac-Comet Downs subregion is estimated at approximately 2,693,397 ha compared to 574,501 ha of remnant vegetation (or 21.3% of the pre-clearing extent) remaining (Accad *et al.* 2021).

The Project has been designed to avoid and/or minimise impacts to remnant vegetation (e.g. by co-locating Project infrastructure and siting infrastructure in primarily cleared agricultural land) However, the Project will result in direct disturbance of 109.1 ha of remnant vegetation, which will add to the vegetation clearance that is proposed to occur for other Projects in the region. The remnant vegetation clearance for the Project represents approximately 0.016% of the current extent (Accad *et al.* 2021) of remnant vegetation in the Isaac-Comet Downs subregion. The area of remnant vegetation proposed to be impacted/cleared is comprised of 16 ha of Endangered REs (RE 11.3.1 and RE 11.4.8), 63.2 ha Of Concern REs (RE 11.3.2 and 11.3.4) and 29.8 ha of Least Concern REs (REs 11.3.9, 11.5.3, 11.3.25, 11.3.27b, and 11.3.27f).

The northern portion of the study area contains a large contiguous area of remnant vegetation that will be subject to small (and temporary) areas of disturbance due to gas drainage works to support underground operations. These areas will be progressively rehabilitated. Given the nature and extent of the disturbance, these activities are unlikely to result in a significant impact on the distribution and abundance of wildlife in the locality.

The Project infrastructure corridor will traverse the riparian corridors of Phillips Creek and One Mile Creek resulting in minor fragmentation of the riparian corridor at these locations. The Saraji East Project (BMA 2021) also proposes to construct a transport and infrastructure corridor, which will traverse One Mile Creek and Phillips Creek to the west of the study area, which may also affect west–east dispersal opportunities for fauna along these streams. To the east of the Project infrastructure corridor, a diversion of Phillips Creek has been approved for the existing Lake Vermont Mine open-cut mining operations. Further east, dispersal opportunities along One Mile Creek and Phillips Creek will be maintained with connection to the Isaac River. The fragmentation and potential impacts to connectivity that will result from the Project is unlikely to significantly affect species' movements given the disturbance that cumulatively will occur to the west and east of the Project. The Project will retain the vast majority of the One Mile Creek and Phillips Creek riparian corridors to allow continued fauna movement.

The Project is predicted to have a negligible cumulative impact on surface water and groundwater quality and quantity (Appendix E, Groundwater Impact Assessment, section 6.2.8; Appendix F, Surface Water Assessment, section 7.7) with a range of management and mitigation measures proposed to be implemented to minimise impacts on terrestrial flora, fauna and their habitats, as described in Sections 21.12.3.1 to 21.12.3.17. The key ecosystem cycles (e.g. water, nutrients) will remain intact and are not expected to be compromised as a result of cumulative impacts.

'Loss of Climatic Habitat Caused by Anthropogenic Emissions of Greenhouse Gases' is listed as a key threatening process under the EPBC Act and consists of reductions in the bioclimatic range within which a given species or ecological community exists due to emissions induced by human activities of greenhouse gases. Climate change and greenhouse gas emissions associated with the Project are described in the Project Air Quality and Greenhouse Gas Assessment (Appendix L, Section 4). The Project greenhouse gas emissions will contribute to global emissions. The potential effects of climate change on the nature and extent of the Project potential impacts have been considered, including those relating to groundwater (Appendix E, Groundwater Impact Assessment, Section 2) and surface water (Appendix F, Surface Water Assessment, section 4.1.2). Climate change effects have been factored into the models used by the Surface Water Assessment (Appendix Z, Flood Modelling Assessment Report, Section 1.3.12) and Groundwater Assessment (Appendix E, Groundwater

Impact Assessment, section 5.3). Therefore, the predictions of changes to surface water and groundwater conditions as a result of the Project are representative of future climate conditions.

The likely impacts of climate change on terrestrial flora and fauna is difficult to predict. However, the potential impacts of the Project are unlikely to significantly exacerbate the expected effects of climate change.

Assessments have been conducted in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a) and 'Queensland Environmental Offsets Policy Significant Residual Impact Guideline' (DEHP 2014) to assess the potential impacts of the Project on MNES and MSES, including those associated with direct, indirect and cumulative potential impacts. The assessments are provided in Section 21.12.4.

The provision of biodiversity offsets in line with Commonwealth and/or State Government policies provide an opportunity to mitigate cumulative impacts. Offsets have been required for many of the Projects within the region and increase the area of protected habitat that will be managed for conservation. Offsets will also be provided for the Project to provide adequate compensation for significant residual impacts on matters of environmental significance and to yield no net conservation loss. The Project's offset requirements are summarised in Section 21.19.

21.12.4 Assessment of impact to listed threatened species and communities

Sections 21.12.4.1 to 21.12.4.10 provide an assessment of the listed TECs and threatened species that are known to be impacted or have the potential to be impacted by the Project, namely:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community (Brigalow TEC);
- Poplar Box Grassy Woodland on Alluvial Plains ecological community (Poplar Box TEC);
- Ornamental Snake;
- White-throated Needletail;
- Squatter Pigeon (southern subspecies);
- Australian Painted Snipe;
- Koala; and
- Greater Glider.

An assessment of the Australian Painted Snipe has been included because despite the likelihood of occurrence of the species being potential, the condition and extent of the potential habitat has justified assessment. Other potential likelihood of occurrence species of conservation significance have not been assessed because the Project area does not contain habitat of condition or extent that justifies assessment.

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.

The ToR identifies other threatened species and communities which were not recorded in the study area and determined to be unlikely or potential to occur for which the Project impact must be addressed. These include:

- Curlew Sandpiper (*Calidris ferruginea*)
- Red Goshawk (*Erythrotriorchis radiatus*)
- Painted Honeyeater (*Grantiella picta*)
- Star Finch (Eastern) (*Neochmia ruficauda ruficauda*)
- Northern Quoll (*Dasyurus hallucatus*)
- Ghost Bat (*Macroderma gigas*)
- Corben's Long-eared Bat (*Nyctophilus corbeni*)
- Grey-headed Flying Fox (*Pteropus poliocephalus*)
- *Cycas ophiolitica*
- Quassia (*Samadera bidwillii*)
- Yakka Skink (*Egernia rugosa*)
- Dunmall's Snake (*Furina dunmalli*)
- Retro Slider (*Lerista allanae*)
- Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin threatened ecological community

Key terms relevant to the assessment of the likelihood of significant impacts are defined below in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:

- *for activities such as foraging, breeding, roosting, or dispersal;*
- *for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);*
- *to maintain genetic diversity and long-term evolutionary development; or*
- *for the reintroduction of populations or recovery of the species or ecological community.*

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area (DoE 2013a).

In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- *a geographically distinct regional population, or collection of local populations; or*
- *a population, or collection of local populations, that occurs within a particular bioregion.*

For Vulnerable species under the EPBC Act, an:

[I]mportant population' is a population that is necessary for a species' long-term survival and recovery (DoE 2013a). This may include populations identified as such in recovery plans, and/or that are:

- *key source populations either for breeding or dispersal*
- *populations that are necessary for maintaining genetic diversity, and/or*

- *populations that are near the limit of the species range.*

Section 21.12.4.10 provides an assessment of the listed migratory species that are known to be impacted or likely to be impacted by the Project.

21.12.4.1 Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC

Description

The Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community (Brigalow TEC) is listed as Endangered under the EPBC Act and occurs within Queensland and New South Wales. The Brigalow TEC generally occurs within the 500–750 mm annual rainfall belt with a predominance of summer rainfall, although winter rainfall peaks occur in the south of its distribution (DAWE 2021a).

In Queensland, the Brigalow TEC predominantly occurs on flat to gently undulating Cainozoic clay plains that are not associated with current alluvium and on gently undulating landscapes on horizontally bedded fine grained sedimentary rocks (DAWE 2021a). Some remnants, however, are associated with river and creek flats, or with old loamy and sandy plains, basalt plains and hills or hills and lowlands on metamorphic or granitic rocks (DAWE 2021a). Where Brigalow is dominant, the soils are predominantly cracking clays; however, texture contrast soils are common where *Eucalyptus* species are co-dominant (DAWE 2021a).

Brigalow flowers between April and October, however, do not flower every year. Brigalow seedlings are relatively rare in natural landscapes, as the seeds typically remain viable for less than a year (DAWE 2021a). Brigalow has a well-developed horizontal root system, and Brigalow is able to produce shoots from these horizontal roots (suckering) in response to disturbance as long as the root stocks remain intact.

The Brigalow TEC comprises patches of vegetation in which Brigalow is one of the most abundant tree species. The tree layer may be dominated by Brigalow or have a co-dominant presence with other species, such as Belah (*Casuarina cristata*) or other *Acacia* or *Eucalyptus* species. Within Queensland, the Brigalow TEC is defined by reference to 16 REs, all of which are listed as Endangered under the VM Act.

The Brigalow TEC can include some vegetation considered to be 'non-remnant' under state classifications; specifically, Brigalow regrowth that is more than 15 years old can be classified as the Brigalow TEC. Areas of Brigalow regrowth are considered not part of the EPBC Act listed Brigalow TEC if they are of poor quality (e.g. more than 50% perennial weeds) (DoE 2013b).

Desktop analysis

The Project is located within the Brigalow Belt North Bioregion (Figure 21.4), which is known to contain Brigalow *(Acacia harpophylla)* woodlands. A number of REs mapped by the Queensland Government within the study area have been identified as having the potential to represent the Brigalow TEC, namely:

- RE 11.3.1 *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains;
- RE 11.4.8 *Eucalyptus cambageana* woodland to open forest with *A. harpophylla* or *A. argyrodendron* on Cainozoic clay plains; and
- RE 11.4.9 *A. harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.

The desktop assessment found the Brigalow TEC has been identified during surveys undertaken for nearby and surrounding projects and is likely to occur within the study area.

Survey effort

Vegetation communities within the study area have been mapped and described in accordance with the 'Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland (V5.0)' (Neldner *et al.* 2019). This includes 245 quaternary sites, 54 secondary survey sites and approximately

500 rapid observation sites. Vegetation community boundaries have been validated in the field using a Global Positioning System (GPS) and refined using 50 cm resolution red/green/blue aerial imagery collected in April 2019 to produce a ground verified vegetation map.

Brigalow vegetation within the study area has been assessed against the key diagnostic characteristics and condition thresholds described in the Commonwealth approved conservation advice (DoE 2013b) to determine whether each patch of the vegetation community meets the Brigalow TEC status.

Survey outcomes

Four ground-truthed vegetation communities associated with Brigalow woodlands have been mapped within the study area and are shown in Figure 21.88.

Patches of Brigalow vegetation have been assessed as meeting the key diagnostic characteristics and condition thresholds to represent the Brigalow TEC:

- 88.5 ha of remnant Brigalow woodland on alluvial plains (VC 1a);
- 46.6 ha of remnant Dawson Gum woodland with Brigalow on undulating Cainozoic clay plains (VC 1b); and
- 19.4 ha of remnant Brigalow with Yellowwood woodland with occasional Dawson Gum on Cainozoic clay plains (VC 1c).

Habitat assessment

A total of 154.5 ha of the TEC occurs within the study area. The distribution of Brigalow TEC within the study area is shown on Figure 21.89.

Impact assessment

The Project will directly disturb 0.9 ha of the Brigalow TEC across four patches through vegetation removal for all Project stages (Figure 21.89, Table 21.43, patches B1, B4, B6, and B17). This will add to the vegetation clearance that is proposed to occur for other Projects in the region.

Table 21.43: Brigalow TEC extent of disturbance to each patch

Patch	**description**	**RE**	**Current extent (ha)**	**Extent of disturbance (ha)**		
				Stages 1,2,3 clearing (ha)	**Stages 2 and 3 residual ponding (ha)**	**Stage 4 clearing (ha)**
B1	Adjacent to One Mile Creek in the western portion of the study area	11.3.1	31.1	**0.3**	0.0	**<0.1**
B2	Adjacent to One Mile Creek in the central portion of the study area	11.3.1	24.9	0.0	**6.9**	0.0
B3	Adjacent to One Mile Creek in the eastern portion of the study area	11.3.1	23.0	0.0	0.0	0.0
B4	Patch to the west of the open-cut pit	11.4.8	2.4	**~0**	0.0	**<0.1**
B5	Patch to the east of the MIA	11.4.9	2.8	0.0	0.0	0.0
B6	Patch to the west of the open-cut pit	11.4.8	1.2	0.0	0.0	**0.2**

Patch	description	RE	Current extent (ha)	Extent of disturbance (ha)		
				Stages 1,2,3 clearing (ha)	Stages 2 and 3 residual ponding (ha)	Stage 4 clearing (ha)
B7	Patch to the north of the open-cut pit	11.4.8	1.6	0.0	0.0	0.0
B8	Patch to the north of the open-cut pit	11.3.1	2.4	0.0	0.0	0.0
B9	Patch to the north of the open-cut pit	11.4.8	1.5	0.0	0.0	0.0
B10	Patch to the north of the open-cut pit	11.4.8	2.0	0.0	0.0	0.0
B11	Patch to the north of the open-cut pit	11.4.8	2.5	0.0	0.0	0.0
B12	Isolated patch to the south of Hughes Creek	11.4.9	6.6	0.0	0.0	0.0
B13	Isolated patch to the south of Hughes Creek	11.4.9	10.0	0.0	0.0	0.0
B14	Isolated patch to the north of the MIA and ETL	11.4.8	2.6	0.0	0.0	0.0
B15	Isolated patch to the north of the MIA and ETL	11.4.8	9.0	0.0	**0.1**	0.0
B16	Isolated patch to the north of Boomerang Creek	11.3.1	1.1	0.0	0.0	0.0
B17	Isolated patch to the south of Boomerang Creek	11.4.8	3.6	**0.3**	**<0.1**	0.0
B18	Isolated patch to the north of Boomerang Creek	11.3.1	2.0	0.0	0.0	0.0
B19	Isolated patch to the south of Boomerang Creek	11.3.1	2.0	0.0	0.0	0.0
B20	Isolated patch to the north of Boomerang Creek	11.3.1	1.9	0.0	0.0	0.0
B21	Isolated patch to the north of Boomerang Creek and adjoining Brigalow HVR	11.4.8	19.7	0.0	0.0	0.0
B22	Isolated patch in the north-east of the study area	11.4.8	0.6	0.0	0.0	0.0
B23	Isolated patch in the north-east of the study area adjoining off-site Brigalow vegetation	11.3.1	0.1	0.0	0.0	0.0
Total	—	**11.3.1**	**154.5**	**0.6**	**7.0**	**0.3**

Above the underground mining area, temporary gas wells and temporary access tracks will be located to avoid impacts to patches of the Brigalow TEC.

Areas of residual ponding are expected to occur within the subsidence footprint area, including adjacent to Boomerang Creek and One Mile Creek. The predicted residual ponding will impact a total of 7.0 ha of Brigalow TEC across three patches (patch B2, B15 and B17). The predicted ponding is considered to have potential to have a deleterious impact to Brigalow TEC vegetation are described in Section 21.12.3.6. Brigalow TEC vegetation occurs as riparian vegetation adjacent to One Mile Creek, including in reaches of the Creek that will be subject to stream morphology changes from subsidence. The potential stream morphology affected areas are co-located with areas of predicted ponding, and the assessment of stream morphology change impacts and mitigation measures are detailed in Section 21.12.3.7.

Brigalow TEC patch B16 and B18 are located within the subsidence footprint but outside the predicted residual ponding footprint. These areas are not expected to undergo any significant impacts relating from subsidence.

Parts of patches B1, B4 and B6 are within the footprint of the Stage 4 open-cut pit. The remaining vegetation of these patches will be greater than the minimum patch size TEC condition threshold of 0.5 ha, and they will retain connectivity to other adjoining Brigalow TEC patches. The affected patches are currently adjoining cleared agricultural land; therefore, the clearing for the open-cut pit is not expected to increase edge effects or increase the likelihood of exotic species abundance or diversity. Therefore, the remaining patches are considered to be unimpacted.

The infrastructure corridor will traverse One Mile Creek that will fragment a patch of Brigalow TEC vegetation and disturb 0.3 ha of the Brigalow TEC. While the existing patch of Brigalow (patch B1) will be fragmented at this location, approximately 14 ha of Brigalow TEC will remain to the west of the corridor (within the study area), and approximately 30 ha of Brigalow TEC will remain to the east of the corridor. These remnant patches are in good condition and, given the extent of the patches remaining and their current condition, there is no evidence to suggest these patches will become unviable post-impact.

Subsidence drainage works (mitigation channels and mitigation bunds) will be implemented to reduce ponding impacts to the Brigalow TEC; however, some ponding is unable to be effectively mitigated. Mitigation channels and bunds are designed to be implemented away from the mapped Brigalow TEC as far as practicable (Figure 21.10). The northern mitigation channel will impact 0.3 ha of Brigalow patch B17. A very small area of Patch B17 (<0.01 ha) will be impacted by predicted subsidence-related ponding. The remaining 3.3 ha of the patch exceeds the minimum TEC patch size criteria and is expected to remain viable.

Patch B2 is a narrow patch of riparian Brigalow adjacent to One Mile Creek, which will be fragmented by the predicted residual ponding. These areas are predicted to experience inundation during flooding events for up to several months every few years (Appendix W, Geomorphological Assessment Report, section 3.3.3). The patch is currently subject to edge effects from surrounding cleared agricultural areas, and the edge effects on the remaining patches resulting from the ponding is considered comparable to existing edge effect conditions. The predicted ponding will fragment this patch into a number of patches, which will each be larger than the minimum patch size TEC condition threshold of 0.5 ha. The surface water assessment report (Appendix W, Geomorphological Assessment Report, section 5.3 has identified that the intersection of One Mile Creek and the subsidence footprint area will experience increased channel velocity and may receive channel bed scouring and stream bank erosion. Changes to stream morphology within patch B2 will be subject to monitoring and interventions to control potential erosive processes within the creek, and TEC Patch will be prescribed within a subsidence management plan. The impacts are not expected to affect the viability of the patch.

Patch B15 will undergo a 0.1 ha reduction in patch size as a result of ponding. The patch will not be substantially fragmented and will remain above the minimum threshold size. The patch is therefore expected to retain viability after the subsidence-related impact.

The identified Brigalow TEC vegetation was within the groundwater dependent ecosystem assessment study area and no Brigalow TEC patches were identified as groundwater dependent (Section 21.15.3). Impacts of erosion and subsidence related cracking and erosion are assessed in Section 21.12.3.6, Section 21.12.3.7 and Section 21.12.3.16. Given the proposed monitoring and management measures for erosion, it is considered unlikely that erosion will impact Brigalow TEC vegetation. The proposed impact is equivalent to 0.5 % of the Brigalow TEC in the study area and <0.01 % for the subregion in which the Project is located. The impact is unlikely to contribute to cumulative impacts to TEC in the subregion. Further discussion of cumulative impacts is provided in Section 21.12.3.18.

The Project also has the potential to increase weed and animal pest populations which have the potential to affect patch viability if pest species are not appropriately managed and infestations develop. However, as described in Section 21.12.3.10 weed and pest management measures will be implemented for the Project. Indirect impacts associated with bushfire risk are considered unlikely given the bushfire prevention and management measures to be implemented (Section 21.12.3.15).

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the Brigalow TEC where possible. The proposed avoidance and mitigation measures for the Brigalow TEC, including timing, predicted effectiveness, monitoring, adaptive management and the relevant statutory or policy basis, is provided in Table 21.44.

Statutory requirements

Conservation, recovery and threat abatement plans relevant to the Brigalow TEC have been considered in the assessment of the TEC, the development of avoidance, mitigation and management measures and/or assessment of significant impact for the Brigalow TEC:

- The 'Approved Conservation Advice for Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community (DoE 2013b), developed at the time of EPBC Act listing, outlines the key diagnostic criteria and condition thresholds for the TEC and the priority conservation actions for the community. The conservation advice also describes areas considered critical to the survival of the community.
- The 'Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community' SPRAT profile provides information about the Brigalow TEC, including relevant regulatory considerations and information in relation to its distribution, regional ecosystems within Queensland and associated flora and fauna within the community.
- The SPRAT profile for this community indicates there is no adopted or made Recovery Plan for this community; however, a Recovery Plan is considered to be required. The SPRAT profile also indicates the national recovery plan for the listed Brigalow ecological community (Butler 2007) will provide the main framework for the community's recovery. The main objective proposed is:

  > *…to conserve and enhance the environmental values of the brigalow ecological community over the long-term by working to increase the extent of both remnant and regrowth brigalow and improving its condition and management.*

Table 21.44: Brigalow TEC impact avoidance and mitigation measures

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Locate the MIA in an area that will not disturb Brigalow TEC.	Mine planning/ construction	Highly effective—avoids impacts to the TEC.	Disturbance/vegetation clearance areas will be monitored against approved disturbance limits. Should clearing exceed approved limits, incident reporting will be initiated with a corrective action plan will be proposed (including proposed timing) and implemented. The corrective actions will be informed by the nature and extent of the exceedance.	DoE (2013b) TSSC (2001)
Carefully select the infrastructure corridor crossing of One Mile Creek to minimise disturbance to Brigalow TEC vegetation.	Mine planning/ construction	Highly effective—minimises impacts to the TEC.		
Co-locate the transport, water, electrical and telecommunications infrastructure within the infrastructure corridor.	Mine planning/ construction	Highly effective—minimises impacts to the TEC.		
Minimise the northern extent of the open-cut pit in the vicinity of One Mile Creek to minimise disturbance to Brigalow TEC vegetation.	Mine planning/ operations	Highly effective—minimises impacts to the TEC.		
Position the electrical infrastructure (transmission line and substation) in the vicinity of the underground drift to avoid clearance of the Brigalow TEC.	Mine planning/ construction	Highly effective—avoids impacts to the TEC.		
Position surface infrastructure required for underground mining (e.g. ventilation shafts and drainage wells) to avoid impacts to the Brigalow TEC.	Mine planning/ construction/ operations	Highly effective—avoids impacts to the TEC.		
Implement vegetation clearance protocols, including the delineation of vegetation adjoining proposed clearance areas to prevent accidental damage (Section 21.12.3.3).	Construction/ operations	Highly effective management technique to manage vegetation clearance activities.		

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Design and undertake subsidence drainage management works to minimise disturbance to the Brigalow TEC from drainage works and minimise ponding in areas of the Brigalow TEC.	Operations	Implementation of measures at other Bowen Basin Mines indicates such works are effective at minimising and managing impacts to the TEC.	Subsidence effects and implemented mitigation and rehabilitation measures will be monitored in accordance with the Subsidence Management Plan (see Section 21.12.3.6) to be prepared for the Project. Subsidence monitoring will be conducted and follow up corrective measures (e.g. additional drainage works) implemented as required.	DoE (2015e)
Limit activities that cause disturbance to minimise occurrence and spread of weeds.	Construction/ operations	Highly effective management technique to manage the spread and occurrence of weeds.	Disturbance/vegetation clearance areas will be monitored against approved disturbance limits.	DoE (2013b)
Regularly inspect mine-related surface disturbance areas and Bowen Basin Coal owned land to identify areas requiring weed management measures to be implemented. Implement weed management measures (e.g. mechanical removal and application of approved herbicides).	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the spread and occurrence of weeds.	Monitor and manage weeds in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project. Corrective actions (such as increasing the frequency or extent of control efforts or alternative control strategies) will be implemented, as necessary.	DoE (2013b), Commonwealth of Australia (2017a), Qld Department of Agriculture and Fisheries weed control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020)
Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by introduced fauna.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Regular monitoring of site will be carried out by environmental personnel. Raise awareness through personnel inductions. Additional measures (such as tool box talks or staff newsletters) will be implemented if inspections indicate a clean, rubbish-free environment is not being maintained.	DoE (2013b), Commonwealth of Australia (2017b), DoE (2015b), DEWHA (2008b)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Store domestic waste in appropriate receptacles and locations.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Regular monitoring of site will be carried out by environmental personnel. Waste generation will be monitored and audited in accordance with the Waste Management Plan. Additional measures (such as provision of additional receptacles or change in location of receptacles) will be implemented if current storage practices encourage feral animals.	DoE (2013b), Commonwealth of Australia (2017b), DoE (2015b), DEWHA (2008b)
Implement pest control measures in accordance with Weed and Pest Management Plan when substantial infestations develop.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Corrective actions (such as increasing the frequency or extent of control efforts or alternative control strategies) will be implemented, as necessary.	DoE (2013b), Commonwealth of Australia (2017b), Qld Department of Agriculture and Fisheries pest control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020), DoE (2015b), DoEE (2016b), DoEE (2017), DEWHA (2008b)
Consult with the Isaac Regional Council and neighbouring mines in relation to weed and pest management activities.	Construction/ operations/ rehabilitation and decommissioning	Coordinated activities are predicted to achieve better regional outcomes for weed and pest species.	Audits will be implemented to monitor the consultation outcomes and the management measures implemented on-site in accordance with the Weed and Pest Management Plan (Section 21.12.3.6).	DoE (2013b), Commonwealth of Australia (2017a), Commonwealth of Australia (2017b), Isaac Regional Council (2020)
Bushfire prevention and management measures will be outlined in the Emergency Response Plan. Inductions of mine site personnel will include fire awareness.	Construction/ operations/ rehabilitation and decommissioning	Effective management procedure to reduce the risk of bushfire.	Any incidence of bushfire will be investigated to determine the requirement for additional controls. Potential adaptive management measures include revision of the Emergency Response Plan and/or a program to increase personnel awareness of bushfire risk (e.g. through tool box talks).	DoE (2013b)

- The SPRAT profile for this community indicates the 'Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads' is relevant to this community.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019) and Australia's actions for nature, including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021), 'Australian Weeds Strategy 2017–2027' (Commonwealth of Australia 2017a) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity (CBD), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on Conservation of Nature in the South Pacific (Apia Convention) or other relevant international conventions.

Current threats to the Brigalow TEC include vegetation clearing, overgrazing of the understorey, fire, plant and animal pests, lack of knowledge, and climate change.

Significant impact assessment

Table 21.45 provides an assessment of the likelihood of significant impacts on the Brigalow TEC in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Table 21.45: Brigalow TEC significant impact assessment

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 require the clearance of 0.9 ha and result in the potential periodic inundation through residual ponding of 7.0 ha over portions of six patches of Brigalow TEC (Figure 21.89). The remaining vegetation of impacted patches of Brigalow TEC will continue to meet the minimum TEC patch size criteria. The Project will result in the total reduction of the extent of Brigalow TEC in the study area by 7.9 ha.
Fragment or increase fragmentation of an ecological community	All Brigalow TEC patches in the study area have been subject to past disturbance including clearing, thinning and grazing. Two patches of Brigalow TEC will be fragmented by the clearance and impacts of residual ponding for the Project (patches B1 and B2). Four patches will be partially cleared, but the remaining Brigalow TEC vegetation will retain its connectivity to adjoining vegetation (patches B4, B6, B15 and B17).
Adversely affect habitat critical to the survival of an ecological community	The patches of Brigalow TEC in the study area meet the key diagnostic characteristics for the TEC and are, therefore, critical to the survival of the TEC. The Project will result in the loss of approximately 7.9 ha of Brigalow TEC that is critical to the survival of the TEC. The remaining patches of Brigalow TEC will continue to meet the TEC characteristic criteria thresholds.

Significance criteria	Assessment of significance
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels or substantial alteration of surface water drainage patterns	The impacts of areas of periodic ponding due to surface subsidence, which modify conditions necessary for Brigalow TEC survival, are considered as a reduction in the extent of the TEC. Management measures will be applied to prevent erosion and sedimentation that may impact Brigalow TEC within the study area. Localised alteration of surface water drainage patterns will be monitored under a Subsidence Management Plan. The Brigalow TEC in the study area has not been identified as a GDE, and modifications to groundwater levels are unlikely to affect the TECs survival (3D Environmental 2022).
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	Parts of six Brigalow TEC patches will be impacted by the Project. The partial clearance of these patches may create potential for edge effects on these patches; however, these edge effects are comparable to the edge effects currently affecting the patches that have all been subject to past disturbances and fragmentation. Weed control measures outlined in Section 21.12.3.6 will be implemented throughout the study area to minimise the risk of degradation of Brigalow TEC through change in species composition. The result of the implementation of the mitigation measures proposed in this assessment will be that it is unlikely the retained TEC in the study area will experience a decline or loss of the functionally important species. Bushfire prevention and management measures will be implemented in accordance with the Emergency Response Plan, which will protect the functionally important species of the Brigalow TEC.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • assisting invasive species, which are harmful to the listed ecological community, to become established, or • 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	Parts of six Brigalow TEC patches will be impacted by the Project. The remaining areas of the impacted patches may be subject to edge effects. However, the impact is likely comparable to the edge effects currently affecting the patches from past disturbances and land management. The Brigalow TEC of the Project area occurs in a highly modified rural landscape where introduced species have been recorded throughout the TEC. The proposed Project is unlikely to produce pathways for invasive species that are not already present in the study area. Given adherence to the proposed avoidance and mitigation measures, it is unlikely that a substantial reduction will occur in the quality or integrity of the retained Brigalow TEC in the study area. The Project is unlikely to result in the mobilisation of pollutants of any kind into this TEC within or adjacent to the Project area. The Project is not likely to use fertilisers on-site or cause regular mobilisation of herbicides that may impact the Brigalow TEC. Control measures, such as sediment dams, will be in place to minimise the potential for pollutants to affect the Brigalow TEC in the study area.
Interfere with the recovery of an ecological community	The Project will result in the reduction of extent of the Brigalow TEC by approximately 7.9 ha. This impact represents an interference with the recovery of the Brigalow TEC.
Conclusion	The Project is considered to have a significant impact on 7.9 ha of the Brigalow TEC. The extent of these impact areas is shown in Figure 21.91.

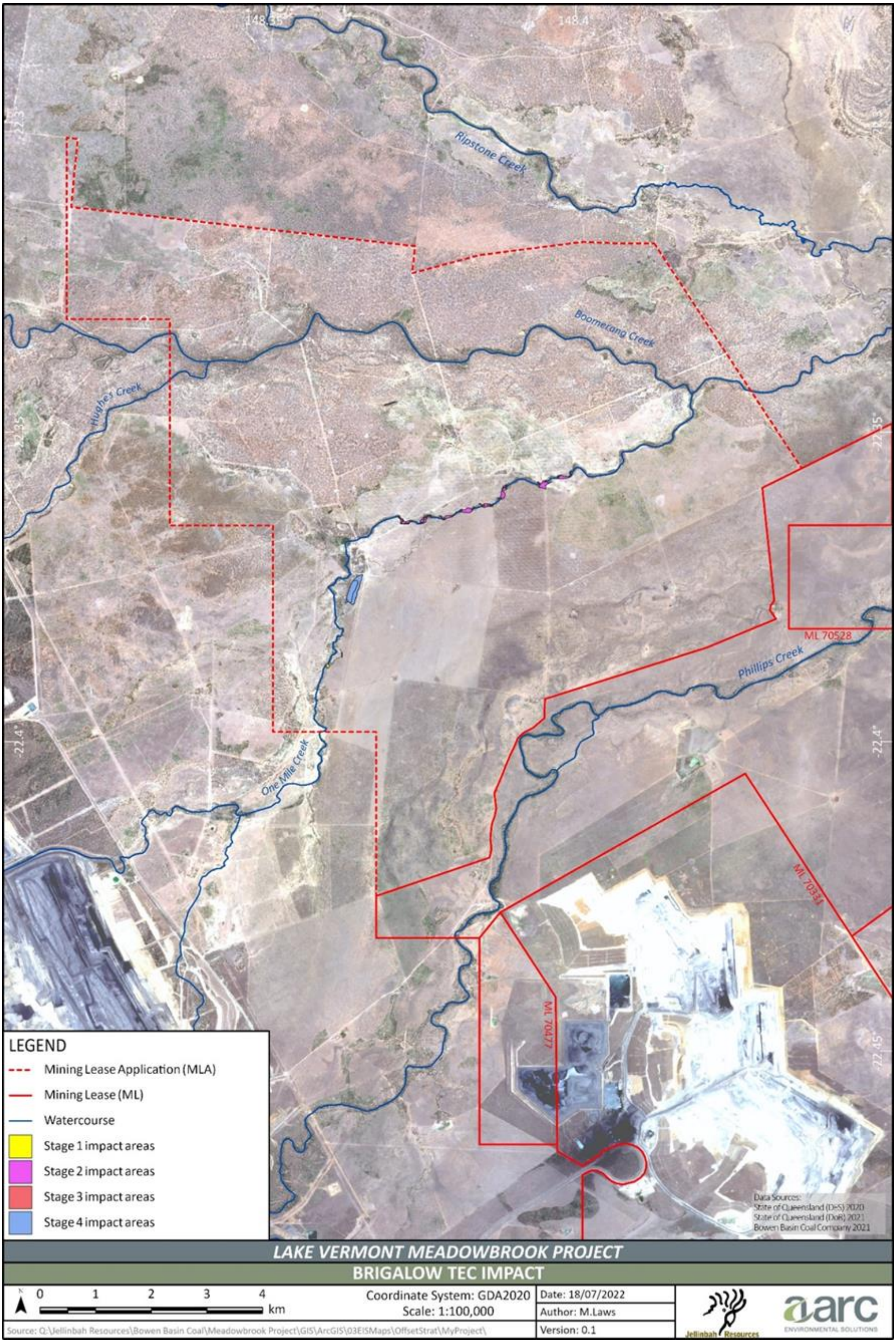

Figure 21.91: Brigalow TEC significant impact areas

21.12.4.2 Poplar Box Grassy Woodland on Alluvial Plains TEC

Description

The Poplar Box TEC has been listed as Endangered under the EPBC Act on 4 July 2019.

This ecological community occurs west of the Great Dividing Range, typically at less than 300 m above sea level (ASL) and between latitudes 20°S to 34°S within the Brigalow Belt North, Brigalow Belt South, south-east Queensland, Cobar Peneplain, Darling Riverine Plains, New South Wales south-western slopes and Riverina IBRA bioregions (DAWE 2021a).

The Poplar Box TEC is typically a grassy woodland with a canopy dominated by *Eucalyptus populnea* and an understorey mostly of grasses and other herbs. The ecological community mostly occurs in gently undulating to flat landscapes and occasionally on gentle slopes on a wide range of soil types of alluvial and depositional origin (DoEE 2019b). Within Queensland, five REs have the potential to represent the Poplar Box TEC, namely: RE: 11.3.2, RE 11.3.17, RE 11.4.7, RE 11.4.12 and RE 12.3.10.

Desktop analysis

The Project is located within the Brigalow Belt North Bioregion (Figure 21.4), which is known to contain the Poplar Box TECs. One Regional Ecosystem mapped by the Queensland Government within the study area has the potential to represent the Poplar Box TEC, namely: RE: 11.3.2 *Eucalyptus populnea woodland on alluvial plains.*

The desktop assessment indicates that the Poplar Box TEC has been recorded to the north of the study area for the Winchester South Project. The community is considered likely to occur within the study area.

Survey effort

Vegetation communities within the study area have been mapped and described in accordance with the 'Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland (V5.0)' (Neldner *et al.* 2019). This includes 245 quaternary sites, 54 secondary survey sites and approximately 500 rapid observation sites. Vegetation community boundaries have been validated in the field using a GPS and refined using the latest aerial imagery available for the study area to produce a ground verified vegetation map.

Poplar Box vegetation within the study area has been assessed against the key diagnostic characteristics and condition thresholds described in the Commonwealth approved conservation advice (DoEE 2019b) to determine whether the vegetation community meets the Poplar Box TEC status.

Survey outcomes

Within the study area, one vegetation community has been found to contain areas consistent with the key diagnostic characteristics (DoEE 2019b) of the Poplar Box TEC, namely the remnant Poplar Box woodland on alluvial plains vegetation community (VC 2a) (Figure 21.88). The majority of this vegetation community meets the structure requirements for this TEC and its condition has been assessed as Class B, good quality.

Habitat assessment

A total of 656.6 ha of the Poplar Box TEC (Class B, good quality) has been mapped within the study area. The distribution of Poplar Box TEC within the study area is shown on Figure 21.89.

Impact assessment

Key threats to the Poplar Box TEC include (DoEE 2019b):

- clearance and fragmentation;
- invasive weeds and pests;
- inappropriate fire and grazing regimes;
- dieback;
- chemical impact and spray drift;
- invasive fauna;
- hydrological changes and salinisation;
- nutrient enrichment; and
- climate change.

The Poplar Box TEC occurs within eight patches within the study area to the north and south of Boomerang Creek (Table 21.46 and Figure 21.89). The Project will not directly disturb the Poplar Box TEC, as no vegetation clearance or habitat disturbance will be undertaken within this community for Project infrastructure.

Table 21.46: Poplar Box TEC Extent of Disturbance to each Patch

Patch	Description	Current extent (ha)	Extent of disturbance (ha)		
			Stages 1,2,3 clearing (ha)	Stage 2 and 3 residual ponding (ha)	Stage 4 clearing (ha)
P1	Patch north of Boomerang Creek, in the west of the study area	52.7	0.0	0.0	0.0
P2	Patch south of Boomerang Creek in the west of the study area	49.5	0.0	0.0	0.0
P3	Patch north of Boomerang Creek	18.6	0.0	**1.6**	0.0
P4	Patch south of Boomerang Creek extending through the central portion of the study area	395.2	0.0	**42.0**	0.0
P5	Patch north of Boomerang Creek	67.7	0.0	**0.8**	0.0
P6	Patch north of Boomerang Creek extending from the eastern boundary of the study area	12.4	0.0	0.0	0.0
P7	Patch south of Boomerang Creek extending from the eastern boundary of the study area	54.7	0.0	0.0	0.0
P8	Isolated patch south of Boomerang Creek in the east of study area	5.8	0.0	0.0	0.0

Above the underground mining area, ventilation shafts, ponding mitigation works and a gas drainage access track will be located to avoid impacts to patches of the Poplar Box TEC.

Areas of potential for ponding are expected to occur adjacent to Boomerang Creek, and these ponding areas are considered likely to impact Poplar Box TEC patches in this area. The predicted residual ponding will impact 44.4 ha over three patches of Poplar Box TEC. The ponding areas are predicted to be inundated periodically for several months every few years (Appendix W, Geomorphological Assessment Report, section 3.3.3) and affected areas are considered likely to experience conditions deleterious to Poplar Box TEC (refer section 21.12.3.6).

For patch P3, ponding is predicted to impact 1.6 ha of the 18.6 ha patch. The patch will not be fragmented by the ponding, and all remaining sections of the patch will retain existing connectivity. No substantial increase in edge effects are expected.

Patch P4 intersects the predicted ponding footprint, and five separate ponding areas are predicted to potentially occur within the patch. This will reduce the 395 ha (maximum predicted ponding) patch size by approximately 42 ha. The potential ponding is predicted to fragment the patch into three patches of 14.3 ha and 17.3 ha and 196.13 ha.

For patch P5, ponding is predicted to impact 0.8 ha of the 67.7 ha patch. The patch will not be fragmented by the ponding, and all remaining sections of the patch will retain connectivity. No substantial increase in edge effects is expected.

The increased patch edges around the ponded areas may increase the edge effects on affected Poplar Box patches. The predicted ponding areas are expected to undergo changes to suitability of plant species, but since no active soil disturbance or movement will be undertaken within the residual ponding areas, the ponding is not expected to generate conditions likely to cause weed incursion in the Poplar Box patches, and the monitoring and maintenance of weeds in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) will effectively manage the occurrence and abundance of feral pests.

Subsidence is considered unlikely to represent a significant impact to the Poplar Box TEC. Woodland vegetation, including Poplar Box vegetation, is expected to retain viability after surface subsidence. Discussion of the expected impact of subsidence to open woodland vegetation is presented in Section 21.12.3.6.

Given the lack of direct disturbance to patches of the Poplar Box TEC and that the patches affected by residual ponding will not be fragmented by the intermittent ponding, all patches of Poplar Box TEC are expected to remain viable post the mining impact.

The proposed impact is equivalent to 5% of the Poplar Box TEC in the study area. The impacts are predominantly due to hydrological change affecting the resilience of the Poplar Box TEC ecosystem, and the modelling for these changes has incorporated the cumulative effects of nearby projects and climate change. The impacts identified to Poplar Box TEC are unlikely to contribute to cumulative impacts in the subregion. Further discussion of cumulative impacts is provided in Section 21.12.3.18.

The identified Poplar Box TEC vegetation was within the groundwater dependent ecosystem assessment study area and no Poplar Box TEC patches were identified as groundwater dependent (refer 21.15.3). Impacts of subsidence related erosion and cracking are assessed in Section 21.12.3.6. Given the proposed monitoring and management measures for erosion, it is considered unlikely that erosion will impact Poplar Box TEC vegetation. The Project also has the potential to increase weed and animal pest populations if they are not appropriately managed. However, as described in Section 21.12.3.1021.12.3.10, weed and pest management measures will be implemented for the Project. Indirect impacts associated with bushfire risk are considered unlikely given the bushfire prevention and management measures to be implemented (Section 21.12.3.15).

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the Poplar Box TEC where practicable. The proposed avoidance and mitigation measures for the Poplar Box TEC, including timing, predicted effectiveness, monitoring, adaptive management and the relevant statutory or policy basis, is provided in Table 21.47.

Table 21.47: Poplar Box TEC impact avoidance and mitigation measures

Avoidance/mitigation measures	**Timing**	**Predicted effectiveness**	**Monitoring and adaptive management**	**Statutory or policy basis**
Locate the MIA in an area that will not disturb Poplar Box TEC.	Mine planning/ construction	Highly effective—avoids impacts to the TEC.	Monitor disturbance/vegetation clearance areas against approved disturbance limits. Should clearing exceed approved limits, incident reporting will be initiated, with a corrective action plan to be proposed (including proposed timing) and implemented. The corrective actions will be informed by the nature and extent of the exceedance.	DoEE (2019b)
Position surface infrastructure required for underground mining (e.g. surface access, ventilation shafts and drainage wells) to avoid impacts to the Poplar Box TEC.	Mine planning/ construction/ operations	Highly effective—avoids impacts to the TEC.		
Implement vegetation clearance protocols, including the delineation of vegetation adjoining proposed clearance areas to prevent accidental damage (Section 21.12.3.3).	Construction/ operations	Highly effective management technique to manage vegetation clearance activities.		
Design and undertake subsidence drainage management works to minimise disturbance to the Poplar Box TEC from drainage works, and minimise ponding in areas of the Poplar Box TEC.	Operations	Implementation of measures at other Bowen Basin Mines indicates such works are effective at minimising and managing impacts to remnant vegetation.	Subsidence effects and implemented mitigation and rehabilitation measures will be monitored in accordance with the Subsidence Management Plan (Section 21.12.3.6) to be prepared for the Project. Subsidence monitoring will be conducted, and follow up corrective measures (e.g. additional drainage works) will be implemented as required.	DoE (2015e)
Limit activities that cause disturbance to minimise occurrence and spread of weeds.	Construction/ operations	Highly effective management technique to manage the spread and occurrence of weeds.	Monitor disturbance/vegetation clearance areas against approved disturbance limits.	DoEE (2019b)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Regularly inspect mine-related surface disturbance areas and Bowen Basin Coal owned land to identify areas requiring weed management measures to be implemented. Implement weed management measures (e.g. mechanical removal and application of approved herbicides).	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the spread and occurrence of weeds.	Monitor and manage weeds in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project. Corrective actions (such as increasing the frequency or extent of control efforts, or alternative control strategies) will be implemented, as necessary.	DoEE (2019b), Commonwealth of Australia (2017a), Qld Department of Agriculture and Fisheries weed control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020)
Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by introduced fauna.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Regular monitoring of the site will be carried out by environmental personnel. Raise awareness through personnel inductions. Additional measures (such as tool box talks or staff newsletters) will be implemented if inspections indicate a clean, rubbish-free environment is not being maintained.	DoEE (2019b), Commonwealth of Australia (2017b), DoE (2015b), DEWHA (2008b)
Store domestic waste in appropriate receptacles and locations.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Regular monitoring of site will be carried out by environmental personnel. Waste generation monitoring and audit will be in accordance with the Waste Management Plan. Additional measures (such as provision of additional receptacles or change in location of receptacles) will be implemented if current storage practices encourage feral animals.	DoEE (2019b), Commonwealth of Australia (2017b), DoE (2015b), DEWHA (2008b)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Implement pest control measures in accordance with the Weed and Pest Management plan where infestations develop.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Monitor and manage pests in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be prepared for the Project. Corrective actions (such as increasing the frequency or extent of control efforts, or alternative control strategies) will be implemented, as necessary.	DoEE (2019b), Commonwealth of Australia (2017b), Qld Department of Agriculture and Fisheries pest control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020), DoE (2015b), DoEE (2016b), DoEE (2017), DEWHA (2008b)
Consult with the Isaac Regional Council and neighbouring mines in relation to weed and pest management activities.	Construction/ operations/ rehabilitation and decommissioning	Coordinated activities are predicted to achieve better regional outcomes for weed and pest species.	Audits will be implemented to monitor the consultation outcomes, and the management measures will be implemented on -site in accordance with the Weed and Pest Management Plan (Section 21.12.3.10)	DoEE (2019b), Commonwealth of Australia (2017a), Commonwealth of Australia (2017b), Isaac Regional Council (2020)
Bushfire prevention and management measures will be outlined in the Emergency Response Plan to be prepared for the Project. Inductions of mine site personnel will include fire awareness.	Construction/ operations/ rehabilitation and decommissioning	Effective management procedure to reduce the risk of bushfire.	Any incidence of bushfire will be investigated to determine the requirement for additional controls. Potential adaptive management measures include revision of the Emergency Response Plan and/or a program to increase personnel awareness of bushfire risk (e.g. through tool box talks)	DoEE (2019b)

Statutory requirements

Conservation, recovery and threat abatement plans relevant to the Poplar Box TEC have been considered in the assessment of the TEC, the development of avoidance, mitigation and management and/or assessment of significant impact for the Poplar Box TEC:

- The 'Approved Conservation Advice for Poplar Box Grassy Woodland on Alluvial Plains' (DoEE 2019b), developed at the time of EPBC Act listing outlines the key diagnostic criteria and condition thresholds for the TEC and the priority conservation actions for the community. The conservation advice also describes areas considered critical to the survival of the community.
- The 'Poplar Box Grassy Woodland on Alluvial Plains' ecological community' SPRAT profile provides information about the indicative distribution of the Poplar Box TEC.
- The SPRAT profile for this species indicates there is no adopted or made Recovery Plan for this ecological community, as the listing and the implementation of actions in the Approved Conservation Advice (DoEE 2019b) provides sufficient protection and guidance on the recovery of the ecological community.
- No Threat Abatement Plan has been identified as being relevant the Poplar Box TEC.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019) and Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021), 'Australian Weeds Strategy 2017–2027' (Commonwealth of Australia 2017a) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.
- The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, Convention on International Trade in Endangered Species of Wild Fauna and Flora or the Convention on Conservation of Nature in the South Pacific (Apia Convention).

Significant impact assessment

Table 21.48 provides an assessment of the likelihood of significant impacts on the Poplar Box TEC in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Table 21.48: Poplar Box TEC significant impact assessment

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 avoids the direct clearance of Poplar Box TEC. Surface subsidence will result in the creation of areas of predicted ponding that is expected to modify the factors necessary for the Poplar Box TECs. Ponding mitigation measures will be employed; however, residual ponding is predicted to impact 44.4 ha of Poplar Box TEC, such that the conditions necessary for the TECs survival will potentially be destroyed by the potential ponding.
Fragment or increase fragmentation of an ecological community	The Poplar Box TEC vegetation in the study area has been subject to past disturbance related to grazing land use. Three patches of Poplar Box TEC will be impacted by residual ponding (patches P3, P4, P5), and this will reduce the Poplar Box TEC vegetation by 44.4 ha across these three patches. One patch (P4) will be fragmented by the residual ponding.

Significance criteria	Assessment of significance
Adversely affect habitat critical to the survival of an ecological community	Habitat critical to the survival of the Poplar Box TEC is 'Class A, High quality' patches (DoEE 2019b). The patches of Poplar Box TEC present in the study area are 'Class B Good quality' and, therefore, considered not to form habitat critical to the survival of the TEC. The Project is unlikely to affect habitat critical to the survival for the TEC.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels or substantial alteration of surface water drainage patterns	The impacts of areas of periodic ponding due to surface subsidence, which modify conditions necessary for Poplar Box TEC survival, are considered as a reduction in the extent of the TEC. Management measures will be applied to prevent erosion and sedimentation resulting from Project activities within the Poplar Box TEC habitat. Given these controls, the Project is not predicted to cause erosion-related impacts that will modify or destroy factors necessary for the survival of the Poplar Box TEC. The Poplar Box TEC in the study area has not been identified as a GDE, and modifications to groundwater levels are unlikely to affect the TEC's survival (3D Environmental 2022).
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	Parts of three Poplar Box TEC patches will be impacted by the Project. The partial impact on these patches may create potential for edge effects on these patches. Edge effects to remaining areas of this TEC adjacent to impact areas are unlikely to be significant, as the TEC is already subject to weed infestation of established ground cover species. Weed control measures will be implemented throughout the study area to minimise the risk of degradation of Poplar Box TEC through change in species composition. The result of the implementation of the mitigation measures proposed in this assessment will be that it is unlikely the retained TEC in the study area will experience a decline or loss of the functionally important species. Bushfire prevention and management measures will be implemented in accordance with the Emergency Response Plan, which will protect the functionally important species of the Poplar Box TEC.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • assisting invasive species that are harmful to the listed ecological community to become established, or • 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	Three Poplar Box TEC patches will be partially impacted by the Project. The remaining areas of the impacted patches may be subject to edge effects; however, the Project area is within a modified rural landscape where introduced species have been recorded throughout the TEC. The proposed Project is unlikely to increase the threat of invasive species in the landscape. The Project is unlikely to result in the mobilisation of pollutants of any kind into this TEC either within or adjacent to the Project area. The Project is not likely to use fertilisers on-site or cause regular mobilisation of herbicides that may impact the Poplar Box TEC. Control measures such as sediment dams will be in place to minimise the potential for pollutants to affect the Poplar Box TEC in the study area.
Interfere with the recovery of an ecological community	There is no national recovery plan for the Poplar Box TEC. The Project will result in the reduction of extent of the Poplar Box TEC by approximately 44.4 ha.
Conclusion	The Project is considered to have a significant impact on 44.4 ha of the Poplar Box TEC. The extent of these impacts is shown in Figure 21.92.

Figure 21.92: Poplar Box TEC significant impact areas

21.12.4.3 Ornamental Snake

Description

The Ornamental Snake (*Denisonia maculata*) is listed as Vulnerable under the EPBC Act and NC Act.

The species is known from the Brigalow Belt North and parts of the Brigalow Belt South biogeographical regions and is sparsely distributed throughout its range (DoE 2014b, DAWE 2021a). The core of the species' distribution occurs within the drainage system of the Fitzroy and Dawson Rivers (McDonald *et al*. 1991; Cogger *et al.* 1993).

The Ornamental Snake occurs within woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions in Queensland Regional Ecosystem Land Zone 4 but also lake margins and wetlands (DAWE 2021a). These habitats are favoured by frogs (the Ornamental Snake's prey) and provide suitable microhabitat features for the species, such as deep cracking clay soils, logs and vegetation debris/litter in which the species shelters.

The Ornamental Snake has most commonly been recorded in Queensland Regional Ecosystem (RE) 11.4.3 and has commonly been recorded in RE 11.4.6, RE 11.4.8 and RE 11.4.9, and less commonly in RE 11.3.3 and RE 11.5.6 (DAWE 2021a, DSEWPaC 2011a). The Ornamental Snake also occurs in cleared areas where the abovementioned RE's formerly occurred, which comprises adequate ground cover to provide shelter (such as gilgai formations, logs, rocks and other debris) for the species. Gilgai formations are found where deep-cracking alluvial soils with high clay contents occur.

The Ornamental Snake is nocturnally active. The diet of this species consists predominantly of frogs, and the species forages in areas where frogs are abundant (DoEE 2019c). The Ornamental Snake has been observed consuming a variety of species (DoEE 2019c). The Ornamental Snake shelters during the day in logs and under coarse woody debris, ground litter and in deep soil cracks (DAWE 2021a). The species is thought to be active year-round, with the exception of cooler months. Peak activity occurs in early summer and through the wet season. During dry periods, *D. maculata* can remain inactive in suitable shelter sites (DAWE 2021a). The Ornamental Snake is viviparous (i.e. gives birth to young that have developed within the mother's body), and typically a litter size ranges from three to 11 (DAWE 2021a).

Desktop analysis

Desktop analysis of relevant databases has been conducted to identify records of the Ornamental Snake within the vicinity of the Project (Wildlife Online, Queensland Museum, Wildnet and Atlas of Living Australia). The desktop assessment also includes a review of ecological survey and assessments of nearby developments for information/records relating to the Ornamental Snake. Details of the desktop analysis are provided in 21.12.1.2.

The Ornamental Snake has been identified during surveys undertaken for surrounding projects including, but not limited to, Isaac Downs (Ecological Survey and Management 2020a), Isaac Plains East (Ecological Survey and Management 2020b), Olive Downs Coking Coal Project (DPM Envirosciences 2018a), Saraji Mine/Saraji East Mining Lease Project (Aecom 2021) and Winchester South Project (e2m 2021).

Desktop analysis of Queensland government mapping, including regional ecosystem mapping, essential habitat mapping, land zone mapping and wetlands, has also been conducted to determine the potential vegetation communities and soil types present and the extent of potentially suitable habitat for the Ornamental Snake. Aerial photography has also been inspected to assess the presence of potentially suitable vegetation and gilgai.

Survey effort

Seasonal fauna surveys of the study area have been conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April) and autumn 2021 (16–25 April) over 45 days in consideration of relevant Commonwealth and Queensland surveys guidelines. The autumn surveys were conducted during optimal climatic conditions for the Ornamental Snake.

Fourteen systematic survey sites were established during the surveys. Three systematic survey sites were established Brigalow woodlands on clay soils, which is potential habitat for the Ornamental Snake (MF04, MF07 and MF08). Each site consisted of the recommended design and trap numbers for pitfalls and funnels as per the Queensland guideline (Eyre *et al.* 2018). Supplementary targeted spotlighting survey effort has been conducted in Autumn 2021.

Survey effort for the Ornamental Snake at systematic and targeted sites included:

- Pitfall traps: 176 trap nights;
- Funnel traps: 264 trap nights;
- Diurnal searches: 75 person hours;
- Spotlighting: 47 per hours in total, with 15 person hours over 3 nights in Brigalow and gilgai habitat.

Survey effort for active searching and spotlighting has not met the duration requirements as per the Commonwealth Guideline, which requires 1.5 person hours diurnally and nocturnally per hectare over at least three days and nights. This was not practicable for the area of habitat within the study area. The Ornamental Snake is most likely to be encountered by searching in and around suitable gilgai habitats during the evening when frogs are most active. The targeted surveys conducted for the Ornamental Snake are considered the most appropriate means of survey. Despite not meeting the DCCEEW survey guidelines, the Ornamental Snake has been confirmed in the study area through targeted searches for this species.

For habitat assessment, amenity surveys have been conducted along transects of 100 m within areas of potentially suitable habitat. The total extent of gilgai formations and maximum gilgai depths have been recorded along the transect. Observations were made of:

- dominant shrub vegetation;
- dominant ground cover vegetation;
- presence of woody debris; and
- presence of soil cracks.

Additional observations of Ornamental Snake habitat suitability were made incidentally throughout the study area.

Further details of the survey timing, effort and methodology are provided in Section 21.12.1.

Survey outcomes

The Ornamental Snake has been recorded at three locations within the study area by the terrestrial fauna surveys. All three records were recorded within Brigalow regrowth vegetation containing well developed gilgai (Figure 21.93).

The habitat assessment transect data and site survey/inspections informed the assessment of habitat amenity for the Ornamental Snake within the study area.

Habitat assessment

Habitat mapping for the Ornamental Snake within the study area is shown on Figure 21.93 and is informed by in-field observations and transect data, aerial photography, soils mapping and information contained in DAWEs Species Profiles and Threats (SPRAT) database, including the relevant statutory documents and published research.

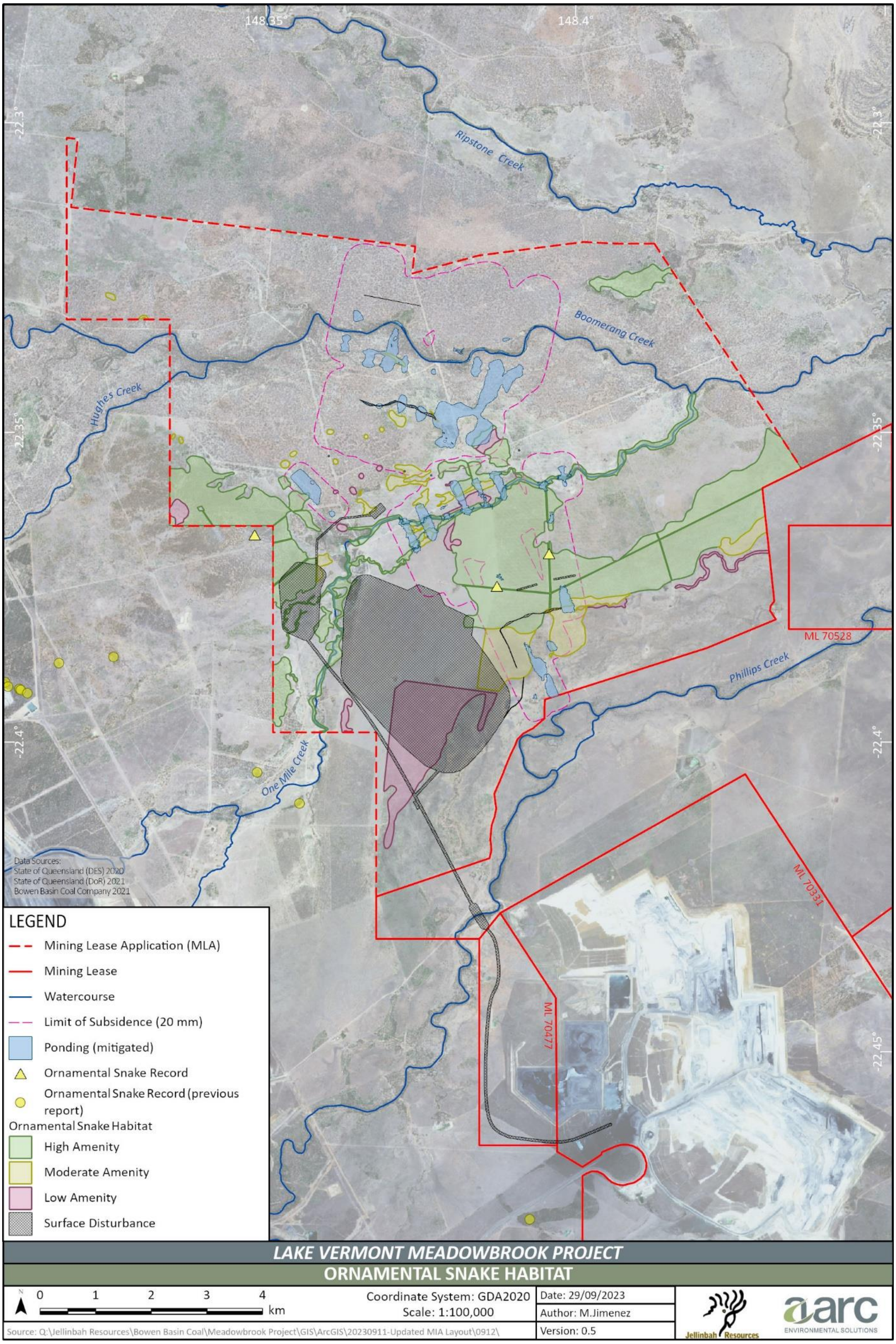

Figure 21.93: Ornamental Snake habitat mapping

Habitat amenity for the Ornamental Snake within the study area has been mapped against the criteria outlined in Table 21.49[4].

Table 21.49: Ornamental Snake habitat amenity assessment criteria

Habitat amenity	Description
High	High amenity habitat is defined as areas of deep gilgai microrelief (60+ cm depth) or ephemeral creek lines (including older systems) on dark clays. Evidence of pooling surface water is common on aerial imagery. In these areas, Ornamental Snakes are known to occur (previous records) or are considered highly likely, and the area is expected to support comparatively higher densities.
Moderate	Moderate amenity habitat includes areas with less pronounced gilgai microrelief (20–60 cm depth) that occurs on either dark (predominantly) or loam (uncommonly) soils. There is reduced evidence of surface water pooling on aerial imagery. On balance, these areas are more likely to be inhabited by Ornamental Snakes than not, though the species may be absent from some areas or in low abundance. These habitats may not hold water in poor rainfall conditions (i.e. droughts).
Low	Low amenity habitat includes areas with slight microrelief (<20 cm) or low possibility of pooling water. Often associated with sand/loam soils. Ornamental Snakes, if present, are likely to be at comparatively low density though, on balance, it is anticipated that most areas will be uninhabited. These habitats are anticipated to contain water only in high rainfall conditions (i.e, well above average) and, even then, may not hold water for lengthy periods. Despite containing water, large dams or permanent waters are not typically frequented by abundant frogs. Considering the extent of more suitable habitat, these waterbodies are generally not mapped as suitable (with some exceptions).
Unsuitable	Unsuitable habitat for the Ornamental Snake includes areas that contain less appropriate soil types (sands and sandy loams), lack suitable microhabitat features, have been subject to historic blade-ploughing which has adversely affected microrelief (unless otherwise indicated by aerial photography or in-field observations) and are characterised by dense, non-native grass species. These habitats are typically not attractive to Ornamental Snakes or large aggregations of their prey (frogs).

Areas of habitat amenity have been determined based on in-field observations and aerial photography by EcoSmart Ecology and AARC. Dark clay soils, which are more likely to retain water and support abundant frog populations, have been assessed using the following hierarchy of confidence:

- direct in-field observations;
- the presence of dark shrub vegetation (Brigalow) on aerial photography and the absence of light green shrub vegetation (*Carissa ovata*); and
- soil mapping of the study area (Appendix C, Soils and Land Assessment, section 4).

Aerial photography of the study area (1 m resolution) has been captured in May 2019 following above average rainfall (~45% greater than average for the months of June to April). At the provided resolution, larger and more substantial microrelief (i.e. gilgais) were visible, and the recent rainfall allowed the extent and/or likely presence of surface water to be assessed.

While the above habitats are relatively easy to define, assigning these criteria to areas within the site is problematic due to gradual transitions in gilgai formations (mapping of distinct boundaries oversimplifies in-field values), the complex patchwork of soils which can occur in some areas (e.g. to the north and west of One Mile Creek) and the history of ploughing to remove woody regrowth, which incrementally alters microrelief in areas that may otherwise show deep gilgai formations. On the site, *Acacia harpophyll*a is generally associated with darker clays, while *Carissa* sp. is generally associated with red soils. These two plant species can be differentiated with high resolution aerial imagery. However, in many areas, there is a mix of the two. While the

4 Assessment of habitat amenity for the Ornamental Snake is only applicable to the study area and is not an assessment of habitats throughout the species range or within the region.

soil mapping by AARC (Appendix C, Soils and Land Assessment, section 4) is suitable for its intended purpose, it does not provide a sufficient level of detail at the scale suitable for mapping Ornamental Snake habitat. As such, it has only been used to predict soil type when required.

Impact assessment

Threats to the Ornamental Snake include (DAWE 2021a):

- habitat loss through clearing;
- habitat fragmentation;
- habitat degradation through overgrazing by stock, especially cattle, or grazing of gilgais during the wet season that leads 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.

A total of 1,672.0 ha of Ornamental Snake habitat has been identified within the study area, including 1,192.5 ha of high amenity, 213.5 ha of moderate amenity and 266.0 ha of low amenity habitat (Table 21.50, Figure 21.93). A total of 211.1 ha of Ornamental Snake habitat is proposed to be cleared for the Project, including 41.7 ha of high amenity, 21.9 ha of moderate amenity and 147.5 ha of low amenity habitat.

Table 21.50: Proposed disturbance of Ornamental Snake habitat

Habitat amenity	Extent within study area (ha)	Extent of direct disturbance (ha)		Extent of subsidence impact (ha)[a]	Extent of predicted ponding impact (ha)
		Stages 1,2,3 clearing (ha)	Stage 4 clearing (ha)		
Low	266.0	4.1	143.4	19.9	4.2
Moderate	213.5	3.6	18.3	100.8	10.9
High	1192.5	38.1	3.6	393.8	27.7
Total	**1672.0**	**45.9**	**165.3**	**514.5**	**42.8**

a Excludes predicted ponding areas

The direct disturbance by clearing will impact Ornamental Snake habitat, which will add to habitat disturbance that is proposed to occur for other Projects in the region. However, it is noted that proposed Project and other existing and approved projects are granted approval in accordance with legislation, and where significant impacts occur as a result, appropriate offsets of these impacts are provided.

Direct disturbance associated with the infrastructure corridor will intersect high amenity Ornamental Snake habitat at One Mile Creek and low amenity habitat located south of the proposed open-cut pit. The clearing for the infrastructure corridor crossing at One Mile Creek will intersect the habitat adjacent to the southern portion of One Mile Creek, and these two patches will be dissected by the Project feature. The mobility of the species and its ability to use shallow water and mobilise through boxed culverts will likely allow the species to continue to disperse along the watercourse despite the infrastructure corridor crossing. The southern portion of the habitat adjacent to One Mile Creek will retain connectivity to habitat continuing along the watercourse to the south of the Project boundary into an area which is not within the impact area of the adjoining, proposed Saraji East project. The low amenity habitat located to the south of the proposed open-cut pit will also be intersected by the infrastructure corridor. The Ornamental Snake is considered likely to be able to disperse through the area despite the presence of the Project feature by mobilising over the corridor and using the culverts which will be located along the watercourse crossing. The open-cut pit will fragment the low amenity habitat to the south of the pit from the moderate and high-quality habitat in the central portion of the study area. Ornamental Snake mobility is likely to allow the species to disperse across the areas of cleared agricultural land such that these habitat patches are unlikely to be effectively fragmented by the open-cut pit.

The surface subsidence within the Ornamental Snake habitat area does not represent a removal of habitat, with the impact presenting as superficial geomorphological changes, which will not have a deleterious effect on soil cracks or gilgai features. The subsidence within identified Ornamental Snake habitat is predicted to be to a maximum depth of 2.9 m and a tilt of typically less than 3% (Appendix A, Subsidence Assessment, Section 4.1.1). This geomorphological change is unlikely to have a deleterious impact on the gilgai features and cracking soils that define the Ornamental Snake habitat, with indirect impacts to the Ornamental Snake habitat also considered unlikely. The predicted subsidence impacts are described in further detail in Section 21.12.3.6 and Section 21.12.3.2. Ornamental Snake habitat occurs within riparian vegetation adjacent to One Mile Creek, including in reaches of the Creek that will be subject to stream morphology changes from subsidence. Potential stream morphology affected areas are co-located with areas of predicted ponding, and the assessment of stream morphology change impacts and mitigation measures are detailed in Section 21.12.3.7. The vegetation forming Ornamental Snake habitat within the study area was not identified to be groundwater dependent (Section 21.15.3).

The predicted areas of residual ponding within Ornamental Snake habitat represent a change in habitat with additional ponds arising. The quality and availability of habitat required for foraging, shelter and breeding and mobility will be retained in the residual ponding areas, although the period of inundation of gilgai features may be increased. The areas of residual ponding are predicted to be inundated for a maximum period of several months every few years, with the period dependent on the volume of inflow and soil permeability (Appendix W, Geomorphological Assessment Report, section 3.3.3), which is considered comparable to the pattern of seasonal inundation as required for habitat for the species. Ornamental Snake diet is predominantly frogs, for which temporary and permanent ponds provide foraging and breeding habitat. Predicted subsidence ponding areas are considered analogous to the temporary ponding areas suitable for the Ornamental Snake prey breeding areas. The impacts of subsidence and predicted ponding is therefore not considered to represent a change in Ornamental Snake foraging habitat, and no deleterious impact to Ornamental Snake foraging is expected.

The extent of flooding in the study area is predicted to increase along the margins of subsided panels however, the changes to flood levels and extent are not considered significant (Appendix W, Geomorphological Assessment Report, section 4.2). The impacts of changes to flooding regimes on Ornamental Snake habitat are, therefore, not expected to be significant.

Gas drainage activities in the proposed southern underground mining area will occur with Ornamental Snake habitat. The gas drainage activities are unlikely to create any significant impacts to this species, with access to be largely achieved using existing tracks, and drainage sites will be remediated as mining progresses. The potential for indirect impacts on the Ornamental Snake from noise and vibration, dust, lighting and vehicle strike is considered to be minimal given the measures that will be implemented to manage these impacts.

The identification of impacts to Ornamental Snake habitat in the study area includes consideration of potential impacts from climate change and adjoining projects that have been incorporated into hydrological modelling (Appendix Z, Flood Modelling Assessment Report, section 1.3.12). Therefore, it is considered that the assessment has taken into account cumulative sources of impact, and no further cumulative impacts to Ornamental Snake habitat will occur. Further discussion of cumulative impacts is provided in Section 21.12.3.18.

Impacts of erosion and subsidence related cracking are discussed in Section 21.12.3.6 and Section 21.12.3.16. Given the proposed monitoring and management measures for erosion, it is considered unlikely that erosion will impact Ornamental Snake habitat. The Project also has the potential to increase weed and animal pest populations if they are not appropriately managed. However, as described in Section 21.12.3.10, weed and pest management measures will be implemented for the Project.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the Ornamental Snake where practicable. The proposed avoidance and mitigation measures for the Ornamental Snake, including timing, predicted effectiveness, monitoring and adaptive management. These measures and their relevant statutory or policy basis, is provided in Table 21.51.

Statutory requirements

A number of conservation, recovery and threat abatement plans are relevant to the Ornamental Snake and have been considered in the development of avoidance, mitigation and management measures and assessment of significant impact for the Ornamental Snake:

- The 'Approved Conservation Advice for *Denisonia maculata* (Ornamental Snake)' (DoE 2014b) developed at the time of the EPBC Act listing provides guidance on recovery and threat abatement activities that can be undertaken to ensure the conservation of the species.
- The '*Denisonia maculata*–Ornamental Snake' SPRAT profile provides information about the Ornamental Snake, including relevant regulatory considerations and information in relation to its population and distribution, habitat, movements, feeding and reproduction.
- The SPRAT profile for this species indicates there is no adopted or made Recovery Plan for this species, as the approved conservation advice (DoE 2014b) provides sufficient direction to implement priority actions and mitigate against key threats.
- The 'EPBC Act Draft Referral guidelines for the nationally listed Brigalow Belt reptiles' (DSEWPaC 2011c) includes information on Ornamental Snake habitats, survey considerations, primary threats, impacts and potential mitigation measures. The Draft Referral Guidelines consider 'important habitat' to be a surrogate for 'important populations' of Brigalow Belt reptiles and lists gilgai depressions and mounds as known important habitat for the Ornamental Snake.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019), Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021), 'Australian Weeds Strategy 2017–2027' (Commonwealth of Australia 2017a) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Convention on Conservation of Nature in the South Pacific (Apia Convention), or other relevant international conventions. The terrestrial ecology assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess their likelihood of occurrence;
- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its 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).

Table 21.51: Ornamental Snake impact avoidance and mitigation measures

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Project infrastructure has been located to minimise direct disturbance to Ornamental Snake habitat.	Mine planning/ construction/ operations	Highly effective—minimises the extent of impacts to Ornamental Snake habitat.	Monitor disturbance/vegetation clearance areas against approved disturbance limits. Monitor/audit implementation of vegetation clearance protocol to confirm it is appropriately implemented (e.g. areas have been clearly delineated, prior inspections have been conducted and habitat features have been assessed for potential salvage). Should clearing exceed approved limits, incident reporting will be initiated with a corrective action plan will be proposed (including proposed timing) and implemented.	DoE (2014b), DSEWPaC (2011c), Ponce Reyes *et al.* (2016)
Disturbance areas will be delineated to prevent accidental damage to adjacent Ornamental Snake habitat.	Construction/ operations	Highly effective management technique to manage Project disturbance activities.		
Fauna spotter/catcher will be on-site when clearing activities occur within Ornamental Snake habitat. Fauna spotter/catcher will monitor clearance activities for Ornamental Snakes and any incidence of fauna mortality or injury will be recorded. Injured fauna will be taken to a wildlife carer or veterinarian.	Construction/ operations	Effectiveness is likely to be variable and dependent on whether individual(s) move from their shelter and whether individual(s) can be caught during the clearing activities.	Adaptive measures will be implemented, as necessary. Potential adaptive measures include pre-clearance surveys/trapping of target fauna.	DoE (2014b)
Fauna spotter/catcher will monitor the fauna encountered and the occurrence of Ornamental Snakes within trenches.	Construction	Highly effective method to ensure trapped animals do not perish.	Adaptive measures include increased frequency of inspection or limiting the duration or extent of the disturbance at any one time.	DSEWPaC (2011c)
Select habitat features (e.g. hollows, logs) will be salvaged during clearance activities for habitat enhancement in Ornamental Snake habitat that will not be disturbed by the Project.	Construction/ operations	Effective if salvaged carefully and placed strategically to enhance existing habitat.	Implementation of the vegetation clearance protocol will be monitored/audited. Corrective measures will be implemented as required.	DoE (2014b)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Design and undertake subsidence ponding drainage management works to minimise hydrological changes to Ornamental Snake gilgai habitats.	Mine planning/ operations	The hydrological modelling (Appendix W, Geomorphological Assessment Report, section 5.5) indicates the subsidence ponding mitigation works will be effective in minimising the hydrological changes that will occur as a result of mine subsidence.	Subsidence effects and implemented mitigation and rehabilitation measures will be monitored in accordance with the Subsidence Management Plan (Section 21.12.3.6) to be prepared for the Project. Audit(s) will be conducted against the Subsidence Management Plan. Corrective measures may include additional works to reduce ponding.	DoE (2015e), DoE (2014b), DSEWPaC (2011c), Ponce Reyes *et al*. (2016)
Implement erosion and sediment control measures.	Construction/ operations/ rehabilitation and decommissioning	Highly effective management measure to minimise the potential for erosion and sedimentation.	Monitoring of the integrity and effectiveness of implemented erosion and sediment controls will be conducted in accordance with the Erosion and Sediment Control Plan that will be prepared for the Project. Adaptive management measures (such as installation of additional erosion controls or increase in frequency of inspections) will be implemented, as required.	DoE (2014b), DSEWPaC (2011c), Ponce Reyes *et al.* (2016)
Implement measures to reduce the risk of the introduction of pollutants (e.g. bunding or containment of hydrocarbon storages, provision of spill kits).	Construction/ operations/ rehabilitation and decommissioning	Highly effective management measure to minimise the potential for leaks and spills or other pollutants being introduced to Ornamental Snake habitat.	Visual inspections will be conducted of containment measures at MIA. Maintenance or implementation of additional controls will be carried out, as required, to maintain integrity and effectiveness. Auditing of management measures and identification of potential system improvements will be conducted.	DoE (2014b), DSEWPaC (2011c), Ponce Reyes *et al*. (2016)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Monitor and manage pest animal populations and implement pest control measures in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Corrective actions (such as increasing the frequency or extent of control efforts or alternative control strategies) will be implemented, as necessary.	DoE (2014b), DSEWPaC (2011c), Ponce Reyes *et al.* (2016), Commonwealth of Australia (2017b), Qld Department of Agriculture and Fisheries pest control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020), DoEE (2017)

Significant impact assessment

The Ornamental Snake population occurring at the study area has been assessed against the definition of 'important population' of a vulnerable species (DoE 2013a). The study area is located near the centre of the Ornamental Snake range within the Brigalow Belt. Dispersal and genetic exchange is likely to occur between the population occupying the study area and the population occupying the broader region. Therefore, it is considered that the population occupying the study area is not likely to be:

- a key source population for breeding or dispersal;
- a population necessary for maintaining genetic diversity; or
- a population near the limit of the species range.

The high amenity habitat with pronounced gilgai relief identified within the study area corresponds with the definition of known important habitat described in SEWPaC (2011c). Therefore, the population occupying this area of potentially important habitat may be considered an important population.

Table 21.52 provides an assessment of the likelihood of significant impacts on the Ornamental Snake in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Table 21.52: Ornamental Snake significant impact assessment

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 the clearing of 211.1 ha of habitat including 147.5 ha of low amenity habitat. The Project may lead to a decrease in the size of an important population. However, 907.4 ha of habitat will be retained in the study area, and 557.5 ha will be affected by subsidence but is expected to retain or increase its habitat viability.
Reduce the area of occupancy of an important population	The Project will result in the removal of a total of 211.1 ha of habitat. This removal of habitat may reduce the area of occupancy within the study area. Habitat for the species will be retained in the study area through retention of 907.4 ha of habitat that will be unaffected by the Project, as well as the 557.5 ha that will be affected by subsidence but is expected to retain or increase its habitat viability.
Fragment an existing important population into two or more populations	The Project will result in the removal of 211.1 ha of habitat. The removal of habitat for the construction of the infrastructure corridor will impact connectivity of habitat located along One Mile Creek and in the habitat patch to the south of the open-cut pit. The open-cut pit will fragment a portion of low amenity habitat to the south of the pit from the habitat in the central portion of the study area. However, the connectivity to habitat outside of the study area will be retained. The mobility of the species is expected to allow it to disperse past Project features, including over or under the infrastructure corridor and *via* surrounding cleared areas. Therefore, the population is considered unlikely to be fragmented into two or more populations.

Significance criteria	Assessment of significance
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the Ornamental Snake listed on the Register of Critical Habitat (DAWE 2021Ac). While the habitat is used by a local population of the species, the areas are unlikely to be necessary for the species as a whole for activities such as: • foraging; • breeding; • roosting; • dispersal; • the long-term maintenance of the species; and • maintaining genetic diversity for the reintroduction or recovery of the species. The high amenity habitat identified in the study area is considered likely to be important habitat for the species. This habitat may be considered to represent habitat critical to the survival of the species despite not being listed on the Register of Critical Habitat, and the Project, therefore, has potential to impact this critical habitat.
Disrupt the breeding cycle of an important population	The Project will result in the removal of a total of 211.1 ha of habitat, and these areas of habitat will not support breeding of the species after clearing. The undisturbed areas are expected to continue to provide for breeding. The areas affected by subsidence are expected to maintain habitat viability for breeding, as key habitat requirements are not expected to be degraded by the process of subsidence, including; gilgai depressions and wetland features, soil cracks, debris and leaf litter. The retained habitat throughout the study area is unlikely to be indirectly impacted by the Project. Indirect impacts, such as weeds and pests, noise and vibration, dust, artificial lighting, vehicle strike and bushfire, will be managed as outlined in sections 21.12.3.10 to 21.12.3.15 and are considered not to have potential to disrupt the breeding cycle of the Ornamental Snake in retained habitat within the study area. The breeding cycle of Ornamental Snake outside the area of habitat to be removed is unlikely to be impacted by the Project.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project requires the removal of 211.1 ha of Ornamental Snake habitat. The removal of this extent of habitat is considered likely to decrease the availability of habitat and cause a decline of the species within the area local to the Project. The habitat retained within the study area is unlikely to undergo any process that is likely to cause the species to decline. The habitat within the subsidence areas will undergo some modification; however, the general habitat requirements of the species will be retained with the addition of increased areas of ponding in wet conditions. Areas of inundated depressions and wetland areas are predicted to be increased within subsidence areas, and therefore, the subsidence areas are considered likely to retain or exceed the availability and quality of habitat present in these areas.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The study area is in a modified rural landscape, and invasive species that may be harmful to the Ornamental Snake exist in the broader region. Predatory species, including feral cats, have been recorded in the study area. The Project is unlikely to result in the introduction and establishment of any invasive species that may predate on the Ornamental Snake in the habitat present within the study area. Feral pigs and cane toads have been recorded and are established in the Ornamental Snake habitat within the study area and are the likely cause of degradation of the habitat. The Project is unlikely to result in the introduction or establishment of any other species likely to be harmful to the Ornamental Snake. Monitoring and management of pests, including corrective actions, will be implemented in accordance with a Weed and Pest Management Plan (Section 21.12.3.10).

Significance criteria	Assessment of significance
Introduce disease that may cause the species to decline	There are no diseases listed as a threat to the Ornamental Snake. The Project is unlikely to introduce a disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no adopted or made Recovery Plan for this species. Priority recovery actions identified by the TSSC (2014) include the identification of populations of high conservation priority, the use of conservation arrangements or management agreements on private land, inclusion in reserve tenure, minimisation of adverse impacts and controlling of introduced pests. The Project is unlikely to substantially interfere with the recovery of the species.
Conclusion	The Project will result in the removal of 211.1 ha of Ornamental Snake habitat. This clearing is identified as likely to reduce the area of habitat availability within the study area and may be critical to the survival of the species in the local area. Therefore, the Project is likely to have a significant impact to the Ornamental Snake. The extent of the significant impact areas is shown in Figure 21.94.

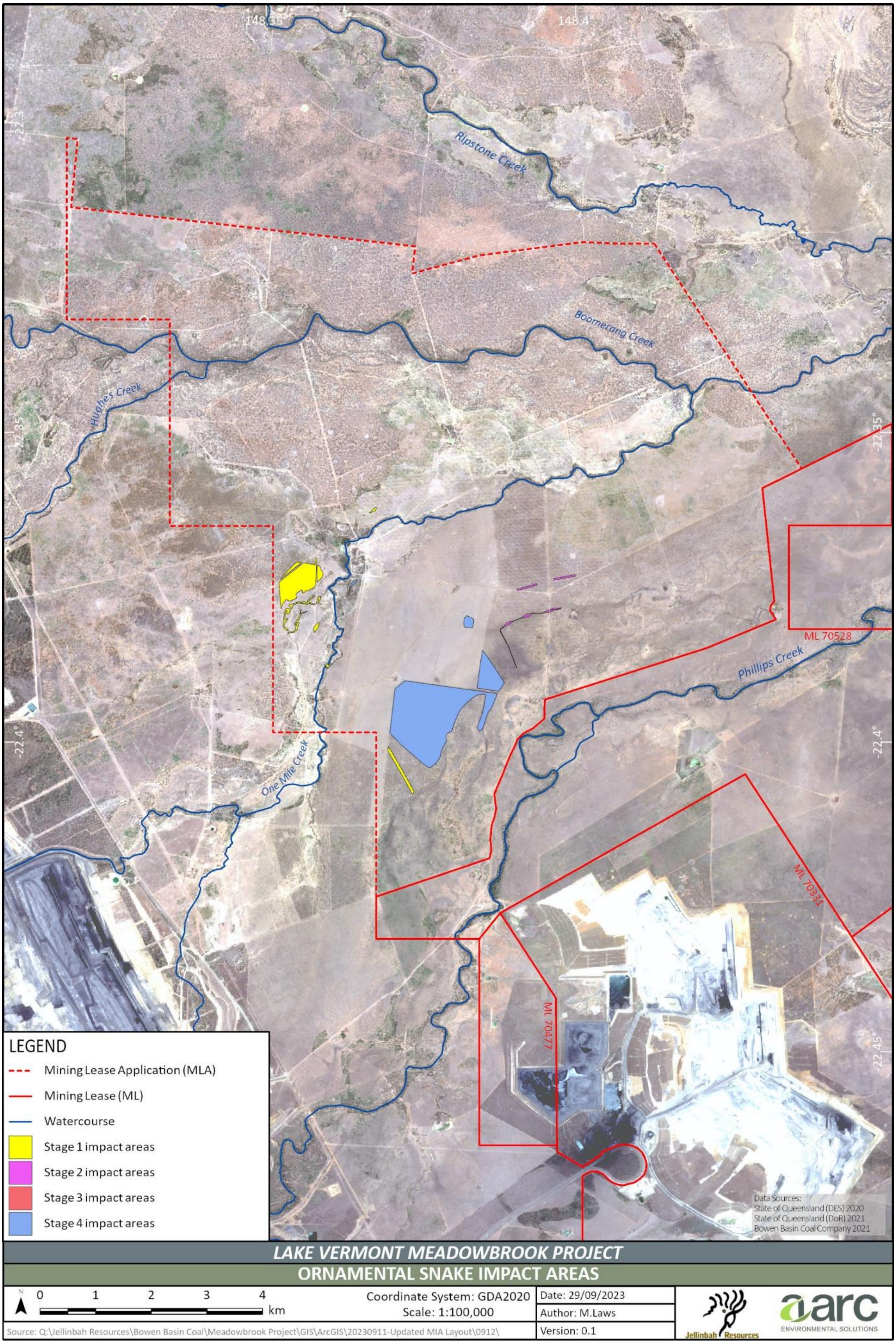

Figure 21.94: Ornamental Snake significant impact areas

21.12.4.4 White-throated Needletail

Description

The White-throated Needletail (*Hirundapus caudacutus*) is listed as Vulnerable under the EPBC Act and NC Act and is a listed migratory and marine species under the EPBC Act.

The White-throated Needletail is a large migratory swift and widespread across eastern and south-eastern Australia during its non-breeding season in September/October (DAWE 2021a, TSSC 2019). In eastern Australia, it has been recorded in all coastal regions of Queensland, extending inland to the western slopes of the Great Divide and occasionally onto adjacent inland plains (DAWE 2021a). The species is considered to be widespread in eastern and south-eastern Australia, from the islands in Torres Strait south to Tasmania. One of two subspecies of White-throated Needletail occurs in Australia although both occur in the northern hemisphere. (DAWE 2021a).

Primarily an aerial species, this species is known to occur across a variety of habitats including wooded areas, open forests, and rainforests (DAWE 2021a). Large tracts of native vegetation, particularly forest, is considered likely to be a key habitat requirement for this species (DoE 2015a). It has been observed flying over farmland, typically over partially cleared pasture or within remnant vegetation at the edge of paddocks where it predominantly forages at cloud level along the edges of low-pressure systems (DAWE 2021a). This species also forages in open habitats or recently disturbed areas (TSSC 2019) feeding on a wide variety of insects (DAWE 2021a), occasionally near ground level. White-throated Needletails seldom alight on the ground or other substrates to catch insects and have very occasionally been seen foraging by launching into the air from trees in pursuit of flying insects or clinging to flowers on eucalypts, searching for insects (DAWE 2021a).

It prefers to roost in forests and woodlands, both among dense foliage in the canopy or in tree hollows, as well as on bark or rock faces, and occasionally roost aerially (DAWE 2021a, DoE 2015a).

Desktop analysis

Desktop analysis of relevant databases has been conducted to identify records of the White-throated Needletail within the vicinity of the Project (Wildlife Online, Queensland Museum, Wildnet and Atlas of Living Australia). The desktop assessment also included review of ecological survey and assessments for nearby developments for information/records relating to the White-throated Needletail. Details of the desktop analysis are provided in Section 21.12.1.2.

The White-throated Needletail has been recorded by surveys conducted for the existing Lake Vermont Mine (WBM Oceanics 2003) and by surveys undertaken for the Saraji Mine (Aecom 2021) and Caval Ridge Mine (BAAM 2009).

Survey effort

Seasonal fauna surveys of the study area have been conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April) and autumn 2021 (16–25 April) over 45 days in consideration of relevant Commonwealth and Queensland surveys guidelines. The surveys were conducted within the survey window for northern and eastern Australia (DAWE 2021a).

Fourteen systematic survey sites were established during the surveys. All systematic sites were established in habitat considered to provide potential foraging habitat to the White-throated Needletail.

Survey effort for the White-throated Needletail at systematic and supplementary sites included:

- diurnal searches: 75 person hours;
- bird surveys: 83 hours;
- opportunistic observations.

The survey effort and timing meet the Commonwealth Guideline (DoEE 2019c) and the Queensland Guideline (Eyre 2018).

Further details of the survey timing, effort and methodology is provided in Section 21.12.1.

Survey outcomes

An individual White-throated Needletail has been recorded during the spring 2019 terrestrial ecology survey within the remnant Poplar Box woodland on alluvial plains (VC 2a) vegetation community (Figure 21.88).

Habitat assessment

The White-throated Needletail does not breed in Australia (Higgins 1996). During the non-breeding season in Australia, the White-throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1,000 m above the ground (DAWE 2021a). While the species forages above most habitat types, the White-throated Needletail is predominantly recorded above wooded areas (TSSC 2019). The Project area contains areas of wooded and cleared areas which may provide foraging habitat for the species.

Impact assessment

Approximately 3371.7 ha of remnant vegetation (woodland habitat) has been identified within the study area (Figure 21.88). A total of 12.2 ha of remnant vegetation is proposed to be cleared for the Project and 96.9 ha is predicted to impacted by predicted potential for ponding. The impacts on White-throated Needletail habitat will add to habitat disturbance that is proposed to occur for other Projects in the region. The clearance of remnant vegetation/habitat for the Project will not fragment habitat for this highly mobile species.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the White-throated Needletail where practicable. The proposed avoidance and mitigation measures for the White-throated Needletail including timing, predicted effectiveness, monitoring, adaptive management and the relevant statutory or policy basis is provided in Table 21.53.

Table 21.53: White-throated Needletail impact avoidance and mitigation measures

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Project infrastructure has been located to avoid or minimise direct disturbance to remnant vegetation.	Mine planning/ construction/ operations	Highly effective—minimises the extent of impacts to woodland habitats.	Monitor disturbance/vegetation clearance areas against approved disturbance limits. Should clearing exceed approved limits, incident reporting will be initiated with a corrective action plan will be proposed (including proposed timing) and implemented. The corrective actions will be informed by the nature and extent of the exceedance.	TSSC (2019), DoE (2015a)
Implement vegetation clearance protocols, including the delineation of vegetation adjoining proposed clearance areas to prevent accidental damage (Section 21.12.3.3).	Construction/ operations	Highly effective management technique to manage vegetation clearance activities.		

Statutory requirements

The following conservation, recovery and threat abatement information has been considered for assessment of the White-throated Needletail:

- The ‘Approved Conservation Advice for *Hirundapus caudacatus* (White-throated Needletail)’ (TSSC 2019), developed at the time of EPBC Act listing and the ‘*Hirundapus caudacutus*–White-throated Needletail’ SPRAT profile provides information about the White-throated Needletail, including its distribution, biology/ecology, threats and conservation actions and priorities.
- The SPRAT profile for this species indicates there is no adopted or made Recovery Plan for this species, as the approved conservation advice (TSSC 2019) provides sufficient direction to implement priority actions and mitigate against key threats and enable recovery.
- The ‘Draft Referral guideline for 14 birds listed as migratory species under the EPBC Act’ (DoE 2015a) provides information on 14 migratory species, including the White-throated Needletail. The referral guideline describes important non-breeding habitat for the White-throated Needletail.
- ‘Australia’s Strategy for Nature 2019–2020’ (Commonwealth of Australia 2019), Australia’s actions for nature including the ‘Threatened Species Strategy 2021–2031’ (Commonwealth of Australia 2021), ‘Australian Weeds Strategy 2017–2027’ (Commonwealth of Australia 2017a) and ‘Australian Pest Animal Strategy 2017–2027’ (Commonwealth of Australia 2017b) outline relevant actions to recover Australia’s threatened plants, animals and ecological communities.

Potential threats to the White-throated Needletail include (DAWE 2021a):

- collision with wind turbines and overhead wires;
- use of insecticides; and
- habitat loss and fragmentation (breeding habitat or non-breeding habitat).

The Project is not inconsistent with the objectives of the EPBC Act or Australia’s obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Convention on Conservation of Nature in the South Pacific (Apia Convention), the China–Australia Migratory Bird Agreement (CAMBA), the Japan–Australia Migratory Bird Agreement (JAMBA), the Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA), Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) or other relevant international conventions. The terrestrial ecology assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess its likelihood of occurrence;
- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its 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).

Significant impact assessment

Table 21.54 provides an assessment of the likelihood of significant impacts on the White-throated Needletail in accordance with the Commonwealth ‘Significant Impact Guidelines 1.1: Matters of National Environmental Significance’ (DoE 2013a).

Table 21.54: White-throated Needletail significant impact assessment

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	Although two subspecies of White-throated Needletails breed in separate populations in the Northern Hemisphere, only one occurs in Australia where they do not occur as smaller populations (DAWE 2021a). The clearing of 12.2 ha of remnant vegetation for the Project and potential modification through occasional residual ponding of up to 96.9 ha of remnant vegetation is unlikely to decrease the size of the population given the extent of habitat available to this species across eastern and south-eastern Australia.
Reduce the area of occupancy of an important population	The population of the White-throated Needletail that may use habitat within the study area is considered not to be an important population. The extent of vegetation clearance required for the Project is unlikely to reduce the area of occupancy of this species. Tracts of native vegetation which can provide roosting habitat will remain within the Project area and is widespread in the region. The study area habitat will continue to provide aerial foraging habitat.
Fragment an existing important population into two or more populations	The White-throated Needletail migrates to Australia during the non-breeding season and is widespread across eastern and south-eastern Australia. The Project will not fragment the population into two of more populations.
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the White-throated Needletail listed on the Register of Critical Habitat. Habitat within the Project area does not represent habitat critical to the survival of the White-throated Needletail.
Disrupt the breeding cycle of an important population	The White-throated Needletail does not breed in Australia. The Project will not disrupt the breeding cycle.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Primarily an aerial species, the White-throated Needletail predominantly forages aerially, feeding on a wide variety of insects. They roost in forest and woodlands. While the Project will include some vegetation clearance, it will not reduce the quality or availability of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	Invasive species are not a serious threat to the White-throated Needletail. The Project is unlikely to result in invasive species that are harmful to the White-throated Needletail.
Introduce disease that may cause the species to decline	Disease is not a known threat to the White-throated Needletail. The Project is unlikely to introduce a disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. Priority conservation actions identified for this species include working with governments in East Asia to minimise disturbance to breeding habitats and the identification and protection of important habitats in Australia (TSSC 2019). The Project is unlikely to substantially interfere with the recovery of the species.
Conclusion	The area of habitat proposed to be cleared and the importance of the habitat present indicate the Project is unlikely to have a significant impact on the White-throated Needletail.

21.12.4.5 Squatter Pigeon (Southern subspecies)

Description

The Squatter Pigeon (*Geophaps scripta scripta*) is listed as Vulnerable under the EPBC Act and NC Act.

The Squatter Pigeon occurs along the inland slopes of the Great Dividing Range, with a distribution from the Burdekin-Lynd divide in central Queensland, west to Charleville and Longreach, east to the coastline between Proserpine and Gladstone and south to scattered sites throughout south-eastern Queensland (Cooper *et al.* 2014).

The Squatter Pigeon is known to occur in remnant or regrowth open forest to sparse, open woodland or scrub dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species, with grassy understories within 3 km of a suitable waterbody (DAWE 2021a). Habitat for the species consists of ground covering vegetation rarely not exceeding 33%, and the species requires bare patches of gravelly or dusty soil for foraging. Breeding habitat occurs in areas of similar vegetation on stony rises occurring on sandy or gravelly soils within 1 km of a suitable waterbody, typically associated with Queensland RE land zones 3, 5 or 7 (DAWE 2021a).

The Squatter Pigeon is known to access suitable waterbodies to drink on a daily basis. Waterbodies suitable for the subspecies include:

- permanent or seasonal rivers;
- Creeks;
- Lakes;
- ponds and waterholes; and
- artificial dams, where there is gently sloping, bare ground on which to approach and stand at the water's edge (DAWE 2021a; Kerswell *et al.* 2020).

The subspecies also prefers to forage and dust-bathe on bare ground under an open canopy of trees (DAWE 2021a). The subspecies is considered unlikely to move far from 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 (DAWE 2021a).

The Squatter Pigeon's diet consists of seeds, and the species mainly forages on seeds that have fallen to the ground from low vegetation, such as grasses, herbs and shrubs (DAWE 2021a). The Squatter Pigeon scrapes a depression into the ground beneath tussock grass, a bush or a fallen log to create a nest. Females typically lay two eggs that are incubated for 17 days, and once hatched, chicks remain within the nest for 2 to 3 weeks and continue to be dependent upon their parents for around four weeks once leaving the nest (Kerswell *et al.* 2020).

Desktop analysis

Desktop analysis of relevant databases has been conducted to identify records of the Squatter Pigeon within the vicinity of the Project (Wildlife Online, Queensland Museum, Wildnet and Atlas of Living Australia). The desktop assessment also includes reviews of ecological surveys and assessments of nearby developments for information/records relating to the Squatter Pigeon.

The desktop analysis has identified numerous records for the species in the vicinity of the Project, which were identified during previous terrestrial ecology surveys for the Lake Vermont Mine (AARC 2012, AARC 2016) and other nearby developments, including Saraji East Mining Project to the west, Winchester South Project to the north-west and Olive Downs Project to the north.

Details of the desktop analysis are provided in Section 21.12.1.2.

Desktop analysis of Queensland government mapping, including regional ecosystem mapping, essential habitat mapping, land zone mapping and water sources was also conducted to determine the potential vegetation communities and soil types present and the extent of potentially suitable habitat for the Squatter Pigeon.

Survey effort

Fauna surveys of the study area have been conducted in autumn 2019 (11–21 March), spring 2019 (6-19 November), autumn 2020 (23–25 March and 1–8 April), autumn 2021 (16–25 April), winter 2021 (16–20 August June)[5] and spring 2021 (6–10 September 2021)[6] over 50 days in consideration of relevant Commonwealth and Queensland survey guidelines. The surveys extended over both Brigalow Belt Bioregion survey timing windows; spring to early summer and autumn (Eyre *et al.* 2018).

Fourteen systematic survey sites were established during the surveys, with at least two sites established in each habitat type. Survey effort for the Squatter Pigeon included:

- active searching: 75 hours;
- diurnal bird surveys: 83 hours;
- camera trapping: 56 trap nights; and
- incidental recordings obtained from opportunistic observations while travelling within the general study.

Survey timing, methodology and effort met the requirements of the Commonwealth and Queensland guidelines. The Project area is greater than 50 ha, ruling out the need for flushing surveys, which are required under Commonwealth guidelines for small survey areas (<50 ha).

Further details of the survey timing, effort and methodology are provided in Section 21.12.1.

Survey outcomes

The Squatter Pigeon has been recorded within the study area during the spring 2019, autumn 2020 and autumn 2021 surveys. A total of 13 individuals were spotted during incidental recordings from opportunistic observations while travelling within the general study area (Appendix G, Terrestrial Ecology Assessment, appendix J). In winter 2021, opportunistic observations by 3D Environmental recorded the Squatter Pigeon to the east of the study area near the Isaac River. Squatter Pigeons were recorded at six locations in the study area and the locations at which the Squatter Pigeon has been recorded in the study area are shown on Figure 21.95.

Based on field survey data (i.e., secondary site assessment; Neldner *et al.* [2020]), remnant vegetation and high value regrowth within the study area typically have a ground cover of less than 33%. While some locations include a high percentage of exotic Buffel Grass, native grass cover is common. Ground cover is not heterogeneous, and open areas were often encountered. Furthermore, grazing pressure was altered in April to June 2021 when cattle were removed from the property and this, accompanied by drought breaking rains in the following months, may have resulted in increased ground cover. Under these conditions, the local population may have shifted into surrounding lands where continued grazing ensured ground cover remained suitable. These changing conditions may explain their sporadic presence at the site and that, under different climatic conditions and grazing regime, it could play an important role for the location population.

Habitat assessment

Habitat mapping for the Squatter Pigeon within the study area is shown on Figure 21.95 and is based on the habitat descriptions outlined in Table 21.55.

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[5] Opportunistic observations of the Squatter Pigeon by David Stanton (3D Environmental) during the conduct of groundwater dependant ecosystem surveys.

[6] Opportunistic observations of the Squatter Pigeon during the conduct of threatened species habitat assessments (Mark Sanders, EcoSmart Ecology and AARC).

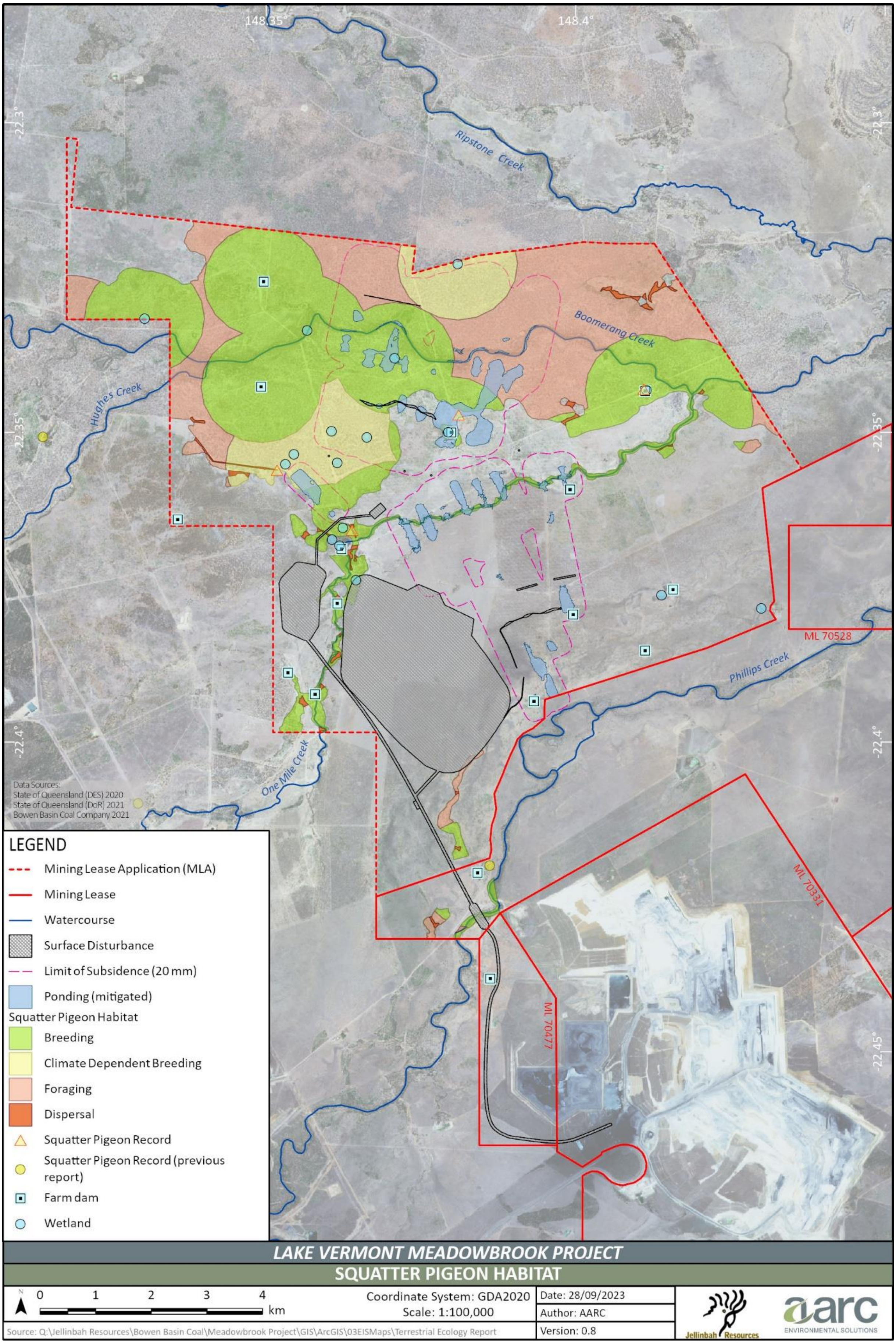

Figure 21.95: Squatter Pigeon habitat mapping

Table 21.55: Squatter Pigeon habitat description and occurrence

Habitat description	Relevant features present within the study area
Potential for breeding	
Remnant or regrowth open forest, woodland, open woodland or scrub, with relatively sparse (<33%) groundcover vegetation, typically an overstorey dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species within 1 km of suitable permanent or semi-permanent water bodies (DAWE 2021a).	Available literature suggests Squatter Pigeons have the potential to nest in areas of suitable habitat within 1 km of a permanent or semi-permanent water source. All areas of remnant and high-value regrowth within the site have been identified as suitable (subject to weather and grazing conditions). Permanent or semi-permanent water bodies identified within the study area include One Mile Creek, all farm dams and a selection of natural wetlands, which were assessed as providing a reliable source of water for breeding under most climatic conditions. Applying the 1 km buffer around these sources suggests breeding opportunity is possible within the areas shown on Figure 21.95. The ephemeral watercourses, Hughes Creek, Boomerang Creek and Phillips Creek, are characterised by sandy substrates. While water can be present in these streams following large rainfall events/flooding, the water quickly disappears within days or, at most, a few weeks. These streams do not provide a semi-permanent or permanent water source for the Squatter Pigeon.
Potential for climatic dependant breeding	
Remnant or regrowth open forest, woodland, open woodland or scrub with relatively sparse (<33%) groundcover vegetation, typically an overstorey dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species within 1 km of suitable seasonal water bodies.	A number of natural wetlands occur within the study area that do not provide a permanent or semi-permanent source of water. However, these natural wetlands may provide a suitable source of water under certain climatic conditions (e.g. in above average wet years). Remnant and high-value regrowth vegetation within 1 km of these natural wetlands may provide breeding habitat for the Squatter Pigeon under certain climatic conditions and have been mapped as 'opportunity for climatic dependant breeding'.
Suitable foraging habitat	
Remnant or regrowth open forest, woodland, open woodland or scrub with relatively sparse (<33%) groundcover vegetation, typically an overstorey dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species within 3 km of suitable permanent, semi-permanent, or seasonal water bodies.	The areas mapped as remnant vegetation and high-value regrowth vegetation within the study area provide suitable groundcover for the Squatter Pigeon (subject to climatic conditions and grazing pressure) and have been mapped as suitable habitat where the vegetation occurs within 3 km of suitable permanent, semi-permanent, or seasonal water sources. The suitable water sources include those described above in 'potential for breeding' and 'opportunity for climatic breeding'. The ephemeral streams, Hughes Creek, Boomerang Creek and Phillips Creek, are considered not to provide a suitable seasonal source of water. Grass cover in the cleared agricultural areas is typically much greater than 33% and unsuitable foraging habitat for the Squatter Pigeon. There is some opportunity for Squatter Pigeon to forage in the immediate vicinity of farm dams, where cattle grazing prohibits grass growth, and along property access tracks. However, these areas are considered unlikely to provide extensive foraging opportunities for the species.

Habitat description	Relevant features present within the study area
Dispersal habitat	
Any forest or woodland occurring between patches of foraging or breeding habitat and suitable waterbodies—includes areas of cleared land less than 100 m wide linking areas of suitable breeding or foraging habitat.	Dispersal habitat has been defined to include any remnant and regrowth open forest or woodland occurring between patches of foraging and breeding habitat and areas of cleared land (less than 100 m wide) that link areas of suitable habitat.

The habitat descriptions in Table 21.55 are based on the information contained in DCCEEWs SPRAT database, including the relevant statutory documents and published research specific to the distribution of habitat for the Squatter Pigeon within the study area.

Potential permanent, semi-permanent and seasonal water sources (watercourses, farm dams and wetlands) within the study area have been inspected by EcoSmart Ecology and AARC to determine their suitability as a water source for Squatter Pigeon breeding and foraging. The habitat assessment involved observations of the characteristics of the potential water source, the ground cover and other microhabitat features in areas surrounding the water source.

Impact assessment

A total of 3510.2 ha of Squatter Pigeon habitat has been identified within the study area, including 1869.7 ha of potential breeding habitat, 459.4 ha of potential climate dependent breeding habitat and 1181.1 ha of additional foraging habitat (i.e. additional to the foraging habitat provided by the potential breeding areas) (Table 21.56 and Figure 21.95).

Table 21.56: Proposed Project footprint within Squatter Pigeon habitat

Habitat amenity	Extent within study area (ha)	Extent of direct disturbance (ha)		Extent of subsidence impact (ha)a	Extent of predicted ponding impact (ha)
		Stages 1,2,3 clearing (ha)	Stage 4 clearing (ha)		
Breeding	1869.7	5.7	7.1	373.5	62.6
Climate-dependent breeding	459.4	0.3	0.0	273.1	8.9
Foraging	1181.1	0.5	2.2	343.7	31.5
Dispersal	29.0	<0.1	0	0	0.6
Total	**3510.2**	**6.5**	**9.3**	**990.3**	**103.6**

A total of 15.8 ha of Squatter Pigeon habitat is proposed to be cleared for the direct surface disturbance of Stages 1, 2, 3 and 4 of the Project, including:

- 12.8 ha of potential breeding habitat;
- 0.3 ha of potential climate dependent breeding habitat;
- 2.7 ha of additional foraging habitat; and
- 29 ha of dispersal habitat.

The Project will result in impacts on Squatter Pigeon habitat, which will add to habitat disturbance that is proposed to occur for other Projects in the region.

The land disturbance associated with the Project (e.g. infrastructure corridor and MIA) will result in some fragmentation of Squatter Pigeon habitat; however, this is unlikely to be significant given the mobility of this species.

A total of 990.3 ha of Squatter Pigeon habitat is located within the proposed subsidence footprint and a further 103.6 ha of habitat is located within the subsidence footprint predicted to experience periodic ponding. The potential indirect impacts of subsidence are discussed in Section 21.12.3.6. No direct impacts to vegetation are expected to result from subsidence with Squatter Pigeon habitat characteristics (within the subsidence area) expected to be maintained. Soil cracks are predicted to develop in the subsidence area, however given the monitoring and management of potential soil cracks (which will be addressed within the Subsidence Management Plan) the quality or availability of Squatter Pigeon habitat within the subsidence footprint is considered unlikely to be impacted.

The expected impacts in areas predicted to undergo periodic ponding are described in Section 21.12.3.6. Squatter Pigeon habitat in areas of predicted ponding is expected to retain vegetation characteristics required for provide suitable habitat of open forest, woodland, open woodland or scrub with relatively sparse (<33%) groundcover vegetation.

The areas of predicted residual ponding are expected to represent a potential change of habitat, distinct from a removal of habitat. These areas are predicted to experience inundation every few years and retain water for several months. The predicted ponding of water in these areas will create an expansion of the potential climatic-dependent breeding habitat into areas that currently provide foraging habitat but do not support breeding habitat because of their distance to water. The availability of Squatter Pigeon habitat is expected to be retained in predicted ponding areas and the quality of habitat is expected to change through the expansion of breeding and climatic dependent breeding areas.

The extent of flooding in the study area is predicted to increase along the margins of subsided panels; the changes to flood levels and extent are not considered significant (Appendix W, Geomorphological Assessment Report, section 4.2). The impacts of changes to flooding regimes on Squatter Pigeon habitat are, therefore, not expected to be significant. Potential or likely GDEs were identified within the study area however assessed to be unlikely to be significantly impacted by the Project (Section 21.15.2). Therefore, groundwater impacts are considered unlikely to impact Squatter Pigeon habitat.

The potential for indirect impacts on the Squatter Pigeon from noise and vibration, dust, lighting and vehicle strike are considered to be minimal given the measures that will be implemented to manage these impacts. Impacts of erosion and subsidence related cracking are assessed in Section 21.12.3.6 and Section 21.12.3.16. Given the proposed monitoring and management measures for erosion, no substantial erosion is expected to occur and it is considered unlikely that erosion will impact Squatter Pigeon habitat. The Project also has the potential to increase weed and animal pest populations if they are not appropriately managed. However, as described in Section 21.12.3.10, weed and pest management measures will be implemented for the Project.

The identification of impacts to Squatter Pigeon habitat in the study area includes consideration of potential impacts from climate change and adjoining projects that have been incorporated into hydrological modelling (Appendix Z, Flood Modelling Assessment Report, section 1.3.12). It is considered that the assessment has, therefore, taken into account cumulative sources of impact, and no further cumulative impacts to Squatter Pigeon habitat will occur. Further discussion of cumulative impacts is provided in Section 21.12.3.18.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the Squatter Pigeon where practicable, as provided in Table 21.57.

Table 21.57: Squatter Pigeon impact avoidance and mitigation measures

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Project infrastructure will be located to minimise direct disturbance to Squatter Pigeon habitat.	Mine planning/ construction/ operations	Highly effective—minimises the extent of impacts to Squatter Pigeon habitat.	Monitor disturbance/vegetation clearance areas against approved disturbance limits. Should clearing exceed approved limits, incident reporting will be initiated with a corrective action plan will be proposed (including proposed timing) and implemented. The corrective actions will be informed by the nature and extent of the exceedance.	TSSC (2015b)
Disturbance areas will be delineated to prevent accidental damage to adjacent Squatter Pigeon habitat.	Construction/ operations	Highly effective management technique to manage Project disturbance activities.		
Regularly inspect mine-related surface disturbance areas and Bowen Basin Coal owned land to identify areas requiring weed management measures to be implemented. Implement weed management measures (e.g. mechanical removal and application of approved herbicides).	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the spread and occurrence of weeds.	Monitoring and management of weeds in accordance with Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project. Corrective actions (such as increasing the frequency or extent of control efforts, or alternative control strategies) will be implemented, as necessary.	TSSC (2015b), Commonwealth of Australia (2017a), Qld Department of Agriculture and Fisheries weed control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020)
Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by introduced fauna.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Regular monitoring of the site will be carried out by environmental personnel. Raise awareness through personnel inductions. Additional measures (such as tool box talks or staff newsletters) will be implemented if inspections indicate a clean, rubbish-free environment is not being maintained.	TSSC (2015b), Commonwealth of Australia (2017b), DoE (2015b), DEWHA (2008b)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Store domestic waste in appropriate receptacles and locations.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests if site protocols are followed by personnel.	Regular monitoring of site will be carried out by environmental personnel. Monitoring and auditing of the Waste Management Plan to be updated for the Project. Additional measures (such as provision of additional receptacles or change in location of receptacles) will be implemented if current storage practices encourage feral animals	TSSC (2015b), Commonwealth of Australia (2017b), DoE (2015b), DEWHA (2008b)
Monitor pest animal populations and implementation of pest control measures in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests	Corrective actions (such as increasing the frequency or extent of control efforts or alternative control strategies) will be implemented, as necessary.	TSSC (2015b), Commonwealth of Australia (2017b), Qld Department of Agriculture and Fisheries pest control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020), DoE (2015b), DoEE (2016b), DEWHA (2008b)
Consult with the Isaac Regional Council and neighbouring mines in relation to weed and pest management activities.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Monitor and manage pests in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project. Audits will be implemented to monitor the consultation outcomes and the management measures will be implemented on site.	TSSC (2015b), Commonwealth of Australia (2017a), Commonwealth of Australia (2017b), Isaac Regional Council (2020)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Bushfire prevention and management measures will be outlined in the Emergency Response Plan. Inductions of mine site personnel will include fire awareness.	Construction/ operations/ rehabilitation and decommissioning	Effective management procedure to reduce the risk of bushfire.	Any incidence of bushfire will be investigated to determine the requirement for additional controls. Potential adaptive management measures include revision of the Emergency Response Plan and/or a program to increase personnel awareness of bushfire risk (e.g. through tool box talks).	TSSC (2015b)

Statutory requirements

A number of conservation, recovery and threat abatement plans are relevant to the Squatter Pigeon and have been considered in assessment of the Squatter Pigeon:

- The 'Conservation Advice for *Geophaps scripta scripta* (Squatter Pigeon [southern])' (TSSC 2015b), developed at the time of EPBC Act listing and '*Geophaps scripta scripta*–Squatter Pigeon (southern)' SPRAT profile provides information about the species, including its distribution, biology/ecology, threats and conservation actions and priorities.
- The SPRAT profile for this species indicates that there is no adopted or made Recovery Plan for this species, as the approved conservation advice (TSSC 2015b) provides sufficient direction to implement priority actions and mitigate against key threats.
- The 'Survey guidelines for Australia's threatened birds' (DEWHA 2010a) includes information on Squatter Pigeon and recommended methods for survey.
- Three threat abatement plans are listed in the SPRAT profile (DAWE 2021a) as being relevant to the Squatter Pigeon, namely:
    1) Department of the Environment (Commonwealth of Australia 2015) Threat abatement plan for predation by feral cats;
    2) Department of the Environment and Energy (2016b) Threat abatement plan for competition and land degradation by rabbits;
    3) Department of the Environment, Water, Heritage and the Arts (DEWHA 2008b) Threat abatement plan for predation by the European red fox.

       A threat abatement plan is a plan made or adopted under section 270B of the EPBC Act which establishes a national framework to guide and coordinate Australia's response to the impacts of a key threatening process.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019), Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021), 'Australian Weeds Strategy 2017–2027' (Commonwealth of Australia 2017a) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

Threats to the Squatter Pigeon (southern) include (DAWE 2021a):

- habitat loss and fragmentation;
- habitat degradation by overgrazing by stock, especially cattle;
- habitat degradation by the establishment of invasive pasture species including Buffel Grass (*Cenchrus ciliaris*); and
- predation by species, including the Fox (*Vulpes vulpes*), Dingo (*Canis familiaris dingo*), and Feral Cat (*Felis catus*).

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora or the Convention on Conservation of Nature in the South Pacific (Apia Convention). The terrestrial ecology assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess its likelihood of occurrence;
- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;

- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitat;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its 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).

Significant impact assessment

The Squatter Pigeon population occurring at the study area is not part of the sub-population occurring south of the Carnarvon Ranges, which is an important sub-population (DAWE 2021a). The species occurs regularly north of the Carnarvon Ranges and is considered one population occurring commonly throughout the northern range. The population occurring at the study area is part of this northern population that has connectivity across a large area for dispersal and breeding. Therefore, the Squatter Pigeon occurring at the study area is neither:

- a key source population for breeding or dispersal; nor
- a population that is necessary for maintaining genetic diversity.

The Squatter Pigeon range extends south to northern New South Wales, north to Mackay and west to near Longreach. Therefore, the population occurring at the study area is not located near the limit of the species range.

The population of Squatter Pigeon that uses the study area is considered unlikely to be an important population according to the criteria of the Significant Impact Guidelines (DoE 2013a).

Table 21.58 provides an assessment of the likelihood of significant impacts on the Squatter Pigeon in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Table 21.58: Squatter Pigeon significant impact assessment

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 that uses habitat within the study area is considered not to be an important population. It is considered that the removal of 15.8 ha of Squatter Pigeon habitat will not lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	The population of Squatter Pigeon that uses habitat within the study area is considered not to be an important population. The removal of 15.8 ha of Squatter Pigeon habitat is considered unlikely to reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations	The population of Squatter Pigeon that uses the habitat within the study area is considered not to be an important population. The removal of 15.8 ha of Squatter Pigeon habitat is considered unlikely to fragment an existing important population into two or more populations.

Significance criteria	Assessment of significance
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the Squatter Pigeon listed on the Register of Critical Habitat (DAWE 2021a). The Squatter Pigeon habitat to be impacted by the Project is considered not critical to the survival of the species as, while the habitat is used by a local population of the species, the areas are unlikely to be necessary for the species as a whole for activities such as: • foraging; • breeding; • roosting; • dispersal; • the long-term maintenance of the species; • maintaining genetic diversity; and • for the reintroduction or recovery of the species.
Disrupt the breeding cycle of an important population	The population of Squatter Pigeon that uses habitat within the study area is considered not to be an important population. The removal of 15.8 ha of Squatter Pigeon habitat is considered unlikely to disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project requires the removal of 15.8 ha of Squatter Pigeon habitat, including 12.8 ha of potential breeding habitat, 0.3 ha of potential climate dependent breeding habitat and 2.7 ha of foraging habitat. The removal of this extent of habitat is unlikely to lead to a long-term decline in the species population given the wider extent of habitat for this species.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The study area is located in a modified rural landscape, and invasive species that are harmful to the Squatter Pigeon exist in the broader region. Predatory species, including feral cat and feral fox, have been recorded and are established in the study area and are recognised threats to the Squatter Pigeon. Buffel grass, which can change understory cover, is already established throughout the study area. The Project is unlikely to result in the introduction and establishment of any invasive species that are harmful to the Squatter Pigeon in the habitat present in the study area. Monitoring and management of pests including corrective actions will be implemented in accordance with a Weed and Pest Management Plan (Section 21.12.3.10).
Introduce disease that may cause the species to decline, or	No diseases are listed as a threat to the Squatter Pigeon. The Project is unlikely to introduce a disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no adopted or made Recovery Plan for this species. The approved conservation advice provides direction to implement priority actions for this species and mitigate against key threats (TSSC 2015b). Priority conservation and management actions include the identification of sub-populations of high conservation priority, development of conservation agreements and control of feral herbivores. The Project is unlikely to substantially interfere with the recovery of the species.
Conclusion	The Project is considered unlikely to result in a significant impact to the Squatter Pigeon. The area of habitat to be disturbed by the Project is a very small proportion of the mapped habitat for the species, both within the study area and the wider region. The impacted habitat is considered not to be utilised by an important population. The predicted subsidence will also provide areas of intermittent ponding which may support the expansion of breeding habitat within the study area, through the provision of seasonal water sources.

21.12.4.6 Australian Painted Snipe

Description

The Australian Painted Snipe (*Rostratula australis*) is listed as Endangered under the EPBC Act and NC Act. It is also listed as a migratory species and marine species under the EPBC Act.

The Australian Painted Snipe is known to occur within wetlands within all states of Australia (DAWE 2021a). This species is most common in eastern Australia where it has been recorded throughout much of Queensland, New South Wales, Victoria and south-eastern South Australia at scattered locations (DAWE 2021a). The species is widespread and is considered not to have a limited geographic distribution (DSEWPaC 2013a). The species is considered to occur in Australia as a single contiguous breeding population (DAWE 2021a).

Habitat for the Australian Painted Snipe includes a variety of shallow wetlands, including temporary and permanent lakes, swamps and claypans (DAWE 2021a). The Australian Painted Snipe forages at the waters' edge and on mudflats (Garnett and Crowley 2000) and eats vegetation, seeds, insects, worms and molluscs, crustaceans and other invertebrates (Marchant & Higgins 1993). Nesting nearly always occurs on small islands or wetlands with complex shorelines, shallow water, exposed mud, with patchy to continuous vegetation surrounding the wetland (Rogers *et al.* 2005). Although the species can utilise modified habitats for foraging, they do not breed within areas that lack suitable cover. This species is mainly crepuscular (active at dawn and dusk) and highly cryptic.

The species requires wetland areas and will move to suitable habitat when the habitat becomes unavailable in an area (DAWE 2021a). Dispersive movements have been attributed to local conditions (i.e. moving to flooded areas, moving from drying to permanent wetlands and moving away from areas affected by drought). (DAWE 2021a).

Desktop analysis

Desktop analysis of relevant databases has been conducted to determine records of the Australian Painted Snipe within the vicinity of the Project, including Wildlife Online, Queensland Museum, Wildnet and Atlas of Living Australia occurrence records. The desktop assessment also includes a review of ecological survey and assessments for nearby developments for information/records relating to the Australian Painted Snipe. Details of the desktop analysis are provided in Section 21.12.1.2.

Very few records of this species have been identified in the region despite the extensive environmental impact assessment surveys conducted for mining developments. Within the vicinity of the Project, this species has been observed by SKM in an area of flooded *Acacia harpophylla* (Brigalow) woodland within the Saraji East Project site in 2007 (BMA 2021), by Ecological Survey & Management (2013) within the Winchester South Project site within a Brigalow lined waterway (Whitehaven Coal 2021), and by DPM Envirosciences (2018a) in a small wetted gilgai within agricultural grasslands within the Olive Downs Project site. The Australian Painted Snipe has not previously been recorded by surveys conducted for the existing Lake Vermont Mine. The species is considered a vagrant visitor only to the region, likely using wetlands on passage to more suitable foraging and breeding grounds.

Desktop analysis of Queensland government mapping includes a review of wetland mapping and identification of areas that may have the potential to provide habitat for the Australian Painted Snipe.

Survey effort

Fauna surveys of the study area have been conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April), autumn 2021 (16–25 April) and spring 2021 (6–10 September) over 50 days in consideration of relevant Commonwealth and Queensland survey guidelines. The surveys extended over both Brigalow Belt Bioregion survey timing windows: spring to early summer and autumn (Eyre *et al.* 2018).

Fourteen systematic survey sites were established during the surveys, with at least two sites established in each habitat type. Survey effort for the Australian Painted Snipe included:

- active searching: 75 hours;
- diurnal bird surveys: 83 hours;
- spotlighting: 47 hours; and
- 0pportunistic observations in suitable habitat.

Survey timing, methodology and effort meet the requirements of the Commonwealth and Queensland guidelines.

Survey outcomes

The Australian Painted Snipe was not detected by the seasonal fauna surveys. Most water bodies within the site are considered not suitable, as they lack a complex mosaic of shallow water, open mudflats and clumping vegetation. This includes almost all farm dams. Where habitat is present, it is minor in extent and low in amenity. The species might only occur as a rare vagrant.

Habitat assessment

Habitat assessment for the Australian Painted Snipe involved inspection of permanent, semi-permanent and seasonal water sources by EcoSmart Ecology and AARC to assess their suitability for Australian Painted Snipe breeding and/or foraging in relation to:

- water body size;
- water retention;
- presence of mudflats; and
- structure of aquatic and fringing vegetation.

Habitat mapping for the Australian Painted Snipe within the study area is shown on Figure 21.96 and is based on the habitat descriptions outlined in Table 21.59. It should be noted that the extent of the low amenity is likely less than indicated due to thick exotic grass growth in some areas. The habitat descriptions in Table 21.59 are based on the information contained in DCCEEWs SPRAT database, including relevant statutory documents and published research specific to the distribution of potential habitat for the Australian Painted Snipe within the study area.

Table 21.59: Australian Painted Snipe habitat description

Habitat description	Features present within the study area relevant to habitat category
Breeding habitat	
Wetlands with a complex shoreline with a mosaic of open mud areas, shallow waters (<5cm) and surrounding groundcover vegetation—clumping vegetation, such as tufted grasses, sedges, small woody plants and continuous reed beds or stands of reed-like vegetation (not including tall dense reed beds such as Cumbungi). Nests are placed on small islands.	Not present within the study area; wetlands within the study area are minor in extent and lack the complex microhabitat features required for this species breeding.
Intermittent foraging habitat	
Shallow permanent or ephemeral freshwater or brackish wetlands and other inundated/waterlogged areas with a variable ground cover (e.g. grasses, shrubs and rushes).	Site habitat assessments indicate the wetland and gilgai habitats within the study area provide the most suitable, marginal (low amenity), intermittent foraging habitat for the Australian Painted Snipe. This includes one natural palustrine wetland and two modified wetlands (palustrine and lacustrine). Less suitable, marginal (low amenity) foraging habitat, is provided by wetted gilgai habitat, which is only available for a short period after rainfall when the gilgai are full. Inspections of farm dams within the study area indicate they do not provide suitable foraging habitat for the Australian Painted Snipe.

While there is potential for transient Australian Painted Snipes to utilise the intermittent foraging habitat in the study area under suitable climatic conditions, the low amenity value of the foraging habitat suggests there is a low likelihood of this species occurring during the life of the mine.

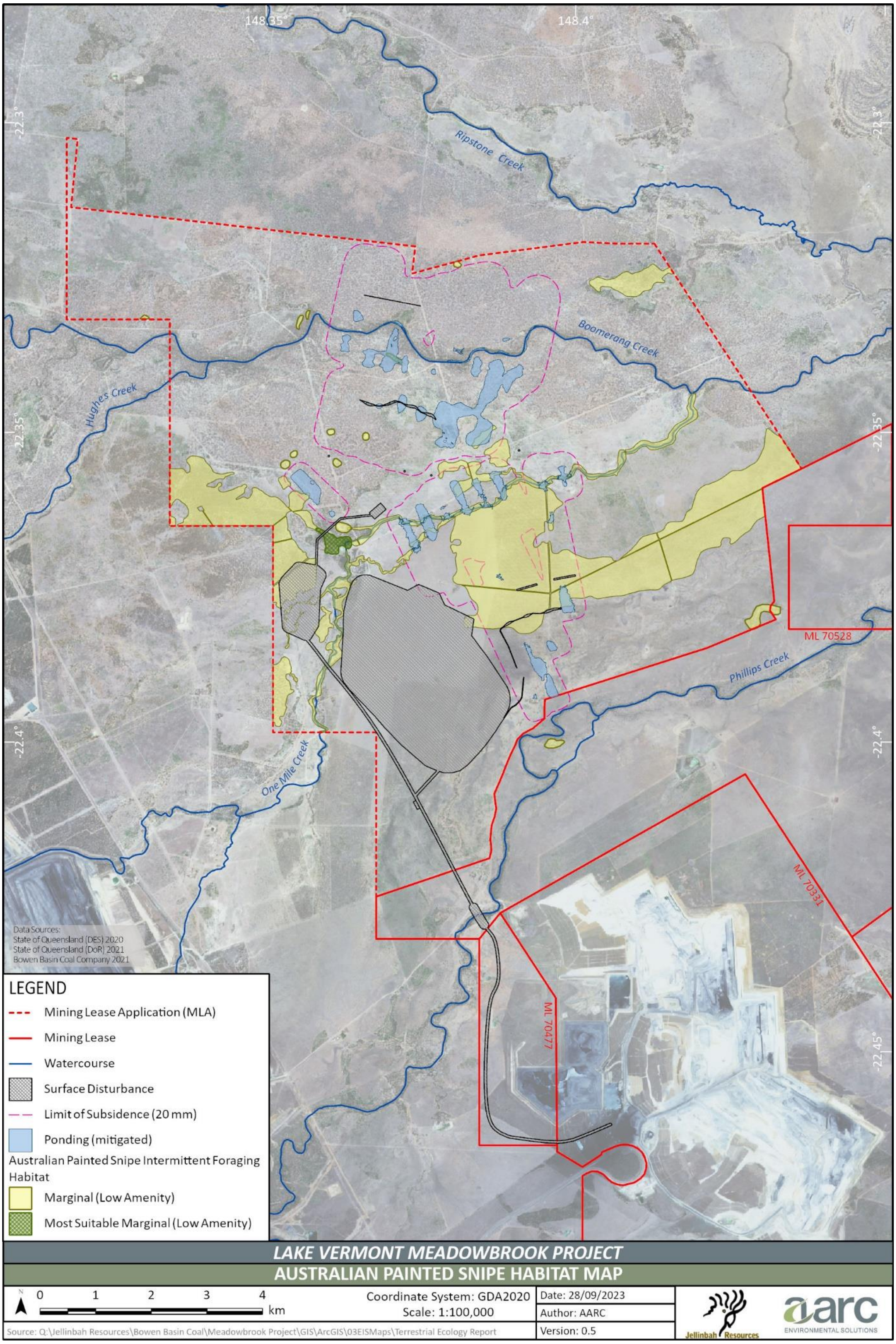

Figure 21.96: Australian Painted Snipe habitat mapping

Impact assessment

A total of 1242.2 ha of Australian Painted Snipe intermittent foraging habitat has been identified within the study area, including 14.2 ha of the most suitable foraging habitat (palustrine and lacustrine wetland areas) and 1228 ha of low amenity foraging habitat (Figure 21.96). A total of 36.5 ha of Australian Painted Snipe habitat is proposed to be disturbed by Stage 1 of the Project and 4.2 ha is proposed to be disturbed by Stage 4 (Table 21.60). The Project will result in impacts on Australian Painted Snipe which, while low in habitat amenity, will add to habitat disturbance that is proposed to occur for other Projects in the region.

Table 21.60: Proposed disturbance of Australian Painted Snipe habitat

Habitat	Habitat amenity	Extent within study area (ha)	Extent of direct disturbance (ha)	
			Stages 1,2,3 clearing (ha)	**Stage 4 clearing (ha)**
Intermittent foraging habitat	Most suitable marginal (low amenity)	14.2	0.3	0.0
	Marginal (low amenity)	1228.0	36.2	4.2
	Total	**1242.2**	**36.5**	**4.2**

The areas of residual ponding occur over a 29.5 ha portion of the identified Australian Painted Snipe habitat. These areas are expected to represent a change of habitat; the ponded areas are likely to hold water for a maximum period of several months every few years depending on volume of inflow and soil permeability (Appendix W, Geomorphological Assessment Report, section 3.3.3), which is likely longer than the habitat currently holds water. This will potentially provide an increase of habitat suitability in these areas. The residual ponding areas also extend outside of the mapped Australian Painted Snipe foraging habitat, and the ponding in these areas may allow these previously unsuitable areas to provide some low amenity foraging habitat to the Australian Painted Snipe.

The extent of flooding in the study area is predicted to increase along the margins of subsided panels; however, the changes to flood levels and extent are considered not significant (Appendix W, Geomorphological Assessment Report, section 4.2). The impacts of changes to flooding regimes on Australian Painted Snipe habitat are, therefore, not expected to be significant.

The potential for indirect impacts to the Australian Painted Snipe from noise and vibration, dust, lighting and vehicle strike is considered to be minimal given the measures that will be implemented to manage these impacts and the low likelihood of its occurrence given more suitable habitats exist in the surrounds and in the wider region. The Project also has the potential to increase weed and animal pest populations if they are not appropriately managed. However, as described in Section 21.12.3.10, weed and pest management measures will be implemented for the Project.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the Australian Painted Snipe where practicable. The proposed avoidance and mitigation measures for the Australian Painted Snipe including timing, predicted effectiveness, monitoring, adaptive management and the relevant statutory or policy basis is provided in Table 21.61.

Table 21.61: Australian Painted Snipe impact avoidance and mitigation measures

Avoidance/mitigation measures	**Timing**	**Predicted effectiveness**	**Monitoring and adaptive management**	**Statutory or policy basis**
Project infrastructure has been located to minimise direct disturbance to Australian Painted Snipe habitat.	Mine planning/ construction/ operations	Highly effective—minimises the extent of impacts to Australian Painted Snipe habitat.	Monitor disturbance/vegetation clearance areas against approved disturbance limits. Should clearing exceed approved limits, incident reporting will be initiated with a corrective action plan will be proposed (including proposed timing) and implemented. The corrective actions will be informed by the nature and extent of the exceedance.	TSSC (2013b); DSEWPaC (2013a), Ponce Reyes *et al.* (2016)
Disturbance areas will be delineated to prevent accidental damage to adjacent Australian Painted Snipe habitat.	Construction/ operations	Highly effective management technique to manage Project disturbance activities.		
Design and undertake subsidence drainage management works to minimise hydrological changes to gilgai and wetland habitats that provide potential foraging habitat for the Australian Painted Snipe.	Mine planning/operations	The hydrological modelling (Appendix W, Geomorphological Assessment Report, section 5.5) indicates the subsidence mitigation works will be effective in minimising the hydrological changes that will occur as a result of mine subsidence to gilgai and wetland habitats.	Subsidence effects and implemented mitigation and rehabilitation measures will be monitored in accordance with the Subsidence Management Plan (Section 21.12.3.6) to be prepared for the Project. Audit(s) will be conducted, and follow up corrective measures (e.g. additional drainage works) will be implemented, as required.	DoE (2015e), TSSC (2013b); DSEWPaC (2013a), Ponce Reyes *et al.* (2016)
Implement erosion and sediment control measures.	Construction/ operations/ rehabilitation and decommissioning	Highly effective management measure to minimise the potential for erosion and sedimentation.	Monitoring will be conducted of the integrity and effectiveness of implemented erosion and sediment controls in accordance with the Erosion and Sediment Control Plan to be prepared for the Project. Adaptive management measures (such as installation of additional erosion controls or increase in frequency of inspections) will be implemented, as required.	TSSC (2013b); DSEWPaC (2013a), Ponce Reyes *et al.* (2016)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Implement measures to reduce the risk of the introduction of pollutants (e.g. bunding or containment of hydrocarbon storages, provision of spill kits).	Construction/ operations/ rehabilitation and decommissioning	Highly effective management measure to minimise the potential for leaks and spills or other pollutants being introduced to Australian Painted Snipe habitat.	Visual inspections will be conducted of containment measures at MIA. Maintenance or implementation of additional controls will be carried out as required to maintain integrity and effectiveness. Management measures will be audited to identify potential system improvements.	TSSC (2013b); DSEWPaC (2013a), Ponce Reyes *et al*. (2016)
Regularly inspect mine-related surface disturbance areas and Bowen Basin Coal owned land to identify areas requiring weed management measures to be implemented. Implement weed management measures (e.g. mechanical removal and application of approved herbicides).	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the spread and occurrence of weeds.	Monitor and manage weeds in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project. Corrective actions (such as increasing the frequency or extent of control efforts, or alternative control strategies) will be implemented, as necessary.	TSSC (2013b), Commonwealth of Australia (2017a), Qld Department of Agriculture and Fisheries weed control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020)
Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by introduced fauna.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Regular monitoring of site will be carried out by environmental personnel. Raise awareness through personnel inductions. Additional measures (such as tool box talks or staff newsletters) will be implemented if inspections indicate a clean, rubbish-free environment is not being maintained.	TSSC (2013b), Commonwealth of Australia (2017b), DoE (2015b), DEWHA (2008b)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Store domestic waste in appropriate receptacles and locations.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests if site protocols are followed by personnel.	Regular monitoring of site will be carried out by environmental personnel. The Waste Management Plan will be monitored and audited to suit the required conditions of the Project. Additional measures (such as the provision of additional receptacles or change in location of receptacles) will be implemented if current storage practices encourage feral animals	TSSC (2013b), Commonwealth of Australia (2017b), DoE (2015b), DEWHA (2008b)
Monitor and manage pests in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be prepared for the Project.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Corrective actions (such as increasing the frequency or extent of control efforts or alternative control strategies) will be implemented, as necessary.	TSSC (2013b), Commonwealth of Australia (2017b), Qld Department of Agriculture and Fisheries pest control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020), DoE (2015b), DEWHA (2008b)
Consult with the Isaac Regional Council and neighbouring mines in relation to weed and pest management activities.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Monitor and manage pests in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project. Audits will be implemented to monitor the consultation outcomes and the management measures implemented on-site.	TSSC (2013b), Commonwealth of Australia (2017a), Commonwealth of Australia (2017b), Isaac Regional Council (2020)

Statutory requirements

The following conservation, recovery and threat abatement information has been considered for assessment of the Australian Painted Snipe:

- The 'Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe)' (DSEWPaC 2013a), 'Commonwealth Listing Advice on *Rostratula australis* (Australian Painted Snipe' (TSSC 2013b) and '*Rostratula australias*–Australian Painted Snipe' SPRAT profile provides information in relation to its population and distribution, habitat, movements and feeding and guidance on threat abatement and recovery actions that can be undertaken for the species.
- The SPRAT profile for this species indicates there is no adopted or made Recovery Plan for this species; however, a Recovery Plan is required. A 'Draft National Recovery Plan for the Australian Painted Snipe–*Rostratula australis*' (DoEE 2019d) provides information on current threats and recovery actions.
- The 'Survey guidelines for Australia's threatened birds' (DEWHA 2010a) includes information on the Australian Painted Snipe and recommended methods for survey.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019), Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021), 'Australian Weeds Strategy 2017–2027' (Commonwealth of Australia 2017a) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

Threats to the Australian Painted Snipe include (DAWE 2021a, DoEE 2019d):

- loss and degradation of wetland habitat due to:
    - drainage of wetlands and diversion of water to agriculture and reservoirs;
    - deterioration of water quality;
    - grazing and associated trampling of wetland vegetation by cattle and/or sheep;
    - the replacement of endemic wetland vegetation by invasive weeds;
    - climate variability and change; and
    - degradation of habitat by invasive herbivores, such as the Feral Pig, Goat and Deer;
- predation by feral species, such as the European Red Fox and Feral Cat;
- inappropriate fire regimes; and
- low genetic diversity.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Convention on Conservation of Nature in the South Pacific (Apia Convention), the China–Australia Migratory Bird Agreement, the Japan–Australia Migratory Bird Agreement, the Republic of Korea–Australia Migratory Bird Agreement or Convention on the Conservation of Migratory Species of Wild Animals.

The terrestrial ecology assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess its likelihood of occurrence;
- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitats;

- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its 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).

Significant impact assessment

Table 21.62 provides an assessment of the likelihood of significant impacts on the Australian Painted Snipe in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Table 21.62: Australian Painted Snipe significant impact assessment

Significance criteria	Assessment of significance
An action is likely to have a significant impact on an 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 Australian Painted Snipe is considered to occur in a single, contiguous breeding population (Garnett & Crowley 2000). As the Project will not disturb breeding habitat, it is unlikely to disrupt the breeding cycle of the Australian Painted Snipe. The extent of Project disturbance to low amenity intermittent foraging habitat is unlikely to lead to a long-term decrease in the size of the population given the extent of foraging habitat available in the wider region. The Project is highly unlikely to decrease the size of a population.
Reduce the area of occupancy of the species	The Australian Painted Snipe has not been recorded by the Project surveys. While the Project will disturb potential intermittent foraging habitat for the Australian Painted Snipe, it is unlikely to reduce the area of occupancy of the species given similar (and higher amenity) wetland and floodplain habitats occur within the local area and wider region.
Fragment an existing population into two or more populations	The Australian Painted Snipe has been recorded at wetlands in all states of Australia. However, it is most common in eastern Australia where it has been recorded throughout much of Queensland, New South Wales, Victoria and south-eastern South Australia at scattered locations (DoEE 2019c and DoEE 2019d). Connectivity of habitat will not be compromised by the Project for this mobile species. The Project will not fragment the population into two of more populations.
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the Australian Painted Snipe listed on the Register of Critical Habitat (DAWE 2021a). The habitat to be disturbed by the Project is considered not critical to the survival of the species, as it is unlikely to be necessary for activities such as foraging, breeding, roosting, dispersal, long-term maintenance of the species, maintaining genetic diversity or recovery of the species.
Disrupt the breeding cycle of a population	The Project will not disturb breeding habitat for the Australian Painted Snipe and is unlikely to disrupt the breeding cycle of the population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No potential breeding habitat will be disturbed by the Project. Up to 40.7 ha of potential intermittent marginal foraging habitat for the Australian Painted Snipe may be directly disturbed by the Project. However, this is unlikely to cause the species to decline given the availability of foraging resources in the local and wider area. As described in Section 21.12.3.8, changes to the flooding regime within the study area and surrounds are predicted to be minor and are unlikely to affect the availability of habitat for this species. Potential indirect impacts associated with the Project, such as weeds and pest animals will be managed so they do not degrade retained habitat within the study area. The Project is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Significance criteria	Assessment of significance
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Land within the study area is currently used for low intensity cattle grazing. Grazing and associated trampling of wetland vegetation by cattle is recognised as a potential threat to this species' habitat. Predation by feral species, such as the European Red Fox and Feral Cat, is also a recognised threat; both have been recorded in the study area. Invasive herbivores, including the Feral Pig and Red Deer, have also been recorded in the study area. The Project is unlikely to increase these threats or result in invasive species becoming established in the species' habitat.
Introduce disease that may cause the species to decline	Disease is not a known threat to this species. There are no indications of disease threatening the population of the Australian Painted Snipe. The Project is unlikely to introduce a disease that may cause the species to decline.
Interfere with the recovery of the species	While there is currently no adopted Recovery Plan for this species, the 'Draft National Recovery Plan for the Australian Painted Snipe –*Rostratula australis*' (DoEE 2019d) outlines recovery objectives and strategies to improve the conservation status of the species. The five key strategies identified to achieve the Draft Recovery Plan objectives are: 1. Manage and protect known Australian Painted Snipe breeding habitats at the landscape scale. 2. Develop and apply techniques to measure changes in population trajectory in order to measure the success of recovery actions. 3. Reduce or eliminate threats at breeding and non-breeding habitats. 4. Improve knowledge of the habitat requirements, biology and behaviour of Australian Painted Snipe. 5. Engage community stakeholders to improve awareness of the conservation of Australian Painted Snipe. 6. Coordinate, review and report on recovery process. The Project is unlikely to interfere with the recovery of the species.
Conclusion	The Project is considered unlikely to significantly impact the Australian Painted Snipe.

21.12.4.7 Koala

Description

The Koala (*Phascolarctos cinereus*) has been listed as vulnerable under the NC Act and the EPBC Act at the time of the Section 75 EPBC Act controlled action decision for the Project (on 22 November 2019). The Koala listing status under the EPBC Act was subsequently updated to endangered in 2022 (after the controlled action decision has been made and significant survey effort was completed. The impact to the species has therefore been assessed using the criteria that applied at the time of the controlled action decision (consistent with legal expectations).

The Koala is known to occur in temperate to tropical forest, woodland and semi-arid communities, in areas that contain known Koala food trees, or shrubland with emergent food trees (DoE 2014a). The koala is a leaf-eating specialist that feeds primarily during dawn, dusk or at night (DoE 2014a). Diet is restricted mainly to *Eucalyptus* species; however, it may also consume foliage of related genera, including *Corymbia, Angophora* and *Lophostemon*. The Koala is also known to supplement its diet with other genera at times, including *Leptospermum* and *Melaleuca* (DoE 2014a).

Koalas tend to move little under most conditions, changing trees only a few times each day (Ellis *et al.* 2009). Dispersing individuals, mostly young males, may occasionally cover distances of several kilometres over land with little vegetation (DAWE 2021a).

Shelter trees play an essential role in thermoregulation and are likely to be selected based on height, canopy cover and elevation (i.e. trees occurring in gullies are preferable) (Crowther *et al.* 2013). A growing body of evidence suggests that shelter trees are equally important as food trees and should be weighted as such when assessing habitat suitability (Crowther *et al.* 2013).

Preferred food and shelter trees are naturally abundant on fertile clay soils, and the highest densities of Koalas are likely to occur along creek lines (DoEE 2019c, TSSC 2012a, DSEWPaC 2012a). A potential Koala habitat tree is considered to be a tree of the *Corymbia, Melaleuca, Lophostemon, Eucalyptus* genera that is edible by koalas or *Angophora* genus with a trunk diameter greater than 10 cm at 1.3 m above ground (State of Queensland 2020).

This species has established home ranges within revegetated eucalypt woodlands (TSSC 2012a). Areas of relatively lower quality habitat that enable movement between higher quality areas also constitutes important habitat for the Koala (DEWHA 2009).

Desktop analysis

Desktop analysis has been conducted of relevant databases to identify records of the Koala within the vicinity of the Project (Wildlife Online, Queensland Museum, Wildnet and Atlas of Living Australia).

The desktop assessment includes reviews of an ecological survey and assessments of nearby developments for information/record purposes relating to the Koala. Numerous records of the species in the vicinity of the Project were identified.

The Koala has been recorded in surveys and assessments for nearby developments, including Saraji East Mining Project to the west, Winchester South Project to the north-west and Olive Downs Project to the north. Details of the desktop analysis are provided in Section 21.12.1.2.

Desktop analysis of Queensland government mapping including regional ecosystem mapping has also been conducted to determine the extent of potentially suitable habitat for the Koala.

Survey effort

Fauna surveys of the study area have been conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April), autumn 2021 (16–25 April) and spring 2021 (6–10 September) over 50 days in consideration of relevant Commonwealth and Queensland surveys guidelines. The spring 2019 survey has been conducted during the recommended direct observation period (TSSC 2012a).

Fourteen systematic survey sites were established during the surveys; all habitat types surveyed systematically are considered to provide potential Koala habitat.

Survey effort for the Koala at systematic and targeted sites included:

- diurnal searches for Koalas and scats: 75 person hours;
- call playback: 11 person hours;
- spotlighting: 58.6 person hours;
- camera trapping: 56 trap nights.

Survey timing, effort and methodology are consistent with the Commonwealth and Queensland guidelines, and the survey methods used are included in the recommendations of both guidelines.

The habitat assessment survey comprises 20 transects 100 m x 50 m to assess the availability of suitable Myrtaceae ‘eucalypt’ trees (species of *Eucalyptus, Angophora* and *Corymbia*) within remnant vegetation and high-value regrowth vegetation within the study area. Myrtaceae eucalypts with a diameter at breast height (DBH) of >10 cm were counted along each transect.

Further details of the survey timing, effort and methodology are provided in Section 21.12.1.

Survey outcomes

The Koala is present within the study area. Six Koala individuals and three scats were recorded during the autumn 2019, spring 2019 fauna surveys and the spring 2021 habitat assessment survey. The species has been observed at systematic trap sites in Eucalypt Dry Woodlands and freshwater wetland habitats and incidentally in remnant vegetation as shown in Figure 21.97.

Habitat assessment

Habitat mapping for the Koala within the study area is shown in Figure 21.97 and is based on the habitat descriptions provided in Table 21.63 that were derived from field habitat assessments conducted by EcoSmart Ecology and AARC. The habitat description in Table 21.63 is based on the information contained in DCCEEW's SPRAT database, including the relevant statutory documents and published research specific to the distribution of habitat for the Koala within the study area.

With the exception of RE 11.3.1, transect data indicates remnant vegetation within the study area (with the minor exceptions noted in Table 21.63) provided abundant Myrtaceae eucalypts (Table 21.64). In many REs, this includes a high density of trees preferentially used for foraging (*E. tereticornis, E. melanophloia* and *E. populnea* (Kerswell *et al.* 2020). Exceptions include RE 11.3.1, 11.3.9, 11.5.8b, 11.5.8c and 11.5.12, which had lower preferred tree densities (<15/ha). Based on these results, some areas of vegetation within the site are likely to support lower Koala densities and can be assessed as having 'marginal' habitat amenity (as per the definition in Kerswell *et al.* 2020).

While all areas of vegetation with dense preferred feed trees have the potential to support comparatively high Koala numbers, given the vegetation structure and occurrence within the landscape, RE 11.3.25 may play a particularly important ecological role for the local population. Koalas show a preference for tree species on more fertile soils with higher leaf nutrient status and possibly high leaf moisture, especially during times of drought or heat stress (Clifton *et al.* 2007; Ellis *et al.* 2010; Davies *et al.* 2014; DAWE 2021b). Koalas are also susceptible to extreme temperatures (DAWE 2021b) and will select trees which provide better thermal regulation (Lunney *et al.* 2014; Briscoe *et al.* 2015). Such trees are often located in gullies and/or have thicker canopies (Crowther *et al.* 2013). It is likely vegetation within RE 11.3.25 fulfils these roles, as it is within close proximity to creek lines (increasing the likelihood of high leaf moisture) and has a comparatively tall, dense canopy. Furthermore, this vegetation is linear, following major creek lines (Boomerang and Phillips Creeks) and may, therefore, also play an important dispersal/movement role.

Vegetation Community VC 1d [Brigalow high-value regrowth) and the adjacent patch of RE 11.4.8 contains few Eucalypts/habitat trees and are considered unsuitable for the Koala. While Eucalypt regrowth can be suitable for the Koala, the cleared agricultural areas within the study area contains low Brigalow regrowth, which is unsuitable for the Koala.

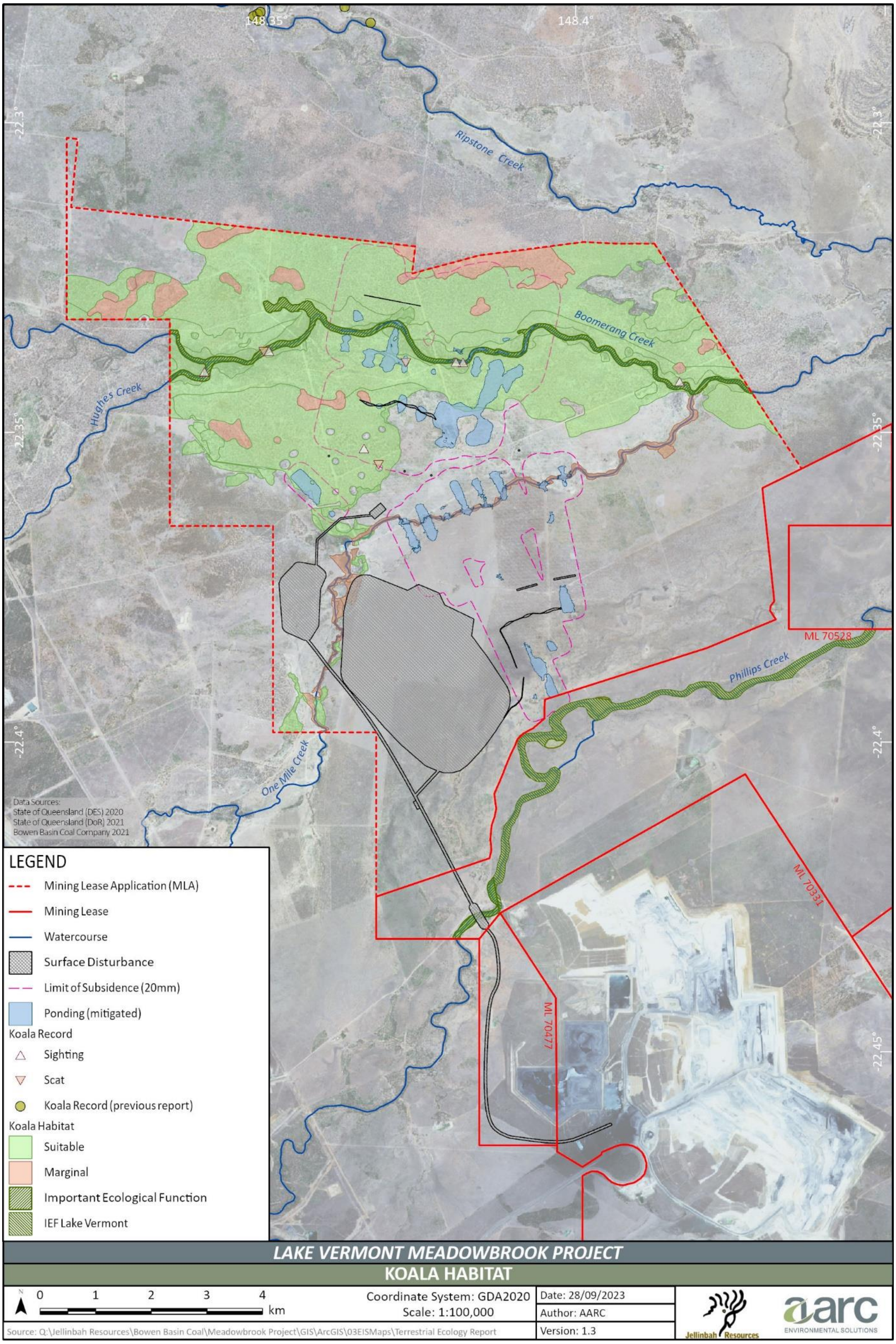

Figure 21.97: Koala habitat mapping

Table 21.63: Koala habitat description and occurrence

<table>
<tr><th>Habitat Description</th><th>Relevant features present within the study area</th></tr>
<tr><td colspan="2">Suitable habitat</td></tr>
<tr><td>Koala habitat is any forest or woodland that contains known koala food tree species or shrubland with emergent food trees (TSSC 2012a). A Koala food tree includes species from the Eucalyptus, Corymbia, Angophora, Lophostemon and Melaleuca genera (DoE 2014a). In inland areas, Koalas are also known to inhabit Acacia woodlands (with emergent food trees) in both riparian and non-riparian environments. Non-food trees such as Brigalow (Acacia harpophylla) and Sally wattle (Acacia salicina) have been utilised by this species for daytime roosting (Ellis et al. 2002). A potential Koala habitat tree is considered to be a tree with a trunk diameter greater than 10 cm at 1.3m above ground (State of Queensland 2020).</td><td>Within the study area, areas mapped as remnant vegetation communities with food tree species density greater that 20 per ha are considered to provide potential suitable habitat for the Koala.
The communities include:
• Eucalypt grassy woodlands (VC 2a [RE 11.3.2], VC 2b [RE 11.3.3], VC 2c [RE 11.3.4] and VC 2e [RE 11.5.3]);
• Eucalypt open forest to woodlands fringing drainage lines (VC 3a [RE 11.3.25]); and
• Eucalypt freshwater wetlands (VC 4a [RE 11.3.27b], VC 4b [RE 11.3.27f], VC 4c [RE 11.5.17, noting the palustrine wetlands themselves have not been mapped]).
A patch of RE 11.3.2 located to the south of Boomerang Creek in the far east of the study area is small in extent and separated (~200 m) from nearby habitats. While Koalas can move over open areas of this distance, it seems unlikely the area will be utilised with regularity considering nearby available habitat. It has, therefore, been mapped here as ‘marginal’ habitat.</td></tr>
<tr><td colspan="2">Marginal habitat</td></tr>
<tr><td>Koala habitat with sub-suitable food tree species density. A potential Koala habitat tree is considered to be a tree with a trunk diameter greater than 10 cm at 1.3 m above ground (State of Queensland 2020).</td><td>Within the study area, areas mapped as remnant vegetation communities with food tree species density lower than 20 per ha are considered to provide potential marginal habitat for the Koala.
The communities include:
• Brigalow woodlands on clay soils (VC 1a [RE 11.3.1], VC 1b [RE 11.4.8], and VC 1c [RE 11.4.9]); and
• Poplar Gum and Clarkson Bloodwood woodland on alluvial plains (VC 2d [RE 11.3.9], VC 2h [RE 11.5.12]).</td></tr>
<tr><td colspan="2">Important ecological function habitat</td></tr>
<tr><td>Koala habitat that may provide:
• refugial habitat features, such as food trees on more fertile soils with higher leaf nutrient status, higher leaf moisture or with thicker canopies; these characteristics are especially important during periods of drought or heat stress;
• connective function between otherwise discontinuous areas of suitable habitat.</td><td>Within the study area, areas mapped as Eucalypt grassy woodlands (VC 3a [RE 11.3.25]) have been identified as potential important ecological function habitat.</td></tr>
</table>

Table 21.64: Estimated tree density per hectare for dominant RE’s within the study area

RE	Number of sites	Estimated Eucalypt* density/ha	Important food species density/ha#
11.3.1	2	24	8
11.3.2	3	82	79

RE	Number of sites	Estimated Eucalypt* density/ha	Important food species density/ha#
11.3.9	2	101	11
11.3.25/27	5	85	52
11.3.4	1	62	54
11.5.3	5	86	79
11.5.8	2	65	12

* including all *Eucalypt, Angophora* and *Corymbia* species
# for the assessed important food tree species included *E. tereticornis, E. melanophloia* and *E. populnea*

Impact assessment

Approximately 3319.5 ha of Koala habitat has been identified within the study area (Table 21.65 and Figure 21.97) of which approximately 12.2 ha of Koala habitat is proposed to be cleared for the Project, and 96.9 ha is predicted to be impacted by residual ponding. The areas of residual ponding are predicted to be inundated for a maximum period of several months every few years, depending on the volume of inflow and soil permeability conditions (Appendix W, Geomorphological Assessment Report, section 3.3.3). This inundation is expected to negatively impact the Koala's staple forage tree species and is, therefore, considered to constitute the removal of the habitat.

Table 21.65: Proposed disturbance of Koala habitat

Habitat amenity	Extent within study area (ha)	Extent of direct disturbance (ha)		Extent of indirect disturbance (ha)
		All stage 1,2,3 direct clearing	Stage 4 – open-cut pit	Predicted periodic ponding
Suitable (important ecological function)	2963.0	4.6 (1.6)	<0.1 (0.0)	88.7 (5.2)
Marginal	356.6	0.6	7.0	8.2
Total	**3319.6**	**5.2**	**7.1**	**96.9**

The subsidence footprint outside of the residual ponding areas is predicted to retain its Koala habitat suitability. Open woodland vegetation subject to comparable surface subsidence conditions has retained its vegetation condition post-subsidence (Section 21.12.3.6). Therefore, the predicted impacts are not likely to substantially impact the Koala forage and breeding trees, and the vegetation that provides Koala habitat within the subsidence footprint is expected to maintain its habitat quality post-subsidence. Canopy trees within the subsidence footprint will be avoided while surface activities for gas drainage are conducted, so gas drainage activities are, therefore, considered unlikely to impact Koala habitat.

The Project will result in impacts on Koala habitat, which will add to habitat disturbance that is proposed to occur for other Projects in the region.

The vegetation clearance associated with the infrastructure corridor will fragment the riparian corridors of One Mile Creek and Phillips Creek.

The extent of flooding in the study area is predicted to increase along the margins of subsided panels. The changes to flood levels and extent are considered not significant (Appendix W, Geomorphological Assessment Report, section 4.2). The impacts of changes to flooding regimes on Koala habitat are, therefore, not expected to be significant. Potential or likely GDEs were identified within the study area, however these areas were all assessed to be unlikely to be significantly impacted by the Project (21.15.3). Therefore, groundwater impacts are considered unlikely to impact Koala habitat.

The potential for indirect impacts to the Koala from noise and vibration, dust, lighting and vehicle strike is considered to be minimal given the measures that will be implemented to manage these impacts. Subsidence impacts related to cracking and erosion are assessed in Section 21.12.3.6 and Section 21.12.3.16. Given the proposed monitoring and management measures for erosion, no substantial erosion is expected to occur and it is considered unlikely that erosion will impact Koala habitat. The Project also has the potential to increase animal pest populations if they are not appropriately managed. However, as described in Section 21.12.3.10, pest management measures will be implemented for the Project.

The proposed impact is equivalent to 3 % of the Koala habitat in the study area. The impacts are predominantly due to hydrological change affecting the resilience of Koala habitat, and the modelling for these changes has incorporated the cumulative effects of nearby projects and climate change (Appendix Z, Flood Modelling Assessment Report, section 1.3.12). The impacts identified to Koala habitat are unlikely to contribute to cumulative impacts in the subregion. Further discussion of cumulative impacts is provided in Section 21.12.3.18.

Avoidance, mitigation and management

The Project has been designed to avoid and/or mitigate impacts to the Koala where practicable. The proposed avoidance and mitigation measures for the Koala, including timing, predicted effectiveness, monitoring, adaptive management and the relevant statutory or policy basis, are provided in Table 21.66.

Table 21.66: Koala impact avoidance and mitigation measures

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Project infrastructure has been located to minimise direct disturbance to Koala habitat.	Mine planning/ construction/ operations	Highly effective—minimises the extent of impacts to Koala habitat.	Monitor disturbance/vegetation clearance areas against approved disturbance limits. Should clearing exceed approved limits, incident reporting will be initiated with a corrective action plan will be proposed (including proposed timing) and implemented. The corrective actions will be informed by the nature and extent of the exceedance.	DSEWPaC (2012), DoE (2014a), DAWE (2021e), DES (2019b)
Implement vegetation clearance protocols, including the delineation of vegetation adjoining proposed clearance areas to prevent accidental damage (Section 21.12.3.3).	Construction/ operations	Highly effective management technique to manage vegetation clearance activities.		
Fauna spotter/catcher will be on-site when clearing activities occur within Koala habitat. Fauna spotter/catcher will monitor clearance activities for the Koala and any incidence of fauna mortality or injury will be recorded. Injured fauna will be taken to a wildlife carer or veterinarian.	Construction/ operations	Highly effective management technique—vegetation clearance activities can be timed to avoid the clearance of trees until vacated by Koalas (should they be present).	Adaptive measures will be implemented, as necessary. Potential adaptive measures will include pre-clearance surveys and progressive clearing around known habitat trees.	DSEWPaC (2012), DoE (2014a),
Speed limits will be imposed to reduce the risk of vehicle strike.	Construction/ operations/ rehabilitation and decommissioning	Highly effective management technique to minimise the potential for vehicle strike.	Monitor incidence of vehicle strike. Adaptive management measures will include signage and/or reduction in speed limits at selected locations identified as having a higher risk of vehicle strike.	DSEWPaC (2012), DoE (2014a), DAWE (2021b), DES (2019b)
Safe driving procedures will be incorporated into site inductions to increase awareness of the risk of vehicle strike.	Construction/ operations/ rehabilitation and decommissioning	Highly effective management technique to minimise the potential for vehicle strike.	Monitor incidence of vehicle strike. Adaptive management measures will include an increase in measures (frequency or methods) or signage to increase awareness	DSEWPaC (2012), DoE (2014a), DAWE (2021b), DES (2019b)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by introduced fauna (e.g. feral dogs).	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests such as feral dogs.	Regular monitoring of site will be carried out by environmental personnel. Raise awareness through personnel inductions. Additional measures (such as tool box talks or staff newsletters) will be implemented if inspections indicate a clean, rubbish-free environment is not being maintained.	DSEWPaC (2012), DoE (2014a), DAWE (2021b), Commonwealth of Australia (2017b)
Store domestic waste in appropriate receptacles and locations.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests, including feral dogs if site protocols are followed by personnel.	Regular monitoring of the site will be carried out by environmental personnel. The Waste Management Plan will be monitored and audited, as necessary, to suit the required conditions of the Project. Additional measures (such as the provision of additional receptacles or change in location of receptacles) will be implemented if current storage practices encourage feral animals.	DSEWPaC (2012), DoE (2014a), Commonwealth of Australia (2017b)
Monitor and manage pest animal populations and implementation of pest control measures in accordance with Weed and Pest Management Plan (Section 21.12.3.10) to be prepared for the Project.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Corrective actions (such as increasing the frequency or extent of control efforts or alternative control strategies) will be implemented, as necessary.	DSEWPaC (2012), DoE (2014a), Commonwealth of Australia (2017b), Qld Department of Agriculture and Fisheries pest control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Consult with the Isaac Regional Council and neighbouring mines in relation to pest management activities.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Monitor and manage pests in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project. Audits will be carried out to monitor the consultation outcomes and the management measures implemented on-site.	DSEWPaC (2012), DoE (2014a), Commonwealth of Australia (2017b), Isaac Regional Council (2020)
Minimise effects of artificial lighting.	Mine planning/ construction	Effective management measure to minimise effects of artificial lighting.	Mine planning for MIA and the infrastructure corridor will include lighting designs (placement, configuration and direction) to minimise light spill.	DAWE (2020), AS/NZS 4282:2019 Control of the obtrusive effects of outdoor lighting' (Standards Australia 2019), DES (2019b)
Bushfire prevention and management measures will be outlined in the Emergency Response Plan. Inductions of mine site personnel will include fire awareness.	Construction/ operations/ rehabilitation and decommissioning	Effective management procedure to reduce the risk of bushfire.	Any incidence of bushfire will be investigated to determine the requirement for additional controls. Potential adaptive management measures include revision of the Emergency Response Plan and/or a program to increase personnel awareness of bushfire risk (e.g. through tool box talks).	DSEWPaC (2012), DoE (2014a), DAWE (2021b)
Design and undertake subsidence ponding drainage management works to minimise hydrological changes to Koala habitats.	Mine planning/ operations	The hydrological modelling (Appendix W, Geomorphological Assessment Report, section 5.5) indicates the subsidence ponding mitigation works will be effective in minimising the hydrological changes that will occur as a result of mine subsidence.	Subsidence effects and implemented mitigation and rehabilitation measures will be monitored in accordance with the Subsidence Management Plan (Section 21.12.3.6) to be prepared for the Project. Audit(s) will be conducted against the Subsidence Management Plan. Corrective measures may include additional works to reduce ponding.	DoE (2015e), DAWE (2021b), DSEWPaC (2011b)

Statutory requirements

Conservation and recovery plans relevant to the Koala have been considered in this assessment as follows:

- The 'Listing advice for *Phascolarctos cinereus* (Koala)' (TSSC 2012a), which outlines the reason for the conservation assessment of the Koala, and the 'Approved Conservation Advice for *Phascolartos cinerus* (combined populations in Queensland, New South Wales and the Australian Capital Territory)' (DSEWPaC 2012a), developed at the time of EPBC Act listing, provides information about the species, including its distribution and habitat, threats and priority management actions.
- The '*Phascolarctos cinereus* combined populations of Queensland, New South Wales and the ACT–Koala' SPRAT profile provides information about the Koala, including relevant regulatory considerations and information in relation to its population and distribution, habitat, life cycle, feeding, movement patterns, threats, abatement and recovery.
- The SPRAT profile for this species indicates there is no adopted or made Recovery Plan for this species; however, a Recovery Plan is required. The 'Draft National Recovery Plan for the Koala (combined populations in Queensland, New South Wales and the Australian Capital Territory)' (DAWE 2021b) provides information, including cultural significance, ecology, current threats, guidance on recovery and further conservation of the species.
- The 'Draft National Recovery Plan for the Koala' considers habitat critical to the survival of a species to be the area that the species relies on to halt decline and promote the recovery of the species that can be unambiguously identified. Under the EPBC Act, the following factors and any other relevant factors may be considered when identifying habitat that is critical to the survival of a species:
    - *a) whether the habitat is used during periods of stress (examples flood, drought or fire);*
    - *b) whether the habitat is used to meet essential life cycle requirements (examples: foraging, breeding, nesting, roosting, social behaviour patterns or seed dispersal processes);*
    - *c) the extent to which the habitat is used by important populations;*
    - *d) whether the habitat is necessary to maintain genetic diversity and long-term evolutionary development;*
    - *e) whether the habitat is necessary for use as corridors to allow the species to move freely between sites used to meet essential life cycle requirements;*
    - *f) whether the habitat is necessary to ensure the long-term future of the species or ecological community through reintroduction or re-colonisation;*
    - *g) any other way in which habitat may be critical to the survival of a listed threatened species or a listed threatened ecological community.*
- The 'EPBC Act referral guidelines for the vulnerable koala' (DoE 2014a) includes information on Koala habitat, modelled distribution, geographic context, threats, interim recovery objectives and survey methods. The Draft Referral Guideline includes a Koala Habitat Assessment Tool to assist in determining habitat quality and whether the habitat constitutes critical habitat.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019), Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

The SPRAT profile for this species indicates no threat abatement plan has been identified as being relevant for this species. However, threats to the Koala include (DAWE 2021a):

- habitat loss and habitat fragmentation;
- vehicle strike;
- predation by domestic or feral dogs;

- climate change induced impacts including drought, fire and heatwaves; and
- disease.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora or the Convention on Conservation of Nature in the South Pacific (Apia Convention). The terrestrial ecology assessment has:

- conducted a thorough desktop assessment to identify records for the species and assessed its likelihood of occurrence;
- undertaken field surveys to target the species within the study area considering Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its 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).

Significant impact assessment

The Koala population occurring at the study area has been assessed against the definition of 'important population' of a vulnerable species (DoE 2013a). The population has been determined to be part of a large population that is distributed throughout the broader region and maintains connectivity for breeding and dispersal throughout this area. Breeding is considered to occur among the population in the broader region; therefore, the population occurring in the study area is not likely to be necessary for maintaining species genetic diversity. The Koala range extends throughout the coast and inland areas of eastern Australia, and the study area is not near the limits of the species range.

It is unlikely the Koala population in the study area is necessary for the species' long-term survival and recovery and, therefore, is not an important population as per the Significant Impact Guidelines for a vulnerable listed species. However, considering the species' recent EPBC Act listing change to endangered, it is considered justified to determine all populations as important for the purpose of impact assessment.

Table 21.67 provides an assessment of the likelihood of significant impacts on the Koala in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Table 21.67: Koala significant impact assessment

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 uses the habitat within the study area can be considered an important population. The removal of 12.3 ha of habitat and potential ponding impact of 96.9 ha on the habitat may lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	The population of Koala that uses the habitat within the study area can be considered an important population. The removal of 12.3 ha habitat and potential ponding impact of 96.9 ha on habitat may reduce the area of occupancy of an important population.

Significance criteria	Assessment of significance
Fragment an existing important population into two or more populations	The population of Koala that uses the habitat within the study area can be considered an important population. The removal of 12.3 ha habitat and potential ponding impact of 96.9 ha on habitat is considered unlikely to fragment an existing important population into two or more populations. The remaining vegetation will retain connectivity to the broader region of Koala habitat.
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the Koala listed on the Register of Critical Habitat (DAWE 2021c). However, the Koala habitat in the study area is considered likely to meet the EPBC Act Referral Guidelines (DoE 2014a) definition of habitat critical to the Koala. Approximately 109.2 ha of Koala habitat will be disturbed by the Project through direct clearing and impact by ponding from subsidence. This action is considered likely to adversely affect habitat critical to the survival of the species. Approximately 2232.8 ha will remain undisturbed by clearing or subsidence within the study area for the local population. A further 977.6 ha of habitat will be retained within the subsidence footprint, which is predicted not to be substantially impacted and expected to continue to provide its current habitat function.
Disrupt the breeding cycle of an important population	The population of Koala that uses the habitat within the study area may be considered an important population. The removal of 12.3 ha of habitat and potential ponding impact of 96.9 ha on habitat is considered unlikely to disrupt the breeding cycle of an important population. The Koala habitat retained is expected to remain suitable for breeding for the species. Indirect impacts will be managed such that the breeding cycle will not be disrupted of the population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project requires the removal of 12.3 ha of habitat, which will result in geomorphological changes creating ponding impacts on 96.9 ha of habitat. This includes 93.3 ha of suitable habitat and 15.8 ha of marginal habitat. The removal of this extent of habitat is unlikely to lead to a long-term decline in the species population given the availability of habitat for the species in the broader region. The study area is connected to areas of remnant vegetation habitat along the northern, north-east and north-west boundaries, including connectivity to the Isaac River in the east of the study area, which represents an area of habitat to support mobility for the species throughout the broader region. The retained habitat throughout the study area is unlikely to be indirectly impacted by the Project. Indirect impacts, such as weeds and pests, noise and vibration, dust, artificial lighting, vehicle strike and bushfire, will be managed as outlined in sections 21.12.3.10 to 21.12.3.15 and are considered not to have potential to impact the availability or quality of habitat to the extent that the Koala is likely to decline. The GDE Assessment (3D Environmental 2022) has identified that the risk of impact to GDEs (which form a portion of Koala habitat in the Project area) is 'low to insignificant'. The impact of groundwater drawdown is, therefore, unlikely to impact the availability or quality of habitat to the extent that the Koala is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The study area is located in a modified rural landscape, and invasive species that are harmful to the Koala exist in the broader region. While predatory species, including wild dogs, are recorded to be established in the study area, the Project is unlikely to result in the introduction and establishment of any invasive species that are harmful to the Koala within the study area. Monitoring and management of pests, including corrective actions, will be implemented in accordance with a Weed and Pest Management Plan (Section 21.12.3.10).

Significance criteria	Assessment of significance
Introduce disease that may cause the species to decline, or	Koala populations are affected by three known viral diseases which are widespread throughout the wild population. These diseases are likely to be present in the population in the study area; however, the proposed Project is unlikely to cause the introduction of these diseases or other diseases to the study area. The Koala population in the study area will retain connectivity to the surrounding Koala habitat and will, therefore, remain exposed to infections from the broader region.
Interfere substantially with the recovery of the species	The Project will result in the clearing of 12.3 ha and impact on 96.9 ha of potential ponding in Koala habitat. The Draft Recovery Plan for the Koala (DAWE 2021b) identifies that direct threats to the Koala include climate change, land use changes and natural system modifications, while ecological threatening processes include habitat loss and fragmentation, habitat degradation and genetic effects. There is currently no habitat for the Koala listed on the Register of Critical Habitat (DAWE 2021c). However, the Koala habitat in the study area is considered likely to meet the EPBC Act Referral Guidelines (DoE 2014a) definition of habitat critical to the Koala. Therefore, the impact of the Project on the Koala habitat in the study area may amount to impacts equivalent to the direct threats identified in the Draft Recovery Plan for the Koala, and the Project may interfere with the recovery of the species.
Conclusion	The Project will result in the clearing or disturbance of 109.2 ha of Koala habitat. This habitat is identified as likely to be critical habitat and, therefore, the Project is likely to have a significant impact to the Koala. The extent of these impact areas is shown in Figure 21.98.

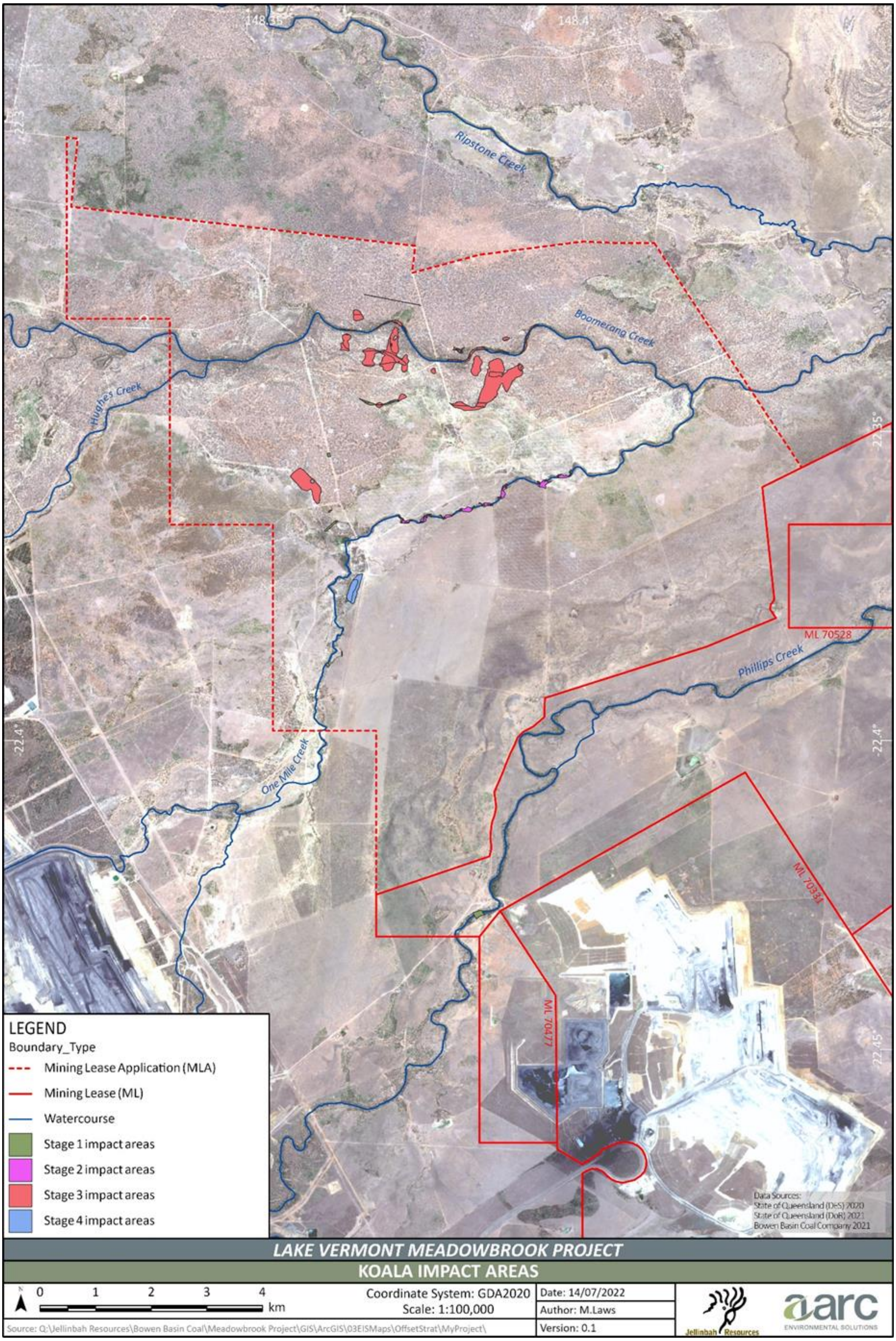

Figure 21.98: Koala significant impact areas

21.12.4.8 Greater Glider

Description

The Greater Glider (*Petauroides volans*) was listed as Vulnerable under the EPBC Act and NC Act at the time of the controlled action decision for the Project. Since this time, it is acknowledged that the listing status for the Greater Glider has been upgraded to Endangered under the NC Act and the EPBC Act. While the updated conservation advice for this species has been considered, ecological surveys and impact assessment have been undertaken using the criteria that applied at the time of the controlled action decision (not applied retrospectively).

The taxonomy of this species may be subject to revision in the near future (McGregor *et al.* 2020); however, this assessment is applicable to the Greater Glider (*Petauroides volans sensu lato*) as referred to on the DAWE Species Profiles and Threats database (DAWE 2021a). The species is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria, with an elevational range from sea level to 1,200 m above sea level.

The Greater Glider is an arboreal, nocturnal marsupial known to occur in Eucalypt dominated habitats ranging from low, open forests on the coast to tall forests in the ranges and low woodland westwards of the Dividing Range (TSSC 2016b, DCCEEW 2022). It is primarily folivorous, with a diet mostly comprising Eucalypt leaves and occasionally flowers. Preferred habitat consists of taller, montane, moist Eucalypt forests with relatively old trees and abundant hollows. It also favours forests with a diversity of Eucalypt species due to seasonal variation in its preferred tree species (TSSC 2016b, DCCEEW 2022). During the day, this species shelters in tree hollows, with a particular selection for large hollows in large old trees (TSSC 2016b, DCCEEW 2022) and requires at least two hollow-bearing trees for every 2 ha of suitable forest habitat (Kerswell *et al.* 2020).

The species is absent from cleared areas and has little dispersal ability to move between fragments through cleared areas. Greater Gliders have been recorded in habitat patches <10 ha however, modelling suggests that in QLD the species requires native forest patches of at least 160 km^2 to maintain viable populations, and low reproductive output and susceptibility to disturbance ensures low viability in small remnants (TSSC 2016b, DCCEEW 2022).

Desktop analysis

Desktop analysis has been conducted of relevant databases to identify records of the Greater Glider within the vicinity of the Project (Wildlife Online, Queensland Museum, Wildnet and Atlas of Living Australia occurrence records). The desktop assessment also includes reviews of an ecological survey and assessments of nearby developments for information/records relating to the Greater Glider.

The desktop analysis identified numerous records for the species in the vicinity of the Project. The Greater Glider is recorded in surveys and assessments for nearby developments, including Saraji East Mining Project to the west, Winchester South Project to the north-west and Olive Downs Project to the north. Details of the desktop analysis are provided in Section 21.12.1.2.

Desktop analysis of Queensland government mapping, including regional ecosystem mapping, has also been conducted to determine the extent of potentially suitable habitat for the Greater Glider.

Survey effort

Fauna surveys of the study area have been conducted in autumn 2019 (11–21 March), spring 2019 (6–19 November), autumn 2020 (23–25 March and 1–8 April), autumn 2021 (16–25 April) and spring 2021 (6–10 September) over 50 days in consideration of relevant Commonwealth and Queensland survey guidelines. All surveys fell within the Brigalow Belt Bioregion recommended survey timing (Eyre *et al*. 2018).

Fourteen systematic survey sites were established during the surveys. Four systematic sites were established in Eucalypt dry woodlands on inland depositional plains (sites MF01, MF05, MF09, MF13) and two systematic sites on Poplar Gum and *Corymbia* spp. woodlands on alluvial plains (sites MF10 and MF14).

For habitat assessment, amenity surveys have been conducted along transects of 100 m x 50 m within areas of potentially suitable vegetation. The canopy cover of Myrtaceae eucalypt species (*Eucalyptus, Angophora* and *Corymbia*) has been recorded using the intercept method (Neldner *et al.* 2020), and the number of trees with suitable hollows (diameter >20 cm, alive or dead) has been recorded. Spotlighting along a 500 m transect has been undertaken at a subset of these sites to record the number of observed Greater Glider individuals.

Survey effort for the Greater Glider at systematic and supplementary sites included:

- active searches: 75 person hours;
- spotlighting: 58.6 person hours; and
- call playback: 11 person hours.

The survey timing, methodology and effort are consistent with the Commonwealth Guidelines. Stag watch surveys were not applied, as spotlighting and call playback at potential den tree areas sufficiently surveyed these areas.

Further details of the survey timing, effort and methodology are provided in Section 21.12.1.

Survey outcomes

The Greater Glider has been recorded at the Project area in woodland and riparian habitats during the autumn 2019, spring 2019, autumn 2020 and spring 2021 surveys. Targeted spotlighting for the Greater Glider conducted during the site habitat assessments also recorded the species. There were 24 records of Greater Gliders within the study area and the locations of Greater Glider records are shown on Figure 21.99.

The habitat assessment transect and spotlight data has been used to assess habitat amenity for the Greater Glider within the study area (Table 21.68)[7]. High counts of tree hollows and *Eucalyptus* spp. canopy cover are associated with higher Greater Glider abundance (DCCEEW 2022), and these characteristics have been used as indicators of Greater Glider habitat amenity. Transects have not been conducted within RE 11.3.3, 11.4.8 or 11.4.9 due to their small extent within the study area and have been assessed for habitat amenity on the basis of other survey experience conducted within these REs.

Table 21.68: Greater Glider habitat amenity assessment criteria

Habitat amenity	**Hollows per ha**	***Eucalyptus* spp. canopy cover**	**Greater Glider transect abundance per km**
High	>10	>40 %	>3
Moderate	>10	<40 %	1
Low	2-9	<40 %	0.25
Unsuitable	<2	Not applicable	NA

Habitat assessment

Habitat mapping for the Greater Glider within the study area is shown in Figure 21.99 and is informed by the assessment of the habitat available at the Project area, information contained in DAWE's SPRAT database, including the relevant statutory documents and published research.

7 Assessment of habitat amenity for the Greater Glider is only applicable to the study area and is not an assessment of habitats throughout the species range or within the region.

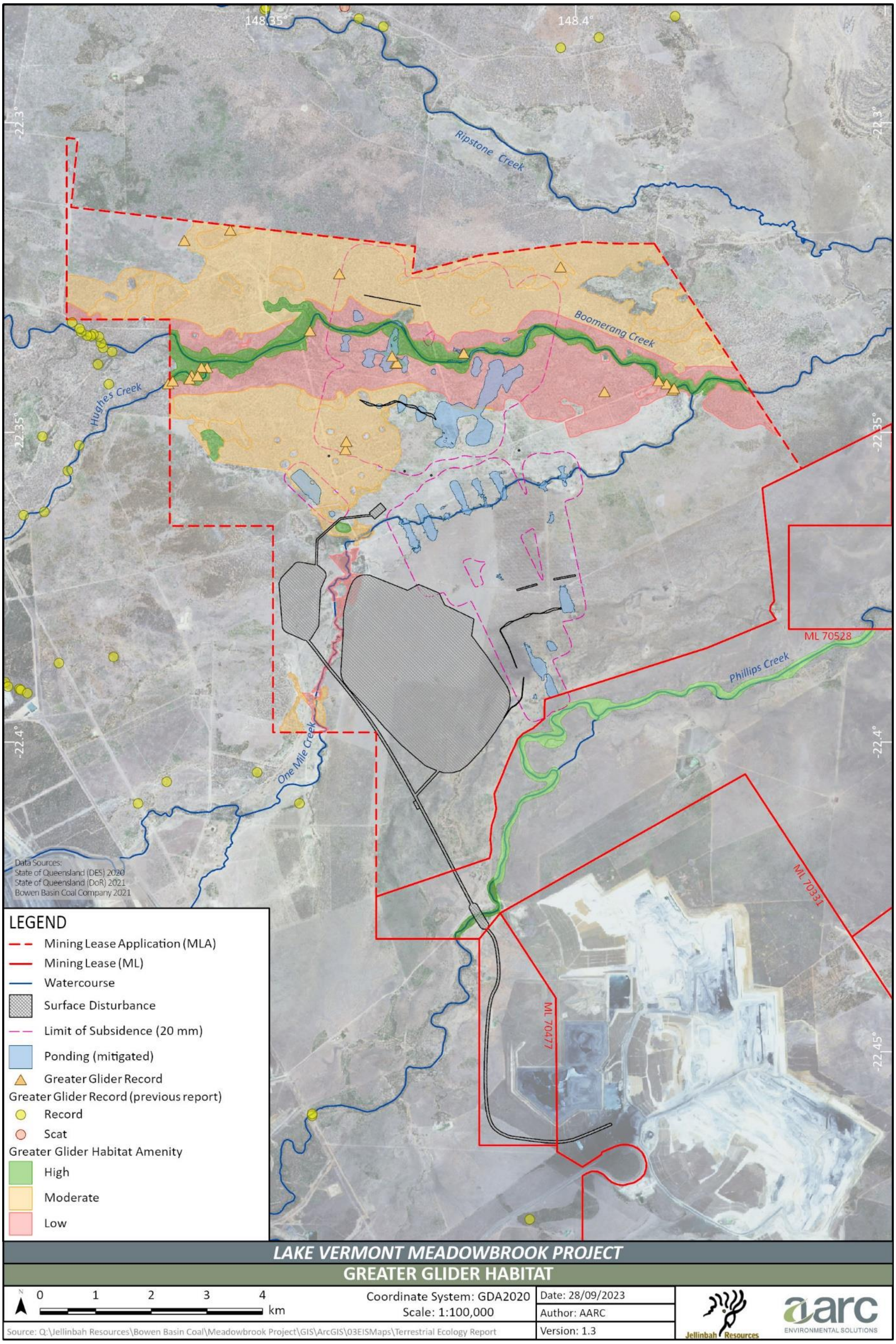

Figure 21.99: Greater Glider habitat mapping

The key habitat requirements of the Greater Glider are:

- presence of suitable fodder trees (Eucalyptus species);
- presence and abundance of hollow-bearing trees with suitably-sized and aged hollows;
- sufficient canopy cover of Eucalyptus species.

The results of the habitat amenity surveys conducted by EcoSmart Ecology and AARC are:

- Three REs assessed as providing high habitat amenity—RE 11.3.25/RE11.3.27, 11.3.3, 11.3.4.
- Three REs assessed as providing moderate habitat amenity—RE 11.3.9, 11.5.8c, 11.5.3 (with the exception noted below).
- Four REs assessed as providing low habitat amenity—RE 11.3.2 (with the exception noted below), 11.3.1 (with the exception noted below), 11.4.8 (with the exception noted below) and 11.4.9.
- REs or specific areas considered unsuitable for the Greater Glider are:
    - RE 11.5.17 (palustrine wetland component containing no Eucalypts);
    - the high-value regrowth Brigalow vegetation in the north-east of the study area and the small patch of RE 11.4.8 situated adjacent to the high-value regrowth Brigalow vegetation (both of which do not contain enough hollows or Eucalypts for the Greater Glider);
    - riparian vegetation (RE 11.3.1) along the western section of One Mile Creek due to the low density of Eucalyptus species, low number of hollow-bearing trees, its more open canopy and narrow linear nature;
    - a portion of RE 11.5.3 in the south near Phillips Creek, as it is small in extent and isolated from other suitable habitat; and
    - a portion of RE 11.3.2 to the south of Boomerang Creek near the eastern boundary of the study area (identified to be too small and isolated to provide suitable habitat).

Impact assessment

Threats to the Greater Glider include (DCCEEW 2022):

- inappropriate fire regimes;
- habitat clearing and fragmentation;
- timber harvesting;
- barbed wire fencing (entanglement);
- increased temperatures and changes to rainfall patterns;
- hyper-predation by owls;
- competition from Sulphur-crested Cockatoos;
- predation by Feral Cats; and
- predation by European Red Foxes.

Approximately 3194.4 ha of Greater Glider habitat have been identified within the study area, including 332.2 ha of high amenity, 1874.0 ha of moderate amenity and 988.1 ha of low amenity habitat (Figure 21.99 and Table 21.69).

Table 21.69: Proposed disturbance of Greater Glider habitat

Habitat amenity	Extent within study area (ha)	Extent of direct disturbance (ha)		Extent of indirect disturbance (ha)
		Stages 1,2,3 clearing	Stage 4 clearing	Stage 2 and 3 residual ponding
High	332.2	1.6	0.0	12.6
Moderate	1874.0	2.9	0.0	17.8
Low	988.1	0.3	7.0	58.3
Total	**3194.3**	**4.8**	**7.0**	**88.7**

A total of 11.9 ha of Greater Glider habitat is proposed to be directly disturbed through clearing for the Project and 88.7 ha indirectly impacted by predicted periodic ponding. The areas of residual ponding are predicted to be inundated for a maximum period of several months every few years depending on inflow volume and soil permeability conditions (Appendix W, Geomorphological Assessment Report, section 3.3.3). This is expected to be sufficient to disturb the Greater Gliders' staple forage tree species and is, therefore, considered sufficient disturbance to cause the removal of the habitat. Further detail of ponding impacts to vegetation is provided in Section 21.12.3.6.

Greater Glider habitat occurs within riparian vegetation adjacent to Boomerang Creek and One Mile Creek, including in reaches that will be subject to stream morphology changes from subsidence. These potential stream morphology affected areas are co-located with areas of predicted ponding, and the assessment of stream morphology change impacts and mitigation measures are detailed in Section 21.12.3.7.

The subsidence footprint outside of the residual ponding areas is predicted to retain its Greater Glider habitat suitability. Open woodland vegetation subject to comparable surface subsidence conditions at other underground mining projects in the Bowen Basin has retained its vegetation condition post-subsidence (Section 21.12.3.6). Therefore, the predicted impacts are not likely to substantially impact the Greater Glider foraging and breeding trees, and the vegetation that provides Greater Glider habitat within the subsidence footprint is expected to maintain its habitat quality post-subsidence. Canopy trees within the subsidence footprint will be avoided while surface activities for gas drainage are conducted. Therefore, the gas drainage activities within the subsidence footprint are not expected to amount to a significant impact on Greater Glider habitat.

The Project will result in impacts on Greater Glider habitat, which will add to habitat disturbance that is proposed to occur for other Projects in the region.

The direct disturbance associated with the Project (e.g. infrastructure corridor and MIA) will result in some fragmentation of Greater Glider low and moderate amenity habitat.

The extent of flooding in the study area is predicted to increase along the margins of subsided panels; however, the changes to flood levels and extent are considered not significant (Appendix W, Geomorphological Assessment Report, section 4.2). The impacts of changes to flooding regimes on Greater Glider habitat are, therefore, not expected to be significant. Potential or likely GDEs were identified within the study area, however these areas were all assessed to be unlikely to be significantly impacted by the Project (Section 21.15.3). Therefore, groundwater impacts are considered unlikely to impact Koala habitat.

The potential for indirect impacts to the Greater Glider from noise and vibration, dust, lighting and vehicle strike is considered to be minimal given the measures that will be implemented to manage these impacts. Impacts of subsidence related cracking and erosion are assessed in Section 21.12.3.6 and will be subject to management and monitoring under a Subsidence Management Plan. Given the proposed monitoring and management measures for erosion, no substantial erosion is expected to occur and it is considered unlikely that erosion will impact Greater Glider habitat. The Project also has the potential to increase animal pest populations if they are not appropriately managed. However, as described in Section 21.12.3.10, pest management measures will be implemented for the Project.

The proposed impact is equivalent to 3% of the Greater Glider habitat in the study area. The impacts are predominantly due to hydrological change affecting the resilience of Greater Glider habitat, and the modelling for these changes has incorporated the cumulative effects of nearby projects and climate change (Appendix Z, Flood Modelling Assessment Report, section 1.3.12). The impacts identified on Greater Glider habitat are unlikely to contribute to cumulative impacts on the subregion. Further discussion of cumulative impacts is provided in Section 21.12.3.18.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to the Greater Glider where practicable. The proposed avoidance and mitigation measures for the Greater Glider, including timing, predicted effectiveness, monitoring, adaptive management and the relevant statutory or policy basis is provided in Table 21.70.

Statutory requirements

Conservation information relevant to the Greater Glider has been considered in this assessment as follows:

- The 'Conservation Advice for *Petauroides volans* (greater glider (southern and central))' (DCCEEW 2022) outlines the reasons for the conservation assessment of the species with regard to the 2022 'up listing' of the species and provides information about the Greater Glider, including information in relation to its distribution, biology/ecology, threats and conservation and management actions.
- The Conservation Advice for *Petauroides volans* (greater glider) (TSSC 2016b) outlines the conservation assessment of the species according to the listing, relevant to the assessment and approval process for the species.
- The '*Petauroides volans*–Greater Glider' SPRAT profile provides information about the relevant regulatory considerations and links to information available in relation to its listing under the EPBC Act. The SPRAT profile indicates there is no adopted or made Recovery Plan for this species; however, a Recovery Plan is required.
- 'Australia's Strategy for Nature 2019–2020' (Commonwealth of Australia 2019), Australia's actions for nature including the 'Threatened Species Strategy 2021–2031' (Commonwealth of Australia 2021) and 'Australian Pest Animal Strategy 2017–2027' (Commonwealth of Australia 2017b) outline relevant actions to recover Australia's threatened plants, animals and ecological communities.

The Project is not inconsistent with the objectives of the EPBC Act or Australia's obligations under the Convention on Biological Diversity, the Convention on International Trade in Endangered Species of Wild Fauna and Flora or the Convention on Conservation of Nature in the South Pacific (Apia Convention). The terrestrial ecology assessment has:

- conducted a thorough desktop assessment to identify records for the species and assess its likelihood of occurrence;
- undertaken field surveys to target the species within the study area in consideration of Commonwealth and Queensland survey guidelines;
- identified potential habitat for the species within the study area;
- identified potential impacts of the Project on the species and its habitats;
- developed avoidance, mitigation and management measures to avoid or minimise potential impacts on the species and its 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).

Table 21.70: Greater Glider impact avoidance and mitigation measures

Avoidance/mitigation measures	**Timing**	**Predicted effectiveness**	**Monitoring and adaptive management**	**Statutory or policy basis**
Project infrastructure has been located to minimise direct disturbance to Greater Glider habitat.	Mine planning/ construction/ operations	Highly effective—minimises the extent of impacts to Greater Glider habitat.	Monitor disturbance/vegetation clearance areas against approved disturbance limits. Should clearing exceed approved limits, incident reporting will be initiated with a corrective action plan will be proposed (including proposed timing) and implemented. The corrective actions will be informed by the nature and extent of the exceedance.	TSSC (2016b), DCCEEW (2022)
Implement vegetation clearance protocols, including the delineation of vegetation adjoining proposed clearance areas to prevent accidental damage (Section 21.12.3.3).	Construction/ operations	Highly effective management technique to manage vegetation clearance activities.		
Fauna spotter/ catcher will be on -site when clearing activities occur within Greater Glider habitat. Fauna spotter/catcher will monitor clearance activities for the Greater Glider, and any incidence of fauna mortality or injury will be recorded. Injured fauna will be taken to a wildlife carer or veterinarian.	Construction/ operations	Potentially effective.	Adaptive measures will be implemented, as necessary. Potential adaptive measures will include pre-clearance surveys and progressive clearing around known habitat trees.	TSSC (2016b), DCCEEW (2022)
Minimise effects of artificial lighting.	Mine planning/ construction	Effective management measure to minimise effects of artificial lighting.	Mine planning for MIA and the infrastructure corridor will include lighting designs (placement, configuration and direction) to minimise light spill.	DAWE (2020), AS/NZS 4282:2019 Control of the obtrusive effects of outdoor lighting' (Standards Australia 2019)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Bushfire prevention and management measures will be outlined in the Emergency Response Plan. Inductions of mine site personnel will include fire awareness.	Construction/ operations/ rehabilitation and decommissioning	Effective management procedure to reduce the risk of bushfire.	Any incidence of bushfire will be investigated to determine the requirement for additional controls. Potential adaptive management measures include revision of the Emergency Response Plan and/or a program to increase personnel awareness of bushfire risk (e.g. through tool box talks).	TSSC (2016b), DCCEEW (2022)
Design and undertake subsidence ponding drainage management works to minimise hydrological changes to Greater Glider habitats.	Mine planning/ operations	The hydrological modelling (Appendix W, Geomorphological Assessment Report, section 5.5) indicates the subsidence ponding mitigation works will be effective in minimising the hydrological changes that will occur as a result of mine subsidence.	Subsidence effects and implemented mitigation and rehabilitation measures will be monitored in accordance with the Subsidence Management Plan (Section 21.12.3.6) to be prepared for the Project. Audit(s) will be conducted against the Subsidence Management Plan. Corrective measures may include additional works to reduce ponding.	DoE (2015e), TSSC (2016b), DCCEEW (2022),- DSEWPaC (2011b)

Significant impact assessment

The Greater Glider population occurring at the study area has been assessed against the definition of 'important population' of a vulnerable species (DoE 2013a). The population is determined to be part of a large population, which is distributed throughout the broader region and maintains connectivity for breeding and dispersal throughout this area. Breeding is considered to occur among the population of the broader region and, therefore, the population occurring in the study area is not likely to be necessary for maintaining species genetic diversity. The Greater Glider range extends throughout the coast and inland areas of eastern Australia, and the study area is not near the limits of the species range.

It is unlikely the Greater Glider population of the study area is necessary for the species' long-term survival and recovery and, therefore, is not an important population as per the Significant Impact Guidelines for a Vulnerable listed species (refer to the Description section above). However, considering the species' recent EPBC Act listing change to Endangered, it is considered justified to determine all populations as important for the purpose of impact assessment.

Table 21.71 provides an assessment of the likelihood of significant impacts on the Greater Glider in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Table 21.71: Greater Glider significant impact assessment

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 Greater Glider using the study area can be considered an important population. The impacts to all Greater Glider habitat amenity categories includes the removal of 11.9 ha of habitat and potential ponding impact on 88.7 ha of habitat is considered unlikely to lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	The population of Greater Glider using the study area can be considered an important population. The impacts to all Greater Glider habitat amenity categories includes the removal of 11.9 ha of habitat and potential ponding impact on 88.7 ha of habitat is considered unlikely to reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations	The population of Greater Glider using the study area can be considered an important population. The impacts to all Greater Glider habitat amenity categories includes the removal of 11.9 ha of habitat and potential ponding impact on 88.7 ha of habitat is considered unlikely to fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of a species	There is currently no habitat for the Greater Glider listed on the Register of Critical Habitat (DAWE 2021c). However, according to the latest approved conservation advice (DCCEEW 2022), all suitable habitat identified within the study area is considered habitat critical to the survival of the species due to being a large contiguous area of eucalyptus forest with mature hollow-bearing trees and forage species canopy cover. As such, impacts on all identified habitat for the Greater Glider within the study area is considered likely to adversely affect habitat critical to the survival of the species. The Project involves clearing and direct impacts on approximately 100.6 ha of Greater Glider habitat

Significance criteria	Assessment of significance
Disrupt the breeding cycle of an important population	The population of Greater Glider using the study area can be considered an important population. The impacts to all Greater Glider habitat amenity categories includes the removal of 11.9 ha of habitat and potential ponding impact on 88.7 ha of habitat is considered unlikely to disrupt the breeding cycle of an important population
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project requires the removal of 11.9 ha of habitat and will result in geomorphological changes causing potential ponding impacts on 88.7 ha of habitat. This includes 14.2 ha of high amenity habitat, 20.7 ha of moderate amenity habitat and 65.6 ha of low amenity habitat. The removal of this extent of habitat is unlikely to lead to a long-term decline in the species population given the wide extent of habitat for this species. The study area is connected to areas of remnant vegetation habitat along the northern, north-east and north-west boundaries. The study area will maintain connectivity to corridors of high amenity riparian eucalypt woodland vegetation, including vegetation adjoining the Isaac River, which represents areas of habitat to support mobility for the species throughout the broader region. The retained habitat throughout the study area is unlikely to be indirectly impacted by the Project. Indirect impacts, such as weeds and pests, noise and vibration, dust, artificial lighting, vehicle strike and bushfire, will be managed, as outlined in sections 21.12.3.10 to 21.12.3.15 and are considered not to have potential to impact the availability or quality of habitat to the extent that the Greater Glider is likely to decline. The Groundwater Dependent Ecosystem Assessment (3D Environmental 2022) identified that the risk of impact on GDEs (which form a portion of Koala habitat in the Project area) is ‘low to insignificant’. The impact on groundwater drawdown is, therefore, unlikely to impact the availability or quality of habitat to the extent that the Greater Glider is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The study area is in a modified rural landscape, and invasive species exist in the broader region. Invasive species (Feral Cats and European Red Foxes) and native species (owls and Sulphur Crested Cockatoos) are recognised as a threat to the Greater Glider (DCCEEW 2022). Feral Cat and European Red Fox were recorded during surveys. Given the proposed monitoring and management of pests, including corrective actions in accordance with a Weed and Pest Management Plan (Section 21.12.3.10), the Project is unlikely to result in the increase of invasive species likely to be harmful to the Greater Glider. The threat to Greater Glider posed by Sulphur Crested Cockatoos is described as ‘suspected’ and is restricted to small local areas in N.S.W. (DCCEEW 2022). The threat of hyper-predation by owls has been observed, however does not indicate a population level impact on the Greater Glider (DCCEEW 2022). The numbers of native owls or Sulphur-crested Cockatoos are considered unlikely to be a threat to the Greater Glider in the study area and the Project is unlikely to impact these threats.
Introduce disease that may cause the species to decline	There are no diseases of the Greater Glider listed as a threat to the species (DCCEEW 2022). The Project is unlikely to introduce a disease that may cause the species to decline.

Significance criteria	Assessment of significance
Interfere substantially with the recovery of the species	There is no adopted or made Recovery Plan for this species; however, a Recovery plan is considered to be required (DCCEEW 2022). Priority conservation actions identified by the Conservation Advice DCCEEW (2022) include: • management of habitat loss, disturbance and modification (including fire) including protection of un-burnt habitat, revision of prescribed burning prescriptions, protection of habitat trees, avoidance of habitat fragmentation and avoidance of the use of barbed wire; • protection of climate change refuge habitat and improve micro-climate conditions in at-risk areas; • manage invasive species threats; and • investigate the feasibility of reintroductions to areas the species was extirpated. The Project is unlikely to substantially interfere with the recovery of the species. The removal of 11.9 ha of habitat and potential ponding impact on 88.7 ha of habitat is considered not to substantially interfere with the recovery of the species.
Conclusion	The Project will result in the clearing or disturbance of 100.6 ha of Greater Glider habitat, including 14.2 ha of high habitat, 20.7 ha of moderate amenity habitat and 65.6 ha of low amenity habitat. All Greater Glider habitat identified within the study area is considered likely to be critical to the survival of the species, and the clearing and ponding impact on 100.6 ha of habitat is therefore considered to be a significant impact.

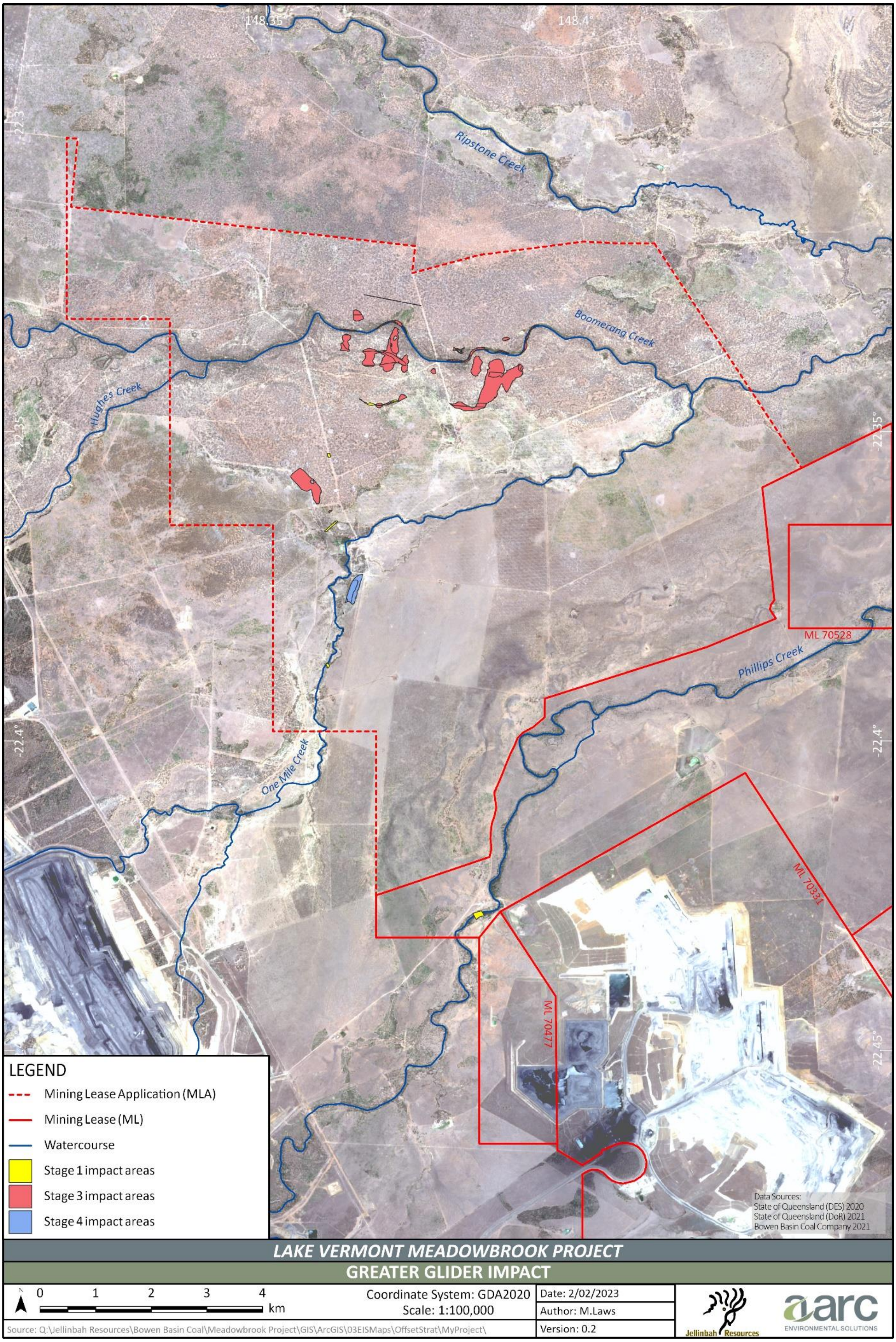

Figure 21.100: Greater Glider significant impact areas

21.12.4.9 Other threatened species

Other threatened species or communities that must be assessed for impacts, as identified within the ToR are assessed within Table 21.72. The detailed survey effort and likelihood of occurrence for each species is provided in Appendix G, Terrestrial Ecology Report (Appendix D and E).

It should be noted that the Red Goshawk (*Erythrotriorchis radiatus*) was listed as vulnerable under the EPBC Act at the time of the Section 75 EPBC Act controlled action decision for the Project. The Red Goshawk listing under the EPBC Act was announced to change to endangered in 2022 after the controlled action decision was made. The impact on the species has been undertaken using the criteria that applied at the time of the controlled action decision.

Table 21.72: Impact assessment of other threatened species

Species	**Threatened species status**	**Occurrence likelihood, survey effort and potential impact**
Curlew Sandpiper (*Calidris ferruginea*)	Critically Endangered	Unlikely to occur. Potential habitat may occur in suitable climatic conditions; however, there are no records of this species within 50 km of the study area. Survey timing, methodology and effort were consistent with the Commonwealth guidelines[7,13] and the Queensland guideline[4]. The species was not detected within the study area. Given the above, it is unlikely that the Project will result in a significant impact to the Curlew Sandpiper.
Red Goshawk (*Erythrotriorchis radiatus*)	Vulnerable	Potential habitat occurs within the study area and there are records for the species within 50 km. Survey timing, methodology and effort were consistent with the Commonwealth guideline[6,7] and the Queensland guideline[4]. The species was not detected within the study area. Given the species was not recorded at the Project area, the species is highly mobile and suitable habitat occurs widely throughout the broader region and it is unlikely that the Project will result in a significant impact on the Red Goshawk.
Painted Honeyeater (*Grantiella picta*)	Vulnerable	Unlikely to occur. Potential habitat may occur; however, there are no records for this species within 50 km of the study area despite extensive fauna surveys for projects nearby and in the wider region. Survey timing, methodology and effort were consistent with the Commonwealth guideline[7] and the Queensland guideline[12]. The species was not detected within the study area. Given the above, it is unlikely that the Project will result in a significant impact to the Painted Honeyeater.
Star Finch (Eastern) (*Neochmia ruficauda ruficauda*)	Endangered	Unlikely to occur. Potential habitat may occur; however, there are no records for this species within 50 km of the study area. Survey timing, methodology and effort were consistent with the Commonwealth guideline[7,8] and the Queensland guideline[4]. The species was not detected within the study area. Given the above, it is unlikely that the Project will result in a significant impact to the Star Finch.

Species	**Threatened species status**	**Occurrence likelihood, survey effort and potential impact**
Northern Quoll (*Dasyurus hallucatus*)	Endangered	Potential habitat for this species is unlikely to occur within the study area. Survey timing, methodology and effort were consistent with the Commonwealth guidelines[15,16] and the Queensland guideline[4]. No suitable denning habitat was identified within the study area, as such targeted surveys utilising cage traps or hair tubes were deemed unnecessary in accordance with Commonwealth guideline[15]. The species was not detected within the study area. Given the above, it is unlikely that the Project will result in a significant impact to the Northern Quoll.
Ghost Bat (*Macroderma gigas*)	Vulnerable	There are no known records for this species within 50 km of the study area. Given the extensive surveys that have occurred nearby and in the wider region, this species is considered unlikely to occur within the study area. Survey timing, methodology and effort were consistent with the Commonwealth guideline[16] and the Queensland guideline[4]. The species was not detected within the study area. Given the above, it is unlikely that the Project will result in a significant impact to the Ghost Bat.
Corben's Long-eared Bat (*Nyctophilus corbeni*)	Vulnerable	Unlikely to occur. Potential habitat may occur; however, there are no records within 50 km of the study area, and the study area is located to the north of the known distribution of this species. Survey timing, methodology and effort were consistent with the Commonwealth guideline[16] and the Queensland guideline[4]. The *Nyctophilus* genus was detected through Anabat recorders, across the surveys. Specialist Greg Ford attributed these indistinguishable calls to either *Nyctophilus gouldi* or *N. geoffroyi* and not the threatened species *N. corbeni.* Given the above, it is unlikely that the Project will result in a significant impact to Corben's Long-eared Bat.
Grey-headed Flying Fox (*Pteropus poliocephalus*)	Vulnerable	Unlikely to occur. Potential habitat may occur; however, there are no records for this species within 50 km of the study area despite the extensive surveys conducted nearby and in the wider region. Survey timing, methodology and effort were consistent with the Commonwealth guideline[16] and the Queensland guideline[4]. The species was not detected within the study area. Given the above, it is unlikely that the Project will result in a significant impact to the Grey-headed Flying Fox.
Cycas ophiolitica	Endangered	Potential habitat unlikely to occur and there are no records for this species within 50 km of the study area. The species was not detected within the study area. Given the above, it is unlikely that the Project will result in a significant impact to *Cycas Ophiolitica*.
Quassia (*Samadera bidwillii*)	Vulnerable	Based on habitat requirements, potential habitat unlikely to occur, and there are no records of the species within 50 km of the study area. The species was not detected within the study area. It is unlikely that the Project will result in a significant impact to the Quassia.

Species	Threatened species status	Occurrence likelihood, survey effort and potential impact
Yakka Skink (*Egernia rugosa*)	Vulnerable	Unlikely to occur. Potential habitat may occur; however, there are no records of the species within 50 km of the study area. Survey timing, methodology and effort were consistent with the Commonwealth guideline[1,3] and the Queensland guideline[4]. The species was not detected within the study area. Given the above, it is unlikely that the Project will result in a significant impact to the Yakka Skink.
Dunmall's Snake (*Furina dunmalli*)	Vulnerable	Occurrence unlikely. Potential habitat may occur; however, there are no records for this species within 50 km of the study area. Survey timing, methodology and effort were consistent with the Queensland guideline[4] and Commonwealth guideline[1]. The species was not detected within the study area. Given the above, it is unlikely that the Project will result in a significant impact to Dunmall's Snake.
Retro Slider (*Lerista allanae*)	Endangered	Unlikely to occur. There are known records of the species within 50 km of the study area near Clermont; however, based on habitat requirements, potential habitat is unlikely to occur within the study area. Survey timing, methodology and effort were consistent with the Commonwealth guideline[1,3] and the Queensland guideline[4]. The species was not detected within the study area. Given the above, it is unlikely that the Project will result in a significant impact to the Retro Slider.
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin threatened ecological community	Endangered	This community was not recorded within the Project area and it is unlikely that the Project will result in a significant impact to the Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin threatened ecological community.

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21.12.4.10 Migratory Species

Desktop analysis and Description

Desktop analysis has been conducted of relevant databases to determine records of migratory species within the vicinity of the Project, including Wildlife Online, Queensland Museum, Wildnet and Atlas of Living Australia occurrence records. The desktop assessment also includes reviews of an ecological survey and assessments of nearby developments for information/records relating to migratory species.

Sixteen species listed as migratory under the EPBC Act have been identified by the desktop assessment as having known records within the wider region (50 km search area) (Section 21.12.1.2). While not having known records within 50 km of the study area, an additional four species listed in the ToR for the Project (Oriental Cuckoo, Yellow Wagtail, Curlew Sandpiper[8] and Pectoral Sandpiper), have also been considered in the survey and assessment of migratory species.

A description of each migratory species, including its distribution, habitat and ecology and assessment of likelihood of occurrence, is provided in Appendix G, Terrestrial Ecology Assessment (Appendix D and E).

Thirteen migratory species have been identified as having the potential to occur within the study area:

1) Fork-tailed Swift;
2) Gull-billed Tern;
3) Caspian Tern;

8 The Curlew Sandpiper is also listed as threatened under the EPBC Act and has been considered in the assessment of threatened species.

4) Black-faced Monarch;

5) Satin Flycatcher;

6) Rufous Fantail;

7) Common Sandpiper;

8) Sharp-tailed Sandpiper;

9) Red-necked Stint;

10) Latham's Snipe;

11) Greenshank;

12) Marsh Sandpiper; and

13) Glossy Ibis.

Migratory species considered to have a higher likelihood of occurring within the study area are the:

- Fork-tailed Swift;
- Satin Flycatcher;
- Caspian Tern;
- Latham's Snipe; and
- Glossy Ibis.

Five migratory species are considered unlikely to occur in the study area (Osprey, Oriental Cuckoo, Spectacled Monarch, Yellow Wagtail and Pectoral Sandpiper), the species have still been targeted by the field surveys as described in Appendix G, Terrestrial Ecology Assessment (section 11.1.8).

Survey effort

Seasonal fauna surveys have been undertaken in autumn 2019 (11–21 March 2019), spring 2019 (6–19 November 2019), autumn 2020 (23–25 March 2020; 1–8 April 2020), autumn 2021 (14–22 April 2021) and spring 2021 (6–10 September 2021) consistent with Commonwealth and Queensland survey guidelines.

Appendix G, Terrestrial Ecology Assessment (section 11.1.9.2) describes the survey effort undertaken and how the survey effort compares to relevant Commonwealth and State guidelines and best practice survey guidelines for each migratory species. In summary, survey methods and effort generally complied with survey guidelines and included, but was not limited to:

- 14 systematic survey sites;
- 75 person hours of active searching;
- 83 person hours of diurnal bird surveys;
- opportunistic observations; and
- survey and inspection of farm dams and wetlands.

While other survey methods have been employed during the terrestrial ecology surveys, those mentioned above are the most relevant for the detection of the migratory birds potentially occurring within the study area.

Survey outcomes

Two migratory species listed under the EPBC Act have been recorded within the study area during the field surveys: the White-throated Needletail and the Caspian Tern (Figure 21.84).

The survey outcomes and assessment for the White-throated Needletail are provided in Section 21.12.2.5. One Crested Tern was recorded opportunistically during the autumn 2021 field survey at a lacustrine wetland (farm dam) within the cleared agricultural area (Figure 21.84).

Habitat assessment

The wetland areas, farm dams and/or inundated paddocks within the study area provide potential foraging habitat for occasional migratory species that utilise wetland habitats, particularly when climatic conditions are suitable. These include species such as the:

- Gull-billed Tern;
- Caspian Tern;
- Common Sandpiper;
- Sharp-tailed Sandpiper;
- Marsh Sandpiper;
- Red-necked Stint;
- Latham’s Snipe; and the
- Greenshank and Glossy Ibis.

The wetland and gilgai habitats mapped as providing potential intermittent foraging habitat for the Australian Painted Snipe (Figure 21.96) within the study area provide potential habitat for the migratory wetland species. As discussed in 21.12.4.6 for the Australian Painted Snipe, wetted gilgai habitat is only available for a short period after rainfall when the gilgai are full. While inspections of farm dams within the study area indicate they do not provide suitable foraging habitat for the Australian Painted Snipe, they may provide potential foraging habitat for migratory wetland bird species. The location of farm dams within the study area is shown in Figure 21.95. Remnant vegetation within the study area provides potential habitat for occasional migratory species such as the:

- Fork-tailed Swift;
- Black-faced Monarch; and the
- Satin Flycatcher and the Rufous Fantail.

The areas of remnant vegetation within the study area providing potential or known habitat for the Koala (Figure 21.97) provides potential habitat for the migratory woodland bird species.

The study area does not provide potential breeding habitat for migratory species, with many being non-breeding visitors to Australia.

Impact assessment

Wetland areas, farm dams and/or inundated paddocks within the study area provide potential intermittent foraging habitat for occasional migratory species that utilise wetland habitats. Approximately 40.7 ha of this habitat will be cleared by the Project. A further 29.5 ha of this habitat will be impacted by residual ponding, which represents a change in this habitat rather than a removal of this habitat. A total of 213.9 ha is modelled to undergo increased ponding as a result of changed hydrology due to surface subsidence (Appendix W, Geomorphological Assessment Report, section 3.3.1). These areas are likely to result in increased suitability for migratory species that use wetland habitats. Remnant vegetation within the study provides potential habitat for occasional migratory species that utilise woodland habitats. A total of 12.2 ha of remnant vegetation is proposed to be cleared for the Project, and a further 96.9 ha of remnant vegetation is predicted to be substantially impacted by residual ponding. The impacts to migratory species' habitat will add to habitat disturbance that is proposed to occur for other Projects in the region. The Project will not fragment habitat for mobile migratory species.

The extent of flooding is predicted to increase along the margins of subsided panels; however, the changes to flood levels are considered not significant (Appendix W, Geomorphological Assessment Report, section 4.2). Therefore, the impact of changes to flooding regimes on migratory species are not expected to be significant.

Avoidance, mitigation and management

The Project has been designed to avoid and mitigate impacts to migratory species where practicable. The proposed avoidance and mitigation measures for migratory species, including timing, predicted effectiveness, monitoring, adaptive management and the relevant statutory or policy basis is provided in Table 21.73.

Statutory requirements

Australia is party to various international conventions and agreements to protect migratory species. These include the:

- China–Australia Migratory Bird Agreement (CAMBA);
- Japan–Australia Migratory Bird Agreement (JAMBA);
- Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA); and
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Each of these agreements provides for the protection and conservation of migratory birds and their important habitats, protection from take or trade except under limited circumstances, the exchange of information, and building co-operative relationships (DAWE 2020). Bird species listed within the appendices/annexes of these agreements/conventions, are subsequently listed as migratory species under the EPBC Act.

The EPBC Act provides the domestic legal framework for implementing Australia's obligations under a number of international conventions related to the environment, including but not limited to, the Bonn Convention. The EPBC Act also includes provisions relating to migratory bird conservation bilateral agreements, including CAMBA, JAMBA and ROKAMBA.

Table 21.73: Migratory Species impact avoidance and mitigation measures

<table>
<tr><th>Avoidance/mitigation measures</th><th>Timing</th><th>Predicted effectiveness</th><th>Monitoring and adaptive management</th><th>Statutory or policy basis</th></tr>
<tr><td>Project infrastructure has been located to minimise direct disturbance to remnant vegetation and wetland habitats.</td><td>Mine planning/ construction/ operations</td><td>Highly effective—minimises the extent of impacts to migratory woodland species habitat.</td><td rowspan="2">Monitor disturbance/vegetation clearance areas against approved disturbance limits.
Should clearing exceed approved limits, incident reporting will be initiated with a corrective action plan will be proposed (including proposed timing) and implemented. The corrective actions will be informed by the nature and extent of the exceedance.</td><td rowspan="2">DoE (2015a), DAWE (2021)</td></tr>
<tr><td>Disturbance areas will be delineated to prevent accidental damage to adjacent remnant vegetation/habitat.</td><td>Construction/ operations</td><td>Highly effective management technique to manage Project disturbance activities.</td></tr>
<tr><td>Design and undertake subsidence drainage management works to minimise hydrological changes to gilgai and wetland habitats.</td><td>Mine planning/ operations</td><td>The hydrological modelling (Appendix W, Geomorphological Assessment Report, section 5.5) indicates the subsidence mitigation works will be effective in minimising the hydrological changes that will occur as a result of mine subsidence to gilgai and wetland habitats.</td><td>Subsidence effects and implemented mitigation and rehabilitation measures will be monitored in accordance with the Subsidence Management Plan (Section 21.12.3.6) to be prepared for the Project.
Audit(s) will be conducted and follow up corrective measures (e.g. additional drainage works) will be implemented as required.</td><td>DoE (2015e), DoE (2015a), DAWE (2021)</td></tr>
<tr><td>Implement erosion and sediment control measures.</td><td>Construction/ operations/ rehabilitation and decommissioning</td><td>Highly effective management measure to minimise the potential for erosion and sedimentation.</td><td>Monitoring will be conducted of the integrity and effectiveness of implemented erosion and sediment controls in accordance with the Erosion and Sediment Control Plan that will be prepared for the Project.
Adaptive management measures (such as installation of additional erosion controls or increase in frequency of inspections) will be implemented, as required. .</td><td>DoE (2015a), DAWE (2021)</td></tr>
</table>

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Implement measures to reduce the risk of the introduction of pollutants (e.g. bunding or containment of hydrocarbon storages, provision of spill kits).	Construction/ operations/ rehabilitation and decommissioning	Highly effective management measure to minimise the potential for leaks and spills or other pollutants being introduced to migratory species habitat.	Visual inspections will be conducted of containment measures at MIA. Maintenance or implementation of additional controls, as required, will be carried out to maintain integrity and effectiveness. Audits of management measures and identification and implementation of potential system improvements will be undertaken.	DoE (2015a), DAWE (2021)
Regularly inspect mine-related surface disturbance areas and Bowen Basin Coal owned land to identify areas requiring weed management measures to be implemented. Implement weed management measures (e.g. mechanical removal and application of approved herbicides).	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the spread and occurrence of weeds.	Monitor and manage weeds in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project. Corrective actions (such as increasing the frequency or extent of control efforts, or alternative control strategies) will be implemented, as necessary.	DoE (2015a), DAWE (2021), Commonwealth of Australia (2017a), Qld Department of Agriculture and Fisheries weed control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020)
Maintain a clean, rubbish-free environment to discourage scavenging and reduce the potential for colonisation of these areas by introduced fauna.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Regular monitoring of site will be carried out by environmental personnel. Raise awareness through personnel inductions. Additional measures (such as tool box talks or staff newsletters) will be implemented if inspections indicate a clean, rubbish-free environment is not being maintained.	DoE (2015a), DAWE (2021), Commonwealth of Australia (2017b), DoE (2015b), DEWHA (2008b)

Avoidance/mitigation measures	Timing	Predicted effectiveness	Monitoring and adaptive management	Statutory or policy basis
Store domestic waste in appropriate receptacles and locations.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests if site protocols are followed by personnel.	Regular monitoring of site will be carried out by environmental personnel. Monitoring and auditing of the Waste Management Plan will be updated for the Project. Additional measures (such as provision of additional receptacles or change in location of receptacles) will be implemented if current storage practices encourage feral animals	DoE (2015a), DAWE (2021), Commonwealth of Australia (2017b), DoE (2015b), DEWHA (2008b)
Monitor and manage pests in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be prepared for the Project.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Monitor and manage pests in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project. Corrective actions (such as increasing the frequency or extent of control efforts or alternative control strategies) will be implemented, as necessary.	DoE (2015a), DAWE (2021), Commonwealth of Australia (2017b), Qld Department of Agriculture and Fisheries pest control strategies (https://www.daf.qld.gov.au), Isaac Regional Council (2020), DoE (2015b), DEWHA (2008b)
Consult with the Isaac Regional Council and neighbouring mines in relation to weed and pest management activities.	Construction/ operations/ rehabilitation and decommissioning	Effective management measure to manage the occurrence and abundance of feral pests.	Monitor and manage pests in accordance with the Weed and Pest Management Plan (Section 21.12.3.10) to be updated for the Project. Audits will be implemented to monitor the consultation outcomes and the management measures implemented on site.	DoE (2015a), DAWE (2021), Commonwealth of Australia (2017a), Commonwealth of Australia (2017b), Isaac Regional Council (2020)

Threats to migratory species include (DoE 2015a, DAWE 2021a):

- loss, modification or fragmentation of habitat;
- invasive species that are harmful to the migratory species;
- actions that result in mortality (e.g. collisions with wind turbines, windows, light houses); and
- human activities at international breeding sites.

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.

Significant impact assessment

An area of 'important habitat' for a migratory species is (DoE 2013a):

a) *habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or*

b) *habitat that is of critical importance to the species at particular lifecycle stages, and/or*

c) *habitat utilised by a migratory species which is at the limit of the species range, and/or*

d) *habitat within an area where the species is declining.*

The potential habitat available to migratory species in the study area is unlikely to provide important habitat for any migratory species.

Important habitats in Australia for migratory shorebirds under the EPBC Act include those recognised as nationally or internationally important (DAWE 2021a). Wetland habitat is considered *internationally important* if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird or a total abundance of at least 20,000 waterbirds. *Nationally important habitat* for migratory shorebirds regularly supports 0.1% of the flyway population of a single species of migratory shorebird, or 2,000 migratory shorebirds or 15 migratory shorebird species.

The 'Revision of the East Asian-Australasian Flyway Population Estimates for 37 Listed Migratory Shorebird Species' (Hansen *et al.* 2016) provides population estimates for 37 migratory shorebirds to help define 'important habitat' for these species. As an example, important habitat for Latham's Snipe is described as areas that have previously been identified as internationally important for the species or areas that support at least 18 individuals of the species (Hansen *et al.* 2016). The 'Referral Guideline for 14 birds Listed as Migratory (DoE 2015a)' also outlines ecologically significant proportions of 14 migratory species, including the Fork-tailed Swift, Rufous Fantail, Black-faced Monarch and Satin Flycatcher.

One Crested Tern has been recorded at one time during surveys conducted over several seasons. Similarly, extensive field surveys conducted for nearby studies and in the wider region also recorded migratory species in low numbers. The area is unlikely to support an ecologically significant proportion of the population of a migratory species.

Table 21.74 provides an assessment of the likelihood of significant impacts on migratory species that have the potential to occur in the study area in accordance with the Commonwealth 'Significant Impact Guidelines 1.1: Matters of National Environmental Significance' (DoE 2013a).

Table 21.74: Migratory species significant impact assessment

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 study area is unlikely to represent an area of important habitat for any migratory species, including the Crested Tern. The Project will not substantially modify, destroy or isolate an area of important habitat for a migratory species.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The study area is unlikely to represent an area of important habitat for a migratory species. Predation by feral species, such as the European Red Fox and Feral Cat is a recognised threat to species such as Latham's Snipe; both pests have been recorded in the study area. The Project is unlikely to increase these threats or result in invasive species becoming established in potential habitat for migratory species.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	The Project is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of a population of a migratory species.
Conclusion	The Project will not result in a significant impact to migratory species listed under the EPBC Act.

21.13 Aquatic ecology

21.13.1 Existing environment

21.13.1.1 Study area

The aquatic ecology study area within the Project is shown in Figure 21.101.The study area includes the waterways and wetlands within, adjacent to, upstream and downstream of the Project footprint. Specifically:

- One Mile Creek, Boomerang Creek and Phillips Creek;
- a section of the Isaac River and Ripstone Creek (north of the Project footprint); and
- the wetlands within the aquatic ecology study area, as shown in Figure 21.101.

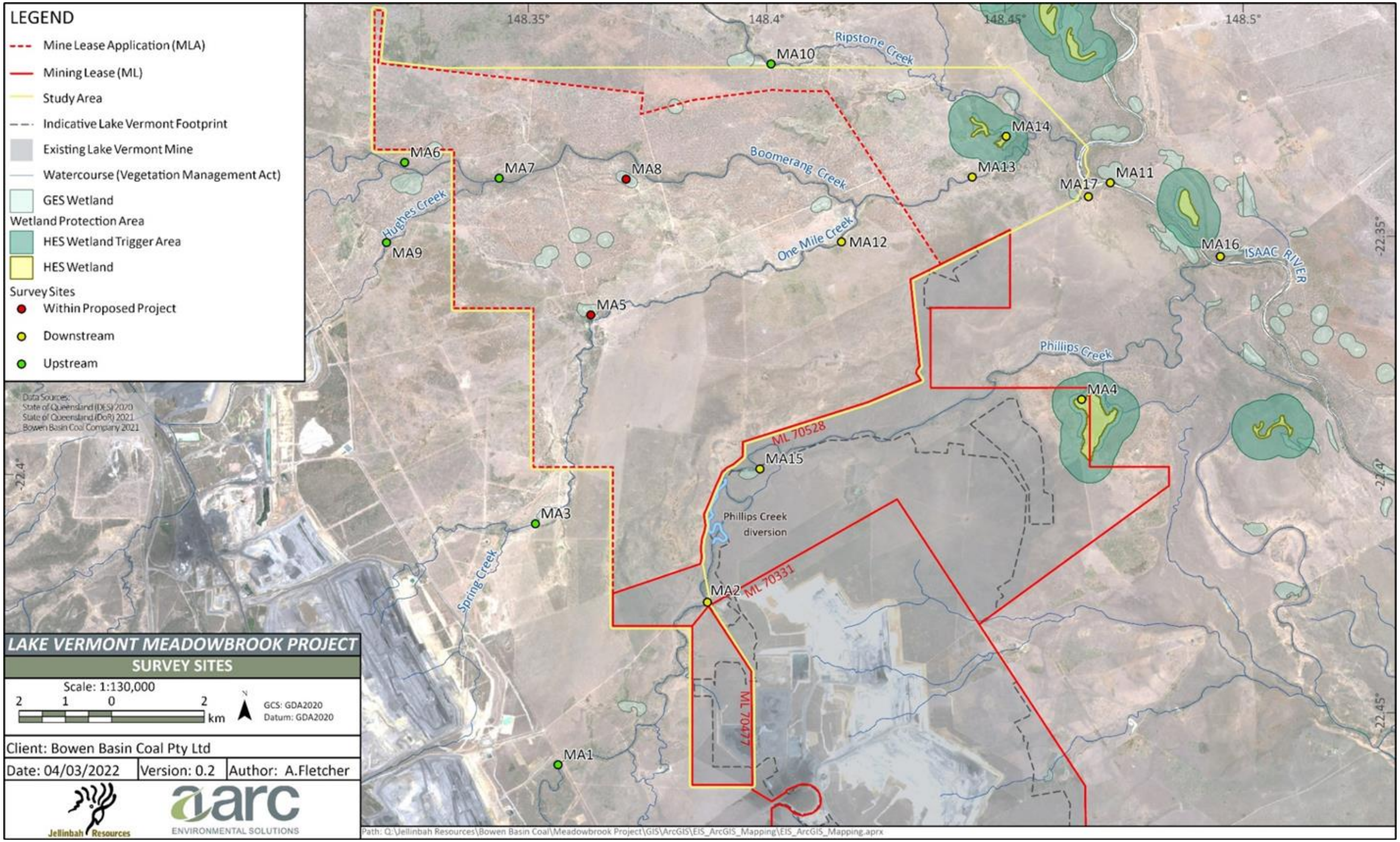

Figure 21.101: Aquatic ecology study area and survey sites

21.13.1.2 Desktop assessment

A desktop assessment has been undertaken to identify and present the ecological values mapped within the study area. The desktop assessment includes:

- a review of the Australian Government and Queensland Government databases and mapping; literature reviews;
- an analysis of aerial imagery;
- ecology assessments from the existing Lake Vermont operations; and
- ecological assessments from surrounding projects.

Searches have been undertaken with a 50 km buffer on the EPBC Act 'Protected Matters Search Tool' and the 'DES Wildlife Online' search and 'WildNet Wildlife Records'. A preliminary field survey has also been undertaken at four sites, which provide additional site-specific context. The results of the desktop assessment (described in Appendix H, Aquatic Ecology Assessment, section 5.2) has been used in the field survey design and methodology.

21.13.1.3 Field survey

Aquatic ecology surveys were conducted within the study area in late wet season 2020 (20 March 2020 to 23 March 2020) and late wet season 2021 (14 April 2021 to 19 April 2021). The survey timings are considered appropriate to maximise the likelihood of detecting aquatic species of significance within the study area. The study area streams and wetlands are ephemeral and observations made during dry and early wet season ecology surveys identified that conditions were unsuitable for aquatic ecology surveys. Conditions are only suitable for aquatic ecology assessments for a short period each year and survey effort was targeted to suitable conditions.

The aquatic ecology surveys included:

- aquatic habitat surveys (physical assessment, habitat bioassessment, and condition assessment);
- surface water and stream sediment quality assessments (physio-chemical sampling);
- aquatic macroinvertebrate sampling; and
- aquatic fauna (fish, turtles, and platypus) surveys.

The survey effort applied at aquatic ecology sites within the study area are detailed in Table 11.1 and the locations of survey sites shown in Figure 11.3.

The field surveys were conducted in accordance with the following guidelines:

- Queensland Government Guidelines:
  - 'Monitoring and Sampling Manual: Environmental Protection (Water) Policy' (DES 2018b); and
  - 'Queensland Australian River Assessment System (AusRivAS) Sampling and Processing Manual' (DNRM 2001).
- Australian Government Guidelines:
  - 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality' (ANZECC & ARMCANZ 2000);
  - 'Survey guidelines for Australia's threatened reptiles' (DSEWPC 2011a); and
  - 'Survey guidelines for Australia's threatened fish' (DSEWPC 2011b).

Surveys were also designed and undertaken in consideration of the relevant species requirements outlined within the SPRAT Database.

No aquatic species listed under the EPBC Act have been considered likely to occur, or have the potential to occur within the study area (Table 21.75),

Table 21.75: Likelihood of occurrence assessment outcomes; conservation significant aquatic spp.

Scientific name	Common name	Conservation status		Likelihood of occurrence
		EPBC status	NC Act status	
Reptiles				
Elseya albagula	Southern Snapping Turtle	CE	E	Unlikely
Rheodytes leukops	Fitzroy River Turtle	V	V	Unlikely
Fish				
Bidyanus bidyanus	Silver Perch	CE	—	Unlikely
Maccullochella peelii	Murray Cod	V	—	Unlikely

21.13.1.4 Survey methodology

Aquatic habitat

Field surveys included assessments of aquatic habitat including physical assessment according to AusRivAS Physical Assessment Protocol and Queensland AusRivAS Sampling and Processing Manual. The habitat assessment also included condition assessment of possible impacts to aquatic EVs caused by major disturbances.

Surface water quality

Surface water quality data were collected at each aquatic ecology sample site in accordance with the Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009 (DES, 2018b) methodology. Field readings of pH, dissolved oxygen, turbidity, EC and temperature were recorded and samples were analysed for following:

- Total Suspended Solids (TSS);
- nutrients (total nitrogen [N], nitrate, nitrite, oxides of nitrogen (NOx), ammonia, Total Kjeldahl Nitrogen, reactive phosphorus and total phosphorus);
- total hardness (CaCO3);
- dissolved major cations (calcium, magnesium, sodium and potassium);
- total and dissolved metals and metalloids (aluminium, arsenic, beryllium, barium, boron, cadmium, chromium, cobalt, copper, lead, iron, manganese, mercury, molybdenum, nickel, selenium, silver, uranium, vanadium and zinc); and
- total petroleum hydrocarbons and total recoverable hydrocarbons.

Stream sediment quality

Sediment quality data were collected at aquatic ecology sample sites accordance with the Queensland Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009 (DES, 2018b). Sediment samples were analysed for concentrations of total metals and metalloids including: arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, vanadium and zinc.

Aquatic macroinvertebrates

Macroinvertebrate sampling was conducted in accordance with the AusRivAS sampling and assessment methodology as outlined by the Queensland Monitoring and Sampling Manual: Environmental Protection (Water) Policy 2009 (DES 2018b).

Macroinvertebrate community indices were calculated and comparisons to made to relevant WQO specified in the Isaac River Sub-basin EVs and Water Quality Objectives (DEHP 2011).

Aquatic flora

Any aquatic flora observed at each of the survey site was recorded.

Aquatic fauna

Survey techniques used to identify the aquatic fauna species present at the survey site included the following:

- opera house trapping;
- box trapping;
- seine netting; and
- habitat searches.

The aquatic fauna survey effort undertaken during each survey event is detailed in Table 21.76 for each sampling technique.

Table 21.76: Aquatic fauna survey effort

Site name	Start date	End date	Opera houses	Box traps	Seine net	Habitat search
2020						
MA2	20/03/2020	22/03/2020	Yes	Yes	-	Yes
MA5	21/03/2020	22/03/2020	Yes	Yes	-	Yes
MA8	19/03/2020	22/03/2020	Yes	-	-	Yes
MA11	22/03/2020	22/03/2020	Yes	-	-	Yes
MA12	22/03/2020	22/03/2020	Yes	Yes	-	Yes
2021						
MA3	18/04/2021	20/04/2021	Yes	Yes	-	-
MA8	18/04/2021	20/04/2021	Yes	Yes	-	-
MA11	18/04/2021	20/04/2021	Yes	Yes	-	-
MA12	18/04/2021	20/04/2021	Yes	Yes	-	-
MA Extra	18/04/2021	20/04/2021	Yes	Yes	Yes	-

21.13.2 Aquatic ecological values

21.13.2.1 Watercourses

The Isaac River is approximately 5 km east of the Project footprint. The Isaac River flows south from north of Moranbah and converges with the Mackenzie River approximately 107 km south-east of the study area. The Mackenzie River converges with the Dawson River to form the Fitzroy River, which eventually discharges into the Coral Sea south-east of Rockhampton (Hatch 2018).

A number of tributaries traverse the study area and flow in an easterly direction into the Isaac River. These tributaries include Boomerang Creek, Hughes Creek, One Mile Creek, Phillips Creek and Ripstone Creek (Figure 21.101). Boomerang Creek is an ephemeral fifth order stream that traverses the northern portion of the study area upstream of its confluence with the Isaac River (Figure 21.101). Hughes Creeks flows into Boomerang Creek near the western boundary of MDL 429. The headwaters of Boomerang Creek and Hughes Creek occur to the west of the study area and traverse the tenure of the Saraji Mine (ML 1775).

One Mile Creek, a third order stream, traverses the study area from the south-west until its confluence with Boomerang Creek towards the north-eastern boundary of the study area. Ripstone Creek, also a third order stream, occurs to the north of the study area and flows eastward before flowing into Boomerang Creek to the east of the study area. The Olive Downs Coking Coal Project has approval to divert a section of Ripstone Creek near the northern boundary of MDL 429. The surface water assessment for the Olive Downs Coking Coal Project has concluded the hydraulic properties of the Ripstone Creek diversion are within the parameters set by the relevant guidelines (Hatch 2018).

Phillips Creek is a fourth order stream that traverses a portion of the southern study area within ML 70528. The creek meanders along the northern boundary of ML 70528, outside the study area, before converging with the Isaac River (Figure 21.101).

Aerial imagery taken of areas to the west of the study area shows that the upstream reaches of all five watercourses that traverse the study area (Boomerang Creek, Hughes Creek, One Mile Creek, Phillips Creek, and Ripstone Creek) have been heavily modified by mining activities, resulting in the removal of catchment, changes in drainage pathways and modified runoff characteristics.

Boomerang Creek, Hughes Creek, One Mile Creek, Ripstone Creek, Phillips Creek and the Isaac River are defined watercourses under the Queensland Water Act.

21.13.2.2 Wetlands

The mapped vegetation management wetlands within the study area and surrounds are shown in Figure 21.101 as General Ecological Significance Wetlands (GES) and High Ecological Significance Wetlands (HES).

The majority of mapped wetlands within the study area are towards the north (between One Mile Creek and Boomerang Creek) and in the east (along the Isaac River). Other palustrine wetlands are mapped along the Isaac River, both upstream and downstream of the confluence of the Isaac River with Boomerang Creek.

There are several HES wetlands to the north and east of the Project (Figure 21.101). The closest HES wetland is located approximately 2.4 km east of the Project, near the confluence of Boomerang Creek and Ripstone Creek. This HES wetland is within the aquatic ecology study area.

An additional HES wetland is approximately 7 km east of the Project at the existing Lake Vermont Mine (partially on ML70528) and 700 m south of Phillips Creek (Figure 21.101). This waterbody is separated from the Project by the disturbance area approved for the existing Lake Vermont Mine.

Although not a MSES, there is a lacustrine wetland of very low conservation value adjacent to One Mile Creek on the western side of the Project site, which has been mapped as part of an ‘Aquatic Conservation Assessment’ (ACA) (DES 2018 - 2021). The landform at this location has been modified to permanently hold water through the construction of a farm dam.

21.13.2.3 Aquatic habitat

Aquatic habitat of watercourses and wetlands within the study area is generally fair to good.

The effects of erosion on the banks of the receiving waters are minimal across all surveyed sites. The leading cause of local erosion appears to be from stock access, with runoff and the influence of edge effects from historic clearing also contributing to the degradation.

The habitat bioassessment scores from the aquatic sites within the sampling environment primarily fell into the fair and good categories. Condition assessment scores ranged from 39 to 49, with a mean of 45.5. Of the sites surveyed, 14 of 15 sites received condition scores above 40, indicating that the influence of activities upstream has had minimal impact. Results of the aquatic habitat assessment, photographs and site descriptions are provided in Appendix H, Aquatic Ecology Assessment (section 8.1).

21.13.2.4 Aquatic flora

The aquatic flora species encountered were common emergent species, two semi-aquatic sedges, *Cyperus difformis*, and *Cyperus iria*. *Cyperus iria* is considered Least Concern under the NC Act and Cyperus difformis is not listed. The lack of both diversity and abundance of aquatic plants at some sites is likely indicative of harsh physical conditions, cattle grazing and trampling, or a combination of these factors.

21.13.2.5 Aquatic fauna

A total of 638 fish have been captured across all sites during both survey periods, representing nine species from five families. A total of 344 crustaceans have been captured across all sites during both survey periods, representing five species from four families. No listed 'endangered, vulnerable or near-threatened' (EVNT) species were noted at any of the survey sites during any of the surveys. All fish species recorded in the study area are considered common, or widespread, species in the Isaac River sub-basin. No pest fish species were noted during any of the surveys. The list of species recorded in the study area is provided in Appendix H, Aquatic Ecology Assessment (Appendix D).

No turtle species listed under the EPBC Act or NC Act were noted during the surveys, and no Least Concern turtle species were noted during the 2020 or 2021 surveys. A single Krefft's River Turtle (*Emydura macquarii krefftii*) has been recorded during the preliminary survey in 2019 from a site on Phillips Creek, upstream of the Project.

The ephemeral nature of the watercourses limits the suitable habitat for turtle species listed under the EPBC Act or NC Act.

21.13.2.6 Macroinvertebrates

Taxonomic richness of the samples is generally low to moderate, ranging from 10 to 17. None of the sites sampled during either survey exhibited a taxonomic richness that met the upper WQO, and nine samples met or exceeded the lower WQO. A list of macroinvertebrate taxa recorded during monitoring is provided in Appendix H, Aquatic Ecology Assessment (Appendix D).

PET taxa richness is below the high WQO in samples from all sites collected in both surveys and is typically below the low WQO, which is representative of the habitats and the ephemeral nature of the watercourses within the study area.

The weighted SIGNAL 2 scores recorded from the samples collected are generally low, ranging from 2.6 to 4.2 and generally fall within Quadrant 4 (site conditions are likely influenced by urban industrial or agricultural pollution). The SIGNAL2 scores indicate poor habitat availability and environmental conditions, which is likely a result of the ephemeral nature of the watercourses within the study area.

21.13.2.7 Matters of National Environmental Significance

Four aquatic species listed as Critically Endangered, Endangered or Vulnerable under the EPBC Act have been identified by the desktop assessment as having known records within the broader region.

Through the likelihood of occurrence assessment, it is concluded that all four aquatic species of conservation significance identified by the database searches are unlikely to occur within the study area (Table 21.75).

21.13.3 Potential impacts

21.13.3.1 Direct impacts

The Project will remove and/or directly modify a small area of aquatic habitat; however, the watercourses in the area to be disturbed are of low to moderate ecological value. The Project will not cause any direct disturbance to wetlands. Specifically, the following activities have the potential to have direct impacts on aquatic ecology values within the study area:

- loss of watercourses and wetlands due to direct disturbance; and
- creation of barriers to fish passage at infrastructure corridor watercourse crossings.

Loss of watercourse and wetlands

Construction of the infrastructure corridor (specifically the haul road) will require stream crossings of Phillips Creek and One Mile Creek.

Where the infrastructure corridor crosses these watercourses, there will be small areas of loss or modifications to the watercourses. The stream crossings will be constructed as causeways with appropriately-sized culverts to allow low flows; however, they will be inundated for approximately five days per annum (Appendix W, Geomorphological Assessment, section 3.3.3). Construction activities will be undertaken during the dry season to minimise erosion and sediment mobilisation while also facilitating time to generate stability of works prior to wet season flows.

A small area of a GES wetland will be disturbed by the proposed ETL and a light vehicle access road running from the MIA to the substation/borehole deliveries area (refer Figure 21.10). This wetland is a lacustrine wetland of very low conservation value adjacent to One Mile Creek. The landform at this location has been modified to permanently hold water through the construction of a farm dam. The ETL alignment has been selected to avoid and minimise clearing of remnant vegetation, habitat and aquatic ecology environmental values as far as reasonably possible. A detailed explanation of the selection of the ETL alignment is provided in Chapter 3, Project Description, Section 3.6.4. The ETL and vehicle access road will result in 0.01 ha of disturbance to the GES wetland/farm dam.

Overall, the aquatic habitats of these watercourses and wetlands are common and typical of the region, and while impacts will mean a minor loss of available aquatic habitat for aquatic communities, this is not expected to impact aquatic ecology on a regional scale.

The small area of direct disturbance to watercourses and wetlands is unlikely to impact aquatic flora on a regional scale. Impacts from direct disturbance to riparian and wetland vegetation communities is discussed in Section 21.12.

Barriers to fish passage at waterway crossings

The construction of waterway crossings along the infrastructure corridor has the potential to create barriers to fish movement along the waterways. Barriers to fish movement that could be created by the Project include waterway crossings at Phillips Creek (purple), One Mile Creek (red) and the minor waterway (green) on ML70477 (Figure 21.102).

The minor waterway (green) is a shallow drainage line of stream order one, is highly ephemeral and is not expected to currently provide fish passage. The disturbance associated with the infrastructure corridor will, therefore, not create an impediment to fish passage.

One Mile Creek and Phillips Creek are highly ephemeral waterways that do not flow for long periods of the year, thus limiting the connectivity of waterways and wetlands within, upstream and downstream of the Project. It is considered that both waterways are likely to provide some localised fish passage for periods during which they sustain flow. Upstream of the Project, both waterways pass through the existing BMA Mine site, where they are both crossed by an existing road network (with culverts located at crossings). Additionally, the proposed Saraji East development will include a ‘transport and infrastructure corridor’ that will cross One Mile Creek and Phillips Creek upstream of the Meadowbrook Project.

The watercourse crossings at Phillips Creek and One Mile Creek associated with the Meadowbrook Project’s infrastructure corridor will be constructed in consideration of fish passage and water flow is anticipated that the proposed culverts will maintain fish passage during periods of low flow. Due to the poor quality fish habitat and fish passage values of the waterways, there is unlikely to be a measurable impact on fish resources beyond the Project area.

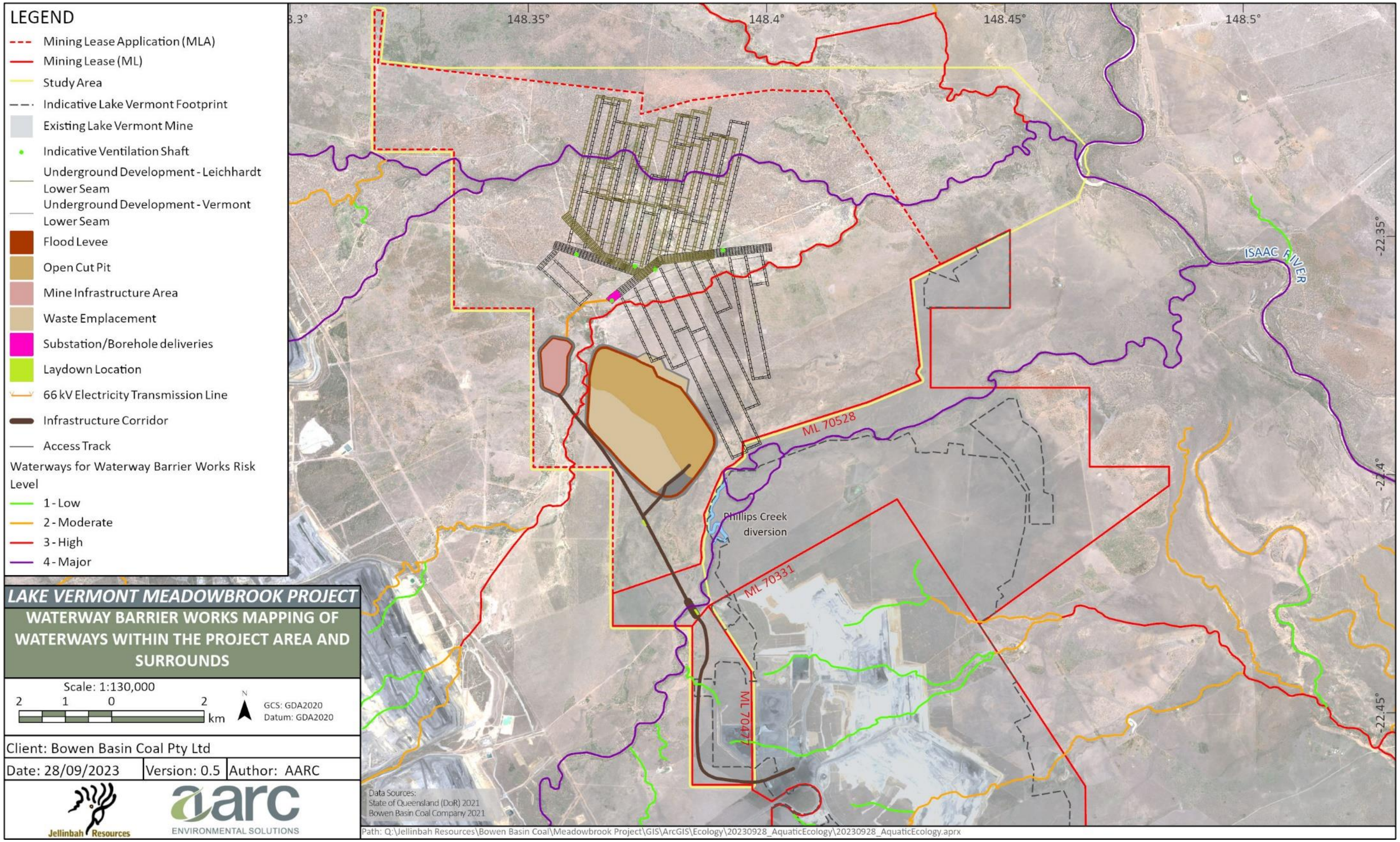

Figure 21.102: Waterway Barrier Works risk mapping of waterways within the study area

21.13.3.2 Indirect impacts

The Project has the potential to indirectly impact aquatic ecology values through changes to water quality and hydrology. Specifically:

- changes in timing and magnitude of flow caused by loss of catchment area;
- subsidence of the stream bed level caused by underground mining operations;
- subsidence-induced changes in ponding caused by underground mining operations;
- changes to flood regimes due to surface infrastructure and subsidence;
- erosion and sedimentation due to Project activities;
- water quality changes due to water releases;
- water quality changes due to releases from final rehabilitated pit landform;
- impacts to water quality from litter, wastes and spills; and
- impacts to aquatic ecosystems utilising groundwater due to groundwater drawdown.

Aquatic ecosystems have the potential to be impacted through changes in hydrology by:

- affecting the life cycles of aquatic species that have adapted to existing hydrological conditions (i.e. affecting cues for movement, migration and breeding);
- changing the diversity and structure of in-stream aquatic habitat ,in turn influencing the composition of aquatic communities;
- introduction and/or proliferation of aquatic weed and pest species in the Project area;
- affecting water quality through changes in the volume and timing of flows (especially flushing);
- increasing erosion of watercourses, which will affect water quality and habitat conditions; and
- altering the connectivity between aquatic habitats through changes in flows.

Impacts to downstream channel flows, ponding and mitigation measures

The Project will result in a loss of catchment area due to the construction of the open pit mining area and the MIA, both of which will be protected by flood levees for the duration of the operations. Both flood protection levees will be removed at mine closure. Additionally, subsidence-induced changes to floodplain morphology will result in the retention of additional water during flood events. The retained water will pond and either seep into the underlying sediments or evaporate, effectively reducing the catchment area and thus the downstream flows.

Where practical, mitigation drains and mitigation bunds are proposed to drain subsided areas and prevent water ingress into subsided areas (Figure 21.103). This is not possible in all areas, and ponding of runoff captured in the floodplain between Boomerang Creek and One Mile Creek will reduce the local catchment draining into One Mile Creek by approximately 9 km^2 (6.9%). This catchment loss will impact the downstream 4 km reach of One Mile Creek before the confluence with Boomerang Creek, in minor runoff events. The stretch of One Mile Creek where flows are modelled to be reduced during regular flow events has moderate aquatic ecological values, and the reduction in flows will have a minor ecological impact on aquatic values.

Impacts on stream flows will be minimal downstream of the confluence, where loss of catchment will make up 1.8% of the 489 km^2 total catchment area. The modelled flood hydrographs downstream of the Boomerang Creek and One Mile Creek confluence for the 50% and 2% AEP events show that loss of catchment will attenuate the flood hydrograph for the 50% AEP event, reducing and delaying the flood peak, compared to existing conditions. This reduction in flow will reduce the 50% AEP flood depths in the Boomerang Creek by approximately 0.3 m to 0.5 m (Figure 21.104).

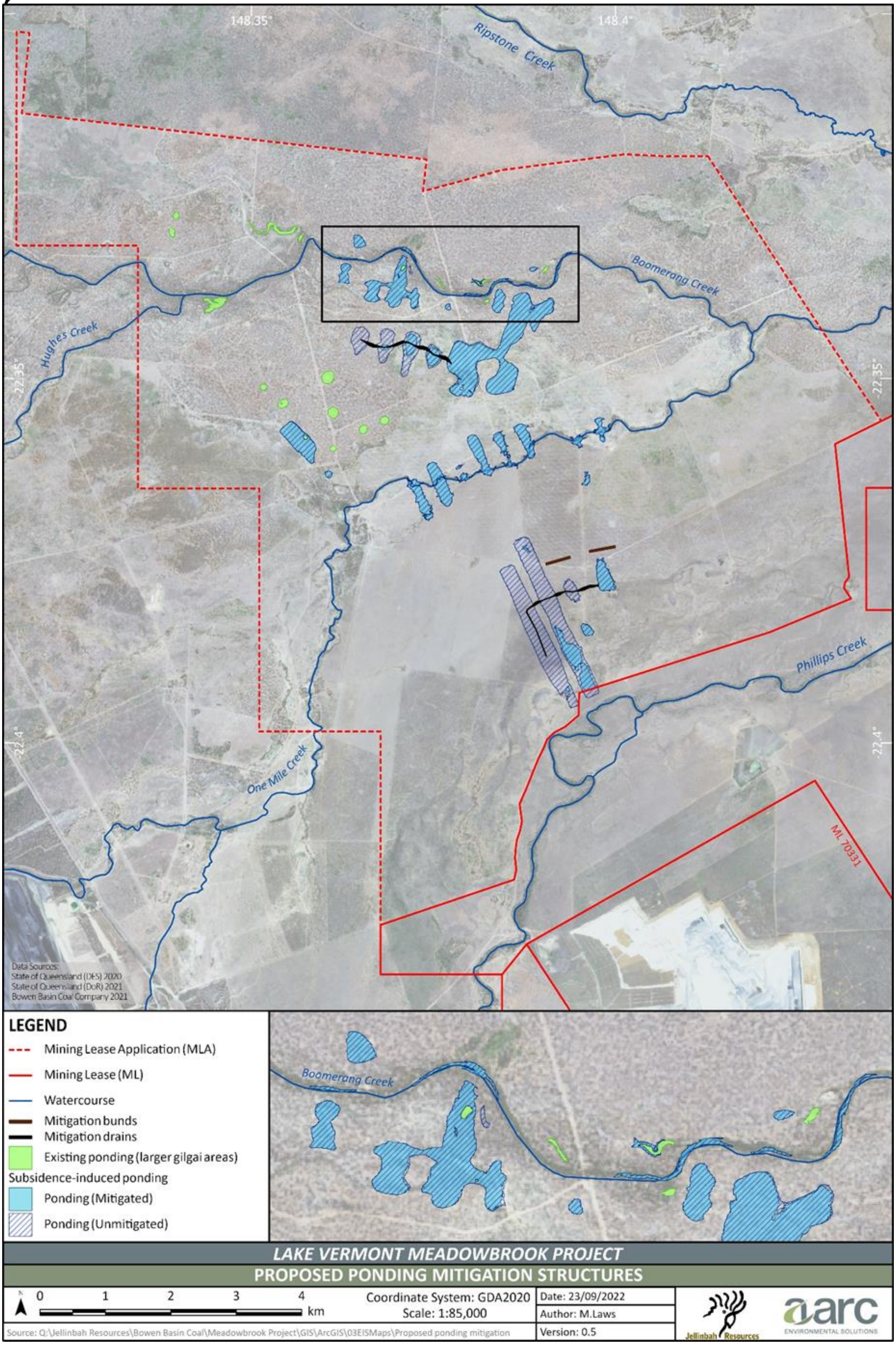

Figure 21.103: Map of mitigated subsidence-induced ponding and location of mitigation measures

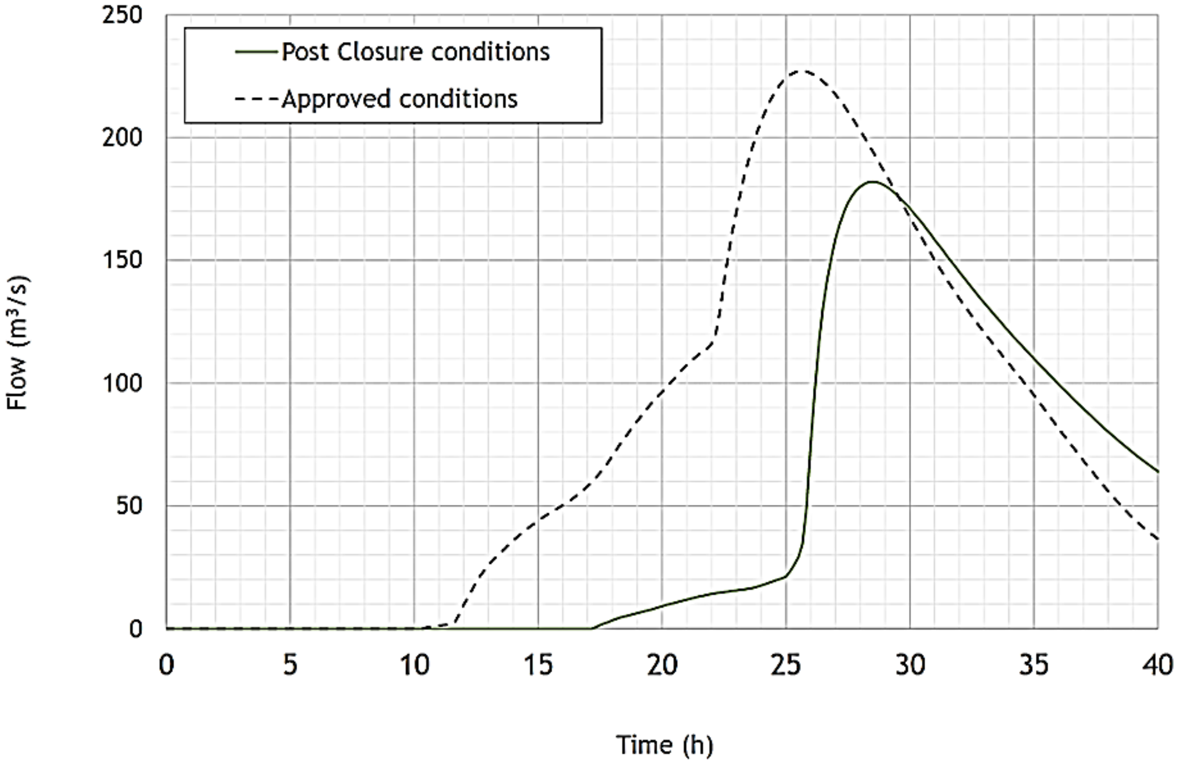

Figure 21.104: Change in downstream flood hydrograph - Boomerang/One Mile Creek 50% AEP

In larger floods, the effect of storage on flood flows and downstream flood levels will be minimal (Figure 21.105). There is not predicted to be any changes to downstream flow in Phillips Creek due to loss of the catchment area.

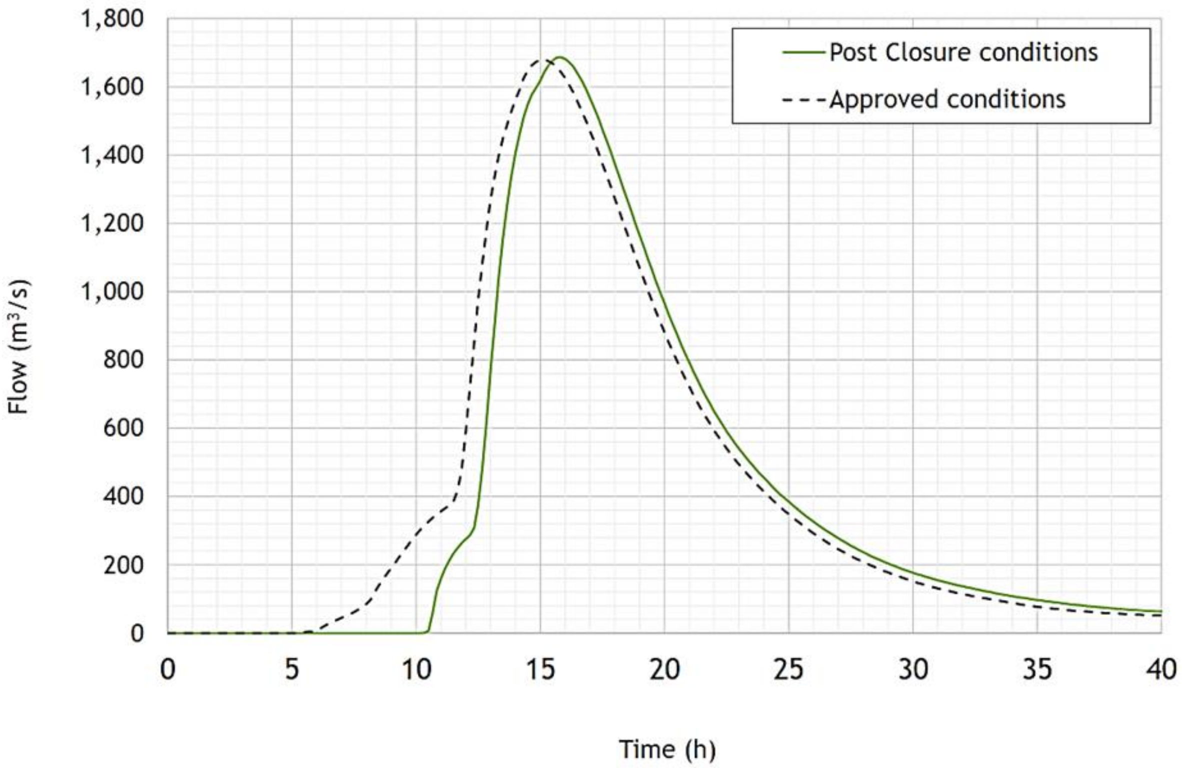

Figure 21.105: Change in downstream flood hydrograph - Boomerang/One Mile Creek 2% AEP

Subsidence-related impacts

One Mile Creek and Boomerang Creek will experience subsidence of the creek bed where the creeks traverse the northern longwall panels. The channel of Phillips Creek will not be affected by subsidence.

Boomerang Creek

Predicted subsidence will result in a series of six main troughs in the channel bed of Boomerang Creek, where there will be a decrease in channel velocity, bed shear and stream power, causing reductions in sediment transport capacity in each trough. This is expected to promote aggradation of the bed (relative to the top of the bank level) in these areas. Channel velocity, bed shear and stream power are greater across each of the pillars when compared to the mine subsidence troughs. However, this increase in-stream flow characteristics differs to the current conditions at four locations where the creek crosses the underlying pillar.

The bed sediments at the downstream side of the relative elevated sections (i.e. the point where the stream flows from the longwall panel into the troughs) are expected to scour, and the elevated section may erode to match the downstream bed profile. There may be marginal increases in bank erosion at these locations.

During initial flows, local incision and bank erosion can be expected over the pillars between troughs. However, given the abundant sediment supplies in Boomerang Creek, the sand bedload will infill the troughs such that the bed grade will revert over time to the pre-mining grade. The expected aggradation relative to the bank levels could accelerate the potential abandonment of the existing Boomerang Creek channel, given the number of remnant channels and abundant sediment supplies in the catchment, a new Boomerang Creek channel could form in the absence of the predicted subsidence.

The erosion and scouring of the watercourse could cause localised loss of in-stream habitat. This could have an impact on habitat availability for macroinvertebrate species and aquatic flora. However, as the erosion is predicted to be localised, it is not expected that this impact will extend off-lease. Nor will it impact habitat availability for other aquatic species, such as fish and turtles, given there is currently limited in-stream habitat for these species.

As there is plentiful sediment supply within Boomerang Creek and the turbidity of the water typically exceeds the water quality guidelines, it is not expected that the increased sediment load associated with the localised erosion and transport of bed sediments will impact water quality to the extent that aquatic ecology values are negatively impacted.

The post subsidence stream profile is conceptualised as following the existing stream course with areas of deeper stream bed located at subsidence troughs; with minimal changes to flow conditions compared to pre-mining conditions. During flow events, flows in the creek are predicted to be retarded by approximately three hours (as modelled downstream of the Boomerang Creek and One Mile Creek confluence for 50% AEP events) and flows are predicted to be reduced by about 0.3 m to 0.5 m flood depth and approximately 20% by volume (Figure 21.104). Impacts to flow in larger flow events are expected to be minimal.

The predicted minor delay in flow event timing, change to duration and changes to flow heights are considered consistent with the existing highly ephemeral streamflow conditions. The subsidence troughs in Boomerang Creek are predicted to rapidly infill during large streamflow conditions, due to abundant sediment present in the stream. The subsidence management plan will include measures for the monitoring of stream morphology and the application of bank protection measures where demonstrable impact on channel form is identified.

Given the existing ephemeral streamflow conditions, expected infilling of troughs, use of bank protection measures if required, and the predicted minor changes to flows, the changes to stream bed morphology are considered to not create a barrier to fish or turtles that may migrate along the watercourses. Project impacts are not expected to result in entrapment of aquatic fauna within stream pools beyond existing conditions.

One Mile Creek

The proposed subsidence will result in a series of eight main troughs in the channel bed due to the differential settlement caused by the unmined pillars resulting from the longwall panels (which are aligned approximately perpendicular to the channel).

The channel velocity, bed shear and stream power will decrease in sections where the channel flows over the subsided panels. This will cause a reduction in sediment transport capacity in each trough, promoting further aggradation of the bed (relative to the top of bank level) in these areas.

Channel velocity, bed shear and stream power are expected to increase at four locations where the watercourse drains from the underlying pillar sections into the lower subsided panel sections. Although velocities will remain below AEP guideline values, (‘Queensland Government Guideline: Works that interfere with water in a watercourse for a resource activity—watercourse diversions authorised under the Water Act)’, the relatively fine sediment in this area and the apparent limitation in sediment supply are expected to erode as the channel morphology changes to reflect the higher bed grade. This may also lead to an increase in bank erosion as the channel capacity increases.

If there is sufficient sediment supply, the post subsidence channel velocity, bed shear and stream power will revert to pre-mining conditions. However, as it appears sediment supply is limited, this may take many years, with the ponds formed likely to persist long-term (Appendix F, Surface Water Assessment, section 7.4.2).

The erosion and scouring of the watercourse could cause localised loss of in-stream habitat, which could have a localised impact on habitat availability for macroinvertebrate species and aquatic flora. However, as the erosion is predicted to be localised, it is not expected that this impact will extend off-lease. Nor will it impact habitat availability for other aquatic species, such as fish and turtles, given there is currently limited in-stream habitat for these species. Given that turbidity at sites on One Mile Creek (MA5 384 NTU (2020), MA12 (262.5 NTU (2020) and 574.66 NTU (2021)) have been recorded as well above WQO value (<50 NTU) under pre-mining conditions, it is unlikely that an increase in turbidity due to localised erosion will impact aquatic flora or fauna communities.

The post subsidence stream profile is conceptualised as following the existing stream course with areas of deeper stream bed located at subsidence troughs with minimal changes to flow conditions compared to pre-mining conditions. In flow events, flows in the creek are predicted to be retarded by approximately three hours as modelled at downstream of the Boomerang Creek and One Mile Creek confluence for 50% AEP events and are predicted to be reduced by about 0.3 m to 0.5 m flood depth and approximately 20% by volume. Impacts to flow in larger flow events are expected to be minimal. The predicted minor delay in flow event timing, change to flow duration and changes to flow heights are considered consistent with the existing highly ephemeral streamflow conditions. Given the existing ephemeral streamflow conditions and the predicted minor changes to flows, the changes to stream bed morphology are considered to not create a barrier to fish or turtles that may migrate along the watercourses. Project impacts are not expected to result in entrapment of aquatic fauna within stream pools beyond existing conditions.

Floodplain and flood impact mitigation measures

Subsidence of the landform due to longwall mining will create a series of depressions aligned with the underground mining panel array oriented in a north–south direction. How the local hydrological regimes will be affected by these depressions has been modelled as part of the hydrological assessment of the Project (Appendix W, Geomorphological Assessment Report, section 3.3.2), and the results are briefly summarised here.

To minimise the extent of ponding caused by the subsided landform, BBC is proposing to establish two drainage channels (mitigation drains) that will be cut through the pillars separating the subsidence troughs to allow free drainage of catchment runoff through the subsidence zone (refer Figure 21.103). Additionally, two small embankments (mitigation bunds) are proposed to be constructed across the subsidence panels to restrict the flow of water from Phillips Creek towards One Mile Creek, preventing ingress into subsided ponds within the floodplain (refer Figure 21.103). These mitigation drains and mitigation bunds will significantly reduce the extent of ponding due to subsidence; however, post-mitigation ponding will still occur. Pre- and post-mitigation ponding is illustrated in Figure 21.103 and the mitigation measures are detailed further in Section 21.2.3.

Subsidence of panels along One Mile Creek will result in surface water flowing laterally into the subsidence areas. Following flood events (50% AEP), water is expected to persist for several months post-filling. with the maximum modelled ponding extent shown in Figure 21.103. However ponding is expected to typically be of smaller extent and duration and pumping of the major ponding areas may be undertaken when depths exceed 0.5m at the deepest point (refer Appendix W, Geomorphological Assessment). The creation of these stream-connected ponds has the potential to create additional aquatic habitat locally, as water is constrained within them rather than passing downstream. Persistence of water in the local landscape for an extended period potentially creates additional habitat for macroinvertebrate assemblages and other aquatic fauna. The sustained inundation of these areas (up to 1 m in depth) may provide seasonal refugial habitat for aquatic fauna between flow events and at times across the dry season. Impacts on vegetation through the establishment of these ponds is discussed in the terrestrial ecology assessment, 21.12.

Changes to flood regimes

Ripstone Creek, One Mile Creek and Boomerang Creek all have relatively shallow channels that experience regular flow breakouts, even in relatively frequent floods. Through much of the Project area, the catchment boundary of One Mile Creek extends to a natural levee along the southern bank of Boomerang Creek. Minor indistinct floodplain flow paths direct runoff from the catchment boundary south-east across the proposed mining area towards One Mile Creek.

The Project is predicted to have three main components that will influence changes to local flooding regimes (depth and velocity), namely:

1) construction of flood protection levees around the open-cut pit and MIA;
2) construction of the haul road; and
3) subsidence caused by underground mining.

The Flood Impact Assessment of the scenarios modelled for the Project are discussed in Section 21.10.7. Expected changes to flood depths indicates that:

- Underground mine subsidence will locally reduce flood levels but increase the depth and extent of flooding.
- Subsidence will increase floodplain storage, which has the effect of reducing downstream flood flows, levels and extents for 50% and 10% AEP flood events on Phillips Creek, One Mile Creek and Boomerang Creek of between 50 and 100 mm.
- For the 10% AEP event over the subsidence panels on the Phillips Creek floodplain downstream of the open-cut mine, reductions in flood level are up to two metres in some areas. In larger events, reductions in level are smaller and within the range of 700 mm to 850 mm.
- For the subsidence areas on One Mile Creek, reductions in level range will be from one metre to 700 mm.
- Along Boomerang Creek, some flood levels have reduced by as much as three metres in the 10% AEP event to 2.5 metres in the PMF in the most affected locations.
- Afflux downstream of the mine lease area is negative for all events, ranging from a 600 mm reduction at the Isaac River in the 50% AEP to 300 mm in the 10% AEP. Reductions in the floodplain of the Isaac River in the larger events from the 2% AEP to the PMF range from 60 to 100 mm.
- In the 0.1% AEP and PMF events, there is also some positive afflux in the vicinity of the confluence of the Boomerang and Isaac Rivers of approximately 30 mm to 50 mm.
- In the 1% AEP event for regional flooding conditions, off-lease impacts are limited to the Phillips Creek northern floodplain, with reductions of up to 100 mm just to the south of the Satellite pit and small increases of 30 mm to the western side of the Satellite pit.
- In the 0.1% AEP flood event, reductions downstream in the Phillips Creek northern tributary are approximately 150 mm.

The flood protection levee around the MIA will increase flood depth around the southern and eastern section, with some of the change in flood depth being attributed to the embankment created by the establishment of the haul road. There will also be a small area over which flood depth increases at the northern extent of this flood protection levee. These changes to flooding depths will be temporary, with levee structures to be removed as part of mine closure.

Despite some increase in flood depth, flood flow velocities are only predicted to be marginally higher than currently experienced along the eastern section of the flood protection levee. Further to this:

- There are no significant changes in velocity expected downstream of the mine lease area in design flood events.
- Across the range of events, the subsidence panels will typically experience velocity reductions of up to 0.5 m/s and velocity increases between the panels of up to 0.7 m/s (with some areas experiencing increases up to 1.2 m/s).
- The Phillips Creek floodplain near the south-eastern corner of the open-cut mine is predicted to experience the greatest velocity increases. Modelled point velocity increases range from 0.8 m/s in the 10% AEP event to approximately 1.3 m/s in the 2% and 1% AEP events, and up to 1.5 m/s in the 0.1% AEP event. These velocity increases will be temporary until the operational pit protection levee has been decommissioned.
- In the 2% and 1% AEP events, increases of 0.2 m/s will occur upstream of the haul road in the channel of Phillips Creek and increases of 0.1 to 0.2 m/s along the haul road on the Phillips Creek northern floodplain.
- Minimal upstream velocity impacts are predicted for the 50% and 10% AEP floods. Minimal increases in velocity are predicted in the 0.1% AEP event.

The increase in flood velocities close to the open-cut levee could cause erosion and sediment transport into the surrounding aquatic environments. It is unlikely the increase in flood velocities and depths associated with the MIA flood protection levee will cause any significant increase in erosion and sediment transport. Both of the proposed levees are designed to ensure they can withstand the predicted velocities during operations and will be removed on decommissioning, at which time the flood velocities will return to pre-mining conditions (Appendix Z, Flood Modelling Impact Assessment, section 3.3.3).

The construction of the haul road will cause changes in the flood regime on the floodplains of Phillips Creek and One Mile Creek. As previously acknowledged, stream crossings will be constructed as causeways, with appropriately-sized culverts to allow low flows; however, they will be inundated for approximately 19 hours per annum (Appendix Z, Flooding Assessment Report, Section 3.3.4). In low flows, when the proposed causeways are not inundated, the afflux created by the haul road will be sufficient to extend off the mine lease area. In the 50% AEP design event, the afflux will be confined to areas within the channel, with a maximum of 60 mm at the lease boundary. Velocities associated with the changed flood patterns due to the establishment of the haul road will be minimal and not expected to cause significant erosion or scouring, provided cross-drainage structures are appropriately designed.

The effect of the change of flood regimes on aquatic ecology values is not anticipated to be significant, given the adaptation of the aquatic flora and fauna to the relatively harsh environmental conditions, which are currently experienced within the study area. Afflux impacts (resultant of the Phillips Creek haul road crossing) are predicted to cause minor increases in upstream flow velocities, however these changes are not expected to impact fish passage. Specifically, in the 2% and 1% AEP events, increases of 0.2 m/s would occur upstream of the haul road in the channel of Phillips Creek and increases of 0.1 to 0.2 m/s would occur along the haul road on the Phillips Creek northern floodplain (Appendix Z, Flood Modelling Impact Assessment, Section 3.3.3). Further, despite the change in the flood regime, the wetland areas within the study area are all still expected to receive water from flood events.

Groundwater drawdown

The aquatic habitats associated with Boomerang Creek, Phillips Creek and the Isaac River, along with the GES wetland and HES wetlands within the study area, may comprise aquatic GDEs. As watercourses and wetlands are ephemeral, any groundwater dependence of the aquatic environments will be for short periods of the year, and given the ephemerality of the aquatic environments, the aquatic species that inhabit them are adapted to wetting and drying cycles.

The groundwater model and groundwater impact assessment (Appendix E, Groundwater Impact Assessment section 3.2 and Appendix V, Groundwater Modelling and Technical Report, section 8.1) have concluded that the only location where the alluvium is permanently saturated is the Isaac River alluvium and that this is consistent with available data from landowner groundwater bores. The modelled drawdown of the alluvium sediments does not extend to the Isaac River; drawdown in the alluvium is confined to a relatively small area along Boomerang Creek, which the groundwater model predicted will contain some water (Appendix V, Groundwater Modelling and Technical Assessment, section 4.4).

Although the alluvium is dry for much of the year, the groundwater impact assessment concluded that the groundwater drawdown contours assigned to the Tertiary sediments can be used to indicate the zone within which any water that does occur within the alluvium will have an enhanced potential for downward seepage. The Tertiary sediment drawdown contours do not extend to the Isaac River; thus, any dependence aquatic ecosystems have on groundwater will not be impacted by the Project.

The HES wetland to the east of the Project area, but within the aquatic ecology study area, has been determined to be partially groundwater dependent (Appendix I, Groundwater Dependent Ecosystem Assessment, section 6.2.5). However, the conceptualisation of this potential GDE noted that it was likely to be a perched alluvial groundwater aquifer more than six metres below the base of the HES wetland but separated from the underlying Tertiary sediments and groundwater environment. This perched aquifer may provide seasonally accessible water to the riparian vegetation of the HES wetland, which will contribute to the aquatic environment of the HES wetland by providing shade and habitat structure. The perched alluvial system is conceptualised as dry for extended periods of the year (including extended drought periods), and as such, the terrestrial vegetation that may seasonally rely on the alluvial groundwater in the perched system will be adapted to long, dry periods. The groundwater modelling conducted for the Project has predicted drawdown will not interact with this HES wetland, and the surface water flows, which recharge the alluvial groundwater lens and provide a water source for terrestrial vegetation at the HES, will not be affected. As such, it is not predicted that there will be impacts on the aquatic environment at this HES wetland as a result of the Project.

The Tertiary sediment groundwater drawdown contours do extend under Phillips Creek, which is mapped as a high potential aquatic GDE. The Tertiary groundwater system drawdown impact to GDEs located on Phillips Creek is predicted to be insignificant because the groundwater system is discontinuous along the length of the watercourse, the riparian trees have capacity to use moisture from multiple sources and the groundwater system is recharged by surface flows and flooding, which provides the dominant driver to support riparian ecological function. In addition, the alluvium under Phillips Creek is unsaturated for most of the year (apart from small pockets that may occur in the alluvium following recharge by rainfall or stream flow), and the creek is ephemeral, indicating aquatic species and communities are not reliant groundwater. Further, as the Tertiary groundwater quality is poor (high salinity) it is considered unsuitable for aquatic ecosystem support; therefore, it is unlikely to be supporting the aquatic environments within the study area.

The assessment of potential impacts on stygofauna is presented in Appendix J, Stygofauna Assessment (section 5). The assessment has determined that depauperate, sporadic and highly localised stygofauna populations of low ecological value are present in the alluvial areas of the study area.

The assessment has determined that the impacts on stygofauna in the Project area is low and suggested ongoing monitoring of groundwater levels and quality to monitor potential changes to the stygofauna community.

It is considered unlikely, therefore, that groundwater drawdown associated within the Project will impact on aquatic ecology values.

Water quality impacts

Erosion and sedimentation

Excavation within a watercourse (such as for the development of a road crossing) can have impacts on aquatic ecosystems downstream. Similarly, changes in flow velocities within streams or the creation of flood protection structures against which flood water flows can increase erosion and increase sediment load within water.

Construction of the watercourse crossings will be undertaken in the dry season, thus minimising the release of sediment into the receiving waters.

The flood protection structures levee will be designed to ensure it could withstand the predicted velocities during operations.

Increases in sediment loads within aquatic environments will increase turbidity and change water conditions. This change in water conditions can affect aquatic organisms (e.g. make it more difficult for aquatic fauna to locate and capture prey items and/or decrease light penetration), which will impact aquatic flora. Pollutants and nutrients, which may have been trapped in the sediment, can also be transported with the sediment and cause contamination or eutrophication of waterways.

However, the watercourses within the study area experience high levels of sediment transport and deposition during the wet season. Watercourses are typically highly turbid, to which the aquatic organisms of the study area are adapted. The erosion and sediment impacts associated with the Project are not expected to significantly impact the aquatic ecological values on a regional scale.

Water releases

There are no releases of mine affected water proposed as part of the Project.

Runoff from the open-cut waste rock dumps will be managed under an Erosion and Sediment Control Plan, which is to be implemented throughout the Project, such that sediment generated and transported by runoff will be settled in a sediment dam. During open-cut mining operations, catchment runoff from overburden dumps will be captured in three sediment dams; being the:

- Southern Sediment Dam;
- Northern Sediment Dam 1; and
- Northern Sediment Dam 2.

Sediment dams will be constructed to contain a 1 in 10-year ARI 24-hour event and will be operated in accordance with the' DES Guideline: Stormwater and environmentally relevant activities' (DES 2021). Sediment dam catchment areas and proposed storage capacities are provided Section 21.9.7.1.

As overburden runoff quality is expected to be relatively benign (Appendix D, Geochemical Assessment, section 4.6), sediment dams have been designed to discharge to the receiving environment (after the settlement of suspended sediment), with minimal impact on downstream water quality anticipated. Significant dilution capacity from flows in the receiving waters during overtopping events will likely result in indiscernible impacts on the receiving environment.

Drainage and seepage

The Geochemical Assessment of Mining Waste Materials Project (Appendix D, Geochemical Assessment, section 6) indicates waste rock at the Meadowbrook Project will have:

- low sulphur content, excess acid neutralising capacity, negligible risk of acid generation and a high factor of safety with respect to potential for the generation of acidity;
- no significant metal/metalloid enrichment compared to median crustal abundance in unmineralised soils;
- slightly alkaline to alkaline surface runoff and seepage with relatively low salinity; and
- low dissolved metal/metalloid concentrations in surface runoff and leachate.

The water extract solutions were generally dominated by ions of sodium, chloride and sulphate, with lesser concentrations of other major ions.

Runoff from the open-cut waste rock dumps will be managed under the existing Sediment and Erosion Control Plan in place at Lake Vermont Mine, which is to be updated to cover Project infrastructure.

The water balance model developed to assess the behaviour of the final rehabilitated pit landform under various climate scenarios is discussed in ⍰. Partial backfilling of the Project open-cut pit will also be undertaken to ensure the rehabilitated pit landform does not present as a lake post-closure. It is likely that the final rehabilitated pit landform will be subject to intermittent periods of ponding but is not expected to be a permanent water body. The final land use of the rehabilitated pit landform is discussed in Chapter 6, Rehabilitation.

Following final rehabilitation, water will seep from the rehabilitated pit landform to the rising groundwater table, minimising the accumulation of salts within any intermittent ponding in the final landform. The equilibrium groundwater flow potential will be towards the final landform at very shallow gradients. Once the groundwater reaches an equilibrium level, seepage from the final landform depression will result in the mounding of groundwater below the landform, with the groundwater flow potential going away from the depression.

Catchment runoff is likely to provide a diminishing source of dissolved salts. The salinity of any water intermittently ponding within the final rehabilitated pit landform will fluctuate significantly and increase over time. Under high and low seepage rate scenarios, the median TDS of the stored water ranges between 270 mg/L and 465 mg/L (Appendix X, Rehabilitated Landform Water Balance Report, section 4.2). The maximum TDS values of this intermittent water body are expected to remain well below the 'low risk' trigger value (4,000 mg/L) of the applied livestock drinking water quality guideline (ANZECC & ARMCANZ 2000).

Litter waste and spills

If litter and waste from construction and operations was to enter aquatic ecosystems, it could potentially entangle aquatic fauna and contribute to the degradation of water and sediment quality. A Waste Management Plan is in place for the Lake Vermont Project, which will be updated to capture the activities of the Project, the risk of litter and waste entering aquatic ecosystems and subsequent impact on aquatic ecology values is very low.

The existing Lake Vermont Waste Management Plan currently outlines:

- waste management principles;
- general, regulated and trackable wastes;
    - site conditions and use of adjacent areas;
    - design of equipment and infrastructure to minimise fire occurrence;
    - separation of potential hazards; and
    - spill control measures.
- waste identified on the project site;
- waste management strategy;
- waste minimisation;
- waste reuse and recycling;
- waste treatment;
- waste disposal; and
- waste streams

The existing Lake Vermont Mine Waste Management Plan will be updated to address all mineral waste management commitments of the Project.

The updated Mine Waste Management Plan will address:

- the geology of the Project area;
- characterisation of mineral waste;
- the monitoring program;
- management strategies;
- emergency and contingency planning;

- review of the management plan:
- with specific detail on the following:
  - containment of tailings;
  - management of seepage and leachates during operations and the foreseeable future;
  - controlling fugitive emissions to air;
  - programming progressive sampling and characterisation to identify acid producing potential and metal concentrations of tailings;
  - maintaining records of the relative locations of any other waste stored within the tailings;
  - rehabilitation strategies; and
  - monitoring of rehabilitation, research and/or trials to verify the requirements and methods for decommissioning and final rehabilitation of tailings, including the prevention and management of acid mine drainage, erosion minimisation and establishment of vegetation cover.

The existing Lake Vermont Mine Waste Management Plan will be updated to include non-mineral waste management commitments.

The updated Waste Management Plan will address:

- management practices that will be utilised to store, handle and dispose of waste on-site;
- measures to simplify the categorisation of waste into general waste, various recyclable wastes and regulated waste;
- designation of general waste collection bins, including bin labelling and emptying schedules;
- storage measures for waste oils, chemicals, batteries and other hazardous and/or regulated substances;
- management measures to reduce the incidence of water supply contamination;
- reduce the incidence and spread of pests from waste streams;
- measures for allocating recyclable waste into separate recyclable streams, including paper and cardboard, metals and recyclable plastics;
- measures for used tyre storage and disposal to be in accordance with the operational policy 'Disposal and storage of scrap tyres at mine sites' (DES, 2014), including the recording of potential on-site tyre disposal locations;
- storage measures for all waste types (e.g. metals, paper, oils, batteries, general waste, etc.) in accordance with:
  - public health, hygiene and safety standards;
  - flammable liquid storage standards (AS 1940:2017, 'The storage and handling of flammable and combustible liquids');
- measures for storage of regulated and/or hazardous waste to ensure that the potential for environmental harm is minimised;
- waste tracking procedures as defined by Schedule 11 of the EP Regulation in accordance with the requirements of Part 9 of the EP Regulation; and
- criterion for waste management performance success and review periods.

Provided the appropriate management of chemicals is maintained, the Project is unlikely to result in leaks or spills that will result in environmental harm. Appropriate storage of chemicals and hydrocarbons will be required as part of ongoing operations, as well as a dedicated fuel and lube facility, which will be constructed to provide adequate containment and spill response programs. An existing 'Chemical and Fuel Management Plan' is in place for the existing Lake Vermont Mine, which will be updated to capture the activities of the Project. As such, the risk of stored chemicals entering aquatic ecosystems and impacting on aquatic ecology values is considered very low.

21.13.3.3 Cumulative impacts

The cumulative impacts to water resources have been assessed based on the predicted impacts of the Project, along with the existing or approved impacts of other activities in the region (Figure 21.3). Cumulative impacts have considered cumulative changes in hydrological characteristics and quality of surface water and groundwater. The cumulative impact assessments include all current and known future coal mining operations, as well as the operation of the Arrow Energy CSG borefield.

The cumulative impact assessment conducted as part of the groundwater impact assessment has concluded that there will be no cumulative drawdown in the alluvium.

Drawdown in the Tertiary sediments from Olive Downs South and Eagle Downs extends southward to coalesce with the drawdown from the Meadowbrook operation, resulting in an additional 2 m to 10 m of drawdown beneath Boomerang Creek and an additional 2 m to 15 m of drawdown beneath Ripstone Creek.

In terms of cumulative impacts from surrounding projects on regional flooding, the assessment (Appendix Z, Flood Modelling Assessment Report, section 4) has noted the Willunga and Olive Downs South domains of the proposed Olive Downs Project, which extend onto the Isaac River floodplain downstream and upstream of the Meadowbrook Project, may have interacting flood impacts.

Both the end of life (2051) conditions of the Project (with mitigation measures and other projects) and the post-closure conditions of the Project (with other projects) have been modelled in the cumulative impact assessment, with the maximum disturbance of all projects modelled to occur simultaneously (conservative assessment). The cumulative impact modelling has been undertaken for the 1 in 1,000 (0.1%) AEP regional flood event.

The cumulative flood impact outside the Project area is dominated by the relatively large disturbance impacts on the Isaac River floodplains approved for other projects. The impacts of the Meadowbrook Project on areas outside the Project are minor, and there are minimal links to impacts from other projects.

Although there will be some direct disturbance to aquatic habitat values within the Project area, the direct disturbance will be to a small area of regional aquatic habitat compared to other approved projects in the region.

21.13.3.4 Facilitated impacts

Facilitated impacts relate to impacts from other projects (including third parties), which are made possible (facilitated) by the Project being assessed (this Project). Facilitated impacts may be expected to occur through the development of infrastructure (e.g. a dam, road or rail line), when that development will 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 the development of any other projects. Mining operations will not facilitate the development of any other projects that could not already be developed. Proposed electrical, water supply and telecommunications infrastructure will link to existing infrastructure at the Lake Vermont Mine and will not facilitate the development of other future projects.

Post-mining, it is expected that, where possible, the Project area will be reinstated to grazing land similar to that which existed prior to mining. Where this cannot be achieved, an alternative use that will provide a comparable value to that of pre-mining will be established to provide long-term ecological value to the region.

It is not considered that the return of lands to an agricultural land use or alternative use that provides similar value will facilitate the development of projects which will 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 aquatic ecology values.

21.13.4 Significant impact assessment, mitigation, management and monitoring

No aquatic flora or fauna are recorded as MNES within, or considered likely to occur within, the study area. Neither the Fitzroy River Turtle nor the Southern Snapping Turtle are expected to occur within the Project area based on results of surveys and habitat assessments. However, an assessment of the potential impacts on the Fitzroy River Turtle and the Southern Snapping Turtle, in accordance with the required impact assessment hierarchy for MNES, is provided in Sections 0 and 21.13.4.2 respectively.

21.13.4.1 Fitzroy River Turtle

Description

The Fitzroy River Turtle (*Rheodytes leukops*) 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 2021). 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 2021). The Fitzroy River Turtle has relatively long forelimbs with five long claws and large cloacal bursae, which has a respiratory function (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 2008a).

The Fitzroy River Turtle is only found in the drainage system of the Fitzroy River, Queensland. It is estimated that this species occurs in a total area of less than 10 000 km² (DoE 2021). Known sites include Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralaba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek and Gogango (DoE 2021). The species is largely sedentary with relatively small home ranges, and its movements have been shown to be restricted between riffle zones and adjacent pools, although large scale movements for dispersal, courtship, nesting migrations and repositioning following flood displacement may occur (Tucker *et al.* 2001).

The Fitzroy River Turtle is found in rivers with large, deep pools with rocky, gravelly or sandy substrates connected by shallow riffles. Preferred areas have high water clarity and are often associated with Ribbonweed (*Vallisneria sp*.) beds (Cogger *et al.* 1993). Common riparian vegetation associated with the Fitzroy River Turtle includes Blue Gums (*Eucalyptus tereticornis*), River Oaks (*Casuarina cunninghamiana*), Weeping Bottlebrushes (*Callistemon viminalis*) and Paperbarks (*Melaleuca linariifolia*) (Tucker *et al.* 2001).

Preferred in-stream habitat for the species is clear, fast flowing watercourses that have:

- rocky, gravelly or sandy substrates;
- large, deep pools (between 1 m 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; and
- in-stream vegetation, in particular Ribbonweed (*Vallisneria sp*.), which is a preferred food source and provides favourable foraging habitat for macroinvertebrates (Cogger *et al.* 1993; Tucker *et al.* 2001; DoE 2020).

The Fitzroy River Turtle is thought to prefer well-oxygenated riffle zones and moves into deeper pools as the riffle zones cease to flow (Tucker *et al.* 2001). However, studies have captured several turtles from deep pools (Gordos *et al.* 2007) where they may associate with surface or sub-surface logs (Tucker *et al.* 2001).

Nesting habitat is restricted to areas with alluvial sand/loam banks 1 m–4 m above water level; however, nesting sites have been found 15 m from the water on flat sandbanks (DEWHA 2008a). Preferred banks include that which have a relatively steep slope, low density of ground/understorey vegetation and partial shade cover. Females have an annual reproductive potential of 46 to 59 eggs laid within three clutches, which are deposited in nesting chambers 170 mm deep (DEWHA 2008a). Nesting occurs from September to November, with hatching occurring between November and March (DoE 2021).

Desktop analysis

There are no records of the Fitzroy River Turtle close to the study area or from the Isaac River. A record of the closest known sightings has been published in the Queensland Wildnet and Atlas of Living Australia, as shown in Figure 21.106. There are no records from the Isaac River sub-catchment and only three records from the

Connors River sub-catchment of the Fitzroy River Basin. Any other records are located a considerable distance downstream (i.e. greater than 100 km) and, as such, will not be impacted by the Project.

None of the other studies conducted for surrounding projects recorded the species as part of survey program. Of note, the aquatic ecology study completed for the Olive Downs Project, which included assessment sites on Risptone Creek and the Isaac River (downstream of the Meadowbrook aquatic study area), did not record the species or habitat for the species as part of the assessment.

Survey effort

Survey effort for the Fitzroy River Turtle included survey of 16 sites between 2020 and 2021 and the survey effort is detailed in Appendix H, Aquatic Ecology Assessment (section 10.1.1.3). The Fitzroy River Turtle can be difficult to survey, as they rarely enter traps. However, the highly turbid waters and ephemeral nature of the watercourses of the study area prevented the use of snorkelling (preferred survey technique). As such, a combination of trapping and habitat assessment have been relied on for the survey of the species.

Survey outcomes

No Fitzroy River Turtles were recorded in the surveys.

Habitat assessment

There is no suitable habitat for the Fitzroy River Turtle within the study area. The habitat within the study area is characterised by ephemeral watercourses that flow for relatively short periods following the cessation of considerable rainfall in the catchment. The preferred habitat of the species (rivers with large, deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles with high water clarity) is not found in the study area, and the ephemeral nature, high turbidity and sandy to fine sediment substrate do not constitute habitat for the species. The Isaac River is the largest watercourse within the study area; however, the ephemeral characteristics of the river do not support year-round habitat for the species. The Project area will not directly disturb any potential habitat for the species.

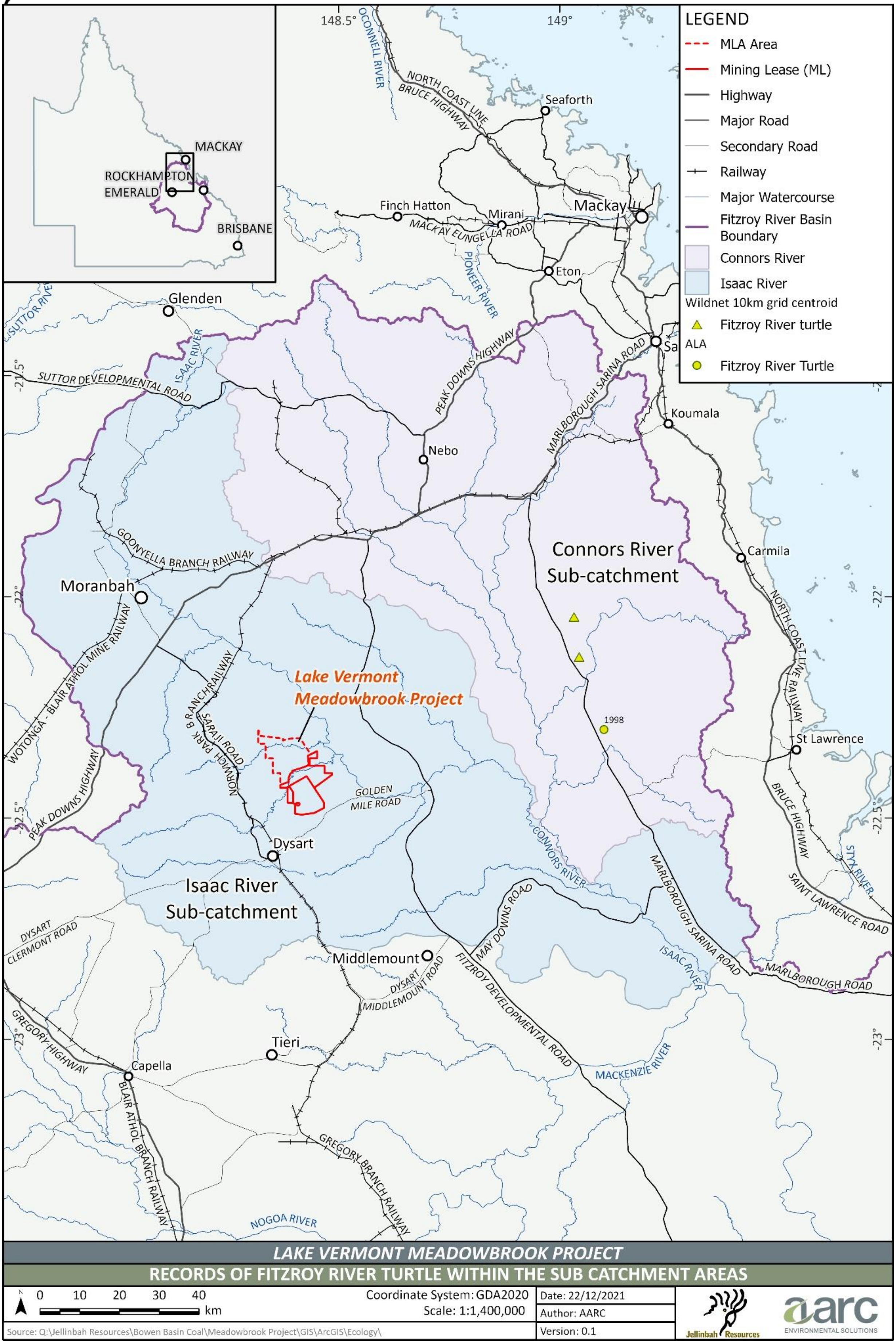

Figure 21.106: Map showing records of Fitzroy River Turtle within the Fitzroy River Basin

Direct impacts

There is no potential habitat for the Fitzroy River Turtle within the study area; thus, there will not be any direct impacts to the species from the Project.

Indirect impacts

The species could be indirectly impacted by changes in watercourse profiles through subsidence (which could change the availability of pool and riffle habitat) or changes in watercourse flow timings or volumes. The subsidence profile from underground mining does not extend to areas that are considered suitable habitat for the Fitzroy River Turtle. The surface water modelling and flood modelling (Appendix Z, Flood modelling assessment report, section 3.3.4) has demonstrated there will not be significant changes to regional flooding or volume or timing of flows on a regional scale. The modelled changes in flooding and surface water flows do not extend to the Isaac River; thus, they do not extend to the likely nearest population of the species. Potential soil erosion and cracking impacts are assessed, and management measures described in Section 21.12.3.6. Given the management measures and that no cracking or erosion is expected to extend to the Isaac River, no impacts to the Fitzroy River Turtle habitat is expected to occur. Surface water flow conditions are not expected to be impacted by groundwater drawdown (Section 21.11.4), and therefore it is considered unlikely that groundwater drawdown or depressurisation will impact the Fitzroy River Turtle habitat.

Given that any habitat for the Fitzroy River Turtle is only likely to be found a significant distance downstream of the Isaac River, any minor changes in water quality due to the Project are unlikely to impact habitat for the species.

The Project is not expected to result in the introduction of any new aquatic pest species to the watercourses that support habitat for the Fitzroy River Turtle. Therefore no indirect impacts on the habitat of the Fitzroy River Turtle is expected. Likewise, it is unlikely there will be any indirect impacts on individuals or habitat of the Fitzroy River Turtle.

Facilitated impacts

The Project will not result in any other actions that have the potential to impact on the Fitzroy River Turtle or their habitats. As such, no facilitated impacts to the Fitzroy River Turtle are predicted.

Cumulative impacts

The Project will not result in any impacts on the Fitzroy River Turtle and is not expected to contribute to any cumulative impacts on the species.

Avoidance, mitigation and management measures

There is no potential habitat for the Fitzroy River Turtle within the study area; thus, direct impacts to the species will be avoided. Given that there is no habitat for the species that is likely to be indirectly impacted, no species-specific management measures are proposed. However, general management measures will be implemented to minimise disturbance to aquatic habitats and minimise changes to water quality, namely by:

- designing watercourse crossings to consider fish passage.
- designing flood levees to withstand increase in flood velocities.
- limiting direct impact on the identified disturbance area.
- locating areas of disturbance outside watercourses and wetlands where possible; and
- developing environmental management plans, including:
  - Erosion and Sediment Control Plan;
  - Water Management Plan;
  - Chemical and Fuel Management Plan; and

- Waste Management Plan

- The significance of the impacts from the Project on the Fitzroy River Turtle (after the avoidance, mitigation and management measures have been implemented) has been assessed against the significant impact criteria for vulnerable species (DoE 2013) in Table 21.77.

Significant impact assessment

Table 21.77: Significant impact assessment for the Fitzroy River Turtle

Significant impact criteria (DoE 2013)	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 study area or downstream of the study area. • It is not expected that the Project will result in mortality of the species or impact on breeding success or movement of the species. • The Project will not cause any impacts on water quality or hydrological flows in an area where the species is known to occur.
Reduce the area of occupancy of an important population	• An important population of the Fitzroy River Turtle has not been identified within the water bodies of the study area. • Studies completed in areas near the Project have failed to detect the species within water upstream or downstream of the Meadowbrook Project. • The hydrological regime of the Isaac River will not be impacted by the Project.
Fragment an existing important population into two or more populations	• An important population of the Fitzroy River Turtle has not been identified within the study area or detected upstream or for a significant distance downstream of the study area. • The Project is not expected to have any direct or indirect impact on the habitat used by the species that will result in the fragmentation of an existing population.
Adversely affect habitat critical to the survival of the species	• The waters within the study area do not provide habitat critical to the survival of the Fitzroy River Turtle.
Disrupt the breeding cycle of an important population	• The waters within the study area do not provide a suitable breeding habitat for the Fitzroy River Turtle.
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 adversely impact the habitat of the Fitzroy River Turtle and, thus, will not cause the species to decline.
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 construction and operation of the Project is not expected to introduce diseases that may cause the Fitzroy River Turtle 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 the species or its habitat.

21.13.4.2 Southern Snapping Turtle

The Southern Snapping Turtle is listed as critically endangered under the EPBC Act.

Description

The Southern Snapping Turtle (*Elseya albagula*) is one of the largest short-necked freshwater turtles in Australia, with females (which are larger than males) reaching up to 42 cm in length (DES 2017a). Adults of the species are heavily built, and females have white markings on their face and neck (Limpus *et al.* 2011).

The White-throated Snapping Turtle is a habitat specialist and has a small home range but is thought to migrate kilometres along rivers to regular nesting sites (Limpus *et al.* 2011). It is only found in the Fitzroy, Mary and Burnett Rivers and associated smaller drainages. The species only inhabits permanent flowing streams and does not occur within farm dams, ephemeral swamplands or brackish waters (Hamann *et al.* 2007). Within the Fitzroy catchment, this species occurs throughout the permanent freshwater reaches from the Fitzroy Barrage to the uppermost spring fed pool in the McKenzie and Dawson sub-catchments. It may also occur in permanent water impoundments (Limpus *et al.* 2011).

The species prefer permanent, clear, well-oxygenated water that is flowing and contains in-stream habitat features and shelter, such as large, woody debris and undercut banks (Todd *et al.* 2013). During the day, the species inhabit areas of high shade (i.e. submerged logs, overhanging riparian vegetation), and at night, they inhabit shallow riffles. The species' preferred habitat has:

- sandy gravel substrates;
- large deep pools (between 1 m and 10 m deep), which provide refuge areas and are associated with glides;
- runs or riffle zones, which provide favourable foraging habitat;
- in-stream features, such as undercut banks, submerged boulders, tree roots and logs, which provide rest and refuge spots;
- in-stream vegetation, which provides a food source and favourable foraging habitat; and
- healthy riparian vegetation. (Limpus *et al.* 2011).

Within the permanent water bodies, the Southern Snapping Turtle is typically found in deep pools (>6 m) bordering a riffle zone (Gordos *et al.* 2007; Hamann et al. 2007). During the dry season, the White-throated Snapping Turtle is found in remnant pools with slow flowing water.

Suitable turtle and nesting habitat preferred by these species include:

- general habitat features, such as:
  - clear, flowing and well-oxygenated water with riffle zones and deep pools;
  - sandy gravel substrate;
  - a diversity of in-stream features, which provide shelter and refuge (e.g. submerged aquatic vegetation, submerged rock crevices, undercut banks and/or submerged logs and fallen trees); and
- nesting habitat features, including sandy or loam banks (Limpus et al. 2011).

Threats

The species is estimated to have lost more than 70% of its hatchling production and more than 70% of juveniles and sub-adults in the last 20 years (Limpus et al. 2011). This loss of juveniles can be attributed to loss of eggs and nests through trampling (particularly by cattle) and failure to recruit immature age classes. Additionally, direct impacts associated with the construction of barrages, dams and weirs have led to a decline in the population across its range (DAWE 2020).

Current threats to the species are outlined in the adopted recovery plan (DAWE 2020) and include:

- predation and trampling at nest sites;
- installation of in-stream barriers, which obstruct movement;
- degradation of habitat and water quality;
- climate change from increased temperatures and changed rainfall patterns; and
- fishing and boating activities.

Desktop analysis

There have been no sightings of the Southern Snapping Turtle close to the aquatic ecology study area or within the Isaac River Catchment. A single sighting has been recorded near the Connors River, as published in the Queensland Wildnet and the Atlas of Living Australia, with an additional recorded sighting near the Mackenzie River, well downstream of the Project. Neither location where the species has been recorded will be impacted by the Project.

None of the other studies conducted in surrounding projects have recorded the species as part of survey program. Of note, the aquatic ecology study completed for the Olive Downs Project, which included assessment sites on Risptone Creek and the Isaac River (downstream of the Meadowbrook aquatic study area), did not record the species or its habitat.

The absence of records from within and around the study area are reflective of the lack of habitat for the species (i.e. permanent flowing water). It is considered likely that the nearest population of the species is at or near the confluence of the Isaac River and Connors River approximately 60 km downstream of the Project footprint and well outside the area of any expected change in surface water flows or water quality due to the Project.

Survey effort

Survey effort for the Southern Snapping Turtle included survey of 16 sites between 2020 and 2021 and the survey effort is detailed in Appendix H, Aquatic Ecology Assessment (section 10.1.2.4). The Southern Snapping Turtle can be difficult to survey as they rarely enter traps. The preferred survey technique is to observe them underwater using snorkelling equipment. However, the highly turbid waters and ephemeral nature of the watercourses of the study area prevented this survey technique from being used. As such, a combination of trapping and habitat assessment have been relied on for the survey of the species.

Survey outcomes

No Southern Snapping Turtles have been recorded in the surveys.

Habitat assessment

There is no suitable habitat for the Southern Snapping Turtle within the study area.

The habitat within the study area is characterised by ephemeral watercourses, which flow for relatively short periods following the cessation of considerable rainfall in the catchment. These ephemeral watercourses are considered unsuitable habitat for the Southern Snapping Turtle. The remnant pools retained in Phillips Creek, One Mile Creek and Boomerang Creek following flow events are comparable to the small non-flowing waterbodies in which the species is unlikely to be found.

The Isaac River is the largest watercourse within the study area; however, this watercourse is still ephemeral and does not constitute preferential habitat for the species.

Direct impacts

There is no potential habitat for the Fitzroy River Turtle within the study area, and thus there will not be any direct impacts to the species from the Project.

Indirect impacts

The species could be indirectly impacted through changes in watercourse profile through subsidence which change that availability of pool and riffle habitat for the species or through changes in watercourse flow timings or volume.

The subsidence profile from underground mining does not extend to areas that are considered suitable habitat for the species. The surface water modelling and flood modelling (Appendix Z, Flood Modelling Assessment Report, section 3.2.2) demonstrated there will not be significant changes to regional flooding, or volume, or timing of flows on a regional scale. The modelled changes in flooding and surface water flows do not extend to the Isaac River, and thus do not extend to the likely nearest population of the species. Potential soil erosion and cracking impacts are assessed (and management measures proposed) in Section 21.12.3.6. Given management measures proposed, no substantial erosion or soil cracking is expected within the Project area and no resulting impacts to Southern Snapping Turtle habitat is expected to occur. Groundwater drawdown is not predicted to impact surface water flows (21.11.4) and therefore it is considered unlikely to impact Southern Snapping Turtle habitat.

Potential impacts to water quality through either sediment chemical release are expected to be minor. Given that any habitat for the Southern Snapping Turtle is only likely to be found a significant distance downstream of the Isaac River, any minor changes in water quality due to the Project are unlikely to impact habitat for the Southern Snapping Turtle.

The Project is not expected to result in the introduction of any new aquatic pest species to the watercourses which support habitat for the Southern Snapping Turtle, and as such, no indirect impacts to the habitat of the Southern Snapping Turtle are expected. As such it is unlikely there will be any indirect impacts to individuals or habitat of the Southern Snapping Turtle.

Facilitated impacts

The Project will not result in any other actions that have the potential to impact on Southern Snapping Turtles or their habitats. As such, no facilitated impacts on the Southern Snapping Turtle are predicted.

Cumulative impacts

The Project will not result in any impacts to the species and is not expected to contribute to any cumulative impacts to the species.

Avoidance, mitigation and management measures

There is no potential habitat for the Southern Snapping Turtle within the study area, and thus direct impacts to the species will be avoided. Given that there is no habitat for the species that is likely to be indirectly impacted, no species-specific management measures are proposed. However, general management measures will be implemented to both minimise disturbance to aquatic habitats and minimise changes to water quality, namely:

- designing watercourse crossings to consider fish passage;
- building flood levees, which are designed to withstand increase in flood velocities;
- limiting the extent of direct impact on the identified disturbance area;
- locating areas of disturbance outside of watercourses and wetlands where possible; and
- developing environmental management plans, including:
    - Erosion and Sediment Control Plan;
    - Water Management Plan;

- Chemical and Fuel Management Plan; and
- Waste Management Plan

Significant impact assessment

The significance of the impacts from the Project on the Southern Snapping Turtle, after the avoidance, mitigation and management measures have been implemented, has been assessed against the significant impact criteria for critically endangered species (DoE 2013) in Table 21.78.

Table 21.78: Significant impact assessment for the Southern Snapping Turtle

Significant impact criteria (DoE 2013a)	**Significant impact assessment for the Project**
An action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that is will:	
lead to a long-term decrease in the size of a population	• A population of the Southern Snapping Turtle has not been identified within the waters of the study area nor downstream of the study area. • It is not expected that the Project will result in mortality of the species, nor impacts to breeding success or movement of the species. • The Project will not cause any impacts to water quality or hydrological flows in an area where the species is known to occur.
reduce the area of occupancy of the species	• The Southern Snapping Turtle has not been found to occupy the area within the study area not any area affected by an altered hydrological regime, as such the Project will impact habitat such that the area of occupancy of the species is reduced.
fragment an existing population into two or more populations	• No populations of Southern Snapping Turtle within the study area, and no populations of the species have been detected upstream of the Project. • The Project is not expected to have any direct or indirect impact on habitat used by the Southern Snapping Turtle. • The Project will not result in modifications to the aquatic environment such that the passage of the Southern Snapping Turtle will be restricted through the Project area (if the aquatic environment was used for such purpose).
adversely affect habitat critical to the survival of the species	• The waters within the study area have not been determined to provide habitat critical to the survival of the species. It is not expected that the waters provide suitable habitat.
disrupt the breeding cycle of an important population	• The waters within the study area do not provide suitable breeding habitat for the species.
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 adversely impact habitat for the Southern Snapping Turtle and thus will not cause the species to decline.
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 southern snapping turtle's habitat.
introduce disease that may cause the species to decline	• There are no diseases known to impact the species. • Disease is not identified as a threat to the species. • The construction and operation of the Project is not expected to introduce diseases that may cause the species to decline.

Significant impact criteria (DoE 2013a)	Significant impact assessment for the Project
interfere substantially with the recovery of the species	• A recovery plan has been adopted for the species. • The Project will not interfere with the recovery of the Southern Snapping Turtle, as it will not directly or indirectly impact this species or its habitat.

21.14 Stygofauna

21.14.1 Background ecology

Stygofauna are animals that live in underground water resources and generally consist of crustaceans and other invertebrate groups such as worms, snails, mites and insects. Stygofauna are typically highly specialised to resource poor aquifers where there is limited light, space and food supply and their dispersal capabilities are entirely dependent on the subsurface hydrological connectivity of the alluvial aquifer with other aquifers

Stygofauna can be delineated into sub-groups:

- Stygoxenes - organisms that have no affinities with groundwater systems but regularly occur by accident in caves and the near surface, shallow alluvial sediments
- Stygophiles - organisms that have greater affinities with the groundwater environment than stygoxenes because they appear to actively exploit resources in the groundwater system and/or actively seek protection from unfavourable surface water conditions and are associated with the riverine hyporheic zone.
- Stygobites – True stygofauna. These are obligate subterranean species, restricted to the shallower subterranean environments such as shallow alluvial aquifers and typically possessing specialised character traits related to a subterranean existence (troglomorphisms), such as reduced or absent eyes and pigmentation, and enhanced non-optic sensory structures.
- Phreatobites – True stygofauna. These are stygobites that are restricted to the deep groundwater substrata of deep alluvial and fractured rock aquifers (phreatic waters). All species within this classification have specialised morphological and physiological adaptations.

21.14.2 Methodology

A baseline assessment to describe stygofauna values within the potential impact area of Project has been conducted in May and September 2021 and is described in Appendix J, Stygofauna Assessment (section 1.2). A review of previous studies in the area identified no stygofauna had previously been detected in the Project area or surrounds. The assessment included phreatobiology net sampling and sieving of hand bailed water for potential stygofauna from 12 groundwater bores located at nine locations within the potential Project impact area as presented in Table 21.79 and Figure 21.107. Water sampling and chemical analysis data between October 2020 and September 2021 were considered in the assessment.

Table 21.79: Stygofauna baseline survey sampling sites

Bore ID	Groundwater Unit	Easting	Northing	Bore depth (m)	Bore slotted depth (m)
W1_MB1	Tertiary sediments	637914	7531373	45.5	42.6-45.1
W1_MB3	Vermont Seam	637919	7531372	124	121.5-124
W2_MB1	Tertiary sediments	637368	7531452	42	33-40
W2_MB2	Girrah 1 Seam	637370	7531452	110	103-110
W3_MB1	Quaternary alluvium	640470	7529435	12	9-12
W3_MB2	Tertiary sediments	640468	7529435	41	34-41
W4_MB1	Quaternary alluvium	638172	7528735	12	9-12
W5_MB1	Rewan Group	638387	7527823	50	43-50
W6_MB1	Permian overburden	637758	7527892	56	49-56

Bore ID	Groundwater Unit	Easting	Northing	Bore depth (m)	Bore slotted depth (m)
W11_MB1	Rewan Group	643941	7524860	120	113-120
W12_MB1	Tertiary sediments	643268	7530165	60	53-60
W14_MB1	Tertiary sediments	645373	7528515	20	14.6-18.6

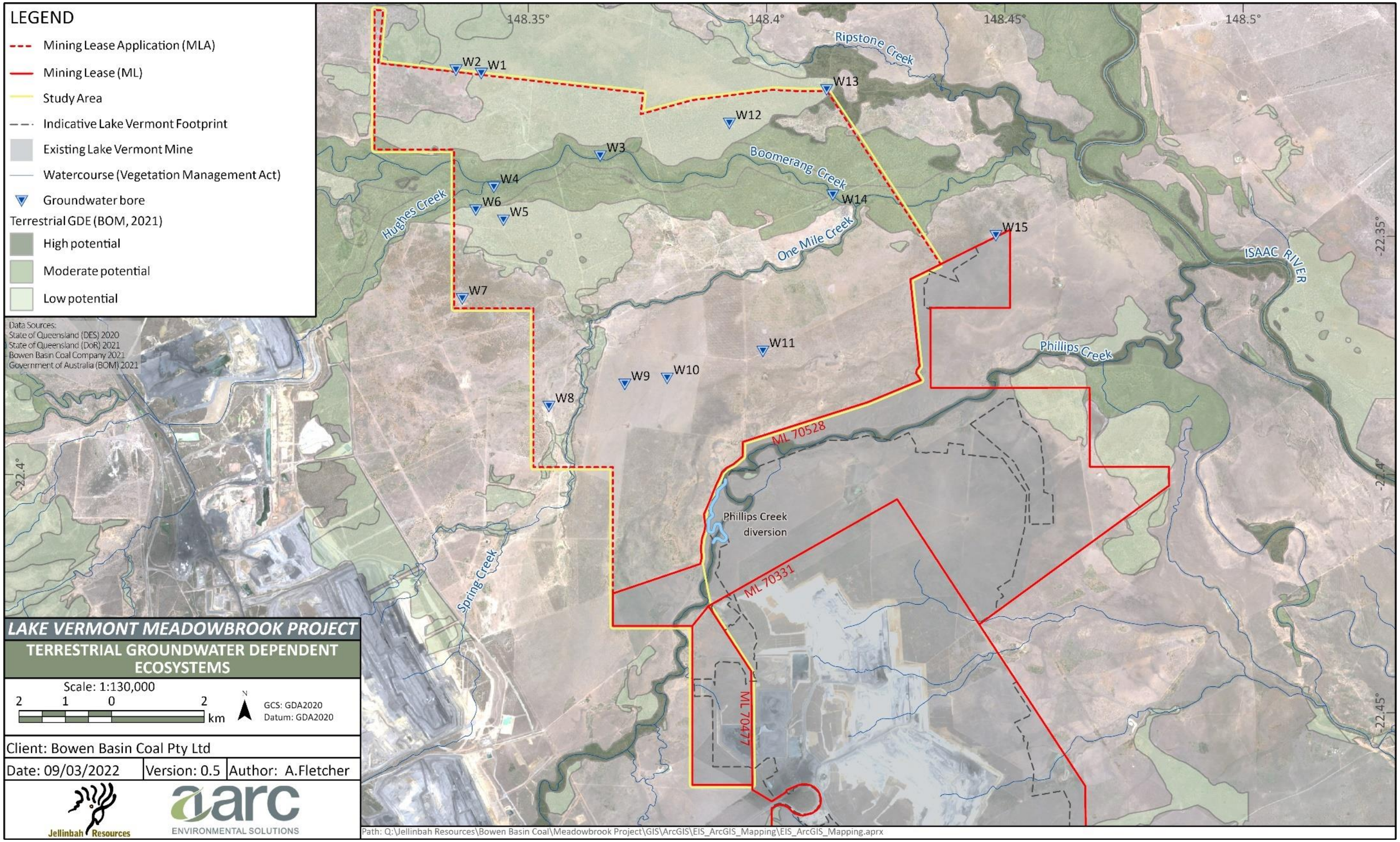

Figure 21.107: Stygofauna baseline sampling sites

21.14.3 Aquifer characteristics

The aquifers surveyed in the baseline stygofauna study (Appendix J, Stygofauna Assessment, section 2) are as follows:

- Quaternary alluvial aquifers – shallow, ephemeral losing groundwater system that does not typically contain permanent groundwater as the alluvial flow seeps downwards into the underlying tertiary sediments.
- Tertiary sedimentary aquifers – generally dry sub-horizontal blanket aquifer with sporadic basal sand and gravel deposits containing localised pockets of groundwater in some instances.
- Rewan Group Triassic sedimentary aquifer – a discrete lens that is fault-bound to the east by the Isaac Fault and is conceptualised as a regional aquitard, with low permeability and likely unimportant as a potential source of groundwater.
- Coal seam Permian aquifers – permeable aquifers confined by generally less permeable overburden and inter-burden. The coal seam aquifers have long residence times and occurrences of highly saline water and are often the first encountered usable volumes of groundwater encountered.

21.14.4 Stygofauna community

Stygofauna have been recorded at two sites along Boomerang Creek and stygophiles/stygozenes have been recorded at four sites along Boomerang Creek. Eight families of invertebrates have been recorded, including:

- two aquatic groundwater families:
  - one family of aquatic worms (Oligochaeta); and
  - one family of Copepoda (Crustacea); and
- six terrestrial invertebrate families.

Results of the stygofauna assessment are detailed in Appendix J, Stygofauna Assessment (section 4), with summarised details relevant to the impact assessment provided below:

- A low diversity of groundwater dependent subterranean fauna are in the shallow, unconfined Tertiary/alluvial aquifers of the Boomerang Creek Alluvium, close to the stream but not in the floodplain.
- Stygofauna are present within the groundwater drawdown zone of the Project and the groundwater flow path of any potential contamination event downstream of the development.
- None of the subterranean fauna species recorded are currently listed as endemic, relictual, rare, endangered or threatened biota or are populations or communities listed under the NC Act or EPBC Act.
- The ecological value of the two bores in which subterranean fauna are detected is considered low due to the restricted nature of the habitat and the very low number of disturbance tolerant taxa collected.
- The disjunct distribution of the fauna between the bores indicates a discontinuous connectivity between the shallow alluvial aquifers and Boomerang Creek.

21.14.5 Potential impacts

The ecological value of and risk value to the stygofauna community of each monitoring bore has been determined based on the results of the baseline surveys (Appendix J, Stygofauna Assessment, section 4.1.2).

The ecological value of the subterranean ecosystems within the alluvial Tertiary and Quaternary aquifers is assessed as low due to the very low numbers of taxa and specimens collected as well as their sporadic occurrence. The groundwater of the alluvial plain is generally too salty (with only minor areas of fresh water) to sustain broad stygofauna communities and the sediments porosity are too fine to enable the migration of fauna to accommodate a more diverse subterranean biodiversity. The ecological value of the other aquifers including the Permian Overburden, Rewan Group sandstone and coal seams surveyed across the flood plain are also ranked as low as they have no stygofauna, high EC, and very fine sediments. Therefore, all aquifer water sources, including the alluvial sediments are assessed as low ecological value.

The risk to the subterranean ecosystems has been assessed to be low. The risk of the proposed Project to these subterranean ecosystems is rated as low based on the shallow modelled depth of drawdown within the Tertiary sediments compared to the depth of the aquifer and the limited potential water quality changes to Boomerang Creek. The impact of the proposed Project and other existing and planned projects in the surrounding areas were not identified to have a cumulative impact to the stygofauna values.

21.14.6 Mitigation, management and monitoring

A Groundwater Monitoring Program for the Project site commenced in October 2020. The continuation of this program is proposed for the duration of the Project, as a mechanism to detect potential changes that may impact stygofauna values. Groundwater trigger levels and limits will be developed using data from the baseline dataset which will work to provide protection for stygofauna values.

The proposed Groundwater Monitoring Program will be detailed in the updated Water Management Plan proposed for the Project, as detailed in Section 21.11.5.4.

21.15 Groundwater dependent ecosystems

21.15.1 Survey methodology

The BoM GDE Atlas maps areas of ‘Moderate potential terrestrial GDEs’ associated with riparian vegetation of Boomerang Creek, Hughes Creek and the eastern section of One Mile Creek, and their associated watercourses. The western section of One Mile Creek is mapped as ‘Low potential terrestrial GDEs’. Phillips Creek, the lower sections of Ripstone Creek and the Isaac River are mapped as ‘High potential terrestrial GDEs’, with associated riparian vegetation mapped as either ‘low’, ‘moderate’ or ‘high’.

A study of potential groundwater dependent ecosystems within the vicinity of the Project site has been undertaken by 3D Environmental in 2021 (Appendix I, Groundwater Dependent Ecosystems). The study included a field assessment in 2021 and included assessment of 17 sites that were considered to be potentially groundwater dependent and mapped HES wetlands (Figure 21.108).

The GDE study methodology included assessment of leaf water potential, soil moisture potential, xylem stable isotope analysis, soil moisture stable isotope analysis, and groundwater bore sampling. The methodology has been informed by best practice methodologies including consideration of the IESC *Information Guidelines Explanatory Note: Assessing groundwater-dependent ecosystems Doody et al.* (2019). The methodology of the GDE assessment is presented in detail in Appendix I, Groundwater Dependent Ecosystems (section 3).

21.15.2 Results

The Groundwater Dependent Ecosystems Assessment (Appendix I, Groundwater Dependent Ecosystems, section 6.1) identified two types of GDEs present within the potential impact area of the Project (Figure 21.109).

- Groundwater dependent vegetation developed on drainage features and associated alluvial landforms present along Boomerang Creek and Hughes creek in the Project area (and Phillips Creek and Isaac River outside the Project area). Conceptual model presented in Figure 21.110 and Figure 21.111.
- Groundwater dependent wetland vegetation developed on perched groundwater lenses to the east of the Project area. Conceptual model presented in Figure 21.112 and Figure 21.113.

The GDEs present on alluvial landforms use groundwater that is seasonally recharged by surface flows and flooding. The GDEs on perched groundwater lenses use water which is recharged from percolating surface water captured at the alluvial unconformity. Neither identified GDE type uses water held in regional tertiary aquifer or coal seams.

21.15.3 Potential impacts

21.15.3.1 Impacts on groundwater dependent HES wetlands

There are no HES wetlands within the proposed MLA area however, there are ten HES wetlands in the vicinity of the Project to the north and east. The geohydrological impact to these HES wetlands and assessment of potential impacts provided in Appendix I, Groundwater Dependent Ecosystems (section 6). The assessment considered the expected groundwater drawdown as predicted by groundwater modelling which included the effects of subsidence and potential cracking (Appendix E, Groundwater Impact Assessment, section 6.2.5).

The HES wetlands are identified as ephemeral rain and surface flow fed wetlands. Five of the wetlands are identified as located within the maximum predicted tertiary aquifer drawdown impact, and in a location with potential for minor groundwater level impacts (identified as HES wetlands 2, 7, 8, 9, and 10 (Figure 21.70).

The approved Olive Downs Coking Coal Project will remove HES wetland 10 located north of Ripstone Creek to develop the Olive Downs South Domain (DPM Envirosciences 2018) and this wetland will therefore not be subject to impacts of the Project. HES wetland 9 has been assessed to be a surface feature perched on a clay aquitard that will not be influenced by groundwater drawdown related impacts. HES wetlands 2 and 7 were also assessed to be surface features with limited infiltration of surface water into underlying sediments and no inferred hydraulic linkage between surface waters and groundwater. A conceptual model has been developed for HES wetland 8 which indicates the presence of a perched lens of fresh groundwater lying at depth below the wetland pan. A GDE monitoring plan will be developed to include HES wetland 8 as the impact of groundwater drawdown is uncertain and will require ongoing seasonal monitoring to identify if impact to hydroecological function will be incurred.

Given the hydrogeological nature of the HES wetlands and the measures proposed in Appendix I, Groundwater Dependent Ecosystem (section 6.4)s, it is considered unlikely the Project will impact any HES wetlands through changes to groundwater.

21.15.3.2 Drawdown impacts to groundwater dependent ecosystems

The assessment of potential impacts to GDEs is presented in Appendix I, Groundwater Dependent Ecosystems (section 6.2), and modelled Tertiary aquifer drawdown in relation to identified GDEs is presented in Figure 21.114. The assessment determined that two types of GDEs were present within the Project impact area. The risk of impact to the GDEs within the Project impact area is identified as 'low to insignificant' due to the following:

1) The recharge of sandy lenses is controlled by surface flows and surface water infiltration into the soil profile and there will be no significant impact to surface flows or flood regimes which act to recharge the groundwater source which supports GDEs.

2) The groundwater perched in the alluvial systems is subject to natural fluctuations in volume in response to changing seasonal conditions and may dry for significant periods.

3) Tree species which characterise the riparian GDE areas are resilient and have capacity to adapt to possible minor reductions in soil moisture availability that may propagate in areas of predicted drawdown.

The assessment determined that there has been no significant residual risk to the GDEs in the vicinity of the Project however, proposed management actions which are detailed in Section 21.15.4.

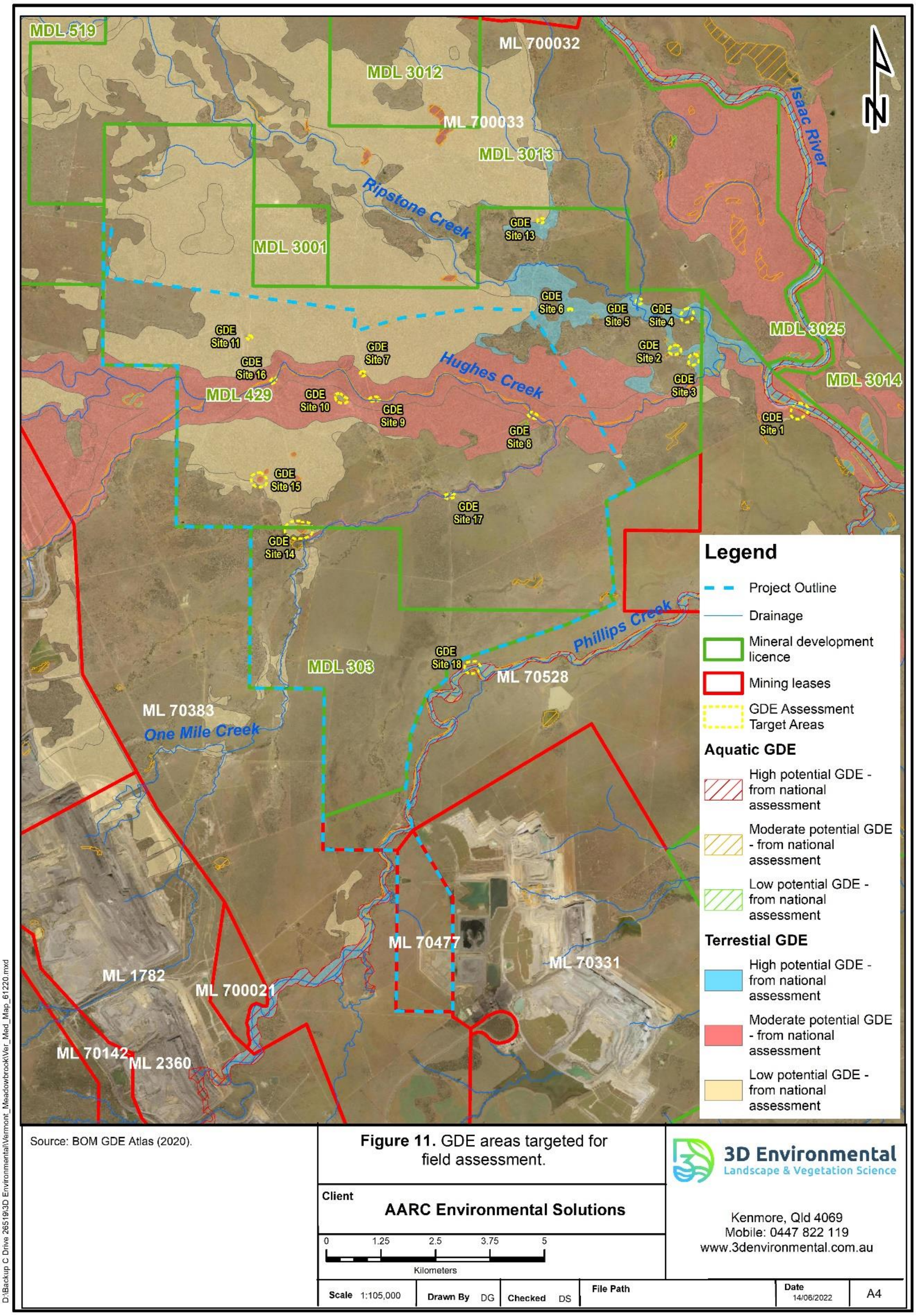

Figure 21.108: GDE areas targeted for field assessment

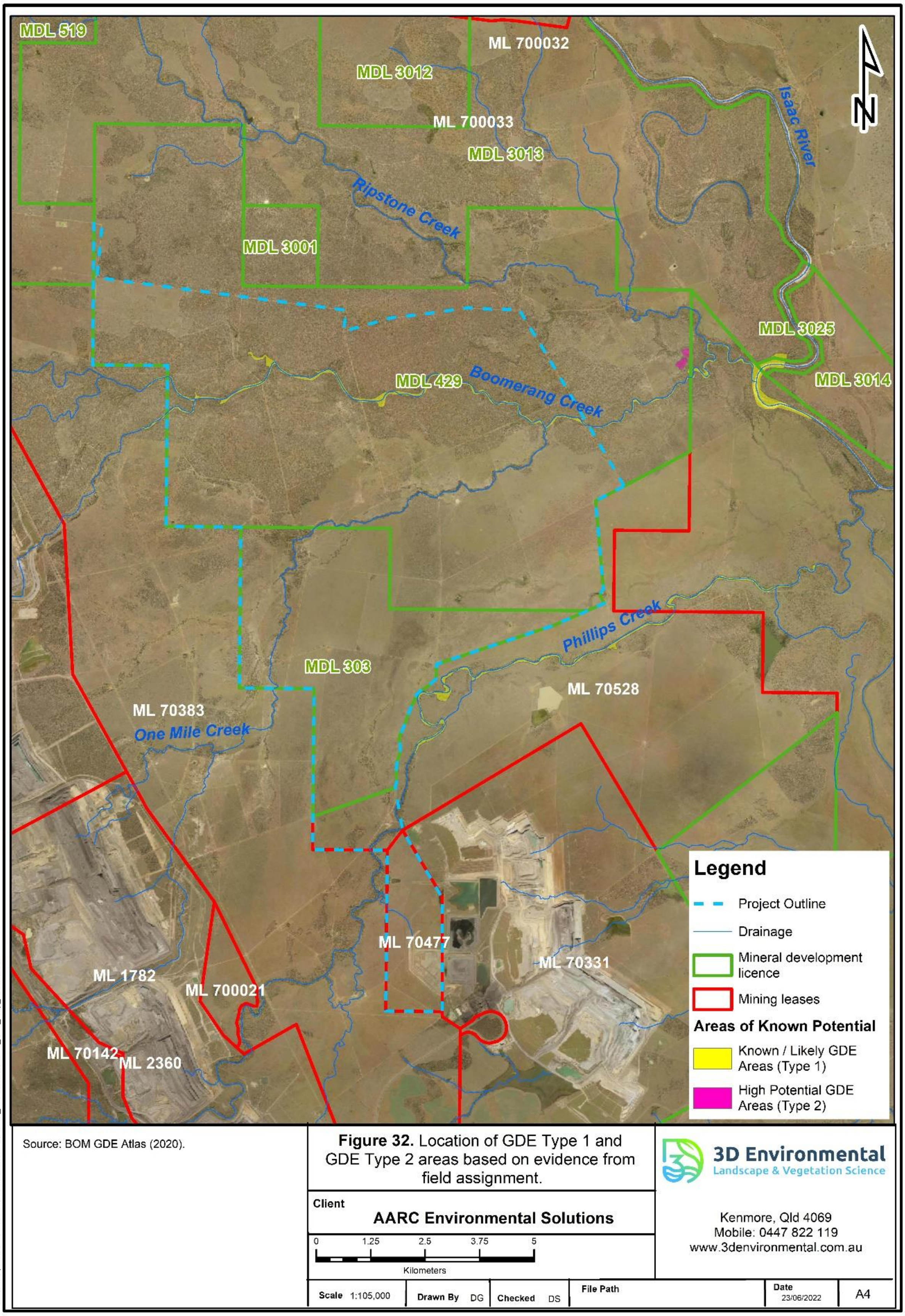

Figure 21.109: Confirmed location of GDE Type 1 and Type 2 areas

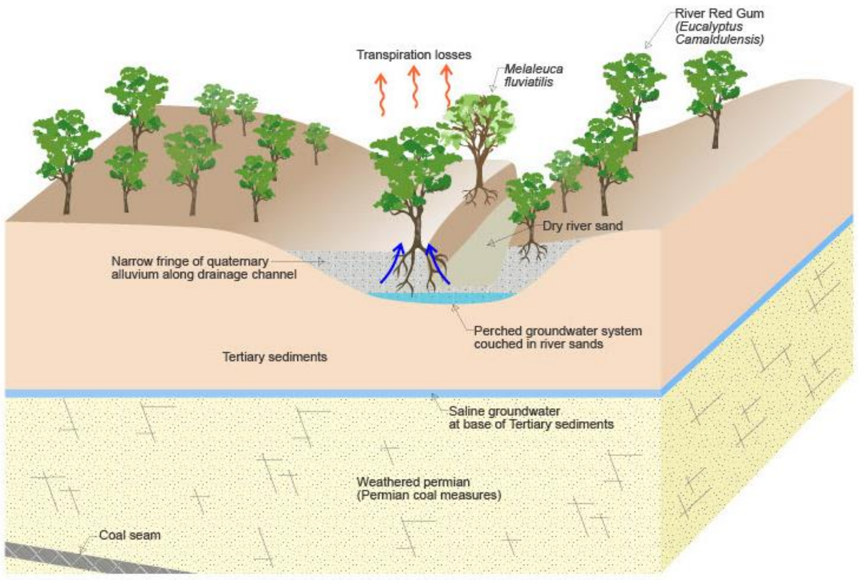

Figure 21.110: Boomerang Creek GDE dry season scenario

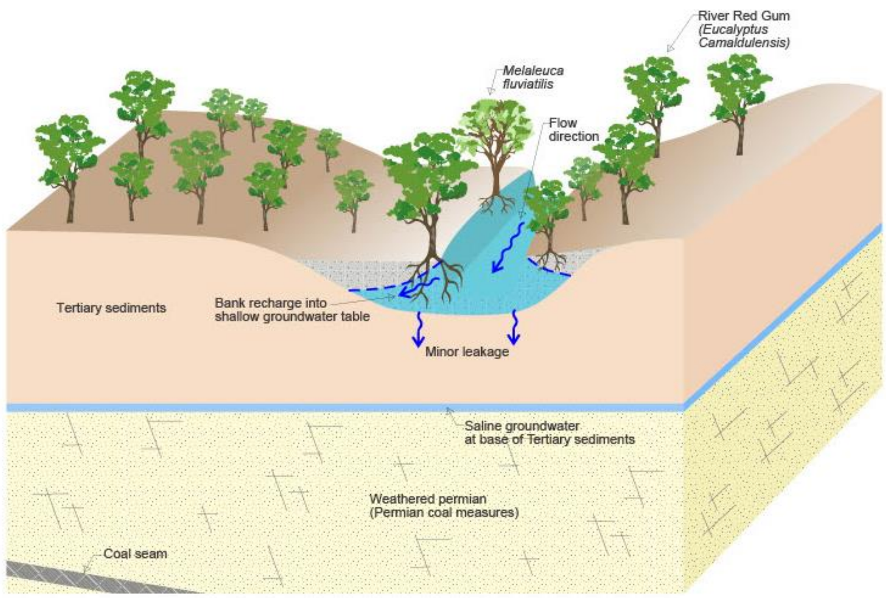

Figure 21.111: Boomerang Creek GDE flooding regime

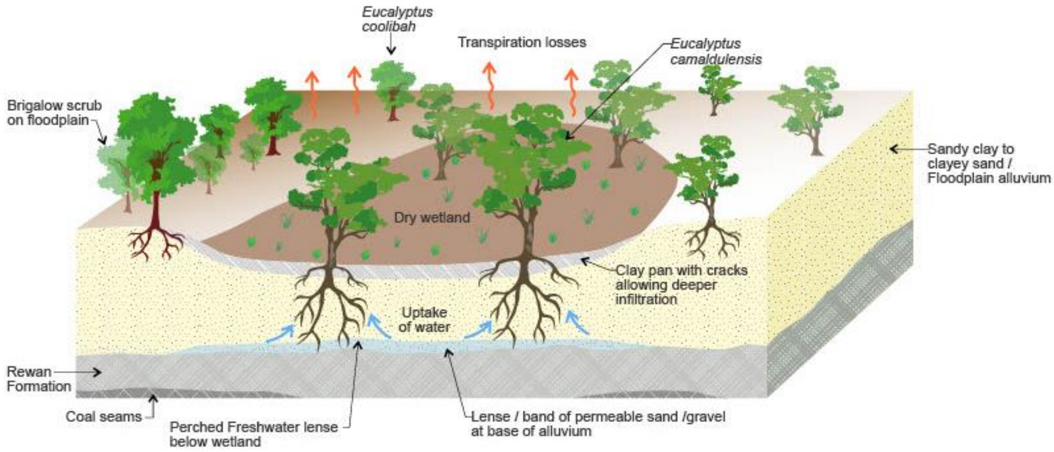

Figure 21.112: Groundwater dependent wetland on perched groundwater lenses dry season scenario

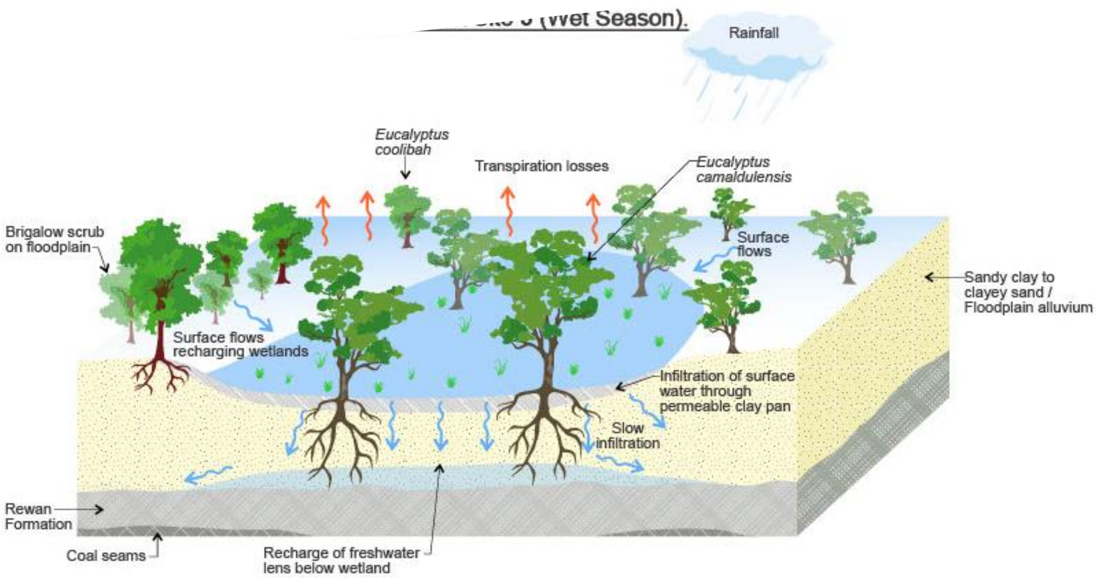

Figure 21.113: Groundwater dependent wetland on perched groundwater lenses flooding regime

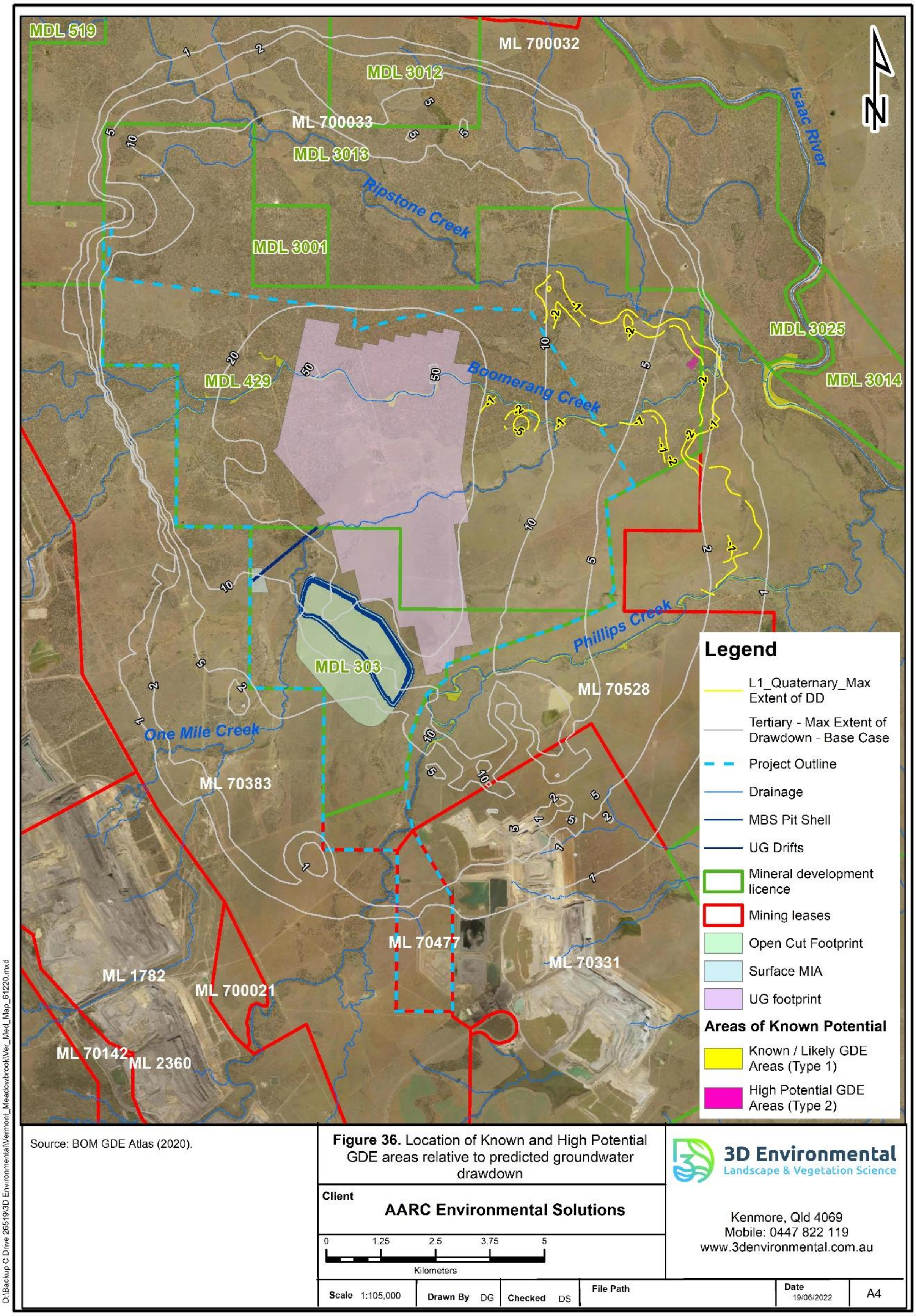

Figure 21.114: Location of GDE areas relative to predicted groundwater drawdown

21.15.4 Mitigation, management and monitoring

Mitigation, management and monitoring measures are proposed in Appendix I, Groundwater Dependent Ecosystems (section 6.4), to minimise the risk of impacts to GDEs. These measures include the following:

- The Project will operate under a Water Management Plan with the primary objective of minimising environmental harm. The Water Management Plan will incorporate erosion and sediment control management measures.
- An updated REMP will be prepared and implemented, as applicable to the management of potential impacts to GDEs that occur within the influence of the Project.
- Groundwater monitoring will be conducted for all Project stages, as described in Section 21.11.5.1.
- Additional baseline data will be collected to further characterise the seasonal ecohydrological function and baseline condition of alluvial GDEs on Boomerang Creek and Phillips Creek and the GDE at HES wetland 8. The collection of baseline data will be conducted within a Groundwater Dependent Ecosystem Monitoring and Management Plan which will provide protocols for:
    - Collection of baseline ecological condition data (Biocondition and Leaf Area Index) for type 1 GDEs over areas where groundwater drawdown in the Tertiary and Quaternary sediments is predicted.
    - Collection of baseline ecological condition data (Biocondition and Leaf Area Index) over HES Wetland 8 (GDE Type 2) where >2m of groundwater drawdown is modelled in the Tertiary sediments.
    - Collection of baseline ecological condition data in GDE areas where limited (<2m) and / or no groundwater drawdown is predicted to provide an ecological control.
    - Prescriptive methods for GDE monitoring over the life of the mine and post mining periods which are tailored to the assessed levels of ongoing risk to GDE function.
    - Mitigations and methods of adaptive management which can be implement if impacts to GDEs are detected which can be linked either directly or indirectly to mining operations associated with the Meadowbrook Project.

21.16 Social and economic matters

21.16.1 Public consultation

Bowen Basin Coal is committed to involving the community during the planning, construction, operation and decommissioning phases of the Project. There is also a commitment to understand all stakeholder concerns in respect of environmental and social impacts anticipated from the Project.

A Social Impact Management Plan (SIMP) (Appendix T, Social Impact Management Plan) has been developed as part of the Project EIS, with this informed by outcomes of the Social Impact Assessment, Appendix Q. The SIMP document contains the ‘Community and Stakeholder Engagement Plan’ adopted for the Project which provided for:

- stakeholder identification;
- development of an engagement action plan;
- development of a complaints management process;
- undertaking of rehabilitation and closure engagement; and
- development of a community consultation register.

A stakeholder profile and analysis has been undertaken as part of the Project SIA to determine the level of engagement most appropriate for each stakeholder. Stakeholder analysis has considered the likely extent of impacts on that stakeholder, as well as the ability of that stakeholder to influence the outcome of the Project.

A summary of the outcomes of the stakeholder analysis process is provided in Table 21.80, with further detail provided in Appendix P, Social Impact Assessment (section 3.4). Engagement has been undertaken with all identified affected and interested persons which included.

Table 21.80: Stakeholder analysis summary

Level of engagement	Stakeholder	IAP2 objective	SIA objective
Collaborate	• Office of Coordinator-General • IRC • Barada Barna Aboriginal Corporation	To partner with the public in each aspect of the decision, including the development of alternatives and the identification of the preferred solution.	Collaborate and partner with communities and stakeholders to ensure their input informs the preparation of SIA.
Involve	• Queensland Ambulance Service • Queensland Police Service • Queensland Fire and Emergency Services • Dysart Medical Centre • Dysart State School • Dysart State High School • Lady Gowrie Daycare Centre • C&K Kindergarten Dysart • Hinterland Community Care • Dysart Community Support Group • Moranbah Traders Association • Local retail businesses • Isaac Affordable Housing Trust • Operator of Lake Vermont Accommodation Village • Real Estate agency	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	Involve stakeholders in the identification of social trends and issues and of social impacts and management measures.
Consult	-	To obtain public feedback on analysis, alternatives and/or decisions.	Consult with stakeholders to obtain baseline social data and input to validate identified impacts and management measures.
Inform	• Department of Resources (formerly DNRME) • Mackay Regional Council • Regional Businesses • Unions • Employment and training providers • Tourists	To provide the public with balanced and objective information to assist them in understanding problems, alternatives, opportunities and/or solutions.	Inform stakeholders of Project information, including aspects of Project design and the SIA process.

The primary means of community and stakeholder engagement has been via semi-structured interviews and meetings structured to:

- enable stakeholders to define local values and the characteristics of potentially affected communities;
- provide stakeholders with an understanding of the Project, including timing and workforce arrangements;
- collect stakeholder input specifically regarding potential social impacts and benefits; and
- collect stakeholder input specifically regarding applicable mitigation and enhancement strategies.

BBC is committed to undertaking ongoing stakeholder consultation during the construction, operation and decommissioning phases of the Project. The Project SIMP outlines the 'Engagement Action Plan'. Ongoing consultation with stakeholders will facilitate monitoring and review of impacts, as well as review of mitigation measures. The SIMP (Appendix T, Social Impacts Management Plan, section 8) provides a monitoring framework to measure the effectiveness of management measures including stakeholder feedback.

21.16.2 Projected social and economic costs and benefits

The Project is located 25 km north-east of Dysart, within the Isaac Regional Council LGA, an established region servicing both mining and pastoral industries.

The Isaac Regional Council Community Strategic Plan describes the central themes of community values for the LGA as:

- community lifestyle;
- community strength and diversity for liveability;
- diverse service provisions to cater for community needs;
- secure and sustainable future; and
- protecting environmental qualities.

The town of Dysart was established in the 1970s as a mining community (dormitory town). The population of Dysart has indicated a steady decline over recent times, with a reported population of 2,342 in 2022. Dysart is comprised of a reported 1,201 residential dwellings, of which 56.9% are reported to be occupied. Dysart generally has comparable labour force characteristics to the broader IRC, with the top three employment industries being:

1) mining (3,757 people, 37.7%);
2) agriculture, forestry and fishing (1,041 people, 10.4%); and
3) education and training (657 people, 6.6%).

21.16.2.1 Potential social impacts

Detailed assessment of the positive and adverse impacts on the social environment have been undertaken for all Project phases, as provided in Appendix P, Social Impact Assessment (section 6). Positive and adverse social impacts were identified of the following categories:

- workforce management;
- housing and accommodation;
- local business and industry procurement; and
- health and community wellbeing.

To manage potential social impacts, mitigation and benefit enhancement measures have been developed. The measures are documented within a Project SIMP (Appendix T, Social Impact Management Plan) and provided for five sub-plan areas:

1) community and stakeholder engagement;
2) workforce management;
3) housing and accommodation;
4) local business and industry procurement; and
5) health and community wellbeing.

21.16.2.2 Potential economic impacts

Potential beneficial economic impacts occur across all Project phases, bringing benefits to local governments (Isaac, Mackay, Livingstone and Rockhampton) as well as state and national economies (Appendix Q, Economic Impact Assessment). Economic impacts of the Project can be summarised as:

- contribution to economic growth;
- maintenance of employment and household incomes;
- provision of support for local and regional businesses;
- contribution to government taxation revenues which can be used by government to provide infrastructure and services to support businesses and households throughout Australia.

The gross regional product within local government areas catchment to the of the Project including direct and flow-on impacts is estimated to be:

- $146.3 million in the Catchment during construction;
- $33.6 million in GRP in the Catchment during capital replacement activities; and
- $315.7 million in GRP per annum through mining activity in the Catchment during peak operations compared to what will otherwise occur if the Project does not proceed.

The taxation revenues to local, state and national governments is estimated to be an annual average of:

- $1,919.4 million in additional revenue to the Australian Government, through personal income tax, fringe benefits tax, company tax and Goods and Services Tax (GST), compared to what will occur without the Project.
- $1,334.5 million in additional revenue to the Queensland Government compared to what will occur without the Project, primarily through royalty payments.

Catchment construction businesses and the supply chain are estimated to receive during peak operations, that will not occur without the Project, revenue of approximately:

- $361.9 million through construction phase activity;
- $83.4 million in capital replacement activity; and
- $8.4 million in business revenue per annum.

21.16.2.3 Potential adverse economic impacts

Potential adverse economic impacts are assessed in Appendix Q, Economic Impact Assessment (section 5). Adverse economic impacts include impacts on regional agricultural production, impacts on local businesses through competition for resources, impacts on local property values from increased demand, impacts on industry from exchange rates and impacts on economic resources. Potential adverse impacts are rated as low risk and it is identified that potential adverse impacts may benefit some stakeholders (e.g. property owners).

21.16.2.4 Potential cumulative economic impacts

Potential adverse economic impacts are assessed in Appendix Q, Economic Impact Assessment (section 6). The Project is anticipated to be a minor contributor to adverse cumulative impacts and the Project contribution is assessed to be low. Real and tangible benefits to government and business investment from the concurrent development of Projects is identified for the economy.

21.16.2.5 Cost–benefit analysis (economic)

The cost–benefit analysis for the Project has been performed to calculate the estimated net benefits to the economy, as a result of the Project over and above the ‘Base Case’ scenario, where the Project does not proceed. The cost–benefit analysis indicates that, assuming a discount rate of 7 %, the net present value of the Project to the Queensland economy is estimated at $968.2 million including significant estimated labour benefits of $140.0 million over the life of the project.

21.16.2.6 Employment opportunities expected to be generated

Employment and income opportunities expected to be generated by the Project were assessed in Appendix Q, Economic Impact Assessment (section 5.2). The Project will support additional employment and household incomes during construction and operation, compared to what will occur without the Project, from both direct and indirect impacts.

Including both direct and flow-on (supply chain) impacts, the Project is estimated to support an additional:

- 1,044 FTE job years (in total) for residents of the Catchment during construction, over the six-year initial capital expenditure phase (noting the majority of construction activity will occur across a two-year construction period).
- 289 FTE job years (in total) will be maintained for residents of the Catchment through capital replacement activities between 2031-32 to 2044-45.
- 414 FTE jobs per annum for residents of the Catchment on average during peak mining activity between 2027-28 and 2027-48.

21.17 Consideration of the action in terms of ecologically sustainable development

Ecologically Sustainable Development (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 core objectives of the strategy are to:

- 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.
- Protect biological diversity and maintain essential ecological processes and life-support systems.

The guiding principles of the strategy are:

- Decision-making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations.
- When 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 on actions and policies should be recognised and considered.
- The need to develop a strong, growing and diversified economy that 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.

The principles of ESD are reflected in the EPBC Act and EP Act and are to be taken into account by the commonwealth minister and the Queensland chief executive, respectively, when deciding whether or not to approve the Project.

Section 3A of the EPBC Act includes the following principles of ESD:

a) *decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;*

b) *if 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;*

c) *the principles of intergenerational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;*

d) *the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making; and*

e) *improved valuation, pricing and incentive mechanisms should be promoted*.

ESD is defined under the EP Act as follows:

*…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 (**ecologically sustainable development**).*

Reflective of the definitions and principles above, the principles of ESD, including the precautionary principle, principle of intergenerational equity, conservation of biological diversity and ecological integrity, and improved valuation and pricing of environmental resources have been considered in all phases of Project design and the environmental impact assessment. Section 21.17.1 to Section 21.17.4 describe the consideration and application of the principles of ESD for the Project. The Project will therefore be undertaken in accordance with the principles of ESD.

21.17.1 Precautionary principle

The application of the precautionary principle prevents an environmental threat being dismissed in a decision-making process because the scientific evidence of that threat is inconclusive. For the principle to apply, two thresholds must be met:

1) there must be a threat of serious or irreversible environmental damage; and

2) there must be a lack of full scientific certainty as to the nature and extent of the threat.

In respect of the Project, an extensive range of measures have been adopted during the planning and design phases to ensure that potential for serious and/or irreversible damage to the environment is minimised. As discussed below, these measures include detailed technical environmental assessments. In addition, for key Project environmental assessment studies, peer review by recognised experts was undertaken.

There are impacts which will inevitably be caused to the environment, and accordingly an objective and comprehensive impact assessment methodology has been undertaken to understand the nature and extent of impacts, the consideration of impact avoidance and mitigation strategies in the design phase, and identification of adaptive management plans and offsets to ensure any variability associated with those impacts can be managed with a high degree of confidence. The specialist assessments evaluating the potential for harm to the environment associated with the development of the Project has therefore reduced the level of uncertainty associated with the potential impacts from the Project.

As set out below, preventative measures are proposed to be taken including the implementation of numerous environmental management plans.

The Project has adopted and will implement a range of internal and external codes of practice, guidelines and standards in relation to environmental management, occupational health and safety and rehabilitation. Consultation with government, landholders and stakeholders has also been undertaken and has informed the preparation of the EIS.

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 16, Hazards and Safety.

Potential short-term, long-term and cumulative impacts have been assessed by qualified professionals to determine the likelihood of environmental degradation and irreversible impacts. In the preparation of this EIS, 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. Risk and uncertainty have also been taken into account through the conduct of sensitivity and uncertainty analysis. For example, the 'Groundwater and Surface Water Assessments' has included the assessment of climate change projections (described further in Chapter 4, Climate) and the associated potential impacts.

In response to these assessment findings, a series of environmental management and monitoring programs, avoidance actions, mitigation measures and environmental offsets have been proposed to adequately address the predefined risks. Contingency protocols have also been considered in the design, operational and rehabilitation phases.

Peer reviews have been undertaken by recognised technical experts regarding

- Subsidence Assessment;
- Groundwater Modelling and Assessment; and
- Surface Water Assessment (for both Geomorphology and Water Balance elements).

The peer reviews are provided in Attachments 5 to 8 of this EIS, respectively.

21.17.2 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 principles of intergenerational equity have been addressed for the Project through:

- assessment of the Project's contribution to climate change and greenhouse gas emissions, and assessment of the impacts on climate change to potential Project impacts;
- consideration of potential short-term, long-term and cumulative impacts on air quality (inclusive of greenhouse emissions), surface water, groundwater, social, economic, transport, climate, aquatic and terrestrial ecology, noise, soil and land, cultural heritage and visual amenity in the preparation of this EIS; and
- development of monitoring programs, avoidance actions, mitigation measures and biodiversity offsets to adequately address the potential impacts.

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 employment, regional business opportunities and from export earnings and royalties for current and future generations.

21.17.3 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 functional ecosystem health with a diverse range of species and habitat present.

Assessments of ecological values are described in Section 21.12 and Section 21.13.

A total of 188 flora species have been recorded during the field surveys, presenting 58 families and 133 genera. Some 35 introduced flora species have also been recorded. The field-validated vegetation mapping has identified communities that are consistent with two threatened ecological communities listed under the EPBC Act, as well as vegetation communities that are listed as Endangered or Of Concern under the NC Act.

A total of 167 native species of terrestrial vertebrate fauna have been recorded during the field surveys, as well as eight introduced species. Native species recorded include:

- 11 amphibians;
- 19 reptiles;
- 109 birds; and
- 27 mammals.

Several conservation significant fauna species listed under the EPBC Act and/or NC Act have been identified in the study area during the field surveys, including the:

- Ornamental Snake
- Squatter Pigeon
- Greater Glider; and
- Koala.

Land clearance is listed as a key threatening process under the EPBC Act. The location of Project infrastructure has been selected to avoid or minimise disturbance to remnant vegetation and environmentally sensitive areas. The proposed underground mining methods provide environmental benefits by considerably reducing the extent of direct disturbance associated with the Project. The underground longwall mining layout adopted has also been selected to minimise impacts on EVs, and the longwalls have been offset from Phillips Creek to avoid subsidence impacts to the watercourse.

Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases is also listed as a key threatening process under the EPBC Act. Greenhouse gas emissions associated with direct emission sources (Scope 1) (e.g. the use of fixed and mobile plant and fugitive coal seam gas emissions), indirect emission sources (Scope 2) (e.g. the use of electricity) and other indirect emissions (Scope 3) (e.g. burning of coal in international power stations for steel production) have been assessed for the Project by Katestone (Appendix L, Air Quality and GHG Assessment, section 4.5). The Project greenhouse gas emissions have been included in the economic valuation of the Project by AEC Group (Appendix Q, Economic Impact Assessment, section 8.2.1.6). Valuation of the Project is discussed in Section 21.17.4

Commonwealth and State Government guidelines have been used to assess the potential for significant residual impacts on matters of national and state significance. A range of measures will be implemented to maintain or improve biodiversity values of the region, including impact avoidance, minimisation, mitigation and provision of offsets (for residual significant impacts). The provision of offsets for the Project complies with the EPBC Act and EO Act (Qld).

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 where practicable and providing for environmental offsets where residual impacts occur.

21.17.4 Valuation

An Economic Impact Assessment has been undertaken for the Project and is provided in Appendix Q. The Economic Impact Assessment incorporates environmental values via direct valuation when practicable (for example, vegetation clearance and greenhouse gas emissions).

Greenhouse gases directly generated by the Project (Scope 1 emissions) on average are estimated to be approximately 305.21 kt CO2-e per year, while indirect emissions (Scope 2) associated with the on-site use of electricity are estimated on average to be 43.26 kt CO2-e per year (Appendix L, Air Quality and Greenhouse Gas Assessment, Section 4.5). The Project is estimated to contribute an average of approximately 348.5 kt CO2-e per year, which exceeds the 25 kt threshold outlined in the NGER Act, requiring Bowen Basin Coal to report to the NGER system. Scope 3 emissions are attributable to the locations where coal is consumed, rather than the Project. The total Scope 1 and Scope 2 GHG emissions in 2020 and 2021 from Australian corporations that had to report to NGER was 554.36 Mt CO2-e (Clean Energy Regulator 2019). Under the Kyoto Protocol Accounting Framework, the total emissions in 2019 from Queensland was 148.22 Mt CO2-e (DoEE 2019a). Based on the highest emissions year, the Project will generate approximately 0.88 Mt CO2-e, representing 0.16% of Australian NGER emissions and 0.60% of Queensland emissions for the modelled worst-case scenario.

The Net Present Value (NPV) of the Project has been estimated by AEC Group (Appendix Q, Economic Impact Assessment, Section 8.3) as the difference between the present value (PV) of future benefits and PV of future costs (Appendix Q, Economic Impact Assessment, Section 8.3). A Cost–Benefit Analysis for the Project shows that the NPV of the Project to the Queensland economy is estimated at $968.2 million.

21.18 Consideration of the action against the objectives of the EPBC Act

The proponent has considered a range of alternatives to the proposed Project as described in Section 21.8 including alternative mining methods, underground mining layouts, open-cut mining layouts, infrastructure alignments, workforce accommodation and final landform design. 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 non inconsistence with relevant approved conservation advices, 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 Terms of Reference have been assessed in accordance with the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DoE 2013)(refer Section 21.12.4.

Where a significant residual impact is identified, environmental offsets with net gain benefit for impacted matters will be provided. A Biodiversity Offset Strategy has been prepared for the Project to propose offsets for identified significant residual impacts in accordance with the EPBC Act Environmental Offsets Policy (DESWPC 2012) and the EO Act Queensland Environmental Offsets Policy (Version 1.12) (DES, 2022).

The Project has not been inconsistent with the objects of the EPBC Act and the principles of ESD (including the precautionary principle, social equity, conservation of biological diversity and ecological integrity and valuation) Section 21.17. The consequences of not proceeding with the Project are presented in Section 21.8.7. The proposed Project is considered to be environmentally acceptable.

21.18.1 The objects of the EPBC Act

The section 3 objects of the EPBC Act are as follows:

a) to provide for the protection of the environment, especially those aspects of the environment that are MNES

b) to promote ESD through the conservation and ecologically sustainable use of natural resources

c) to promote the conservation of biodiversity

d) to promote a co-operative approach to the protection and management of the environment involving governments, the community, landholders and indigenous peoples

e) to assist in the co-operative implementation of Australia's international environmental responsibilities

f) to recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity, and

g) to promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.

The proposed Project is consistent with the objects of the EPBC Act demonstrated by the following:

- The proposed Project includes measures for the protection of the environment, especially MNES through the consideration of a range of alternative Project designs (Section 21.8), application of avoidance and mitigation measures (Section 0 and Section 21.13.4) and proposal of offsets (Section 21.19).
- The proposed Project allows the extended operation of the Lake Vermont Mine facilities and thereby promotes the ESD of the mineral resources through the applying considerations of ecological sustainable development (Section 21.17).
- Biodiversity values of the proposed Project area have been identified (Section 21.12 to 21.15) and conservation of these values achieved through mitigation or offsets for identified impacts.
- 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 (Chapter 2, Consultation Process).

- Indigenous peoples knowledge of biodiversity and heritage values have been promoted through the collaboration and consultation with Barada Barna Aboriginal Corporation.
- Preservation of cultural heritage through understanding and assessing values present.
- The proposed Project involved and consulted with the Barada Barna Aboriginal Corporation, local and regional community groups and local and state government agencies.
- Commitment to undertaking ongoing stakeholder consultation throughout the Project to understand all stakeholder concerns in respect of environmental and social impacts anticipated from the Project.
- Engagement with community for co-operative implementation in environmental responsibilities.
- Recognition of the indigenous groups role in respect to conservation and sustainability in response to Project impacts.

21.19 Environmental offsets

21.19.1 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).

21.19.2 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 two threatened ecological community and three threatened species listed under the EPBC Act. A summary of the impacts is provided in Table 21.81.

Table 21.81: MNES significant impact summary

Protected Matter	EPBC Act Status	Total area to be significantly impacted (ha)
Brigalow TEC	Endangered	7.9
Poplar Box TEC	Endangered	44.4
Ornamental Snake	Vulnerable	211.1
Koala	Vulnerable[1]	109.2
Greater Glider	Vulnerable[1]	100.6

1 Species listing at the time of the controlled action decision

21.19.3 Offset requirements

Stage 1 – 3 offsets

The proposed offset strategy which addresses all MNES offsets required for the stage 1 to 3 significant impacts of the Project is detailed in Appendix K, MNES Biodiversity Offsets Strategy (section 2.5). The area of significant impact of each stage and proposed offsets as detailed in the Biodiversity Offsets Strategy are shown in Table 21.82. The extent of areas subject to significant impact for each Project stage is shown in Figure 21.115 to Figure 21.119.

The Biodiversity Offsets Strategy proposes staged offset delivery in line with the progressive Project disturbance and identifies the proposed offset areas for stages 1 to 3 will all be located within the Project proposed MLA on land owned by the proponent (Figure 21.120). The proposed offset site maintains riparian corridors associated with Boomerang Creek, Hughes Creek, One Mile Creek and Phillips Creek provide east–west fauna movement opportunities through the landscape. The riparian vegetation along these streams is mapped as regionally significant corridors (Boomerang Creek, Hughes Creek, One Mile Creek, Phillips Creek) connecting to state significant riparian vegetation along the Isaac River (Figure 21.120). The riparian corridors associated with these streams provide dispersal habitat for the MNES offset matters Koala and Greater Glider.

The proposed offset areas for stages 1 to 3 including the allocation of available offset assessment units within the offset area are detailed in Appendix K, MNES Biodiversity Offsets Strategy (section 2.7). The offset strategy provides the total breakdown of assessment units (Refer Appendix K, MNES Biodiversity Offsets Strategy, section 7) as allocated to each proposed offset matter.

The proposed offset strategy satisfies the requirements of the EPBC Act Environmental Offsets Policy 2012 (DSEWPaC, 2012b) for stages 1 to 3 and offset areas would be secured prior to the start of each respective Project stage by declaration as an area of high conservation value under section 19F of the VM Act. Offset areas will be subject to Appendix U, Offset Area Management Plan, which provides offset completion criteria to be attained and maintained for the period of EPBC Act approval. Statutory protection of the offset area would be maintained under the VM Act, Nature Conservation Act 1992 (Qld) (NC Act) and EPBC Act.

Stage 4 offsets

A separate Offset Strategy for impact for Stage 4 will be agreed with DCCEEW at a date not less than 18 months prior to Stage 4 impacts commenting. The Offset Strategy will be accompanied by an OAMP for Stage 4 and the offsets will be secured prior to commencement of that Stage. It is noted that Stage 4 is scheduled for 2045. It is anticipated that the offsets for Stage 4 will be located on the same property (Meadowbrook). The stage 4 offset strategy would provide:

- detail of the environmental offset for the stage 4 significant impacts
- justification that the proposed offsets satisfy the requirements of the EPBC Act Environmental Offsets Policy 2012 (DSEWPaC, 2012b);
- evidence of the offset area connectivity to dispersal habitat and fauna habitat corridors; and
- the means of legally securing the proposed offset area.

Table 21.82: MNES impacts and proposed offset areas

MNES	Significant impact areas					Impact site quality	Impact quantum	Offset areas				Offset start quality	Quality without offset	Quality with offset	Offset quantum and % of liability provided
	Stage 1	Stage 2	Stage 3	Stage4	Total stages 1 - 3			Stage 1	Stage 2	Stage 3	Total stages 1 -3				
Brigalow TEC	0.6	6.9	0.1	0.3	7.6	5.01	3.8	1.82	20.88	0.30	23.0	5.45	5.45	7	102.33%
Poplar Box TEC	0.0	0.0	44.4	0.0	44.4	7.14	31.08	0.00	0.00	291.7	291.7	6.53	5.97	8	151.37%
Ornamental Snake	41.1	4.6	0.3	165.4	46.0	4.10	18.40	105.48	10.08	0.65	116.21	4.35	4.03	7	117.73%
Greater Glider	4.5	0.0	89.1	7.0	93.58	4.96	46.80	17.55	0.00	347.45	365.0	5.69	5.69	7	100.56%
Koala	4.8	8.2	89.1	7.1	102.1	5.89	61.2	22.61	38.59	418.8	480.0	5.78	5.78	7	101.13%

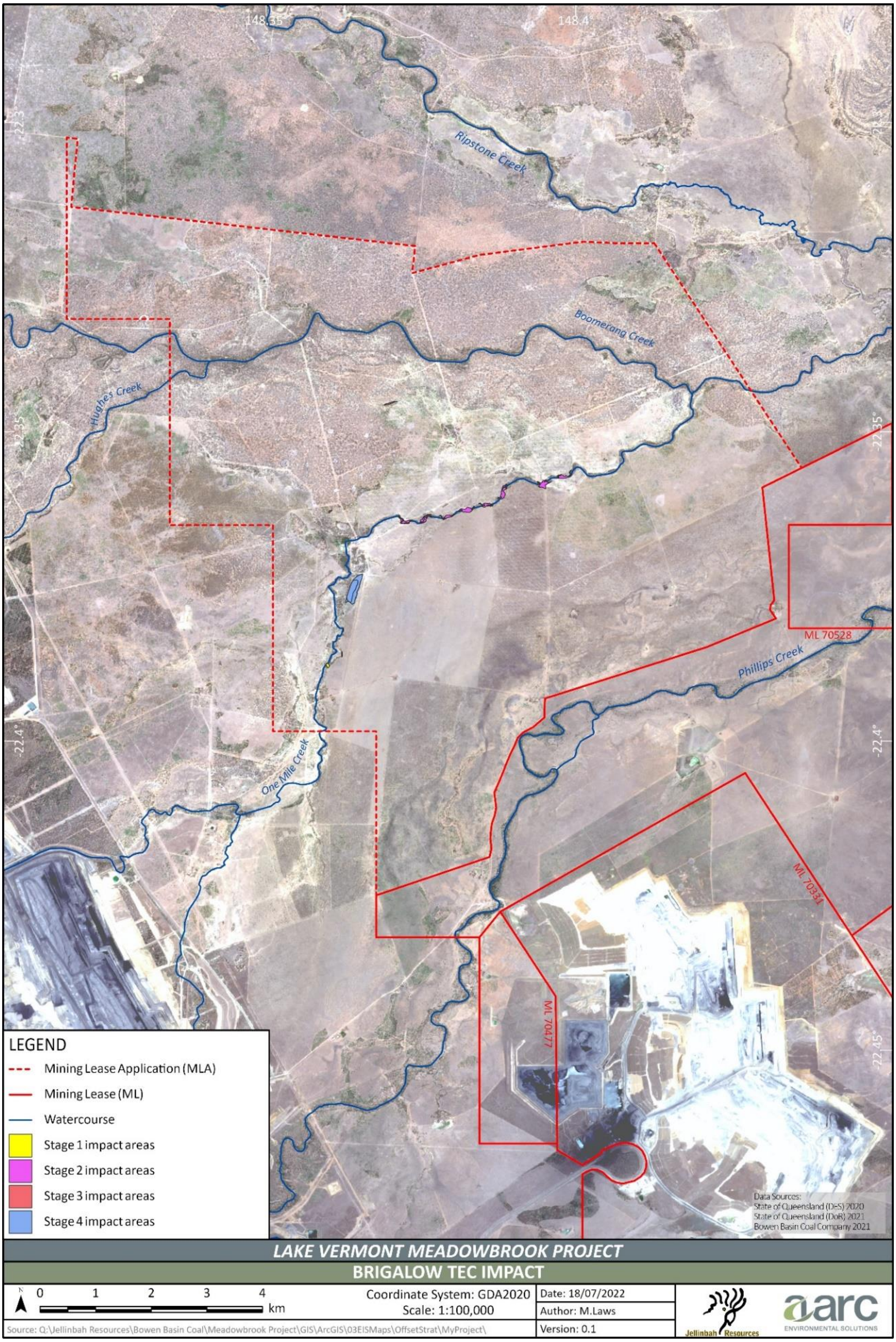

Figure 21.115: Brigalow TEC significant impact areas

Figure 21.116: Poplar Box TEC significant impact areas

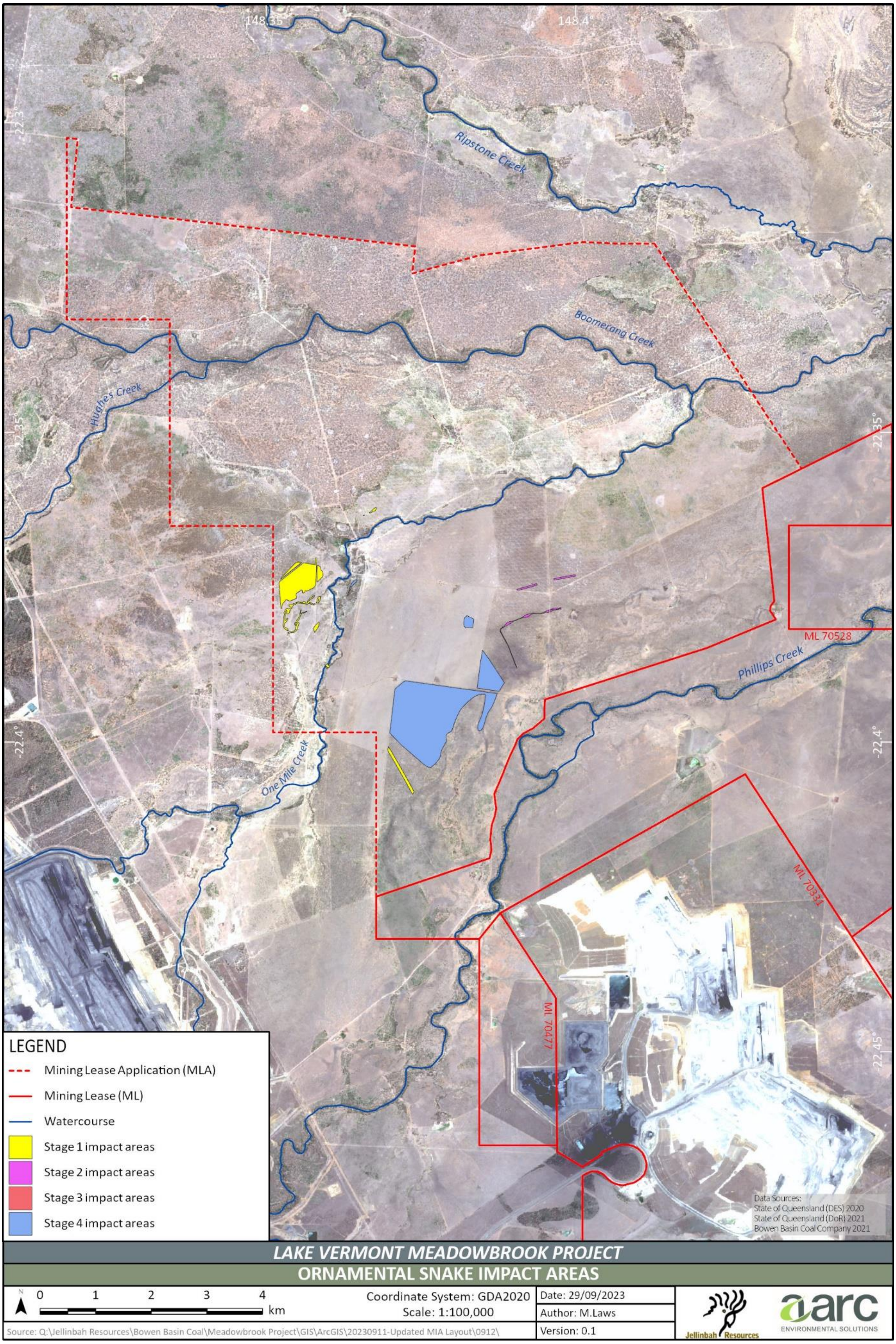

Figure 21.117: Ornamental Snake significant impact areas

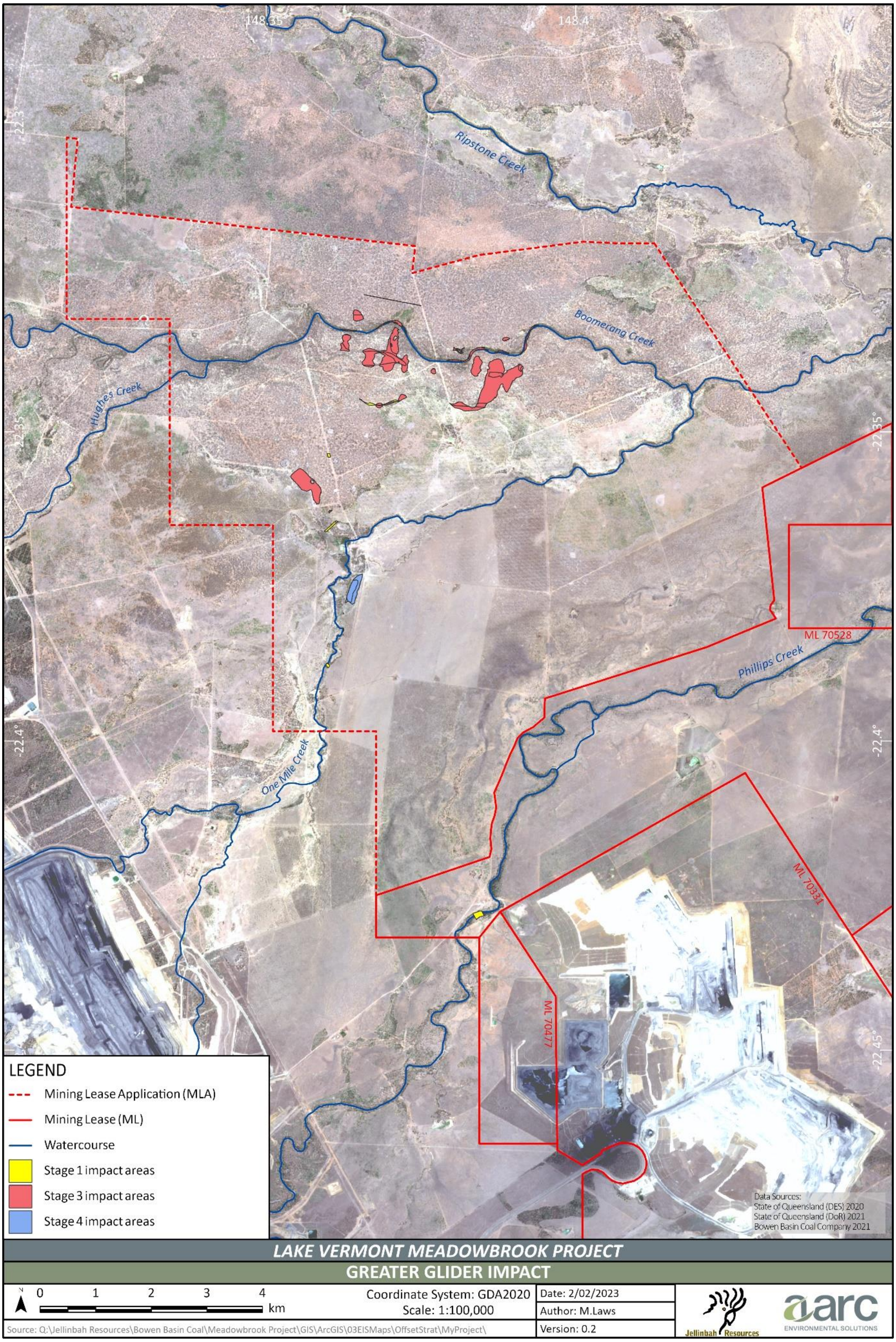

Figure 21.118: Greater Glider significant impact areas

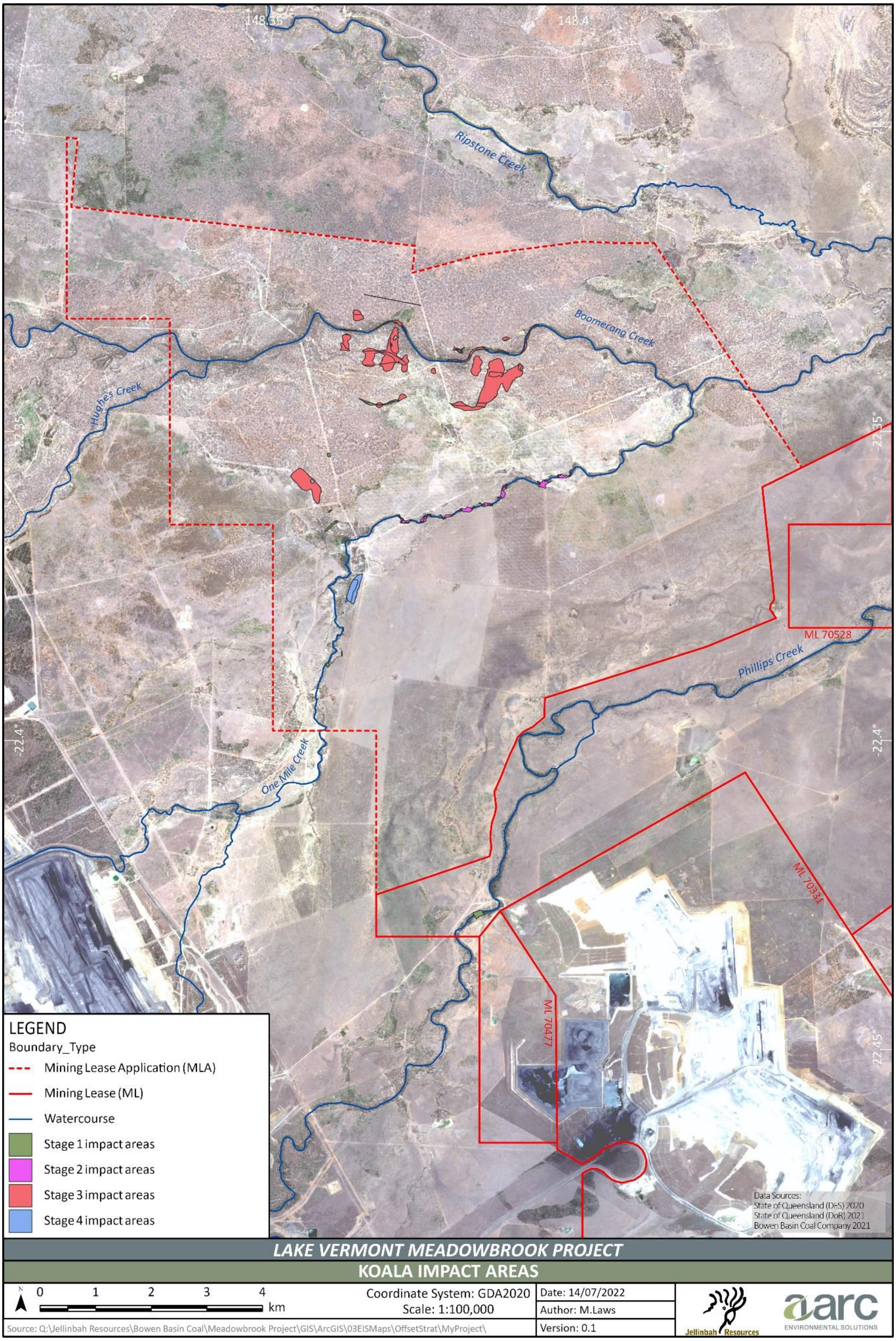

Figure 21.119: Koala significant impact areas

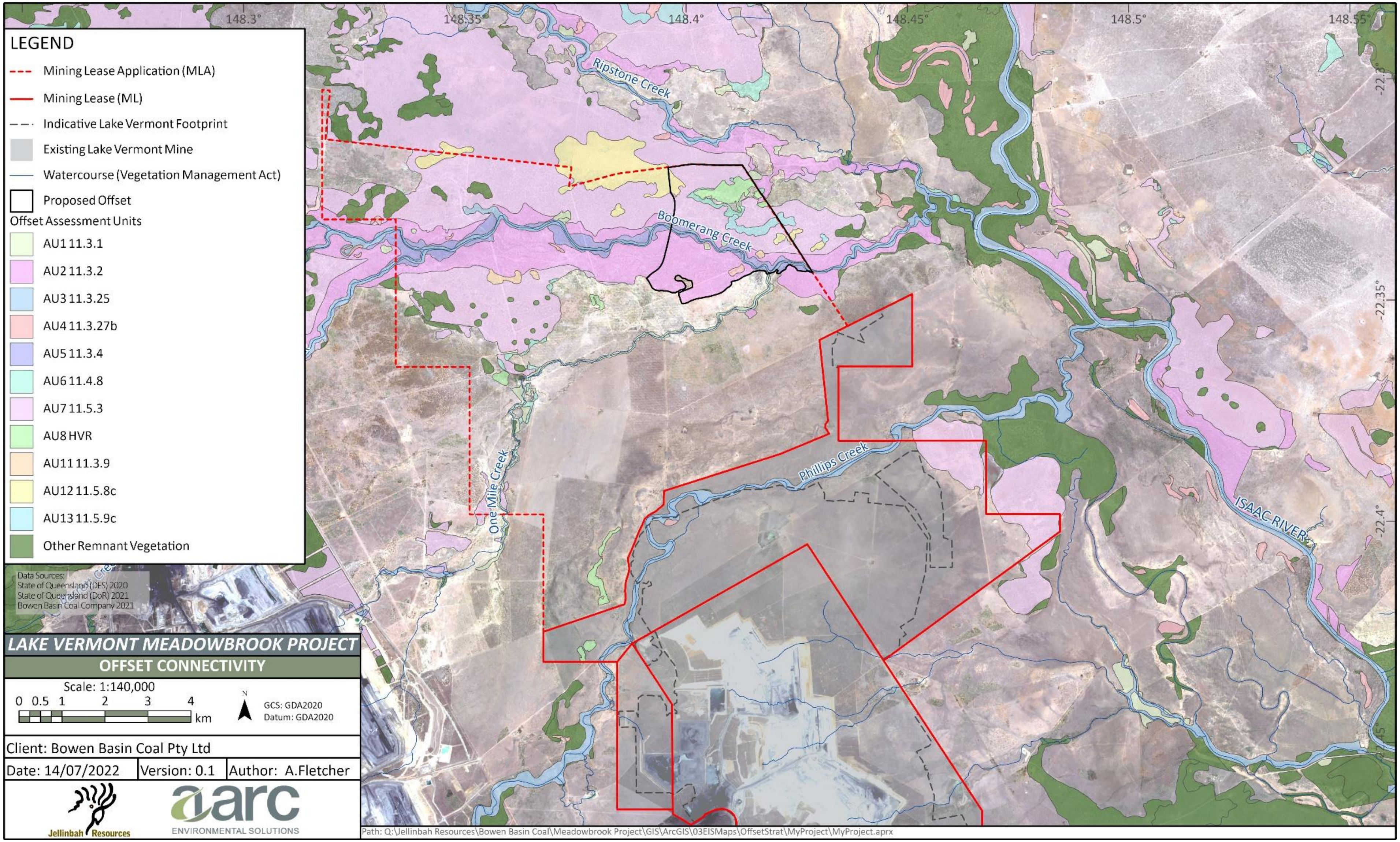

Figure 21.120: Proposed stage 1 - 3 offset area and connectivity