ENVIRONMENTAL AUTHORITY APPLICATION

Sapphire (PL1035), Central (PL1038), Lancewood (PL1045) Supporting Information

Prepared for:

Blue Energy Ltd
Level 10, 26 Wharf Street
BRISBANE QLD 4000

SLR Ref: 620.30617.00000-R01
Version No: -v1.0
January 2022

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 16, 175 Eagle Street
Brisbane QLD 4000 Australia
(PO Box 26 Spring Hill QLD 4004)
T: +61 7 3858 4800
E: brisbane@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Blue Energy Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
Final for issue v.1.0	28 January 2022	D. Clarke / D. Taylor	D. Taylor	M. Caslin
Update v.0.8	2 December 2021	D. Clarke	D. Taylor	M. Caslin
Draft for client review v.0.7	19 November 2021	D. Clarke	D. Taylor	M. Caslin

EXECUTIVE SUMMARY

Eureka Petroleum Pty Ltd, a wholly owned subsidiary of Blue Energy Limited are applying for an Environmental Authority (EA) for a greenfield coal seam gas (CSG) activity at three leases within ATP814 (Authority to Prospect) tenements in the Moranbah/Glendon region (the Project). The Applicant has complied this supporting information for the Department of Environment and Science (DES) consideration to accompany an application under section 125 the *Environmental Protection Act 1994* (EP Act) to conduct Environmentally Relevant Activity (Schedule 3) for an EA for Sapphire (PL 1034), Central (PL 1038) and Lancewood (PL 1045).

This application seeks to authorise the Applicant to conduct petroleum activities in each lease area under one EA in accordance with the DES Streamline Model conditions for petroleum activities. The total area encompassing all three PL's is approximately 31,498 ha, of which 1,046 ha (3.32%) is projected to be disturbed with each of the 530 well pads being constructed and operated over a 20-year period.

The project has been designed and would be managed in accordance with the Streamline Model conditions for petroleum activities and therefore a standard EA application is sought for these activities. This supporting information provides DES with an outline of each environmental value and appropriate mitigation measures that would be implemented during construction, operation and rehabilitation phases of the project.

Assessment of the activities have been carried out in accordance with the Queensland Government technical information requirements for an environmental authority application. A brief overview of each environmental value is provided as follows:

Land – A desktop-based soil and land resource assessment was conducted. A wide range of soils, including dispersive soils, may be present within the Project area requiring site specific management measures if disturbed. Where dispersive soils are disturbed, amelioration measures of these soils would be implemented to minimise the erosion risk and in accordance with the streamlined model conditions.

Noise – A noise impact assessment deemed both construction and operational noise from CSG activities could be managed through the implementation of appropriate management controls and in particular the final siting of well pads in locations that would minimise the impact on any identified sensitive receptors.

All activities are able to be managed to comply with the streamlined model conditions with noise buffers established around sensitive receptors.

Terrestrial Ecology – A combined approach of desktop assessments and a rapid vegetation assessment across each PL concluded that Category B and Category C Environmental Sensitive Areas (ESAs) were present across all areas. These constraints have been mapped in accordance with the streamlined model conditions, including buffer areas, with all CSG infrastructure to be placed in accordance with the proposed conditions and therefore minimising the disturbance Category B ESA's. Prior to any site disturbance, a flora and fauna survey would be conducted in accordance with the streamlined model conditions to determine the environmental values present and if additional mitigation or relocation of the proposed CSG asset is warranted.

Surface Water – A broadscale flooding risk assessment was conducted for each of the PL's and concluded that whilst the overall risk of flooding impacts are likely to be low, as the majority of the activities would be conducted in elevated areas. A site-specific flood assessment would be conducted during detailed design and prior to any site disturbance.

EXECUTIVE SUMMARY

The highest risk to surface water resources was found to be during drilling pad preparation and drilling activities. During these activities, the installation and use of appropriate erosion and sediment control measures and management of produced water would be implemented and maintained. The management of these activities has been outlined in this assessment and deemed to a low risk to the overall impact to surface water values.

Groundwater – A groundwater assessment conducted across all three PL's showed maximum groundwater drawdown resultant from CSG activities to be negligible across the Project area. Water quality monitoring will be undertaken throughout the Project life to determine whether CSG production is impacting on groundwater quality for landholder bores in accordance with the streamlined modelled conditions.

Air Quality – An air quality impact assessment was conducted and concluded that no air quality constraints were identified for the Project. Air emissions are restricted to exhaust from pad electrical generators that drive well head pumps and the possibility of flaring of low-pressure gas. Mitigation and monitoring measures will be undertaken to minimise emissions to air and assist in the management of air quality impacts associated with the construction and operational activities in accordance with the streamlined model conditions.

Desktop based assessments for waste, rehabilitation and a risk were conducted for the Project with no major impacts discovered. Where impacts from these aspects become raised throughout the Project life, appropriate measures will be taken to ensure these impacts are mitigated in line with the streamline model condition.

Based on the proposed activities presented in this assessment, it is proposed that any identified impact to any environmental value can be managed in accordance with the streamlined model conditions for petroleum activities for the life of the project.

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

ABBREVIATIONS

Abbreviation	Abbreviation
AHD	Australian Height Datum
Applicant	Blue Energy Limited ACN 054 800 378
AS	Australian Standard
BoM	Bureau of Meteorology
BUA	Beneficial Use Agreement
CCA	Conduct and Compensation Agreements
CMA	Cumulative Management Area
CSG	Coal Seam Gas
dBA	Decibels (A-weighted)
DES	Department of Environment and Science
DAWE	Department Agriculture, Water and the Environment
DoR	Department of Resources
DRDMW	Department of Regional Development, Manufacturing and Water
EA	Environmental Authority
EMP	Environmental Management Plan
EN	Endangered
EP Act	*Environmental Protection Act 1994* (Qld)
EPC	Exploration Permit Coal
EPM	Exploration Permit Mineral
EPP Air	*Environmental Protection (Air) Policy 2019 (Qld)*
EPP Noise	*Environmental Protection (Noise) Policy 2019 (Qld)*
EPP Water	*Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (Qld)*
EP Reg	*Environmental Protection Regulation 2008 (Qld)*
EPBC	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ESA	Environmentally Sensitive Area
EV	Environmental Value
GAB	Great Artesian Basin
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse Gases
Ha	Hectare
HDPE	High density polyethylene
LAAR	Land Access Activity Request
mAHD	Metres Above Australian Height Datum
ML	Megalitre

Abbreviation	Abbreviation
MLES	Matter of Local Environmental Significance
MNES	Matter of National Environmental Significance
MSES	Matters of State Environmental Significance
N/A	Not Applicable
NC Act	*Nature Conservation Act 1992* (Qld)
NEPM	National Environment Protection (Site Assessment) Measure
NGER	National Greenhouse and Energy Reporting
NT	Near Threatened
OGIA	Office of Groundwater Impact Assessment
P&A	Plug and Abandon
Petroleum Legislation	*Petroleum and Gas (Production and Safety) Act 2004* (Qld), and applicable regulations, as the context requires.
PL	Petroleum Lease
PLA	Petroleum Lease application
PPL	Petroleum Pipeline Licence
Petroleum Lease	The area currently subject to PL application - PL 1034, PL 1038 and PL 1045
Qld	Queensland
RE	Regional Ecosystem
RoW	Right of Way
RPI Act	*Regional Planning Interests Act 2014* (Qld)
S&D	Stock and Domestic
SCADA	Supervisory control and data acquisition
SMC	DES Streamline Model Conditions for petroleum activities
TDS	Total Dissolved Solids
TJ	Terajoule
TSP	Total Suspended Particles
UWIR	Underground water impact report 2016 prepared by the Queensland Office of Groundwater Impact Assessment
VM Act	*Vegetation Management Act 1999* (Qld)
VU	Vulnerable
WQOs	Water Quality Objectives

1 Introduction

1.1 Overview

Blue Energy Limited (Blue Energy) on behalf of Eureka Petroleum Pty Ltd., ABN 50107185222 (the Applicant and Tenure Holder) has prepared this supporting information report to accompany the application under the *Environmental Protection Act 1994* (EP Act) for an Environmental Authority for PL 1034, PL 1038 and PL 1045. This application seeks to authorise the Applicant to conduct petroleum activities in PL 1034, PL 1038 and PL 1045 in accordance with the DES Streamline Model conditions for petroleum activities.

Blue Energy holds tenements within Queensland's Bowen Basin in addition to other surrounding regions of Queensland, Northern Territory and South Australia. Blue Energy are an Australian proprietary company limited by shareholders and are the sole party involved in this Project. Blue Energy are applying for one Environmental Authority (EA) which will encompass three petroleum leases (PLs) for coal seam gas (CSG) operations at three of their ATP814 (Authority to Prospect) tenements in the Moranbah region (the Project). The three PL tenements will be managed and operated under the one EA are PL 1034, PL 1038 and PL 1045 and are shown in Figure 1.

The focus of Blue Energy's activities up to this point have been to explore and appraise CSG fields inside their tenements. Through this process, Blue Energy have identified PL 1034, PL 1038 and PL 1045 as appropriate sources of gas production to for domestic and/or overseas markets to warrant this EA Application to realise this production.

It is a condition of approving these PLs, that there is a relevant EA issued under the *Environmental Protection Act 1994* (QLD) (EP Act) covering the activities proposed to be carried out across the three tenures under one single EA.

The proposed EA will cover CSG activities project over a 20 year development period at 530 well pad locations including associated gas and water gathering network infrastructure, with a total disturbance as outlined in Table 1.

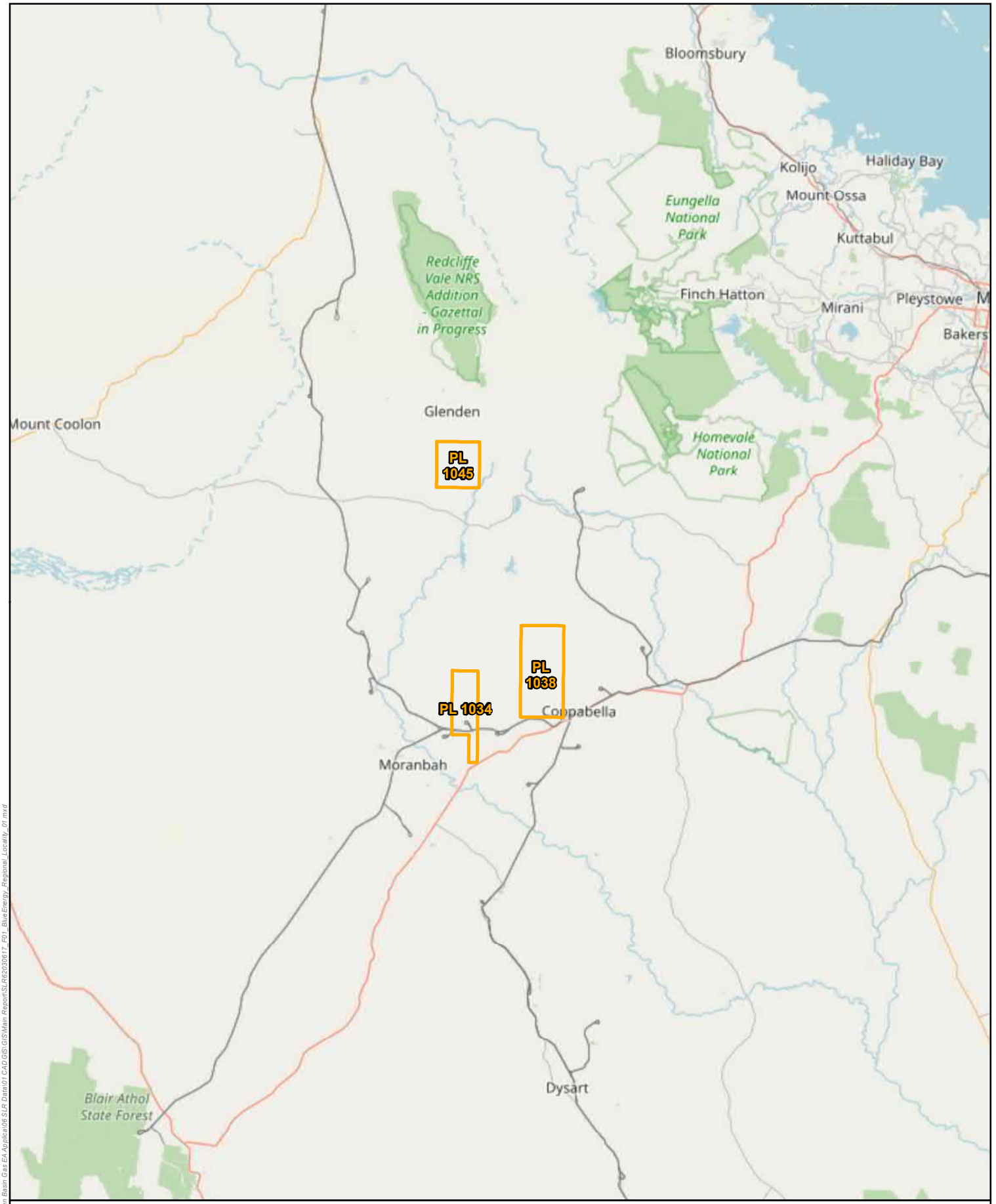
Table 1 Disturbance Areas

Petroleum lease	Total PL Area (ha)	Total Project Disturbance Area (ha)	Percentage of lease disturbed
Sapphire PL 1034	7,628	238	3.12%
Central PL 1038	15,900	528	3.32%
Lancewood PL 1045	7,970	280	3.51%

A total of 530 well pads (lateral, multi and vertical) are proposed across the proposed development area presented in Figure 2. The distribution of the various well pads is outlined in Table 2.

Table 2 Distribution of well pads

Petroleum lease	Lateral Well pads	Multi Well Pads	Vertical Well pads	TOTAL
Sapphire PL 1034	32	53	32	117
Central PL 1038	78	108	78	264
Lancewood PL 1045	49	51	49	149



0 10 20 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:1,000,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	JN

LEGEND

Roads

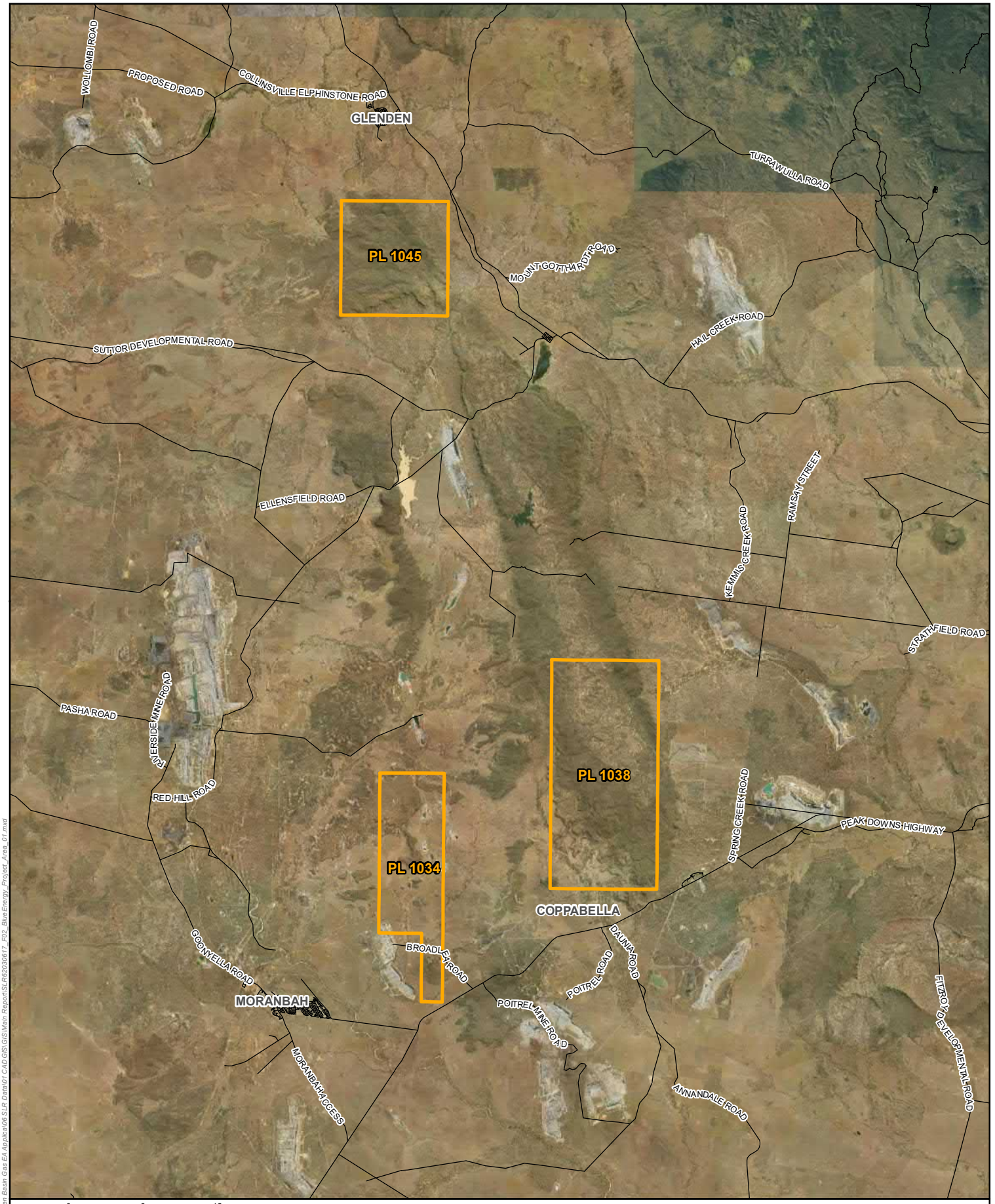
Petroleum Lease Boundary

BLUE ENERGY EA APPLICATION

Regional Locality

FIGURE 1

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306 17_F01_BlueEnergy_Regional_Locality_01.mxd



0 6 12 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:400,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	JN

LEGEND

Roads

Petroleum Lease Boundary

BLUE ENERGY EA APPLICATION

Project Area

FIGURE 2

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306617_F02_Blue Energy_Project_Area_01.mxd

1.2 Environmental Protection Act 1994

Sections 125 and 126 of the EP Act sets out the requirements for a properly made application – CSG activities. Each requirement is outlined in Table 3 with references to where these requirements are addressed in this application.

Standard criteria, as defined by Schedule 4 of the EP Act and relevant Environmental Protection Policies (EPP) have been considered and applied throughout the application and supporting documents.

Table 3 Key Requirements for Environmental Authority Applications under the EP Act

EP Act Section	Requirement	Reference
125(1)(a)	Application made to administering authority	Submitted to DES via their online portal
125(1)(b)	Application made in the approved form	Submitted online via the DES portal
125(1)(c)	Describe all environmentally relevant activities for the application	Section 2
125(1)(d)	Describe the land on which each activity will be carried out	Section 2 and 4
125(1)(e)	Application accompanied by the prescribed fee	Paid online at time of submission via the online portal
125(1)(f)	If two or more entities jointly make the application – nominate one as the principal applicant	Not applicable. Blue Energy is the sole applicant.
125(1)(g)	State whether the application is - (i) a standard application or (ii) a variation application or (iii) a site-specific application	This is a standard application
125(1)(h)	State whether the applicant is a registered suitable operator	The applicant is a registered suitable operator with the operator number entered as part of the online application. The operator number is 659638.
125(1)(i)	If a development permit under the Planning Act, or an SDA approval under the State Development Act, is required under either of those Acts for carrying out the environmentally relevant activities for the application—describe the permit or approval	No development permits or approvals are required.
125(1)(j)	If the application is a standard or variation application – declaration that each relevant activity complies with the eligibility criteria	Standard Application
125(1)(k)	For a variation application – state the standard conditions the applicant seeks to change	Not applicable
125(1)(l)(i)	If the application is a variation or site-specific application – include an assessment of each relevant activity on the environmental values (EV) including:	Not Applicable
125(1)(l)(i)A	Description of EVs likely to be affected by each relevant activity	Not Applicable

EP Act Section	Requirement	Reference
125(1)(l)(i)B	Details of an emissions or releases likely to be generated by each relevant activity	Not Applicable
125(1)(l)(i)C	Description of risk and likely magnitude of impacts on EVs	Not Applicable
125(1)(l)(i)D	Details of the management practices proposed to be implemented to prevent or minimise adverse impacts	Not Applicable
125(1)(l)(i)E	Details of how the land the subject of the application will be rehabilitated after each relevant activity ceases	Not Applicable
125(1)(l)(ii)	Include a description of the proposed measures for minimising and managing waste generated by any amendments to the relevant activity	Not Applicable
125(1)(l)(iii)	Include details of any site management plan or environmental protection order that relates to the land the subject of the application	Not Applicable
125(1)(m)	If the application is for a prescribed ERA – state whether the applicant wants an EA granted for the application to take effect on a day nominated by the applicant	No nominated day
125(1)(n)	If the application is a site-specific application for a mining activity relating to a mining lease—be accompanied by a proposed PRC Plan	Not applicable
125(1)(o)	Include any other document relating to the application prescribed under a regulation.	Not applicable
125(2)	Despite (1)(l) if application is for a variation application, it need only include the matters mentioned in that subsection to the extent it seeks to change standard condition for the activity or authority	Not applicable
125(3)	Subsection (1)(l) does not apply for an application if an EIS has been completed or CG has issued conditions and an assessment of the environmental risk would be same as the assessment in the EIS	Not applicable
125(4)	Subsection (1)(l) does not apply for a variation application under section 123(2) if the application seeks only to apply the CG conditions	Not applicable
125(5)	Despite subsection (1), if the application is a variation or site-specific application for the prescribed ERA mentioned in the Environmental Protection Regulation 2019, schedule 2, section 13A— (a) it need only include the matters mentioned in subsection (1)(l)(i)(A) to (D), (ii) and (iii) to the extent the matters relate to fine sediment, or dissolved inorganic nitrogen, entering the water of the Great Barrier Reef or Great Barrier Reef catchment waters; and (b) subsection (1)(l)(i)(E) does not apply for the application.	Not applicable

EP Act Section	Requirement	Reference
125(6)	Subsection (1)(l) does not apply for a variation application or site-specific application, and subsection (1)(n) does not apply for a site-specific application for a mining activity relating to a mining lease – (a) the chief executive has, under chapter 3, part 2 or 3, approved the voluntary preparation of an EIS for the project the subject of the application and the applicant has— (i) started the EIS process for the application; or (ii) stated in the application that the applicant will prepare an EIS under chapter 3, part 1; or (b) the chief executive has, under chapter 3, part 3, decided that an EIS is required for the application; or (c) the Coordinator-General has, under the State Development Act, section 26(1)(a), declared that the project the subject of the application is a coordinated project for which an EIS under that Act is required.	Not applicable
126(1)	A site-specific application for a CSG activity must also state the following:	Applicable
126(1)(a)	the quantity of CSG water the applicant reasonably expects will be generated in connection with carrying out each relevant CSG activity;	Section 2, 10
126(1)(b)	the flow rate at which the applicant reasonably expects the water will be generated;	Section 2
126(1)(c)	the quality of the water, including changes in the water quality the applicant reasonably expects will happen while each relevant CSG activity is carried out;	Section 2, 11
126(1)(d)	the proposed management of the water, including, for example, the use, treatment, storage or disposal of the water;	Section 11
126(1)(e)	the measurable criteria (the management criteria) against which the applicant will monitor and assess the effectiveness of the management of the water, including, for example, criteria for each of the following:	Applicable
126(1)(e)(i)	quantity and quality of water used, treated, stored or disposed of;	Sections 2, 11
126(1)(e)(ii)	protection of the environmental values affected by each relevant CSG activity;	Section 11
126(1)(e)(iii)	the disposal of waste, including, for example, salt, generated from the management of the water;	Section 11
126(1)(f)	The action proposed to be taken if any of the management criteria are not complied with, to ensure the criteria will be able to be complied with in the future	Section 11

EP Act Section	Requirement	Reference
126(2)(a),(b)	The proposed management of the water cannot provide for using a CSG evaporation dam in connection with carrying out a relevant CSG activity unless: (a) The application includes an evaluation of: (i) best practice environmental management for managing the CSG water; and (ii) alternative ways for managing the water; and (b) the evaluation shows there is no feasible alternative to a CSG evaporation dam for managing the water	There will be no CSG evaporation dams
126(3)	This section does not apply for a site-specific application for a CSG activity if— (a) the Coordinator-General has evaluated an EIS for the CSG activity under the State Development Act; and (b) there are Coordinator-General's conditions for each relevant activity the subject of the application; and (c)an assessment of the environmental risks of the activity would be the same as the evaluation mentioned in paragraph (a), if completed.	Not applicable
126A(1)	Requirements for site-specific applications – involving the exercise of underground water rights (1). This section applies if: (a) the application related to a site-specific environmental authority for - (i) a resource project that includes a resource tenure that is a mineral development licence, mining lease or petroleum lease; or (ii) a resource activity for which the relevant tenure is a mineral development licence, mining lease or petroleum lease; and	Not applicable
126A(2)(a)	The application must also state the following - (a) any proposed exercise of underground water rights during the period in which resource activities will be carried out under the relevant tenure	Section 10
126A(2)(b) & (c)	(b) The areas in which underground water rights are proposed to be exercised (c) For each aquifer affected, or likely to be affected, by the exercise of underground rights: (i) a description of the aquifer; and (ii) an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers and surface water; and (iii) a description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights; and (iv) the predicted quantities of water to be taken or interfered with because of the exercise of underground water rights during the period in which resource activities are carried out	Sections 2, 10

EP Act Section	Requirement	Reference
126A(2)(d)	The environmental values that will, or may, be affected by the exercise of underground water rights and the nature and extent of the impacts on the environmental values	Section 10
126A(2)(e)	Any impacts on the quality of groundwater that will, or may, happen because of the exercise of underground water rights during or after the period in which resource activities are carried out	Section 10
126A(2)(f)	Strategies for avoiding, mitigating or managing the predicted impacts on the environmental values stated for paragraph (d) or the impacts on the quality of groundwater mentioned in paragraph (e)	Section 10

1.3 Environmentally Relevant Activities

This EA application seeks authorisation to undertake resource activities that are petroleum activities as outlined below in Table 4.

Table 4 Environmentally relevant activities

Environmentally Relevant Activity Environmental Protection Regulation 2019; Schedule 3	Threshold	Aggregate environmental score
Schedule 3 - 8 - a petroleum activity or greenhouse gas storage activity, other than an activity mentioned in any of items 1 to 7, that includes 1 or more activities mentioned in Schedule 2 for which an aggregate environmental score is stated.	Not Applicable	126

1.4 Notifiable Activities

Notifiable activities are those activities identified as likely to cause environmental harm through contamination of land and are described in Schedule 3 of the EP Act. No notifiable activity is proposed to be carried out on the land associated with the proposed Project.

1.5 Environmentally Authority Conditions

Streamlined model conditions (SMCs) for petroleum activities (ESR/2016/1989) are being sought for this application to be complied with for this EA application. The SMCs are specified throughout this document under the relevant criteria and summarised in full in Appendix A.

1.6 EPBC Act Considerations

The *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) is a key piece of environmental legislation which is administered by the Australian Government. The Act provides a framework for the protection and management of nationally and internationally significant flora, fauna, ecological communities and heritage. Matters of National Environmental Significance (MNES) as defined in the EPBC Act are:

- World heritage properties
- National heritage places

- Wetlands of international importance
- Nationally threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mining), and
- A water resource in relation to CSG and large coal mining (the water trigger).

The Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DEWHA, 2013) provide the following guidance on the definition of a "significant" impact to MNES:

A significant impact is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. All of these factors are considered when determining whether an action is likely to have a significant impact on the environment.

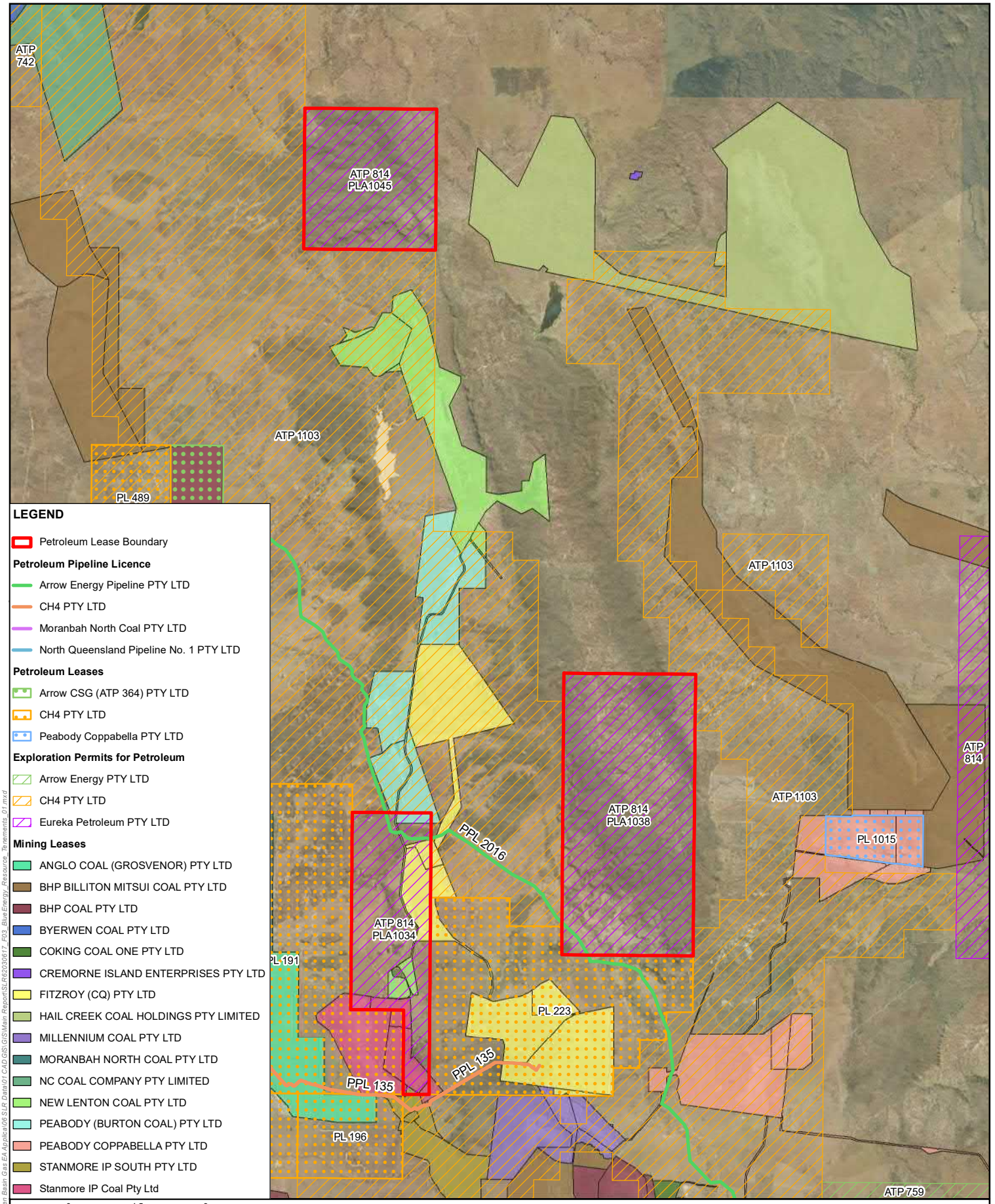
A referral under the EPBC Act will be made to the Minister for the Environment for consideration outlining the likely impact on all MNES for this Project.

2 Project Outline

2.1 Location

The Project consists of three Blue Energy PL's with Sapphire (PL 1034) and Central (PL 1038) located approximately 10 km and 24 km northeast of Moranbah respectively, and Lancewood (PL 1045) located approximately 6.5 km south of Glenden in Central Queensland. The petroleum lease tenements for the Project are shown in Figure 3 and are a portion of those leases under ATP 814.

The Moranbah region is a heavily developed resource area and there are pre-existing extractive activities and associated infrastructure located throughout the region. There are a number of large mines throughout the area such as Isaac Plains Mine, Goonyella Coal Mine, Broadmeadow Mine and Broadlea Mine. The Arrow Energy owned Moranbah Gas Project is one of the oldest and geographically largest CSG fields in Australia. Arrow Energy also owns PL 486 which is known as the Bowen Gas Project and is yet to be constructed. The Blue Energy owned tenements are located within the middle of these Arrow developments and provide good opportunity for Blue Energy to utilise existing and/or planned coal seam gas infrastructure. The surrounding mining and petroleum tenements of the Project is presented in Figure 3.



LEGEND

- Petroleum Lease Boundary

Petroleum Pipeline Licence

- Arrow Energy Pipeline PTY LTD
- CH4 PTY LTD
- Moranbah North Coal PTY LTD
- North Queensland Pipeline No. 1 PTY LTD

Petroleum Leases

- Arrow CSG (ATP 364) PTY LTD
- CH4 PTY LTD
- Peabody Coppabella PTY LTD

Exploration Permits for Petroleum

- Arrow Energy PTY LTD
- CH4 PTY LTD
- Eureka Petroleum PTY LTD

Mining Leases

- ANGLO COAL (GROSVENOR) PTY LTD
- BHP BILLITON MITSUI COAL PTY LTD
- BHP COAL PTY LTD
- BYERWEN COAL PTY LTD
- COKING COAL ONE PTY LTD
- CREMORNE ISLAND ENTERPRISES PTY LTD
- FITZROY (CQ) PTY LTD
- HAIL CREEK COAL HOLDINGS PTY LIMITED
- MILLENNIUM COAL PTY LTD
- MORANBAH NORTH COAL PTY LTD
- NC COAL COMPANY PTY LIMITED
- NEW LENTON COAL PTY LTD
- PEABODY (BURTON COAL) PTY LTD
- PEABODY COPPABELLA PTY LTD
- STANMORE IP SOUTH PTY LTD
- Stanmore IP Coal Pty Ltd

0 4.5 9 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:325,000 at A4
Project Number:	620.30617
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	DT

SLR

BLUE ENERGY EA APPLICATION

Resource Tenements

FIGURE 3

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306 17_F03_Blue Energy_Resource_Tenements_01.mxd

2.2 Coal Seam Gas Extraction

2.2.1 Gas Formation and Gathering

The generation of CSG occurs when a coal seam is being formed. This gas originates predominantly in the form of methane, being stored within the cleats of the coal seam. Although some gas escapes naturally into the environment, the majority of it is held in the seam from the hydrostatic pressure of groundwater and the overlying rock acting on the coal seam.

Regarding gas extraction, the coal in the seam itself is not removed during the recovery of the gas. Gas is extracted from the coal seam by drilling a well into, and along the seam, removing the groundwater from the seam and therefore reducing the hydrostatic pressure. The gas then desorbs from the coal and flows through the fractures in the coal towards the well and then to the well head at the surface.

Alongside the gas, groundwater is pumped to the surface and is then separated from the gas at the well head via a gravity separator. Normally the groundwater flow is highest initially and then falls over time as the pressure within the coal seam reduces, with gas production increasing after the pumping sequence commences. During this time of high groundwater flow, a small amount of gas is still being pumped to the surface. Flares are therefore constructed and operated in these times which ignite this initial excess gas safely before production increases to a viable level in order to start pumping larger volumes of gas along the pipeline.

Depressurising the coal seam of can take days to months depending on factors such as well configuration and local geology/hydrogeology. The quantities of gas and water extracted from each well also differs individually depending on these factors. The typical gas production and water extraction over time in a gas well is displayed in Figure 4.

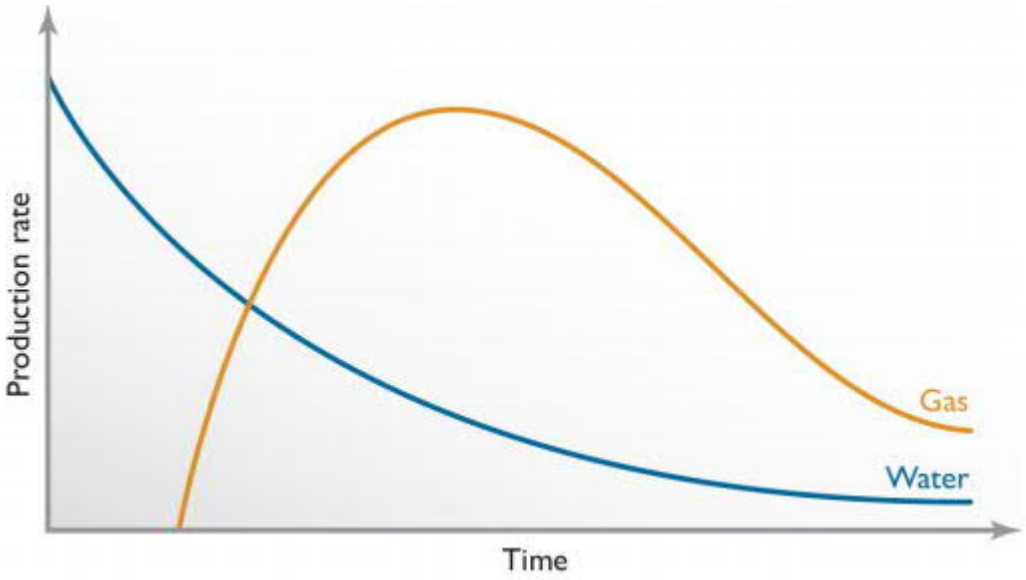


Figure 4 Gas production and water extraction over time in a typical gas well (Santos, 2014)

The groundwater pumped to the surface is proposed to be collected and provided by Blue Energy to nearby mines for beneficial re-use activities, such as coal washing and dust suppression. The gas that is being pumped towards the surface is considered 'wet' gas, as it contains other gaseous substances, the most prevalent being water vapour. The water quality of the groundwater can range from fresh water (100 mg/L total dissolved solids (TDS)) to brackish water (10,000 mg/L), with the majority of aquifers in the Bowen basin contained within coal seams trending towards the higher end of this range. This extracted water will be managed in accordance with the standard model conditions for CSG.

Extracted gas, once separated at the well head, is transported downstream into gas flowlines which lead to a centralised facility where gas is compressed. Compression facilities are outside of the scope of this EA Application and will not be considered within this document. Blue Energy would rely on other facilities functioning in the vicinity of the Project area. These facilities include:

- Proposed North Queensland Gas Pipeline, located north-west of Lancewood to supply gas to Northern Australia.
- Arrow Bowen Pipeline (PPL 144) proposed by Arrow Energy, located between Sapphire and Central to supply gas to Gladstone.
- Compression stations located West of Sapphire. Stations will compress gas ahead of being transported via an approved compressed gas transmission pipeline such as those presented in the recently released Bowen Basin Concept Study (KPMG, 2021) prepared for the Department of Resources.

Gas flow lines will require water condensate drainage points along their route as water drops out of the 'wet gas'. These flowlines can be above or below the ground surface and operate at low pressure to reticulate gas to a compression facility. After the compression of gas, major gas transmission pipelines transport gas to market for domestic or overseas buyers.

2.2.2 Well Development

Blue Energy are proposing to develop three PLs incrementally over the life of the Project. As new areas are developing and/or existing wells are expanded further, there will equally be declining areas of production where the decommissioning of wells and infrastructure is undertaken alongside progressive rehabilitation of the landscape. This will mean there will not be one very large disturbance area at any one time across each of the PLs – small areas across the PLs will be constructed, utilised and then decommissioned appropriately. Construction impacts can therefore be minimised via this approach, as well as this being the most efficient way to extract gas over the long term as it supplies a steady stream of gas to the centralised facility.

2.2.3 Construction of a Gas Production Well

The construction of a gas well initially consists of constructing a well pad and lay-down area which will hold the additional infrastructure and equipment required for the drilling and development of a lateral or vertical well. In order for a well pad to be prepared, the area around the site, typically within a 100 m x 100 m area, must:

- Clear surrounding vegetation
- Level the ground surface including clearing topsoil
- Construct a pit to hold all material removed from the drilling of the well (drilling muds)
- Bring water tanks onto site to hold groundwater extracted from wells
- Construct a cellar (chamber which the drilling assembly passes through)

- Construct a well via a steel and cement casing to allow for the pumping of groundwater and flow of gas to surface
- Erect a pump unit and construct and connect gas gathering lines, and
- If required for production testing, install portable well testing equipment including a flare

Following clearing of vegetation, topsoil will be stockpiled into windrows and batters will be stabilised to minimise erosion. This will be achieved by:

- Seeding and revegetation of topsoil stockpiles
- Stockpiles will be created with a low slope angle to reduce erosion risk, and
- Potential erosive subsoil to be ameliorated with gypsum to reduce erosion risk.

Gas wells are created by drilling through the overlying strata into the coal seam. The timing to complete the well drilling depends on factors such as the following:

- The geology/hydrogeology of the overlying strata
- The equipment used to drill (e.g. the drill rig), and
- Target depth of the well.

Approximate depths for each of the PL's are outlined in Table 5.

Table 5 Maximum depth of vertical wells within each PL

PL	Maximum depth
Sapphire (PL 1034)	~ 760 m
Central (PL 1038)	~ 1,130 m
Lancewood (PL 1045)	~ 800 m

Typically, wells are drilled vertically, however, Blue Energy are planning to pair each vertical well with horizontal, or lateral wells, which will be drilled along coal seams. A schematic of this well pairing is shown in Figure 5.

All drill rigs are equipped with high levels of safety measures, including a blow-out preventer which ensures that if unexpected high water/gas pressures are encountered, the system can be shut off to prevent water or drilling fluids being released into the surrounding environment. Drilling fluids are used to cool the drill bit and maintain the pressure control of the well to therefore stabilise hole that is being drilled. These fluids and the cuttings created from removing the strata are removed and disposed of (if they cannot be recycled) after the well is drilled to target depth.

On completion of the well to target depth, the well may be lined so the coal seam gas (and water) can be removed effectively. To prevent mixing between aquifers, the well casings are cemented into position. The lateral wells would be drilled within one coal seam, connecting this seam to the vertical well to allow for effective gas and water extraction. To reduce impact, multiple lateral wells targeting different seams will be drilled from the one pad. At the surface and once the well has been completed, a pump is then connected, and tubing placed into the well to extract and pump gas and water to the surface for resource use. Water and gas are separated at the well head as per industry standard practices, and the gas is piped at low pressure via a network of gathering lines to compression facilities where it is further transported downstream to market and the produced water pumped to a holding tanks for further use.

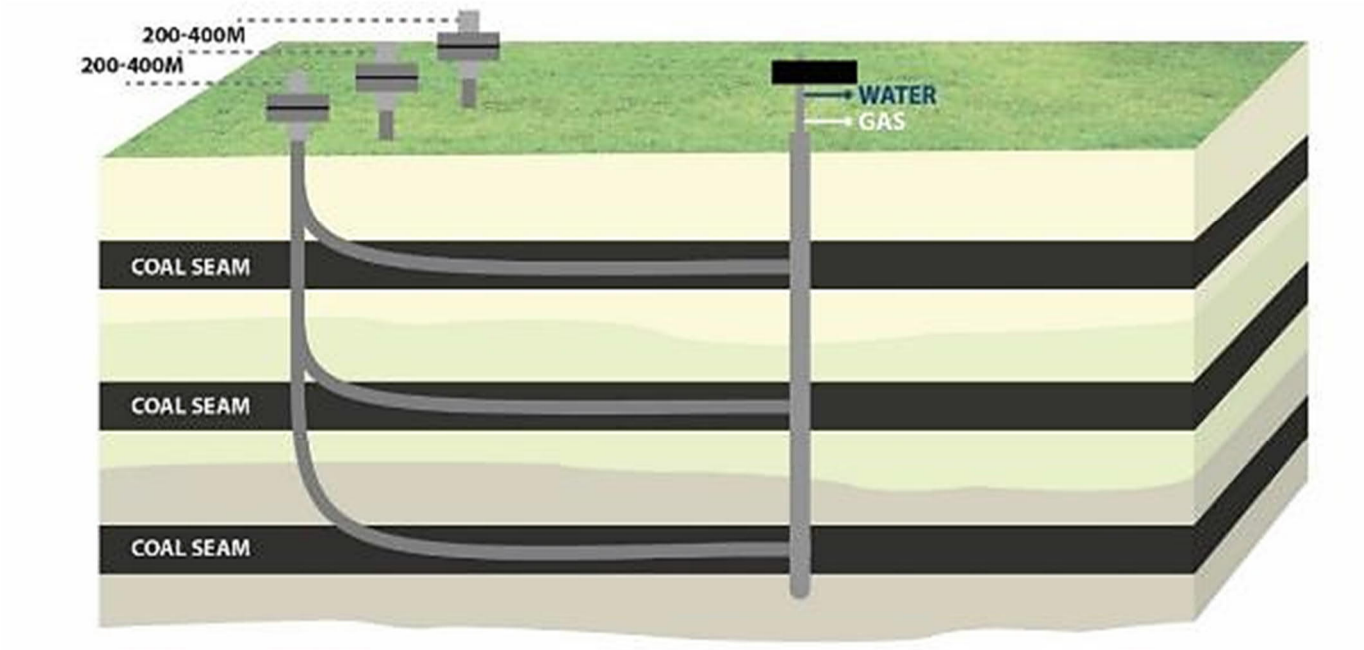


Figure 5 Lateral well intersecting with vertical production well at multiple seam depths

2.2.4 Decommissioning and Rehabilitation of Wells

When drilling is completed, and the well head, pump and telemetry equipment installed, an operational perimeter fence would be built, and the equipment used to construct the well would be removed from the laydown area. The majority of the construction laydown area will be rehabilitated, other than that required for operational activities.

When a gas well is no longer required for operations, the well is sealed from the bottom to the surface using cement plugs. The steel casing is also cut off and sealed below the surface level, with the remaining surface infrastructure being removed. The decommissioning of gas well will be in accordance with regulatory and approval requirements and utilises industry best practice.

Surface gathering lines as well as transmission pipelines will also be decommissioned. Surface pipelines will be removed and the surrounding land rehabilitated. Buried pipelines will not be removed as this would further disturb the ground surface, therefore these will be left and decommissioned safely in accordance with the *Code of Practice for constructing and abandoning coal seam gas wells and associated bores in Queensland* (Department of Natural Resources and Mines, 2013). Equipment will be recycled and re-used in other areas of the PL for ongoing wells development.

Detailed rehabilitation strategy is outlined in Section 11.

2.3 Project Progression

Based on volumetric modelling from production and core hole data, the estimated Project reserves are displayed in Table 6.

Table 6 Project reserves within each PL

PL	Project reserves
Sapphire (PL 1034)	275 Petajoules (PJs) of reserves and 360 PJs of contingent resource
Central (PL 1038)	87 PJs of reserves and 455 PJs contingent resource
Lancewood (PL 1045)	1 PJs of reserves and 463 PJs contingent resource

This is based on a current modelling prediction providing an expected project life of 20 years before first abandonment of wells; however, optimising production may extend the life of this Project. An initial development period (to full establishment) will be required for each of the PLs. Early test wells are likely to be drilled in each area at the start of the project, but the full project development will be started as per the breakdown for the PLs shown in Table 7.

Table 7 Initial development period within each PL

PL	Initial development period
Sapphire (PL 1034)	10 years, commencing at year 0 from Project start, excluding pilot well testing.
Central (PL 1038)	15 years, commencing at year 5 from Project start, excluding pilot well testing.
Lancewood (PL 1045)	10 years, commencing at year 7 from Project start, excluding pilot well testing.

After the initial drilling, operations in the field may consist of work overs to extend the life of a well and other well enhancement activities. Production activities inside each PL are modelled to continue for 20 years pending geological characteristics encountered during drilling. New drilling may occur after the initial development period into other seams where it is economical for Blue Energy to do so.

In terms of abandonment, this will occur on a well-by-well basis and is anticipated to be approximately 20 years after well development. Wells across the Project area are still expected to produce approximately 0.1 TJ per day, meaning gas production is still economically viable. Well work overs may therefore occur approximately every 2 – 3 years after this depending on the production of the individual well and therefore may extend the life of some wells across the Project area.

2.3.1 Project Development

Each PL will gradually progress with over time with construction of the works, where wells will be built progressively over a 20 year period. The development cycle will involve the construction and operation of wells across the Project during which all gas production will be delivered to the existing surrounding pipeline and compression station infrastructure for processing. Over this period, Blue Energy will complete over 100 km of seismic assessment, civils work for 530 well pads and construct 700 kms of gas and water gathering lines. The construction of major transportation gas pipelines may change where produced gas is transmitted via the gathering lines inside each PL. These changes to gas transportation will be directly influenced by the location of each PL in relation to the proposed infrastructure project. The general works that will occur across all PLs is summarised below:

- 2D and/or 3D seismic acquisition of the staged area prior to drilling

- Construction of well pad with vertical, lateral or multi well heads constructed. Bi-lateral wells will access multiple coal seams. Vertical wells will have pumps operational to extract gas
- In field gathering lines constructed
- Trunk line to transfer gas and water into existing nearby treatment and compression facilities, and
- Water pipeline construction to nearby mine(s) for beneficial reuse.

The Project progression chart, indicating the proposed start and finish time in years for all PLs is displayed in Figure 6. The Project progression is shown spatially across each of the PLs in Figure 7 to Figure 9.

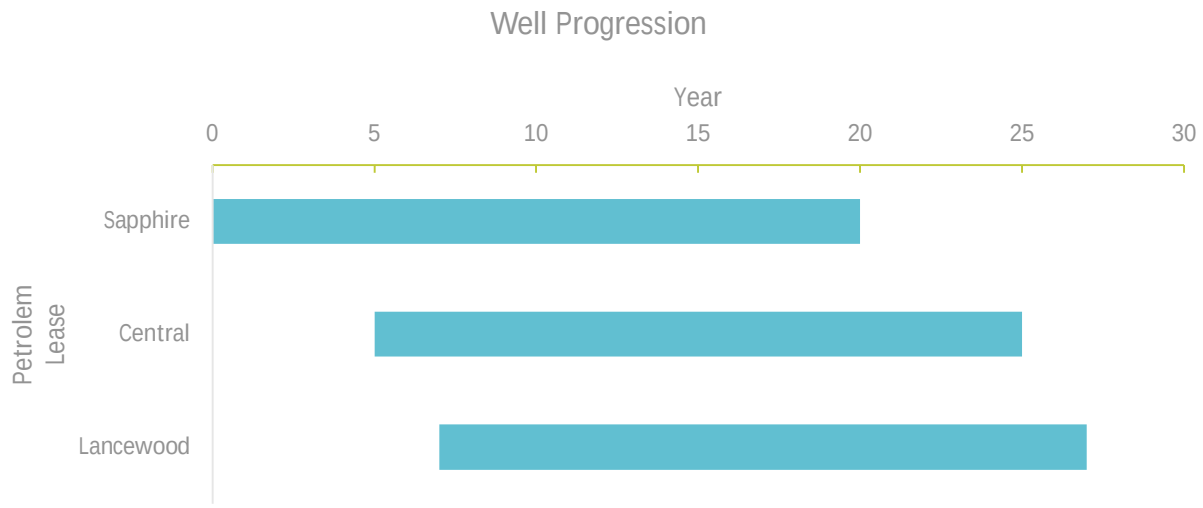
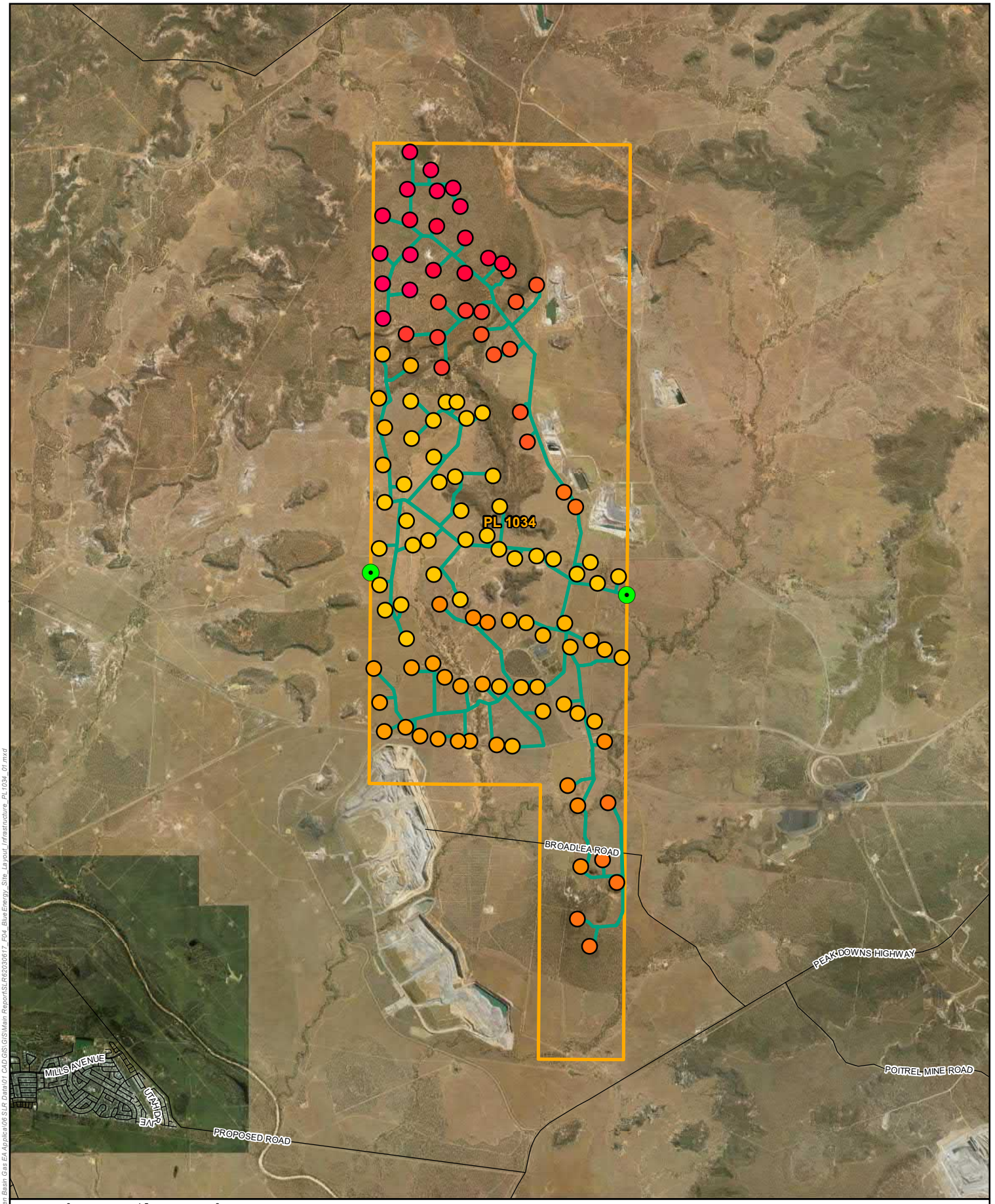


Figure 6 Progression sequences across the Project area

Proposed activities encompass both on-the-ground works, engineering, procurement and planning and approval work to facilitate the implementation of the future years of the development plan.

Planning and approval work will include:

- liaising with potential co-development partners
- obtaining approvals for land access from landholders and cultural clearance from Traditional Owners
- obtaining approvals to transport gas and water into the three PLs
- negotiating Gas Sales Agreements, and
- obtaining necessary Government approvals.



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	GC

LEGEND

- Project Area (PL 1034)
- Gathering Lines
- Sapphire - Tie in Point (TIP)

Development Years

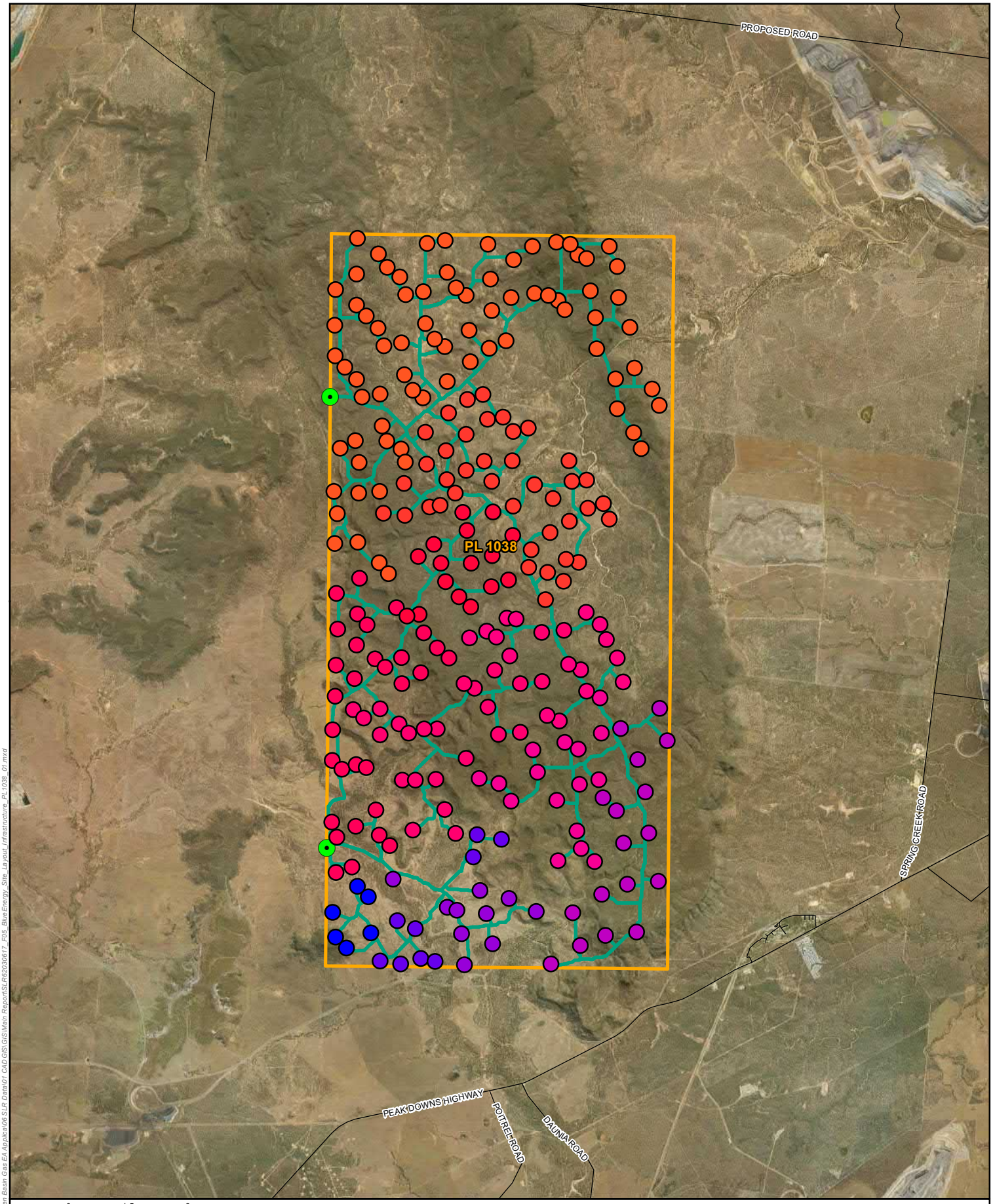
- Year 1
- Year 2
- Year 3
- Year 4
- Year 5
- Year 6
- Year 7
- Year 8
- Year 9
- Year 10

BLUE ENERGY EA APPLICATION

Site Layout & Infrastructure PLA 1034 (Sapphire)

FIGURE 7

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306617_F04_BlueEnergy_Site_Layout_Infrastructure_PL1034_01.mxd



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:125,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	JN

LEGEND

- Project Area (PL 1038)
- Gathering Lines
- Central - Tie in Point (TIP)

Development Years

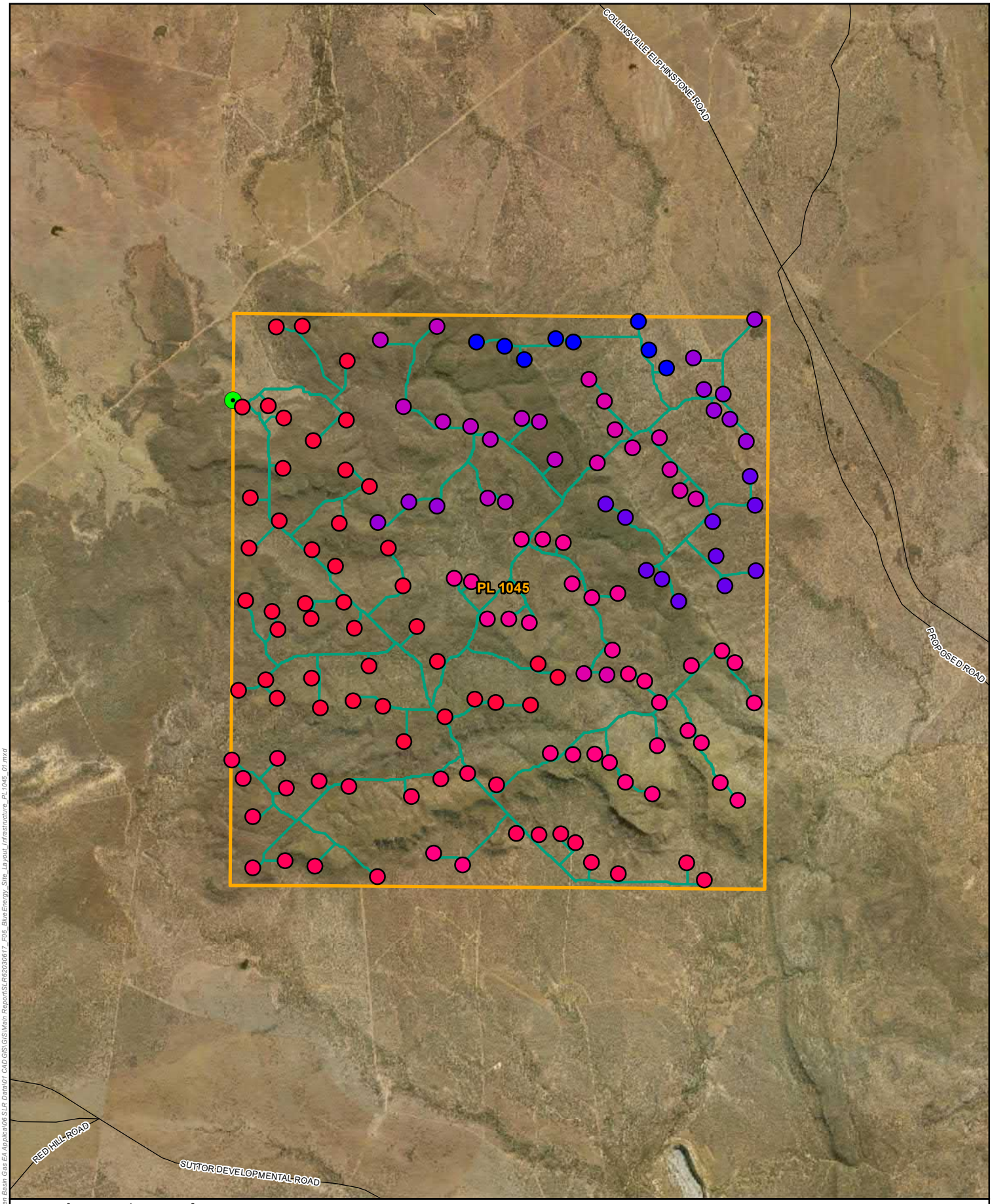
- Year 6
- Year 7
- Year 8
- Year 10
- Year 11
- Year 12
- Year 13
- Year 15
- Year 16
- Year 17
- Year 18

BLUE ENERGY EA APPLICATION

Site Layout & Infrastructure PLA 1038 (Central)

FIGURE 8

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306 17_F05_Blue Energy_Site_Layout_Infrastructure_PL1038_01.mxd



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	GC

LEGEND

- Project Area (PL 1045)
- Gathering Lines
- Lancewood - Tie in Point (TIP)

Development Years

- Year 8
- Year 10
- Year 12
- Year 13
- Year 14
- Year 15
- Year 16
- Year 17
- Year 18

BLUE ENERGY EA APPLICATION

Site Layout & Infrastructure PLA 1045 (Lancewood)

FIGURE 9

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306617_F06_BlueEnergy_Site_Layout_Infrastructure_PL1045_01.mxd

Activities will include further on the ground works for field development. The proposed location of well pads, gathering lines, infrastructure and site layout are displayed in Figure 7 to Figure 9. Final well pad locations will be confirmed once the following has been determined:

- environmental constraints including biodiversity values
- consideration of cultural and heritage constraints
- consideration of any sub surface constraints and post seismic activity, and
- consent of landowners and other stakeholders is obtained.

Blue Energy propose to have wells producing over a 20 year development life within each of the three PLs. The number of wells developed over each year will be further refined throughout the initial construction. It is anticipated that at full development, the Project will encompass the following:

- establishment of a total of 530 well pads across the three PLs, and
- drilling of a combination of lateral and vertical wells, with an average of 1-5 wellheads per lateral well pad.

2.4 Types of Petroleum Activities and Geological Setting

The Project is located in the geological Bowen Basin, which is one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian period. The Bowen Basin is the largest productive coal basin in Australia. Coal seam gas resources have been found within coals from the Rangal and Fort Cooper Coal measures of the Permian Blackwater Group within the application area. The Rangal Coal Measures are present above the Fort Cooper Coal Measures and are comprised of feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams. The Fort Cooper Coal Measures is comprised of comprised of lithic sandstone, mudstone, conglomerate, shale, coal and tuff (Geoscience Australia, 2021).

Blue Energy proposes to develop the CSG activities with a combination of lateral and vertical wells using multi well pads. Two primary coal seams (Rangal and Fort Coopers) will be targeted, and each lateral will have an intended inseam length of 1,000 m and up to 2,000 m. A third coal seam, the deeper Moranbah coal measures will be targeted in some areas depending on its depth and seismic investigations. There are two primary geological domains to be developed; shallow, higher permeability coal and deeper, lower permeability coal. The stratigraphy of the area has been conceptualised by Arrow Energy (2013), the conceptual cross sections are shown in Figure 10.

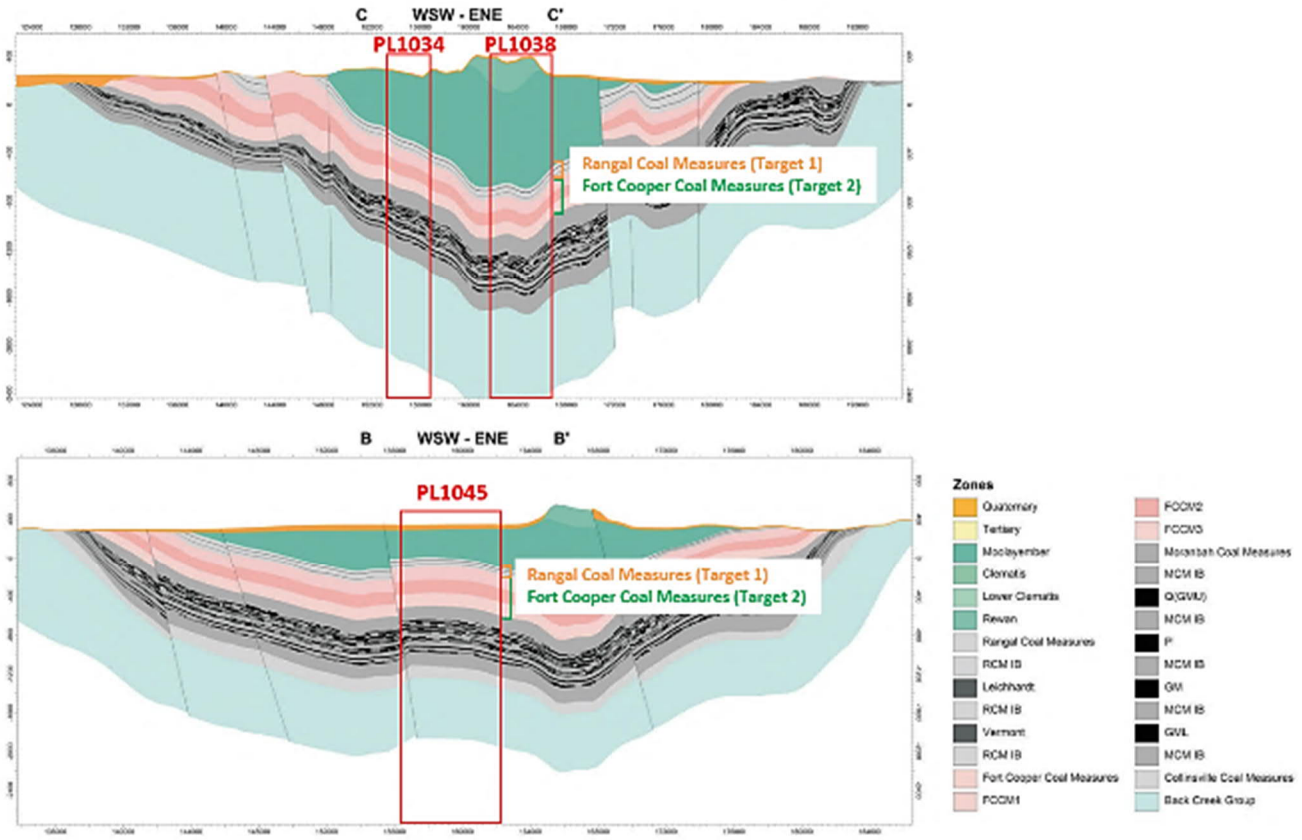


Figure 10 Conceptual Cross Sections (Modified from Arrow Energy 2013)

2.5 Infrastructure

The locations of infrastructure within the Project area will ultimately be dependent on discussions with the landholders and other stakeholders. Existing infrastructure will be utilised to the extent practicable, and this is expected to facilitate the earliest possible production start from the Project by reducing time and costs. The indicative location of the well pads and gathering lines are provided in Figure 7 to Figure 9.

2.5.1 Multi-well Pads

Blue Energy proposes to develop the field with a combination of lateral and vertical wells that operate in tandem using multi well pads. Well construction will be built in accordance with all relevant and accepted guidelines and standards for Queensland CSG wells.

It is anticipated that a single well pad would require the clearing of up to 1 ha, whilst multi well pads would have a disturbance area not exceeding 1.5 ha as outlined in the streamlined conditions. The exact number of wells per pad will be determined prior to drilling as more site-specific information is acquired. Generally, multi well pads will have between two and five wellheads, based on site-specific geological information. Due to the nature of the resources across the Project, Blue Energy's process to maximise the resource is to run seismic prior to any development to get a clearer picture of the subsurface prior to siting well pads and infrastructure. Once this exercise is completed and the sub-surface experts identify the area of most probable success, land access and cultural heritage constraints are mapped. Blue Energy will follow the following measures in order to minimise the amount of disturbance in the well pad clearance areas:

- Maximise the use of areas of pre-existing disturbance
- Avoid, minimise or mitigate any impacts, including cumulative impacts on areas of native vegetation or other areas of ecological value
- Minimise disturbance to land that may result in land degradation
- Avoid, then minimise isolation, fragmentation, edge effects or dissection of tracts of native vegetation, and
- Avoid then minimise clearing of native mature trees.

Well locations will be selected so as to utilise the existing gas gathering network surrounding the PLs (e.g. Arrow Energy's operations west of Sapphire), as well as proposed projects such as the approved Arrow Bowen Pipeline and North Queensland Gas Pipeline. All wells will be connected into the main gas header in each of the respective PLs, allowing water and gas to be processed. Power will be supplied by field fuel gas, diesel or mains depending on well locations. All production wells will require gas and water metering, downhole pump and gas-powered, with production equipment controlled remotely by a SCADA system.

2.5.2 Well Construction

CSG wells produced from naturally fractured (cleated) reservoirs do not require hydraulic fracture through cemented casing as gas can traverse through the seam towards the well. Therefore, no hydraulic fracturing is proposed for the activities outlined in this EA Application. Lateral wells are completed with uncemented, pre-perforated liners to reduce rubble in the borehole and mitigate well collapse. Furthermore, it has been determined that multi laterals drilled at a downdip azimuth is the preferred development style. Additional technical advantages to the lateral design include:

- The ability for the wells to free-flow gas via the lateral, with water produced from the vertical, significantly reducing workover costs associated with replacing failed pumps
- Multiple coal seams can be developed at the same time, reducing development costs and surface disturbance.
- Well pads can be shared between vertical and lateral wells reducing development foot print
- Additional coal seams can be targeted at a lower cost, optimising the development

The current well design is to drill a build-section down to the coal seam, so the well enters the seam close to horizontal. The build-section is cased and cemented. The lateral borehole is then drilled in the coal seam in a downdip azimuth and completed with a perforated liner in the open-hole reservoir. The lateral well will then intersect with a drilled vertical well with a pump placed at its bottom, allowing gas to be pumped towards the surface from the lateral seam via the vertical well's pump.

2.5.3 Gas and Water Systems

The Project will require the installation of a buried gas and water gathering system from each vertical (production) well to a shared processing facility or pipeline. Initially, all production gas will be transported and tolled through a neighbouring compression facility to the west of Sapphire where it would be treated using existing infrastructure by entering a tolling agreement.

Water gathering lines will be installed in parallel with the gas lines. Pipelines on the Project will have a 20 m Right of Way (ROW), with the installation of 700 km of gas and water pipelines to be constructed over the life of the three PLs. This will equate to a total surface disturbance of 530 ha over the duration of development for the Project. Where feasible Blue Energy also aims to maximise co-location of infrastructure within existing access tracks/fence lines/cleared areas and minimise ROW widths.

Modelling will be conducted to size the gas and water headers. Gas produced from the wells will be collected in separate gathering lines and transported back to an existing shared compression hub for processing. Water which is gathered from wells will be distributed to nearby mines for beneficial reuse. In addition to this, a MOU signed for a hydrogen supply project between Blue Energy and Stanmore Resources will additionally help leverage supply gas and water from this Project's operations to the hydrogen project.

Blue Energy will construct linear infrastructure in the same manner as the framework set out for the well pad clearance areas:

- Maximise the use of areas of pre-existing disturbance
- Avoid, minimise or mitigate any impacts, including cumulative impacts on areas of native vegetation or other areas of ecological value
- Minimise disturbance to land that may result in land degradation
- Avoid then minimise isolation, fragmentation, edge effects or dissection of tracts of native vegetation, and
- Avoid then minimise clearing of native mature trees.

2.5.4 Compression Station

This Project scope does not include a compression station and therefore this EA application will not be considering or evaluating a compression station as a part of this approvals process. Instead, Blue Energy will seek, by entering an agreement, the shared usage of Arrow Energy's and/or CSL's compression hub, both in nearby vicinity to the Sapphire and Central tenements. Lancewood will aim to connect to the North Queensland Gas Pipeline which is currently in operation. In addition to the current infrastructure in the area, Arrow Energy has approval for a new Bowen Gas Pipeline, and the Queensland Government is currently reviewing other pipe line options. Blue Energy is in discussions with third parties for the construction and operation of open access gas processing facilities that can be built in the region.

2.6 Exploration and Production Methods

Blue Energy propose to develop the field with a combination of lateral and vertical wells. Lateral wells will be constructed as down dip laterals intersecting a vertical production well. The thickest seams will be targeted, and each lateral will be drilled to an intended 1,000 m inseam. Over time longer laterals will be considered, which will reduce the overall well requirements and surface disturbance.

There are two primary geological domains to be developed; shallow, higher permeability coal, and deeper, lower permeability coal. The conceptual well design changes between these two domains.

All production wells will require gas and water metering and downhole pumps. Well pumps will be powered by a gas-powered compressor (or main power depending on location). All well production equipment will be controlled remotely by a SCADA system. Once wells are operational, there is potential for solar powered pumps to be the primary source of gas production at the vertical well head, decommissioning the gas gensets. These solar powered pumps will work by pumping during the 8 to 12 hour day (subject to daylight), letting the well fill up with water during the 12 hours the pump is not active, and then restarting the next day. As gas will be produced from the laterals, this should effectively produce a similar gas production curve to a gas genset as it optimises and improves upon the efficiency of the production of gas for each well whilst saving on gas expenditure. Emissions will also not be present from the solar powered gensets.

2.7 Annual Production Rates (CSG)

The forecast raw production profile across the development and production life for the Project is shown in Table 8 below. There is approximately 1710 TJ of gas expected to be produced in the Project application area over the forecast development time frame. It is envisaged that pilot wells would be drilled in 2022 with production to commence within two years of the grant of the PL.

Table 8 Estimated annual rates of CSG production

Year	Gas Production - Terajoules		
	Sapphire	Central	Lancewood
1	12.43	12.43	9.94
2	30.85	29.86	18.72
3	38.15	33.80	20.78
4	38.85	29.66	22.31
5	37.46	29.30	23.55
6	36.31	33.87	27.20
7	36.08	35.70	28.28
8	36.58	35.86	29.22
9	37.47	33.99	30.46
10	37.59	32.70	31.79
11	35.44	34.09	32.65
12	32.39	34.70	31.17
13	30.18	34.24	28.08
14	28.56	32.50	25.77
15	27.36	30.18	24.23
16	26.49	28.49	23.12
17	25.81	27.33	22.34
18	25.16	26.35	21.66
19	24.53	25.52	21.07
20	20.65	21.54	17.93
Total	618.34	602.09	490.26
Average/year	30.92	30.10	24.51

The approximate total annual expected CSG water production shown in Table 9.

Table 9 Expected produced water volumes

Year	Produced Water – ML		
	Sapphire	Central	Lancewood
1*	108	39	108
2	241	193	241
3	351	165	331
4	385	238	321
5	386	208	274
6	387	277	341
7	397	298	387
8	410	312	395
9	425	331	407
10	442	351	374
11	440	370	398
12	412	380	414
13	391	352	417
14	377	332	412
15	366	318	391
16	356	308	375
17	348	221	363
18	340	215	354
19	333	210	345
20	326	206	337
Total	7,220	5,323	6,985
Average/year	356	264	344

* Assumed 20% of year 2 production.

The water quality will be analysed and assessed to determine disposal and/or reuse options. The most likely option for the destination of water produced will be to provide it to the surrounding mines for their own purposes, resulting in beneficial reuse. Currently there is a long term shortage of water for mine usage in the area.

2.8 Construction and Operational Workforce

It is proposed to use a construction workforce which is experienced in current construction activities in adjoining lease areas, which will aim to include workers utilised previously by Blue Energy to ensure consistent standards. The workforce is expected to be based in Moranbah/Coppabella, where construction crews will travel to site daily from mine camps and/or in town accommodation. There will be the need for temporary ablutions and other waste receptacles at each work site, which would be serviced by a licensed contractor.

2.9 Streamlined Model Conditions

This EA Application is proposed to meet the DES streamlined model conditions. The proposed mitigation and programs that demonstrate the activities compliance against each of these conditions are provided in Appendix A.

3 Land

3.1 Environmental Values

The environmental values (EVs) of the land to be protected or enhanced are the:

- Integrity of undisturbed land and ecosystems
- Integrity of the topsoil as a resource for rehabilitation
- Stability of disturbed land and ensuring it is non-polluting
- Integrity of soil health and function including the physical and chemical attributes relative to vegetation establishment and growth
- Integrity of soil stability and structure for erosion protection, and
- Suitability of the land for continued agricultural use after rehabilitation.

The EP Regulation provides the following environmental objective and performance outcomes with regards to land. Under Schedule 5, Part 3, Table 1 of the EP Regulation, the environmental objectives for activities with land impacts are:

Environmental Objectives

The activity is operated in a way that protects the environmental values of land including soils, subsoils, landforms and associated flora and fauna.

Performance Outcomes

There is no actual or potential disturbance or adverse effect to the environmental values of land as part of carrying out the activity.

All of the following:

a. activities that disturb land, soils, subsoils, landforms and associated flora and fauna will be managed in a way that prevents or minimises adverse effects on the environmental values of land

b. areas disturbed will be rehabilitated or restored to achieve sites that are—

i. safe to humans and wildlife; and

ii. non-polluting; and

iii. stable; and

iv. able to sustain an appropriate land use after rehabilitation or restoration;

c. the activity will be managed to prevent or minimise adverse effects on the environmental values of land due to unplanned releases or discharges, including spills and leaks of contaminants;

d. the application of water or waste to the land is sustainable and is managed to prevent or minimise adverse effects on the composition or structure of soils and subsoils.

3.2 Existing Environment

3.2.1 Geology

The Project Area is located on several geological units of interest across the three PLs, all of which form part of the greater Permian-Triassic Bowen Basin. Coal bed methane gas resources have been found within the Permian units across the Project PLs including the Rangal Coal Measures, Fort Cooper Coal Measures and Moranbah Coal Measures. Sediments comprise of coals, sandstones, siltstones, conglomerates and claystones. The Rangal Coal Measures range in thickness from 25 m to 200 m. The Moranbah Coal Measures have an estimated thickness inside the Project area of 100 m to 700 m.

The Permain beds are overlayed by Triassic units across the PLs which include the Moolayember Formation, Clematis Sandstone and Rewan Formation. These units comprise of lithic sandstone, sandstone, conglomerate and mudstone. Finally, the Triassic units are overlayed by Tertiary and Quaternary alluvium, of which consists of sequences of unconsolidated clay, silt, sand, gravel and colluvium.

The predominant solid geology lithology across all sites in the Project area comprises of a single main rock type being early to middle Triassic age arenite mudrock (Rewan Group) as shown in Figure 11.

Surface geological types of the Project, from which surface soils are derived, include those listed from oldest to youngest above and shown in Figure 12.

3.2.2 Topography and Landforms

The three PL's inside the Project area are located within Brigalow Belt Bioregion and locally within the Northern Bowen Basin sub-bioregion. The Brigalow Belt bioregion is known as a wide band of acacia-wooded grassland that runs between the tropical rainforest of the coast to the semi-arid interior of Queensland. The Northern Bowen Basin sub-bioregion covers an area of 13,169 km^2 and is comprised of rugged ranges and alluvial plains.

The Project area is split between the Upper Isaac River Catchment (PL 1034, PL 1038 and PL 1045) and Connors River Catchment area's (PL 1038). More details regarding the catchments, sub catchments and associated rivers inside the Project area are outlined in the Section 6.

PL 1038 and PL 1045 typically comprise of landforms with high hills or rugged mountains with frequent steep scarps benched slopes & rocky bluffs as well as strongly to moderately undulating or low hilly lands with broad valleys. PL 1034 consists of gently to broadly undulating plains with plateaux and mesas, including steep-scarped dissected margins. The Project area is primarily dominated by brigalow (*Acacia harpophylla)* and softwood vegetation communities overlying outcrops of Tertiary and Bowen Basin sediments.

The local topography across the Project area is detailed further in Figure 13, with Table 10 outlining the average elevation changes across the three areas.

Table 10 Local topography and PL elevation

PL	Elevation
Sapphire (PL 1034)	240 m to 250 m AHD
Central (PL 1038)	250 m to 450 m AHD
Lancewood (PL 1045)	400 m to 650 m AHD

3.2.3 Soils

In summary, a wide range of soils are likely to be present within the Project areas that are derived from the various surface geological formations. Typically, Rudosols dominated the areas inside each PL with higher elevations, whereas Vertosols and Sodosols were more prevalent in the lower lying areas, including valleys in the region.

Across the Project area there is limited detail for identifying, describing and mapping the site-specific soils and, by extension, prescribing detailed soil management practices to protect and reinstate current land suitability, good quality agricultural land, and strategic cropping land classifications to maintain the agricultural socio-economic capability of the land post mining operations. Generalised soil management practices, however, can be specified that recognise the different soil types and the need to manage each separately to preserve and maintain their individual characteristics for post mining rehabilitation.

Despite the limited detail, the major soil types could be identified via the ASRIS Level 4 mapping tool which is outlined for all three PL's in more detail below. These soil types are displayed across the Project area in Figure 14. Brief descriptions of each ASC soil order are provided in Table 12 based on Isbell & NCST (2021).

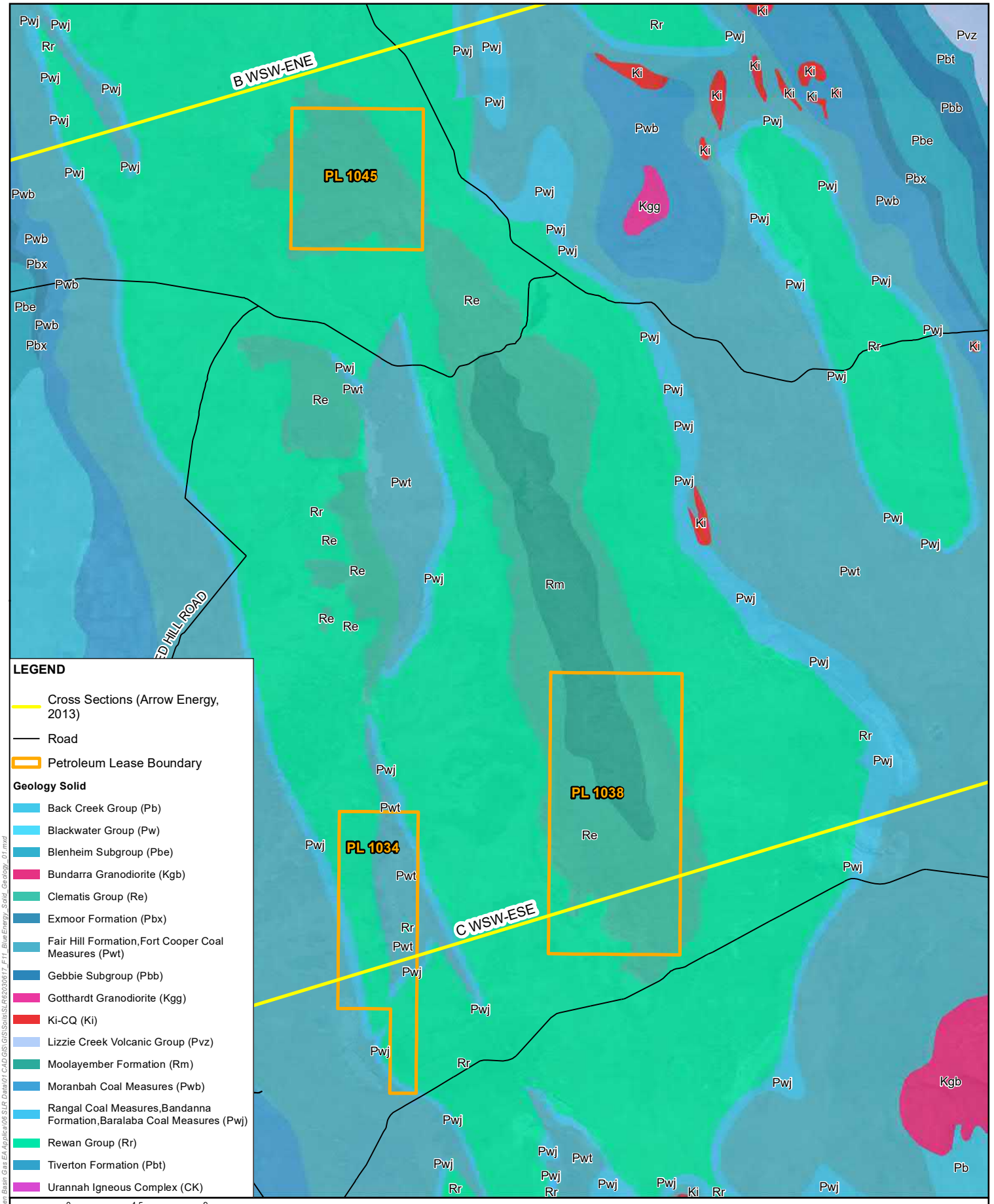
Table 11 ASC soil orders for each PL

PL	Description
Sapphire	Predominantly Vertosols with varying representation from Rudosols, Kandosols and Sodosols.
Central	Dominated by Rudosols with limited amounts of Vertosols and Sodosols.
Lancewood	dominated by Rudosols with limited amounts of Vertosols and Sodosols.

Table 12 Brief descriptions of ASC soil orders likely to be encountered within The Project

ASC Order	Description
Vertosol	Clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates
Kandosol	Soils that lack strong texture contrast and have massive or only weakly structured B horizons and are not calcareous throughout
Sodosol	Soils with strong texture contrast between A horizons and sodic B horizons, which are not strongly acid
Rudosol	Soils with negligible pedologic organisation. Usually young soils where soil forming factors have had little time to pedologically modify parent rocks or sediments

Where Sodosols are present, there is likely to be an increase in dispersion risk due to the higher sodicity in the soil. Where sodosols are being built upon or construction works are disturbing the soil surface, amelioration of these soils should occur to order to minimise the erosion risk resultant from construction works.



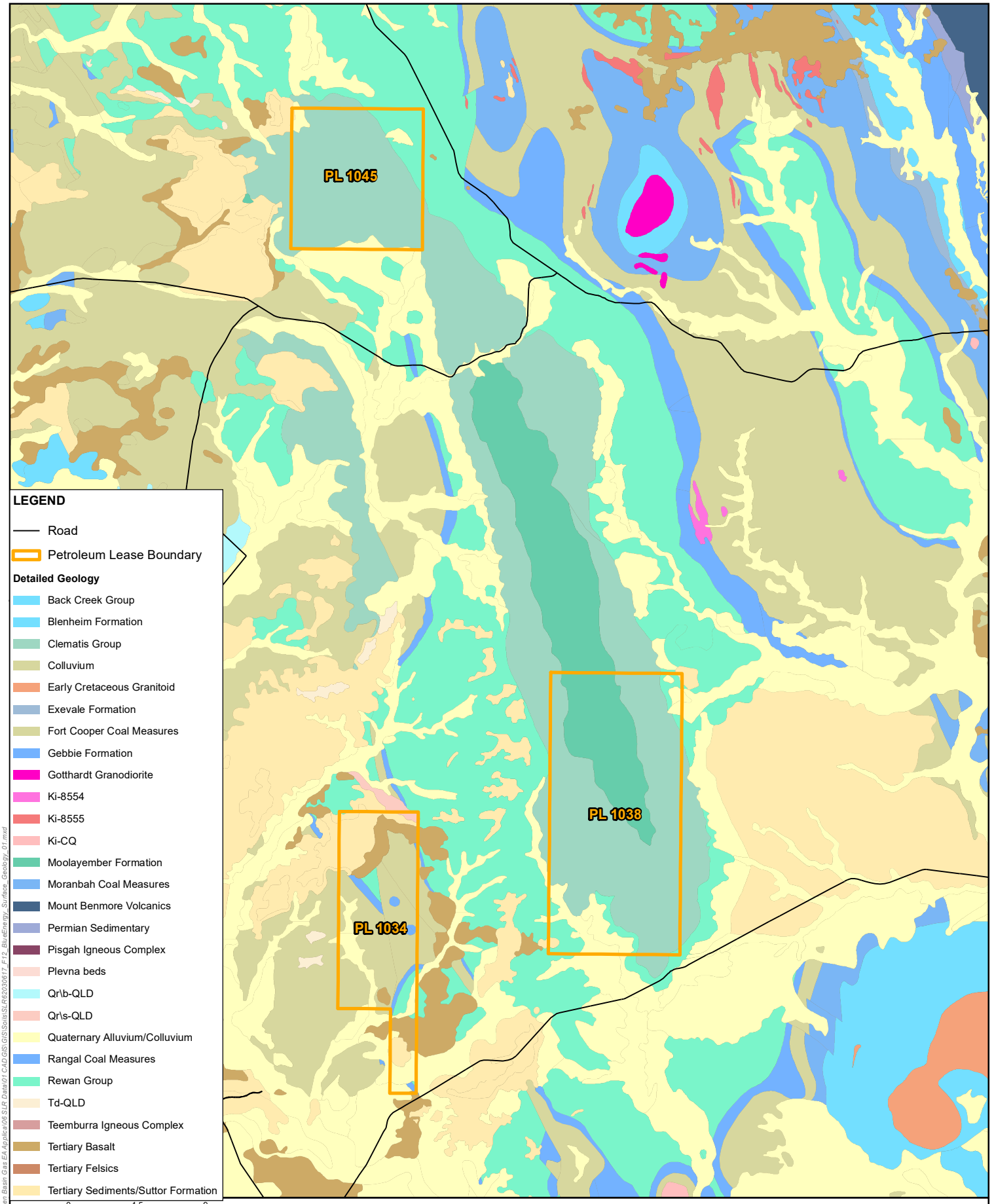
Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:325,000 at A4
Project Number:	620.30617
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	DC

BLUE ENERGY EA APPLICATION

Solid Geology

FIGURE 11

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Soils\SLR620306617_F11_BlueEnergy_Solid_Geology_01.mxd



Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:325,000 at A4
Project Number:	620.30617
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	DC

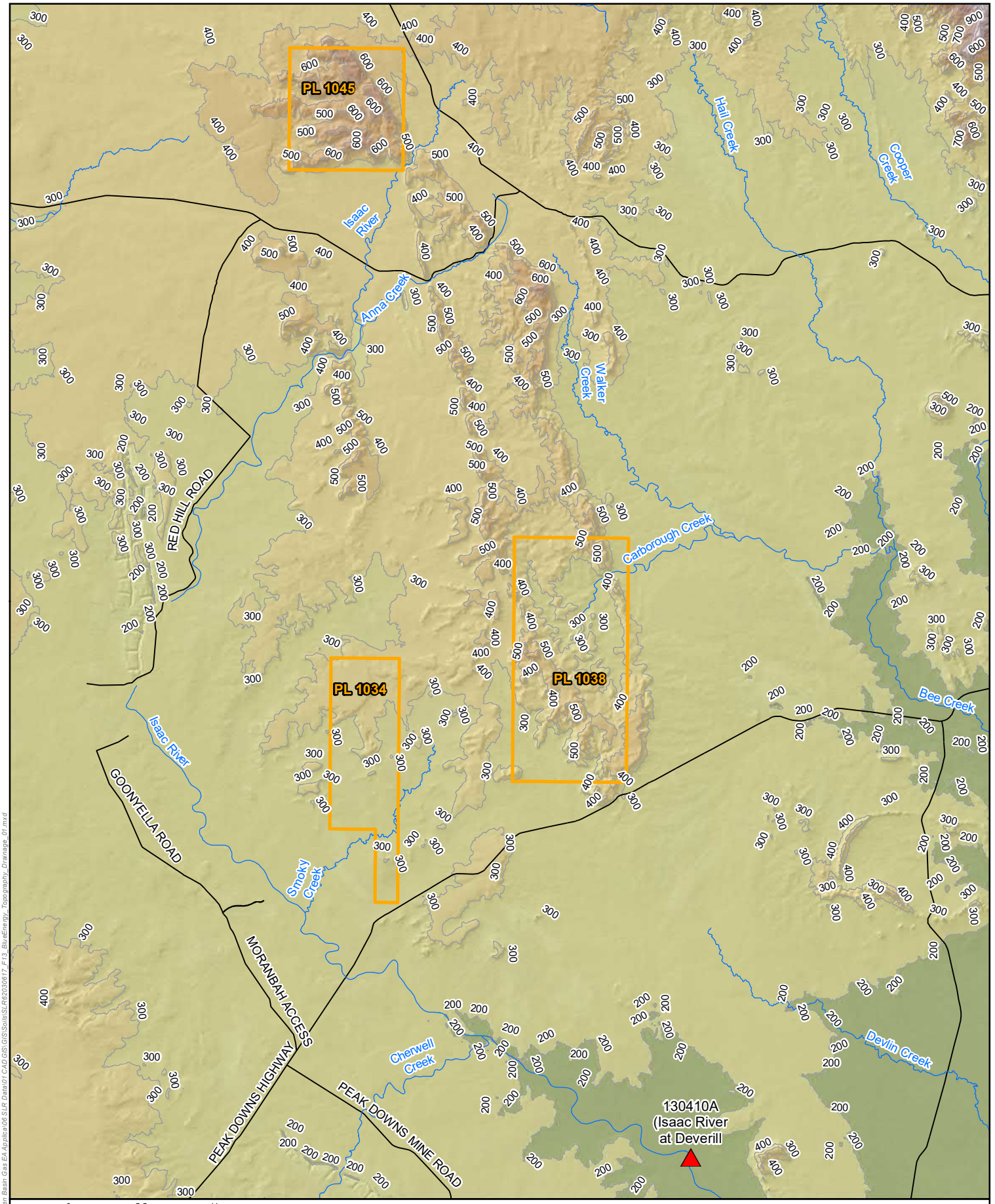
SLR

BLUE ENERGY EA APPLICATION

Surface Geology

FIGURE 12

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Soils\SLR620306617_F12_BlueEnergy_Surface_Geology_01.mxd



0 5.5 11 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:375,000 at A4
Project Number:	620.30617
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	DC

LEGEND

- Surface Water Monitoring Station
- Road
- Contours 100m
- Petroleum Lease Boundary

Elevation (mAHD)

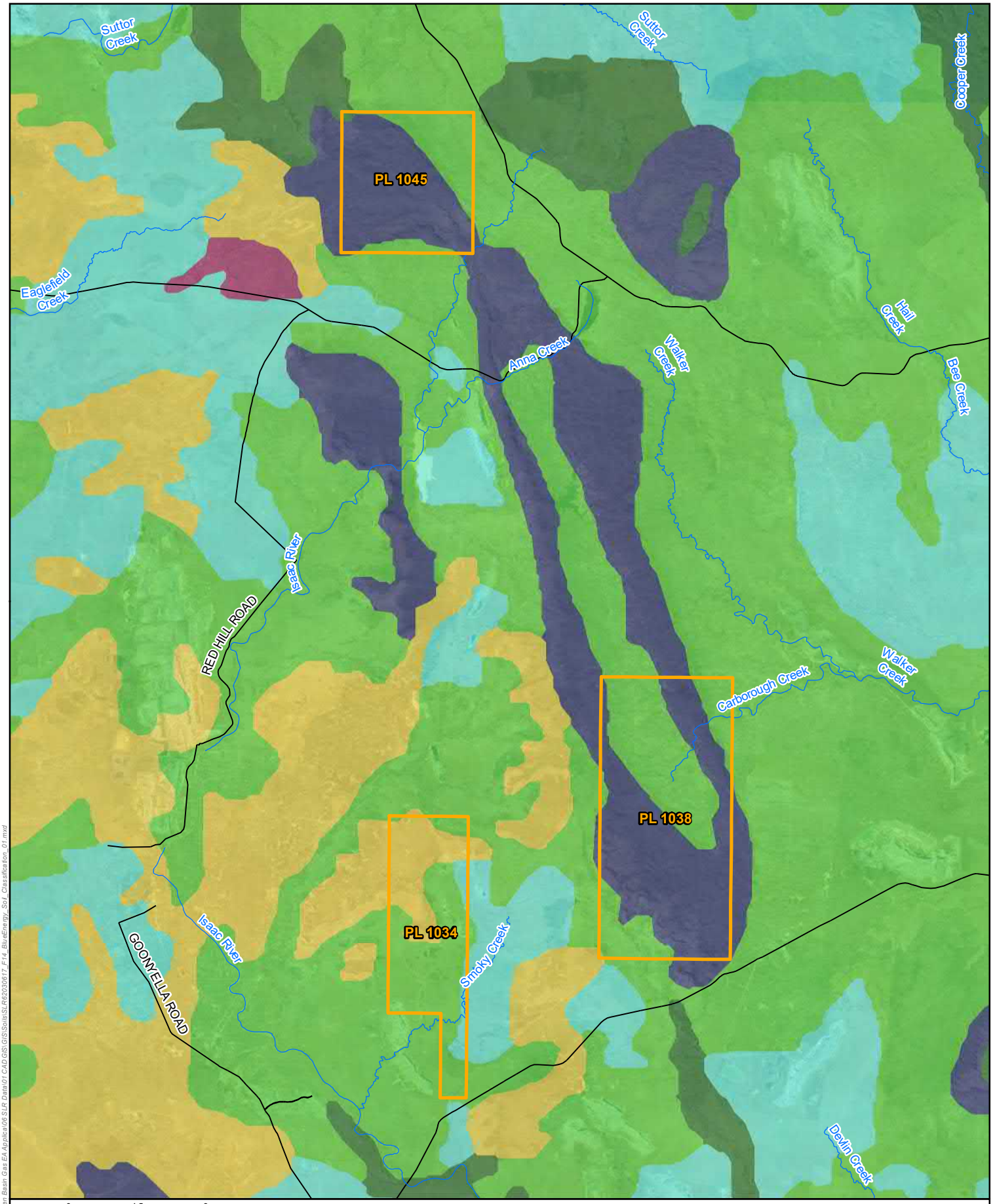
- 0 - 100
- 101 - 200
- 201 - 300
- 301 - 400
- 401 - 500
- 501 - 600
- 601 - 700
- 701 - 800
- 801 - 900
- 901 - 1,100

BLUE ENERGY EA APPLICATION

Topography and Drainage

FIGURE 13

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Soils\SLR620306617_F13_BlueEnergy_Topography_Drainage_01.mxd



0 4.5 9 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:325,000 at A4
Project Number:	620.30617
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	DC

LEGEND

- Road
- Petroleum Lease Boundary

Soils Classes (1:2M)

- Chromosol
- Dermosol
- Ferrosol
- Hydrosol
- Kandosol
- Kurosol
- Rudosol
- Sodosol
- Tenosol
- Vertosol

BLUE ENERGY EA APPLICATION

Soil Classification

FIGURE 14

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Soils\SLR620306617_F14_BlueEnergy_Soil_Classification_01.mxd

3.2.4 Existing Tenure

The land tenure within the Project is mixed between lands lease and freehold. Mining Leases (MLs) are situated within and to the north and south-west of PL 1034, with those being Isaac Plains Mine, Broadlea Mine and Broadmeadow Mine. As shown in Figure 15, Figure 16 and Figure 17, resource activities surround the Project area.

3.2.5 Land Use

Major roads within the Project area's vicinity for PL 1034 and PL 1038 include the Peak Downs Highway and Broadlea Road. Suttor Developmental Road and Collinsville Elphinstone Road are located in the vicinity of PL 1045. These roads are all located within road easements. The urban area of Moranbah is approximately 10 km to the east of PL 1034's boundary and 30 km east of PL 1038's boundary. The town of Glenden is located approximately 10 km north of PL 1045. The regional locality of the Project area including nearby towns and roads is shown in Figure 1.

Land use within the Project is primarily agricultural, predominantly grazing (Figure 18 to Figure 20).

3.2.6 Strategic Cropping Land Classification

The Project is located in the Western Cropping Zone of the Strategic Cropping Area as defined under the *Regional Planning Interests Act 2014*. From the State Strategic Cropping Land mapping, none of the Project area is mapped as Strategic Cropping Land.

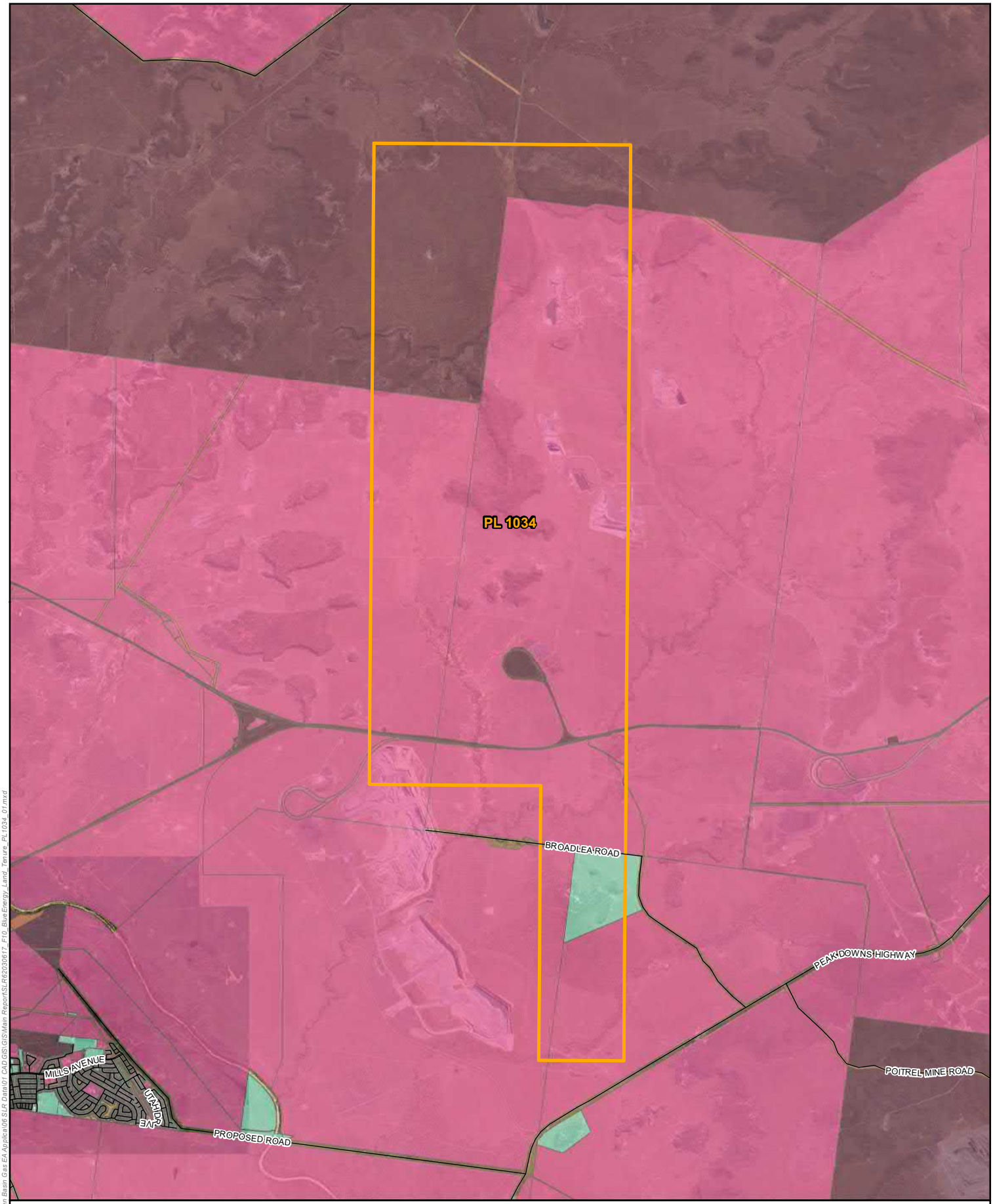
3.3 Emissions and Releases

Environmental values as they relate to land may be impacted from the proposed activities through the release of contaminants to the environment. Contaminants may be associated with wastes generated by the activities proposed or emissions related to air contaminants once deposited.

Contaminated waste has the potential to be generated from the following activities:

- CSG drilling and well completion activities
- Raw CSG water (as a waste)
- Treated CSG water (as a waste), and
- CSG operational activities (all other activities associated with the CSG project).

The release, risks related to, and management of wastes is treated in Section 8.



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	JN

LEGEND

- Project Area (PL 1034)

Tenure

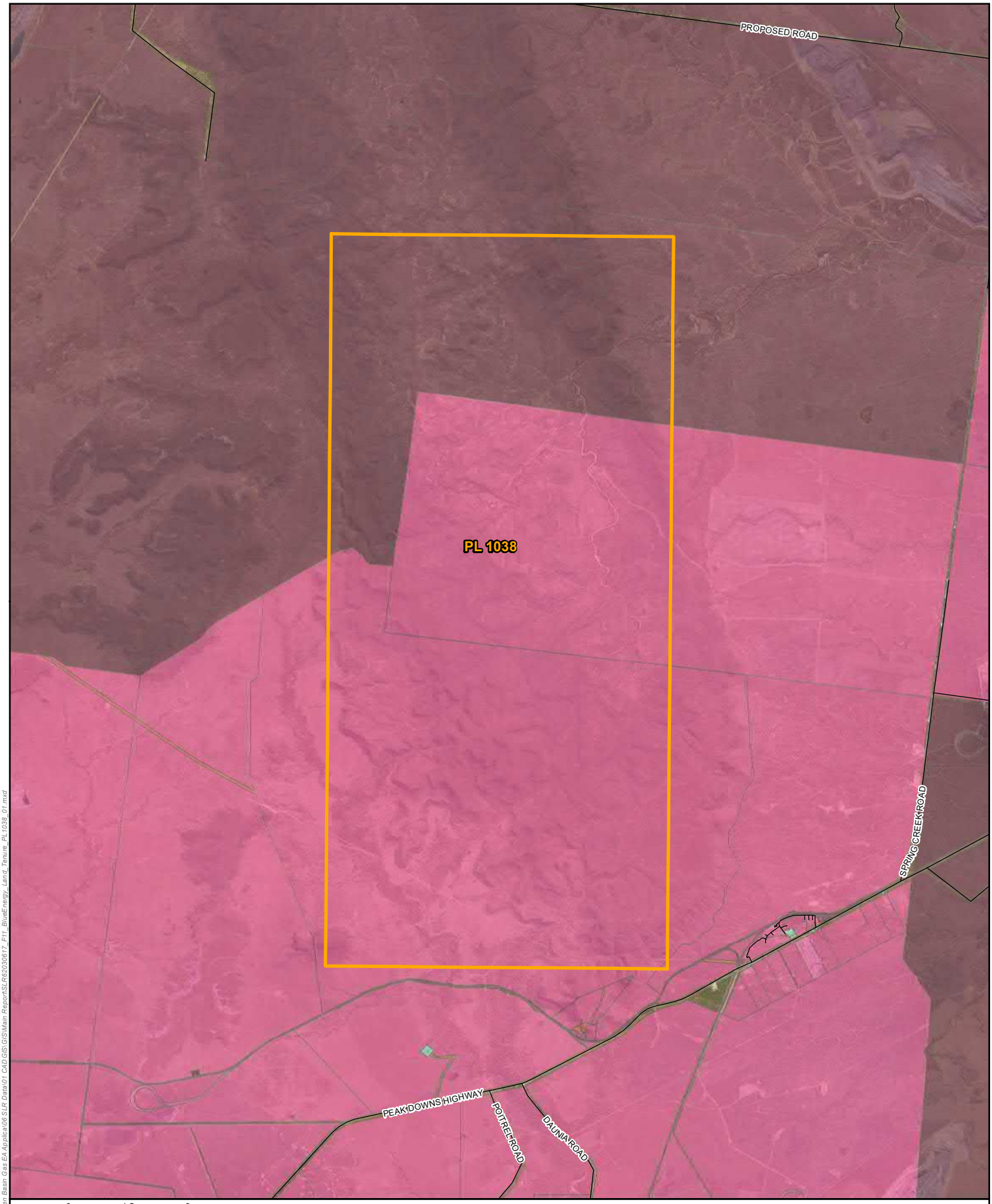
- Covenant
- Easement
- Freehold
- Lands Lease
- Profit à Prendre
- Reserve
- State Land

BLUE ENERGY EA APPLICATION

Existing tenure within and immediately surrounding PLA 1034 (Sapphire)

FIGURE 15

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306 17_F10_BlueEnergy_Land_Tenure_PL1034_01.mxd



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:125,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	JN

LEGEND

- Project Area (PL 1038)

Tenure

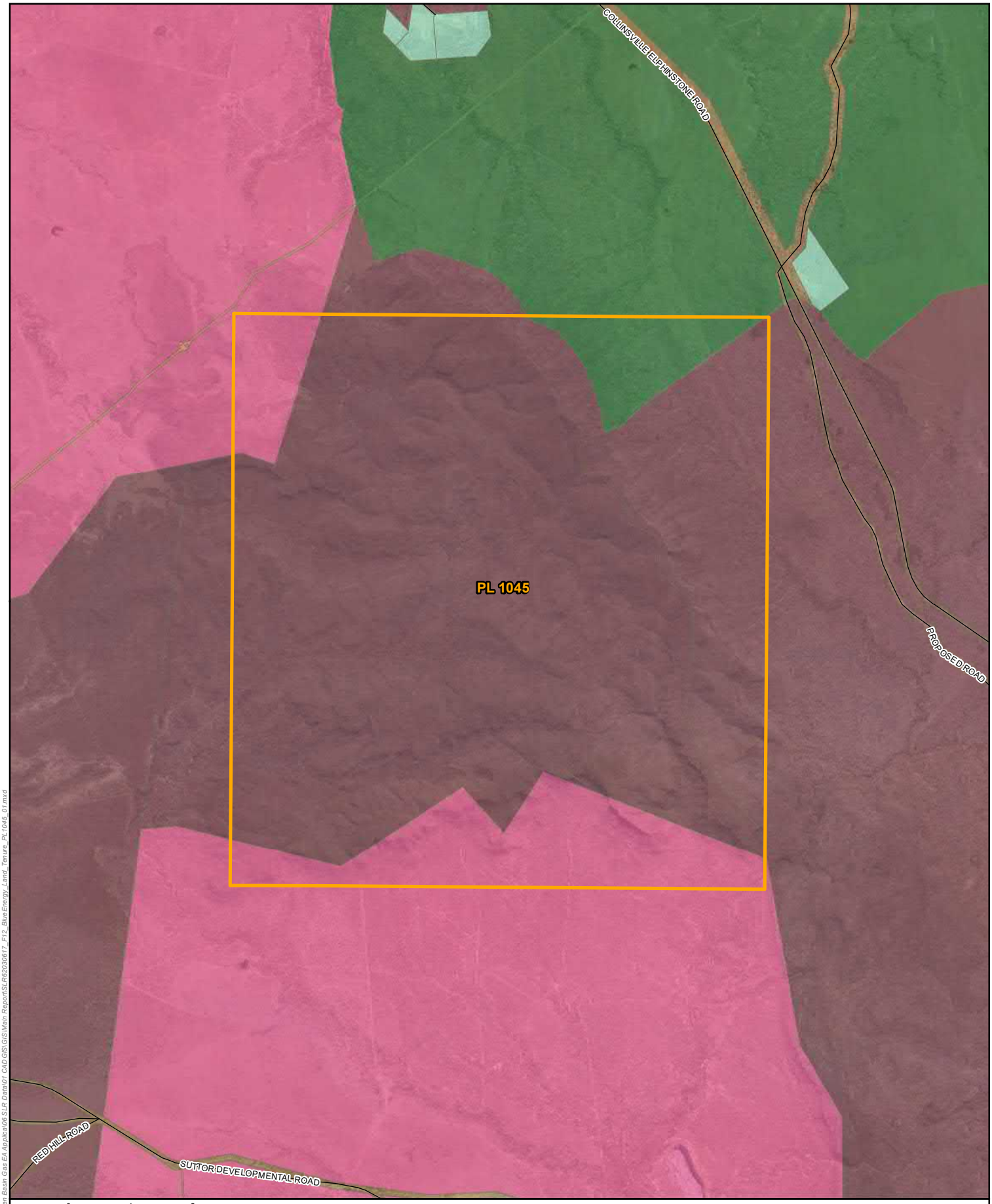
- Easement
- Freehold
- Lands Lease
- Reserve
- State Land

BLUE ENERGY EA APPLICATION

Existing tenure within and immediately surrounding PLA 1038 (Central)

FIGURE 16

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306 17_F11_BlueEnergy_Land_Tenure_PL1038_01.mxd



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	GC

LEGEND

- Project Area (PL 1045)

Tenure

- Easement
- Freehold
- Lands Lease
- Profit à Prendre
- Reserve
- State Land

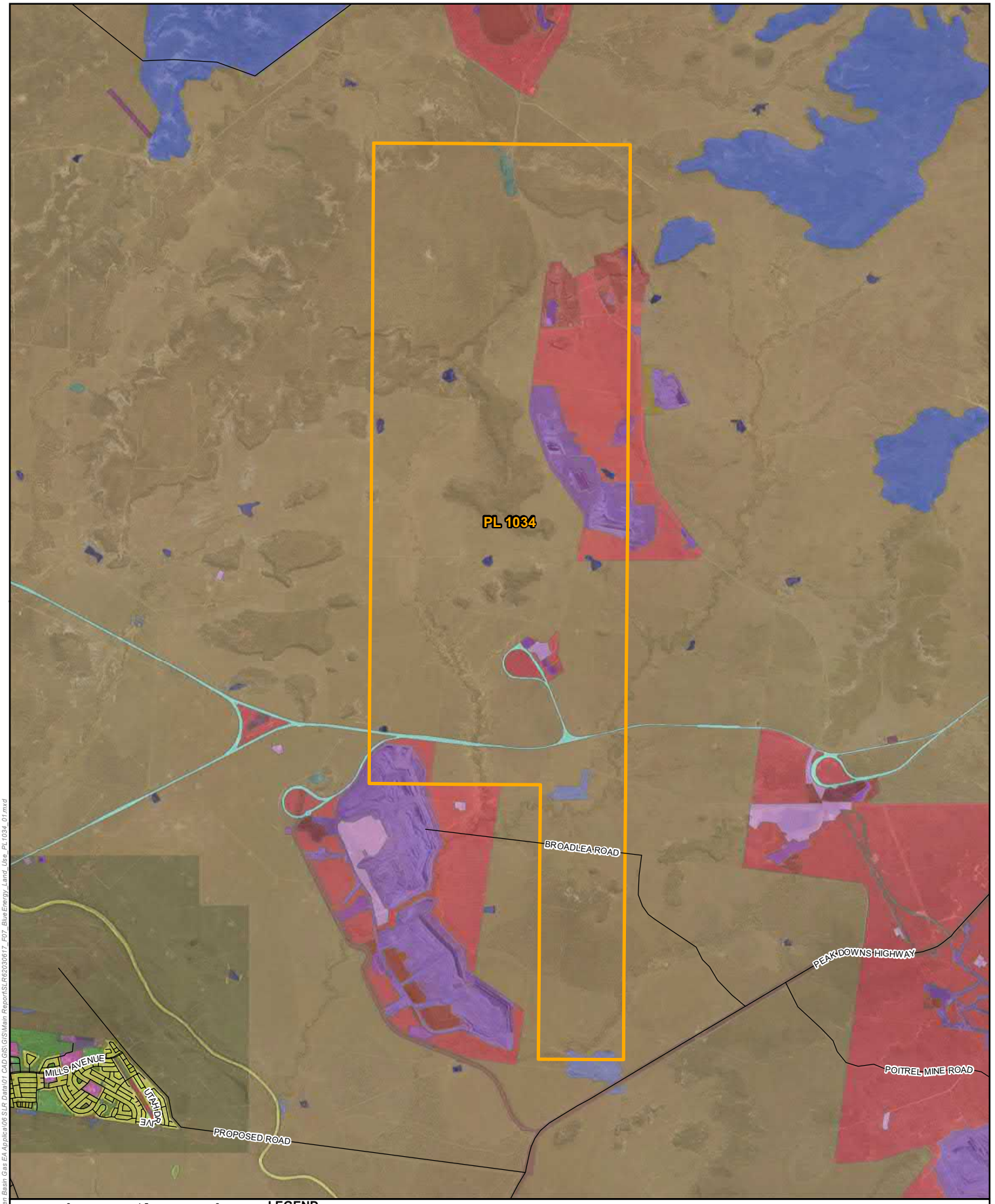
SLR

BLUE ENERGY EA APPLICATION

Existing tenure within and immediately surrounding PLA 1045 (Lancewood)

FIGURE 17

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306617_F12_BlueEnergy_Land_Tenure_PL1045_01.mxd



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	JN

LEGEND

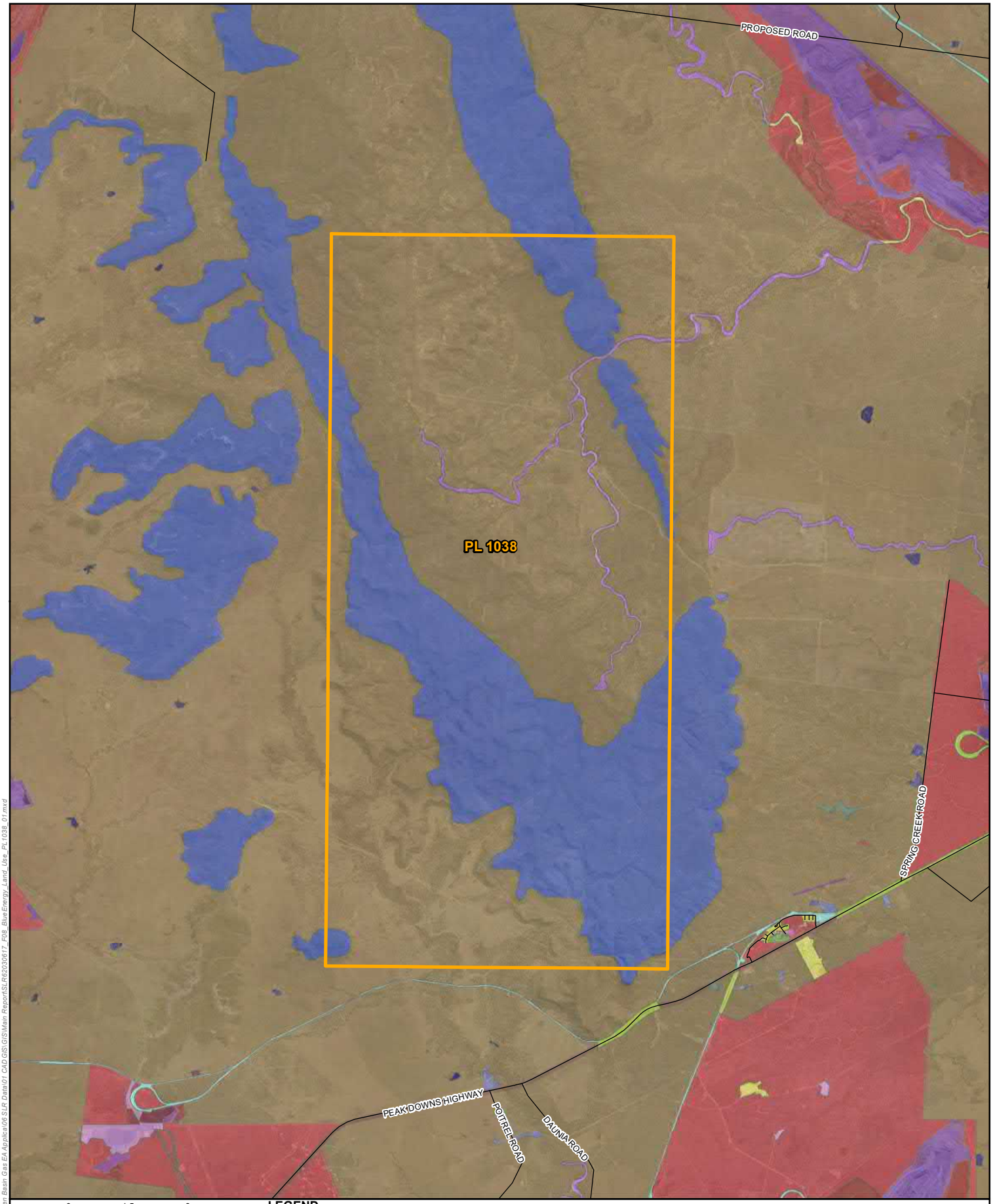
- Project Area (PL
- **Land Use**
- Airports/aerodromes
- Commercial services
- Electricity substations and transmission
- Extractive industry not in use
- Farm buildings/infrastructure
- Grazing native vegetation
- Lake
- Mines
- Mining
- Other minimal use
- Public services
- Quarries
- Railways
- Recreation and culture
- Rehabilitation
- Reservoir
- Residual native cover
- River
- Roads
- Rural residential with agriculture
- Tailings
- Urban residential
- Water extraction and transmission
- Water storage - intensive use/farm dams

BLUE ENERGY EA APPLICATION

Land Use PLA 1034 (Sapphire)

FIGURE 18

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306 17_F07_BlueEnergy_Land_Use_PL1034_01.mxd



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:125,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	JN

SLR

LEGEND

- Project Area (PL 1038)

Tertiary

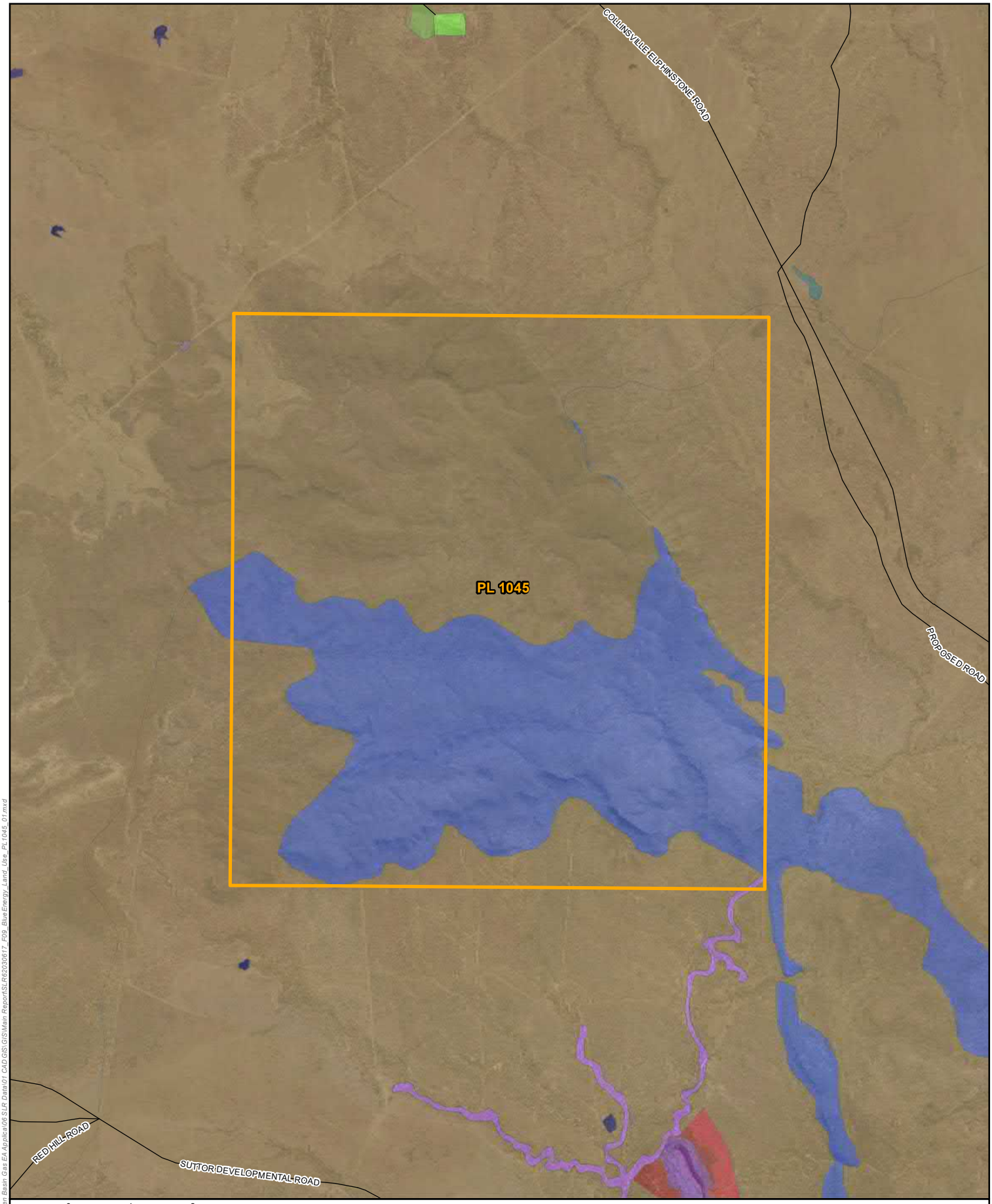
- Airports/aerodromes
- Commercial services
- Effluent pond
- Electricity substations and transmission
- Extractive industry not in use
- Farm buildings/infrastructure
- Grazing native vegetation
- Marsh/wetland
- Marsh/wetland - production
- Mines
- Mining
- Other minimal use
- Public services
- Quarries
- Railways
- Recreation and culture
- Rehabilitation
- Reservoir
- Residual native cover
- Roads
- Tailings
- Transport and communication
- Urban residential
- Water extraction and transmission
- Water storage - intensive use/farm dams

BLUE ENERGY EA APPLICATION

Land Use PLA 1038 (Central)

FIGURE 19

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306017_F08_BlueEnergy_Land_Use_PL1038_01.mxd



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	GC

LEGEND

- Project Area (PL 1045)

Land Use

- Extractive industry not in use
- Grazing native vegetation
- Landfill
- Marsh/wetland - production
- Mines
- Other minimal use
- Quarries
- Recreation and culture
- Reservoir
- Residual native cover
- Water extraction and transmission
- Water storage - intensive use/farm dams

BLUE ENERGY EA APPLICATION

Land Use
PLA 1045 (Lancewood)

FIGURE 20

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306 17_F09_BlueEnergy_Land_Use_PL1045_01.mxd

3.4 Possible Changes in Land Suitability and Uses

The existing land use of grazing will be impacted upon by CSG activities, resulting in a post CSG landscape within the Project that will include:

- Water storage(s) i.e., portable water tanks, and
- Remaining infrastructure.

During CSG activities, the Project's operational footprint will be minimised as far as practicable. Although minimal, agricultural land suitability will primarily be affected by a reduction in the available agricultural land.

After decommissioning of CSG activities, land will be rehabilitated to its prior land use or otherwise, in consultation with the landowner.

3.5 Potential Impacts and Management Practices

To minimise the potential for the CSG activities to result in contamination of land, a Waste Management Plan (WMP) will be developed and implemented throughout operations. The WMP will detail waste management practices in accordance with the waste management hierarchy and will provide measures to be implemented to minimise the likelihood of contamination. Further details relating to waste management are provided in Section 8. Additionally, CSG water will be managed in accordance with a CSG Water Management Plan, also addressed in Section 8.

Following the completion of CSG activities, all wells, pipelines, equipment, structures and buildings not required by the landowner following the cessation of CSG activities will be decommissioned. A contaminated site assessment will be conducted, and any necessary remedial action taken.

3.5.1 Land Management Objectives

The primary land management objectives for the CSG activities during construction, operation and post operations are:

- To manage land within the PL areas so as to minimise impact on the PL land, surrounding properties and downstream surface water and groundwater quality
- To protect current and future land-use potential
- To minimise erosion from disturbed areas
- To ensure potential impacts to topsoils are minimised
- To protect future land use values of areas by ensuring that only land within the lease area required for CSG activities is disturbed
- To progressively rehabilitate land disturbed by CSG activities consistent with the post operations land use objectives contained in Section 0
- To minimise water quality impacts from the CSG activities on groundwater and surface water environmental values
- To ensure that adverse impacts on the nature conservation and biodiversity values of the area are minimised
- Cleared material is stored appropriately and able to be effectively used during rehabilitation activities

- The rehabilitation success of the disturbed areas is optimised
- To minimise and manage potential soil contamination during the development of the CSG fields
- To ensure storage and handling of chemicals and dangerous goods does not cause environmental harm, and
- To preserve potential future CSG resources.

3.5.2 Commitments

3.5.2.1 Performance Criteria

Performance criteria for the CSG activities during construction, operation and post CSG are:

- No complaints from landholders or third parties
- Topsoil recovered ahead of disturbance in accordance with nominated stripping depths
- Effectively store, manage (based on storage duration) and reuse topsoil in rehabilitation activities
- Return land to its previous land use quality, or otherwise in consultation with land owners
- Land degradation is prevented
- Spill containment facilities constructed and operated in accordance with the relevant Australian Standard and the conditions of the EA
- No intentional contamination of the environment, and
- Storage and handling procedures for chemicals and dangerous goods in accordance with the relevant Australian Standard and EA conditions.

3.5.2.2 Control Strategies

Topsoil Management

- Clearing and topsoil removal will only be undertaken where necessary for ongoing operations or drilling
- Clearing will only commence when suitable erosion and sediment control measures are in place
- Topsoil will be recovered ahead of disturbance and stockpiled/windrowed (or reused directly where possible) in a secure area
- Topsoil stockpiles/windrows will be located away from drainage channels, operational activities, and stormwater flow, standing vegetation and vehicle movements so that it is available in later rehabilitation
- Topsoil stockpiles/windrows will be limited to 2 m in height where ever possible, be clearly identified as a topsoil stockpile and will be fenced to exclude cattle
- Topsoil stockpiles/windrows will be surveyed and soil type, location, volume, source and stockpiling date will be maintained as part of the topsoil management plan
- Current best practice for erosion and sediment control measures will be undertaken in accordance with the Engineers Australia Erosion and Sediment Control Guidelines to minimise the potential for sedimentation of receiving waters
- Where soil will be stockpiled/windrowed for a long time (>3 months), it will be revegetated to protect the soil from erosion, maintain organic matter and maintain active populations of beneficial microbes

- Cleared vegetation or soil will not be pushed up against trunks of trees or stored against fence lines
- Soil stockpiles/windrows will not be placed within the bed or banks of watercourses
- Soil and surface stability will be maintained at all times (e.g. temporary erosion control berms, drains and sediment barriers will be installed as necessary and maintained until final construction clean-up is completed)
- Regular inspection of disturbed areas will be undertaken to ensure any erosion problem areas are identified and repaired as necessary
- The time between trenching and backfilling will be minimised to prevent erosion of exposed soils, and
- Development of an erosion and sediment control plan including requirements for rehabilitation of eroded areas.

Land Management

- Clearing will be limited to the minimum practicable. Where practicable, trees will be trimmed rather than felled
- A clearing permit system will be developed and implemented to ensure all vegetation clearing and surface disturbance is approved by the appropriate level of management
- All clearing boundaries will be illustrated on construction drawings and clearly marked in the field
- Cleared vegetation will be stockpiled/windrowed away from operational activities, drainage channels and vehicle movements so that it is available for use in erosion and sediment control, soil stockpile/windrow protection and management, and rehabilitation where practicable
- Where practicable, existing access tracks will be utilised
- All vehicle movements will be restricted to designated access roads, hardstand areas and easement areas, and
- All cleared and disturbed areas will be regularly inspected to assess the effectiveness of environmental protection measures.

3.6 Streamlined Model Conditions

The proposed activities are compliant with the Streamlined Model Conditions, a full detailed assessment has been provided in Appendix A.

4 Noise

4.1 Environmental Values and Noise Criteria

A Noise Impact Assessment (NIA) was prepared by SLR to determine the potential impacts of the proposal on EVs. The EVs that are to be enhanced or protected are prescribed by the *Environmental Protection (Noise) Policy 2019* (EPP Noise) as the qualities of the acoustic environment that are conducive to protecting:

- the health and biodiversity of ecosystems, and
- human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following:
  - sleep
  - study or learn
  - be involved in recreation, including relaxation and conversation, and
  - The amenity of the community.

An assessment of an EA Application requires that DES consider the environmental objective and performance outcomes provided for under Schedule 8, Part 3, Division 1 of the *Environmental Protection Regulation 2019* (Qld), shown below in Table 13.

Table 13 Noise Environmental Objectives (EP Reg, 2019)

Environmental Objective	Performance Outcome
The activity will be operated in a way that protects the environmental values of the acoustic environment.	1. Sound from the activity is not audible at a sensitive receptor; and 2. The release of sound to the environment from the activity is managed so that adverse effects on environmental values including health and wellbeing and sensitive ecosystems are prevented or minimised.

The DES, in partnership with the Australian Petroleum Production and Exploration Association (APPEA) published in 2016 *Streamlined Model Conditions, ESR/2016/1989* (hereafter referred to as SMC) for the petroleum industry. The conditions can be incorporated in an environmental authority to manage petroleum activities and meet the objectives of the *Environmental Protection Act 1994* (EP Act).

Long term noise events are defined in the SMC as "*a noise exposure, when perceived at a sensitive receptor, persists for a period of greater than five (5) days, even when there are respite periods when the noise is inaudible within those five (5) days.*" Given that noise emissions generated by construction activities are anticipated to occur for a period of greater than five (5) days the long term noise nuisance limits are deemed applicable.

The (long term) noise limits in Table 14 are referenced from the model conditions. These limits were developed with reference to the 'deemed background levels' which were established to derive noise limits that are practicably achievable.

Table 14 Noise Limits (Streamlined Model Conditions, 2016)

Time Period	Metric	Long Term Noise Limits	Deemed background level (L_{A90})
Daytime 7.00 am to 6.00 pm	$L_{Aeq,adj,(15min)}$	40 dBA	35 dBA
Evening 6.00 pm to 10.00 pm	$L_{Aeq,adj,(15min)}$	35 dBA	30 dBA
Night-time 10.00 pm to 6.00 am	$L_{Aeq,adj,(15min)}$	28 dBA	25 dBA
	Max $L_{pA,(15min)}$	55 dBA	-
Morning 6.00 am to 7.00 pm	$L_{Aeq,adj,(15min)}$	35 dBA	30 dBA

4.2 Existing Environment

No background noise measurements were completed for this assessment. Blue Energy is prepared to accept the deemed minimum background noise levels as stated in 2016 *Streamlined Model Condition*. These deemed minimum background noise levels are reproduced in Table 14.

Based on SLRs experience in conducting background noise measurements in Queensland's CSG fields, measured background noise levels at noise sensitive receptors are routinely equal to or lower than the deemed background noise levels. This is generally due to 'natural' noise sources (i.e., bird song, wind and wind generated vegetation noise, seasonal insects) controlling the sound scape. During the most sensitive night-time periods, these 'natural' sources are often either infrequently measured or are not present for periods of time, therefore the background noise level is routinely below the deemed minimum background noise level of 25 dBA L_{A90}. Even where 'introduced' noise sources are present (i.e., from roads, mines, CSG etc), their contribution tends to be influenced by meteorological conditions. That is, there are periods of time where these sources can contribute to or dominate the measured background noise level (and potentially elevate it above the deemed minimum noise levels), however the opposite can also occur where meteorological conditions are such that these sources are either inaudible/unmeasurable or they do not significantly contribute to the measured background noise level.

For this Project, the deemed minimum background noise levels are considered applicable for the Project given the rural nature that the Project area is located within and the expected low background noise levels within this area. It's noted that Sapphire is situated in an area with existing mining activities and Arrow's CSG activities. Existing background levels would be established prior to the commencement of activities to establish a baseline for background noise levels in the vicinity.

4.2.1 Topography

For the purposes of the noise prediction modelling, the landscape was assumed to be level and soft ground, this ensures that modelled results demonstrate the 'worst case scenario'.

4.2.2 Nearest Sensitive Receptors

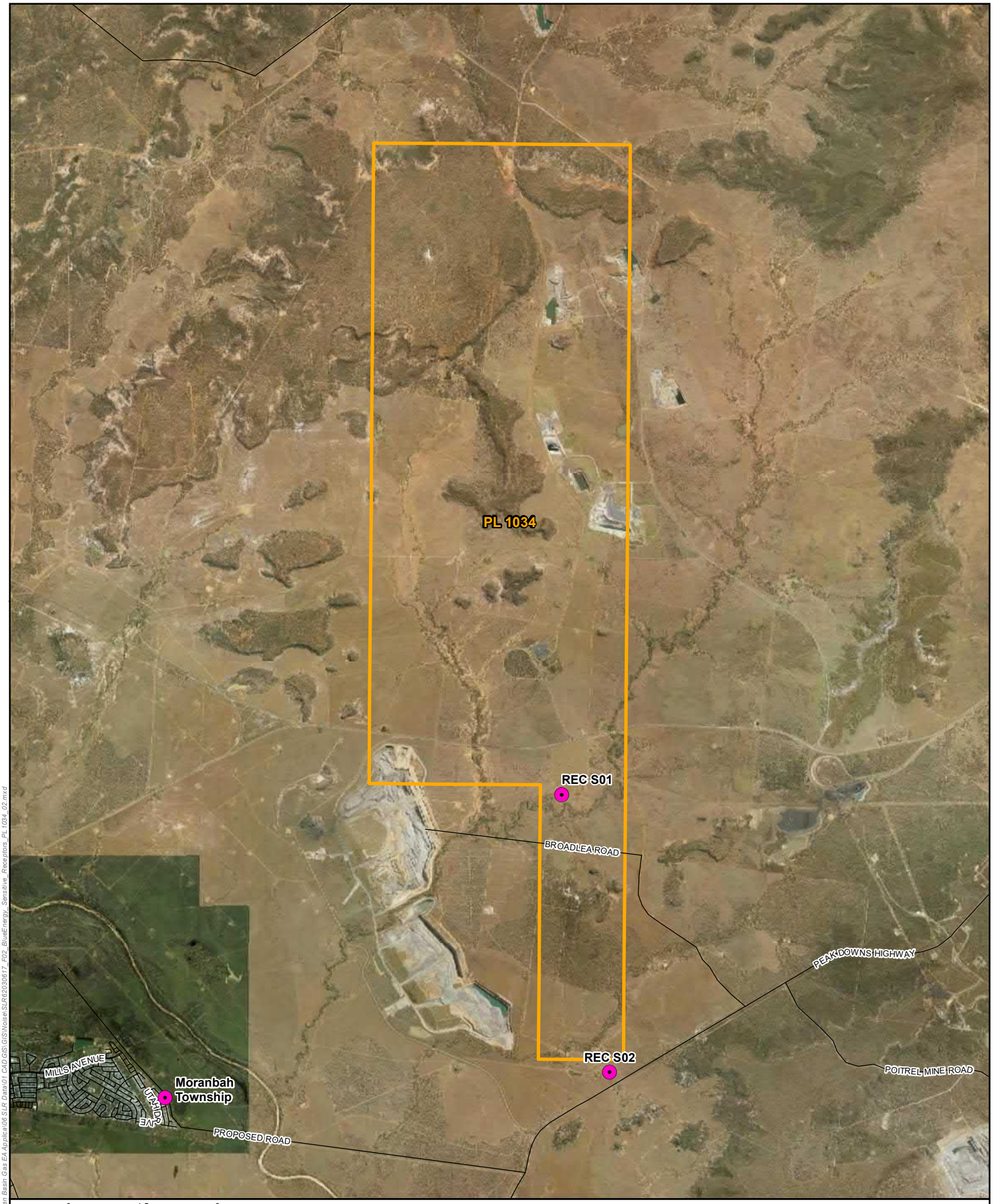
As per the definition of sensitive receptors within the EPP Noise and the SMC, there are at least 21 identified sensitive receptors located either within the three (3) PL's, or with a general 5 km buffer from the proposed PL's.

The Sapphire and Central PL's are located approximately 7.6 km and 21 km northeast of Moranbah respectively, the Central PL is located approximately 2.3 km west of Coppabella, and the Lancewood PL is located approximately 5.9 km south of Glenden. Each of these townships have several hundred sensitive receptors within them, however for the purpose of this Assessment, it has been represented by one receptor.

All sensitive receptors identified for this Assessment are summarised in Table 15 and shown in Figure 21, Figure 22 and Figure 23, for PL 1034, PL 1038 and PL 1045 respectively.

Table 15 Assessed Sensitive Receptors

PL	Receptor ID	Receptor Type	Receptor Coordinates (GDA94, Zone 55)		Distance to PL (km)
			Easting	Northing	
PL 1034 (Sapphire)	Moranbah Township	Township	611302	7566117	7.6
	REC_S01	Homestead	619304	7572240	Within PL
	REC_S02	Homestead	620268	7566633	0.3
PL 1038 (Central)	Coppabella Township	Township	640192	7576703	2.3
	REC_C01	Homestead	639305	7585415	1.4
	REC_C02	Homestead	643061	7577560	5.2
	REC_C03	Homestead	642755	7577359	4.9
	REC_C04	Homestead	641782	7577477	3.9
	REC_C05	Mine Camp (Coppabella Village)	641120	7576539	3.3
	REC_C06	Homestead	640696	7575758	2.9
	REC_C07	Homestead	640347	7575931	2.5
	REC_C08	Mine Camp (Terowie Village Camp)	639784	7573023	3.5
	REC_C09	Homestead	637959	7575446	0.5
	REC_C10	Homestead	637959	7573204	2.8
	REC_C11	Homestead	633365	7573281	2.7
	REC_C12	Homestead	633542	7572353	3.7
	REC_C13	Homestead	633552	7571564	4.4
	REC_C14	Homestead	628343	7570469	5.6
PL 1045 (Lancewood)	Glenden Township	Township	615402	7637438	5.9
	REC_L01	Homestead	622172	7637710	6.4
	REC_L02	Lake Elphinstone Campsite	627895	7617743	8.3
	REC_L03	Homestead	603906	7621388	8.5



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.30617
Date:	12-Nov-2021
Drawn by:	PW
Reviewed by:	GC

LEGEND

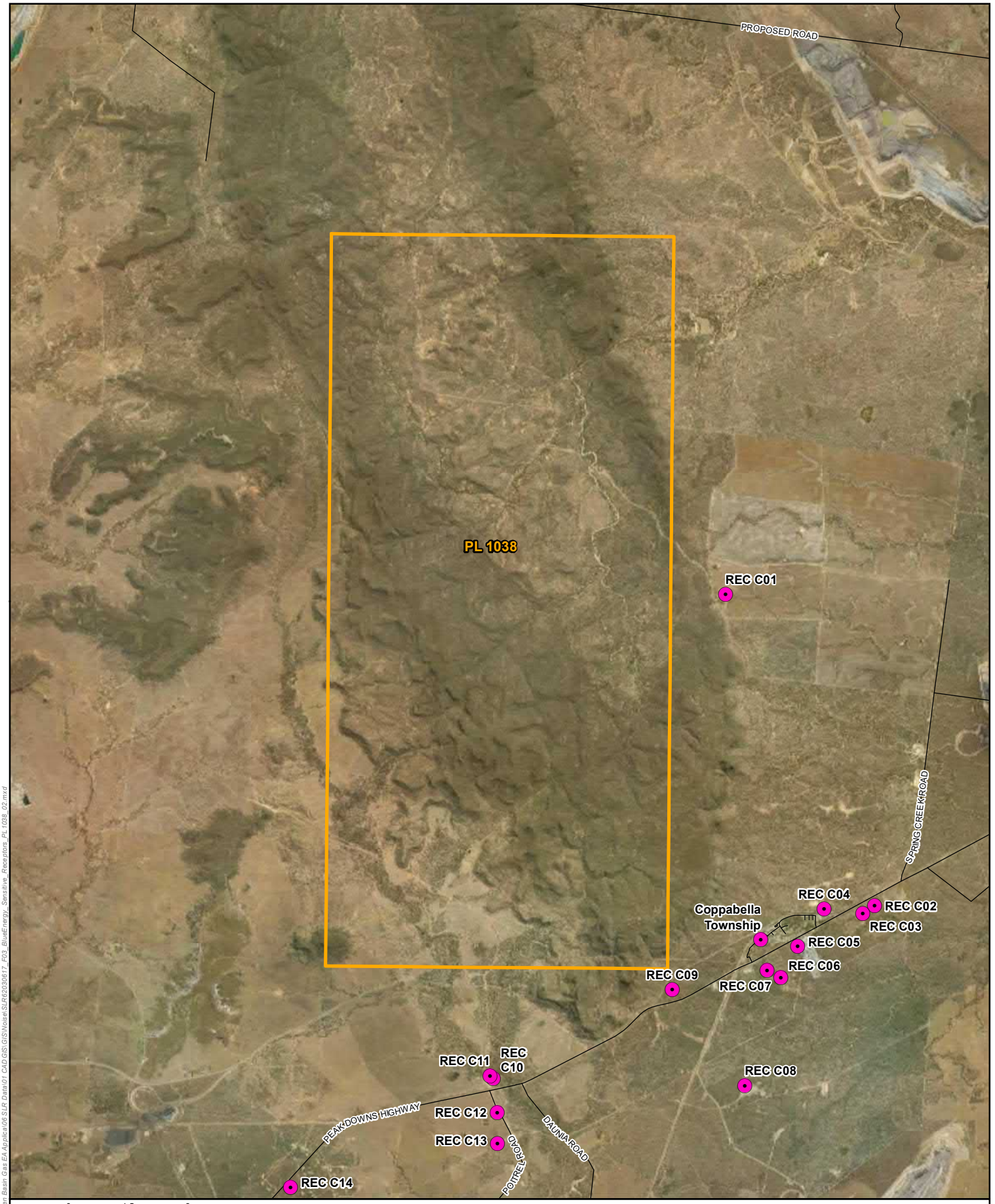
- Sensitive Receptor Location
- Roads
- Project Area (PL 1034)

BLUE ENERGY EA APPLICATION

Sensitive Receptors PLA 1034 (Sapphire)

FIGURE 21

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Noise\SLR620306617_F02_BlueEnergy_Sensitive_Receptors_PL1034_02.mxd



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:125,000 at A4
Project Number:	620.30617
Date:	12-Nov-2021
Drawn by:	PW
Reviewed by:	GC

LEGEND

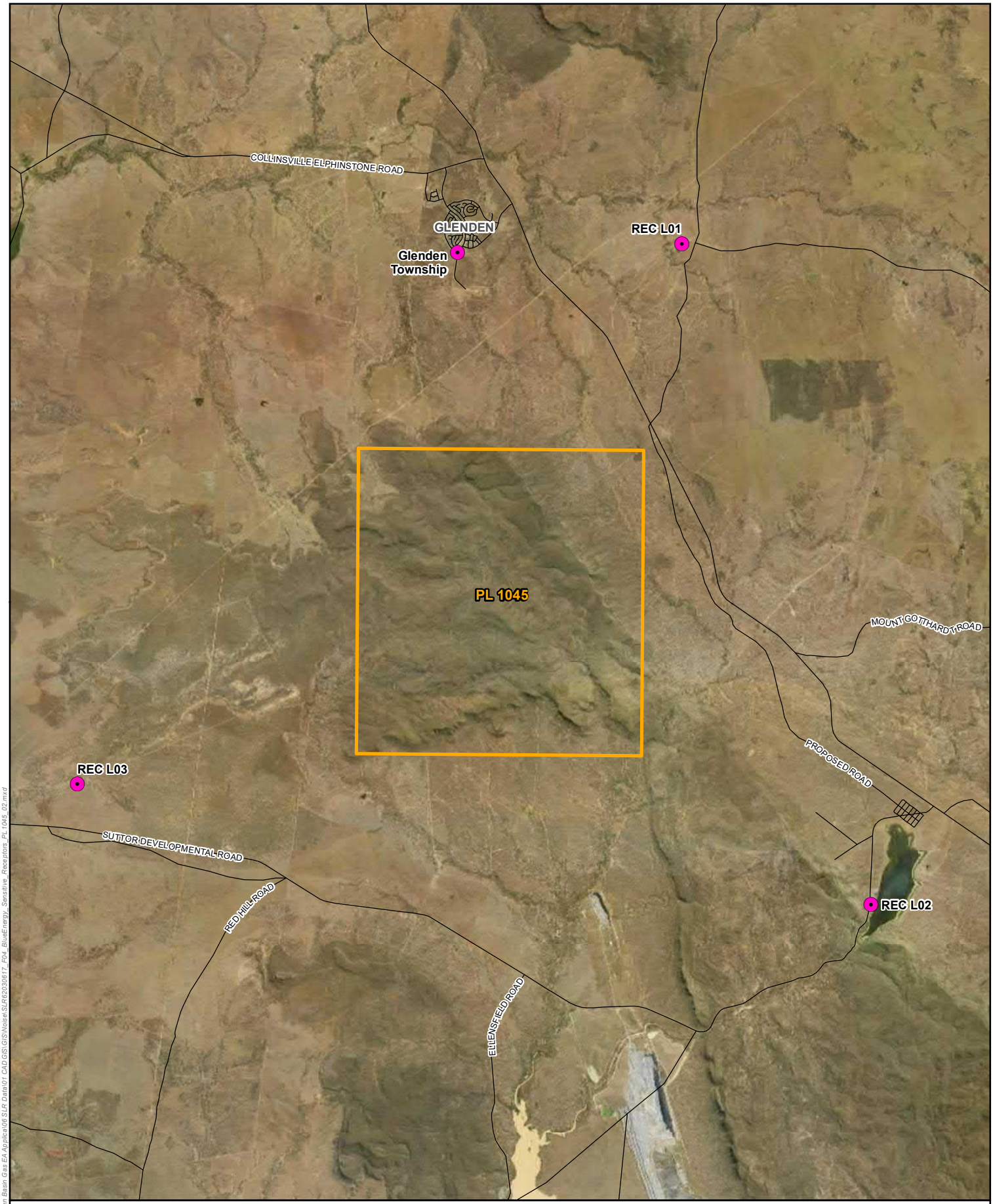
- Sensitive Receptor Location
- Roads
- Project Area (PL 1038)

BLUE ENERGY EA APPLICATION

Sensitive Receptors PLA 1038 (Central)

FIGURE 22

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Noise\SLR620306617_F03_BlueEnergy_Sensitive_Receptors_PL1038_02.mxd



0 2 4 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.30617
Date:	12-Nov-2021
Drawn by:	PW
Reviewed by:	GC

LEGEND

- Sensitive Receptor Location
- Roads
- Project Area (PL 1045)

BLUE ENERGY EA APPLICATION

Sensitive Receptors PLA 1045 (Lancewood)

FIGURE 23

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Noise\SLR620306617_F04_BlueEnergy_Sensitive_Receptors_PL1045_02.mxd

4.2.3 Meteorology

For the purpose of the predicted noise modelling, the NIA has adopted the 'planning for Noise Control' default meteorological conditions, which are considered to be the 'worst case' meteorological conditions for noise prediction.

4.3 Emissions and Releases

The NIA prepared by SLR has identified potential noise emitting activities for the purpose of the noise prediction modelling. Potential noise sources have been separated into 'construction' emissions and 'operations' emissions. The associated construction and operation activities, as well as individual equipment and plant expected to generated noise emissions have been presented below in Table 16 and Table 17.

Table 16 Estimated activity noise emissions

Activity	Estimated Noise emission (dBA)
Drilling (includes mud pump)	113
Cementing	118
Completions/ Workover	117
5.5kW well head pump	88
10kVA gas generator	91

Table 17 Estimated equipment noise emissions

Equipment	Estimated Noise emission (dBA)
Sideboom tractor	110
Bending machine	94
Generator	93
Compressor	103
Dump truck	106
Excavator 30T	103
Grader 14G	106
Padding machine	110
Sideboom pipelayer	108
Water truck	104
Welding	101
Tack rig	114
Pump	108
Roller	101
Road train	103

Equipment	Estimated Noise emission (dBA)
Loader	104
Trencher	110
Bobcat	97
Telehandler	107
Tilt truck	107

4.4 Potential Impacts and Management Practices

Through consultation with Blue Energy, construction and operational phase scenarios with corresponding equipment and stages were developed to support this Assessment. These included the construction of the gathering pipeline network and gas wells (construction of gas wells including well pad construction and Development and Construction (D&C) activities), and the operations of the gas wells. Sound power levels (SWL) were assigned to each plant item (construction or operations) with reference to SLR's in-house database of noise emission levels, which are based on our experience in assessing noise from similar CSG projects.

4.4.1 Noise Assessment – Construction Phase

The NIA has identified the minimum noise buffer distance required for the identified activities to comply with the SMC noise limits and have been summarised as follows:

- Day-time (7:00 am to 6:00 pm) 40 dBA L_{Aeq} noise limit –
  - Well Pad – 600 m to 825 m.
  - Pipeline – 550 m to 800 m.
- Morning (6:00 am to 7:00 am) 35 dBA L_{Aeq} noise limit –
  - Well Pad – 900 m to 1,200 m.
  - Pipeline – 800 m to 1,150 m.

4.4.1.1 Well Pad and Pipeline Construction

A generic noise model was developed to assess the noise emissions from various well pad and pipeline construction stages. This involved creating a flat-ground noise model and assuming all equipment detailed in Table 18 was working in a relatively straight line with typical separation distances of 25 m to 300 m between plant items. From this, a noise emission level for each stage was predicted at various off-set distances to determine a compliance "buffer" distance.

Table 18 Well Pad and Pipeline Construction Noise Sources

Plant	Well Pad Construction		Pipeline Construction								SWL (dBA)
	Pad & access	Connections	Clear & grade	Stringing	Bending	Welding	Trenching	Lowering	Backfilling	Hydrotesting	
Sideboom tractor					1						110
Bending machine					1						94
Generator										2	93
Compressor										2	103
Dump truck									4		106
Excavator 30T	1	2	1	1	1		2	2	2		103
Grader 14G	1	1	1						1		106
Padding machine									2		110
Sideboom pipelayer								3			108
Water truck	1		1	1	1	1	1	1	1	1	104
Welding						8					101
Tack rig						1					114
Pump										5	108
Roller	1										101
Road train	3										103
Loader	1										104
Trencher		1					1				110
Bobcat		1									97
Telehandler		1									107
Tilt truck	3										107

4.4.1.2 D&C Activities

SWL data used for noise modelling of D&C activities have been sourced from the SLR D&C activity database and are outlined in Table 19. All sources have been modelled as one (1) off and represent typical operations for drilling (including mud pump), cementing with a cement rig during drilling works and completions/workover works. The SWL in Table 19 represent an 'unmitigated' activity and have all been modelled at a height of 2 m above ground.

Table 19 SWLs of D&C Activities

D&C Activity	Overall SWL, LAeq dBA	Octave Band SWL, LAeq dBA								
		31 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Drilling (includes mud pump)	113	82	101	106	103	101	107	108	101	90
Cementing	118	77	91	95	107	107	114	114	107	98
Completions/ Workover	117	74	103	106	106	107	112	112	104	92
Completions Jetting	123	50	74	86	99	105	120	119	107	89

Similar to the prediction of pipeline construction offset noise buffers, predicting D&C activity offset noise buffers also involved creating a flat-ground noise model and assuming each D&C activity detailed in Table 19 in the centre of that flat-ground model. From this, a noise emission level for each D&C activity was predicted at various off-set distances to determine a compliance "buffer" distance.

The NIA has identified the minimum required noise buffer to ensure noise emission remain below the relevant SMC guidelines, there have been shown below in Table 20.

Table 20 Predicted Development and Construction (D&C) Activity offset noise buffer distances

D&C Activity	Offset Noise Buffer Distance (m) to comply with:				
	28 dBA LAeq		35 dBA LAeq		40 dBA LAeq
	Neutral	Adverse	Neutral	Adverse[1]	Neutral
Drilling w Mud Pump	1,400	1,900	900	1,100	650
Cementing	1,850	2,500	1,250	1,750	900
Completions/Workover	1,900	2,600	1,150	1,600	800
Completions w Jetting	2,600	3,300	1,700	2,300	1,200

A number of wells are located within the D&C Noise buffer identified above (see Figure 21 and Figure 22). A total of 19 wells are situated within the offset noise buffer established around sensitive receptor *REC S01*, meaning that the above Construction activities may result in an exceedance of the noise thresholds provided in the SMC. There is also one well within the D&C Noise buffer of sensitive receptor *REC S02*. These two identified sensitive receptors have been assessed as homesteads has identified that both of these homesteads have been sold for land use purposes. [1]

Finally, a total of three wells are situated within the D&C Noise buffer of sensitive receptor *REC C09*.

It is worth noting that the Predicted Noise Modelling has utilised a 'worst case' scenario, and anticipated noise generation may be substantially minimised through the implementation of noise reduction techniques. Specific techniques are provided below.

[1] Pers comm Blue Energy, 17/11/2021.

Source Noise Control Strategies

- Quietest plant and equipment (e.g. the use of white-noise "buzzing" or "self-adjusting" reversing alarms) that can economically undertake the work should be selected, wherever possible.
- Regular maintenance of equipment in order to keep it in good working order.
- As much as possible use of modern equipment with noise abatement technologies

Work Practice Control Strategies

- Construction work to occur, wherever possible, within the daytime period (i.e. 7:00 am to 6:00 pm). Outside this period, it is recommended that that tool-box talks and other 'administration' based activities should take place to limit noise emission from the construction site onto neighbouring sensitive receptors.
- Operators of construction equipment to be made aware of the potential noise problems and of techniques to minimise noise emission through a continuous process of operator education.
- As a project wide initiative, the use of "self-adjusting volume" or "broad-band buzzer" type reversing alarms should be utilised to avoid additional annoyance to neighbours from tonal "beeper" alarms.
- Speed limit along access roads be limited (nominally 40 km/hr) to reduce noise from light and heavy vehicles trucks (i.e. 4WDs and trucks).

Community Liaison Strategies

- Utilise community consultation framework to provide access to information for the community and maintain positive relations with residents.

Where construction noise levels exceed the recommended criteria or in the event of complaints, an investigation of construction noise should occur.

In addition to the above practical recommendations, for limited duration construction activities (i.e. well pad/pipeline construction and/or D&C activities), entering into an alternate (noise) agreement with effected receptor/s falling within the offset noise buffers detailed in this Assessment may be the most appropriate form of noise mitigation. This should be considered during the detailed design phase of this Project.

4.4.2 Noise Assessment – Operation Phase

SWL data used for noise modelling of well operations have been sourced from the SLR CSG database from similar projects, and are outlined in Table 21.

Table 21 Operational Well Noise Sources

Source	Source Height (m)	Octave Band Frequency SWL (dBA)									Total (dBA)
		31.5	63	125	250	500	1k	2k	4k	8k	
5.5kW well head pump	1.0	77	78	79	81	81	84	81	77	71	88
10kVA gas generator	1.0	84	87	88	88	88	86	84	81	76	91

Similar to the prediction of pipeline construction and D&C activity offset noise buffers, predicting well operation offset noise buffers also involved creating a flat-ground noise model and assuming each operational well noise source detailed in Table 21 in the centre of that flat-ground model. From this, a noise emission level for an operational well was predicted at various off-set distances to determine a compliance "buffer" distance with regard to the operational limits stated in Table 14.

This Assessment has determined compliance offset buffer distances from a single well (whether that be for a single vertical well or multi-lateral well) with a gas generator. It is noted that Blue Energy are also investigating the option of powering gas well from either mains power or a solar panel/battery arrangement located at the well lease (electrified option). The noise emission from the single gas powered well would be considered the base case, with the electrified option generating lower noise emissions. As a result, if the applicable noise criteria are achieved for the gas powered single well scenario, it would also be achieved for the electrified single gas well scenario.

Two wells have been identified within the Operational Noise buffer of the sensitive receptor *REC S01.* In the modelled 'worst case' scenario, operational noises of the wells may exceed the thresholds prescribed in the SMC. *REC S01* has been identified as a homestead has identified that this homestead has been sold for land use purposes. [2]

It is worth noting that the Predicted Noise Modelling has utilised a 'worst case' scenario, and anticipated noise generation may be substantially minimised through the implementation of noise reduction techniques. Specific techniques are provided below.

- Noise walls/barriers located at each well which would allow for access and ventilation but screen noise in the direction of adjacent sensitive receptor/s. Noise walls/barriers would be most effective when located in close proximity to the dominant noise sources and 'line of sight' is broken between the noise source and the sensitive receptor/s. As a general rule, noise barriers can provide up to 10 dBA noise reduction when effectively located.
- Investigate the availability of quieter gas engine generators compared to those assumed for this Assessment, or replacing with electrified/solar powered well heads to remove the need for gas engine generators.
- Modify the operating load of the operational well to reduce the overall noise output.
- Negotiate landholder agreements with surrounding landholders in order to manage noise impacts at the receiver.

4.5 Streamlined Model Conditions

SLR has conducted a noise impact assessment of the key construction and operational phases to support the Environmental Approval of the proposed Sapphire (PLA1034), Central (PLA1038) and Lancewood (PLA1045) Project.

Construction

The following off-set distances from well pad and pipeline construction should be used as a 'guide' to allow compliance with the morning (6:00 am to 7:00 am) 35 dBA L_{Aeq} noise limit and day-time (7:00 am to 6:00 pm) 40 dBA L_{Aeq} 'long-term' noise limit:

[2] Pers comm Blue Energy 17/11/2021.

- Day-time (7:00 am to 6:00 pm) 40 dBA L_{Aeq} noise limit –
  - Well Pad – 600 m to 825 m.
  - Pipeline – 550 m to 800 m.
- Morning (6:00 am to 7:00 am) 35 dBA L_{Aeq} noise limit –
  - Well Pad – 900 m to 1,200 m.
  - Pipeline – 800 m to 1,150 m.

The off-set noise buffer distances to comply with the most stringent noise limit, being the night-time 28 dBA L_{Aeq} noise limit, the during D&C activities range from 1,400 m to 2,600 m for neutral weather and 1,900 m to 3,300 m for adverse weather.

If cementing can be avoided during the most stringent night-time period, the offset noise buffer distance for drilling can be adopted at 1,400 m to 1,900 m (neutral to adverse weather respectively). Similarly, as jetting is not proposed, the offset noise buffer distance for completions/workover can be adopted at 1,900 m to 2,600 m (neutral to adverse weather respectively).

Numerous practical recommendations to assist in mitigating construction noise emissions have been provided with reference to AS 2436-2016 "*Guide to Noise Control on Construction, Maintenance and Demolition Sites*". In addition to those practical recommendations, for limited duration construction activities (i.e. well pad/pipeline construction and/or D&C activities), entering into an alternate (noise) agreement with effected receptor/s falling within the offset noise buffers detailed in this Assessment may be the most appropriate form of noise mitigation. This should be considered during the detailed design phase of this Project.

Operations

With regard to the most stringent noise limit, being the night-time 28 dBA L_{Aeq} noise limit, the offset noise buffer distances during well operations (single gas powered well) range between 250 m for neutral weather to 350 m for adverse weather.

As mentioned above, for the scenario where the well is electrified, the offset noise buffer distances would be lower than those documented above. Therefore, if compliance is achieved for the single gas powered well documented above it would also be achieved for the electrified scenario.

For instances where operational wells are proposed to be located within distances to noise sensitive receptors that are less than those offset noise buffer distances stated above, noise mitigation options would need to be investigated, and could take the form of; the installation of noise walls/barriers to screen noise, investigating quieter equipment or electrified equipment, modifying operating load, negotiating landholder agreements, and/or relocating wells to distances greater than those stated above.

The proposed activities compliance with the Streamlined Model Conditions has been provided in Appendix A.

5 Ecology

5.1 Environmental Values

The environmental values of The Project and adjacent areas which are to be protected or enhanced are:

- The integrity of undisturbed ecosystems
- The integrity of bioregions and regional ecosystems and the habitat values they provide
- Flora, including vegetation communities, endangered, vulnerable, rare or near threatened, special least concern, and pest species
- The integrity of habitat for endangered, vulnerable, or near threatened and special lease concern species
- Category B and C environmentally sensitive areas (ESA's)
- Fauna, including fauna present, protected animal breeding places, endangered, vulnerable or near threatened species, pest species, plants or animals and their habitats, including threatened wildlife, near threatened wildlife and rare wildlife under the relevant legislation including *Nature Conservation Act 1992*
- Prescribed environmental matters as defined in Queensland's *Environmental Offsets Act 2014*
- State and nationally significant biodiversity values
- Areas with high ecological significance values including, but not limited to, nationally threatened ecological communities, large tracts of remnant vegetation and connectivity corridors, and
- The integrity of movement corridors provided by riparian zone vegetation.

5.2 Existing Environment

As described in Section 2.1, The Project is located in the Moranbah region, which is a heavily developed resource area with pre-existing extractive activities through the region. The Blue Energy owned tenements are located within the middle of several Arrow Energy gas projects.

A Terrestrial Flora and Fauna Technical Report was prepared by SLR, which employed a joint approach of desktop analysis and rapid field vegetation assessments to evaluate environmental constraints and values attributable to the study area. Utilising best available resources, the desktop assessment encompassed:

- Detailed review of current ecological databases
- Inspection of spatial datasets and available mapping
- Review of previous studies
- Collation of existing records, and
- Literature review of species and potential threats and impacts.

Techniques described in the Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland (Neldner *et al*., 2020) were used to collect sufficient data during the field vegetation assessments to verify the RE codes of the State mapped remnant vegetation in the PLs. The purpose of the survey was to determine the appropriate RE code, extent of vegetation communities throughout reasonably

accessible portions of the PLs to ground-truth MSES vegetation and ESAs in accordance with the Streamlined Model Conditions for Petroleum Activities. The key data recorded in the field relevant to this report are:

- Vegetation structure including height of each stratum and cover density
- Key species within each stratum, and
- Geology, landform and other landzone characteristics.

Fauna survey methodology was restricted to opportunistic visual observations for fauna species, including those that are threatened under State and Commonwealth legislation, as no systematic or targeted surveys for fauna were undertaken during the survey period.

The outcomes of the desktop assessment rapid field assessment are summarised in the following sections.

5.2.1 Database Searches

The EPBC Act Protected Matters Search Tool (PMST) (DAWE, 2021a; Appendix B3 and the Queensland Government Wildlife Online (WO) database (DES, 2021a; Appendix B2 were utilised to determine species, communities and areas of conservation significance with potential relevance to the Project area. Both searches included a 20 km buffer around a central co-ordinate within the study area allowing for inclusion of the entire study area with a substantial buffer incorporating similar habitat in the surrounding landscape. Further inspection of location records for flora and fauna species of concern was also undertaken using SPRAT database searches (DAWE, 2021b) and the DES WildNet species profile spatial datasets (DES, 2021b) where applicable.

The following mapping sources were reviewed as part of the desktop analysis:

- Queensland Globe interactive mapping (QLD Globe, 2021)
  - Regulated vegetation maps (including DoR, 2021)
  - Protected plants flora survey trigger map
  - Essential habitat map
  - Protected areas
  - Fish habitat areas
  - Connectivity areas
- Referable wetlands (DES, 2021b)
- ESAs Map (DES, 2021c)
- Atlas of Living Australia (ALA) species occurrence maps (ALA, 2021)

5.2.2 Previous Studies

A search for publicly available previous studies within or adjacent to the PLs was undertaken, but no relevant studies were identified.

5.2.3 Threatened Ecological Communities

Four threatened ecological communities (TECs), as defined under the EPBC Act, were identified as potentially occurring within the PMST within a 20km radius of the PLs. These are described in Table 22.

Table 22 EPBC Act TECs potentially occurring within 20km of each PL

TEC description	Status	PL
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	Sapphire; Central; Lancewood.
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Sapphire; Central; Lancewood.
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Sapphire; Central; Lancewood.
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Sapphire; Central; Lancewood.

Several REs consistent with EPBC Act TECs were ground-truthed to occur within the PLs. Furthermore, several State mapped REs that were inaccessible and unable to be verified during field assessments are also consistent with EPBC Act TECs. These ground-truthed and State mapped REs are presented in Table 23 with their corresponding EPBC Act TECs. No REs consistent with EPBC Act TECs were ground-truthed to occur within accessible portions of Lancewood.

Table 23 Ground-truthed and State mapped REs corresponding to EPBC Act TECs within the PLs

TEC	Corresponding REs					
	Sapphire (PL 1034)		Central (PL 1038)		Lancewood (PL 1045)	
	GT	SM	GT	SM	GT	SM
Brigalow (*Acacia harpophylla* dominant and co-dominant)	11.3.1, 11.9.1, 11.9.5	11.4.9, 11.9.1, 11.9.5	11.3.1, 11.9.5	11.3.1, 11.4.9, 11.9.5	-	11.4.8
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	11.8.11	11.8.11, 11.9.3	-	11.9.3	-	-
Poplar Box Grassy Woodland on Alluvial Plains	11.3.2	11.3.2	11.3.2	11.3.2	-	11.3.2
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	11.8.13, 11.9.4a,	11.5.15, 11.8.13, 11.9.4a	-	-	-	11.8.3

5.2.4 Threatened Flora Species

A total of 13 EVNT flora species were returned in the database searches. The EPBC Act PMST search returned seven, four and three species potentially occurring within 20 km of the Lancewood, Central and Sapphire PLs, respectively (DAWE, 2021a; see Appendix B3. The Queensland Government WO extract showed records of three, two and five EVNT flora species within a 20 km radius of the Lancewood, Central and Sapphire PLs, respectively (DES, 2021a, see Appendix B2). Table 24 shows all EVNT flora species recorded from the database searches and their status under State and Commonwealth legislation, as well as their likelihood of occurring

within the PLs. Appendix B1 provides justification for the likelihood of occurrence determination for each species. Of the 13 flora species returned in the desktop analyses, two were assessed as being highly likely to occur within the Lancewood and Central PLs along with three species within the Sapphire PL. One species was determined to be moderately likely to occur within the Lancewood along with three species in the Sapphire PL. The remaining species were considered to have a low likelihood of occurrence.

Flora species were surveyed as part of rapid vegetation assessments to determine and describe REs across the PLs. However, these assessments were not specifically designed to create a comprehensive inventory of flora species present within the study area. Furthermore, no systematic or targeted assessments for threatened flora species were conducted as part of the field survey. No threatened flora species, as listed under the NC Act and EPBC Act, were identified to occur within the PLs during RE determination assessments. A number of invasive flora species, including two restricted invasive flora species were identified within the PLs during quaternary flora assessments. These included Parthenium (*Parthenium hysterophorus*) and Harrisia Cactus (*Harrisia martinii*), which are Category 3 invasive species under the *Biosecurity Act 2014*.

Targeted field surveys are required to determine the presence/absence of species determined to have a moderate to high likelihood of occurring within the PLs and to comprehensively map the extent of suitable habitat, thereby informing strategies to avoid, minimise and manage potential impacts to these species.

5.2.5 Threatened Fauna Species

A total of 22 EVNT fauna species were returned from the database searches. The EPBC PMST search returned 18 species as potentially occurring within 20km of both the Lancewood and Central PLs and 19 in the Sapphire PL (DAWE, 2021a, see Appendix B3). The Queensland Government WO extract showed records of four species occurring within 20km of the Lancewood PL and five species within 20km of both the Central and Sapphire PLs (DES, 2021a, see Appendix B2. The results of these searches have been combined in Table 25, which also shows the result of the likelihood of occurrence assessment for each of these species. Of the 22 fauna species returned in database searches, three were assessed as being highly likely to occur within each of the PLs. Additionally, four species were determined as moderately likely to occur within the Lancewood PL, along with two and three species in the Central and Sapphire PLs, respectively. One species, the Squatter Pigeon (southern) was determined to be present based on observations during the field assessment. The remaining species were considered to have a low likelihood of occurring in the PLs. EVNT fauna species likelihood of occurrence assessments are provided in Appendix B1

An assessment of the presence/absence of fauna species was not undertaken as part of the field assessment. However, incidental observations of threatened fauna species were recorded. One threatened fauna species, the Squatter Pigeon (southern), was incidentally observed during field assessments. Several individuals of this species were observed in the vicinity of a cattle dam in the southern portion of the Central PL. Targeted field surveys are required to determine the presence/absence of other species determined to have a moderate to high likelihood of occurring within the PLs and to comprehensively map the extent of suitable habitat, thereby informing strategies to avoid, minimise and manage potential impacts to these species.

5.2.6 Migratory Species

A total of 14 migratory terrestrial fauna with potential to occur within 20kms of the PLs were returned from database searches. These included 13 species returned in the PMST search (DAWE, 2021a; see Appendix B3) and one species from the WO extract (DES, 2021a, see Appendix B2. The results of these searches have been combined in Table 26, which also shows the result of the likelihood of occurrence assessment for each of these species. Of the 14 fauna species returned in database searches, all were considered to have a low likelihood of occurring in the PLs. Migratory terrestrial fauna species likelihood of occurrence assessment is provided in

Appendix B1. An assessment of the presence/absence of fauna species was not undertaken as part of the field assessment, therefore no migratory terrestrial species were observed. Targeted field surveys for migratory terrestrial fauna are not required, as no species that have been assessed to have a moderate to high likelihood of occurrence, therefore are unlikely to be significantly impacted by the project.

Table 24 Near threatened and threatened flora species identified from database searches

Status[1]		Family	Scientific name	Common name	PL	Source[2]	WO records	Likelihood of occurrence
NCA	EPBC							
E	-	Amaranthaceae	*Ptilotus uncinellus*	-	Lancewood	-	-	-
					Central	-	-	-
					Sapphire	WO	1	High
NT	-	Apocynaceae	*Cerbera dumicola*	-	Lancewood	-	-	-
					Central	WO	3	High
					Sapphire	WO	7	High
V	V	Asteraceae	*Ozothamnus eriocephalus*	Eungella Hairy Daisy	Lancewood	PM	-	Moderate
					Central	-	-	-
					Sapphire	-	-	-
NT	-	Combretaceae	*Macropteranthes leiocaulis*	Smooth-barked Bonewood	Lancewood	WO	2	High
					Central	-	-	-
					Sapphire	-	-	-
LC	V	Euphorbiaceae	*Bertya opponens*	Coolabah Bertya	Lancewood	PM	-	High
					Central	-	-	-
					Sapphire	-	-	-
NT	-	Euphorbiaceae	*Bertya pedicellata*	-	Lancewood	-	-	-
					Central	WO	9	High
					Sapphire	WO	6	High
V	V	Euphorbiaceae	*Omphalea celata*	-	Lancewood	PM	-	Low
					Central	-	-	-

Status[1]		Family	Scientific name	Common name	PL	Source[2]	WO records	Likelihood of occurrence
NCA	EPBC							
					Sapphire	-	-	-
LC	V	Myrtaceae	*Eucalyptus raveretiana*	Black Ironbox	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
V	E	Poaceae	*Dichanthium queenslandicum*	King Bluegrass	Lancewood	WO/PM	18	Low
					Central	PM	-	Low
					Sapphire	WO/PM	3	Moderate
LC	V	Poaceae	*Dichanthium setosum*	Bluegrass	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Moderate
NT	-	Poaceae	*Digitaria porrecta*	Finger Panic Grass	Lancewood	WO	4	Low
					Central	-	-	-
					Sapphire	-	-	-
V	V	Simaroubaceae	*Samadera bidwillii*	Quassia	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
E	-	Solanaceae	*Solanum adenophorum*	-	Lancewood	-	-	-
					Central	-	-	-
					Sapphire	WO	2	Moderate

1. *Status: LC = Least Concern, E – Endangered, V = Vulnerable, NT = Near Threatened*
2. *20 km search radius for records. WO = Wildlife online database, PM = EPBC Act Protected Matters Report*

Table 25 Near threatened and threatened fauna species identified from database searches

Status[1]		Family	Scientific name	Common name	PL	Source[2]	WO records	Likelihood of occurrence
NCA	EPBC							
BIRDS								
E	V	Accipitridae	*Erythrotriorchis radiatus*	Red Goshawk	Lancewood	WO/PM	3	Moderate
					Central	PM	-	Low
					Sapphire	PM	-	Low
V	V, M, Ma	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	Lancewood	WO	1	Low
					Central	-	-	-
					Sapphire	-	-	-
V	V	Columbidae	*Geophaps scripta scripta*	Southern Squatter Pigeon	Lancewood	WO/PM	6	High
					Central	WO/PM	20	Present
					Sapphire	WO/PM	40	High
E	E	Estrildidae	*Neochmia ruficauda ruficauda*	Southern Star Finch	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
E	E	Estrildidae	*Poephila cincta cincta*	Southern Black-throated Finch	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
V	V	Falconidae	*Falco hypoleucos*	Grey Falcon	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
E	E	Rostratulidae	*Rostratula australis*	Australian Painted Snipe	Lancewood	PM	-	Low

Status[1]		Family	Scientific name	Common name	PL	Source[2]	WO records	Likelihood of occurrence
NCA	EPBC							
					Central	PM	-	Low
					Sapphire	PM	-	Low
CE	CE, M, Ma	Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
V	V	Tytonidae	*Tyto novaehollandiae kimberli*	Masked Owl (northern)	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
MAMMALS								
LC	E	Dasyuridae	*Dasyurus hallucatus*	Northern Quoll	Lancewood	PM	-	Moderate
					Central	PM	-	Moderate
					Sapphire	PM	-	Moderate
NT	-	Emballonuridae	*Taphozous australis*	Coastal Sheathtail Bat	Lancewood	-	-	-
					Central	WO	3	Low
					Sapphire	WO	3	Low
E	V	Megadermatidae	*Macroderma gigas*	Ghost Bat	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
V	V	Vespertilionidae	*Nyctophilus corbeni*	Corben's Long-eared Bat	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low

Status[1]		Family	Scientific name	Common name	PL	Source[2]	WO records	Likelihood of occurrence
NCA	EPBC							
V	V	Petauridae	*Petauroides armillatus* (synonymous with *P. volans)*	Central Greater Glider	Lancewood	WO/PM	5	High
					Central	WO/PM	41	High
					Sapphire	WO/PM	31	High
V	V	Phascolarctidae	*Phascolarctus cinereus*	Koala	Lancewood	PM	-	High
					Central	WO/PM	12	High
					Sapphire	WO/PM	11	Moderate
LC	V	Pteropidae	*Pteropus poliocephaus*	Grey-headed Flying-fox	Lancewood	PM	-	Low
					Central	-	-	-
					Sapphire	-	-	-
REPTILES								
V	V	Elapidae	*Denisonia maculata*	Ornamental Snake	Lancewood	PM	-	Moderate
					Central	WO/PM	1	High
					Sapphire	WO/PM	5	High
V	V	Elapidae	*Furina dunmalli*	Dunmall's Snake	Lancewood	-	-	-
					Central	PM	-	Low
					Sapphire	PM	-	Low
V	V	Scincidae	*Egernia rugosa*	Yakka Skink	Lancewood	PM	-	Moderate
					Central	PM	-	Moderate
					Sapphire	PM	-	Moderate
E	E	Scincidae	*Lerista allanae*	Retro Slider	Lancewood	-	-	-
					Central	PM	-	Low

Status[1]		Family	Scientific name	Common name	PL	Source[2]	WO records	Likelihood of occurrence
NCA	EPBC							
					Sapphire	PM	-	Low
CE	CE	Chelidae	*Elseya albagula*	Southern Snapping Turtle	Lancewood	PM	-	Low
					Central	-	-	-
					Sapphire	PM	-	Low
V	V	Chelidae	*Rheodytes leukops*	Fitzroy River Turtle	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low

1. *Status: LC = Least Concern, SLC = Special Least Concern, V = Vulnerable, NT = Near Threatened, E = Endangered, CE = Critically Endangered, M = Migratory, Ma = Marine*
2. *20km search radius for records. WO = Wildlife online database, PM = EPBC Act Protected Matters Report*

Table 26 EPBC Act listed migratory species identified from database searches

Status[1]		Family	Scientific name	Common name	PL	Source[2]	WO records	Likelihood of occurrence
NCA	EPBC							
BIRDS								
SLC	M, Ma	Apodidae	*Apus pacificus*	Fork-tailed Swift	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
V	V, M, Ma	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	Lancewood	WO	1	Low
					Central	-	-	-
					Sapphire	-	-	-
SLC	M, Ma	Cuculidae	*Cuculus optatus*	Oriental Cuckoo	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
SLC	M, Ma	Monarchidae	*Monarcha melanopsis*	Black-faced monarch	Lancewood	PM	-	Low
					Central	-	-	-
					Sapphire	-	-	-
SLC	M, Ma	Monarchidae	*Myiagra cyanoleuca*	Satin flycatcher	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	-	-	-
SLC	M, Ma	Motacillidae	*Motacilla flava*	Yellow Wagtail	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
SLC	M, Ma	Pandionidae	*Pandion haliaetus*	Osprey	Lancewood	PM	-	Low

Status[1]		Family	Scientific name	Common name	PL	Source[2]	WO records	Likelihood of occurrence
NCA	EPBC							
					Central	PM	-	Low
					Sapphire	PM	-	Low
SLC	M, Ma	Rhipiduridae	*Rhipidura rufifrons*	Rufous fantail	Lancewood	PM	-	Low
					Central	-	-	-
					Sapphire	-	-	-
SLC	M, Ma	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
SLC	M, Ma	Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
CE	CE, M, Ma	Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
SLC	M, Ma	Scolopacidae	*Calidris melanotos*	Pectoral Sandpiper	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low
SLC	M, Ma	Scolopacidae	*Gallinago hardwickii*	Latham's Snipe	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low

Status[1]		Family	Scientific name	Common name	PL	Source[2]	WO records	Likelihood of occurrence
NCA	EPBC							
SLC	M, Ma	Scolopacidae	*Tringa nebularia*	Common greenshank	Lancewood	PM	-	Low
					Central	PM	-	Low
					Sapphire	PM	-	Low

1. *Status: SLC = Special Least Concern, E = Endangered, CE – Critically Endangered, M = Migratory, Ma = Marine.*
2. *20km search radius for records. WO = Wildlife online database, PM = EPBC Act Protected Matters Repor*

5.2.7 Regional Ecosystem Mapping

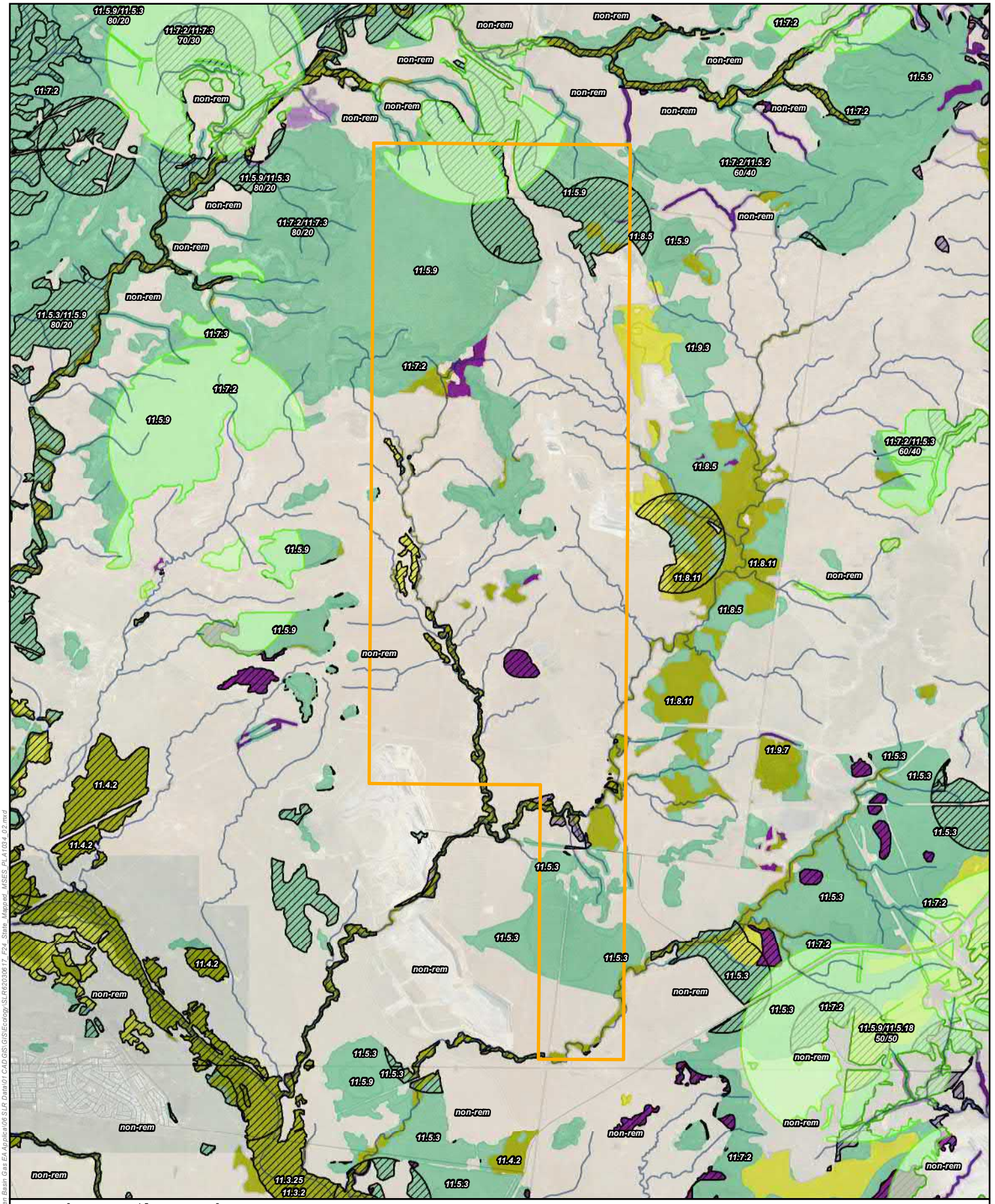
A combined total of 34 REs are state-mapped to occur across the three PLs, which include 19 in Sapphire, 17 in Central and 12 in Lancewood (Table 27) (DoR, 2021). State-mapped REs occur primarily as homogenous polygons comprised of one distinct RE or, in some cases, as heterogeneous polygons comprising attributes of multiple vegetation communities. State mapped regional ecosystems are displayed in Table 27 and Figure 24 to Figure 26.

Table 27 State mapped regional ecosystems within the PLs

Code	VM Act class	Biodiversity status	REDD short description	Structural category	PL
11.3.1	Endangered	Endangered	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Mid-dense	Central
11.3.2	Of concern	Of concern	*Eucalyptus populnea* woodland on alluvial plains	Sparse	Sapphire; Central; Lancewood
11.3.4	Of concern	Of concern	*Eucalyptus tereticornis* and/or *Eucalyptus spp.* woodland on alluvial plains	Sparse	Central; Lancewood
11.3.7	Least concern	Of concern	*Corymbia spp.* open woodland on alluvial plains	Very sparse	Sapphire
11.3.25	Least concern	Of concern	*E. tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage lines	Sparse	Sapphire; Central; Lancewood
11.3.36	Of concern	Of concern	*Eucalyptus crebra* and/or *E. populnea* and/or *Eucalyptus melanophloia* on alluvial plains. Higher terraces	Sparse	Central
11.4.2	Of concern	Of concern	*Eucalyptus spp.* and/or *Corymbia spp.* grassy or shrubby woodland on Cainozoic clay plains	Sparse	Lancewood
11.4.8	Endangered	Endangered	*Eucalyptus cambageana* woodland to open forest with *A. harpophylla* or *Acacia argyrodendron* on Cainozoic clay plains	Sparse	Lancewood
11.4.9	Endangered	Endangered	*A. harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	Sparse	Sapphire; Central
11.5.3	Least concern	No concern at present	*E. populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	Sparse	Sapphire; Central
11.5.9c	Least concern	No concern at present	*E. crebra* and other *Eucalyptus spp.* and *Corymbia spp.* woodland on Cainozoic sand plains and/or remnant surfaces	Sparse	Sapphire
11.5.15	Least concern	Endangered	Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces	Dense	Sapphire
11.7.1	Least concern	Of concern	*A. harpophylla* and/or *C. cristata and Eucalyptus thozetiana* or *Eucalyptus microcarpa* woodland on lower scarp slopes on Cainozoic lateritic duricrust	Sparse	Sapphire

Code	VM Act class	Biodiversity status	REDD short description	Structural category	PL
11.7.2	Least concern	No concern at present	*Acacia spp.* woodland on Cainozoic lateritic duricrust. Scarp retreat zone	Sparse	Sapphire; Central; Lancewood
11.7.3	Least concern	No concern at present	*Eucalyptus persistens*, *Triodia mitchellii* open woodland on stripped margins of Cainozoic lateritic duricrust	Very sparse	Sapphire
11.7.4	Least concern	No concern at present	*Eucalyptus decorticans* and/or *Eucalyptus spp.*, *Corymbia spp.*, *Acacia spp.*, *Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust	Sparse	Central
11.7.5	Least concern	No concern at present	Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks	Sparse	Sapphire
11.8.3	Of concern	Of concern	Semi-evergreen vine thicket on Cainozoic igneous rocks	Dense	Lancewood
11.8.4	Least concern	No concern at present	*E. melanophloia* woodland to open woodland on Cainozoic igneous rocks.	Very sparse	Lancewood
11.8.5	Least concern	No concern at present	*Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks	Very sparse	Sapphire
11.8.11	Of concern	Of concern	*Dichanthium sericeum* grassland on Cainozoic igneous rocks	Grassland Sch 4	Sapphire
11.8.13	Endangered	Endangered	Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks	Dense	Sapphire
11.9.1	Endangered	Endangered	*A. harpophylla-E. cambageana* woodland to open forest on fine-grained sedimentary rocks	Mid-dense	Saphire
11.9.2	Least concern	No concern at present	*E. melanophloia* +/- *E. orgadophila* woodland to open woodland on fine-grained sedimentary rocks	Sparse	Sapphire; Lancewood
11.9.3	Least concern	No concern at present	*Dichanthium spp.*, *Astrebla spp.* grassland on fine-grained sedimentary rocks	Grassland Sch 4	Sapphire; Central
11.9.4a	Of concern	Endangered	Semi-evergreen vine thicket or *A. harpophylla* with a semi-evergreen vine thicket understorey on fine-grained sedimentary rocks	Dense	Sapphire
11.9.5	Endangered	Endangered	*A. harpophylla* and/or *C. cristata* open forest to woodland on fine-grained sedimentary rocks	Mid-dense	Sapphire; Central
11.9.7a	Of concern	Of concern	*E. populnea*, *Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks	Sparse	Sapphire; Central
11.9.9	Least concern	No concern at present	*E. crebra* woodland on fine-grained sedimentary rocks	Sparse	Central; Lancewood
11.10.1	Least concern	No concern at present	*C. citriodora* woodland on coarse-grained sedimentary rocks	Sparse	Central
11.10.4a	Least concern	No concern at present	*E. decorticans*, *L. angustifolius* +/- *Eucalyptus spp.*, *Corymbia spp.*, *Acacia spp.* woodland on coarse-grained sedimentary rocks	Sparse	Central; Lancewood

Code	VM Act class	Biodiversity status	REDD short description	Structural category	PL
11.10.7	Least concern	No concern at present	*E. crebra* woodland on coarse-grained sedimentary rocks	Sparse	Central; Lancewood
11.10.8	Of concern	Of concern	Semi-evergreen vine thicket in sheltered habitats on medium to coarse-grained sedimentary rocks	Dense	Central
11.10.12	Least concern	No concern at present	*E. populnea* woodland on medium to coarse-grained sedimentary rocks	Sparse	Lancewood



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.30617
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	MM

LEGEND

- Watercourse (VMA)
- Project Area (PL 1034)
- Flora Survey Trigger Map
- Essential Habitat

State Mapped Regional Ecosystems (Biodiversity Status)

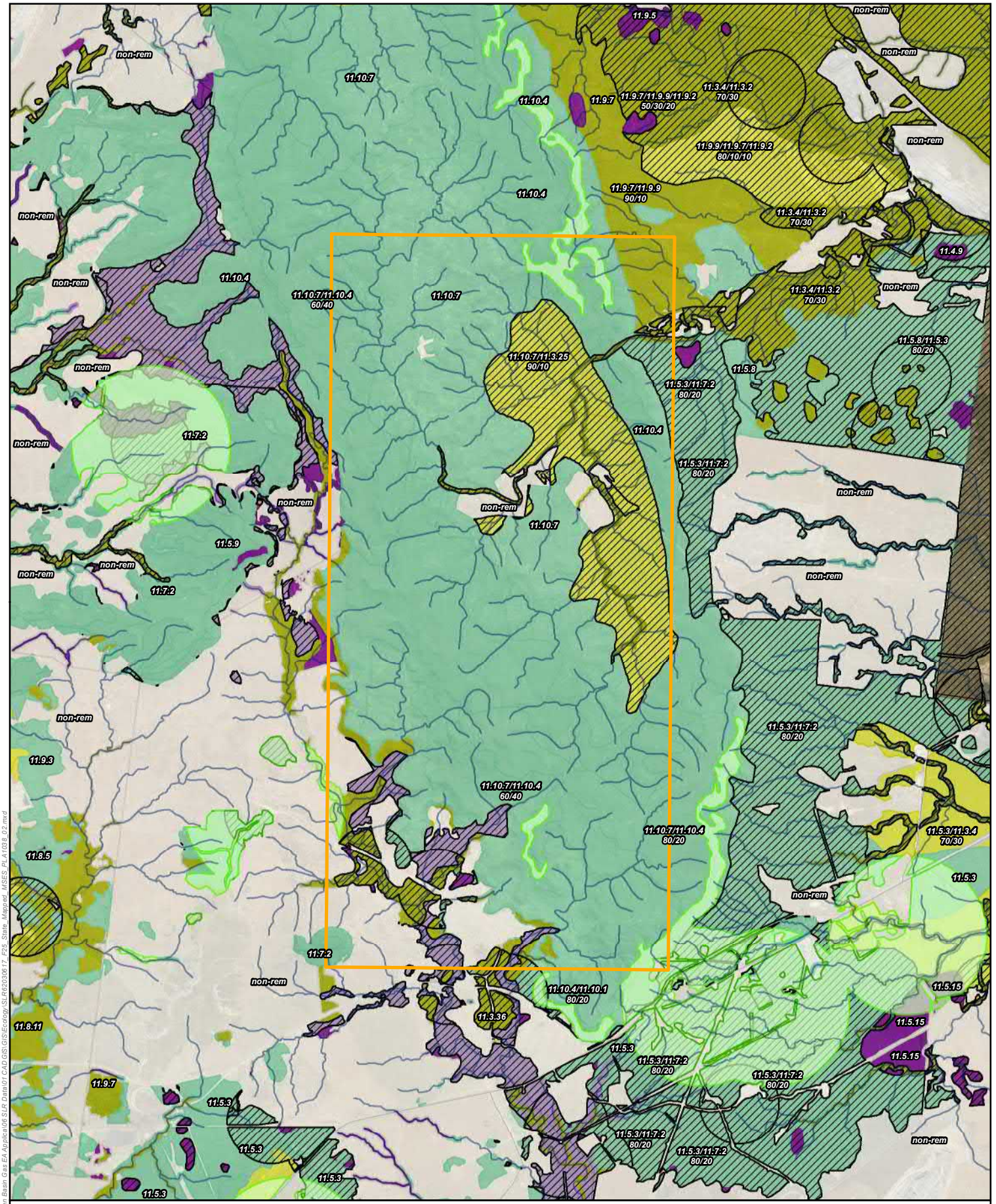
- Endangered - Dominant
- Endangered - Sub-dominant
- Of Concern
- Of Concern - Sub-dominant
- No concern at present
- Non-remnant
- Water

BLUE ENERGY EA APPLICATION

Project Area - PL 1034 State Mapped MSES

FIGURE 24

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\Ecology\SLR620306617_F24_State_Mapped_MSES_PLA1034_02.mxd



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:125,000 at A4
Project Number:	620.30617
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	MM

LEGEND

- Watercourse (VMA)
- Project Area (PL 1038)
- Flora Survey Trigger Map
- Essential Habitat

State Mapped Regional Ecosystems (Biodiversity Status)

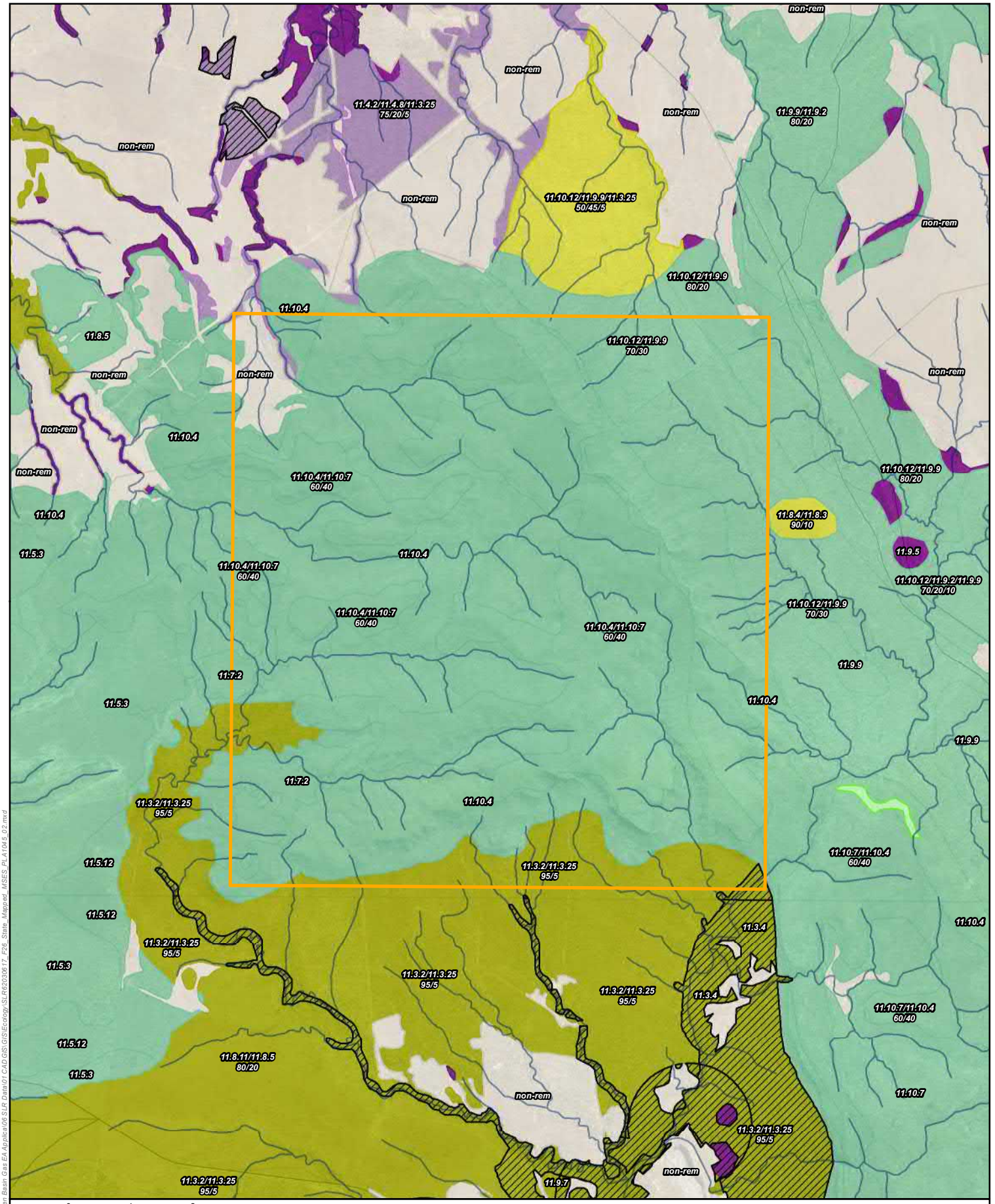
- Endangered - Dominant
- Endangered - Sub-dominant
- Of Concern
- Of Concern - Sub-dominant
- No concern at present
- Non-remnant
- Water

BLUE ENERGY EA APPLICATION

Project Area - PL 1038 State Mapped MSES

FIGURE 25

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\Ecology\SLR620306617_F25_State_Mapped_MSES_PLA1038_02.mxd



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.30617
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	MM

LEGEND

- Watercourse (VMA)
- Project Area (PL 1045)
- Flora Survey Trigger Map
- Essential Habitat

State Mapped Regional Ecosystems (Biodiversity Status)

- Endangered - Dominant
- Endangered - Sub-dominant
- Of Concern
- Of Concern - Sub-dominant
- No concern at present
- Non-remnant

BLUE ENERGY EA APPLICATION

Project Area - PL 1045 State Mapped MSES

FIGURE 26

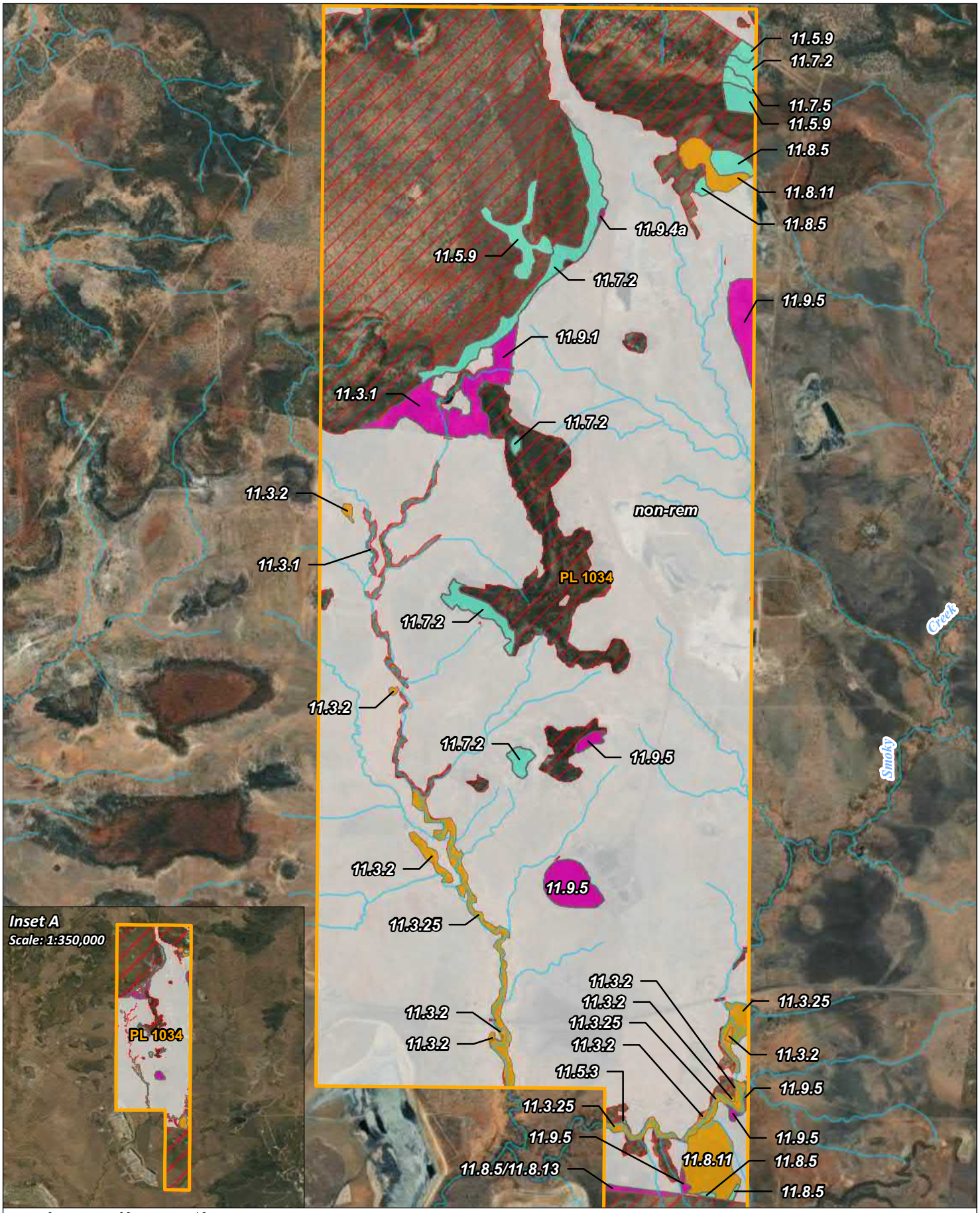
H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\Ecology\SLR620306617_F26_State_Mapped_MSES_PLA1045_02.mxd

A combined total of 19 vegetation communities equating to VM Act regional ecosystems were ground-truthed within the PLs during rapid vegetation assessments. These REs are described in Table 28 and displayed in Figure 27 to Figure 30. Additionally, large areas within the Sapphire and Central PLs show evidence of prior landholder clearing of remnant vegetation. This has resulted in some discrepancies in areas of State mapped remnant vegetation, which is now cleared and non-remnant. Large proportions of each PL were inaccessible during ground-truthing activities. Therefore, ground-truthed REs presented in this report do not represent a comprehensive overview of the distribution and occurrence of all REs within each PL.

Table 28 State mapped regional ecosystems

RE code	VM Act class	Biodiversity Act status	REDD short description	Structural category	PL
11.3.1	Endangered	Endangered	*A. harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Mid-dense	Sapphire; Central
11.3.2	Of concern	Of concern	*E. populnea* woodland on alluvial plains	Sparse	Sapphire; Central
11.3.4	Of concern	Of concern	*E. tereticornis* and/or *Eucalyptus spp.* woodland on alluvial plains	Sparse	Central
11.3.25	Least concern	Of concern	*E. tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Sparse	Sapphire; Central; Lancewood
11.3.36	Of concern	Of concern	*E. crebra* and/or *E. populnea* and/or *E. melanophloia* on alluvial plains. Higher terraces	Sparse	Central
11.5.3	Least concern	No concern at present	*E. populnea* +/- *E. melanophloia* +/- *C. clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	Sparse	Sapphire
11.5.9	Least concern	No concern at present	*E. crebra* and other *Eucalyptus spp.* and *Corymbia spp.* woodland on Cainozoic sand plains and/or remnant surfaces	Sparse	Sapphire; Central
11.5.12	Least concern	No concern at present	*C. clarksoniana* woodland and other *Corymbia spp.* and *Eucalyptus spp.* on Cainozoic sand plains and/or remnant surfaces	Sparse	Lancewood
11.7.2	Least concern	No concern at present	*Acacia spp.* woodland on Cainozoic lateritic duricrust. Scarp retreat zone	Sparse	Sapphire
11.7.5	Least concern	No concern at present	Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks	Sparse	Sapphire
11.8.5	Least concern	No concern at present	*E. orgadophila* open woodland on Cainozoic igneous rocks	Very sparse	Sapphire
11.8.11	Of concern	Of concern	*D. sericeum* grassland on Cainozoic igneous rocks	Grassland Sch 4	Sapphire
11.8.13	Endangered	Endangered	Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks	Dense	Sapphire

RE code	VM Act class	Biodiversity Act status	REDD short description	Structural category	PL
11.9.1	Endangered	Endangered	*A. harpophylla-E. cambageana* woodland to open forest on fine-grained sedimentary rocks	Mid-dense	Sapphire
11.9.4a	Of concern	Endangered	Semi-evergreen vine thicket or *A. harpophylla* with a semi-evergreen vine thicket understorey on fine-grained sedimentary rocks	Dense	Sapphire
11.9.5	Endangered	Endangered	*A. harpophylla* and/or *C. cristata* open forest to woodland on fine-grained sedimentary rocks	Mid-dense	Sapphire; Central
11.10.4a	Least concern	No concern at present	*E. decorticans*, *L. angustifolius* +/- *Eucalyptus spp.*, *Corymbia spp.*, *Acacia spp.* woodland on coarse-grained sedimentary rocks	Sparse	Lancewood
11.10.7	Least concern	No concern at present	*E. crebra* woodland on coarse-grained sedimentary rocks	Sparse	Central; Lancewood
11.10.8	Of concern	Of concern	Semi-evergreen vine thicket in sheltered habitats on medium to coarse-grained sedimentary rocks	Dense	Central



0 0.9 1.8 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	620.30228
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	MM

LEGEND

- Watercourse (VMA)
- Project Area (PL 1034)
- State-Mapped Regional Ecosystems

Ground-Truthed Regional Ecosystems (Biodiversity Status)

- Endangered
- Of concern
- No concern at present
- Non-remnant

BLUE ENERGY EA APPLICATION

Project Area - PL 1034 Ground-Truthed Regional Ecosystems

FIGURE 27

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Ecology\SLR620306l7_F27_GTREs_PLA1034_001.mxd

0 0.65 1.3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:45,000 at A4
Project Number:	620.30617
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	MM

LEGEND

- Watercourse (VMA)
- Project Area (PL 1038)
- State-Mapped Regional Ecosystems

Ground-Truthed Regional Ecosystems (Biodiversity Status)

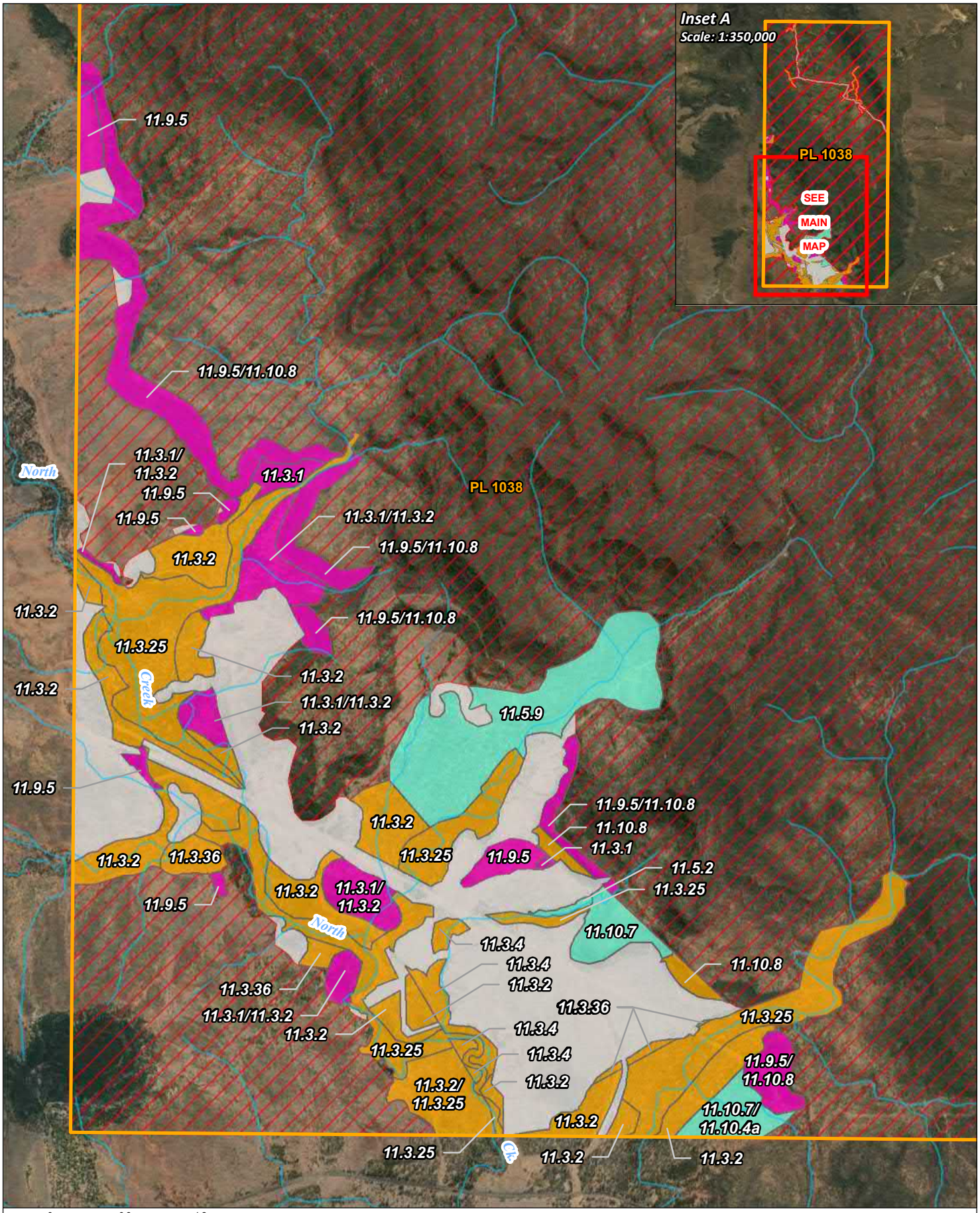
- Endangered
- Of concern
- No concern at present
- Non-remnant

BLUE ENERGY EA APPLICATION

Project Area - PL 1038 (North) Ground-Truthed Regional Ecosystems

FIGURE 28

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CADGIS\GIS\Ecology\SLR620.30617_F28_GTREs_PLA1038_NORTH_01.mxd



0 0.6 1.2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:40,000 at A4
Project Number:	620.30228
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	MM

LEGEND

- Watercourse (VMA)
- Project Area (PL 1038)
- State-Mapped Regional Ecosystems

Ground-Truthed Regional Ecosystems (Biodiversity Status)

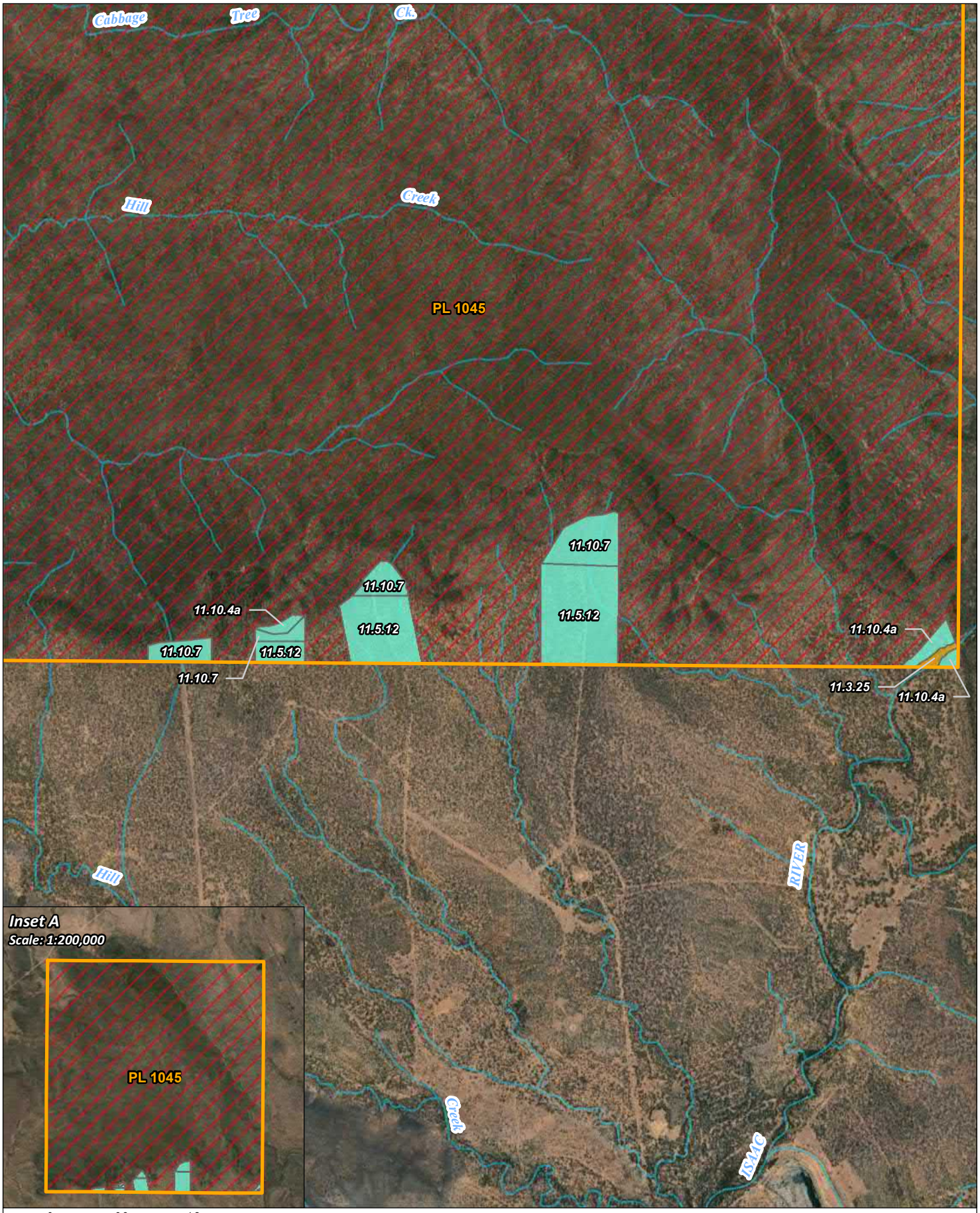
- Endangered
- Of concern
- No concern at present
- Non-remnant

BLUE ENERGY EA APPLICATION

Project Area - PL 1038 (South) Ground-Truthed Regional Ecosystems

FIGURE 29

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CADGIS\GIS\Ecology\SLR620306l7_F29_GTREs_PLA1038_SOUTH_001.mxd



0 0.6 1.2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:42,000 at A4
Project Number:	620.30228
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	MM

LEGEND

- Watercourse (VMA)
- Project Area (PL 1045)
- State-Mapped Regional Ecosystems

Ground-Truthed Regional Ecosystems (Biodiversity Status)

- Of concern
- No concern at present

BLUE ENERGY EA APPLICATION

Project Area - PL 1045 Ground-Truthed Regional Ecosystems

FIGURE 30

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Ecology\SLR620306617_F30_GTREs_PLA1045_001.mxd

5.2.8 Environmentally Sensitive Areas (ESAs)

There are several State-mapped ESAs within each of the PLs, and in the surrounding area, on the map of ESAs (DES, 2021c). ESAs State-mapped to occur within the PLs are described within Table 29.

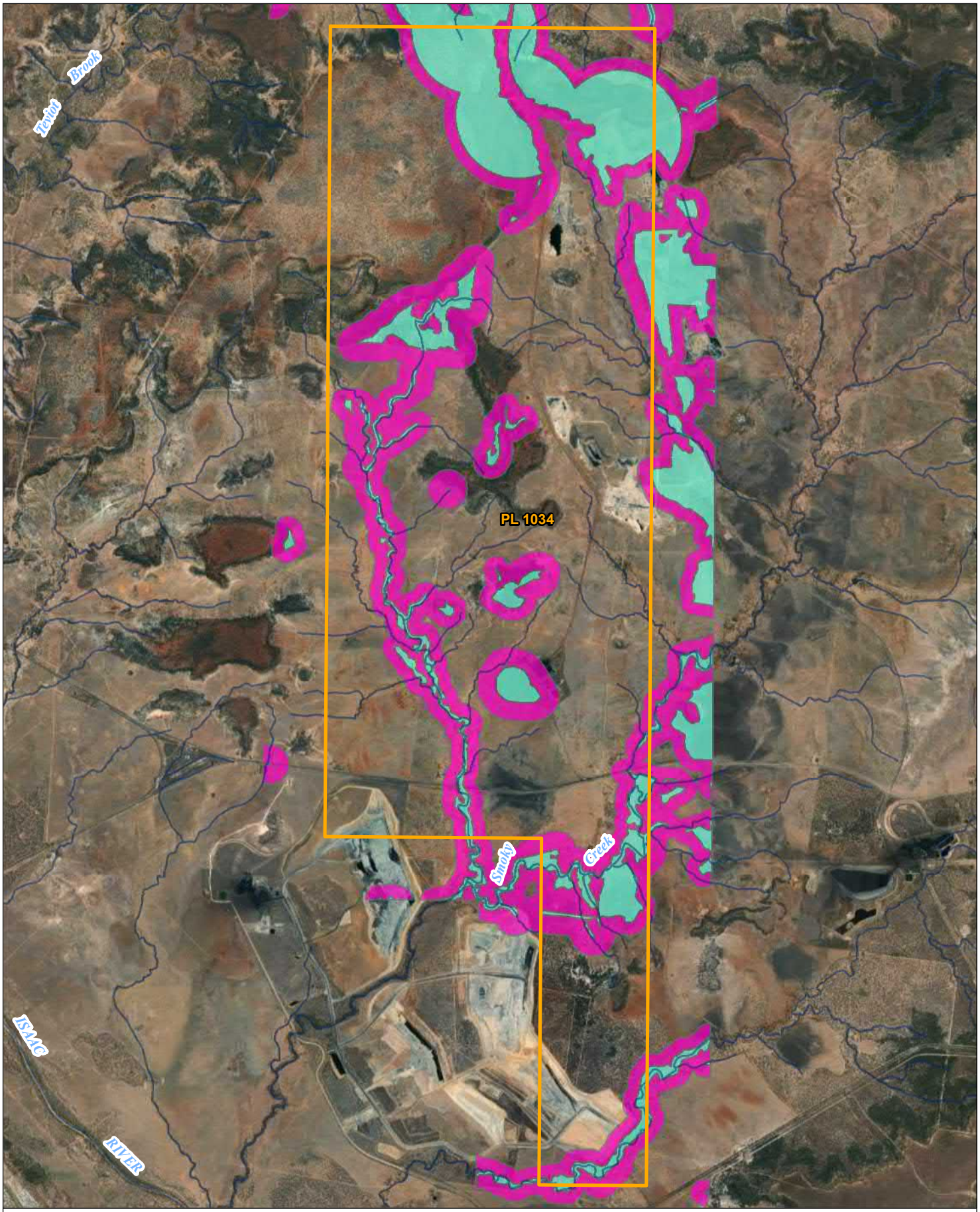
Table 29 State mapped ESAs within the PLs

ESA category	ESA description	PL
B	'Endangered' REs – regrowth and remnant (Biodiversity Status)	Sapphire; Central; Lancewood
C	Essential habitat	Sapphire; Central; Lancewood
C	'Of Concern' REs – remnant (Biodiversity Status)	Sapphire; Central; Lancewood

All ground-truthed vegetation communities in equating to 'endangered' or 'of concern' correspond to either a Category B or Category C ESA, respectively. As a result, ground-truthing efforts have resulted in the field verification of category B and C ESAs within the PLs, as displayed in Table 30 and Figure 31 to Figure 33.

Table 30 Endangered or Of Concern REs ground-truthed and State mapped within the PLs

RE code	Status		Structural category	Corresponding ESA
	VM Act	Biodiversity status		
11.3.1	Endangered	Endangered	Mid-dense	Category B ESA
11.3.2	Of concern	Of concern	Sparse	Category C ESA
11.3.4	Of concern	Of concern	Sparse	Category C ESA
11.3.7	Least concern	Of concern	Very sparse	Category C ESA
11.3.25	Least concern	Of concern	Sparse	Category C ESA
11.3.36	Of concern	Of concern	Sparse	Category C ESA
11.4.2	Of concern	Of concern	Sparse	Category C ESA
11.4.8	Endangered	Endangered	Sparse	Category B ESA
11.4.9	Endangered	Endangered	Sparse	Category B ESA
11.5.15	Least concern	Endangered	Dense	Category B ESA
11.7.1	Least concern	Of concern	Sparse	Category C ESA
11.8.3	Of concern	Of concern	Dense	Category C ESA
11.8.11	Of concern	Of concern	Grassland Sch 4	Category C ESA
11.8.13	Endangered	Endangered	Dense	Category B ESA
11.9.1	Endangered	Endangered	Mid-dense	Category B ESA
11.9.4a	Of concern	Endangered	Dense	Category B ESA
11.9.5	Endangered	Endangered	Mid-dense	Category B ESA
11.9.7a	Of concern	Of concern	Sparse	Category C ESA
11.10.8	Of concern	Of concern	Dense	Category C ESA



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:80,000 at A4
Project Number:	620.30228
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	MM

LEGEND

- Watercourse (VMA)
- Project Area (PL 1034)

Authorised Petroleum Activities in ESAs

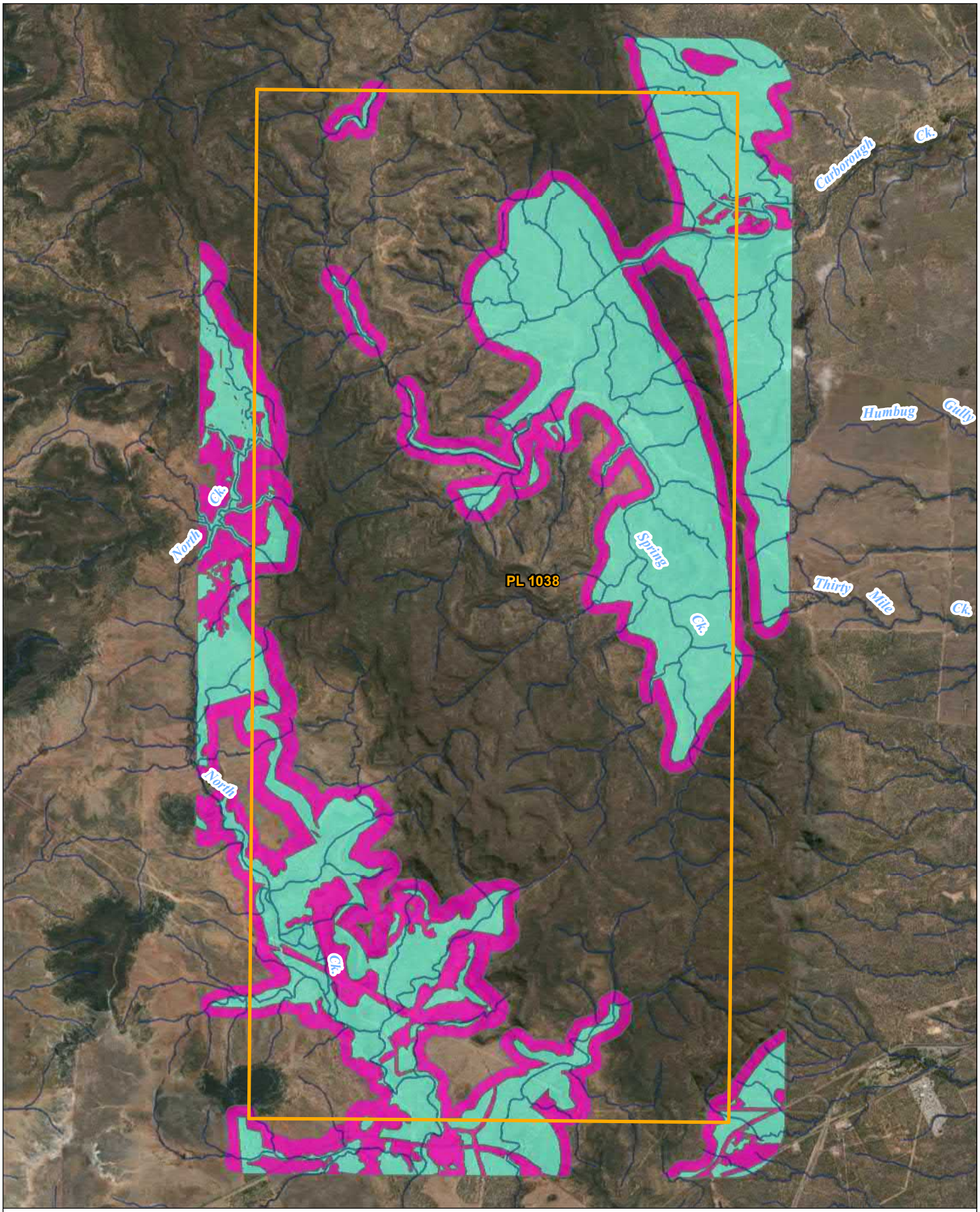
- Only Low Impact Petroleum Activities Permitted
- Only Essential Petroleum Activities Permitted

BLUE ENERGY EA APPLICATION

Project Area - PL 1034 Environmentally Sensitive Areas

FIGURE 31

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Ecology\SLR620306617_F31_ESAs_PLA1034_01.mxd



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:90,000 at A4
Project Number:	620.30228
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	MM

LEGEND

- Watercourse (VMA)
- Project Area (PL 1038)

Authorised Petroleum Activities in ESAs

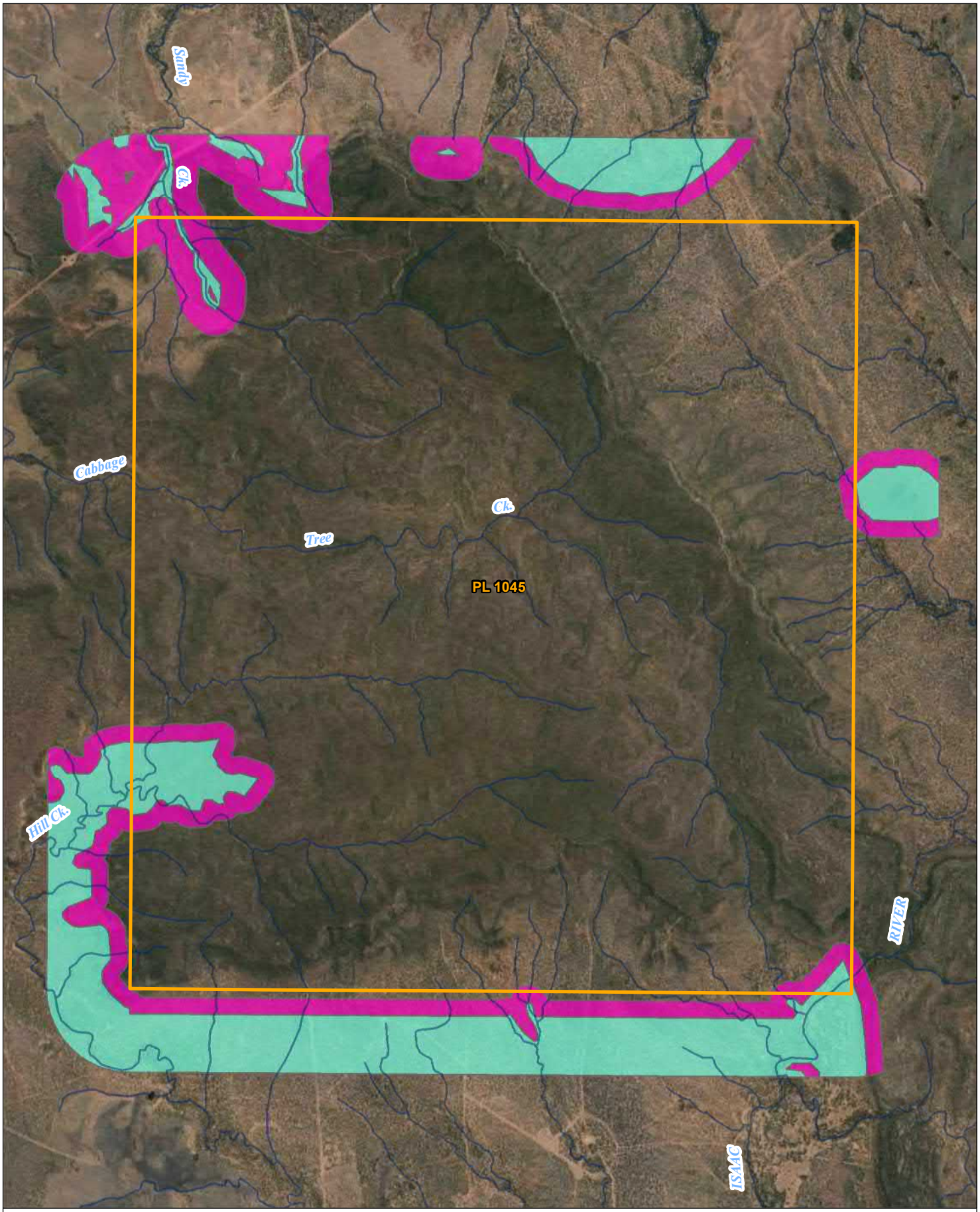
- Only Low Impact Petroleum Activities Permitted
- Only Essential Petroleum Activities Permitted

BLUE ENERGY EA APPLICATION

Project Area - PL 1038 Environmentally Sensitive Areas

FIGURE 32

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CADGIS\GIS\Ecology\SLR620306l7_F32_ESAs_PLA1038_01.mxd



0 0.9 1.8 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:60,000 at A4
Project Number:	620.30228
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	MM

LEGEND

- Watercourse (VMA)
- Project Area (PL 1045)

Authorised Petroleum Activities in ESAs

- Only Low Impact Petroleum Activities Permitted
- Only Essential Petroleum Activities Permitted

BLUE ENERGY EA APPLICATION

Project Area - PL 1045 Environmentally Sensitive Areas

FIGURE 33

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Ecology\SLR620306l7_F33_ESAs_PLA1045_01.mxd

5.2.9 Protected Wildlife Habitat

Several areas of mapped essential habitat and high-risk areas shown on the flora survey trigger map were revealed in desktop assessments, as outlined below.

5.2.9.1 Sapphire (PL 1034)

There are several areas of mapped essential habitat within the Sapphire PL (Figure 24) (QLD Globe, 2021), which includes essential habitat for the Ornamental Snake (*Denisonia maculata*) and Central Greater Glider (*Petauroides armillatus*), which is synonymous with the Greater Glider (*Petauroides volans*). An additional polygon of essential habitat for the Squatter Pigeon (*Geophaps scripta scripta*) is located immediately adjacent to, but just outside of, the central eastern boundary of the PL (DoR, 2021).

There is one mapped high-risk polygon for threatened flora within the northern portion of the Sapphire PL (Figure 24) (QLD Globe, 2021). This high-risk polygon is attributed to a record of *Cerbera dumicola* (ALA, 2021), which is listed as Near Threatened under the NC Act. The prescribed MSES for protected wildlife habitat does not include near-threatened species.

5.2.9.2 Central (PL 1038)

There are large polygons of mapped essential habitat for the Ornamental Snake within the south-western and north-eastern portions of the Central PL (Figure 25) (QLD Globe, 2021; DoR, 2021).

There are four mapped high-risk polygons for threatened flora, which occur across the southern and northern portions of the Central PL (Figure 25) (QLD Globe, 2021). A polygon within the south-eastern portion of the PL is attributed to *Bertya pedicellata* (ALA, 2021), however information is limited as to what species the remining polygons are attributed to.

5.2.9.3 Lancewood (PL 1045)

There is a small polygon of mapped essential habitat for the Ornamental Snake within the south-eastern portion of the Lancewood PL (Figure 26) (QLD Globe, 2021; DoR, 2021).

There are no mapped high-risk polygons for threatened flora within or adjacent to the Lancewood PL (Figure 26) (QLD Globe, 2021).

5.2.10 Protected Areas

There are no MSES protected areas within or adjacent to any of the PLs.

5.2.11 Watercourses and Wetlands

Each of the three PLs contain a variety of VM Act watercourses, including several first, second and third order watercourses. A fourth order watercourse bisects the south-eastern portion of the Lancewood PL, a fourth order watercourse occurs east to west across the southern portion of the Sapphire PL and several fourth order watercourses are mapped within the Central PL (QLD Globe, 2021).

No wetlands of international importance (Ramsar wetlands) are located within the PLs or surrounding area.

There are no MSES wetland values, including high ecological significance wetlands or regulated vegetation within 100 m of a wetland, within the PLs.

There are no fish habitat areas within the PLs, or in the surrounding area, as declared by the Fisheries (General) Regulation 2019 (Schedule 3) (QLD Globe, 2021).

The PLs contain waterways for waterway barrier works that provide for fish passage. Fish passage attributes of 1 (low risk) to 4 (major) are present in all of the PLs.

5.3 Emission and Releases

A range of emissions and releases from CSG activities can pose potential risks to ecological EVs. These are broadly characterised into four activity areas:

- CSG extraction processes
- Raw CSG water storage
- Treated CGS water disposal, and
- CSG operations which can include chemicals and fuels storage and leakage etc.

CSG activities will not be located within close proximity to any of the above identified ecological areas and values and there are no planned or expected emissions or releases to any of the above identified ecological environmental areas and values.

Drilling and construction of petroleum wells will not be located within close proximity to any of the above identified ecological areas and values.

Raw CSG water will not be released into any of the above identified ecological areas and values.

Treated CSG water will be managed according to beneficial use priorities and treated accordingly. At the time of this report, these arrangements have not been formalised, however, Blue Energy are in preliminary negotiations with adjacent mining operations to accept this water for reuse. It is not proposed to include the release of this water into any of the above identified ecological areas and values.

5.4 Potential Impacts and Management Practices

5.4.1 Matters of State Environmental Significance

5.4.1.1 Regulated Vegetation

Regulated vegetation is a MSES and identified within the Queensland Environmental Offsets Policy – Significant Residual Impact Guideline as a prescribed regional ecosystem that:

- Is an endangered or of concern regional ecosystem, as defined under the VM Act, or
- intersects with an area shown on the vegetation management wetlands map, as defined under the VM Act, to remove doubt this refers to that component of a regional ecosystem that lies within a mapped wetland, or
- is located within the defined distance from the defining banks of a watercourse identified on the vegetation management watercourse map, as defined under the VM Act.

Table 31 details criteria for the assessment of significant residual impacts to regulated vegetation.

Table 31 Regulated vegetation significant residual impact test criteria

		Clearing in a RE that is 'endangered' or 'Of concern'	Clearing in the portion of a RE that lies within a mapped wetland	Clearing in a RE that is within the defined distance of a watercourse
1	For clearing for linear infrastructure: • Greater than 25m wide in a grassland (structural category (SC)) RE; or • Greater than 20m wide in a sparse SC RE; or • Greater than 10m wide in a dense to mid-dense SC RE.	X	X	X
	For clearing other than clearing for linear infrastructure: • Area greater than 5ha where in a grassland SC RE; or • Area greater than 2ha where in a sparse SC RE; or • Area greater than 0.5ha where in a dense to mid-dense SC RE.			
2	Clearing within 50 m of the defining bank.	N/A	X	N/A
3	Clearing within 5 m of the defining bank.	N/A	N/A	X

For a prescribed activity to have a significant residual impact on an RE that lies within a mapped wetland, criteria 1 and 2 must be exceeded.

For a prescribed activity to have a significant residual impact on an RE that is within the defined distance of a watercourse, criteria 1 and 3 must be exceeded.

Endangered and Of Concern REs

A variety of REs are ground-truthed and State mapped to occur within the PLs, several of which equate to endangered or of concern REs under the VM Act (Table 32). As described above, REs identified under the VM Act as being either 'endangered' or 'of concern' equate to the regulated vegetation MSES. Therefore, any vegetation clearing within these areas equating to or exceeding the relevant criteria in Table 31 will result in a significant residual impact to this MSES and may result in the requirement of offsets under the Environmental Offsets Regulation (2014).

In addition to the assessment of likely impacts to MSES under the Environmental Offsets Regulation (2014) the assessment of impacts to matters regulated under the Environmental Protection Regulation (2008) (EP Regulation) need to be considered. The EP Regulation states that REs with an 'endangered' status under the REDD equate to a Category B ESA and REs with an 'of concern' status within the REDD equate to a Category C ESA. In accordance with the Streamlined Model Conditions for Petroleum Activities, REs with an 'of concern or 'endangered' Biodiversity status, in addition to the VM Act status, are relevant in determining impacts to State regulated matters (Table 32).

Table 32 Endangered or Of Concern REs ground-truthed and State mapped within the PLs

RE code	Status		Structural category	Corresponding ESA
	VM Act	Biodiversity status		
11.3.1	Endangered	Endangered	Mid-dense	Category B ESA
11.3.2	Of concern	Of concern	Sparse	Category C ESA
11.3.4	Of concern	Of concern	Sparse	Category C ESA
11.3.7	Least concern	Of concern	Very sparse	Category C ESA
11.3.25	Least concern	Of concern	Sparse	Category C ESA
11.3.36	Of concern	Of concern	Sparse	Category C ESA
11.4.2	Of concern	Of concern	Sparse	Category C ESA
11.4.8	Endangered	Endangered	Sparse	Category B ESA
11.4.9	Endangered	Endangered	Sparse	Category B ESA
11.5.15	Least concern	Endangered	Dense	Category B ESA
11.7.1	Least concern	Of concern	Sparse	Category C ESA
11.8.3	Of concern	Of concern	Dense	Category C ESA
11.8.11	Of concern	Of concern	Grassland Sch 4	Category C ESA
11.8.13	Endangered	Endangered	Dense	Category B ESA
11.9.1	Endangered	Endangered	Mid-dense	Category B ESA
11.9.4a	Of concern	Endangered	Dense	Category B ESA
11.9.5	Endangered	Endangered	Mid-dense	Category B ESA
11.9.7a	Of concern	Of concern	Sparse	Category C ESA
11.10.8	Of concern	Of concern	Dense	Category C ESA

Activity restrictions apply to these ESAs and their protection zones according to the Streamlined Model Conditions for Petroleum Activities. Therefore, it is likely that impacts to these areas will be avoided or minimised by design. These activity restrictions include:

- Low impact petroleum activities:
  - Petroleum activities which do not result in the clearing of native vegetation, cause disruption to soil profiles through earthworks or excavation or result in significant disturbance which cannot be rehabilitated immediately using hand tools after the activity is completed.
- Essential petroleum activities:
  - Activities that are essential to bringing the resource to the surface, which are defined within the Streamlined Model Conditions for Petroleum Activities.

It should be noted that primary and secondary protection zones apply to Cat B and/or Cat C ESAs. These protection zones are defined as:

- Primary protection zone is the area within 200m from the boundary of any Cat A, B, or C ESA.
- Secondary protection zone in relation to a Cat A or Cat B ESA means an area within 100m from the boundary of the primary protection zone.

Remnant Vegetation Associated with a Watercourse

Remnant vegetation associated with a watercourse shown on the VM Act watercourse and drainage feature map is classified as a MSES under the Queensland environmental offsets framework. There are several VM Act State mapped watercourse and drainage features, ranging from first to fourth order watercourses, within the PLs (QLD Globe, 2021) (Figure 24 to Figure 26). The extent to which the remnant vegetation associated with these watercourses is considered a protected matter is determined by the bioregional context and the stream order of the watercourse or drainage feature.

All vegetation communities within the PLs are classified as remnant vegetation. Therefore, the extent of vegetation communities within the defined distance of the banks of the State mapped watercourse/drainage features is a MSES. The PLs are located within a non-coastal bioregion and the relevant defining distance for REs associated with a watercourse are shown in Table 33.

Table 33 Defined distance for REs associated with a watercourse (non-coastal bioregions) as shown in the Queensland Environmental Offsets Policy V1.8

Watercourse stream order	Distance from defining bank (m)
1 or 2	25
3 or 4	50

As identified above, clearing of vegetation within the defined distance of the State mapped watercourse or drainage features should be avoided where possible. Where impacts are unavoidable, the following criteria are used to determine whether the impacts are significant, therefore triggering environmental offset liability:

- Clearing occurs within 5m of the defining bank of the feature, AND
- The following area thresholds are exceeded:
  - Greater than 20m wide for linear infrastructure in a sparse RE.
  - Greater than 2ha for non-linear infrastructure in a sparse RE.
  - Greater than 10m wide for linear infrastructure in a dense to mid-dense RE.
  - Greater than 0.5ha for non-linear infrastructure in a dense to mid-dense RE.

5.4.1.2 Connectivity Areas

Significant impacts to connectivity values, in accordance with the Landscape Fragmentation and Connectivity (LFC) tool were not assessed as part of this report. Assessments of significant impacts to connectivity within each PL should be undertaken in conjunction with resolved areas of proposed disturbance to determine impacts at a local and regional scale. A description of broad connectivity values within each PL is provided below.

The Sapphire PL contains large areas of non-remnant vegetation within the central portion of the PL, however large polygons of remnant vegetation occur within the northern portion of the PL. This non-remnant vegetation is interspersed with small to moderate sized polygons of State-mapped remnant vegetation, including remnant vegetation along a watercourse. This watercourse vegetation may provide connectivity values for local fauna to larger patches of remnant vegetation to the north and south of the PL, in addition to habitat for species such as the Ornamental Snake.

The Central PL is dominated by State-mapped contiguous polygons of remnant vegetation, however there are several areas of non-remnant vegetation within the southwestern and central portion of the PL. Remnant vegetation within the PL has high connectivity to State-mapped remnant vegetation to the north, south and east of the PL. Therefore, remnant vegetation within the PL likely provides important connectivity values within the local and regional context.

Except for the north-western corner of the Lancewood PL, the entirety of the PL contains State mapped remnant vegetation, which has connectivity to both the Sapphire and Central PLs via mapped remnant vegetation. Therefore, it is likely that remnant vegetation within each of the three PLs provides connectivity values for fauna and flora species on the local and regional scale.

5.4.1.3 Wetlands and Watercourses

The PLs do not contain any wetland protection areas or wetlands of high ecological significance as shown on the map of referrable wetlands (DES, 2021). The watercourses present within the PLs are not 'high ecological value waters' as identified under the Environmental Protection (Water) Policy 2009. Additionally, no wetlands of international importance (Ramsar wetlands) are located within or near the PLs. Therefore, significant impacts to MSES watercourses and wetlands are unlikely to occur as a result of development of the PLs.

Several VM Act watercourses are State mapped to occur within the PLs. Several of these watercourses are not associated with remnant vegetation due to pre-disturbance impacts associated with agricultural practices. These watercourses are generally characterised by areas of shallow relief within the surrounding landscape and local catchment and are likely subject to brief and highly ephemeral flows. For most of the year, and during times of prolonged drought, it is expected that these watercourses will remain dry. Disturbance to watercourse features present in the PLs should be avoided where possible to minimise impacts to local environmental values and effects upon water quality and hydrology downstream of the project area. Strategies to preferentially avoid and then minimise impacts to watercourses should adhere to those identified within conditions (Water 4, 6, 7 and 8) within the Streamlined Model Conditions for Petroleum Activities.

5.4.1.4 Protected Wildlife and Essential Habitat

Essential Habitat

There are several areas of State mapped essential habitat for the Ornamental Snake and Central Greater Glider within each PL. Additionally, there is a State mapped area of essential habitat for the Squatter Pigeon (southern) to the immediate east of the Sapphire PL. An assessment of ground-truthed essential habitat values for threatened fauna was not undertaken as part of the field assessment. Therefore, all areas of essential habitat are based on those presented within State mapping.

Essential habitat equates to a Category C ESA under the EP Regulation, which is outlined within the Streamlined Model Conditions for Petroleum Activities. Only low impact petroleum activities are permitted within the State mapped essential habitat areas. Additionally, only essential petroleum activities are permitted within the primary protection zone of these State mapped areas.

Any activity that may result in the clearing of native vegetation will be avoided by design in this area of essential habitat due to only low impact petroleum activities being permitted within the State mapped essential habitat areas. Therefore, it is likely that there will be no significant impacts to State mapped essential habitat within the PLs.

Protected Plant High-risk Areas

State mapped protected plant high-risk areas are a MSES and occur within the Sapphire and Central PLs (Figure 24 to Figure 26). Prior to undertaking any clearing activities within these areas, protected plant surveys are required in accordance with provisions described within Flora Survey Guidelines – Protected plants (DES, 2020).

5.4.1.5 Protected Areas

The PLs do not contain any MSES protected areas.

5.4.1.6 Fish Habitat Areas and Waterways Providing for Fish Passage

The PLs do not contain any MSES declared fish habitat areas.

5.4.1.7 Legally Secured Offset Areas

The PLs do not contain any legally secured offset areas.

5.4.2 Matters of National Environmental Significance

5.4.2.1 Threatened Ecological Communities

REs equating to four EPBC Act TECs are ground-truthed and State mapped to occur within the PLs (Table 34).

Table 34 EPBC Act TECs potentially occurring within 20km of each PL

TEC description	Status	PL
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	Sapphire; Central; Lancewood.
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Sapphire; Central; Lancewood
Poplar Box Grassy Woodland on Alluvial plains	Endangered	Sapphire; Central; Lancewood
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Sapphire; Central; Lancewood

Ground-truthed and State mapped REs occurring within the PLs that equate to a TEC are either a Category B or Category C ESA under the EP Regulation. Therefore, only low impact petroleum activities are permitted to occur within these areas in addition to activity restrictions within their protection zones. As such, it is unlikely that these TECs will be significantly impacted by development of the PLs as impacts will be avoided and minimised by design. Additionally, activity restrictions within the primary protection zone of these REs also limit the potential and severity of impacts.

An exception to this is RE 11.9.3, which does not equate to an ESA but is listed as an RE corresponding to the Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin TEC. In addition to the designated RE, key diagnostic characteristics and condition thresholds for this community need to be met in order for it to be considered sufficiently meet TEC criteria. This is due to natural grasslands within the region experiencing a degree of disturbance and degradation. Therefore, it is recommended that additional field assessments be undertaken to quantify whether mapped areas of RE 11.9.3 represent 'Best quality' or 'Good quality' patches for this TEC.

5.4.2.2 Listed Threatened Species

Many of the relevant MNES threatened flora and fauna species listed under the EPBC Act are also listed under Queensland legislation and therefore also have relevance as MSES. Consequently, all conservation significant flora and fauna species are discussed collectively in Section 5.4.3 and 5.4.4 below.

5.4.2.3 Migratory Fauna

Fourteen migratory fauna, as listed under the EPBC Act, were returned in the PMST search. Of these, all were considered to have a low likelihood of occurring within the PLs. Therefore, it is not considered that any will be significantly impacted.

5.4.3 Conservation Significant Flora Species

Desktop searches returned a combined total of 13 conservation-significant flora species either recorded within 20km of the PLs or potentially relevant to the PLs. Likelihood of occurrence assessments determined that several of these species have a moderate to high likelihood of occurring within the PLs, which are described below. It is recommended that detailed field assessments are undertaken to ground-truth the presence/absence of habitat values and local populations of threatened flora species identified within this report as having a moderate to high likelihood of occurring within the PLs. Ground-truthing assessments will provide greater resolution on information used to assess the likely or potential impacts to these species and inform strategies to avoid, minimise, or mitigate impacts through development of the PLs.

5.4.3.1 Ptilotus uncinellus

Ptilotus uncinellus is listed as endangered under the NC Act and one record of this species was returned from ~5 km to the northwest of the Sapphire PL. Little information is available for this species, however local populations have been documented to occur on south-facing slopes in woodlands of *Acacia shirleyi* on tertiary Plateaux (Bean, 2010). Desktop assessments identified potentially suitable habitat for this species within the Sapphire PL that may correspond to that which this species has been recorded in the local area. Based on the presence of a local record and potentially suitable habitat, this species was determined to have a high likelihood of occurring within the Sapphire PL.

5.4.3.2 Cerbera dumicola

Cerbera dumicola is listed as near threatened under the NC Act and several local records for this species within 20km of the Central and Sapphire PLs, one of which is <1km to the north of the Sapphire PL. This distinctive species occurs across a range of habitats including sandstone hills, plateaus, woodlands, mine rehabilitation areas, sand/clay and rhyolite slopes, evergreen vine thickets on brown sandy loam (DES, 2021 and references therein). Potentially suitable habitat for this species is mapped to occur across the Sapphire and Central PLs, therefore, in combination with the presence of local records, it is considered that this species has a high likelihood of occurring in these areas.

5.4.3.3 Eungella Hairy Daisy

The Eungella Hairy Daisy is listed as vulnerable under both the NC Act and EPBC Act. This species is endemic to QLD and is known from the Bowen and Mackay area of Central QLD. Most records of this species occur to the east of the PLs, however there are several records between 22 to 24km to the north of the Lancewood PL. This species is known to occupy a variety of habitats including vine forest, Eucalypt forest on rocky ridges and on the edges of creek banks. Local records of this species to the North of the Lancewood PL in RE 11.10.4a/11.10.1. RE 11.10.4a is State mapped to occur across the Lancewood PL, therefore local habitat for this species is likely to be present.

5.4.3.4 Smooth-barked Bonewood

The Smooth-barked Bonewood is listed as near threatened under the NC Act and is documented to occur in dry rainforest and vine thicket communities. There are two local records of this species occurring within 20km of the Lancewood PL and vine thicket communities (RE 11.8.3) are State mapped to occur across this PL. Therefore, there is potentially suitable habitat for this species within the Lancewood PL and it is considered that this species has a moderate likelihood of occurring. RE 11.8.3 is characterised as a Category C ESA, therefore significant impacts to this community, and thus suitable habitat for this species, are likely to be avoided by design. However, comprehensive vegetation mapping to ground-truth the extent of suitable habitat for this species across the PL will further inform the likelihood of potential significant impacts to this species.

5.4.3.5 Coolabah Bertya

The Coolabah Bertya is listed as vulnerable under the EPBC Act and there is one local record of this species occurring ~6km to the south of the Lancewood project area. This species occurs in various habitats including open woodlands and shrublands dominated by *Acacia* and *Eucalyptus* species and has also been recorded in vine thicket communities (TSSC, 2016a). Due to the presence of potentially suitable habitat for this species likely being present within the Lancewood PL, based on State RE mapping, and the occurrence of local records, it is considered that this species has a moderate likelihood of occurring.

5.4.3.6 Bertya pedicellata

Bertya pedicellata is listed as near threatened under the NC Act and several local records were returned to occurring within 20km of both the Central and Sapphire PLs. This species is documented to occur in eucalypt woodlands and forests, Acacia woodland and shrubland on rocky slopes of skeletal sandy/loamy soils. Potentially suitable habitats for this species were determined to occur within these two PLs based on both desktop and ground-truthing assessments. Based on the presence of local records and potentially suitable habitat this species was determined to be highly likely to occur within both of these PLs.

5.4.3.7 King Bluegrass

King Bluegrass is listed as vulnerable under the NC Act and is endangered under the EPBC Act. Several local records were returned from within 20km of both the Lancewood and Sapphire PLs. However, it was determined that habitat within the Lancewood PL is likely to be unsuitable for this species. Two natural grassland communities are State mapped to occur within the Sapphire PL and one of these (RE 11.8.11) was ground-truthed to be present. This community represents optimal habitat for this species, however, is likely to be slightly degraded due to agricultural impacts. Therefore, it is considered that this species has a moderate likelihood of occurring within the Sapphire PL.

5.4.3.8 Bluegrass

Bluegrass is listed as vulnerable under the EPBC Act and no local records of this species occurring within 20km of any of the PLs. However, the State mapped and ground-truthed occurrence of RE 11.8.11 within the Sapphire indicates that potentially suitable habitat for this species occurs within this PL. Because of this, and the PL occurring within the modelled distributed for this species, it is considered that this species has a moderate likelihood of occurring within the Sapphire PL.

5.4.3.9 Solanum adenophorum

Solanum adenophorum is listed as endangered under the NC Act and two local records of this species were recorded to occur within 20 km of the Sapphire PL. This species is endemic to Queensland in the Dingo-Nebo-Clermont region, growing in Acacia woodland on slight slopes and in deep cracking clay soils (DES, 2021d). It is considered that potentially suitable, but degraded habitat for this species likely occurs within the Sapphire PL. Therefore, it is suggested that this species has a moderate likelihood of occurring within this PL.

5.4.4 Conservation Significant Fauna Species

Desktop searches returned 22 threatened fauna species either recorded within 20km of the PLs or potentially relevant to the PLs. One of these, the Squatter Pigeon (southern) was incidentally observed within the Sapphire PL during field assessments. Likelihood of occurrence assessments determined that several additional species have a moderate to high likelihood of occurring within the PLs, which are described below. It is recommended that detailed field assessments are undertaken to ground-truth the presence/absence of habitat values and local populations of threatened flora species identified within this report as having a moderate to high likelihood of occurring within the PLs. Ground-truthing assessments will provide greater resolution on information used to assess the likely or potential impacts to these species and inform strategies to avoid, minimise, or mitigate impacts through development of the PLs.

5.4.4.1 Red Goshawk

The Red Goshawk is listed as endangered under the NC Act and as vulnerable under the EPBC Act. Three local records of this species from within 20km of the Lancewood PL were returned. This species prefers open forests and woodland with a mosaic of vegetation types, particularly near riverine systems and permanent water where there is an abundance of prey species (DAWE, 2021b), and individuals may have a home range of up to 200km^2 or more (Aumann & Baker-Gabb, 1991). Potentially suitable habitat for this species likely occurs within the Lancewood PL based on desktop and ground-truthing results, however, is likely to be degraded. Because of this, and the presence of local records, it is considered that this species has a moderate likelihood of occurring within the Lancewood PL.

5.4.4.2 Squatter Pigeon

The Squatter Pigeon (southern) is listed as vulnerable under both the NC Act and EPBC Act and numerous local records were returned from within 20 km of all three PLs. This species was determined to be highly likely to occur within the Lancewood and Sapphire PLs and was observed to be present within the Central PL.

The species is ground-dwelling and has specific habitat requirements relating to vegetative structure and composition. Sparse, patchy ground cover, allowing freedom of movement while foraging on the ground, is preferred. This tends to consist of native perennial tussock grasses to approximately 33% cover, with or without low shrubs and native forbs (the seeds of some non-native forbs, such as *Stylosanthes spp*., are also eaten) and interspersed with bare, dusty ground, leaf litter and coarse woody debris. These habitats appear to provide the

balance of openness to facilitate foraging, complexity to provide cover, and vantage points from which to view potential threats.

Suitable habitats can be identified with some confidence by soil type. The preferred open forest to open woodland habitats generally occur on well-draining gravelly, sandy or loamy soils. In Queensland, suitable habitats are generally limited to land zones 5 and 7—sandy to loamy soils on low to gently rising or undulating PLins and low lateritic escarpments. It often occurs in burnt areas and, like many granivorous birds, is often encountered on tracks and roadsides (TSSC, 2015a).

The southern subspecies of the Squatter Pigeon is very rare in the south of its range (southern Queensland and New South Wales) and is affected by multiple pressures further north. Habitat clearing and fragmentation, including for agriculture, and grazing pressures, especially cattle grazing in the north and sheep grazing in the south, are the primary drivers of the subspecies' decline to date. These are ongoing pressures, though cattle grazing is considered less impactful than sheep grazing as some pasture improvement species are eaten by Squatter Pigeons and cattle grazing does not always involve vegetation clearing. Other current threats include grazing by feral mammals, predation by feral predators, transformation of habitats by weeds, fire regime change, and illegal shooting (TSSC, 2015a), and vehicle strike.

Squatter Pigeons were incidentally observed foraging around a cattle dam in the southern portion of the Central PL during field assessments. It is recommended that pre-clearance surveys for this species are undertaken in accordance with the Survey Guidelines for Australia's Threatened Birds (CoA, 2015) prior to developing suitable habitat for this species within the PLs. Surveys should focus on the detection of nests, which occur on the ground, and nesting individuals during the spring and summer months. The development of a species management plan for this species will also in assist in the development of strategies to avoid, minimise and mitigate potential impacts to this species due to development of the PLs.

5.4.4.3 Northern Quoll

The Northern Quoll is listed as endangered under the EPBC Act and was returned in the PMST report. No local records of this species were returned from WO records occurring within 20km of the PLs, however there are several local records of this species occurring within 100km of the PLs and the PLs occur within the modelled distribution for this species.

Across its range the Northern Quoll utilises a wide variety of habitats; in Queensland it occupies a diversity of habitats including rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert. However, habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. Habitats usually have a high structural diversity containing large diameter trees, termite mounds or hollow logs for denning purposes, and are close to water (DAWE, 2021b). Results from desktop and ground-truthing assessments indicate that potentially suitable habitat for this species occurs within the PLs, therefore it is considered that this species has a moderate likelihood of occurring within woodland communities with topographic and structural complexity within the PLs.

5.4.4.4 Central Greater Glider

The Central Greater Glider is listed as vulnerable under both the NC Act and EPBC Act and there are several local records within 20km of each of the three PLs. State mapped essential habitat for this species occurs within the Sapphire PL. The Central Greater Glider (*Petauroides armillatus*) has recently been split from the nominate species (*Petauroides volans*) (McGregor *et al*., 2020). As such, little specific information is currently available for this new species. However, the life history traits and habitat requirements of the Central Greater Glider remain

similar to the nominate species and therefore habitat requirements and threats remain similar. As such, the relevant listing advice for the nominate species is relevant to the Central Greater Glider and will be referenced in this report in lieu of more species-specific information.

This species inhabits Eucalypt-dominated coastal low open forests to tall forests in the ranges and low woodlands west of the Great Dividing Range (Van Dyck *et al.*, 2013). Typically, this species is found in highest abundance in tall, montane, moist eucalypt forests with relatively old trees and abundant hollows, although distribution may be patchy even in suitable habitat. Home ranges of this species are typically relatively small, although ranges are larger in low-productivity forests and more open woodlands (TSSC, 2016c). This is a folivorous species that primarily feeds upon eucalypt leaves and favours environments where multiple eucalypt species are present to account for seasonal variation (TSSC, 2016c). The species is particularly vulnerable to habitat fragmentation as they require two to four dens for every two hectares of suitable habitat and have low dispersal ability (TSSC, 2016c). The Greater Glider is also sensitive to logging and wildfire and is slow to recover following major disturbance.

Ground-truthed and State RE mapping indicates that suitable habitat for this species likely occurs within all PLs. Because of this, and with the presence of local records, this species was considered highly likely to occur within each PL. However, core habitat for this species within the PLs is likely to be restricted to RE 11.3.2, 11.3.4 and 11.3.25. All three of these REs equate to a Category C ESA under the Streamlined Model Conditions for Petroleum Activities, therefore potential impacts to this will likely be avoided or minimised by design.

5.4.4.5 Koala

The Koala is listed as vulnerable under the EPBC Act and the NC Act and there are several local records of this species within 20km of the Central and Sapphire PLs. Additionally, all three PLs occur within the modelled distribution for this species. In Queensland the species occurs from the Einasleigh Uplands west of Cairns south through central and Coastal Queensland; population densities are highest in the southeast and, generally, are lower with increasing distance inland and north (TSSC, 2012). Koala densities in inland Queensland can be as low as one Koala per 100ha, though individuals may be concentrated in riverine vegetation where the quality and quantity of foraging and resting resources are highest. As with the Central Greater Glider, the highest quality habitat for this species within the PLs is likely to occur within the Category C ESA REs 11.3.2, 11.3.4 and 11.3.25. Therefore, potential impacts to this species within the PLs is likely to be avoided or minimised by design.

5.4.4.6 Ornamental Snake

This species is listed as vulnerable under both the NC Act and EPBC Act and, in addition to the occurrence of State mapped essential habitat for this species, there are local records of this species within 20km of the Central and Sapphire PLs. Based on this, it is considered that this species has a high likelihood of occurring within the Central and Sapphire PLs. Additionally, this species is considered to have a moderate likelihood of occurring within the south eastern portion of the Lancewood PL due to State mapped essential habitat for this species within this area.

The Commonwealth Environment Department considers that an occurrence of important habitat for this species is a surrogate for an 'important population' of the species. As there is essential habitat for this species mapped to occur within each of the three PLs, then it is considered that this is sufficient basis for the PLs to comprise an important population of this species. However, it should be noted that field assessments did not include an assessment of the presence/absence of high-quality habitat for this species or systematic or targeted assessments to determine the occurrence of this species within the PLs.

State mapped essential habitat equates to a Category C ESA under the Streamlined Model Conditions for Petroleum Activities. Therefore, potential impacts to areas that may harbour an important population or State mapped high-quality habitat for this species within the PLs will likely be avoided or minimised by design. However, it is recommended that additional ground-truthing assessments are undertaken to assess the presence/absence of this species within the PLs and to ground-truth local habitat suitability for this species. The development and implementation of a species management plan for this species prior to development of the PLs may assist in avoiding, managing, or mitigating any potential impacts to this species within the PLs.

5.4.4.7 Yakka Skink

This species is listed as vulnerable under both the NC and EPBC Acts. No local records of this species were returned within 20km of the PLs during desktop assessments, however the PLs occur within the modelled distribution for this species.

The known distribution of this cryptic species extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. This vast area covers portions of the Brigalow Belt, Mulga Lands, South-east Queensland, Einasleigh Uplands, Wet Tropics and Cape York Peninsula biogeographical regions. This species is known to occur in open dry sclerophyll forest, woodland and scrub. The core habitat of this species is within the mulga lands and Brigalow Belt South bioregions. It is most commonly found in cavities under and between partly buried rocks, logs or tree stumps, root cavities and abandoned animal burrows. This species often takes refuge in large hollow logs and has been known to excavate deep burrow systems, sometimes under dense ground vegetation (DAWE, 2021b and references therein).

Desktop assessments identified the presence of potentially suitable habitat within remnant vegetation communities within each of the three PLs. However, the quality of this habitat was unable to be determined during these assessments and fauna habitat assessments did not form part of rapid vegetation assessments undertaken within the PLs. Based on the desktop presence of potentially suitable habitat, and the PLs occurring within the modelled distribution for this species, it is considered that this species has a moderate likelihood of occurring within the PLs. However, it is recommended that targeted pre-clearance assessments to ground-truth local habitat values for, and the presence/absence of, this species within areas of the PLs that are proposed to be developed is undertaken. This will aid in avoiding, minimising and managing any potential impacts to this species due to development of the PLs.

5.5 General Mitigation Measures

5.5.1 Vegetation Clearing

During construction activities, the following measures should be implemented to minimise disturbance impacts and any potential harm to habitat values, and flora and fauna present within the area:

- The boundary of areas to be cleared should be clearly marked, to ensure the disturbance footprint is minimised, and
- Clearing should occur in a sequential manner to allow any fauna present in the area to escape to areas away from construction activities.

Vegetation stockpiles will provide habitat for small ground-dwelling mammals and reptiles during development of the PLs. It is important to locate these stockpiles away from high traffic areas and ensure they are not isolated from contiguous vegetation at the edge of the site. This will reduce the likelihood of fauna travelling across impacted areas.

Cleared vegetation should be managed according to the following best practice principles:

- Where possible, logs and large branches with hollows should be reserved and stockpiled separately (at the edge of the site) for rehabilitation purposes, and
- Any mulching should occur as near as possible to the time of clearing to prevent the establishment of stockpiles as fauna habitat.

5.5.2 Fauna Management

The following recommendations relate to the management of potential impacts to fauna during clearing activities.

Site personnel and management should be cognisant of the risks posed by vegetation clearing and construction to fauna. During clearing and construction activities the following measures should be implemented to minimise likelihood and severity of potential impacts to habitat values and flora and fauna present within the area:

- The boundary of areas to be cleared should be clearly marked to ensure the disturbance footprint is minimised, and
- Clearing should occur in a sequential manner to allow any fauna present in the area to escape to areas away from construction activities.

Management of other fauna species on site will aid in reducing the overall ecological impact of the work. Excavated areas can pose a risk to native fauna through entrapment and exposure. Excavated areas should be checked regularly for trapped fauna, with inspection occurring at least twice daily. These areas should be checked early in the morning for fauna that have become trapped overnight, and again in the late afternoon for fauna that have become trapped during the day. Safe egress points should be included to allow fauna to escape of their own accord. Any fauna that cannot escape of its own accord should be removed in a manner that is safe for both the animal and the person handling the animal. Only a suitably qualified and experienced person should handle fauna species.

During the vegetation clearing and construction periods the use of a fauna spotter-catcher, with appropriate damage mitigation permits is recommended to minimise the chances of injury to native fauna. The fauna spotter-catcher should have a current rehabilitation permit and should be present during clearing activities. The role of the spotter-catcher would be to advise on appropriate clearing methods to ensure animal escape paths are maintained and relocate fauna located within the disturbance area accordingly. The *Nature Conservation (Wildlife Management) Regulation 2006* prohibits tampering with a native animal breeding place; however, it is a reasonable excuse for a person to tamper with the breeding place if the tampering happened in the course of a lawful activity that was not directed towards the tampering; and the tampering could not have been reasonably avoided. Impacts on nesting birds can be avoided by minimising unnecessary clearing of vegetation such as trees (especially hollow-bearing trees) and shrubs that may contain animal breeding places and by engaging a fauna spotter-catcher.

Vehicle strike represents a general threat to native fauna species, but is particularly relevant to the squatter pigeon, which was observed within the Central PL and is ground-dwelling, often occurring on roads and tracks. The following controls are recommended to minimise the likelihood of vehicle strike in general, with a focus on reducing the likelihood of death or injury to Squatter Pigeons:

- Site inductions or toolbox meetings should include information about sensitive aspects of the environment in which personnel are working, including the risk of injury or death to Squatter Pigeons from vehicles.

- Due to the ground dwelling nature of the species, all vehicles should remain on existing access tracks and roads wherever possible.
- Clearing works should be carried out in a sequential manner that allows fauna to escape to natural areas away from construction works and should be undertaken outside the breeding seasons of threatened fauna where possible.
- Speed limits should be implemented as appropriate for the condition of the roads and access tracks on site. Reduced speed limits in areas where Squatter Pigeons are regularly observed would further reduce.

5.5.3 Pest and Weed Management

Two restricted invasive flora species, including Parthenium and Harrisia Cactus, were identified to occur within the PLs during rapid vegetation assessments. Both these species are category 3 restricted invasive species under the Biosecurity Act. Despite these pest species being common throughout the local and broader region, both have the potential to impact biodiversity and environmental values within the PLs.

Where reasonable and practical, it is recommended that pest flora and fauna species are managed in accordance with the Biosecurity Act, the Isaac Regional Council Biosecurity Plan 2020-2023, and a site-specific pest management plan is developed and implemented to manage the abundance and spread of pest species, ensure that new species are not introduced and reduce the impact of pest species to threatened flora and fauna species. Management focus for the control of weeds should be on prevention—ensuring that vehicles, plant and materials brought into the PLs are weed seed free and that disturbed areas are monitored for weed outbreaks.

The Biosecurity Act outlines a general biosecurity obligation (GBO). The GBO identifies that everyone is responsible for managing biosecurity risks that are:

- Under their control, and
- That they know about or should reasonably know about.

Under the GBO, individuals and organisations whose activities pose a biosecurity risk must:

- Take all reasonable and practical steps to prevent or minimise each biosecurity risk
- Minimise the likelihood or causing a ‘biosecurity event’, and limit the consequences if such an event is caused, and
- Prevent or minimise the harmful effects a risk could have, and not do anything that might make any harmful effects worse.

5.6 Streamlined Model Conditions

The proposed activities are compliant with the Streamlined Model Conditions, a full detailed assessment has been provided in Appendix A.

6 Surface Water

6.1 Context

6.1.1 Regional Catchment

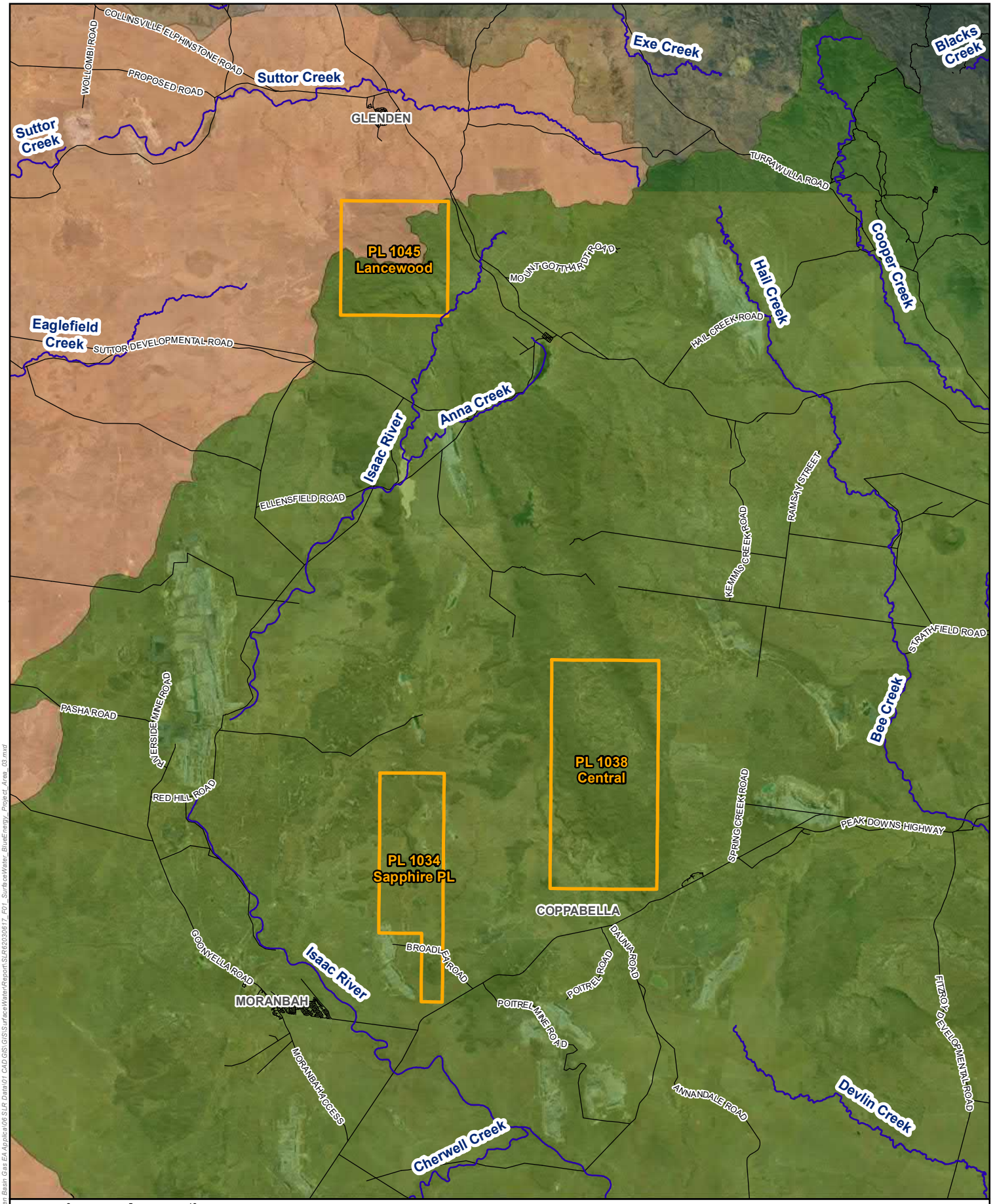
The Project consists of three separate Petroleum Leases referred to as Sapphire, Central and Lancewood. Sapphire and Central are located in Fitzroy River Basin (Isaac River sub-basin) while the Lancewood site is located in the Burdekin River Basin (Suttor River sub-basin). The site locations and regional river basins are shown in Figure 34.

Central is located along a ridgeline with the site discharging runoff to the north-east and south-west. The area located to the east of the ridgeline discharges to Carborough Creek and Walker Creek which ultimately flows into the Mackenzie River. The area located to the west of the ridge discharges via un-named tributaries into North Creek which ultimately flows into Isaac River.

Sapphire is located to the west of Central. The area is located within the Isaac River Catchment, with runoff from the site discharging south into Smokey Creek. Smokey Creek discharges into the Isaac River upstream of the confluence with Grosvenor Creek.

Lancewood is located north of Central and Sapphire. The area is located along a ridge with the southern half discharging into the upper reaches of the Isaac River via Hill Creek, and a number of unnamed tributaries. The northern half of the area discharges to the north via Cabbage Tree Creek, Sandy Creek and a number of un-named tributaries into Suttor Creek which flows into Suttor River. Suttor River flows in a westerly direction and enters Lake Dalrymple.

Land uses within the Fitzroy and Burdekin River Basin include mining, agriculture and bushland. The Project has a combined area of approximately 31,278 ha (312 km^2), representing a relatively small portion of the 22,000 square kilometres (km^2) Isaac Connor sub catchment and 140,000 km^2 greater Fitzroy Basin catchment area and 73,949 km^2 of the Suttor River sub-basin. Figure 34 illustrates the Project area relative to the broader Fitzroy and Suttor River Basins.



0 5 10 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:400,000 at A4
Project Number:	620.30617
Date:	07-Dec-2021
Drawn by:	LC
Reviewed by:	NB

LEGEND

- Roads
- Waterway
- Petroleum Lease Boundary

Sub-basin

- Isaac River
- Suttor River

BLUE ENERGY EA APPLICATION

Project Area Regional Waterways and Sub-Basins

FIGURE 34

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\SurfaceWater\Report\SLR620.30617_F01_SurfaceWater_BlueEnergy_Project_Area_03.mxd

6.2 Legislative Framework

The Relevant legislation in relation to surface water resources for the Project includes:

- *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act), including water trigger
- *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water)
- Environmental Protection (Water) Policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River) September 2011,
- *Environmental Protection Act 1994* (the EP Act)
- *Fisheries Act 1994*
- *Water Act 2000* (QLD) (the Water Act)
- Water Plan (Fitzroy Basin) 2011
- *Water Reform and Other Legislation Amendment Act 2014* (WROLA Act)

6.2.1 Commonwealth Legislation

Under the EPBC Act, an action involving a 'CSG development' will require approval from the Commonwealth Environment Minister if the action has, will have, or is likely to have, a significant impact on a water resource. The *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments — impacts on water resources* (the Guideline) provides a self-assessment framework and exemptions to determine if a referral under the EBPC Act is required. It is SLR's opinion that the project would not constitute a significant impact on a surface water resource.

The Isaac River is a declared water course under the *Water Act 2000* (Water Act). Queensland Globe Spatial Data identifies Suttor Creek, Hill Creek, Isaac River, Smokey Creek, Teviot Brook, and Carborough Creek as watercourses and a number of un-named tributaries as drainage features under the definitions of the Water Act.

6.2.2 State Legislation

Under the Water Act, a Water Licence is required for taking or interfering with surface water, overland flow water or underground water. Changes to a number of provisions in the Water Act came into effect on 6 December 2016 through the *Water Reform and Other Legislation Amendment Act 2014* (WROLA Act). These changes included a simplification of the water licensing process and a number of exemptions. Under Section 97 and 98 of the Water Act, diversions associated with an EA (Section 97) or resource activity (Section 98) are approved through the EA process. The EA process applies to the extent that the water course diversion is on tenure associated with the EA. It is considered that there are no watercourse diversions required for the project and therefore this assessment is not required.

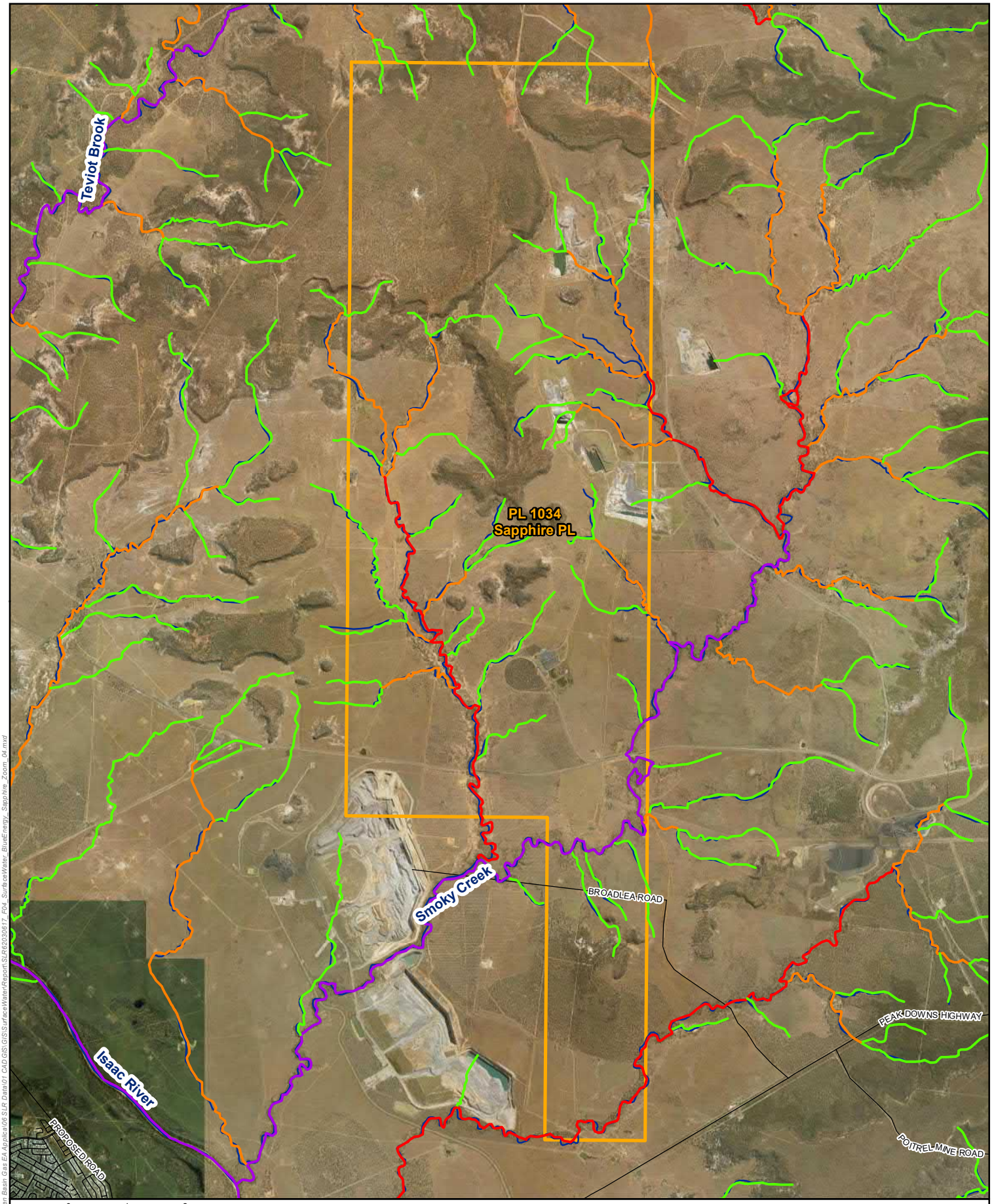
The Fitzroy Basin Water Resource Plan 2011 and Fitzroy Basin Water Resource Operations Plan (DNRM, 2016) outline the use of water within the basin under the Water Act. The plan defines the availability of water and provides a framework for sustainable management such as targets for environmental flow objectives and regulating the taking of overland flow. The Project falls within the Isaac Connors Sub Basin area of the Fitzroy Basin Water Resources Plan, with no specific objectives set for this sub basin area in the vicinity of the Project.

The EPP (Water) outlines the objectives of the EP Act with regards to water. In particular the EPP Water Isaac River Sub Basin Plan outlines the Environmental Values and Water Quality Objectives for the region. These are discussed in Section 6.3.

The *Fisheries Act 1994* regulates waterway barrier works within watercourses and drainage features. Mapping for waterway barrier works classifies waterways based on their risk of impact to fish passage. The waterways within the Project area are shown in Figure 35, Figure 36 and Figure 37 and are classified as:

- North Creek major / high
- Un-named tributaries of North Creek low to high
- Smokey Creek high / major
- Un-named tributaries of Smokey Creek low/high
- Hill Creek low to high
- Un-named tributaries of Hill Creek low/moderate
- Cabbage Tree Creek low to major
- Sandy Creek low to high
- Carborough Creek major

Any waterway barrier works within these watercourses will need to apply for a permit from the Department of Agriculture and Fisheries and mitigation measures proposed in line with the identified risk of impact classification.



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:85,000 at A4
Project Number:	620.30617
Date:	07-Dec-2021
Drawn by:	LC
Reviewed by:	NB

LEGEND

Roads

Petroleum Lease Boundary

Waterway

Low

Moderate

High

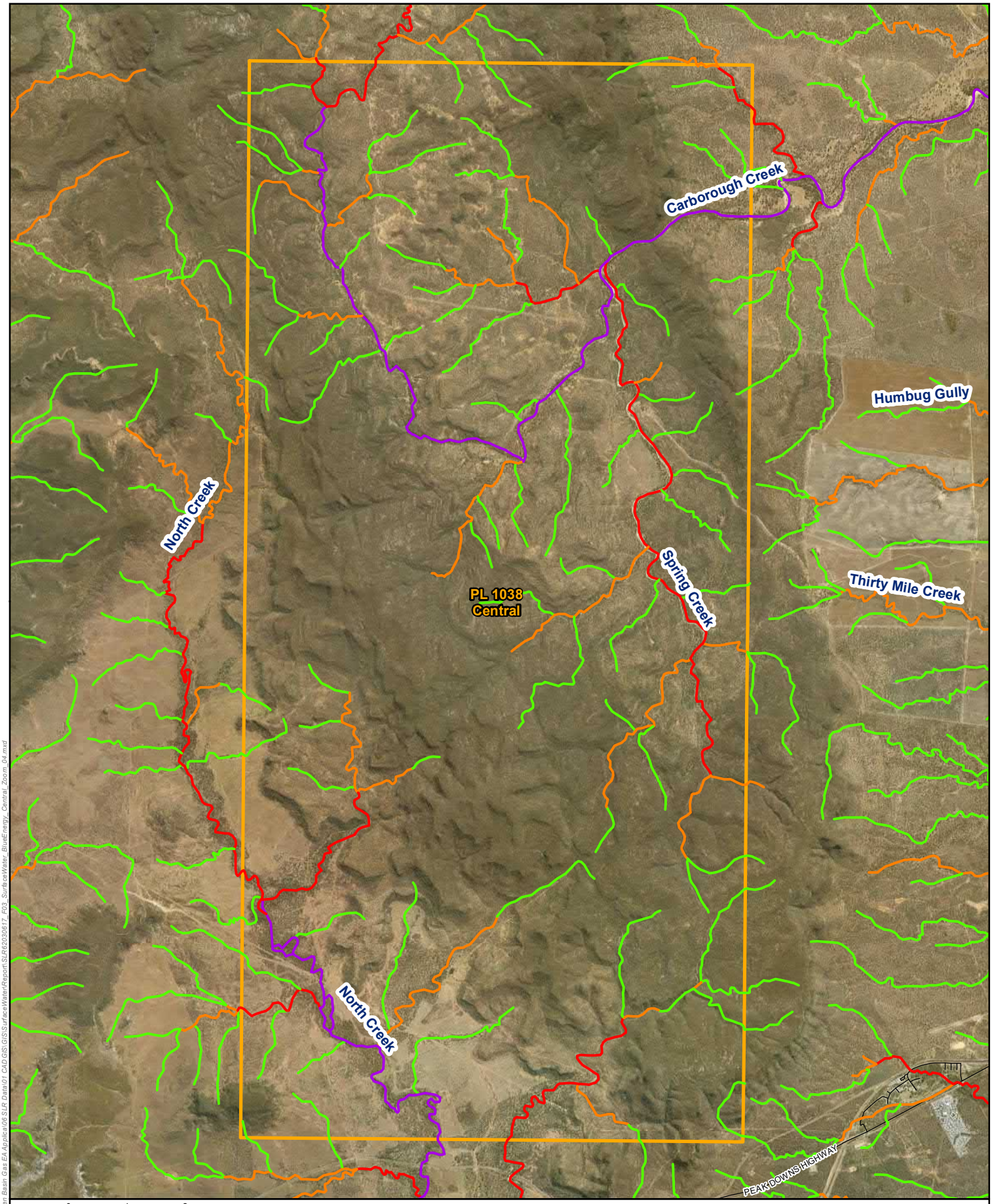
Major

BLUE ENERGY EA APPLICATION

Waterways inside the Sapphire Project Area

FIGURE 35

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\SurfaceWater\Report\SLR620306 17_F04_SurfaceWater_BlueEnergy_Sapphire_Zoom_04.mxd



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:85,000 at A4
Project Number:	620.30617
Date:	07-Dec-2021
Drawn by:	LC
Reviewed by:	NB

LEGEND

- Roads
- Petroleum Lease Boundary

Waterway

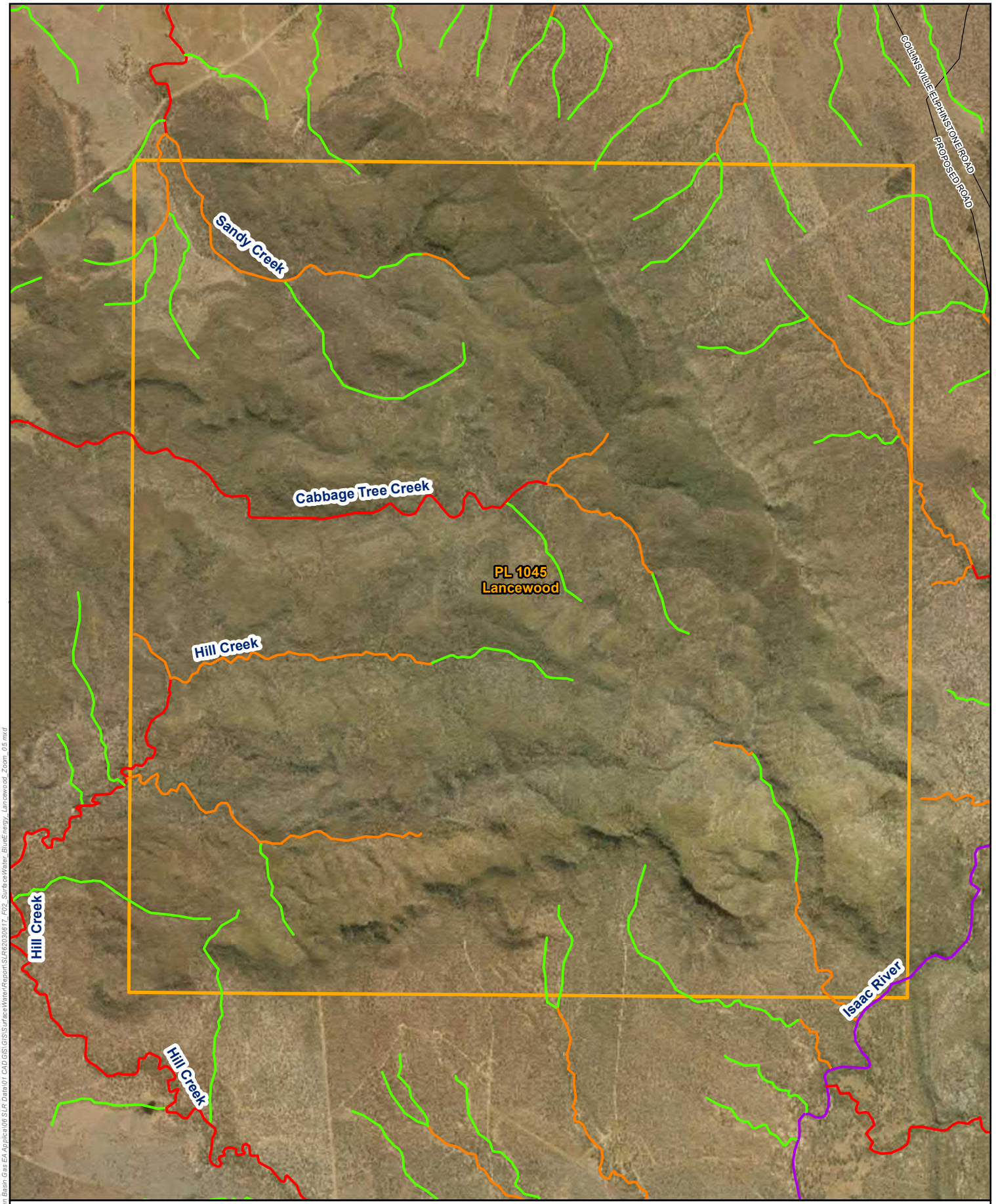
- Low
- Moderate
- High
- Major

BLUE ENERGY EA APPLICATION

Waterways inside the Central Project Area

FIGURE 36

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applicia\06 SLR Data\01 CAD\GIS\GIS\SurfaceWater\Report\SLR620306 17_F03_SurfaceWater_BlueEnergy_Central_Zoom_04.mxd



0 1 2 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:55,000 at A4
Project Number:	620.30617
Date:	07-Dec-2021
Drawn by:	LC
Reviewed by:	NB

LEGEND

- Roads
- Petroleum Lease Boundary

Waterway

- Low
- Moderate
- High
- Major

BLUE ENERGY EA APPLICATION

Waterways inside the Lancewood Project Area

FIGURE 37

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\SurfaceWater\Report\SLR620306617_F02_SurfaceWater_BlueEnergy_Lancewood_Zoom_05.mxd

6.3 Environmental Values and Water Quality

The Environmental Values (EVs) for the Project are listed in the Environmental Protection (Water) Policy 2009 for Isaac River Sub-basin Environmental Values (DES, 2011). The Project Site is located within the Isaac Western Upland and Tributaries Catchment, and in close proximity to the Isaac River and Lower Connors River Main Channel. As any adverse impact due to the Project would affect the Isaac River, EVs from both sub-basins have been noted in this assessment. The applicable EVs are defined and outlined in Table 35.

All relevant EVs need to be considered when evaluating a water body. The level of environmental and water quality protection must be determined to maintain each of the EVs. Management goals that are established to protect the environmental values should reflect the specific problems and/or threats to the values, desired levels of protection and key attributes that must be protected (ANZECC & ARMCANZ, 2000).

Table 35 Environmental Values for the Project – for Central, Sapphire and southern sub-catchment of Lancewood.

Environmental Value		Description	Potential Impacts of the Project
	Aquatic Ecosystems	Maintaining or improving the ecological condition of waterbodies and their riparian zones, with contaminant trigger values selected from the ANZECC 2000 Guidelines depending on the location within the catchment.	Applies to the Isaac River northern tributaries. The Project has the potential to impact on aquatic ecosystems.
	Irrigation	Suitability of water supply for irrigation, for example, irrigation of crops, pastures, parks, gardens and recreational areas.	Applicable. Isaac River is a source of water supply for irrigation.
	Farm water Supply/Use	Suitability of domestic farm water supply, other than drinking water, for example, water used for laundry and produce preparation.	Applicable. Possibly used for potable farm supply.
	Stock Watering	Suitability of water supply for production of healthy livestock.	This value is relevant with surrounding land use for beef cattle grazing.
	Aquaculture	Health of aquaculture species and humans consuming aquatic foods (such as fish, molluscs and crustaceans) from commercial ventures.	Due to the ephemeral nature of the watercourses and their location, it is considered unlikely that waterways will be used for aquaculture.
	Aquatic Foods (Cooked)	Protecting water quality to produce healthy aquatic foods such as fish, crustaceans and shellfish for human consumption and aquaculture activities.	Unlikely to be a source of aquatic foods.
	Primary Recreation	Health of humans during recreation which involves direct contact and a high probability of water being swallowed, for example, swimming, surfing.	Although ephemeral this may still be a used for primary recreation.
	Secondary Recreation	Health of humans during recreation which involves indirect contact and a low probability of water being swallowed, for example, wading, boating.	As above, it is considered possible that the waterways will be used for secondary recreation.

Environmental Value		Description	Potential Impacts of the Project
	Visual Recreation	Aesthetic qualities of waters, including visual clarity and colour, surface films and debris, and nuisance organisms.	The waterways have values for visual recreation.
	Drinking Water	Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment.	Possible that raw water supplies may be taken from the river for drinking.
	Industrial Use	Suitability of water supply for industrial use, for example, food, beverage, paper, petroleum and power industries. Industries usually treat water supplies to meet their needs.	There are no industrial water users in the vicinity of the Central and Sapphire sites. However, southern sub-catchment of Lancewood site drains south toward Burton Gorge Dam.
	Cultural and Spiritual Values	Indigenous and non-indigenous cultural heritage, for example, custodial, spiritual, cultural, and traditional heritage, lifestyles, symbols, landmarks.	The waterways may hold cultural and spiritual values.

Table 36 Environmental Values for the Project – for northern and central sub-catchments of Lancewood.

Environmental Value		Description	Potential Impacts of the Project
	Aquatic Ecosystems	Maintaining or improving the ecological condition of waterbodies and their riparian zones, with contaminant trigger values selected from the ANZECC 2000 Guidelines depending on the location within the catchment.	Applies to the upper Suttor basin. The Project has the potential to impact on aquatic ecosystems.
	Irrigation	Suitability of water supply for irrigation, for example, irrigation of crops, pastures, parks, gardens and recreational areas.	No indication of water used for irrigation.
	Farm water Supply/Use	Suitability of domestic farm water supply, other than drinking water, for example, water used for laundry and produce preparation.	No indication of water used for farm water supply/use.
	Stock Watering	Suitability of water supply for production of healthy livestock.	This value is relevant with surrounding land use for beef cattle grazing.
	Aquaculture	Health of aquaculture species and humans consuming aquatic foods (such as fish, molluscs and crustaceans) from commercial ventures.	Due to the ephemeral nature of the watercourses and their location, it is considered unlikely that waterways will be used for aquaculture.
	Aquatic Foods (Cooked)	Protecting water quality to produce healthy aquatic foods such as fish, crustaceans and shellfish for human consumption and aquaculture activities.	Applicable. Potential source of aquatic foods.
	Primary Recreation	Health of humans during recreation which involves direct contact and a high probability of water being swallowed, for example, swimming, surfing.	Although ephemeral this may still be a used for primary recreation.

Environmental Value		Description	Potential Impacts of the Project
	Secondary Recreation	Health of humans during recreation which involves indirect contact and a low probability of water being swallowed, for example, wading, boating.	As above, it is considered possible that the waterways will be used for secondary recreation.
	Visual Recreation	Aesthetic qualities of waters, including visual clarity and colour, surface films and debris, and nuisance organisms.	The waterways have values for visual recreation.
	Drinking Water	Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment.	Possible that raw water supplies may be taken from the river for drinking.
	Industrial Use	Suitability of water supply for industrial use, for example, food, beverage, paper, petroleum and power industries. Industries usually treat water supplies to meet their needs.	There are no industrial water users in the vicinity.
	Cultural and Spiritual Values	Indigenous and non-indigenous cultural heritage, for example, custodial, spiritual, cultural, and traditional heritage, lifestyles, symbols, landmarks.	The waterway holds cultural and spiritual values.

6.3.1 Guideline Values

Where more than one EV applies to receiving waters, the most stringent Water Quality Objective (WQO) is adopted to protect all identified EVs. Aquatic ecosystem WQO therefore form the basis of the WQO for this Project. Table 37 outlines the guideline WQO identified for the Protection of aquatic ecosystems.

Table 37 Guideline Values for the Protection of Aquatic Ecosystems

Management Intent (Level of Protection)	Upper Isaac River Catchment (refer plans WQ1301, WQ1310)	
	Parameter	Water Quality Objectives
Aquatic Ecosystems, Moderately Disturbed	Ammonia N	<20 µg/L
	Oxidised N	<60 µg/L
	Organic N	<420 µg/L
	Total nitrogen	<500 µg/L
	Filterable reactive phosphorus	<20 µg/L
	Total phosphorus	<50 µg/L
	Chlorophyll a	<5.0 µg/L
	Dissolved oxygen	85%–110% saturation
	Turbidity	<50 NTU
	Suspended solids	<55 mg/L
	pH	6.5–8.5
	Conductivity (EC) baseflow	<720 µS/cm

Management Intent (Level of Protection)	Upper Isaac River Catchment (refer plans WQ1301, WQ1310)	
	Parameter	Water Quality Objectives
	Conductivity (EC) high flow	<250 µS/cm
	Sulphate	<25 mg/L

Notes, N = nitrogen, EC = electrical conductivity, ND = no data, µg/ L = micrograms per litre, mg/L = milligrams per litre, NTU = Nephelometric Turbidity Units, µS/cm = microSiemens per centimetre

6.4 Existing Environment

6.4.1 Existing water users

A search of the Queensland Government database for licenced water users was undertaken on 19 November 2021. No licenced surface water users were identified within a 25 km radius of the Project.

The Project is not proposing to capture surface water runoff other than the disturbance areas from each well pad which has the potential to be contaminated by drilling fluids and sediments from disturbed areas. Each well pad would have a surface area of 1 ha to 1.5 ha depending on the pad layout and type. Table 38 shows the maximum potential surface area captured for each catchment and percentage reduction of total catchment. The reduction in catchment area for each creek system as a result of the runoff capture and treatment associated with each well pad is estimated at less than 2%. Therefore, it is concluded there is limited impact to the hydrologic regime of the ephemeral creeks and rivers contained by the Project.

Table 38 Catchment reduction percentage

Project Area	Local Creek Catchment	Catchment area (ha)	Combined area of wells (ha)	% loss of catchment
Central	Carborough Creek	13,275	220	2%
	North Creek	13,263	139.5	1%
Sapphire	Smokey Creek	13,917	128.5	1%
Lancewood	Hill Creek	4,674	59	1%
	Cabbage Tree Creek	1,686	39.5	2%
	Sandy Creek	1,347	26.5	2%
	Isaac River	13,266	62.5	0%

6.4.2 Wetlands

Several wetlands have been identified to the east of the Central PL. Riverine wetlands are all wetlands and deep water habitats within a channel. The channels are naturally or artificially created, periodically or continuously contain moving water, or connecting two water bodies of standing water. Palustrine wetlands are primarily vegetated non-channel environments of less than 8 ha, while lacustrine wetlands are large, open, water dominated systems (e.g. lakes) larger than 8 ha.

Figure 38 outlines wetlands identified on and near the PL's, of which Central was the only PL identified.

0 2 4 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.30617
Date:	26-Nov-2021
Drawn by:	LC
Reviewed by:	NB

LEGEND

- Roads
- Petroleum Lease Boundary
- Wetland Protection Area

BLUE ENERGY EA APPLICATION

Wetland Protection Area

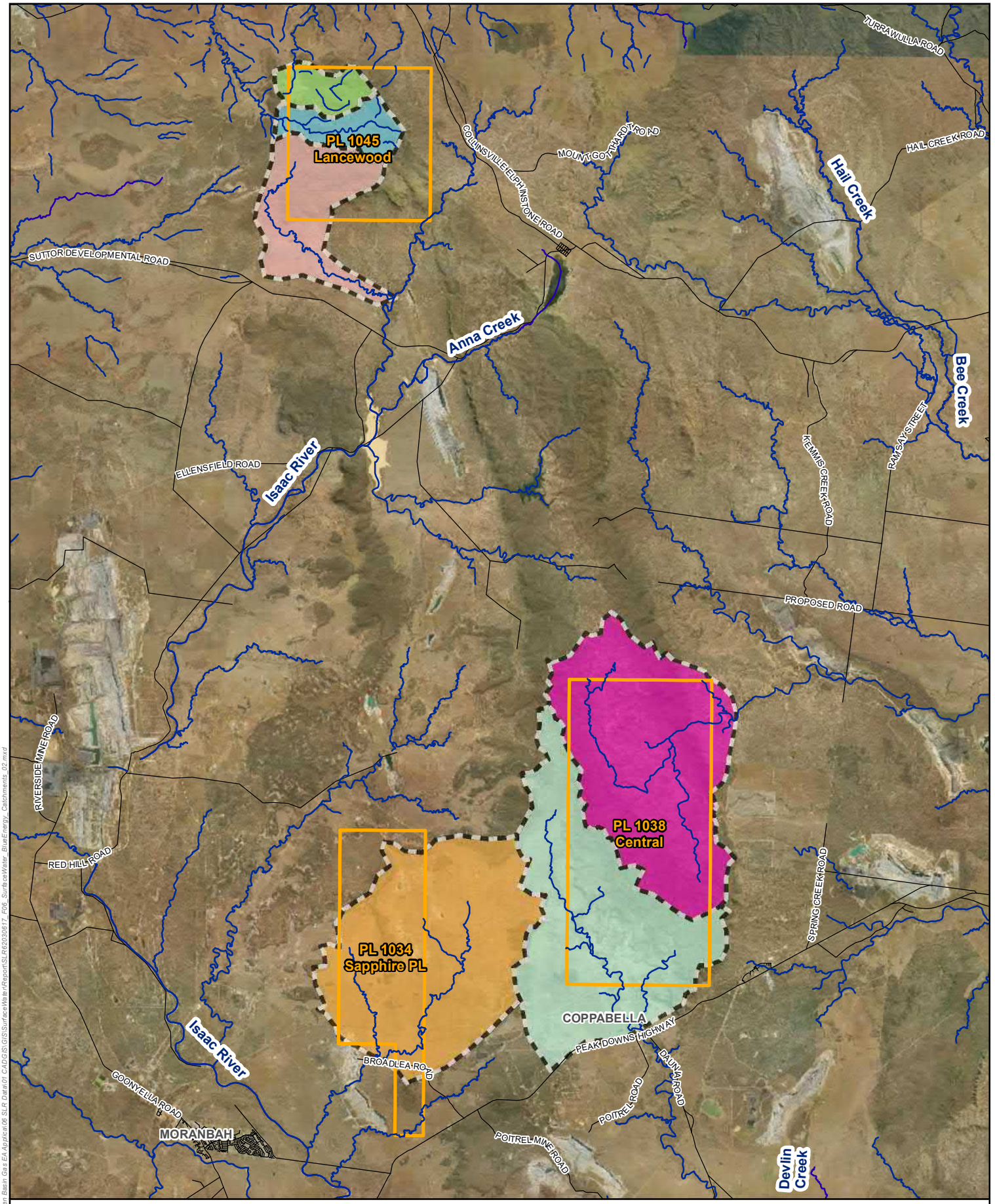
FIGURE 38

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\SurfaceWater\Report\SLR620306 17_F05_SurfaceWater_BlueEnergy_Wetlands_02.mxd

6.4.3 Floodplain Assessment

The Project is subject to inundation in the 1% AEP event due to flooding of the creeks and tributaries which discharge to Suttor Creek and Isaac River (Queensland Reconstruction Authority (QRA) Broadscale Mapping Project). Each of the three PL's do not appear to be inundated by rising floodwater from major river systems, but rather inundation from smaller creeks and tributaries. Majority of the PL's are located on elevated land above the floodplain with the exception of Sapphire which potentially may be impacted by regional Isaac River flooding.

The local creek catchments are shown in Figure 39. 1% AEP flood mapping produced by the QRA Broad-scale Mapping Project is provided in Figure 40.



0 5 10 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:300,000 at A4
Project Number:	620.30617
Date:	26-Nov-2021
Drawn by:	LC
Reviewed by:	NB

LEGEND

- Roads
- Waterway
- Petroleum Lease Boundary

Creek Catchment

- Cabbage Tree Creek
- Caborough Creek
- Hill Creek
- North Creek
- Sandy Creek
- Smoky Creek

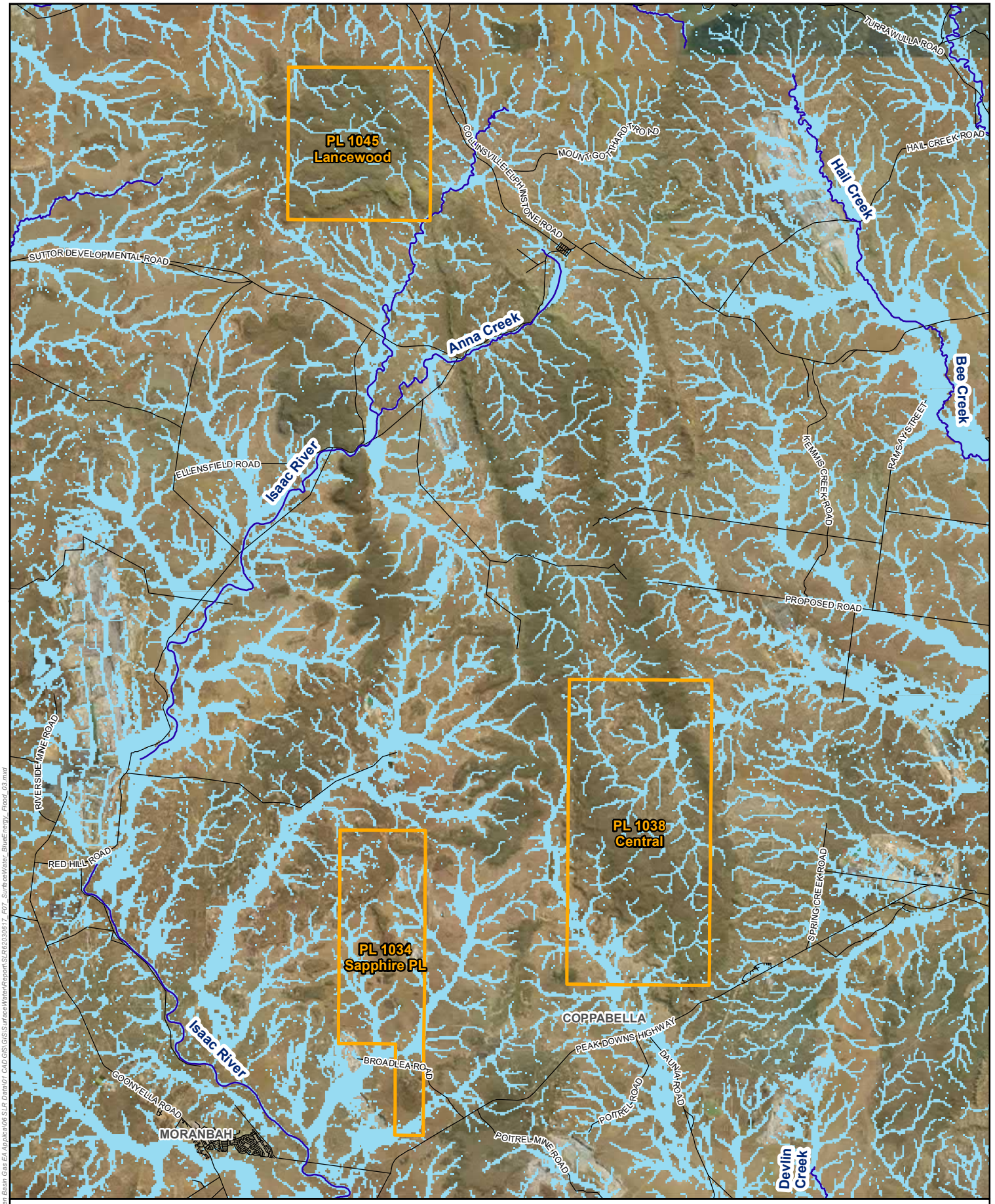
BLUE ENERGY EA APPLICATION

Creek Catchments

SLR

FIGURE 39

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\SurfaceWater\Report\SLR620306017_F06_SurfaceWater_BlueEnergy_Catchments_02.mxd



0 5 10 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:300,000 at A4
Project Number:	620.30617
Date:	06-Dec-2021
Drawn by:	LC
Reviewed by:	NB

LEGEND

- Roads
- Waterway
- Petroleum Lease Boundary

BLUE ENERGY EA APPLICATION

1% AEP Flood Extent Basin Level Flood Mapping

FIGURE 40

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\SurfaceWater\Report\SLR620.30617_F07_SurfaceWater_BlueEnergy_Flood_03.mxd

6.5 Surface Water Management

Surface water management is required to minimise, through effective control, the release of contaminants to waterways downstream of all project activities. Surface water management is required for both rainfall runoff from the well pads and overland flow or localised flooding from adjacent waterways.

The Project will, as a minimum, employ a surface water management philosophy that will involve:

- Where possible, ensure storm water runoff from undisturbed areas both on and surrounding each well site is diverted away from disturbed areas and released directly into adjacent waterways.
- Infrastructure and gas wells are protected from flooding of Isaac River and tributaries by preventing the egress of floodwater into the gas wells.
- All significant quantities of hydrocarbon and chemical products stored on site are stored in temporary or permanent bunding which is not affected by flooding, up to and including the 0.1% AEP event.
- Sediment transport is reduced through revegetation. For example, progressive rehabilitation is applied to areas no longer required for operational use.
- Standard Operating Procedures (SOPs) will continue to be developed, implemented and revised for those aspects that can adversely impact on surface water management if not properly conducted.
- The continued implementation of the Environmental Management System will ensure that roles and responsibilities for activities that may affect surface water are clearly defined and that appropriate management actions are developed and implemented for these mining activities to provide a commensurate level of environmental protection.
- All water management structures will be designed and constructed using practical hydraulic parameters based on an appropriate risk-based rainfall event, catchment size, slopes, discharge design and soil types.
- Spill capture and retention devices are used for refuelling and similar areas.
- Runoff from oily water areas will be treated using an oil-water separator.
- Disturbance will be kept to an operational minimum for safe operation to reduce the area exposed.
- High use areas will be sealed to reduce degradation.

6.5.1 Activities requiring management

Potential emissions or releases from the activities proposed for the Project that are likely to affect surface water during the construction and operational phases without the implementation of management measures include:

- Erosion and sedimentation of stormwater during establishment and use of access tracks, gathering network, hard stand areas for lease pads and raw water storage tanks.
- Stormwater contamination resulting from contact with drilling muds and CSG raw water during drilling and CSG extraction.
- Accidental spills and/or leakage of raw CSG water directly to land and/or surface waters during extraction, transport, storage and treatment, and subsequent movement to surface waters via stormwater flow and/or shallow groundwater.

- Accidental spills of chemicals during use, or leakage of chemicals from on-site storage tanks, either directly to land and/or surface waters, and the subsequent movement to surface waters via stormwater flow and/or shallow groundwater.
- Sedimentation of surface waters during construction of gathering networks and CSG raw water pipelines across and/or underneath waterways. Activities that could cause soil erosion and generate sediment unless controlled during construction and operation:
  - Stripping of vegetation, subsoil and topsoil
  - Stockpiling of subsoil and topsoil
  - Earthworks activities
  - Construction of associated infrastructure and water management structures (i.e. clean water diversions, dirty water channels and sediment dams)
  - Construction / upgrades of waterway crossings
  - Construction/maintenance of roads, and
  - Vehicle and machinery movements.

6.5.2 Potential impact on surface waters

The potential impacts to surface water EVs, the identified risk associated with the impact and the proposed management practices to reduce/remove the risk is discussed in the following sections.

The transport of sediment off site and into natural drainage systems can have a wide range of detrimental effects including safety, social, economic and environmental impacts. Pollution can occur in the form of finer sediment fractions such as silts and clays that create turbid water, and also in the form of coarse sediments such as sand particles that travel off-site.

The potential impacts of fine and coarse sediment runoff impacts are shown in Table 39 below.

Table 39 Potential impacts of fine and coarse sediment runoff (adapted from IECA 2008)

Environment	Fine Sediment (turbidity)	Coarse Sediment
Minor waterways such as creeks	• Health and biodiversity issues for aquatic life within permanent pools • Water quality and aquatic health issues associated with desilting operations, especially if the deposited sediment contains significant metal concentrations • Turbid water retained in pools • Reduced light penetration into water column	• Loss of aquatic habitats • Increased potential for creek erosion • Water quality and aquatic health issues associated with de-silting operations • Social cost of increased drainage and flooding problems • Economic cost of de-silting and rehabilitating waterways • Ecological damage resulting from de-silting activities.

Environment	Fine Sediment (turbidity)	Coarse Sediment
Major waterways, such as rivers, estuaries and bays	• Health and biodiversity issues for aquatic life • Reduced light infiltration into water column • Smothering of sessile biota • Water quality and aquatic health issues associated with nutrients and metals attached to settled and suspended clay sized particles, and consequent de-silting operations • Economic impacts in community stakeholders reliant upon healthy waterways such as recreational and commercial fisheries, and ecotourism • Social stigma associated with turbid water flows	• Economic cost of dredging operations • Water quality and aquatic health issues associated with de-silting operations • Ecological issues associated with dredging operations • Smothering of sessile biota

6.5.3 Surface Water Management Controls

To minimise the impacts to surface waters, the following controls will be applied to the Project.

6.5.3.1 Containment of CSG raw water

CSG raw water will be contained on-site with stored raw water to be transferred to a treatment facility. Containment will be sized to store the generated volume of raw water and provide sufficient freeboard to contain the 1% AEP 48hr rainfall event.

6.5.3.2 Erosion and sediment control measures

To prevent sediment from mobilising to adjacent overland flow paths and creeks, sediment controls should be in place to prevent release into the environment.

Best practice (IECA 2008) soil management are implemented where appropriate:

- Topsoil should be preserved for reuse on the site wherever possible
- Wherever reasonable and practicable, strip and stockpile topsoil immediately before bulk earthworks, and confine any soil disturbance to the immediate construction stage
- Topsoil should be stripped only while in a light moisture condition. If the soil is too dry, stripping it will pulverise the soil, if too wet it may lead to 'clodding' or 'hardsetting' – particularly if the soil has a high silt or clay content
- To the maximum degree practicable, topsoils should not be mixed with subsoils during the stripping and stockpiling procedure, especially if the subsoils are dispersive
- If it is desirable to retain the seed content of the soil, then the stockpiling should consist of long low mounds no greater than 1 to 1.5 m in height, otherwise topsoils stockpiles should not exceed 3m in height. Long term stockpiles (i.e. >12 months) may need to be mulched or temporarily vegetated to prevent weed infestation

- Stripped topsoil should be used as soon as possible, and preferably not stockpiled for more than 12 months. Long term stockpiling can degrade its biological and chemical qualities
- Maintain all stockpiles in a free draining condition to avoid long-term soil saturation
- All topsoil should be tested for fertility and adjusted (where necessary), even if the soil originated from the site
- Soil should be removed from stockpiles in a manner that avoids vehicles travelling over the stockpiles if possible
- Exposed sub-soils should be covered as soon as practicable, especially if dispersive
- After spreading topsoil, ensure the surface is left in a scarified (roughened) condition to assist moisture infiltration and inhibit soil erosion
- When working adjacent to a waterway, avoid spreading topsoil at a significantly different elevation form where it originated
- Ensure all exposed sub-soils are covered, especially if dispersive, and
- Soil stockpile areas should be rehabilitated as soon as reasonable and practicable after the material has been removed.

The default classification of sediment control techniques is outlined in Table 40 for sheet and concentrated flow treatment techniques. IECA recommends either Type I, 2 or 3 devices to be employed depending on the annual soil loss estimates and erosion risk assessments. A soil loss estimate should occur for the project prior to construction commencing to determine the type of controls required.

Furthermore, clean water diversions have been used to separate the flow sources and allow for treatment of only dirty water sources.

Table 40 ESC Measures (IECA, 2008)

Type 1	Type 2	Type 3
Sheet Flow Techniques		
Buffer Zone capable of infiltrating 100% of stormwater runoff or process water	Buffer zone capable of infiltrating the majority of flows from design storms.	Buffer Zone
Infiltration basin or sand filter bed capable of infiltrating 100% of flow	Block & Aggregate Drop Inlet Protection	Excavated drop inlet protection
	Compost/mulch berm	Fabric drop inlet protection
	Filter sock	Fabric Wrap Field Inlet sediment trap
	Filter sock drop inlet protection	Filter fence
	Mesh and aggregate drop inlet protection	Modular sediment trap
	Rock and aggregate drop inlet protection	Straw bale barrier
		Sediment fence

Type 1	Type 2	Type 3
Concentrated Flow Treatment Techniques		
Sediment Basin (sized in accordance with design standard	Filter Tube Dam	Coarse Sediment Trap
	Rock filter Dam	Modular Sediment Trap
	Sediment Basin (smaller than design standard)	U-Shaped Sediment Trap
	Sediment Trench	
	Sediment Weir	

6.5.3.2.1 Clean Water management

Clean Water Diversions

Clean water diversions direct 'clean' water runoff from upstream catchments around the potentially disturbed and/or contaminated areas of the site. The local topographical conditions at each site are such that the use of clean water diversions is likely to be required for catchments upslope of small disturbance areas.

Any clean water diversion structures will be designed to convey the 2-year ARI design discharge in accordance with Table 4.3.1 of the IECA guideline and will include suitable channel lining measures, as required. In the event that the site is impacted by an overland flow path, the clean water diversion capacity should be reassessed to ensure sufficient flood immunity to the proposed well pad immunity.

In the event the well pad has been identified as at risk of flooding, the flood assessment shall determine the immunity required for any clean water diversions.

Conveyance Channels

Runoff from areas exposed during the works will be controlled by construction of temporary conveyance channels and bunds/banks that will direct sediment laden runoff to suitably designed and constructed ESC devices. Proposed conveyance channels will be designed following finalisation of the final landform.

Conveyance channels will be designed to convey runoff from a 2-year ARI rainfall event in accordance with Table 4.3.1 of the IECA guideline. Energy dissipation and sediment trapping structures (i.e. check dams) may be required (at regular intervals to limit erosion, however, this will be determined during the design of the conveyance channels).

6.5.3.2.2 Dirty water treatment

Check Dams

Check dams are used in channels to trap sediment and reduce the potential for scouring to occur. They can be made from a number of different materials including rock, coir logs, hay bales etc. Check dams are typically installed at regular intervals – typically closer together on steeper slopes.

It is important that check dams are installed such that flows cannot pass around the sides and that they overflow over the check dams themselves. The use of sandbags and hay bales are limited to temporary erosion and sediment control in channels during construction, as these devices tend to deteriorate over time. Where sandbags are used, it is important not to overfill them as this can cause gaps when the sandbags are wedged together. Two thirds to three quarters to full is generally the right amount of material within each sandbag.

Sediment Fences

Sediment fences act as minor sediment dams. They temporarily detain runoff, trapping sediment and allowing filtered water to pass. Sediment fences should be constructed around the base of any small areas of exposed land that are not subject to concentrated overland flows and that are not adequately protected by existing structures. Sediment fencing should be installed around the extent of the disturbance area where sediment-laden water could potentially enter clean downstream receiving waters. They are placed on the contour, or slightly convex to the contour, and each end of the fence should be turned to create a stilling pond up slope of the fence. Sediment fences require regular maintenance. Trapped sediments should be removed, pickets straightened, filter cloth re-secured and tightened as required.

Rock Chutes

Cut fill batters associated with construction of the well pad may also require treatment. This may require rock chutes to safely get the runoff down the fill batters. This will need to be assessed depending on the final landform.

6.5.3.2.3 Sediment Basins

Sediment basins can be used to capture runoff from disturbed areas prior to discharge to the environment.

6.5.3.2.4 Access Tracks/ pipeline infrastructure

To ensure any potential surface water impacts associated with the pipelines, site access tracks and roads are minimised, the following measures are undertaken:

- Roadside drainage, such as table drains, are incorporated into the construction of the roads, and be maintained regularly throughout the life of the Project
- Cut and fill batters associated with service tracks are formed to a safe slope and stabilised by vegetation. Where cut batters are greater than 1.5 m, stabilisation methods are applied to these areas such as laying back, revegetation and drainage. Stabilisation is assisted by spreading topsoil and/or by applying chemical or organic mulch over the exposed batter surface. Fill batters are constructed with grades no steeper than greater than 3(H):1(V)
- Horizontal Direct Drilling (HDD) should be investigated for pipeline crossings of waterways to prevent bank stability and disturbance of riparian vegetation.

6.5.4 Works within Waterways

There will be works involved in the construction of access tracks, pipelines and wells on the 1% AEP floodplain of the Isaac River.

No access tracks are proposed for crossing of the Isaac and no construction of infrastructure is proposed in or within 50 m of any waterbody and its associated riparian zone with the exception of some access tracks and pipelines that may need to transect some minor drainage lines. In addition, no works will occur within 200 m of a MSES high ecologically significant (HES) watercourse.

Locations proposed for any disturbance works will be initially assessed via desktop assessment of relevant government databases to ensure they are not located in or near a waterbody. Site inspections of the proposed locations carried out by a suitably qualified and experienced person will confirm acceptability of the desktop findings.

Potential impacts to overland flow paths are expected to be low due to the ephemeral nature of the drainage lines, as long as works are carried out during the dry season. Any works could result in sedimentation of waterways, impacts to aquatic ecosystems and disturbance to riparian zones and banks if not managed and rehabilitated correctly. Any waterway crossing works will include the following:

- Confirm works are waterway barrier works, referring to the Department of Agriculture and Fisheries (DAF) policy document Waterway barrier works and approval and fisheries assessment policy (FHMOP008).
- Locate the proposed crossing site on each waterway for waterway barrier works spatial data layer.
- Determine what assessment is required for the waterway barrier works (self-assessable or development approval).
- Confirm proposed works meet standard provided in the latest version of the DAFs Accepted development requirements for operational works that is constructing or raising waterway barrier works.
- Seek relevant approval, if required. If self-assessable, complete proposed works as per the engineered designed construction plans that have been designed on appropriate rainfall data.
- Establishment and implementation of an erosion and sediment control plan (ESCP).
- Disturbance and rehabilitation of the banks and riparian zones to be undertaken in accordance with accepted standards and a Construction Environmental Management Plan (CEMP) that will be developed by a suitably qualified and experienced person for all construction activities.

6.5.5 Wetlands

No works will be conducted in or within 200 m from a generally or high ecologically significant wetland. Locations proposed for any works will be initially assessed via desktop assessment of relevant government databases to ensure they are not located in or near a wetland. Site inspections of the proposed locations carried out by a suitably qualified and experienced person will confirm the desktop findings.

6.5.6 Flood risk

The broad-scale mapping project flood overlay mapping has been used to assess potential risk of inundation of the well pad locations. The mapping has been developed based on STRM terrain information with runoff estimated using Rainfall-on-Grid (ROG). Mapping is available based on the 1% AEP event, and a large extreme event.

Based on the available mapping and indicative well pad locations, the risk of inundation to a proposed well pad was determined from regional flooding and overland flow of surface water from tributaries and creeks. This is indicative only based on the coarse terrain grid and lack of waterway definition or local terrain features which could significantly change the flood extent.

Although no well pads appeared to be inundated with rising floodwater from the Isaac River or other surface water features, the well pads could still be affected by overland flow and localised flooding. It is proposed that a drainage assessment be carried out for any site identified as "at risk". Based on a local assessment of waterway location, definition and review of accurate survey to determine flood/overland flow extent, a site suitability assessment should be carried out. The assessment may require the well pads to be bunded to provide sufficient immunity or that the well should be moved to an alternative location if a solution cannot be found.
Well pads which may require further detailed assessment are shown in Figure 41.

6.5.7 Accidental releases

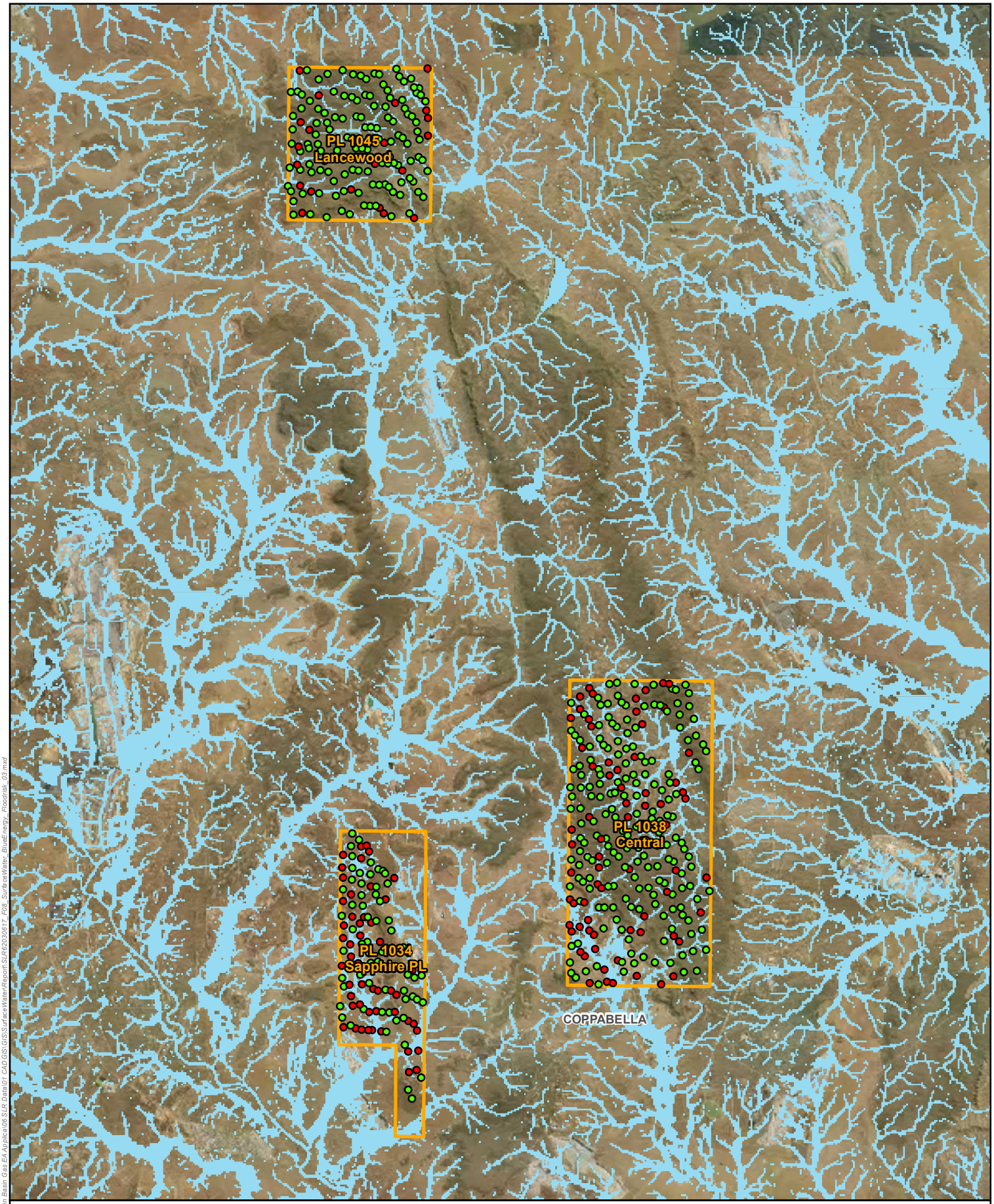
While no releases to surface waters are planned as part of this activity, there is always a potential for accidental releases of contaminants (raw CSG water/chemicals) to land and subsequent movement to local waterways and shallow groundwater via overland flow and seepage. Any accidental spills will be managed under a CEMP that will be developed for the proposed works by a suitable qualified and experienced person and primarily include the following:

- provision of necessary spill kits and emergency response procedures
- capture of contaminant
- removal of contaminant, and
- remediation of receiving area (if required) and monitoring.

6.5.8 Receiving Environment Monitoring Program (REMP)

A Receiving Environment Monitoring Plan (REMP) will be developed and implemented by a suitably qualified and experienced person prior to commencement of any works. The purpose of the REMP is an ongoing monitoring program that is aimed at measuring water quality and trends relevant to the Project's waterways and wetlands with the intent of identifying any potential impacts to surface water receiving environments and surface water EVs from the proposed CSG activities. Early identification of potential impacts will be immediately investigated and mitigation measure implemented where necessary. The REMP will include as a minimum:

- Assess the condition and state of receiving waters and sediments, taking into account temporal variation.
- Facilitate assessment against water quality and sediment quality objectives for the relevant environmental values.
- Include monitoring from Reference sites and sites located downstream of PL activities.
- Specify the frequency and timing of sampling to reliably assess ambient conditions and derive site specific trigger values.
- Outline the method to be followed when implementing monitoring of sediment quality, water quality and biological indicators.
- Apply appropriate procedures outlined in ANZECC (2000) Guidelines (recently updated and published as ANZECC, 2018), Sediment Quality Guidelines of CSIRO (Simpson & Batley, 2016) and the DES Monitoring and Sampling Manual (DES, 2018).
- Incorporate stream flow and hydrological information in the interpretation of water quality, sediment quality and biological data.



0 5 10 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:300,000 at A4
Project Number:	620.30617
Date:	06-Dec-2021
Drawn by:	LC
Reviewed by:	NB

LEGEND

- Roads
- Waterway
- Petroleum Lease Boundary

Basin Level Flood Mapping

- 1% AEP

Flood Risk

- Low risk
- Requires further assessment

BLUE ENERGY EA APPLICATION

1% AEP Event Flood Risk Assessment

FIGURE 41

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applicatio\06 SLR Data\01 CAD\GIS\GIS\SurfaceWater\Report\SLR620306 17_F08_SurfaceWater_BlueEnergy_Floodrisk_03.mxd

- Monitor and record the effects of the release of contaminants on the receiving environment periodically and whilst contaminants are being discharged from the site.

6.6 Streamlined Model Conditions

The proposed activities are compliant with the Streamlined Model Conditions, a full detailed assessment has been provided in Appendix A.

7 Groundwater

This section provides a summary of the Groundwater Assessment prepared by SLR in support of this EA application (refer Appendix C). The assessment provides due consideration to the potential impacts the project may have with specific reference to Department of Environment and Science (DES) Guideline: *ESR/2015/1837 Application Requirements for Activities with Impacts to Water* (Department of Environment and Science, 2015). Environmental impacts to groundwater associated with environmentally relevant activities in Queensland are regulated under the EP Act and subordinate legislation including:

- *Environmental Protection Regulation 2019*, and
- *Environmental Protection Policy (Water and Wetland Biodiversity) 2019* (Queensland Government, 2019).

7.1 Environmental Values

The *Environmental Protection Policy (Water and Wetland Biodiversity) 2019* (EPP (Water and Wetland Biodiversity)) aims to achieve objectives set out by the *Environmental Protection Act 1994* (EP Act) and applies to all waters of Queensland. EPP (Water and Wetland Biodiversity) provides a framework to protect and/or enhance the suitability of Queensland waters for various beneficial uses by:

- Identifying environmental values and management goals for Queensland waters
- State water quality guidelines and water quality objectives (WQO) to enhance or protect the environmental values
- Provide a framework for making consistent, equitable and informed decisions, and
- Monitoring and reporting on the condition of Queensland waters.

7.1.1 Regional EVs

Groundwater resources for Sapphire (PL 1034) are scheduled under the EPP (Water and Wetland Biodiversity) as Isaac Groundwaters (Zone 34) of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1310). The legislated environmental values (EV's) for these groundwaters are listed in Table 41. The other two leases, Central (PL 1038) and Lancewood (PL 1045) are not listed under the EPP (Water and Wetland Biodiversity).

Surface water resources within the vicinity of the site are scheduled under the EPP (Water and Wetland Biodiversity) as:

- Waters of the Isaac northern tributaries of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1301), and

- Waters of the Isaac and lower Connors Rivers main channel) of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1301).

Table 41 Environmental Values in the Isaac River Sub-basin

Environmental Value	Groundwater (WQ1310)	Surface water (WQ1301)
Aquatic Ecosystem	✓	✓
Water supply for Irrigation	✓	✓
Stock Watering	✓	✓
Aquaculture	✓	
Human Consumption		✓
Primary Recreation	✓	✓
Secondary Recreation		✓
Visual Recreation		✓
Drinking Water	✓	✓
Industrial Water Supply		✓
Cultural and Spiritual Values	✓	✓

7.1.2 Water Quality Objectives

The EPP (Water and Wetland Biodiversity) also provides limited water quality objectives for underground aquatic ecosystem protection in Fitzroy Basin groundwaters. These WQOs provided in the EPP (Water and Wetland Biodiversity) are classified by groundwater depth and regional chemistry zone. Under the EPP (Water and Wetland Biodiversity), groundwater at and surrounding the Project site will need to be compared to the WQO's relevant to the Zones 34 of the Isaac River Groundwaters of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1310). WQOs for these zones are presented in the Groundwater Assessment in Appendix C. It should be noted that where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters.

7.2 Existing Environment

7.2.1 Regional Geology and Stratigraphy

The Project is located in the northern geological Bowen Basin, which is one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian period. The Bowen Basin is the largest productive coal basin in Australia. The Bowen Basin stretches from Townsville to south of the Queensland-New South Wales border in a north to south direction. In the southern parts, the extent of the Bowen Basin and the hydrogeological Great Artesian Basin (GAB) overlap. Coal bed methane gas resources have been found within coals from the Rangal and Fort Cooper Coal measures of the Permian Blackwater Group within the application area.

The post-depositional structure of the Bowen Basin is dominated by compressional tectonics which has formed regional scale north to northwest striking, easterly dipping thrust faults, the major structural elements in the Bowen Basin. The fault system forms platforms/shelves that are separated by sedimentary troughs.

7.2.2 Local Geology and Stratigraphy

Surface geological mapping of the project area shows that outcropping units across the PLs are predominantly Triassic and Tertiary aged, covered by alluvium in some areas. The stratigraphy of the Project area relevant to PLs is shown in Table 42 and is further discussed in the Groundwater Assessment (Appendix C).

Table 42 Stratigraphy of the project area

Period	Stratigraphic Unit	Description	Distribution	Max Thickness (m)
Quaternary	Quaternary Alluvium/ Colluvium	Alluvium comprising sand, gravel and clay[2]. Colluvium comprising clay, sand, gravel and soil.	Surficial cover mainly associated with rivers, within all PLs.	~50[2]
Tertiary	Tertiary Sediments	Unconsolidated sediments including mud, sand, gravel, residual soils and colluvium[2].	Surficial cover in the north and south of Sapphire (PL 1034), and a small area in the north of Central (PL 1038).	~120[2]
	Suttor Formation	Quartz and clayey sandstone, mudstone and conglomerate, fluvial and lacustrine sediments with minor interbedded basalt[1].	Outcropping at Central (PL 1038) and Sapphire (PL 1034).	~10[1]
	Basalt	Predominantly olivine rich flows[1].	Only present at Sapphire (PL 1034).	~60[3]
Triassic	Moolayember Formation (Rm)	Mudstone, micaceous lithic sandstone and micaceous siltstone[2].	Only present at Central (PL 1038), outcrops within Lancewood (PL 1045) and Central (PL 1038).	~ 200[2]
	Clematis (Re)	Cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone[1].	Only Present at Lancewood (PL 1045) and Central (PL 1038). Outcrops across most of Lancewood (PL 1045) and Central.	~ 300[2]
	Rewan Group (Rr)	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate at base[1].	Outcrops in the north of Lancewood (PL 1045) and Central (PL 1038) and in small areas of Sapphire (PL 1034).	~ 840[1]

Period	Stratigraphic Unit	Description	Distribution	Max Thickness (m)
Late Permian	Rangal Coal Measures	Feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams[1].	Present across all PLs at depth. Outcrops in small areas across Sapphire (PL 1034).	~200[1]
	Fort Cooper Coal Measures and equivalents	Lithic sandstone, mudstone, conglomerate, shale, coal and tuff[1].	Present across all PLs. Outcrops within Central (PL 1038) and Sapphire (PL 1034).	~600[2]
	Moranbah Coal Measures and equivalents	Labile sandstone, siltstone, mudstone and coal with conglomerate in some areas[1].	Present across all PLs but does not outcrop.	~700[2]
Middle Permian	Back Creek Group	Quartzose to lithic sandstone, siltstone, mudstone, shale, conglomerate, limestone and sandy coquinite.	Present across all PLs but does not outcrop.	~400[1]

1 Geoscience Australia (2021)
2 Arrow Energy (2013)
3 DoR Bore Reports (2021)

7.2.3 Regional Hydrogeology

A summary of the regional hydrostratigraphy is presented in Table 43. The hydrostratigraphic units related to the Project area is summarised in Section 7.2.4 and are discussed in further detail in the Groundwater Assessment (Appendix C).

Table 43 Summary of regional hydrostratigraphic units

Period	Geologic Unit	Dominant Hydrostratigraphic Classification
Quaternary / Tertiary	Alluvium	Minor Aquifer
Tertiary	Tertiary Sediments/ Suttor Formation	Minor Aquifer
	Basalt	Minor Aquifer
Triassic	Moolayember Formation	Aquitard
	Clematis Group	Major Aquifer
	Rewan Group	Aquitard
Late Permian	Rangal Coal Measures	Aquitard (interburden between coal measures) and aquifer (coal sequences
	Fort Cooper Coal Measures and equivalents	
	Moranbah Coal Measures and equivalents	
Middle Permian	Back Creek Group	Aquitard

7.2.4 Local Hydrogeology

The Quaternary Alluvium is associated with watercourses (primarily the Isaac River) and paleochannels across the Project area. The alluvium forms a significant aquifer within coarser grained horizons.

The Suttor Formation and Tertiary sediments outcrop at Sapphire (PL 1034) and Central (PL 1038). The geologic boundary between the two is often difficult to distinguish and often are not separated by drilling programs (AGE, 2020). The strata of the Suttor Formation contains (as well as sediments) sedimentary deposits and interbedded basalts. The sediments do not contain significant volumes of groundwater and are not considered to be a significant aquifer (AGE, 2020). Consolidated sediments of the Tertiary (i.e. interbedded sedimentary rocks of the Suttor Formation) also vary in grain size and are interbedded at different thicknesses with basalt. Where deposits are coarser and thicker, they have more potential to hold groundwater. Thicker deposits of basalt are often logged (from drilling programs) and considered as a different unit (Tertiary basalt).

Tertiary aged basalt is present at Sapphire (PL 1034). Due to weathering and jointing of the basalt, the aquifer is compartmentalised in some areas and therefore exhibits heterogeneous groundwater characteristics (Arrow Energy, 2013).

Triassic aged strata including the Moolayember Formation, Clematis Sandstone and Rewan Group underlie the Quaternary and Tertiary units in some areas (refer to Table 7 in Appendix C).

The Moolayember Formation is made up of low permeability sediments which hydraulically separate the sediments of the Bowen Basin from the overlying Surat Basin (OGIA, 2019). Regionally the formation is considered an aquitard (Evans et al., 2018).

The Clematis Sandstone is present across most of Lancewood (PL 1045) and Central (PL 1038). The Clematis forms localised islands and are not connected to the Great Artesian Basin (GAB) system. Regionally the Clematis forms an important aquifer which is used for water supply across the Bowen Basin (OGIA, 2016).

The Rewan Formation unconformably overlies the Permian coal measures with up to 300 to 700m of low permeability sediments. The Rewan Formation is recognised as an aquitard and forms a confining layer to the underlying Permian units (AGE, 2020).

The Permian Coal Measures includes the Rangal Coal Measures, Fort Cooper Coal Measures, Moranbah Coal Measures and Back Creek Group. These units are comprised of a varying sequence of sedimentary rocks, where the coal seams form the main water bearing features due to fractures and are layered in a sequence of predominantly low permeability sediments. Hydraulic conductivities are variable and range from low to moderate permeability, depending on degree of faulting and fracturing. It is generally expected that the hydraulic conductivity of the coal seams is three times that of the interburden and that there is a general decreasing trend with depth (AGE, 2020).

7.3 Groundwater Baseline Assessment

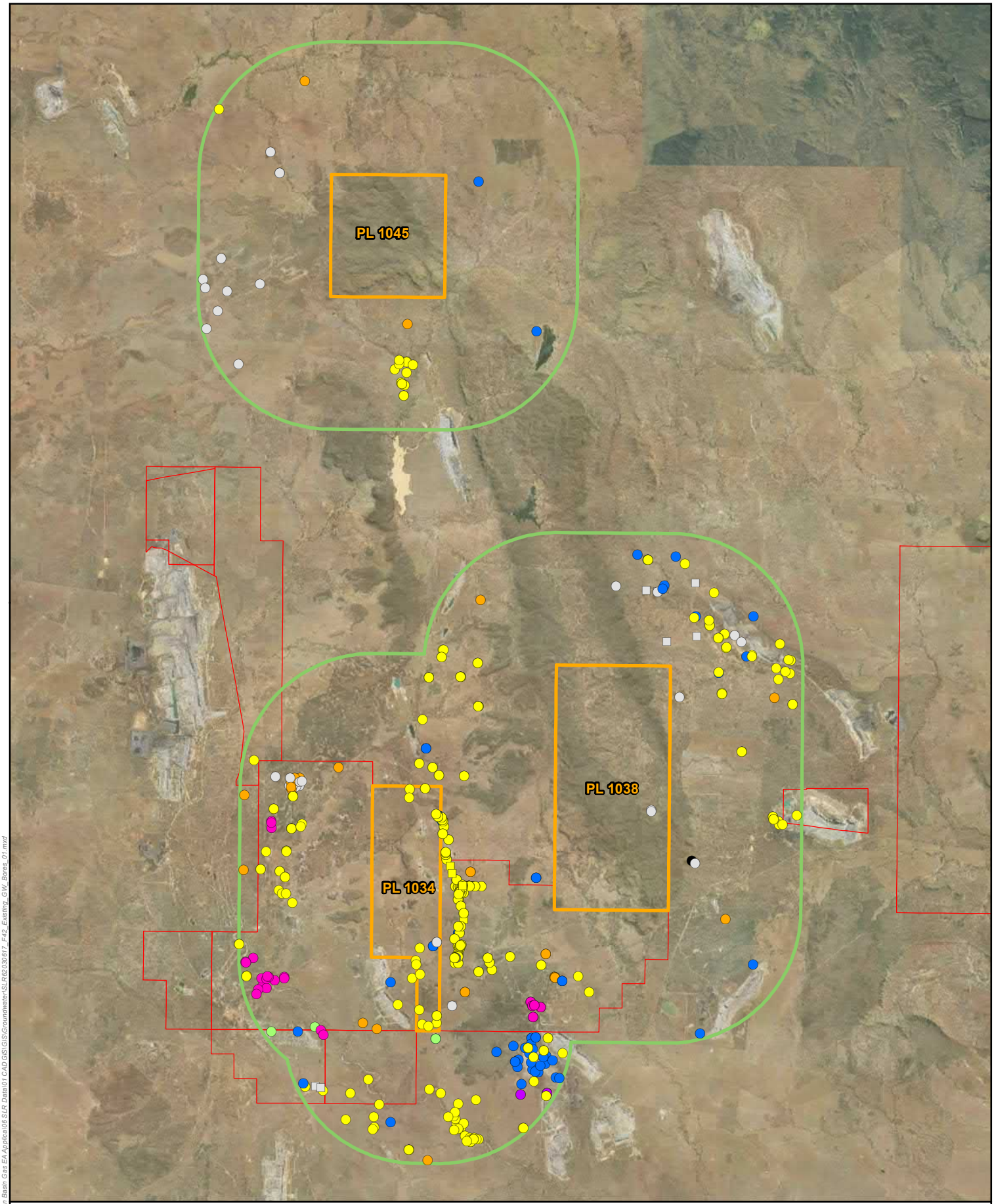
7.3.1 Groundwater Users

A search of the current Department of Resources (DoR) groundwater bore database (DoR, 2021) was conducted for third party bores within 10 km of Sapphire (PL 1034), Central (PL 1038) and Lancewood (PL 1045). The assessment found that there were 404 existing registered water bores in the search area. Of these bores there are four which are located within Sapphire (PL 1034), two within Central (PL 1038) and none within Lancewood (PL 1045). The database shows known drill dates between 1920 and 2021. Of the 404 existing bores, 56 were listed as being used for water supply and 38 had an unknown use.

A summary of the search information is presented in Table 44 and the location of all existing bores identified presented in Table 44.

Table 44 Number and facility role for third party bores within 10 km

Facility Role	Total	Within PLs
Petroleum or Gas Exploration	22	-
Mineral or Coal Exploration	1	-
Water Supply	56	3
Mine Monitoring	257	-
Coal Seam Gas Monitoring	24	-
Sub-Artesian Monitoring	2	-
Water Resources Investigation	1	-
Unknown	38	3



0 5.5 11 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:375,000 at A4
Project Number:	620.30617
Date:	09-Dec-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

- Petroleum Lease Boundary
- 10km Buffer
- Other Petroleum Leases

Registered Bore Use - Existing

- Coal Seam Gas Monitoring
- Mine Monitoring
- Mineral or Coal Exploration
- Petroleum or Gas Exploration
- Stratigraphic Investigation
- Sub-Artesian Monitoring
- Water Resources Investigation
- Water Supply
- Unknown

Registered Bore Use - Abandoned but still useable

- Mine Monitoring
- Unknown

BLUE ENERGY EA APPLICATION

Existing Registered Groundwater Bores within 10km of Petroleum Lease 1034, 1038 and 1045

FIGURE 42

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Groundwater\SLR620306l7_F42_Existing_GW_Bores_01.mxd

7.3.2 Environmental Users

Environmental use of groundwater includes direct vegetation use of groundwater, expression of groundwater at surface in the form of springs, and expression of groundwater at surface in the form of baseflow to surface streams. These are collectively termed Groundwater Dependent Ecosystems (GDEs).

The Queensland GDE mapping builds on existing information including wetland mapping, regional ecosystem mapping, spring and waterholes databases and drainage lines (Queensland Government, 2017).

The dataset contains shapefile data which show the following categories of GDEs:

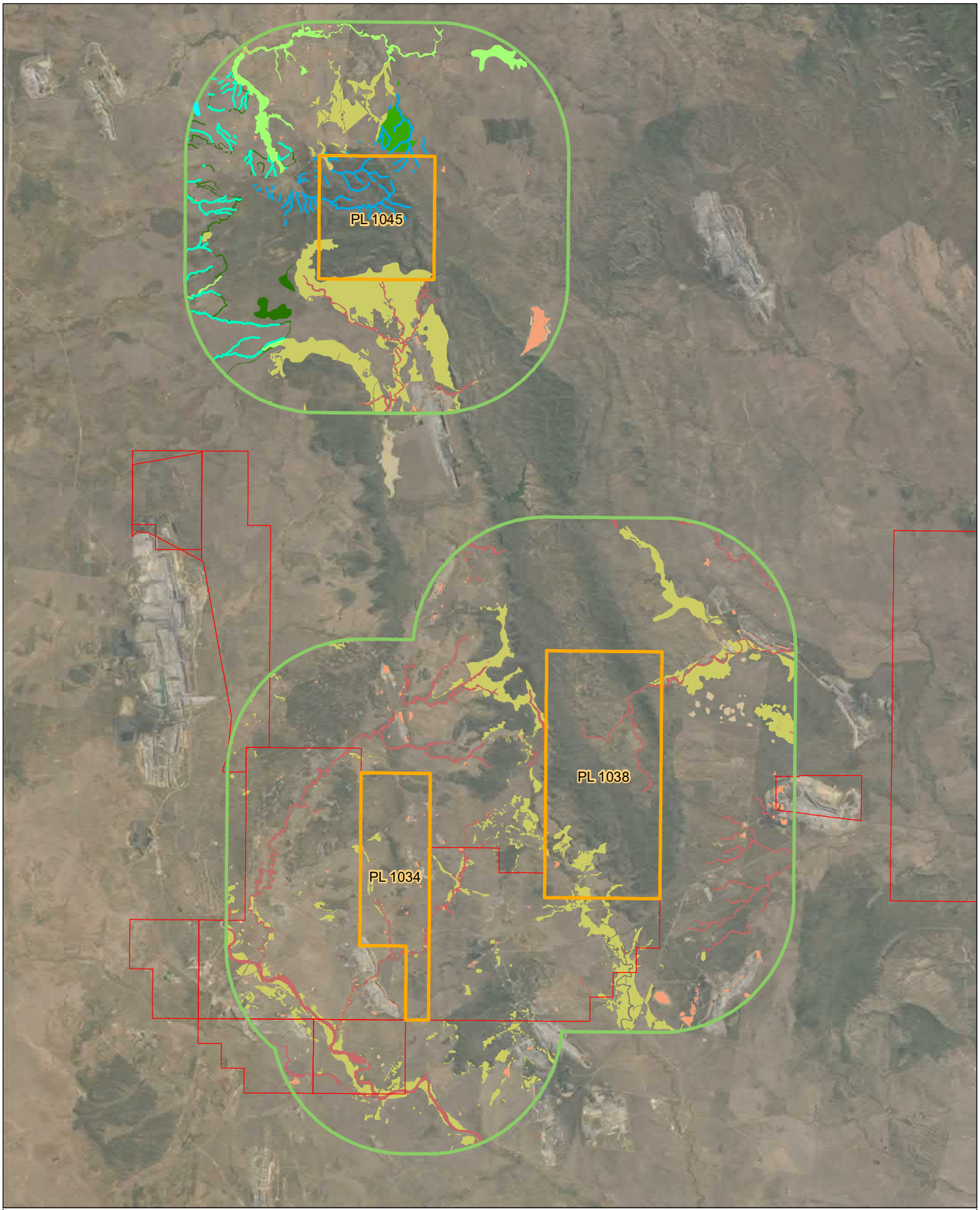
- Aquatic GDEs
- Terrestrial GDEs
- Subterranean GDEs (including stygofauna)
- Ecosystems dependent on the surface expression of groundwater, and
- Springs.

The dataset contains information on both known and potential GDE areas. Known GDEs refers to areas that have been verified through field studies while potential GDEs refer to areas that have been mapped at a large scale primarily through analysis of GIS data. The dataset was queried to assess the presence of GDEs within a 10 km buffer of the PLs. The search showed the following GDEs in the area and are shown on Figure 43.

- Terrestrial GDEs – Potential, derived with low, moderate and high confidence (within Lancewood (PL 1045) and within the 10 km buffer of Lancewood (PL 1045)), and
- Ecosystems dependent on the surface expression of groundwater – Potential, derived with moderate and high confidence (within Lancewood (PL 1045) and within the 10 km buffer of Lancewood (PL 1045)).

The search did not show any subterranean or aquatic GDEs or springs within a 10 km buffer of the site.

A search for wetlands within a 10 km buffer of the mining lease was conducted using the Wetland data version 5 – wetland areas – Queensland dataset downloaded from the QSpatial portal (DES, 2015). The search showed that there were several wetlands in the area including lacustrine, palustrine, riverine and those that were not classified (Figure 43). It should be noted that the wetland investigation was entirely desktop based and has not been ground-truthed.



0 2.5 5 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:375,000 at A4
Project Number:	620.30617
Date:	08-Oct-2021
Drawn by:	PM

Potential Surface Expression GDE
- Derived GDE - high confidence
- Derived GDE - moderate confidence

Potential Terrestrial GDE
- Derived GDE - high confidence
- Derived GDE - moderate confidence
- Derived GDE - low confidence

Wetland Areas
- Lacustrine
- Palustrine
- Riverine
- RE 1-50% wetland
- Project Petroleum Lease
- 10km Buffer
- Other Petroleum Leases

Data Source: DNRME Petroleum leases and registered groundwater bores. Imagery ESRI Basemaps 2019-2020.

BLUE ENERGY EA APPLICATION

Potential GDEs and Wetland areas within 10km of Petroleum Lease 1034, 1038 and 1045

FIGURE 43

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Groundwater\SLR620.30617_GW_GDEs_01.mxd

7.3.3 Groundwater Levels

A search for groundwater level data for registered bores in all aquifers was conducted using the DoR (2021) database. A selection of bores from each aquifer was chosen to describe groundwater level in each hydrostratigraphic unit, or where no information was available, groundwater levels were sourced from existing literature. This is summarised in Table 45 and further discussed in the Groundwater Assessment (Appendix C).

Table 45 Groundwater level summary

Hydrostratigraphic unit	Groundwater level range (mAHD)	Groundwater level range (mBGL)	Date
Quaternary alluvium	185.0 – 192.2[1]	15.7 – 11.0[1]	April 2019
Tertiary (basalt)	235.0 – 284.0	32.1 – 26.7	November 2020
Triassic Rewan Formation	232.0 – 251.0	6.9 – 35.7	April 2014
Permian	184.0 – 237.0	19.6 – 7.1	June/April 2020

[1] *Reported at the Isaac Downs Project by AGE (2020)*

7.3.4 Groundwater Quality

Groundwater quality statistics for field EC and pH for registered bores within 10 km of PLs are shown in Table 46 and further discussed in the Groundwater Assessment (Appendix C).

Table 46 pH and EC statistics for registered bores within 10 km of PLs

Statistic	pH (Field)				Electrical Conductivity (Field)			
Formation	min	max	median	type	min	max	median	salinity
Quaternary Alluvium	7.9	8.0	8.0	Slightly alkaline	8,851	13,700	13,180	Moderately to highly brackish
Tertiary	7.1	8.8	8.3	Slightly alkaline	773	17,940	16,760	Fresh to saline
Rewan	7.7	9.1	8.1	Slightly alkaline to alkaline	1,390	24,600	5,390	Fresh to saline
Permian	7.6	8.9	8.2	Slightly alkaline	1,060	17,450	2,940	Fresh to saline

7.3.5 Conceptual Hydrogeological Model

Conceptualisation of hydrogeological units relevant to the project area are summarised below and are further discussed in Appendix C. A conceptual cross section (Arrow Energy, 2013) is shown in Figure 44.

The hydrostratigraphic units across the Project area include:

- Quaternary Alluvium associated with watercourses and paleochannels, which forms an aquifer in coarser horizons. Recharge is variable depending on climatic conditions but occurs primarily via direct infiltration from rainfall. Discharge is via evapotranspiration, downwards leakage and stream discharge (AGE, 2020).

- Tertiary aged strata including:
  - Cainozoic sediments and the Suttor Formation, which do not form good aquifers and do not contain significant volumes of groundwater. Recharge to the sediments occurs via direct rainfall infiltration, and upwards leakage where the gradient permits. Discharge occurs from downwards leakage (AGE, 2020).
  - Basalt, which has variable groundwater characteristics due to compartmentalisation. Recharge occurs via rainfall infiltration where the unit outcrops and from downwards seepage. Discharge occurs from pumping and horizontal seepage (AGE, 2020).
- Triassic aged strata including:
  - The Moolayember formation, a low permeability aquitard (Evans et al., 2018). Recharged via downwards seepage from the overlying formations. Discharge occurs via downwards seepage.
  - The Clematis Sandstone which forms an important aquifer regionally. The unit is recharged primarily from rainfall where it outcrops. Discharge occurs from pumping and downwards leakage.
  - The Rewan group, a low permeability aquitard which confines the underlying Permian. The unit is recharged from rainfall where it outcrops and from downwards seepage. Groundwater discharge is to the underlying Permian coal measures (AGE, 2020).
- Permian aged strata including the Rangal Coal Measures, Fort Cooper Coal Measures, Moranbah Coal Measures. The Permian strata are comprised of low permeability sediments which confine higher permeability coal seams. Recharge occurs primarily where the units subcrop, through faults, fractures, bedding planes and coal seams. Discharge occurs via downwards leakage, dewatering or upwards seepage where the hydraulic gradient permits (AGE, 2020).

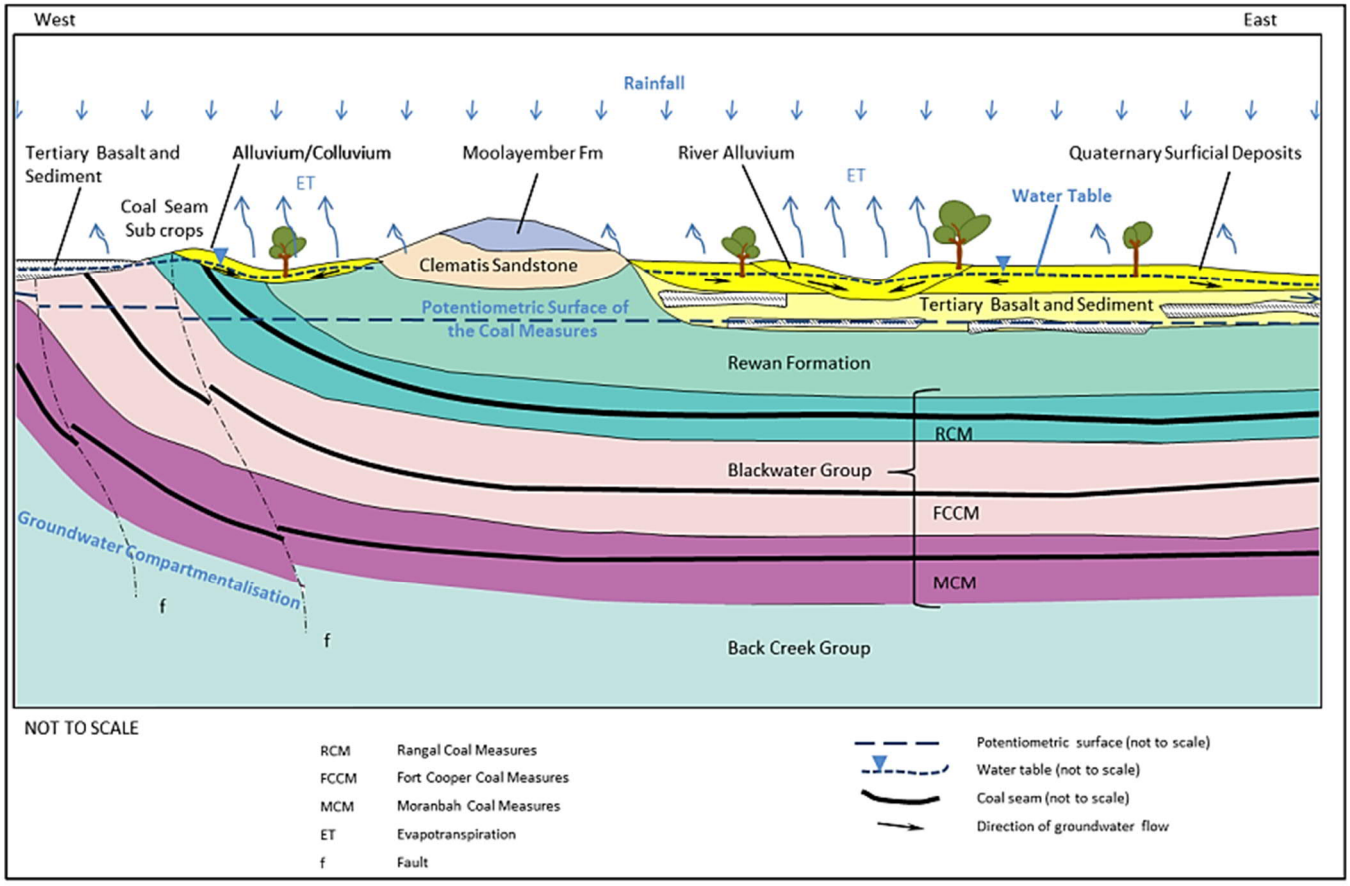


Figure 44 Conceptual hydrogeological model (Arrow Energy, 2013)

7.4 Prediction of Groundwater Impacts

7.4.1 Methodology

7.4.1.1 Model Set Up

Analytical modelling (using MLU) has been used to assess groundwater level impacts associated with gas and water production from an anticipated 530 planned wells across the Project site including:

- 117 planned wells at Sapphire (PL 1034)
- 264 planned wells at Central (PL 1038)
- 149 planned wells at Lancewood (PL 1045)

The assessment has been conducted to include a 40-year life, with a staggered well plan and each well running for a total of 20 years. It is assumed that wells at Sapphire (PL 1034) will begin at year one with wells at Central (PL 1038) and Lancewood (PL 1045) beginning 5 and 7 years after respectively.

A discussion on the analytical solution and modelling assumptions that were involved are discussed in more detail in Appendix C.

Due to differing geology across the PLs each area was modelled individually.

The hydraulic parameters used in the analytical model set up were estimated based on the desktop review of studies that have been conducted in the area (refer to Appendix C) and are shown in Table 47 to Table 49 and sensitivity analysis was performed in order to test the sensitivity of the values (discussed below).

Table 47 Layers and parameters used for the analytical model set up for Sapphire (PL 1034)

Model Layer	Formation	Type	Thickness (m)	Kh* (m/day)	Kv* (m/day)	Sy* / Storage
Layer 1	Alluvium/Tertiary	Aquifer	30	1	-	0.1
Layer 2	Interburden (Rewan/Rangal)	Aquitard	520	-	0.00001	0.0005
Layer 3	Coal (Rangal)	Aquifer	10	0.1	-	0.00005
Layer 4	Interburden (Rangal/FCCM)	Aquitard	190	-	0.00001	0.0005
Layer 5	Coal (FCCM)	Aquifer	10	0.05	-	0.00005
Layer 6	Interburden (MCM)	Aquitard	150	-	0.00001	0.0005

*Kh: horizontal hydraulic conductivity. Kv: vertical hydraulic conductivity. Sy: Specific yield

Table 48 Layers and parameters used for the analytical model set up for Central (PL 1038)

Model Layer	Formation	Type	Thickness (m)	Kh (m/day)	Kv (m/day)	Sy / Storage
Layer 1	Clematis	Aquifer	180	0.1	-	0.01
Layer 2	Interburden (Rewan/Rangal)	Aquitard	740	-	0.00001	0.0005
Layer 3	Coal (Rangal)	Aquifer	10	0.1	-	0.00005
Layer 4	Interburden (Rangal/FCCM)	Aquitard	190	-	0.00001	0.0005
Layer 5	Coal (FCCM)	Aquifer	10	0.05	-	0.00005
Layer 6	Interburden (MCM)	Aquitard	150	-	0.00001	0.0005

Table 49 Layers and parameters used for the analytical model set up for Lancewood (PL 1045)

Model Layer	Formation	Type	Thickness (m)	Kh (m/day)	Kv (m/day)	Sy / Storage
Layer 1	Alluvium/Clematis	Aquifer	185	0.1	-	0.01
Layer 2	Interburden (Rewan/Rangal)	Aquitard	345	-	0.00001	0.0005
Layer 3	Coal (Rangal)	Aquifer	10	0.1	-	0.00005
Layer 4	Interburden (Rangal/FCCM)	Aquitard	250	-	0.00001	0.0005
Layer 5	Coal (FCCM)	Aquifer	10	0.05	-	0.00005
Layer 6	Interburden (MCM)	Aquitard	195	-	0.00001	0.0005

7.4.1.2 Water Abstraction

For Sapphire (PL 1034), Central (PL 1038) and Lancewood (PL 1045), there is no test extraction data available to estimate the future expected gas and water abstraction rates. Blue Energy have supplied an estimate of annual water extraction rates for the two target formations based on actual CSG well production in the Bowen Basin. The estimated well water production rate is shown in Figure 45. It shows a typical CSG curve, with initial larger extraction rates, which then reduce over time and keep at a lower level. This curve was used as a best estimate for the well production rates in the groundwater analytical model. Water abstraction in general and in relation to model set up is further discussed in Appendix C. The models assumed that the provided abstraction rate is representative for the conditions at the three PLs. Once the first (test) wells are active, the water extraction volumes should be verified and if necessary, the estimated water production rate should be adjusted for future modelling.

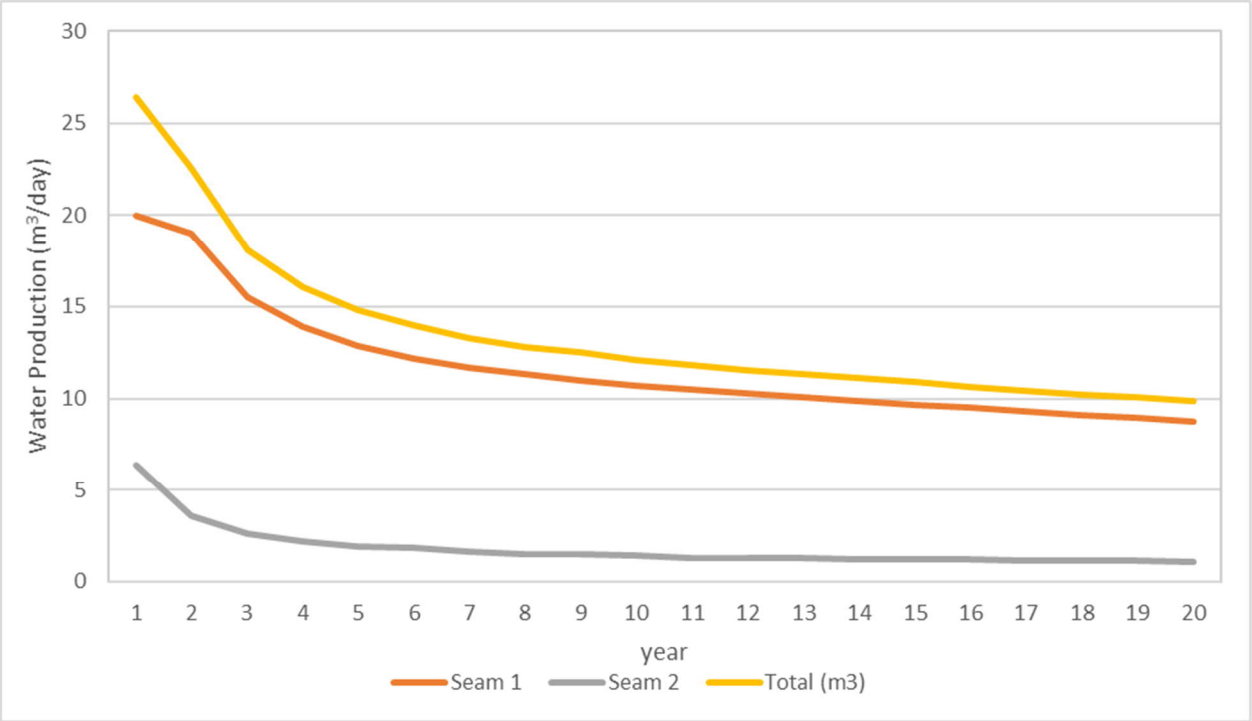


Figure 45 Water abstraction rate estimate

7.4.1.3 Sensitivity Analysis

For the sensitivity analysis, three additional scenarios have been assessed to evaluate the model sensitivity. The sensitivity analysis was conducted for Year 20 and at Lancewood (PL 1045) only. The general conclusions are transferrable to the other PLs, because all three models were similar in structure and differing only in thickness of layers and number of wells. The sensitivity analysis concluded:

- Increasing the hydraulic conductivity of the coal measures by a factor of 10 (scenario 1) causes the predicted drawdown curves in the coal measures to reach further out, but the total absolute drawdown to be smaller.

- Decreasing the hydraulic conductivity of the coal measures by a factor of 10 (scenario 2) causes the predicted drawdown curves in the coal measures to reach less far, but the total absolute drawdown to be larger. Increasing the hydraulic conductivity of the interburden (Rewan and Rangal) overlying the first target (scenario 3) causes the drawdown in the coal measures to be smaller. This is because part of the water would be sourced from the Rewan/overburden.

A detailed description of the results of each scenario to the base case is presented in Appendix C.

7.4.2 Results

7.4.2.1 Overlying Aquifers

Due to differing geology and amount of cover across PLs, the aquifer above the target coal measures was modelled as alluvium/tertiary at Sapphire (PL 1034) and Clematis at Central (PL 1038) and Lancewood (PL 1045). The modelling results showed a maximum drawdown of 0.1m in the alluvium/tertiary (Figure 46) and 1 m in the Clematis (Figure 47 and Figure 48) This means that, as expected, the Rewan Formation acts as a barrier to vertical flow (aquitard) and to the drawdown predicted in the Rangal Coal Measures from water production in that unit. This means water will not migrate upwards into the overlying aquifer to any significant or measurable degree. Given these negligible expected impacts, the drawdowns in the overlying aquifers have not been mapped.

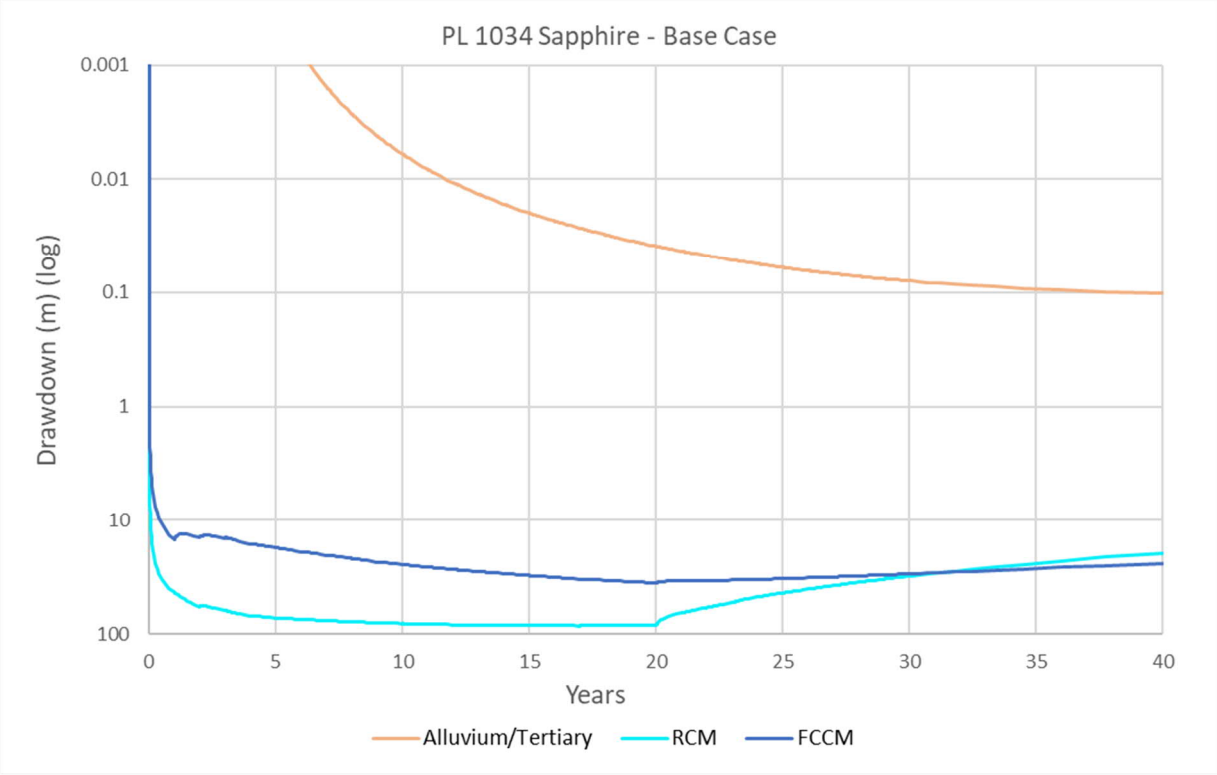


Figure 46 Drawdown at Sapphire (PL 1034) – Base Case

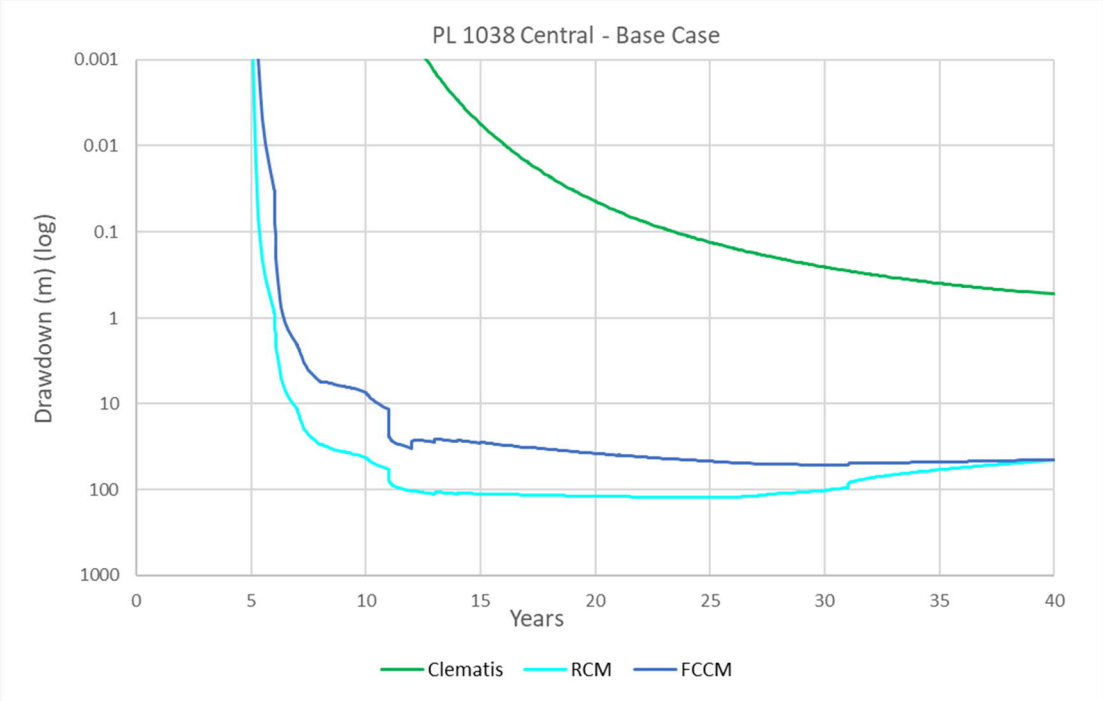


Figure 47 Drawdown at Central (PL 1038)– Base Case

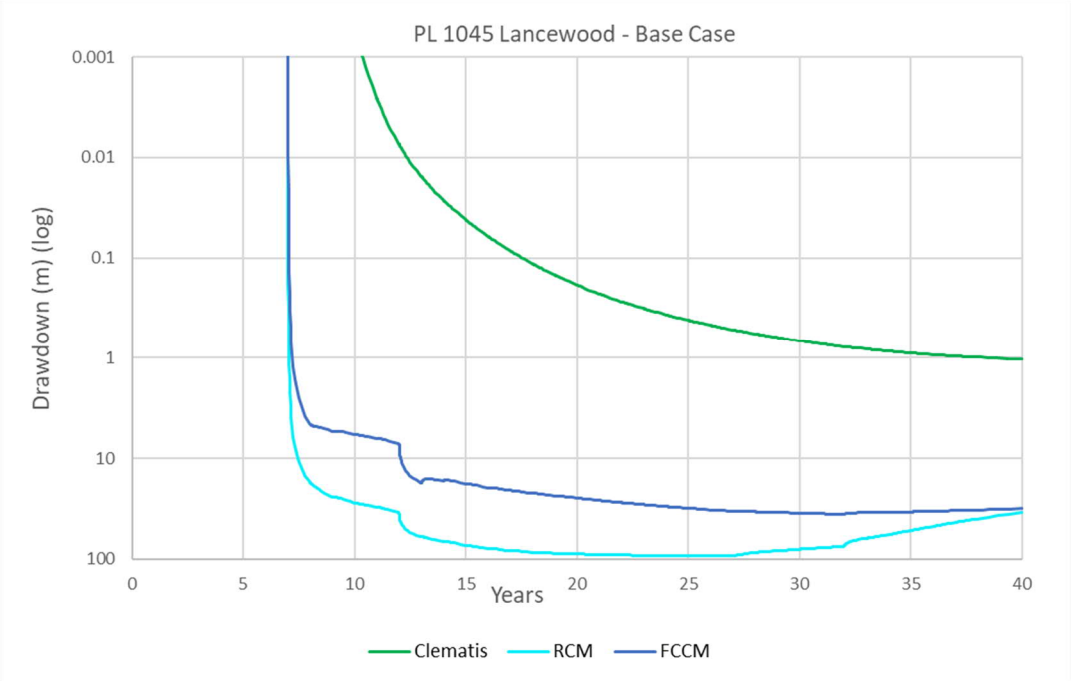


Figure 48 Drawdown at Lancewood (PL 1045) – Base Case

7.4.2.2 Rangal Coal Measures

Figure 49 (Lancewood (PL 1045)) and Figure 50 (Sapphire (PL 1034) and Central (PL 1038)) show the 5 m water level drawdown contour in the Rangal Coal Measures target coal seam at 5, 10, 20 and 40 years. The 5 m drawdown contour extends to a maximum of approximately 8 km at year 40 from the boundary of PLs. It is apparent that the zone of impact is increasing with more well pads becoming active with each additional year, which would be expected due to increasing water production with more wells becoming active. As can be seen in Figure 50 the zone of impact converges between Sapphire (PL 1034) and Central (PL 1038) between years 10 and 20.

7.4.2.3 Fort Copper Coal Measures

Figure 51 (Lancewood (PL 1045)) and Figure 52 (Sapphire (PL 1034) and Central (PL 1038)) show the 5 m water level drawdown contour in the Fort Cooper Coal Measures target at 5, 10, 20 and 40 years. The 5 m drawdown contour extends to a maximum of approximately 5 km at Lancewood (PL 1045) and 7 km at Sapphire (PL 1034) and Central (PL 1038). As can be seen for the Rangal Coal Measures, the zone of impact increases as more well pads become active (e.g. at year 10 at Central (PL 1038) the impact is only in the north). As can be seen in Figure 52, the zone of impact between Sapphire (PL 1034) and Central has converged at year 20.

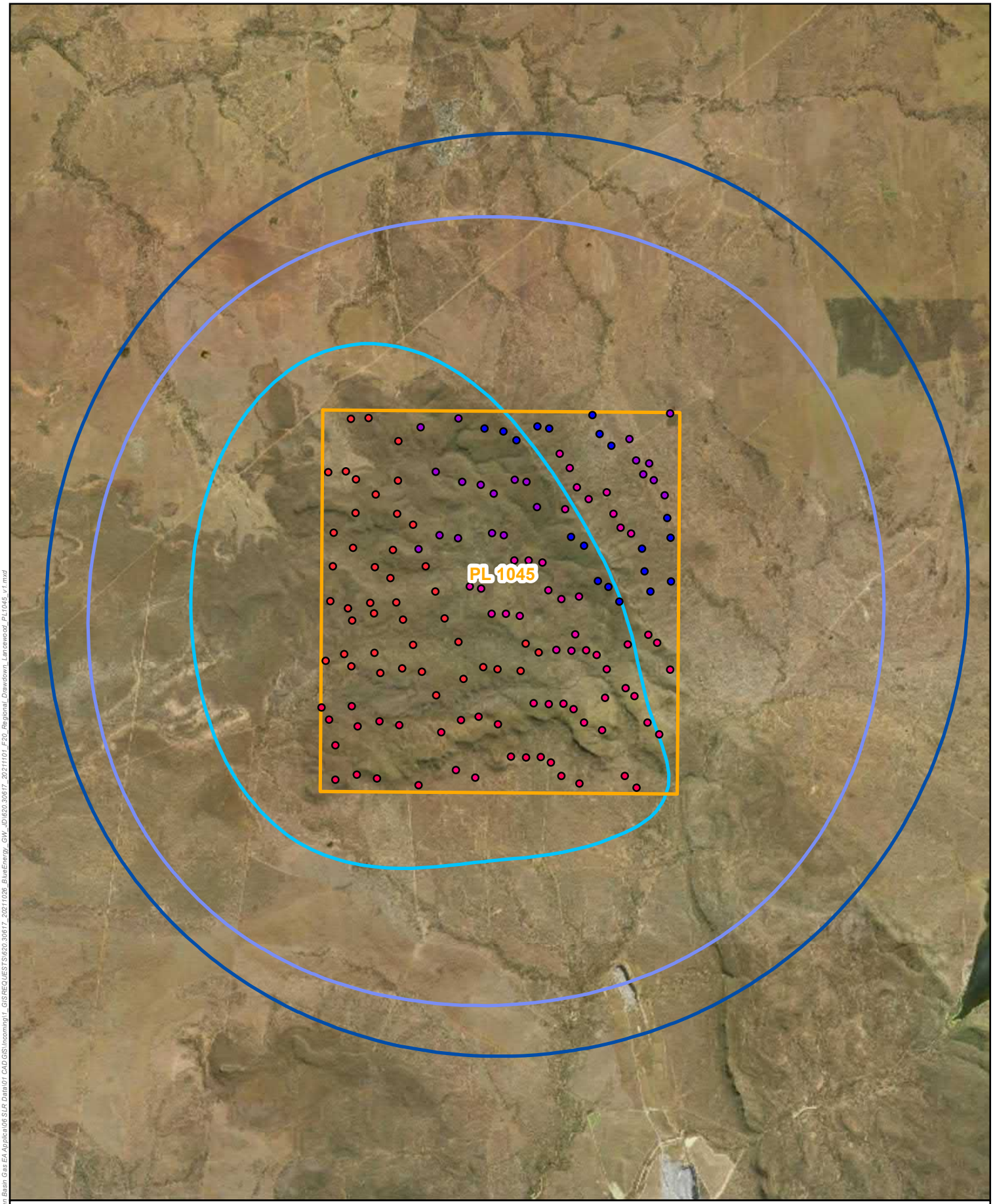
7.4.3 Water Level Impacts on Landholder Bores

The landholder bore desktop assessment is presented in Section 7.3.1. As the desktop results have not been confirmed with a bore census, the impacts were assessed on a more general level. To assess water level impacts on landholder bores a hypothetical bore was placed in the centre of each PL in each model layer (Clematis at Lancewood (PL 1045) and Central (PL 1038) and Alluvium/Tertiary at Sapphire (PL 1034), Rangal Coal Measures and Fort Cooper Coal measures for all three models) to visualise the drawdown over time. The MLU software is not able to export water level or drawdown information for layers considered an aquitard (the Rewan Formation. The drawdown graphs are included as Figure 46 to Figure 48.

At Sapphire (PL 1034), where the alluvium was modelled, this showed a maximum drawdown of 0.1 m, which is considered negligible. Modelled drawdown in the Clematis was also found to be negligible (maximum of 1 m).

Figure 49 to Figure 52 show existing registered landholder bores which have listed coal measures (any coal measures, not specified which ones) as the associated aquifer and their use as water supply or unknown. The figures show that there are 11 bores within the 5 km drawdown buffer at Sapphire (PL 1034) and Central (PL 1038). These are registered bores 105435, 131612, 131613, 131614, 131615, 46582 and 85078.

It should be noted that this assessment was desktop based and a landholder bore survey is recommended prior to site works commencing.



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:120,000 at A4
Project Number:	620.30617
Date:	03-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

Project Petroleum Lease

Development Years

- 7-8
- 9-10
- 11-12
- 13-14
- 15-16
- 17-18

5 Metre Drawdown

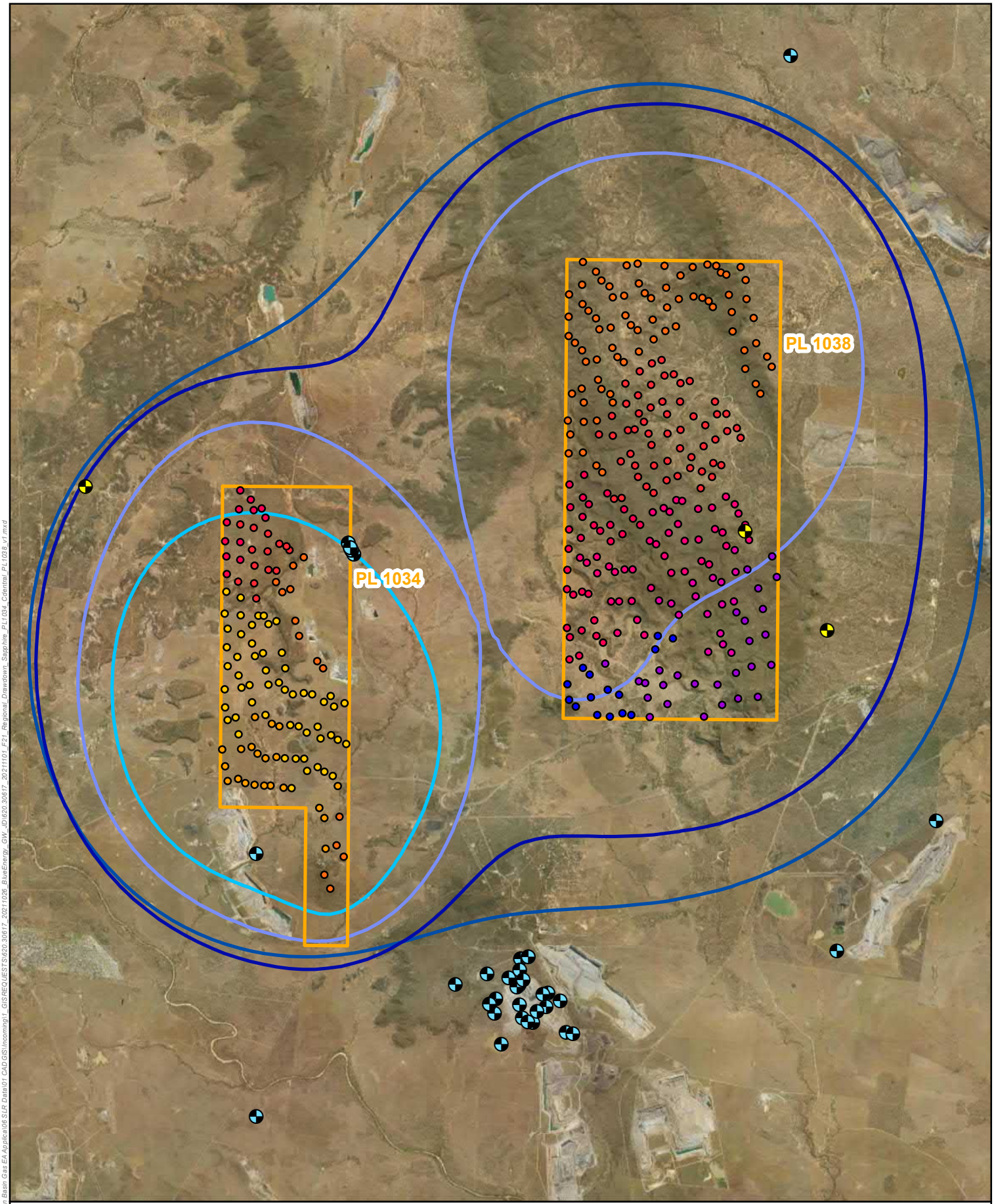
- Year 10
- Year 20
- Year 40

BLUE ENERGY EA APPLICATION

Regional Drawdown in the Rangal Coal Measures (Lancewood PL 1045)

FIGURE 49

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\Incoming\1_GISREQUESTS\620.30617_20211028_BlueEnergy_GW_JD\620.30617_20211101_F20_Regional_Drawdown_Lancewood_PL1045_v1.mxd



0 3 6 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:200,000 at A4
Project Number:	620.30617
Date:	03-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

Project Petroleum Lease

Registered Groundwater Bore Use

- Water Supply
- Unknown

Development Years

- 1-2
- 3-4
- 5-6
- 7-8
- 9-10
- 11-12
- 13-14
- 15-16
- 17-18

5 Metre Drawdown

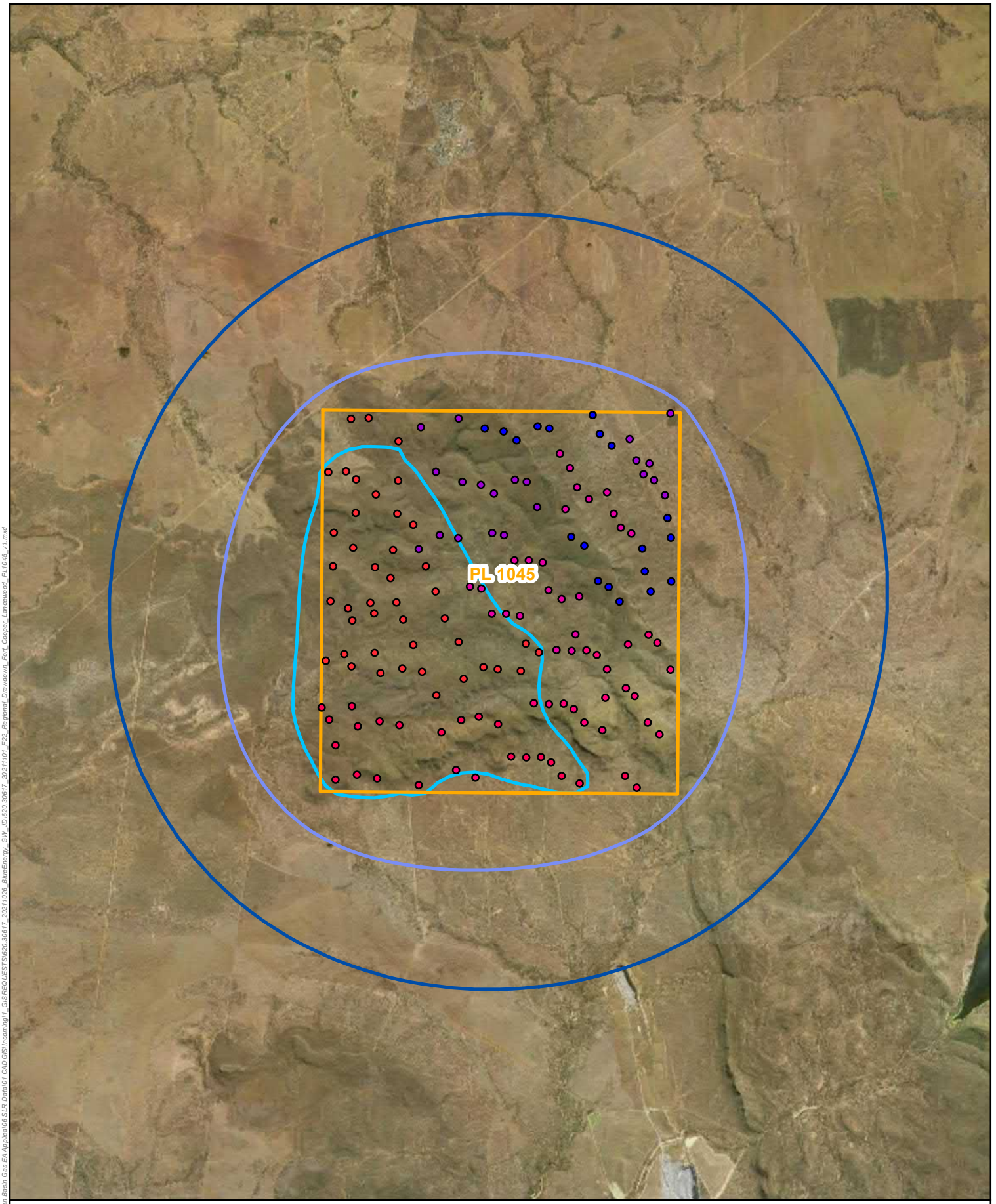
- Year 5
- Year 10
- Year 20
- Year 40

BLUE ENERGY EA APPLICATION

Regional Drawdown in the Rangal Coal Measures (Sapphire PL 1034 and Central PL 1038)

FIGURE 50

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\Incoming\1_GISREQUESTS\620.30617_20211028_BlueEnergy_GW_JD\620.30617_20211101_F21_Regional_Drawdown_Sapphire_PL1034_Cdentral_PL1038_v1.mxd



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:120,000 at A4
Project Number:	620.30617
Date:	03-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

Project Petroleum Lease

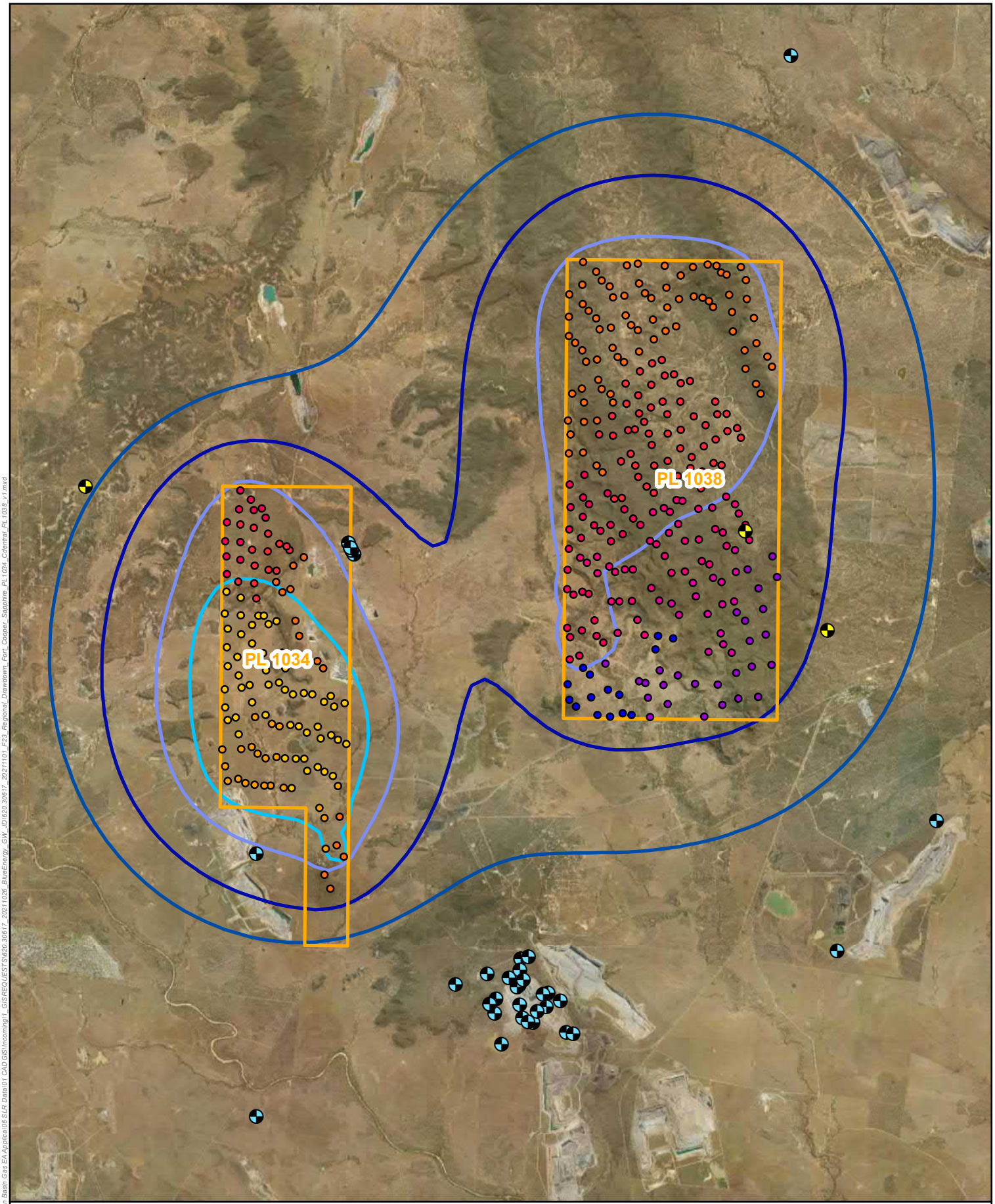
Development Years	5 Metre Drawdown
7-8	Year 10
9-10	Year 20
11-12	Year 40
13-14	
15-16	
17-18	

BLUE ENERGY EA APPLICATION

Regional Drawdown in the Fort Cooper Coal Measures (Lancewood PL 1045)

FIGURE 51

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\Incoming\1_GISREQUESTS\620.30617_20211028_BlueEnergy_GW_JD\620.30617_20211101_F22_Regional_Drawdown_Fort_Cooper_Lancewood_PL1045_v1.mxd



0 3 6 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:200,000 at A4
Project Number:	620.30617
Date:	03-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

Project Petroleum Lease

Registered Groundwater Bore Use

- Water Supply
- Unknown

Development Years

- 1-2
- 3-4
- 5-6
- 7-8
- 9-10
- 11-12
- 13-14
- 15-16
- 17-18

5 Metre Drawdown

- Year 5
- Year 10
- Year 20
- Year 40

BLUE ENERGY EA APPLICATION

Regional Drawdown in the Fort Cooper Coal Measures (Sapphire PL 1034 and Central PL 1038)

FIGURE 52

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\Incoming\1_GISREQUESTS\620.30617_20211028_BlueEnergy_GW_JD\620.30617_20211101_F23_Regional_Drawdown_Fort_Cooper_Sapphire_PL1034_Cdental_PL1038_v1.mxd

7.5 Groundwater Monitoring Strategy

The details for the proposed Water Monitoring Strategy are presented in Appendix C. In summary, it is recommended to install three shallow and three nested deep bores in each PL (Sapphire (PL 1034), Central (PL 1038) and Lancewood (PL 1045)).

Shallow formations are the alluvium, tertiary or the Clematis Sandstone. No water level impacts were predicted for those formations and hence the water level monitoring will be used to verify these modelling results. Further, any changes to the groundwater quality will be monitored at these locations.

The deep formations targeted will be the Rangal Coal Measures or the Fort Cooper Coal measures. Water level monitoring at the deep bores will verify drawdown predictions. Further, water quality samples will be taken to identify any changes in groundwater quality.

The modelling predicted that a drawdown in the deep coal measures will not result in a drawdown in the shallow formation. The nested locations (a shallow and a deep bore in the same locations) will assist in verifying these vertical gradients.

7.5.1 Water Level Monitoring

Monitoring of groundwater levels is required to identify the impacts from CSG production and to verify the aquifer drawdown predicted by the impact assessment. A reference point such as bore collar will be established and surveyed to a known height datum (i.e. Australian Height Datum). Measurements for water levels will be made monthly for the duration of pumping (whilst production testing is occurring). The data will be reviewed after the initial 24-month monitoring period to determine any seasonal variations that need to be taken into consideration. After this period, the monitoring frequency would also be reviewed.

To monitor water levels within the Permian coal measures the monitoring network proximal to the Project area is required. It is proposed that vibrating wire piezometer (VWP) nested sites should be constructed with shallow monitoring bores targeting the shallow formations (Quaternary alluvium, Tertiary or Clematis) located next to deeper monitoring bores targeting the Permian coal measures. This will enable lateral and vertical groundwater drawdown effects of the target units to be determined.

7.5.1.1 Water Quality Monitoring

Water quality monitoring will be undertaken to determine whether CSG production is impacting on groundwater quality over the duration of the proposed CSG operation.

Review of the local surface and solid geology show that the coal measures do not subcrop within the predicted area. Due to the depth of the coal measures beneath the Project area (>250 m) direct connectivity with the shallow formations (Quaternary alluvium, Tertiary or Clematis) is not expected. Nevertheless, all proposed monitoring bores should be sampled monthly for an initial 24 months to establish a water quality baseline.

The parameters suite for laboratory analysis will be in accordance with that undertaken for the baseline sampling and monitoring requirements, which are listed below. All samples will be submitted to a National Association of Testing Authorities (NATA) registered laboratory for analysis.

Ongoing sampling will be undertaken on a monthly basis for the first 24 months of operation (post re-commencement of the production testing) and reviewed to determine whether a reduced sampling frequency is warranted (i.e., quarterly or bi-annually). Collected samples will be analysed for the following:

- pH, electrical conductivity and total dissolved solids
- major anions (bicarbonate, carbonate, chloride, sulphate) and cations (calcium, magnesium, sodium, potassium)
- nutrients (ammonia, nitrite, nitrate, total phosphorus)
- dissolved and total metals (aluminium, arsenic, barium, cadmium, copper, cobalt, lead, nickel, zinc, boron, strontium), and
- total petroleum hydrocarbons, BTEX, PAHs.

Groundwater samples will be collected from the monitoring bores in accordance with procedures specified in the *Environmental Protection (Water) Policy 2009 Monitoring and Sampling Manual* (DES, 2018) and *Australian Standards Water Quality - Sampling AS 5667 (1998)*. The groundwater sampling will need to conform to applicable procedures for sampling equipment decontamination, preservation and transport, documentation and chain of custody protocol, and quality assurance / quality control.

7.5.2 Reporting

The results of the Groundwater Monitoring Strategy as detailed in this section will be reported annually via a short summary report as required by the Underground Water Impact Report (UWIR). Recommendations made will be addressed by the updated UWIR as required every three years. This will include a summary of the monitoring data recorded to date which will document changes in water quality and groundwater levels.

7.6 Risk Assessment

The risk assessment for impacts to groundwater is included in Appendix C. A number of potential impacts to EVs were identified. The majority of unmitigated impacts were considered to be low impacts. Further mitigation measures resulted in the residual risk being low for most of the identified impacts.

7.7 Streamlined Model Conditions

The proposed activities are compliant with the Streamlined Model Conditions, a full detailed assessment has been provided in Appendix A.

8 Air Quality

This section provides an assessment of air quality impacts associated with key construction and operational phases of the Project and has been carried out in accordance with the DES Technical information requirements for an environmental authority application for activities with impacts to air (ESR/2015/1840). For the proposed design of the Project, air pollutant emissions have been assessed against the relevant air quality guidelines for Queensland to demonstrate that the objectives for maintaining health, wellbeing and amenity can be met by the Project.

8.1 Air Quality Criteria

Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) enables the framework for environmental assessments to be developed in Queensland. The EP Act is applicable to all members and bodies in the community, including industry and government. It provides a method for government departments to incorporate environmental factors into their decision-making process.

A summary of the objective of the EP Act is as follows:

> *The object of the Environmental Protection Act 1994 is to protect Queensland's environment while allowing for 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.* (EPP (Air) Explanatory Notes, General outline).

There is a general environmental duty to prevent and minimise environmental harm under section 319 of the EP Act. The EP Act specifically states:

> *A person must not carry out an activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm (the general environment duty).*

To decide the measures required to meet the general environmental duty in accordance with the EP Act, regard must be had to:

- *the nature of the harm or potential harm*
- *the sensitivity of the receiving environment*
- *the current state of technical knowledge for the activity*
- *the current state of successful application of the different measures that might be taken, and*
- *the financial implications of the different measures as they would relate to the type of activity.*

The EP Act allows the Environment Minister to produce Environmental Protection Policies, designed to protect environmental aspects in Queensland. The *Environmental Protection (Air) Policy 2019* was developed under this framework in 2008, with the most recent revision being published in August 2019 and coming into force as of 1 September 2019.

Environmental Protection (Air) Policy 2019

The *Environmental Protection (Air) Policy 2019* (EPP Air, 2019) provides for the management and regulation of commercial and industrial air emissions that could adversely impact on sensitive receptors.

The purpose the EPP (Air) is summarised below:

> *The purpose of the EPP (Air) is to achieve the object of the Act in relation to the air environment* (EPP (Air) Part 2, Section 3).
>
> *The purpose of this policy is achieved by –*
>
> *a) Identifying environmental values to be enhanced or protected; and*
>
> *b) Stating indicators and air quality objectives for enhancing or protecting the environmental values; and*
>
> *c) Providing a framework for making consistent, equitable and informed decisions about the air environment.*

The environmental values listed in the EPP (Air) that are to be enhanced or protected under the policy are:

a) The qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems; and

b) The qualities of the air environment that are conducive to human health and wellbeing; and

c) The qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures and other property; and

d) The qualities of the air environment that are conducive to protecting agricultural use of the environment.

Queensland air quality guidelines are published in Schedule 1 of the EPP (Air) to protect the environmental values listed above. The ambient air quality goals prescribed for the key pollutants of concern in this study are shown in Table 50.

Table 50 EPP (Air) 2019 Ambient Air Quality Objectives

Indicator	Environmental Value	Air Quality Objective ($\mu g/m^3$ at 0°C)	Averaging Period
NO_2	Health and wellbeing	246	1 Hour
		62	Annual
	Health and biodiversity of ecosystems	33	Annual
CO	Health and wellbeing	11,000	8 Hours

Section 8 of the EPP (Air) sets out a management hierarchy for activities involving air emissions that affect, or may affect, an environmental value to be enhanced or protected under this policy:

a) Avoid air emissions (e.g. using technology that avoids air emissions)

b) Recycle air emissions (e.g. re-using air emissions in another industrial process)

c) Minimise air emissions (e.g. treating air emissions before disposal), and

d) *Manage air emissions (e.g. locating an activity that releases air emissions in a suitable area to minimise the impact of the air emissions).*

8.1.1 Sensitive Receptors

There are at least 21 identified sensitive receptors located within an approximate 5 km buffer from the PLs.

Sapphire and Central are located approximately 7.6 km and 21 km northeast of Moranbah respectively, Central is located approximately 2.3 km west of Coppabella, and Lancewood is located approximately 5.9 km south of Glenden. Each of these townships have several hundred sensitive receptors within them, however for the purpose of this assessment, each has been represented by one receptor point located at the closest edge of the residential area.

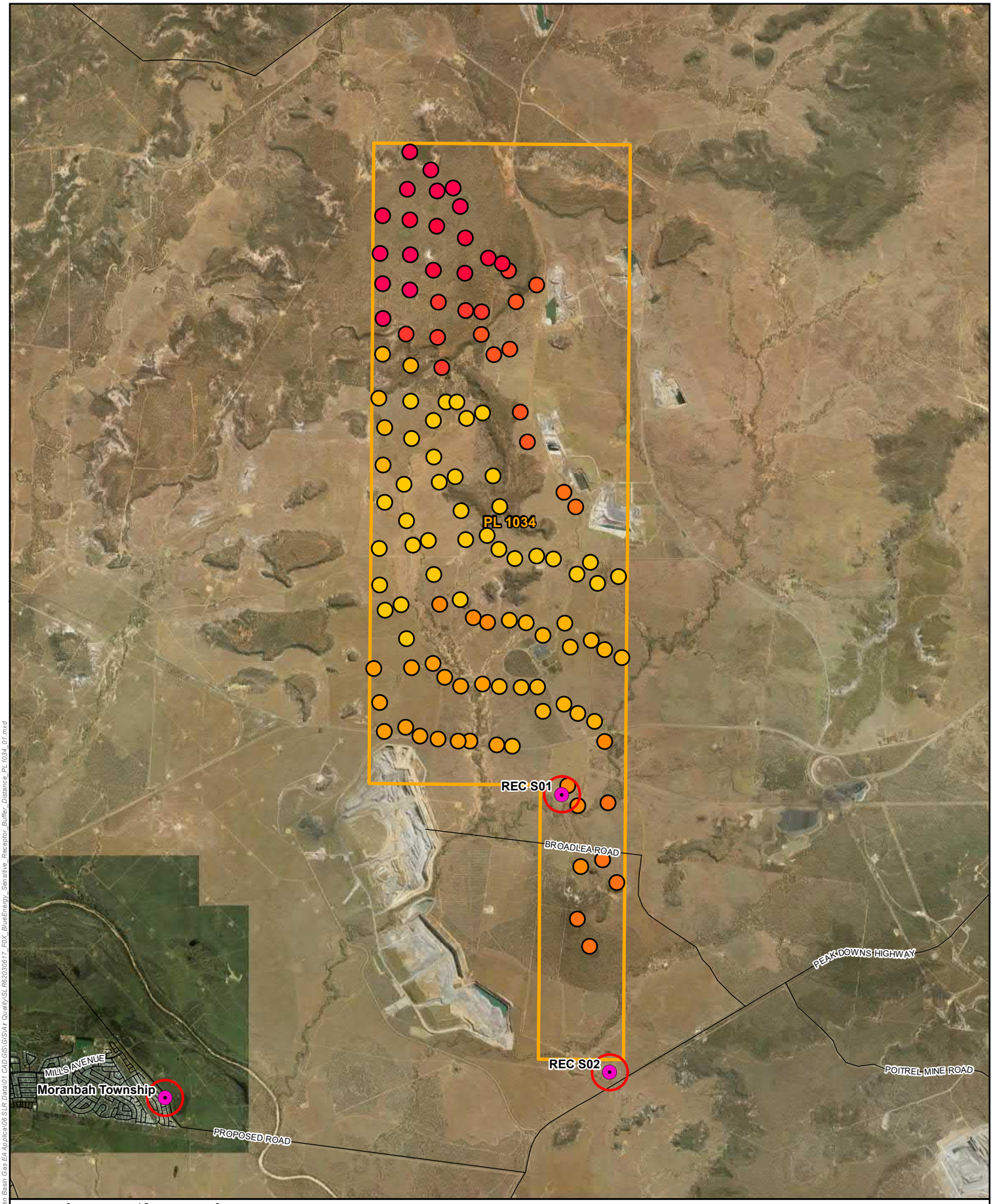
All sensitive receptors identified are summarised in Table 51 and shown in Figure 53, Figure 54 and Figure 55 for PL 1034, PL 1038 and PL 1045 respectively.

Blue Energy has advised that REC_S01, which is within PL 1038 (Central), is currently owned by Isaac Plains Coal Mine (Stanmore IP Coal Pty Ltd), and understood to become vacant in due course, therefore rendering this receptor non sensitive for the Project. While this receptor is currently occupied, even under the control of Isaac Plains Coal Mine, it remains a sensitive receptor for Blue Energy and the Project (and has been assessed as such), unless Blue Energy can seek a suitable alternative agreement with this receptor.

Table 51 Assessed Sensitive Receptors

PLA	Receptor ID	Receptor Type	Receptor Coordinates (GDA94, Zone 55)		Distance to PL (km)
			Easting	Northing	
PL 1034 (Sapphire)	Moranbah Township	Township	611,302	7,566,117	7.6
	REC_S01	Homestead	619,304	7,572,240	Within PL
	REC_S02	Homestead	620,268	7,566,633	0.3
PL 1038 (Central)	Coppabella Township	Township	640,192	7,576,703	2.3
	REC_C01	Homestead	639,305	7,585,415	1.4
	REC_C02	Homestead	643,061	7,577,560	5.2
	REC_C03	Homestead	642,755	7,577,359	4.9
	REC_C04	Homestead	641,782	7,577,477	3.9
	REC_C05	Mine Camp (Coppabella Village)	641,120	7,576,539	3.3
	REC_C06	Homestead	640,696	7,575,758	2.9
	REC_C07	Homestead	640,347	7,575,931	2.5
	REC_C08	Mine Camp (Terowie Village Camp)	639,784	7,573,023	3.5
	REC_C09	Homestead	637,959	7,575,446	0.5
	REC_C10	Homestead	637,959	7,573,204	2.8
	REC_C11	Homestead	633,365	7,573,281	2.7
	REC_C12	Homestead	633,542	7,572,353	3.7
	REC_C13	Homestead	633,552	7,571,564	4.4
	REC_C14	Homestead	628,343	7,570,469	5.6
PL 1045 (Lancewood)	Glenden Township	Township	615,402	7,637,438	5.9
	REC_L01	Homestead	622,172	7,637,710	6.4
	REC_L02	Lake Elphinstone Campsite	627,895	7,617,743	8.3
	REC_L03	Homestead	603,906	7,621,388	8.5

Note 1: Receptor currently owned by Isaac Plains Coal Mine. Remains a sensitive receptor until either Blue Energy seeks an alternative agreement with this receptor, or it is vacated due to mining operations at Isaac Plains Coal Mine.



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:100,000 at A4
Project Number:	620.30617
Date:	03-Dec-2021
Drawn by:	PW
Reviewed by:	GS

LEGEND

- Sensitive Receptor Location
- 360m Buffer Distance
- Project Area (PL 1034)

Development Years

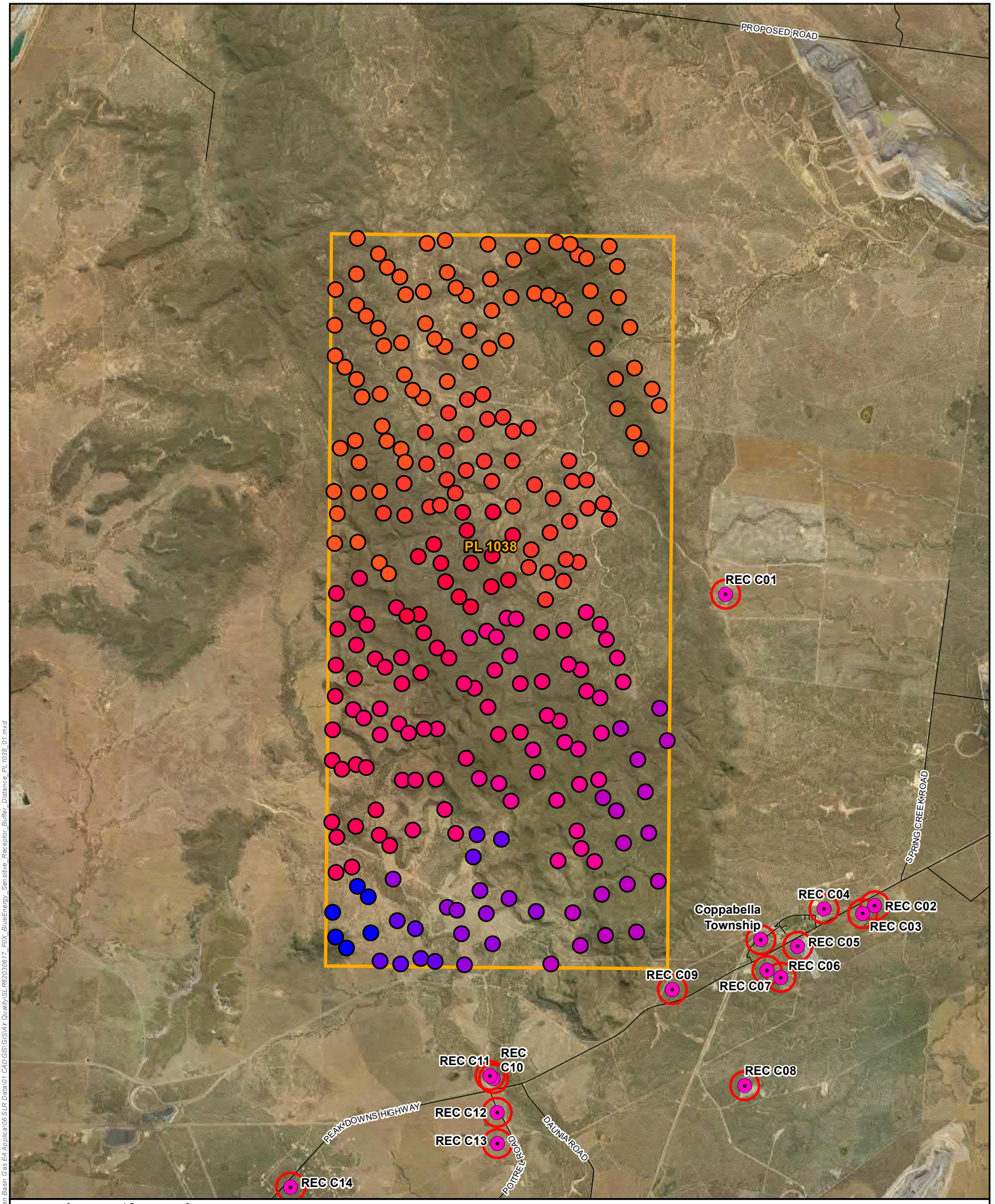
- Year 1
- Year 2
- Year 3
- Year 4
- Year 5
- Year 6
- Year 7
- Year 8
- Year 9
- Year 10

BLUE ENERGY EA APPLICATION

Sensitive Receptor 360m Buffer Distance PLA 1034 (Sapphire)

FIGURE 53

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\v1 Quality\SLR620306617_FIX_BlueEnergy_Sensitive_Receptor_Buffer_Distance_PL1034_01.mxd



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:125,000 at A4
Project Number:	620.30617
Date:	03-Dec-2021
Drawn by:	PW
Reviewed by:	GS

LEGEND

- Sensitive Receptor Location
- 360m Buffer Distance
- Project Area (PL 1038)

Development Years

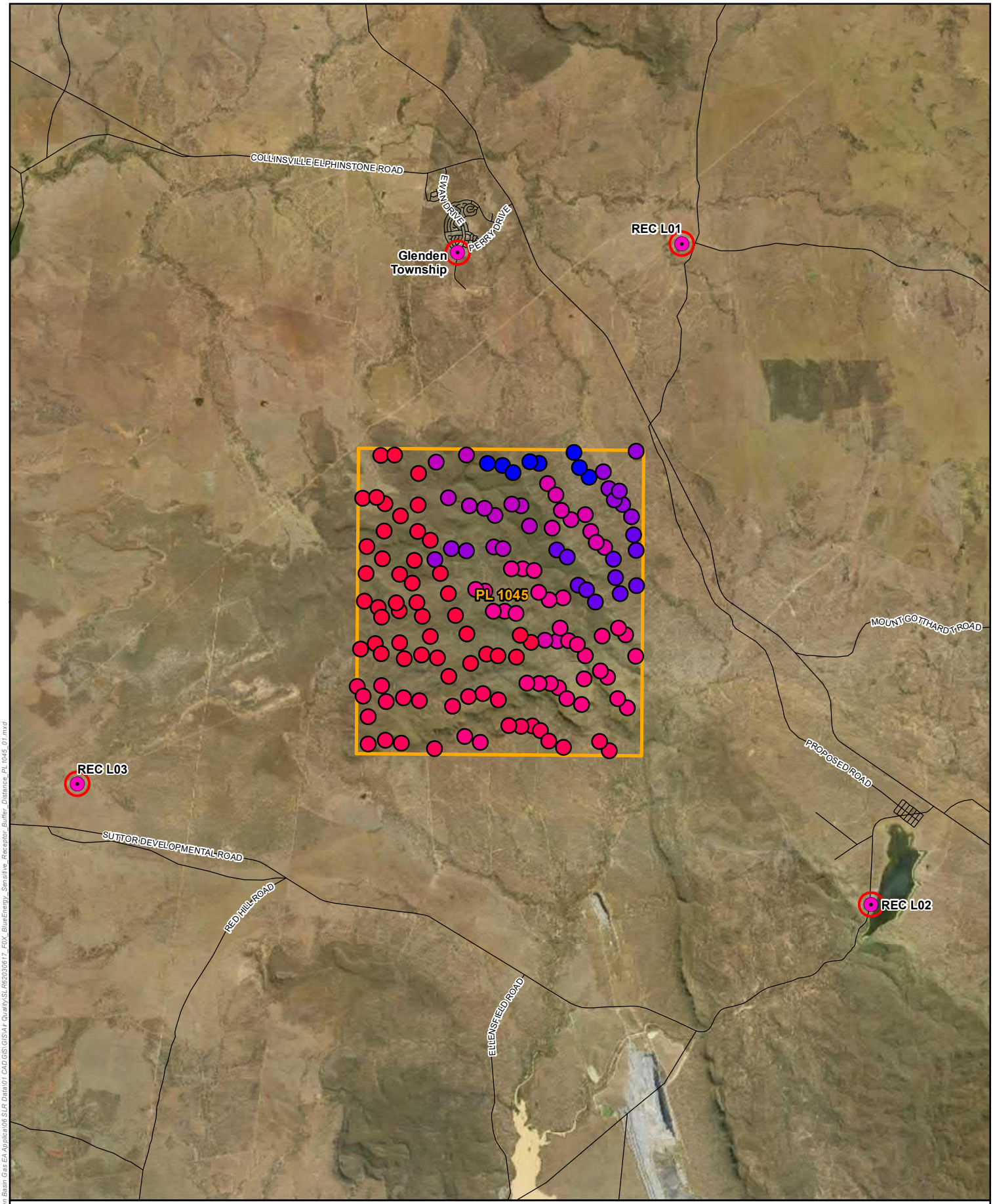
- Year 6
- Year 7
- Year 8
- Year 10
- Year 11
- Year 12
- Year 13
- Year 15
- Year 16
- Year 17
- Year 18

BLUE ENERGY EA APPLICATION

Sensitive Receptor 360m Buffer Distance PLA 1038 (Central)

FIGURE 54

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\4.1 Quality\SLR620306617_FIX_BlueEnergy_Sensitive_Receptor_Buffer_Distance_PL1038_01.mxd



0 2 4 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:150,000 at A4
Project Number:	620.30617
Date:	03-Dec-2021
Drawn by:	PW
Reviewed by:	GS

LEGEND

- Sensitive Receptor Location
- 360m Buffer Distance
- Project Area (PL 1045)

Development Years

- Year 8
- Year 10
- Year 12
- Year 13
- Year 14
- Year 15
- Year 16
- Year 17
- Year 18

BLUE ENERGY EA APPLICATION

Sensitive Receptor 360m Buffer Distance PLA 1045 (Lancewood)

FIGURE 55

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\v1 Quality\SLR620306617_F0X_BlueEnergy_Sensitive_Receptor_Buffer_Distance_PL1045_01.mxd

8.1.2 Existing Air Quality Environment

DES operates a number of air quality monitoring sites around Central Queensland to monitor air quality in these regions and to confirm compliance with air quality goals.

Four ambient air quality monitoring stations located at Miles, Hopeland, Condamine and Tara in the Darling Downs are in operation to monitor for any air quality impacts associated with the intensive CSG production activities in this region. These monitoring stations are operated by CSIRO's Gas Industry Social and Environmental Research Alliance (GISERA) as part of the Surat Basin Air Quality study. Miles airport was selected as a representative station of these four and the modelling year 2019 was analysed to provide background air quality concentrations for the pollutants of concern, being Nitrogen Dioxide (NO_2) and Carbon Monoxide (CO). It's appreciated that these monitoring stations are not in the region of the proposed Blue activities, they will provide a representative estimate of background air quality levels.

Estimated Background NO_2 and CO Levels

A summary of the analysis of these datasets are presented in Table 52. As a conservative approach, the 99.5th percentile measured 1-hour average NO_2 and 8-hour average CO concentrations recorded by the Miles monitoring site during the 2019 calendar year have been used as representative background levels for the Project.

A summary of the adopted background pollutant levels used in this study is presented in Table 52.

Table 52 Adopted Background Levels for Assessing Cumulative Impacts

Pollutant	Averaging Period	Adopted Background Concentration	
		ppm	µg/m³
NO_2	1-Hour	0.018	37
	Annual	0.005	10
CO	8-Hour	0.7	875

8.2 Potential Sources of Emissions to Air

The key emissions to air during the construction phases would be fugitive dust (particulate matter) emissions from drilling activities, pad and access track preparation and handling of earth materials, wheel-generated dust associated with vehicle movements and wind erosion of exposed areas. The use of diesel-fired plant and equipment such as drill rigs during the construction works (such as trucks, graders, excavators) would also result in emissions of diesel combustion products.

Post construction, the key potential air emissions from the Project would be emissions of products of CSG combustion from dewatering engines.

The temporary use of diesel powered generators may be required occasionally during the commissioning phase of the Project to assist with dewatering. Flaring of gas during initial dewatering activities may also occur until operational gas flow is achieved.

Pollutants emitted from combustion emissions would include the following:

- Oxides of nitrogen (NO_X): NO_X is a mixture of gases that are composed of nitrogen and oxygen. Two of the most toxicologically significant compounds are nitric oxide (NO) and nitrogen dioxide (NO_2). Other gases belonging to this group are nitrous oxide (N_2O) and nitrogen pentoxide (N_2O_5). The majority of NO_X (90 to 95%$_{(v/v)}$) generated by the combustion of fossil fuels is in the form of NO, with NO_2 contributing the remaining 5 to 10%$_{(v/v)}$ along with traces of N_2O. The NO reacts in the atmosphere to form NO_2 as the plume travels downwind.
- Carbon monoxide (CO): CO forms due to incomplete combustion of carbon in fuels (e.g. petrol, wood, coal, natural gas).
- Sulfur dioxide (SO_2): Emissions of SO_2 from fossil fuel combustion are directly proportional to the sulfur content of the fuel. As the sulfur content of CSG is very low, emissions of SO_2 from the combustion of CSG would be negligible and have not been considered further. Combustion of diesel is anticipated to only occur temporarily.
- Particulate matter: Small quantities of particulate matter are formed during combustion, predominantly in the fine particulate size range, from carry-over of non-combustible trace constituents in the fuel and lubricating oil and as products of incomplete combustion. Emissions of particulate matter from CSG-fired engines or proposed well head generators (for occasional use) are minimal and have not been considered further.
- Volatile Organic Compounds (VOCs): VOCs is a collective term used to describe organic carbon-based compounds with the ability to enter the atmosphere as a vapour. Due to the ubiquitous nature of organic compounds emitted from natural and anthropogenic processes, there is a myriad of organic compounds that fall under the definition of VOCs. The environmental, human-health and amenity (i.e. odour) impacts of ambient concentrations of VOCs depend on the composition of the gases, hence there are no ambient air quality criteria for "Total VOCs", only for selected key individual VOC constituents. CSG is predominantly (greater than 98%$_{(v/v)}$) methane (CH_4) and contains a limited mixture of VOCs in trace amounts (trace amounts are predominantly ethane). Ambient air quality guidelines do not typically consider CH_4 as a VOC as it contributes little to the formation of ground level ozone (O_3). Emissions of VOCs have therefore not been considered further.

Combustion of diesel at the well pads would also give rise to emissions to air. However, these units would only operate during the commissioning phase, under certain upset operating conditions or for testing and maintenance of the unit. The very limited operation of the back-up generators means that there is no potential for significant off-site air quality impacts and this source has not been considered further.

Similarly, field flaring at well pads and on gathering lines would also give rise to emissions to air. However, these units would only operate during the dewatering phase, under certain upset operating conditions or for testing and maintenance. The infrequent operation of the flares, the very hot plumes generated, the low flow rates of the flares and the significant distances to the nearest receptors means that there is no potential for significant off-site air quality impacts and this source has not been considered further.

8.2.1 Fugitive Emissions

The key fugitive emissions to air associated with the project are:

- Fugitive dust emissions from construction activities (assessed in Section 8.4.1), and
- Fugitive emissions of CSG associated with leaks and venting from pipelines, processing plant and other gas production infrastructure.

The composition of CSG within the Bowen Basin is typically:

- Methane (CH_4) 98 mol%
- Carbon dioxide (CO_2) 0.2 mol%
- Nitrogen (N_2) 1 mol%
- Non-Methane Volatile Organic Compounds (NMVOCs) >0.05 mol%

As shown above, the vast majority of CSG is methane (CH_4), which is not an air toxic and has no ambient air quality guidelines. This is also the case for Carbon Dioxide (CO_2). Emissions of CH_4 and CO_2 are of a concern due to their potential to contribute to the greenhouse effect and thus climate change.

NMVOCS are only present in trace amount in CSG and do not have potential to give rise to air quality impacts or exceedances of relevant criteria, even in the case of a major venting event. No further assessment of these emissions is therefore warranted.

8.3 Assessment Methodology

The key potential air pollution and amenity issues associated with fugitive dust emissions from construction-related activities are:

- Nuisance due to dust deposition (soiling of surfaces) and visible dust plumes, and
- Elevated suspended particulate concentrations (PM_{10}).

Modelling of dust from construction activities is generally not considered appropriate, as emission rates can vary significantly depending on a combination of the activity and prevailing meteorological conditions (i.e., rainfall and wind speed), which cannot be reliably predicted.

A qualitative assessment has therefore been performed of the potential risks to air quality associated with dust from construction activities associated with the Project based on the *IAQM Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management (IAQM 2014).

The IAQM method uses a four-step process for assessing dust impacts from construction activities:

- Step 1: Screening based on distance to the nearest sensitive receptor; whereby the sensitivity to dust deposition and human health impacts of the identified sensitive receptors is determined.
- Step 2: Assess risk of dust effects from activities based on:
    a. the scale and nature of the works, which determines the potential dust emission magnitude, and
    b. the sensitivity of the area surrounding dust-generating activities.
- Step 3: Determine site-specific mitigation for remaining activities with greater than negligible effects.
- Step 4: Assess significance of remaining activities after management measures have been considered.

Step 2a of the IAQM assessment methodology provides “dust emissions magnitudes” for each of four dust generating activities:

- Demolition
- Earthworks

- Construction, and
- Track-out (the movement of site material onto public roads by vehicles).

No demolition of existing structures would be performed as part of Project construction activities, and this category of works has not been considered further.

8.3.1 Dispersion Modelling Methodology

A quantitative air dispersion modelling study was performed to assess potential air quality impacts associated with products of CSG combustion at wellheads. The emission sources modelled represent a construction scenario and an operational scenario. The proposed locations of well heads are presented in Figure 53, Figure 54, and Figure 55.

Table 53 Modelling Scenarios

Source	Operational Scenario	Sources Modelled
Wellheads	Construction	Drill Rig
	Operation	Dewatering Pump Low pressure flare

8.3.2 Selection of Models

Emissions from Blue Energy drilling and dewatering activities were modelled using a combination of the Weather Research and Forecast (WRF), CALMET and CALPUFF models. CALPUFF is a transport and dispersion model that ejects “puffs” of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so, it typically uses the fields generated by a meteorological pre-processor CALMET, discussed further below. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period.

The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

8.3.3 Meteorological Modelling

Three-dimensional meteorological data for the project and surrounding areas were generated using a combination of WRF and CALMET models. Based on the analysis of long-term (2016-2020) meteorological data recorded at the nearest meteorological station located at Moranbah, the 2019 calendar year was selected as the representative calendar year for use in this study.

8.3.3.1 Weather Research and Forecast Model

The WRF model is a next-generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting needs. The model serves a wide range of meteorological applications across scales from tens of meters to thousands of kilometres.

For this AQIA, the WRF modelling system was used to produce the meteorological field required to provide the 'initial guess' field for the CALMET meteorological model. Parameters used in the WRF model for this AQIA are presented in Table 54.

Table 54 Meteorological Parameters – WRF

Parameter	Domain 1	Domain 2	Domain 3	Domain 4
Modelling domain	1,890 km × 1,890 km	180 km × 180 km	84 km × 96 km	54 km × 54 km
Grid resolution	27 km	9 km	3 km	1 km
Number of vertical levels	30			
Microphysics	WSM6			
Cumulus parametrization	Kain-Fritsch			
Shortwave radiation physics	Dudhia			
Longwave radiation physics	RRTM			
Planetary boundary layer	YSU			

8.3.3.2 CALMET

In the simplest terms, CALMET is a meteorological model that develops hourly wind and other meteorological fields on a three-dimensional gridded modelling domain that are required as inputs to the CALPUFF dispersion model. Associated two-dimensional fields such as mixing height, surface characteristics and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, sea breeze, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final hourly varying wind field therefore reflects the influences of local topography and land uses.

The CALMET model was run for a 32.5 km × 32.5 km domain centred on the three PLs, with a 400 m grid resolution. WRF-generated three-dimensional meteorological data were used as the "initial-guess" wind field, and local topography and land use information were used to refine the wind field predetermined by the WRF output.

Table 55 details the parameters used in the meteorological modelling to drive the CALMET model.

Table 55 Meteorological Modelling Parameters - CALMET

Parameter	Data
Modelling period	1 January 2019 to 31 December 2019
Meteorological grid resolution	400 m
Initial guess filed	WRF output
Vertical resolution (cell heights)	9 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1200 m, 2000 m, 3000 m)
Data assimilation	None

8.3.3.3 Meteorological Data Used in the Dispersion Modelling

This section presents a summary of the key meteorological conditions predicted by CALMET in the south-west corner of the Project area (as it is less impacted by topography and hence will provide worst case assessment for far field impacts) for the 2019 calendar year.

8.3.3.4 Wind Speed and Direction

A summary of the annual wind behaviour predicted by CALMET for the Project area is presented in Figure 56. The predicted wind data indicates that during 2019, the area experienced light to moderate winds (between 1.5 m/s and 8 m/s), predominantly from the eastern and south-eastern quadrants. Calm wind conditions (wind speeds less than 0.5 m/s) were predicted to occur approximately 3 percent of the time.

The seasonal wind roses indicate significant variation between the seasons. In summer, winds are light to moderate (1.5 to 8 m/s) and predominantly from the eastern quadrant. In autumn, winds are light to moderate and predominantly from the southeast quadrant. In winter, winds from the southern quadrant are predominant, while in spring, light to moderate winds were distributed in all directions with minimal winds from the western quadrant.

8.3.3.5 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Gifford-Turner (PGT) assignment scheme identifies six Stability Classes, A to F, to categorise the degree of atmospheric stability as follows:

- A = Extremely unstable conditions
- B = Moderately unstable conditions
- C = Slightly unstable conditions
- D = Neutral conditions
- E = Slightly stable conditions
- F = Moderately stable conditions.

The meteorological conditions defining each PGT stability class are shown in Table 56.

Figure 56 Wind Roses for Project Area, as Predicted by CALMET (2019)

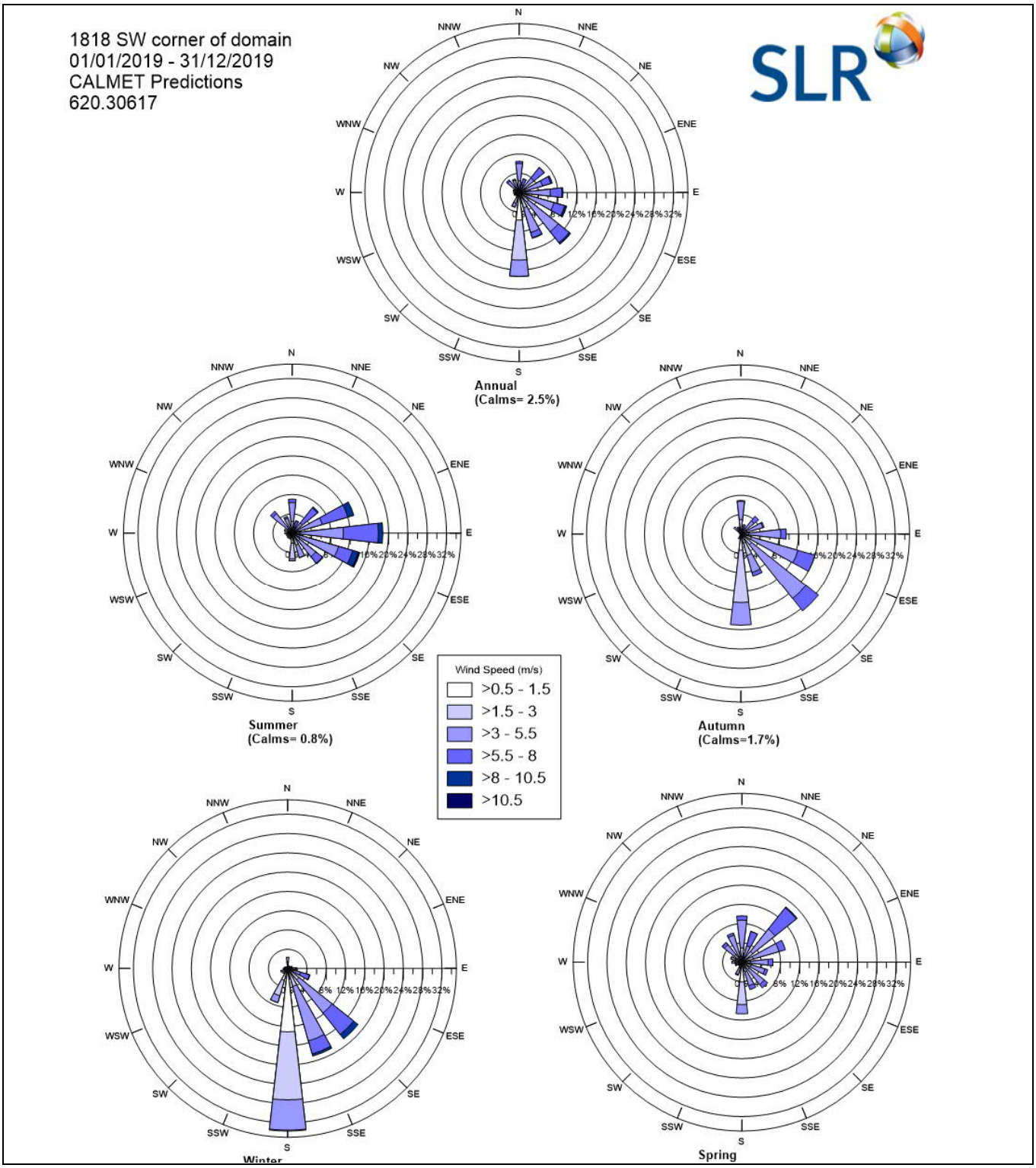


Table 56 Meteorological Conditions Defining PGT Stability Classes

Surface wind speed (m/s)	Daytime insolation			Night-time conditions	
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	<= 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

Notes:

- *Strong insolation corresponds to sunny midday in midsummer; slight insolation to similar conditions in midwinter.*
- *Night refers to the period from 1 hour before sunset to 1 hour after sunrise.*
- *The neutral category D should also be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour preceding or following night as defined above.*

Source: NOAA, 2018.

Figure 57 shows the frequency distribution of the atmospheric stability classes predicted for the Project area. The results indicate that neutral conditions (Stability Class D) occur most frequently in the area. A significant number of stable conditions (Stability Class F) are also predicted; these conditions are associated with a low level of pollutant dispersion due to limited mechanical mixing in the atmosphere.

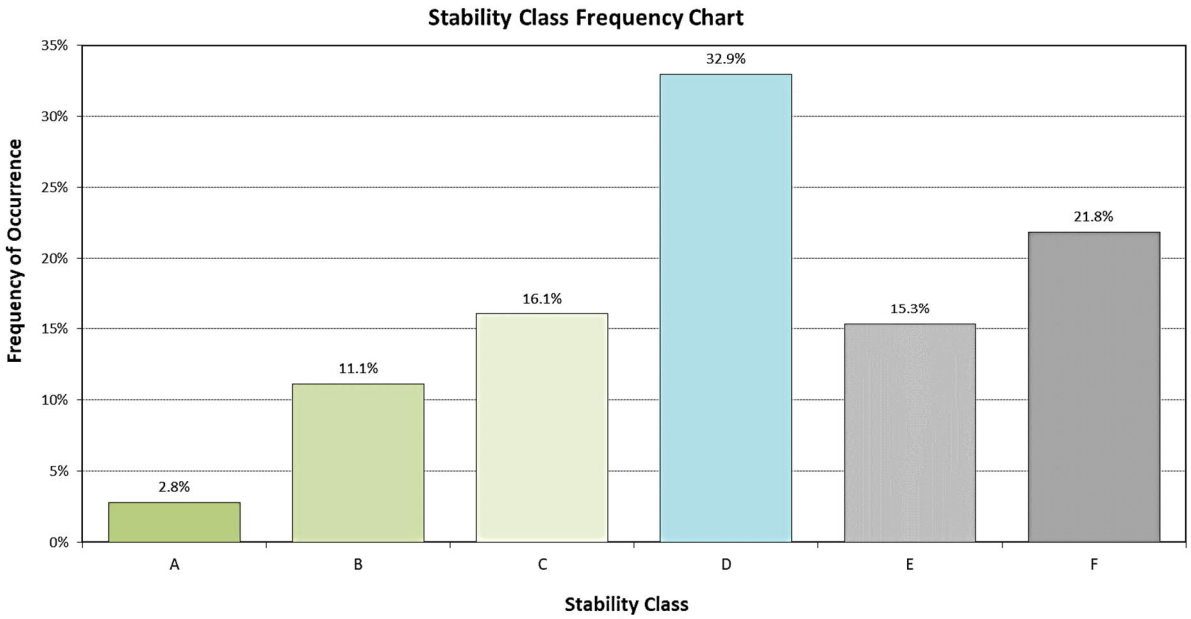


Figure 57 Stability Class Distribution Predicted by CALMET for Blue Energy (2019)

8.3.3.6 Mixing Heights

Diurnal variations in maximum and average mixing heights predicted by CALMET in the Project area are illustrated in

Figure 58. As would be expected, an increase in the mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer.

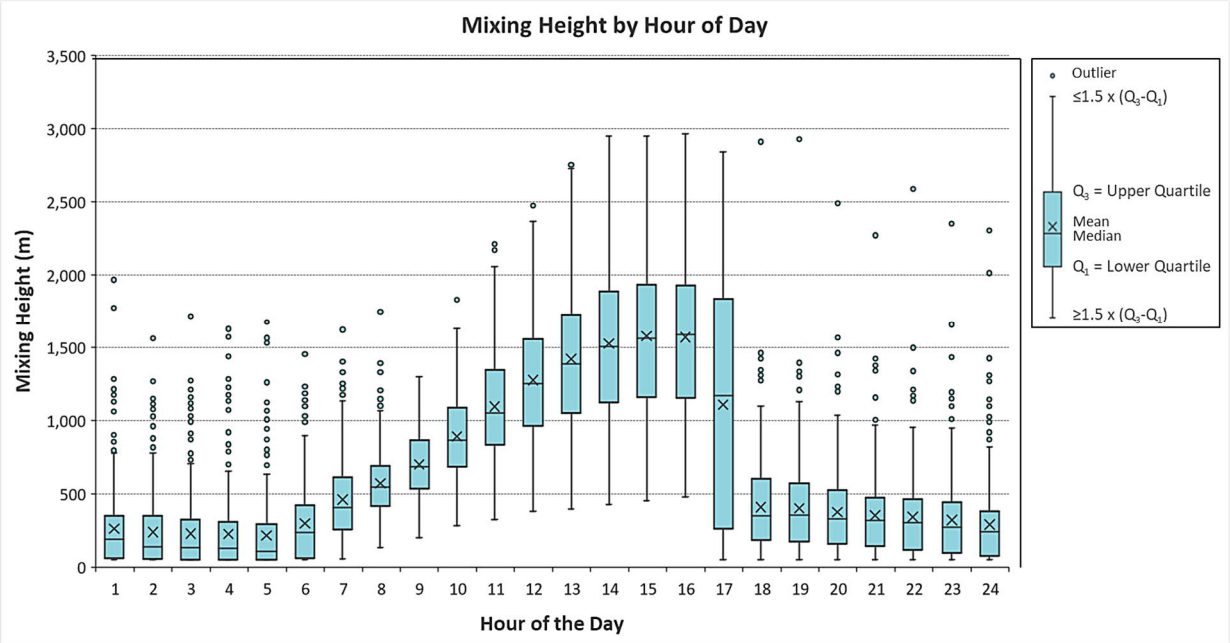


Figure 58 Mixing Heights Predicted by CALMET for Blue Energy (2019)

8.3.4 Dispersion Model Configuration

As discussed in Section 8.3.2, dispersion modelling was conducted using the CALPUFF dispersion model and three-dimensional meteorological data output from CALMET. Emissions from the Project were represented by a point source located at a nominal location within the model domain with little terrain influence in order to maximise the possible extent of impacts from the construction and operational emission sources.

8.3.5 NO_X to NO_2 Conversion

NO_X emissions from gas combustion sources generally consist of only 10% NO_2 and 90% NO. The NO will convert to NO_2 in the environment, in the presence of ozone and sunlight, however, the reaction converting NO to NO_2 has a conversion rate that takes place over several hours and results in increased NO_2 concentrations further down plume (where the plume is significantly diluted), not close to the source.

For this assessment, it has been conservatively assumed that 30% of NO_X emitted from combustion sources have been converted to NO_2 by the time the plumes reach the identified sensitive receptor locations.

8.3.6 Stack and Emission Data

Drill Rig Emissions

Emissions from the drill rigs during well construction have been assessed based on SLR's experience with similar operations. The stack parameters and emission rates used in the modelling are shown in Table 57.

Modelling was performed using and by locating the source in flat terrain to predict worst distances from the source (i.e., not blocked by terrain) within the meteorological file compiled as described in Section 8.3.3. The results of this modelling is used in Section 8.4 to derive off-set distances for this source that can be applied across the Project as part of the constraints analysis for locating wells.

Table 57 Model Inputs for Drill Rigs

Source	Stack Height	Exhaust Temperature	Stack Diameter	Exhaust Vertical Velocity	NO_X Emission	CO Emission
	(m)	(°C)	(m)	(m/s)	(g/s)	(g/s)
Drill Rig	2.5	732	0.25	0.1#	4.56	0.76

Horizontal emission

Wellhead generator emissions

Worst case emissions from wellhead generators that provide power to electrical dewatering pumps have been assessed based on specifications for a Shelby 60 kVA engine, which has been selected as a representative engine in the absence of specific engine makes/models being available for the Project. Emission characteristics for these engines are summarised in Table 58. It's noted that these emission rates are estimated at 100% load, which is worst case for air emissions for the 60 kVA engine. The typical maximum operating load for well head engines is approximately 30 kW (approximately 60% load), where NO_x emissions are estimated to be 0.45 g/s, while typical loads range between 5 – 15%, where NO_x emissions are estimated to be less than 0.12 g/s.

Modelling was performed using the stack parameters and emission rates shown in in Table 58 and by locating the source in a nominally central location within the meteorological file compiled as described in Section 8.3.3. The results of this modelling is used in Section 8.4.3.1 to derive off-set distances for these engines that can be applied across the Project as part of the constraints analysis for locating wells.

Table 58 Model Inputs for the Wellhead Dewatering Pump Engines – Peak Emissions

Source	Stack Height	Exhaust Temperature	Stack Diameter	Exhaust Vertical Velocity	NO_X Emission	CO Emission
	(m)	(°C)	(m)	(m/s)	(g/s)	(g/s)
Dewatering pump generator	2.5	732	0.25	0.1#	1.67	0.11

Horizontal emission

8.4 Air Quality Impact Assessment

8.4.1 Construction Activities

Potential downwind air quality impacts associated with combustion gas emissions from drill rigs have been assessed using dispersion modelling methodology described in Section 8.3, based on the emission rates presented in Section 8.3.6.

The other potential air quality impacts associated with the construction-phase activities are nuisance and health-related impacts due to fugitive dust emissions from earthworks and trenching activities. These potential impacts have been assessed qualitatively in Section 8.4.2 using the IAQM methodology (Appendix D).

Drill Rig Combustion Emissions

The estimated drill rig NO_X emissions listed in Table 57 have been modelled using the emission source located at a nominal location near the centre of the modelling domain. To enable a more refined assessment of near source predictions, the modelling was performed using a fine resolution 400 m by 400 m nested domain, centred on the emission source, which had a 10 m polar receptor spacing with 10 degree arcs.

The downwind NO_X concentrations predicted for each meteorological file were then post-processed to calculate the maximum ground level NO_2 concentration predicted in any direction downwind (based on a 30% NO_2/NO_X ratio as per Section 8.3.5).The resulting concentration-distance profile for the 1-hour average NO_2 predictions are shown in Figure 59. Annual average predictions are not presented as drill rigs would not operate in the same location for a full year.

Figure 59 shows that the maximum predicted incremental 1-hour NO_2 concentrations are well below the 1-hour average ground level NO_2 criterion of 250 µg/m^3 at all distances downwind and drop to near background levels within approximately 350 m of the source. These predictions include background NO_2 levels. Given that the drill rigs only operate for limited time periods at each well location, the potential for adverse air quality impacts is therefore not considered a significant risk.

The results indicate that provided multiple drill rigs are not operating simultaneously within 200 m of each other (which is unlikely to ever occur) the potential for any cumulative impacts is very low.

The large majority of wells are located much greater than 300 m from a sensitive receptor, with almost all located greater than 1,000 m from a sensitive receptor. This is because noise impacts from drilling activities typically constrains how close drill rigs can operate to sensitive receptors, with unacceptable noise impacts generally predicted for sensitive receptors located less than 350 m from a well site. Given this, the drill rig air assessment results for NO_2 do not indicate a significant risk for adverse air quality impacts. This is consistent with DES's guidance notes for assessment of drill rigs (DES, 2016):

> *Any fuel burning or combustion facility that is temporary or mobile is not considered a significant risk to the environment because the emissions are occurring on a temporary basis within the airshed (e.g. emissions from a generator used on a drilling rig, or standby or emergency generators). It is not necessary or desirable to condition emission limits or require monitoring of emissions from a temporary or mobile facility. A fuel burning or combustion facility that is temporary or mobile or does not meet the 500 kg in an hour threshold is covered by environmental nuisance provisions.*

Given that the CO emissions from the drill rigs are less than 20% of the NO_X emissions (see Table 57) and the CO guideline is much higher than those for NO_2, the assessment indicates there is no significant risk associated with CO emissions from the drill rig.

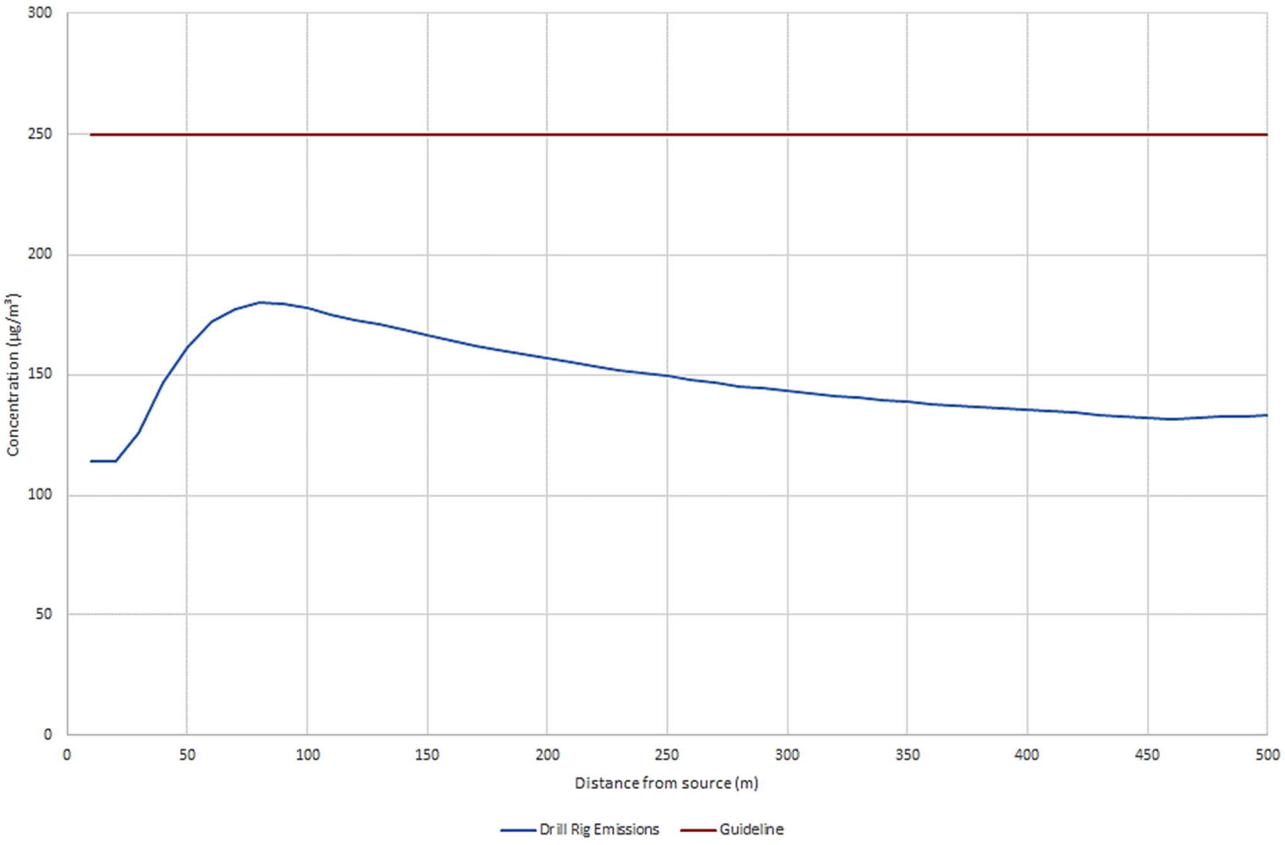


Figure 59 Maximum Predicted Incremental Downwind 1-Hour Average NO_2 Concentrations – Drill Rig

8.4.2 Fugitive Dust

Step 1 – Screening Based on Separation Distance

The Step 1 screening criteria provided by the IAQM guidance recommends screening out any assessment of impacts from construction activities where sensitive receptors are located more than 350 m from the boundary of the site, more than 50 m from the route used by construction vehicles on public roads and more than 500 m from the site entrance.

The following assessment of potential air quality impacts associated with fugitive dust from well pad, gathering pipeline and access road construction activities would therefore only be relevant to instances where these activities are occurring within 350 m of a sensitive receptor. Given that almost all wells are located greater than 300 m from a sensitive receptor, this assessment is therefore only expected to be relevant to a small proportion of wells.

Step 2a – Assessment of Scale and Nature of the Works

The two main construction activities associated with well pad construction, trenching and access road construction are earthworks and trackout. Actual construction of the structures on the surface of the well pad would have negligible potential for any air quality impacts and have not been considered further.

The equipment typically required for well pad, gathering pipeline and access road construction are as follows:

- Clear and grade of the well pad site would generally involve the use of a dozer, grader and excavator. Forming the well lease work pad and access road preparation would typically involve the use of a bulldozer, excavator, truck, bucket loader and a rolling/compacting machine.
- Trenching and backfilling for the gathering pipeline construction would typically require the use of a trencher, three side booms, an excavator, padder and water truck.
- Access road construction would typically involve a grader, roller and trucks (e.g. two B-Double side tippers).

A water truck would also be used to suppress dust emissions and a mulcher/shredder may be required to process any cleared vegetation.

Based upon the above assumptions and the IAQM definitions, the dust emission magnitudes for individual well pad sites and for road and pipeline active construction areas have been categorised as presented in Table 59.

Table 59 Categorisation of Dust Emission Magnitude for Well Pads, Gathering Pipelines and Access Roads

Activity	Dust Emission Magnitude	Basis
Earthworks	Small	Total site area less than 2,500 m^2, less than five heavy earth moving vehicles active at any one time, formation of bunds less than 4 m in height, total material moved less than 20,000 t.
Trackout	Small	Less than 10 heavy vehicle movements per day, surface materials with a low potential for dust generation, less than 50 m of unpaved road length.

Step 2b – Risk Assessment

Receptor Sensitivity:

Based on the criteria listed in Table B-1 of the IAQM, the sensitivity of the identified receptors in this study is concluded to be *high* for health impacts and *high* for dust soiling, as they include residential areas where people may be reasonably expected to be present continuously as part of the normal pattern of land use.

Sensitivity of the Area:

Using the classifications shown in Table B-2 of the IAQM, the sensitivity of the area to dust soiling is classified as '*low*' and the sensitivity of the surrounding area to health effects (Table B-3, IAQM) has also been classified as '*low*'. This categorisation has been made taking into account the individual receptor sensitivities derived above and the anticipated number of receptors present, i.e. no sensitive receptors within 100 m.

Risk Assessment:

Given the sensitivity of the general area is classified as '*low*' for dust soiling and '*low*' for health effects, and the dust emission magnitudes for the various construction phase activities as shown in Table 59, the resulting risk of air quality impacts is as presented in Table 60.

The results indicate that there is a negligible risk of adverse dust soiling and human health impacts occurring at nearby sensitive receptor locations as a result of the proposed earthworks activities and for track-out onto public roads, even if no mitigation measures were to be applied to control emissions.

Table 60 Preliminary Risk of Air Quality Impacts from Well Pads, Gathering Pipeline and Access Road Construction (Uncontrolled)

Impact	Sensitivity of Area	Dust Emission Magnitude		Preliminary Risk	
		Earthworks	Trackout	Earthworks	Trackout
Dust Soiling	Low	Small (Table 59)	Small (Table 59)	Negligible Risk	Negligible Risk
Human Health	Low			Negligible Risk	Negligible Risk

Step 3 - Mitigation Measures

As presented in Table 60, the IAQM risk assessment methodology indicates that there is a negligible risk of adverse air quality impacts associated with the construction of well pads, gathering pipeline and access roads. Nonetheless, Blue Energy will implement a range of dust mitigation measures to ensure that adverse air quality impacts do not occur during well, pipeline and road construction activities. The extent of disturbed areas are also minimised to minimise wind erosion.

Step 4 - Residual Impacts

Given that the uncontrolled emissions are concluded to have negligible risk for adverse impacts on sensitive receptors, the risks of residual impacts, after mitigation measures are applied, would also remain negligible.

8.4.3 Operational Activities

The only operational phase air emission sources identified as requiring assessment are the dewatering pump generators at the wellheads to drive electric pumps.

8.4.3.1 Wellhead Generators

The estimated wellhead engine NO_X emissions listed in Table 58 have been modelled using an emission source located at a flat location within the modelling domain to reduce any significant influence of terrain which is quite substantial across the domain. To enable a more refined assessment of near source predictions, the modelling was performed using a 10 m polar coordinate spacing with 10 degree arcs.

The downwind NO_X concentrations predicted were then post-processed to calculate the maximum ground level NO_2 concentration predicted in any direction downwind (based on a 30% NO_2/NO_X ratio as per Section 8.3.5), and the resulting concentration-distance profiles are shown in Figure 60.

Figure 60 shows that the maximum predicted incremental 1-hour average NO_2 concentrations are below the 1-hour average ground level NO_2 criterion of 250 µg/m^3 once greater than 400 m of the source. These predictions include background NO_2 levels. Figure 60 shows that this is predicted to occur within 400 m of the well pad emission source.

Figure 61 shows that the maximum predicted incremental annual average NO_2 concentrations are below the annual average ground level NO_2 criterion of 33 µg/m^3 within approximately 50 m of the source. These predictions include background NO_2 levels.

Given that the large majority of probable well locations are located much greater than 300 m from a sensitive receptor, with almost all located sensitive receptors located greater than 300 m from a PLA, the modelling results for NO_2 do not indicate a significant risk for adverse impacts.

Given that the CO emissions from the dewatering pump engines are less than 10% of the NO_X emissions (see Table 58) and the CO guideline is much higher than those for NO_2, provided that the well sites are located to prevent any risk of NO_2 impacts, there would be no risks associated with CO emissions from the dewatering pump engine.

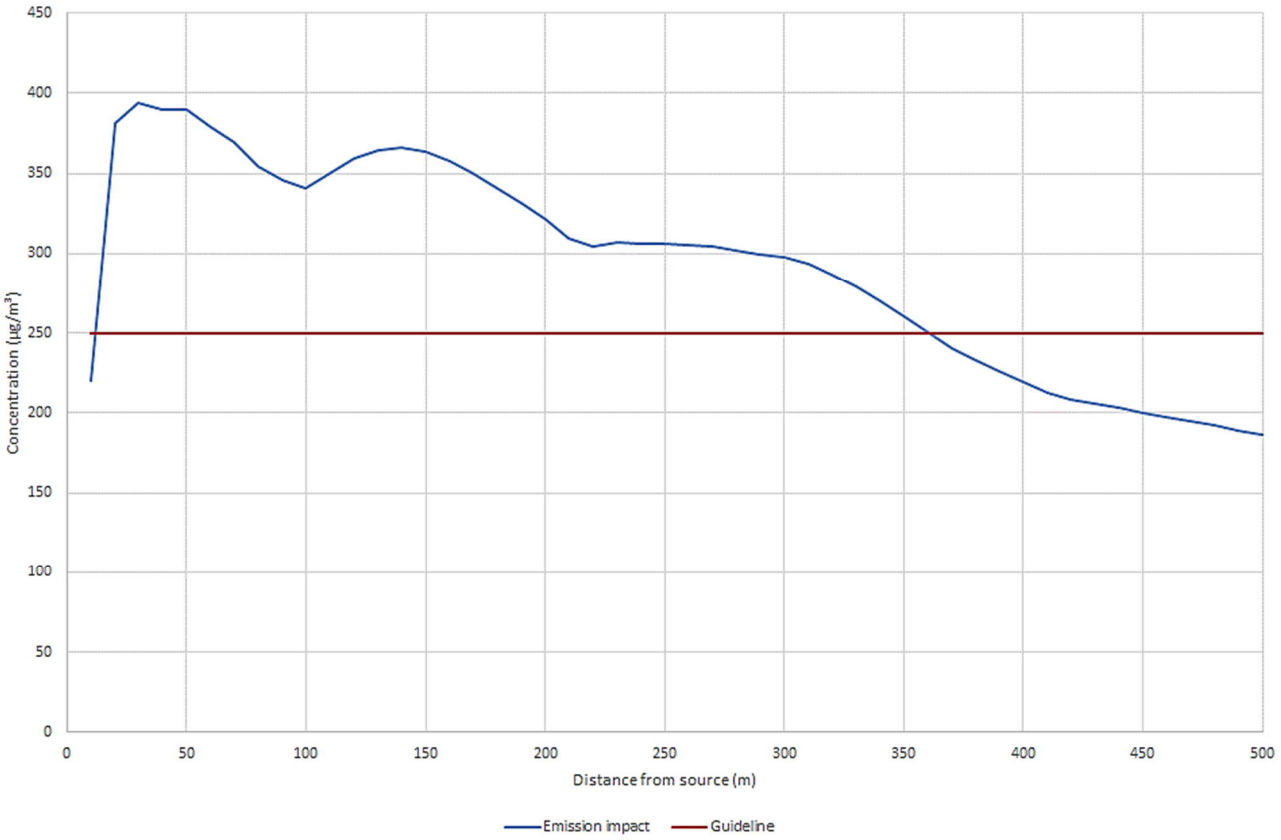


Figure 60 Maximum Predicted Downwind 1 hour Average NO_2 Concentrations – Dewatering generators

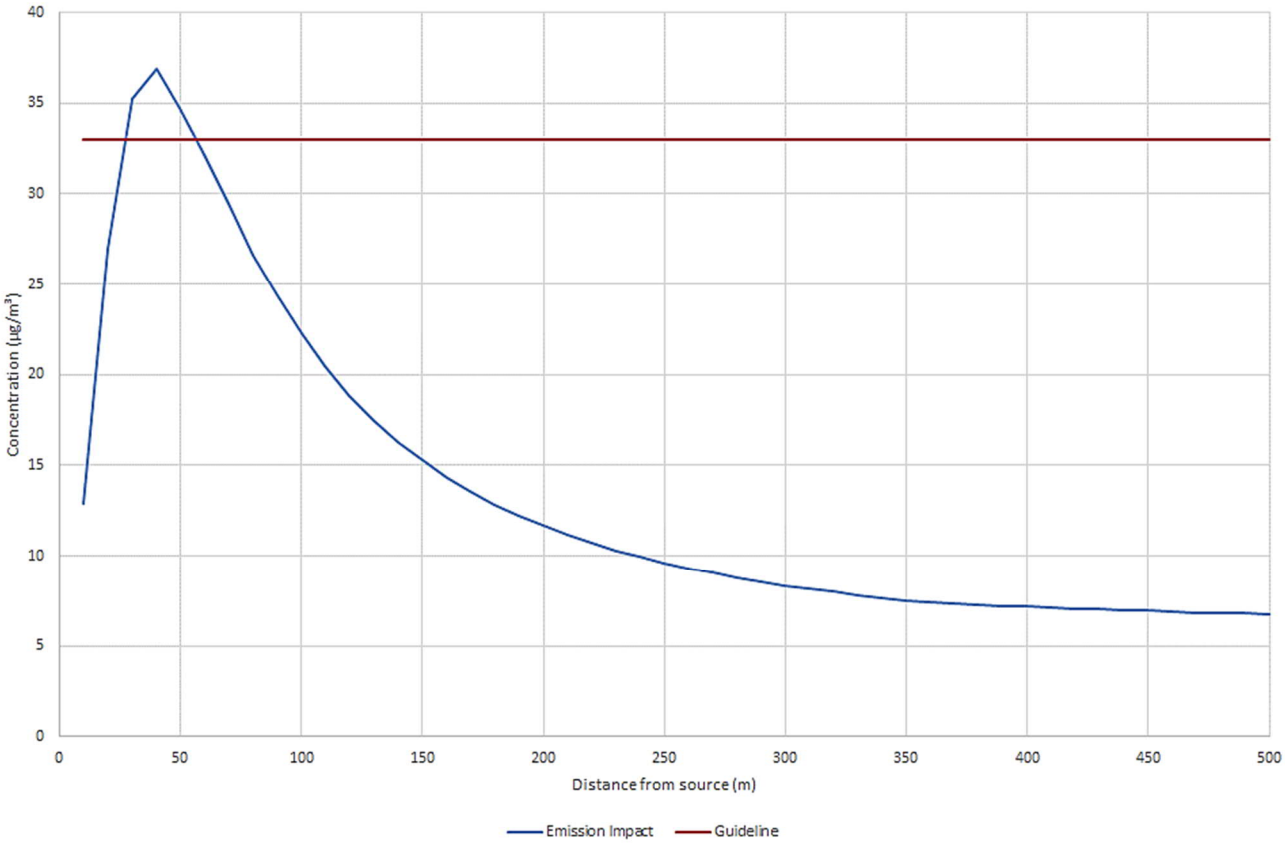


Figure 61 Maximum Predicted Downwind Annual Average NO_2 Concentrations – Dewatering Pumps

8.5 Mitigation and Monitoring

8.5.1 Mitigation Measures

Blue Energy is committed to applying a hierarchy of controls in order to minimise environmental impact. Equipment that results in environmental impact will be:

- Avoided
- Substituted out, or
- Have mitigations imposed to reduce the impact.

In order to determine what equipment should be installed for the project (and therefore what equipment should be avoided), equipment selection will consider as part of the assessment process:

- Low emissions to air
- High energy efficiency and fuel efficiency
- Low generation of waste
- Low greenhouse gas emissions
- Avoidance of ozone depleting substances

- Avoidance of particularly hazardous chemicals
- Low emissions of pollutants to water, and
- Low water use.

Modelling of emissions from drill rigs and dewatering pumps that would operate as part of the Project, as presented in this report, indicates that to ensure NO_2 emissions meet guideline concentrations, they should be located more than 200 m from sensitive receptors.

Replacing the dewatering engines with electrical (solar/battery) powered engines would reduce the impact of the Project even further.

Further details on the proposed mitigation measures relating to air emissions are provided in Table 61.

Table 61 Mitigation Commitments

Project Phase	Mitigation Measures
Construction: - production wells - gathering lines - production facilities - pipelines	• Reassessment of facility air emission impacts as part of detailed design, utilising selected sites and equipment. The assessment should be completed utilising 3D modelling. • Minimise land cleared for construction purposes (e.g. production well leases and equipment lay-down areas). • The period of time surfaces are left bare will be minimised. • Minimise the number and size of stockpiles, and water or cover as necessary. • Progressively rehabilitate disturbed areas through revegetation or mulching. • Undertake dust suppression during clearing and construction activities, especially in high wind conditions. Roads, access tracks and other areas may be watered to suppress dust. Vehicle travelling speeds will be restricted, and movements will be limited to approved access tracks. • Dust generating activities in proximity to sensitive locations will be timed, when possible, to prevent dust nuisance at the receptor. Works upwind of receptors will be ceased, if dust cannot be controlled through standard mitigation options, during windy weather conditions. • Selection of gaskets, seals and vehicle exhaust systems that are suitable for the task, and maintained according to manufacturer's recommendations. • Manufacturer's recommendations and guidelines with respect to air emissions are followed at all times. • Air pollution control technologies are to be maintained in good working order and kept in place at all times the equipment is operating. • Air emissions will be monitored at the source in accordance with Environmental Authority conditions. • Odours will be managed so that they do not cause environmental nuisance or harm to sensitive receptors.

Project Phase	Mitigation Measures
Operational Phase	• Implement a preventative maintenance program to ensure engines are operating efficiently to minimise NO_X, CO, methane and VOC emissions. • Implement a quantifiable monitoring and measuring program. • Roads, access tracks and other areas may be watered to suppress dust. Vehicle travelling speeds will be restricted, and movements will be limited to approved access tracks. • Selection of gaskets, seals and vehicle exhaust systems that are suitable for the task, and maintained according to manufacturer's recommendations. • Manufacturer's recommendations and guidelines with respect to air emissions are followed at all times. • Air pollution control technologies are to be maintained in good working order and kept in place at all times the equipment is operating. • Air emissions will be monitored at the source in accordance with Environmental Authority conditions. • Odours will be managed so that they do not cause environmental nuisance or harm to sensitive receptors. • Equipment that produces abnormal monitoring results will trigger maintenance /review procedures in order to return emissions to acceptable levels. Where practical, the equipment should not be brought back into service until normal operational emissions are achieved.
Decommissioning Phase	• Minimise the number and size of stockpiles. • Rehabilitate disturbed areas to the maximum extent possible through revegetation or mulching. • Undertake dust suppression during decommissioning and earthworks activities, especially in high wind conditions. Roads, access tracks and other areas may be watered to suppress dust. Vehicle travelling speeds will be restricted, and movements will be limited to approved access tracks. • Dust generating activities in proximity to sensitive locations will be timed, when possible, to prevent dust nuisance at the receptor. Works upwind of receptors will be ceased, if dust cannot be controlled through standard mitigation options, during windy weather conditions. • Odours will be managed so that they do not cause environmental nuisance or harm to sensitive receptors.
Vehicles and machinery	• Ensure all vehicles and machinery are fitted with appropriate emission control equipment, maintained frequently and serviced to the manufacturer's specifications. • Smoke from internal combustion engines should not be visible for more than ten seconds.

8.6 Conclusions

An air quality impact assessment, including a detailed air dispersion modelling study, has been performed to assess potential air quality impacts from the proposed Project. Dispersion modelling was performed for air emissions from drill rigs and dewatering pump engines to confirm the required separation distances between well heads and sensitive receptors.

Based on the modelling results, the following conclusions have been drawn for the proposed Project:

- Modelling of estimated emissions of NO_X from drill rigs showed that the maximum incremental NO_2 concentrations are predicted to be below the 1-hour average ground level NO_2 criterion of 250 µg/m^3 at all distances downwind, and reduce close to background levels within approximately 300 m downwind of the source. Drill rigs only operate for limited time periods at each well location, and not always at maximum load. The large majority of wells are also located much greater than 300 m from a sensitive receptor. In addition, noise impacts from drilling activities constrains how close drill rigs can operate to sensitive receptors, with unacceptable noise impacts typically predicted for sensitive receptors located less than 350 m from a well site. Given this, and consistent with DES's guidance notes for assessment of drill rigs, these results do not indicate a significant risk for adverse air quality impacts.
- Modelling of estimated emissions of NO_X from the wellhead engines that provide power to dewatering pumps showed that the maximum incremental NO_2 concentrations are predicted to be below the 1-hour average ground level NO_2 criterion of 250 µg/m^3 within approximately 400 m downwind of the source. Given that the large majority of probable well locations are located much greater than 300 m from a sensitive receptor and most receptors are located greater than 300 m from the Project the modelling results for NO_2 do not indicate a significant risk for adverse impacts.
- A risk-based assessment of potential heath and nuisance impacts from fugitive dust emissions associated with construction of the infrastructure sites proposed as part of the Project, concluded that there is a negligible risk of any adverse impacts due to the large separation distances between these sites and nearby sensitive receptors.

Based on the above, no air quality constraints have been identified for the Project as a result of this air quality impact assessment. Mitigation and monitoring measures are presented in this report to minimise emissions to air and assist in the management of air quality impacts associated with the Project.

8.7 Streamlined Model Conditions

The proposed activities are compliant with the Streamlined Model Conditions, a full detailed assessment has been provided in Appendix A.

9 Waste

9.1 Environmental Values

There are no prescribed environmental values relating to waste management. Nevertheless, in general, environmental values that can be impacted by waste from the proposed activities are associated with these matters:

- Human health and wellbeing
- Air quality
- Land quality and land use
- Surface and groundwater quality
- Visual amenity, and
- Biodiversity and ecological processes.

Under *Schedule 5, Part 3, Table 1* of the *EP Regulation*, the environmental objectives for activities with waste impacts are:

Environmental Objective

Any waste generated, transported, or received as part of carrying out the activity is managed in a way that protects all environmental values.

Performance Outcome

a. Waste generated, transported or received is managed in accordance with the waste and resource management hierarchy in the *Waste Reduction and Recycling Act 2011*; and

b. If waste is disposed of, it is disposed of in a way that prevents or minimises adverse effects on environmental values.

In Queensland, the key pieces of legislation relating to waste management are the *EP Act*, *EP Reg*, *WRR Act* and *WRR Reg*. The purpose of the *WRR Act* is to promote waste avoidance and reduction and to encourage resource recovery and efficiency. The achievement of the objectives of the *WRR Act* are guided by:

- the waste and resource management hierarchy; and
- the waste and resource management principles, which are:
  - The polluter pays principle (all costs associated with the management of waste should be borne by the persons who generated the waste)
  - The user pays principle (all costs associated with the use of a resource should be included in the prices of the goods and services that result from the use)
  - The proximity principle (waste and recovered resources should be managed as close to the source of generation as possible), and
  - The product stewardship principle (there is a shared responsibility between all persons who are involved in the life cycle of a product for managing the environmental, social and economic impact of the product).

The waste management hierarchy from most desirable to least is:

1. AVOID unnecessary resource consumption
2. REDUCE waste generation and disposal
3. RE-USE waste resources without further manufacturing
4. RECYCLE waste resource to make the same or different products
5. RECOVER waste resources, including the recovery of energy
6. TREAT waste before disposal, including reducing the hazardous nature of waste
7. DISPOSE of waste only if there is no viable alternative.

9.2 Emissions and Releases

There are four general areas that CSG activities can be categorised into:

- CSG extraction process (the process of drilling and completing wells)
- Raw CSG water (as a waste)
- Treated CSG water (as a waste), and
- CSG operational activities (all other activities associated with the CSG project including construction).

9.2.1 CSG Extraction Activities

The CSG extraction process creates wastes such as drilling fluids and cuttings. The proper disposal of these wastes is required to prevent contamination of lands and waters, and increased sedimentation of waters.

9.2.2 Raw CSG Water

Raw CSG water is expected to be of a high salinity and may contain other contaminants from drilling fluid or possibly hydrocarbons from the coal layers of the aquifer. This water would pose a potential risk to EVs through potential contamination of unconfined groundwater aquifers such as the Tertiary and Quaternary Sediments, springs, surface water ecosystems and GDEs.

Beneficial reuse of produced water is proposed with adjacent mining activities. No raw CSG water is planned for release to the environment.

9.2.3 CSG Operational Activities

Wastes that are expected to be generated through CSG operational activities at the Project (including construction of infrastructure other than wells) can be characterised as general waste, recyclable waste, or regulated waste.

9.2.3.1 General Waste

Waste that is not defined as regulated waste under legislation and can include putrescible wastes (easily decomposed) and non-putrescible wastes (not easily decomposed).

9.2.3.2 Recyclable Waste

Waste that is not defined as regulated waste under legislation and is able to be reconditioned, reprocessed or reused.

9.2.3.3 Regulated Waste

Waste that is regulated under legislation and requires specific controls and action. Listed, hazardous, regulated, controlled, and trackable wastes typically have specific handling and disposal requirements in order to manage their associated hazards.

Wastes that are expected to (or could) be generated are presented in Table 62 below. Confirmation of these wastes as well as volumes will become known as investigations and development progresses once the PL is issued.

Table 62 Expected waste streams from the Project

Waste Type	Description	Activity	Volumes	Management measures
General Waste				
Green waste	Whole or parts of trees, bushes, grass or similar	Construction and/or maintenance	Minimal	Where possible use in the rehabilitation activities otherwise dispose to landfill
Domestic waste	• Soft plastics and film • Food wastes • Contaminated recyclables • Food wrappers and containers • Polystyrene / coffee cups • Aluminium foil, waxed paper / cardboard • Non-recyclable plastics	All activities	Some	Dispose to landfill
Pipeline tape wrap	Tape used to wrap pipeline for protection	Construction and operational activities	Some	Disposal to landfill
Timber	Untreated timber derived from packaging and uses that cannot be reused or recycled.	All activities	Some	Recycled / reused where practical otherwise dispose to landfill.
Treatment filters and membranes	Cartridge filters generated from water treatment process	Water treatment	Minimal	Recycled / reused where practical otherwise dispose to landfill.
Wellhead separator waste	Separators at wellheads separate gas and water and remove other materials and fines	Production	Minimal	Recycled / reused where practical otherwise dispose to landfill.

Waste Type	Description	Activity	Volumes	Management measures
Recyclable Waste				
General Recycling	• Plastic bottles and clean food containers • Glass bottles, jars milk cartons • Aluminium cans & bottles • Metal lids • Paper cups • Cardboard and paper packaging • Paper (office paper, magazines, envelopes, food boxes)	All activities	Some	Recycled at local facility wherever feasible
Intermediate bulk containers	Containers used for transport of fluids and bulk materials	All activities	Some	Returned to supplier once no longer required
Plastic (HDPE)	Waste HDPE includes dam liner material, flowlines and drip tubes from irrigation activities	Construction and operation activities	Minimal	Reuse or recycle wherever practicable
Scrap Metals	Uncontaminated scrap metals and wiring. *No pressurised cylinders or drums with chemical or oily residue.	All activities	Some	Reuse, sell or return to supplier wherever practicable.
Regulated Waste				
Asbestos and synthetic mineral fibre insulation (SMF)	Asbestos and asbestos containing material can be found in items such as lagging, insulation, gaskets and brake pads. SMF may be rock or glass wool used for insulation	All activities	Minimal	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility.
Batteries	Lead, gel, nickel-cadmium and alkaline type batteries generated from equipment, vehicles, generators and electronics	All activities	Minimal	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility.
Chemical waste and chemical containers	Chemical wastes may include herbicides, pesticides, water treatment chemicals (biocides), paints, solvents. Regulated chemical containers are those containing any volume of free chemical that is regulated. These may include waste oil containers and aerosol cans containing solvent or paint.	All activities	Some	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility.

Waste Type	Description	Activity	Volumes	Management measures
Contaminated soil	Contaminated soils are generated where local spills of hydrocarbons and other contaminants may occur.	All activities	Minimal	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility.
Kitchen waste	Waste cooking oil and grease trap from kitchen camps.	Incidental activities	Minimal	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility
Drilling muds and cuttings	Waste drilling muds are generated from the drilling process.	Drilling activities	Some	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility
Salt or brine	Salt or brine is generated because of treating produced water using RO technology	Operational and water treatment activities.	Minimal	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility
Medical and clinical waste	Sharps and biohazard wastes are generated at camps during routine medical care and treatment	Incidental activities	Minimal	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility

Waste Type	Description	Activity	Volumes	Management measures
Oily filters, rags, absorbents	Oily filters, rags and absorbents are generated from routine equipment sand vehicle servicing, repair and filter changes	All activities	Some	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility
Tyres	Tyres and tubes are generated from tyre change on work vehicles and equipment	All activities	Negligible	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility
Used spill kits	Used spill kits are generated from spill clean-up of chemicals and hydrocarbons.	All activities	Minimal	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility
Waste oil	Small quantities of waste oil are generated routinely from vehicle and equipment oil changes	All activities	Minimal	Transported by appropriately licensed transporter to an appropriately licensed disposal/ recycling facility

9.3 Potential Impacts and Management Practices

Potential impacts to the identified environmental values may result from excessive waste generation from the inefficient use of resources, or from the improper management or storage of wastes generated during the activities carried out. Improper management or storage of waste can result in land contamination and groundwater and surface water pollution.

Waste will be managed in accordance with the waste management hierarchy as required by the *WRR Act*, to avoid or minimise the potential for:

- release of waste to land or waters either through inappropriate waste disposal or accidental release
- inadequate waste management leading to inappropriate disposal or inadequate re-use and recycling, and/or
- impacts to the environment, land use or well-being of people resulting from inappropriate waste disposal.

9.3.1 Raw CSG Water

Raw CSG water is expected to be of a high salinity and may contain other contaminants from drilling fluid or possibly hydrocarbons from the coal layers of the aquifer. This water would pose a potential risk to EVs through potential contamination of unconfined groundwater aquifers such as the Tertiary and Quaternary Sediments, springs, surface water ecosystems and GDEs.

All raw CSG water will be stored in above ground tanks to prevent seepage (no dams will be utilised) and initially piped to a nominated centralised location on each PL for treatment and further storage in above ground tanks, or transported directly to an end user at adjacent coal mine/s. Once the capacity of each PL's water treatment facilities are reached, water will either be removed from site and/or new facilities will be constructed in nearby proximity to these water treatment sites.

9.3.2 Treated CSG Water

In addition to meeting the requirements of *s.126* of the *EP Act* and *Chapter 3* of the *Water Act 2000*, *s.28* of the *EP Reg* requires that CSG activities addresses the requirements of the *Coal Seam Gas Water Management Policy 2012* and the prioritisation hierarchy for managing and using CSG water and the prioritisation hierarchy for managing saline waste.

The prioritisation hierarchy for CSG water management options in the *CSG Water Management Policy* are:

Priority 1 – beneficial use for one or more of the following: the environment, existing water users, and existing or new water-dependent industries. Beneficial use of CSG water may include:

- coal washing and dust suppression

CSG water is proposed to be managed for beneficial use priority 1 at adjacent coal mine for reuse.

9.3.3 Other Waste

No other significant waste streams have been identified for this Project.

9.4 Streamlined Model Conditions

The proposed activities are compliant with the Streamlined Model Conditions, a full detailed assessment has been provided in Appendix A.

10 Stimulation Activities

As outlined in Section 2, Blue Energy propose to develop the Project area with a series of lateral down-dip and vertical wells. Wells will utilise a pump for extraction of produced water and gas from the coal seams. However, it should be noted that stimulation activities e.g. hydraulic fracking will not be occurring in any capacity as a part of this Project. Therefore, stimulation activities should not be assessed as a part of this application.

11 Rehabilitation

Rehabilitation activities undertaken for the Project will reinstate any areas which have been disturbed as part of the construction or operational activities, to their previous landforms. Blue Energy will comply with the standard conditions as they apply to site rehabilitation and those requirements under the EP Act.

The following measures will be incorporated into rehabilitation activities for the Project:

- Maximise the use of previously disturbed areas and avoid areas of environmental sensitivity wherever possible
- Minimise clearing of vegetation where feasible
- Maintain the required buffer distances between petroleum activities and environmentally sensitive areas
- Prompt rehabilitation of unavoidable disturbances to environmental values, and
- Ongoing monitoring and maintenance of rehabilitated areas.

The purpose of the rehabilitation activities will be to ensure the sites are stable, safe and non-polluting. Rehabilitation will be undertaken with the consultation of landowners, and in accordance with the agreed land use.

11.1 Overview of Activities

The activities that will be undertaken for the Project are detailed in Section 2. In summary, key activities will include:

- Acquiring 2D and 3D Seismic prior to the drilling of lateral wells
- placement of infield gathering lines
- Drilling of lateral and vertical wells. The proposal will involve the construction of up to 530 well pads across the Project area, and
- Progressive rehabilitation of reticulation pipelines and drill pad areas.

11.2 Rehabilitation Commitments

Rehabilitation at the Project will be undertaken in accordance with a Decommissioning and Rehabilitation Management Plan which will be prepared prior disturbance being carried out. Specific rehabilitation indicators and success criteria include:

- Wells abandoned according to the Petroleum and Gas (Production and Safety) Act 2004 (PG Act), and best practice
- Stability of rehabilitated areas
- Indicators for erosion and sediment control
- Vegetation cover and diversity
- Absence of pest and weed species
- Downstream water quality, and

- Land returned to the pre-disturbance land use as stated under the rehabilitation hierarchy. Inside the Project area this is mainly agricultural grazing land.

Control strategies for rehabilitation include:

- Detailed planning prior to disturbance, such as topsoil stockpile locations
- Implementation of practical landform designs, to prevent erosion and establish final landform stability
- Identification of appropriated post-mine land use consistent with the location environmental constraints and values
- Progressive rehabilitation of disturbed areas, using appropriate rehabilitation procedures for the areas having been disturbed
- Implementation of best practice erosion control measures
- Regular monitoring and visual inspection of rehabilitated areas will be undertaken to ensure the site meets minimum rehabilitation goals, and
- A corrective action program will be implemented to identify and address failed areas of rehabilitation.

11.3 Rehabilitation Activities

Rehabilitation will be undertaken progressively and include the following activities:

- Consultation with landholders to ensure appropriate rehabilitation objectives are developed
- Decommissioning of infrastructure including well sites and pipelines
- Rehabilitation of seismic lines, access tracks and infrastructure areas, and
- Monitoring of rehabilitation areas.

Where infrastructure is to be left for the landholder, a written agreement with each applicable landowner and submitted alongside the Final Rehabilitation Report.

11.3.1 Decommissioning Infrastructure

Following the completion of CSG activities, all wells, pipelines, equipment, structures and buildings not required by the landowner following the cessation of CSG activities will be decommissioned. A contaminated site assessment will be conducted and will form part of the Final Rehabilitation Report and any necessary remedial action taken.

Decommissioning of infrastructure used in the production of CSG will be undertaken in accordance with the relevant provisions of the PG Act and the *Petroleum and Gas (Safety) Regulation 2018 (44)* (PG Reg).

Well Pads

At the completion of well construction, the disturbance footprint is reduced once operational. The following will be undertaken:

- Any drill muds or associated waste materials will be either removed from site and appropriately disposed or buried on site following appropriate testing and agreement with the landowner.

- Compacted areas around the lease pad no longer required will be ripped, topsoiled and seeded to promote revegetation. The vegetation will be suitable for the final land use
- Installation of appropriate erosion and sediment control structures will be undertaken
- Contouring of the surface prior to topsoiling and seeding
- Topsoils which have been stockpiled during well pad construction will be re-spread evenly over the disturbed area. Sub-soils, especially where dispersive, will not be left exposed and topsoil is to be roughly applied on top of them to minimise erosion. Topsoil should be sourced from the closest stockpile to minimise handling and vehicle movements, and
- Seeding will be undertaken to promote vegetative cover. The area will be regularly inspected, with maintenance and re-seeding undertaken in consultation with the landowner if required.

Upon decommissioning, well sites will be plugged and abandoned in accordance with the PG Act, PG Reg and the *Code of Practice for constructing and abandoning coal seam gas wells and associated bores in Queensland.* Wells will be plugged with cement as the primary sealant in a manner that prevents any water or gas leakage. Prior to surface abandonment, the absence of pressure/flow internally within the well and externally behind all casing strings will be confirmed. Wells will then be cut off approximately 1.5 m below the ground surface and capped with a steel marker plate.

Gas and Water Gathering Pipelines

Decommissioning of pipelines will occur in accordance with the requirements of *AS2885.3 – Gas and liquid petroleum operation and maintenance*. The *Australian Pipeline Industry Association's Code of Environmental Practice for Onshore Pipelines* will also be used as a guide for the decommissioning process.

Decommissioning will include:

- Above ground pipelines will be removed or cut at ground level
- Where pipelines are buried, decommissioning will be via abandonment in-situ to avoid any disturbance of revegetation, and
- Prior to abandonment, all pipelines will be disconnected and purged. Water used in purging will disposed of via one of the following options:
  - directly reused where appropriate for petroleum and/or mining activities
  - treated so that it meets water quality criteria for the intended reuse, or
  - disposed of via evaporation.

Dams

No dams will be built in the Project area.

Compressor Stations and Other Infrastructure

No compressor stations will be built in the Project area and therefore they will not be assessed in this application. Other infrastructure will be dismantled and removed from site. Where possible, infrastructure components will be recycled. All waste materials will also be removed from site by a licenced contractor.

11.4 Rehabilitation Strategies

11.4.1 Seismic Lines

Full rehabilitation of the seismic lines is planned to occur after the activities have taken place. Rehabilitation activities will include re-contouring, topsoiling, seeding and establishing ground cover.

11.4.2 Access Tracks

Where access tracks are to be left for the landholder, a written agreement will be submitted alongside the Final Rehabilitation Report. Access tracks which are not required by the landowner will undergo full rehabilitation. This will include the following activities:

- Ripping to correct soil compaction where necessary and replacement of topsoil, and
- Revegetation consistent with the final land use objectives.

11.4.3 Well Sites and Infrastructure Areas

Well sites and infrastructure areas will be decommissioned as outlined above. Once the decommissioning process is complete, general rehabilitation strategies will include:

- Remediation of any contaminated land
- Backfilling of any excavations resulting from decommissioning
- Grading of sites to original contours, where practicable
- Erosion and sediment control works, and
- Revegetation consistent with the final land use objectives.

A detailed Rehabilitation Plan will be developed which will further outline decommissioning and rehabilitation strategies for each of the infrastructure areas listed in the above sections prior to commencement of site activities.

11.5 Final Land Use Objectives

The final land use objectives for the affected areas will include returning land to its previous use where possible. At a minimum, rehabilitated areas must meet the following goals:

- The site must be made safe for humans and animals
- The site must be non-polluting, with appropriate erosion and sediment control measures
- The site must be stable, and
- The site must be self-sustaining.

Further details regarding land use objectives will be contained are within a site Rehabilitation Plan.

11.6 Monitoring

A Rehabilitation Monitoring Program will be established and maintained to review the progress and success of all rehabilitation activities throughout the life of the project. Regular inspections undertaken of rehabilitation areas will be assessed against the rehabilitation indicators and success criteria outlined above.

The Rehabilitation Monitoring Program will include a checklist to be used by qualified personnel to track the success of final rehabilitation. The checklist will monitor the success of the rehabilitation and identify any areas which require any remedial actions. Photographic records will also be taken to accompany each inspection to assist in monitoring progress. After each site inspection, information collated will be compared with previous inspections to determine the rehabilitation performance.

Should monitoring identify areas of erosion or pest species, appropriate management strategies will be implemented.

11.7 Corrective Action

In the event that the Rehabilitation Monitoring Program identified that the rehabilitation commitments are not being achieved and/or the rehabilitation strategies are not effective, actions will be taken to rectify the issue. Examples of corrective actions may include (but not limited to) re-seeding or planting of tube stock, erosion and sediment control, vegetation management to promote colonisation. Any corrective actions will be documented.

11.8 Streamlined Model Conditions

To streamline Blue Energy's rehabilitation documents, an overarching Rehabilitation plan will be developed to provide for the streamlined model conditions. The plan/s will be completed as part of Blue Energy's review of its environmental management documents prior to the commencement of site works.

The plan will include monitoring requirements to test progress and compliance against the Streamlined Model Conditions as outlined in Appendix A.

12 Risk Assessment

A risk assessment was undertaken for the Project. This assessment concentrated on key environmental risks and considered the following:

- Identification of the key risks and a determination of the likelihood of this occurring at any time throughout the construction, operation and post operational project phases
- Consideration of the potential consequences if the event was to happen
- Identification of proposed measures targeted at mitigating the risks, and
- Consideration of any residual risk and identification as to whether further mitigation measures were required.

Provided in Table 63 and Table 64 is a summary of both risk level and likelihood descriptors adopted to assign the various risk rankings for the risk assessment matrix. The risk assessment matrix adopted for the Project's risk assessment is provided in Table 65.

The risk assessment, encompassing all key environmental risks associated with the Project, is presented in Table 66.

Table 63 Risk Level Descriptors

Level	Descriptor	Examples
5	Catastrophic	Long term environmental damage Permanent irreparable damage to the environment Sustained detrimental state and community outrage
4	Major	Significant environmental damage – potentially permanent Release of pollution off site. Significant loss of environmental sources Organised community concern
3	Moderate	Violation of regulation or guideline with moderate damage to the environment and significant clean-up costs Release of pollution off site Community concerns and complaints
2	Minor	Minor violation of regulation or guideline with minimal damage to the environment and small clean up. Immediately contained on site Local government action, minor community complaints
1	Insignificant	Short term disturbance with minor environmental release or damage that is not reportable No impact outside site boundary No community complaints

Table 64 Likelihood Descriptors

Level	Descriptor	Examples
5	Almost Certain	This event is likely to occur in most circumstances
4	Likely	This event will probably occur in most circumstances (at least once every six months)
3	Possible	This event is likely to occur at some time (about once every year)
2	Unlikely	This event may occur at some time (about once in every 5 years)
1	Rare	This event has never been known to occur or is extremely unlikely this could ever occur.

Table 65 Risk Assessment Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Medium (5)	Medium (10)	High (15)	Very High (20)	Very High (25)
Likely	Low (4)	Medium (8)	High (12)	Very High (16)	Very High (20)
Possible	Low (3)	Medium (6)	Medium (9)	High (12)	High (15)
Unlikely	Low (2)	Low (4)	Medium (6)	Medium (8)	High (10)
Rare	Low (1)	Low (2)	Low (3)	Medium (4)	Medium (5)

Table 66 Risk Assessment for the Project

Environmental Value	Likelihood	Consequence	Unmitigated Risk Rating	Impact minimisation, mitigation or avoidance	Likelihood	Consequence	Residual Risk Rating
Noise							
Temporary noise and vibration disturbance to sensitive receivers during drilling and constructionof well surface locations and gathering lines	3	3	9	Construction will be limited to 6.30am to 6.30 pmMonday to Saturday, excluding public holidays. Activities which are not audible or within relevantnoise levels may be undertaken outside of these hours. Noise attenuation devices where required will be fitted.	2	3	6
Noise disturbance to sensitive receivers surrounding areas during well production.	3	2	6	Provide respite periods. Direct noisy equipmentaway from sensitive receptors. Shut down operational equipment when not required. Implement regular maintenance program.	2	2	4
Noise disturbance to native fauna	2	2	4	Noisy work to be undertaken 6.30am to 6.30 pm Monday to Saturday. Infrastructure to be located away from areas of native habitat where possible.	1	2	2
Increase noise associated with additional trafficduring construction	2	2	4	Construction will be limited to 6.30am to 6.30 pmMonday to Saturday, excluding public holidays.	1	2	2
Noise nuisance and disturbance during rehabilitation	3	2	6	Rehabilitation will be undertaken during daylighthours. Machinery used will be well maintained. Landowners will be notified.	2	2	4
Ecology							
Loss and/or fragmentation of native vegetationresulting from clearing for wells and gathering pipelines.	3	4	12	Project design has minimised impacts to vegetation communities. Clearing restricted toonly what is essential for CSG activities.	2	3	6
Significant impact to Matters of State Environmental Significance (MSES).	3	4	12	Ecological surveys will be underaken to verify areas of MSES. Design infrastructure to avoid anyareas that would impact upon MSES.	2	3	6
Spread of weeds to agricultural areas	3	3	9	On the ground surveys to identify the location anddensity of listed weed species. Initiate a weed management plan prior to construction and clearing activities. Initiate a rehabilitation plan to ensure local native species dominate all impacted areas.	2	3	6
Increase in feral animals due to land disturbanceand waste production	2	3	6	The siting of stockpiles areas, spill dumps, refuseareas and vehicle parking areas where possible will be within areas already cleared or proposedto be cleared to minimise feral animal occurrences. Feral animal control programs will be conducted as required.	2	2	4
Night time activities affecting behaviour of nocturnal and diurnal fauna	2	2	4	Night time works will be limited and will be temporary in nature.	1	2	2
Injury to native fauna	3	4	12	On the ground surveys will commence prior to any clearing activities to avoid remnant vegetation and essential habitat which will reduce the likelihood of impacting native fauna. A fauna spotter/catcher will be used if any remnant vegetation is to be cleared.	2	3	6

Groundwater							
Groundwater drawdown negatively impacts on groundwater quality	2	4	8	Results of groundwater modelling indicate there will be minimal impact to the aquifer.	2	2	4
Groundwater drawdown impacts to GDEs located within the study area	2	4	8	GDEs in this area exist in the shallow alluvium. Movements of any contaminants from the target seam into shallow alluvium is considered unlikely.	1	2	2
Groundwater water drawdown impacts on Tertiary or Quaternary aquifers. Impacts to groundwater users abstracting water for stock use or domestic use.	2	4	8	Groundwater monitoring program will be implemented for the Project.	2	2	4
Groundwater water drawdown impacts on Tertiary or Quaternary aquifers. Impacts to groundwater users abstracting water for irrigation.	2	3	6	Groundwater monitoring program will be implemented for the Project.	2	2	4
Groundwater abstraction has a negative impact on GDE such as creeks. Impacts to recreational activities such as fishing.	2	4	8	Groundwater monitoring program will be implemented for the Project.	2	2	4
Gas wells causing fugitive gas migration into groundwater	2	3	6	All CSG wells will be constructed in accordance with Queensland Code of Practice for the construction and abandonment of coal seam gas and petroleum wells and associated bores in Queensland .	2	2	4
Contamination of groundwater due to hydrocarbon or chemical spills.	3	3	9	All fuels and chemicals will be stored appropriately in accordance with AS1940:2004 - The storage and handling of flammable and combustible liquids . Transfer of fuels only in bunded areas. Water quality testing of any bund sump waters prior to discharge.	2	2	4
Surface Water and Wastewater							
Ecological impacts due to inappropriate disposal of raw CSG to drainage lines and surface waters.	3	3	9	There is no disposal of CSG water to local streams.	2	2	4
Ecological impacts in aquatic ecosystems due to accidental release of contaminants or sediments.	3	3	9	There is no planned disposal of CSG water to local streams.	2	2	4
Abstraction of surface water resulting in reduce supply for stock water	2	1	2	There is no planned extraction of surface water.	1	2	2
Impact to riparian vegetation due to CSG activities and impacts to visual amenity	2	2	4	All production facilities will be located >200m from a wetland and >100 m from the high bank of a watercourse. Construction of linear infrastructure through a waterway or wetland when no other practicable option is available will be either undertaken under no flow; or conducted in times of flow so as to not impact water flow.	1	2	2
Negative impacts on surface waters used for human consumption	2	2	4	All produced water will be sent to an appropriate area on the relevant PL for processing. Dirty stormwater catchments are paved and bunded. Diversion drains will be installed to direct run off from operational areas. They will be routinely monitored and maintained.	2	2	4

Air Quality							
Impacts on local air quality due to dust emissions associated with construction activities	3	2	6	Appropriate siting of infrastructure relative to sensitive receptors, minimising disturbed areas, water spray or water cart operation on unsealed roads and active areas during dry conditions.	2	1	2
Impacts on local air quality due to combustion- related emissions (e.g. CO and NOx) associated with construction activities	2	1	2	Ensure regular maintenance of vehicle/equipment, avoid idling for prolong period	1	1	1
Impacts on local air quality from well head pump emissions during operation	2	1	2	Appropriate siting of wellheads relative to sensitive receptors	1	1	1
Impacts on local air quality from fugitive dust and vehicle emissions during production and post-development activities	2	1	2	Appropriate siting of wellheads and access tracks relative to sensitive receptors	1	1	1
Odour nuisance due to emissions from drilling activities	2	1	2	Appropriate siting of wellheads relative to sensitive receptors	1	1	1
Waste							
Accidental release of hazardous waste to the environment	2	3	6	Avoiding and reducing the generation of waste as per the waste hierarchy and prescribed in the Waste Reduction and Recycling Act 2011 .	1	3	3
Increase in the demand of local waste storage facilities.	3	1	3	Avoiding and reducing the generation of waste where possible	2	1	2
Littering due to inappropriate disposal of general waste.	2	4	8	Appropriate waste storage facilities will be placed around the area. These will be serviced by a licensed waste contractor.	2	2	4
Land contamination due to inappropriate storage of hazardous wastes	2	4	8	Appropriate waste storage facilities will be placed around the area. These will be serviced by a licensed waste contractor who is qualified and experience is hazardous waste storage	2	2	4
Heritage							
Impacts to items of indigenous heritage not previously identified	2	3	6	Unexpected Finds Protocol developed and implemented. Blue Energy have a Cultural Heritage Investigation and Management Agreement with the Traditional Owners for the relevant PL and are working towards a new one for the Project. Cultural Heritage is assessed through the Blue Energy Permit to Disturb process. All disturbances are cleared by a TO scouting party.	2	2	4
Impacts to items of non indigenous heritage not previously identified	2	2	4	Unexpected Finds Protocol developed and implemented	1	1	1
Community							
Job creation during construction	3	3	9	Employment strategy developed to ensure on and off site infrastructure can cope with level of employment during construction	2	2	4
Job creation during operation	3	3	9	Employment strategy developed to ensure on and off site infrastructure can cope with level of employment during construction	2	2	4

Increase demand on community resources	2	2	4	Employment strategy developed to ensure community resources can cope with level of employment during both construction and operation	1	1	1
Increase demand on service supply such as water, electricity and gas	2	2	4	Consultation with service providers as required	1	1	1
Impact to housing supply due to increase in local employment	2	2	4	Employment strategy developed to ensure housing can cope with level of employment during construction and operation	1	1	1
Increase traffic on local roads	3	2	6	Employment strategy developed to ensure on and off site infrastructure can cope	2	1	2
Geology and Soils							
Erosion of exposed soils and release of sediment laden runoff into creeks and rivers	3	3	9	Prepare and implement ESCP, cover with mulch or hydro mulch cleared areas exposed to rainfall, rehabilitate finished areas immediately, maintain sheet flow across exposed areas, install flow controls to slow sheet flow, install filtration devices at discharge points (i.e. mulch berms), etc. Controls to be implemented as per the SMCs.	1	3	3
Loss of topsoil associated with construction activities.	3	3	9	Topsoil removed for infrastructure will be retained for rehabilitation. Blue Energy have a rehabilitation management plan which will ensure suitability of the landform farming post CSG activities.	2	2	4
Contamination of soils due to CSG activities	3	3	9	Store potential contaminants appropriately, use potential contaminants in accordance with manufacturers' specifications, store within a bunded area, train staff in handling procedures and incident notification.	1	4	4
Compaction of soils in access tracks and hard stand areas	3	2	6	Construct access tracks and hard stand areas with suitable materials to protect the natural soil profile beneath, where no longer required remove construction materials, strip topsoil to specified depth, rip subsoil and ameliorate as appropriate for the soil unit's physical and chemical properties, reinstate topsoil and ameliorates as appropriate for the soil unit's physical and chemical properties, revegetate with appropriate species, achieve >80% ground cover within 2 years	1	2	2

13 References

https://eisdocs.dsdip.qld.gov.au/Santos%20GLNG%20Gas%20Field%20Development/EIS/Main%20Report/chapter-03-natural-gas-from-coal-seams.pdf

AGE. (2020). *Isaac Downs Groundwater Impact Assessment*. Report prepared for Stanmore IP South Pty Ltd.

ANZECC. (2018). *Water Quality Guidelines*.

Application Requirements for Activities with Impacts to Water ESR/2015/1837. Department of Environment and Science.

Arrow Energy. (2013). *Arrow Bowen Gas Project Environmental Impact Statement*. Retrieved from https://www.arrowenergy.com.au/environment/project-assessment-eis/bowen-gas-project-eis

Atlas of Living Australia. (2021). Available at http://www.ala.org.au.

Aumann, T. & Baker-Gabb. D. (1991). RAOU Report 75. *A management plan for the Red Goshawk*. RAOU. Melbourne: Royal Australasian Ornithologists Union.

Australian Pipelines Industry Association. (2017). *Code of Environmental Practice for Onshore Pipelines*.

Australian Standard AS 1055 – 1997, *Description and measurement of environmental noise*. Standards, Australian.

Australian Standard AS 2885.3 – 2012, *Gas and liquid petroleum operation and maintenance*. Standards, Australian.

Bean, A.R. (2010). *Kelita (Amaranthaceae),* a new genus from Queensland, Australia. *Muelleria.* 28(2), 105-109.

Bureau of Meteorology. (BOM). (2021). *Map of Climate Zones Australia*. Retrieved from http://www.bom.gov.au/climate/how/newproducts/images/zones.shtml.

Department of Agriculture, Water and the Environment. (DAWE) (2021b). *Species profile and threats database*. Department of the Environment and Energy, Canberra. Retrieved from http://www.environment.gov.au/sprat.

Department of Agriculture, Water and the Environment. (DAWE). (2021a). *EPBC Act protected matters report*.

Department of Environment and Science (EHP). (2014). *Queensland Environmental Offsets Policy—Significant Residual Impact Guideline*. State of Queensland, 2014.

Department of Environment and Science (DES). (2013). *Noise Measurement Manual*.

Department of Environment and Science (DES). (2018). *Monitoring and Sampling Manual.*

Department of Environment and Science. (DES). (2015). Wetland data - version 5 - wetland areas – Queensland. Retrieved from, http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=%22Wetland data - version 5 - wetland areas - Queensland%22.

Department of Environment and Science. (DES). (2020). *Flora survey guidelines—protected plants*. State of Queensland, 2021.

Department of Environment and Science. (DES). (2021a). *Queensland Government wildlife online*.

Department of Environment and Science. (DES). (2021b). *Map of referable wetlands*.

Department of Environment and Science. (DES). (2021c). *Environmentally sensitive areas map*. Department of Environment and Science, Brisbane. Retrieved from: http://www.ehp.qld.gov.au/licences-permits/maps_of_environmentally_sensitive_areas.php.

Department of Environment and Science. (DES). (2021d). *Species Profiles*. Available from: https://apps.des.qld.gov.au/species-search/.

Department of Natural Resources and Mines and Energy (DNRME). (2018). *Code of Practice For the construction and abandonment of coal seam gas and petroleum wells and associated bores in Queensland*.

Department of Resources. (DoR). (2021). *Groundwater Database – Queensland*. Retrieved from http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=%22Groundwater Database - Queensland%22.

Department of Resources. (DoR). (2021). *Vegetation management report*. The State of Queensland. Retrieved from: https://www.dnrm.qld.gov.au/qld/environment/land/vegetation/vegetation-map-request-form.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPC). (2013). *NPI Emission Estimation Technique Manual for Oil and Gas Extraction and Production*. Canberra: Department of Sustainability, Environment, Water, Population and Communities, 2013.

End of waste Framework - ESR/2016/3233. Department of Environment and Science.

Environment Protection Policy (Water and Wetland Biodiversity) 2019. Queensland Government.

Environmental Protection (Air) Policy 2019. Queensland Government.

Environmental Protection (EP) Act 1994. Queensland Government.

Environmental Protection (Noise) Policy 2019. Queensland Government.

Evans T, Pavey C, Cassel R, Ransley T, Sparrow A, Kellett J, Galinec V, Dehelean A, Bell J, Caruana L & Kilgour P. (2018). *Conceptual modelling for the Galilee subregion. Product 2.3 for the Galilee subregion from the Lake Eyre Basin Bioregional Assessment*. Department of the Environment and Energy, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. https://www.bioregionalassessments.gov.au/assessments/23-conceptual-modelling-galilee-subregion.

Eyre. T.J., Ferguson, D.J., Hourigan, C.L., Smith, G.C., Mathieson, M.T., Kelly, A.L., Venz, M.F. & Hogan, L.D. (2018). *Terrestrial vertebrate fauna survey assessment guidelines for Queensland.* Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government.

Geoscience Australia. (2021). *Australian Stratigraphic Unit Database*. Retrieved from https://asud.ga.gov.au/search-stratigraphic-units/.

Department of Environment and Science (DES). (2013). *Guideline: Application requirements for Petroleum activities (EMR 705).*

McGregor, D.C., Padovan, A., Georges, A., Krockenberger, A., Yoon, H. & Youngentob, K.N. (2020). Genetic evidence supports three previously described species of greater glider, *Petauroides volans*, *P. minor*, and *P. armillatus*. *Scientific Reports*. 10(19284).

Nature Conservation Act 1992. Queensland Government.

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S., Butler, D.W., McDonald, W.J.F, Addicott, E.P. and Appelman, C.N. (2020) *Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland*. Version 5.1. Updated March 2020. Queensland Herbarium, Queensland Department of Environment and Science, Brisbane.

OGIA. (2019). *Groundwater Modelling Report – Surat Cumulative Management Area.* OGIA, Brisbane. https://www.resources.qld.gov.au/__data/assets/pdf_file/0008/1460627/groundwater-modelling-report-surat-cma.pdf.

Petroleum and Gas (safety) Regulation 2018. Queensland Government.

Queensland Environmental Offsets Act 2014. Queensland Government.

Queensland Globe (QLD Globe). (2021). Available from: https://qldglobe.information.qld.gov.au/.

Queensland Government. (2016). *Guideline: Streamlined model conditions for petroleum activities. ESR/2016/1989.*

Queensland Government. (2017). Groundwater dependent ecosystems WetlandInfo. Retrieved 14, September, 2021 from, available at https://wetlandinfo.des.qld.gov.au/wetlands/ecology/aquatic-ecosystems-natural/groundwater-dependent/

Queensland Government. (2021). *Scientific Land Owners (SILO) database – Australian climate data from 1889 to yesterday*. Retrieved from https://www.longpaddock.qld.gov.au/silo/point-data/.

Queensland Herbarium. (2021). *Regional ecosystem description database*. Version 12 (March 2021). Brisbane: Queensland Department of Science, Information Technology, Innovation and the Arts.

Regional Planning Interests Act 2014. Queensland Government.

Simpson, S & Batley,G. (2016). *Sediment Quality Guidelines.*

Threatened Species Scientific Committee (TSSC). (2008). *Approved conservation advice for Rheodytes leukops (Fitzroy tortoise)*. Canberra: Department of the Environment (now Department of Agriculture, Water and Environment).

Threatened Species Scientific Committee (TSSC). (2012). *Listing advice for Phascolarctos cinereus (Koala)*. Canberra: Department of the Environment (now Department of Agriculture, Water and Environment).

Threatened Species Scientific Committee (TSSC). (2015a) *Conservation Advice Geophaps scripta scripta squatter pigeon (southern)*. Canberra: Department of the Environment.

Threatened Species Scientific Committee (TSSC). (2015b). *Approved Conservation Advice for Nyctophilus corbeni* (South-eastern Long-eared Bat). Canberra: Department of the Environment (now Department of Agriculture, Water and Environment).

Threatened Species Scientific Committee (TSSC). (2016a). *Conservation Advice Bertya opponens*. Canberra: Department of the Environment and Energy.

Threatened Species Scientific Committee (TSSC). (2016b). *Approved Conservation Advice for Macroderma gigas* (Ghost Bat). Canberra: Department of the Environment (now Department of Agriculture, Water and Environment).

Threatened Species Scientific Committee (TSSC). (2016c*). Approved Conservation Advice for Petauroides Volans (Greater Glider)*. Department of the Environment. Australian Government, Canberra.

Van Dyck, S., Gynther, I., & Baker, A. (2013). *Field companion to the mammals of Australia*. Sydney: New Holland Publishers.

Vanderduys, E. (2012). *Field guide to the frogs of Queensland*. Collingwood, Victoria: CSIRO Publishing.

Wilson, P. R. & Taylor, P. M. (2012). *Land zones of Queensland*. Brisbane: Queensland Herbarium, Queensland Department of Science, Information Technology, Innovation and the Arts.

Wilson, S. & Swan, G. (2017). *A Complete Field guide to the reptiles of Australia*. Sydney: New Holland Publishers.

APPENDIX A

Streamlined Model Conditions

Ref	Condition	Action program for compliance
GENERAL ENVIRONMENTAL PROTECTION		
AUTHORISED ACTIVITIES		
General 1		
General 2		
General 3		
General 4		
General 5		
General 6		
MONITORING STANDARDS		
General 7 PESCD 1	All monitoring must be undertaken by a suitably qualified person.	Blue Energy will ensure that all monitoring is undertaken by a suitably qualified person.
General 8	If requested by the administering authority in relation to investigating a complaint, monitoring must be commenced within 10 business days.	Monitoring will be commenced within 10 business days If requested by the administering authority.
General 9	All laboratory analyses and tests must be undertaken by a laboratory that has NATA accreditation for such analyses and tests.	Laboratory analyses and tests will be undertaken by a NATA accredited laboratory.
General 10	Notwithstanding condition (General 9), where there are no NATA accredited laboratories for a specific analyte or substance, then duplicate samples must be sent to at least two separate laboratories for independent testing or evaluation.	It is anticipated that this will not be required, however, if no NATA accredited laboratory is available, duplicate samples will be sent to two separate laboratories for independent analysis.
General 11	Monitoring and sampling must be carried out in accordance with the requirements of the following documents (as relevant to the sampling being undertaken), as amended from time to time:	Monitoring/sampling will be carried out in accordance with the requirements of the relevant documents outlined in General 11.

Ref	Condition	Action program for compliance
	(a) for waters and aquatic environments, the Queensland Government's Monitoring and Sampling Manual 2009 – *Environmental Protection (Water) Policy 2009* (b) for groundwater, *Groundwater Sampling and Analysis – A Field Guide* (2009:27 GeoCat #6890.1) (c) for noise, the Environmental Protection Regulation 2008 (d) for air, the *Queensland Air Quality Sampling Manual* and/or Australian Standard 4323.1:1995 *Stationary source emissions method 1: Selection of sampling positions*, as appropriate for the relevant measurement (e) for soil, the *Guidelines for Surveying Soil and Land Resources, 2nd edition* (McKenzie *et al.* 2008), and/or the *Australian Soil and Land Survey Handbook, 3rd edition* (National Committee on Soil and Terrain, 2009) (f) for dust, Australian Standard AS3580.	
NOTIFICATION		
General 12	In addition to the requirements under Chapter 7, Part 1, Division 2 of the *Environmental Protection Act 1994*, the administering authority must be notified through the Pollution Hotline and in writing, as soon as possible, but within 48 hours of becoming aware of any of the following events: (a) any unauthorised significant disturbance to land (b) potential or actual loss of structural or hydraulic integrity of a dam (c) when the level of the contents of any regulated dam reaches the mandatory reporting level (d) when a regulated dam will not have available storage to meet the design storage allowance on 1 November of any year (e) potential or actual loss of well integrity (f) when the seepage trigger action response procedure required under condition (Water 14(g)) is or should be implemented (g) unauthorised releases of any volume of prescribed contaminants to waters (h) unauthorised releases of volumes of contaminants, in any mixture, to land greater than: i. 200 L of hydrocarbons; or ii. 200 L of stimulation additives; or iii. 500 L of stimulation fluids; or iv. 1 000 L of brine; or	The administering authority will be notified through the Pollution Hotline and in writing, as soon as possible, but within 48 hours of becoming aware of any of the events outlined in General 12.

Ref	Condition	Action program for compliance
	v. 5 000 L of untreated coal seam gas water; or vi. 5 000 L of raw sewage; or vii. 10 000 L of treated sewage effluent. (i) the use of restricted stimulation fluids (j) groundwater monitoring results from a landholder's active groundwater bore monitored under the stimulation impact monitoring program which is a 10% or greater increase from a previous baseline value for that bore and which renders the water unfit for its intended use (k) monitoring results where two out of any five consecutive samples do not comply with the relevant limits in the environmental authority.	
FINANCIAL ASSURANCE		
General 13 PESCB 1	Petroleum activities that cause significant disturbance to land must not be carried out until financial assurance has been given to the administering authority as security for compliance with the environmental authority and any costs or expenses, or likely costs or expenses, mentioned in section 298 of the *Environmental Protection Act 1994*.	If the project causes significant disturbance to land, it will not be carried out until financial assurance has been provided to the administering authority.
General 14	Prior to any changes in petroleum activities which would result in an increase to the maximum significant disturbance since financial assurance was last given to the administering authority, the holder of the environmental authority must amend the financial assurance and give the administering authority the increased amount of financial assurance.	Prior to any changes in petroleum activities which would result in an increase to the maximum significant disturbance, Blue Energy will amend the financial assurance and give the administering authority the increased amount of financial assurance.
General 15	If the amount of financial assurance held by the administering authority has been discounted and either the nominated period of financial assurance has ended, or an event or change in circumstance has resulted in the holder of the environmental authority no longer being able to meet one or more of the mandatory pre-requisites or applicable discount criteria, the holder of the environmental authority must amend the financial assurance and give the administering authority the increased amount of financial assurance as soon as practicable.	If financial assurance has been discounted and the nominated period of financial assurance has ended, or there has been a change in circumstance resulting in the inability of Blue Energy to meet mandatory pre-requisites, Blue Energy will amend the financial assurance and give the administering authority the increased amount as soon as possible.
CONTINGENCY PROCEDURES FOR EMERGENCY ENVIRONMENTAL INCIDENTS		

Ref	Condition	Action program for compliance
General 16	Petroleum activities involving significant disturbance to land cannot commence until the development of written contingency procedures for emergency environmental incidents which include, but are not necessarily limited to: (a) a clear definition of what constitutes an environmental emergency incident or near miss for the petroleum activity. (b) consideration of the risks caused by the petroleum activity including the impact of flooding and other natural events on the petroleum activity. (c) response procedures to be implemented to prevent or minimise the risks of environmental harm occurring. (d) the practices and procedures to be employed to restore the environment or mitigate any environmental harm caused. (e) procedures to investigate causes and impacts including impact monitoring programs for releases to waters and/or land. (f) training of staff to enable them to effectively respond. (g) procedures to notify the administering authority, local government and any potentially impacted landholder.	Significant disturbance to land is not expected, however, Blue Energy has appropriate procedures in place for emergency environmental events as documented throughout this EA and supporting documents.
MAINTENANCE OF PLANT EQUIPMENT		
General 17 PESCC 4	All plant and equipment must be maintained and operated in their proper and effective condition.	All plant and equipment will be maintained and operated in their proper and effective condition.
General 18	The following infrastructure must be signed with a unique reference name or number in such a way that it is clearly observable: (a) regulated dams and low consequence dams (b) exploration, appraisal and development wells (c) water treatment facilities (d) brine encapsulation facilities (e) landfill cells (f) sewage treatment facilities (g) specifically authorised discharge points to air and waters	The infrastructure outlined in General 18 will be signed with a unique reference name or number in such a way that it is clearly observable.

Ref	Condition	Action program for compliance
	(h) any chemical storage facility associated with the environmentally relevant activity of chemical storage (i) field compressor stations (j) central compressor stations (k) gas processing facilities; and (l) pipeline compressor stations.	
General 19	Measures to prevent fauna being harmed from entrapment must be implemented during the construction and operation of well infrastructure, dams and pipeline trenches.	Measures to prevent fauna being harmed from entrapment will be implemented during the construction and operation of well infrastructure, dams and pipeline trenches.
EROSION AND SEDIMENT CONTROL		
General 20	For activities involving significant disturbance to land, control measures that are commensurate to the site specific risk of erosion, and risk of sediment release to waters must be implemented to: (a) allow stormwater to pass through the site in a controlled manner and at non-erosive flow velocities (b) minimise soil erosion resulting from wind, rain, and flowing water (c) minimise the duration that disturbed soils are exposed to the erosive forces of wind, rain, and flowing water (d) minimise work-related soil erosion and sediment runoff; and (e) minimise negative impacts to land or properties adjacent to the activities (including roads).	The Project does not involve significant levels of land disturbance however, construction and operational activities will be completed using appropriate stormwater, erosion, and sediment control methods.
COMPLINTS		
General 21	Petroleum activities must not cause environmental nuisance at a sensitive place, other than where an alternative arrangement is in place.	Assessment has demonstrated that environmental nuisance is not expected as a result of this project. Ongoing landowner engagement will continue and in the event that environmental nuisance becomes an issue, mitigation measures and management practices will be put in place.
DOCUMENTATION		

Ref	Condition	Action program for compliance
General 22	A certification must be prepared by a suitably qualified person within 30 business days of completing every plan, procedure, program and report required to be developed under this environmental authority, which demonstrates that: (a) relevant material, including current published guidelines (where available) have been considered in the written document (b) the content of the written document is accurate and true; and (c) the document meets the requirements of the relevant conditions of the environmental authority.	A certification will be prepared by a suitably qualified person within 30 business days of completing every plan, procedure, program and report required to be developed under this environmental authority, as outlined in General 22.
General 23	All plans, procedures, programs, reports and methodologies required under this environmental authority must be written and implemented.	All plans, procedures, programs, reports and methodologies required under this environmental authority will be written and implemented.
General 24	All documents required to be developed under this environmental authority must be kept for five years.	All documents required to be developed under this environmental authority will be kept for five years.
General 25	All documents required to be prepared, held or kept under this environmental authority must be provided to the administering authority upon written request within the requested timeframe.	All documents required to be prepared, held or kept under this environmental authority will be provided to the administering authority upon written request within the requested timeframe.
General 26	A record of all complaints must be kept including the date, complainant's details, source, reason for the complaint, description of investigations and actions undertaken in resolving the complaint.	A record of all complaints will be kept, including all relevant details outlined in General 26.
WASTE MANAGEMENT		
GENERAL WASTE MANAGEMENT		
Waste 1 PESCC 24	Measures must be implemented so that waste is managed in accordance with the waste and resource management hierarchy and the waste and resource management principles.	A waste management plan will be developed before any petroleum activities begin.
Waste 2	Waste, including waste fluids, but excluding waste used in closed-loop systems, must be transported off-site for lawful re-use, remediation, recycling or disposal, unless the waste is specifically authorised by conditions <<Insert List>> to be disposed of or used on site.	Waste, including waste fluids, but excluding waste used in closed-loop systems, will be transported off-site for lawful re-use,

Ref	Condition	Action program for compliance
		remediation, recycling or disposal, unless the waste is specifically authorised to be disposed of or used on site.
Waste 3	Waste fluids, other than flare precipitant stored in flare pits, or residual drilling material or drilling fluids stored in sumps, must be contained in either: (a) an above ground container; or (b) a structure which contains the wetting front.	Waste fluids will be contained as per Waste 3.
Waste 4	Green waste may be used on-site for either rehabilitation or sediment and erosion control, or both.	Noted.
Waste 5	Vegetation waste may be burned if it relates to a state forest, timber reserve or forest entitlement area administered by the *Forestry Act 1959* and a permit has been obtained under the *Fire and Rescue Service Act 1990*.	Noted.
PIPELINE WASTEWATER		
Waste 6	Pipeline waste water, may be released to land provided that it: (a) can be demonstrated it meets the acceptable standards for release to land; and (b) is released in a way that does not result in visible scouring or erosion or pooling or run-off or vegetation die-off.	If pipeline wastewater is released, it will meets the acceptable standards for release to land and be released in a way that does not result in visible scouring or erosion or pooling or run-off or vegetation die-off.
AUTHORISED USES FOR PRODUCED WATER FOR PETROLEUM ACTIVITIES		
Waste 7	Produced water may be re-used in: (a) drilling and well hole activities; or (b) stimulation activities.	Noted.
Waste 8	Produced water may be used for dust suppression provided the following criteria are met: (a) the amount applied does not exceed the amount required to effectively suppress dust; and (b) the application: i. does not cause on-site ponding or runoff ii. is directly applied to the area being dust suppressed iii. does not harm vegetation surrounding the area being dust suppressed; and iv. does not cause visible salting.	Produced water that is used for dust will comply with the criteria outlined in Waste 8.
Waste 9	Produced water may be used for construction purposes provided the use: (a) does not result in negative impacts on the composition and structure of soil or subsoils (b) is not directly or indirectly released to waters	If produced water is used for construction, it will comply with conditions in Waste 9.

Ref	Condition	Action program for compliance
	(c) does not result in runoff from the construction site; and (d) does not harm vegetation surrounding the construction site.	
Waste 10	If there is any indication that any of the circumstances in condition (Waste 8)(b)(i) to (Waste 8(b)(iv)) or (Waste 9)(a) to (Waste 9(d)) is occurring the use must cease immediately and the affected area must be remediated without delay.	If there is any indication that any of the circumstances in (Waste 8)(b)(i) to (Waste 8(b)(iv)) or (Waste 9)(a) to (Waste 9(d)) is occurring the use will cease immediately and the affected area will be remediated without delay.
USE OF PRODUCED WATER FOR IRRIGATION ACTIVITIES		
Waste C1	Irrigation of produced water is authorised providing it ensures: (a) ensures that soil structure, stability and productive capacity can be maintained or improved (b) toxic effects to crops do not result; and (c) yields and produce quality are maintained or improved.	If produced water is used for irrigation, it will ensure that soil structure, stability and productive capacity can be maintained or improved, toxic effects to crops do not result and yields and produce quality are maintained or improved.
Waste C2	Irrigation of produced water is authorised providing a written report is provided to the chief executive which: (a) certifies that the outcomes in condition (Waste C1) will be achieved (b) states water quality criteria, which has been determined in accordance with the assessment procedures outlined in Waste Schedule, Table 1—Assessment procedures for water quality criteria (c) includes a water monitoring program to monitor that the outcomes listed in condition (Waste C1) are being achieved.	If produced water is used for irrigation, a written report will be provided to the chief executive for authorisation which includes the information outlined in Waste C2.

Ref	Condition	Action program for compliance
	<table><tr><th>Water quality criteria</th><th>Assessment procedure</th></tr><tr><td>electrical conductivity sodium adsorption ratio pH</td><td>Salinity Management Handbook, with reference to Chapter 11; and/or Australian and New Zealand Guidelines for Fresh and Marine Water Quality, with reference to Volume 1 Chapter 4 and Volume 3 Chapter 9. The assessment should consider: - soil properties within the root zone to be irrigated (e.g. clay content, cation exchange capacity, exchangeable sodium percentage) - water quality of the proposed resource (e.g. salinity, sodicity) - climate conditions (e.g. rainfall) - leaching fractions - average root zone salinity (calculated) - crop salt tolerance (e.g. impact threshold and yield decline) - management practices and objectives (e.g. irrigation application rate, amelioration techniques) - broader landscape issues (e.g. land use, depth to groundwater) - any additional modelling and tests undertaken to support the varied water quality parameters. </td></tr><tr><td>heavy metals</td><td>Australian and New Zealand Guidelines for Fresh and Marine Water Quality, with reference to Volume 1 Chapters 3 and 4 and Volume 3 Chapter 9. The assessment should aim to derive site specific trigger values (e.g. cumulative contaminant loading limit) based on the methodology provided in the above mentioned procedure.</td></tr></table>	
SEWAGE TREATMENT		
Waste 11	Treated sewage effluent or greywater can be released to land provided it: (a) meets or exceeds secondary treated class B standards for a treatment system with a daily peak design capacity of between 150 EP and 1500 EP; or (b) meets or exceeds secondary treated class C standards for a treatment system with a daily peak design capacity of less than 150 EP.	Not applicable. There will be no sewage treatment on site.
Waste 12	The release of treated sewage effluent or greywater authorised in condition (Waste 11) must: (a) be to a fenced and signed contaminant release area(s) (b) not result in pooling or run-off or aerosols or spray drift or vegetation die-off (c) be to a contaminant release area(s) that is kept vegetated with groundcover, that is: i. not a declared pest species ii. kept in a viable state for transpiration and nutrient uptake; and iii. grazed or harvested a	Not applicable. There will be no sewage treatment on site.
Waste 13	Notwithstanding condition (Waste 11), treated sewage effluent that meets or exceeds secondary treated class A standards may be used for dust suppression or construction activities, provided the use meets the criteria in condition (Waste 8) or (Waste 9), as relevant to the use	Not applicable. There will be no sewage treatment on site.
Waste 14	Sewage pump stations must be fitted with a: (a) stand-by pump; and	Not applicable. There will be no sewage treatment on site.

Ref	Condition	Action program for compliance
	(b) high level alarm to warn of imminent pump station overflow, that operates without mains power or with a back-up power source that starts automatically in the event of a power failure.	
RESIDUAL DRILLING MATERIAL		
Waste 15	If sumps are used to store residual drilling material or drilling fluids, they must only be used for the duration of drilling activities.	If sumps are used to store residual drilling material or drilling fluids, they will only be used for the duration of drilling activities.
Waste 16	Residual drilling material can only be disposed of on-site: (a) by mix-bury-cover method if the residual drilling material meets the approved quality criteria; or (b) if it is certified by a suitably qualified third party as being of acceptable quality for disposal to land by the proposed method and that environmental harm will not result from the proposed disposal.	Residual drilling material will only be disposed on site as per the methods outlined in Waste 16.
Waste 17	Records must be kept to demonstrate compliance with condition (Waste 15) and (Waste 16).	Will be complied with.
ONSITE WASTE DISPOSAL – GENERAL WASTE		
Waste 18	General waste may be disposed of onsite at a dedicated landfill facility provided that the general waste: (a) is not a liquid (b) does not contain, or is not comingled with regulated waste (c) does not contain an organic fraction of more than 5% of the general waste stream (d) was generated from activities permitted under this environmental authority; and (e) does not exceed 10 000 tonnes in any year.	General waste will be disposed of on site if possible, provided that they meet the requirements of Waste 18.
Waste 19	The landfill used for the disposal of general waste must be: (a) on land owned by the holder of the relevant resource authority(ies) (b) designed by a suitably qualified person and certified as being suitable for the containment of the waste (c) designed and located so that the landfill is protected from any potential adverse consequences of regional or local flooding to the probable maximum flood level (d) designed and operated to exclude stormwater runoff from entering the landfill (e) capped upon closure with capping methodology certified by a suitably qualified person as being suitable for containing the waste.	The landfill used for the disposal of general waste will be as per condition Waste 19.

<table>
<tr><th>Ref</th><th>Condition</th><th>Action program for compliance</th></tr>
<tr><td>Waste 20</td><td>Waste disposal activities must not result in any negative effect on public health particularly in relation to propagation of diseases and the breeding and harbourage of flies, mosquitoes, rats and other pest organisms.</td><td>Waste disposal activities will not result in any negative effect on public health.</td></tr>
<tr><td>Waste 21</td><td>Waste disposal must not result in litter escaping the boundary of the landfill facility</td><td>Waste disposal will not result in litter escaping the boundary of the landfill facility.</td></tr>
<tr><td colspan="3">PROTECTING ACOUSTIC VALUES</td></tr>
<tr><td>Noise 1</td><td>Notwithstanding condition (General 21), emission of noise from the petroleum activity(ies) at levels less than those specified in Protecting acoustic values, Table 1—Noise nuisance limits are not considered to be environmental nuisance.
Protecting acoustic values, Table 1 – Noise nuisance limits
<table>
<tr><th>Time period</th><th>Metric</th><th>Short term noise event</th><th>Medium term noise event</th><th>Long term noise event</th></tr>
<tr><td>7:00am—6:00pm</td><td>$L_{Aeq,adj,15\,min}$</td><td>45 dBA</td><td>43 dBA</td><td>40 dBA</td></tr>
<tr><td>6:00pm—10:00pm</td><td>$L_{Aeq,adj,15\,min}$</td><td>40 dBA</td><td>38 dBA</td><td>35 dBA</td></tr>
<tr><td rowspan="2">10:00pm—6:00am</td><td>$L_{Aeq,adj,15\,min}$</td><td>28 dBA</td><td>28 dBA</td><td>28 dBA</td></tr>
<tr><td>Max $L_{Ax,15\,min}$</td><td>55 dBA</td><td>55 dBA</td><td>55 dBA</td></tr>
<tr><td>6:00am—7:00am</td><td>$L_{Aeq,adj,15\,min}$</td><td>40 dBA</td><td>38 dBA</td><td>35 dBA</td></tr>
</table>
The noise limits in Table 1 have been set on the following deemed background noise levels (L_{ABG})
7:00am—6:00 pm: 35 dBA
6:00pm—10:00 pm: 30 dBA
10:00pm—6:00 am: 25 dBA
6:00am—7:00 am: 30 dBA</td><td>Noted.</td></tr>
<tr><td>Noise 2</td><td>If the noise subject to a valid complaint is tonal or impulsive, the adjustments detailed in Protecting acoustic values, Table 2—Adjustments to be added to noise levels at sensitive receptors are to be added to the measured noise level(s) to derive $L_{Aeq, adj, 15\ min.}$
Protecting acoustic values, Table 2 – Adjustments to be added to noise levels at sensitive receptors
<table>
<tr><th>Noise characteristic</th><th>Adjustment to noise</th></tr>
<tr><td>Tonal characteristic is just audible</td><td>+ 2 dBA</td></tr>
<tr><td>Tonal characteristic is clearly audible</td><td>+ 5 dBA</td></tr>
<tr><td>Impulsive characteristic is detectable</td><td>+ 2 to + 5 dBA</td></tr>
</table></td><td>In the event of a valid noise complaint, a noise management plan will be developed within a reasonable and practicable timeframe; and the noise management plan will address the following matters:
Identification of noise sources that are impacting upon noise sensitive receptors;
Identification of noise sources that are impacting upon noise sensitive receptors;</td></tr>
</table>

Ref	Condition	Action program for compliance
		Quantify the noise levels at the identified sensitive receptors and take into account the adjustments mentioned in Table 2 - Adjustments to be added to noise levels at sensitive receptors Introduce reasonable and practicable control or abatement measures to reduce identified intrusive noise sources; Handling of future noise complaints of a similar nature; Community liaison and consultation; and Training of staff and contractors in noise management practices.
Noise 3	Notwithstanding condition (Noise 1), emission of any low frequency noise must not exceed either (Noise 3(a)) and (Noise 3(b)), or (Noise 3(c)) and (Noise 3(d)) in the event of a valid complaint about low frequency noise being made to the administering authority: (a) 60 dB(C) measured outside the sensitive receptor; and (b) the difference between the external A-weighted and C-weighted noise levels is no greater than 20 dB; or (c) 50 dB(Z) measured inside the sensitive receptor; and (d) the difference between the internal A-weighted and Z-weighted (Max LpZ, 15 min) noise levels is no greater than 15 dB.	Low frequency noise is not expected to be emitted as a result of this project.
Noise 4 PESCC 21	A Blast Management plan must be developed for each blasting activity in accordance with Australian Standard 2187.	Not applicable. No blasting will occur
Noise 5 PESCC 22	Blasting operations must be designed to not exceed an airblast overpressure level of 120 dB (linear peak) at any time, when measured at or extrapolated to any sensitive place.	Not applicable. No blasting will occur
Noise 6 PESCC 23	Blasting operations must be designed to not exceed a ground-borne vibration peak particle velocity of 10mm/s at any time, when measured at or extrapolated to any sensitive place	Not applicable. No blasting will occur
PROTECTING AIR VALUES		
VENTING AND FLARING		

Ref	Condition	Action program for compliance
Air 1	Unless venting is authorised under the *Petroleum and Gas (Production and Safety) Act 2004* or the *Petroleum Act 1923*, waste gas must be flared in a manner that complied with all of [Air1[a]] and [Air1[b]] and [Air1[c]] or with [Air1[d]]: (a) an automatic ignition is used (b) a flame is visible at all times while the waste gas is being flared (c) there are no visible smoke emissions other than for a total period of no more than 5 minutes in any 2 hours, or (d) it used an enclosed flare	When flaring, waste gas will be flared in a manner that complies with Air 1.
FUEL BURNING AND COMBUSTION FACILITIES – AUTHORISED POINT ACCESS		
Air 2A	A fuel burning or combustion facility must not be operated unless it is listed in Protecting air values, Table 1–Authorised point sources. [None mentioned in Table 1]	Not applicable. No compression activities will be carried out as a part of the Project.
Air 2B	If a fuel burning or combustion facility is listed in Protecting air values, Table 1—Authorised point sources, the fuel burning or combustion facility must be operated so that the releases to air do not exceed the limits specified in Protecting air values, Table 1—Authorised point sources at the specified release point reference.	Not applicable. No compression activities will be carried out as a part of the Project.
POINT SOURCE AIR MONITORING		
Air 3	Point source air monitoring for each fuel burning or combustion facility listed in Protecting air values, Table 1—Authorised point sources must: (a) be undertaken once: i. in the first three months after each facility is first commissioned, and then ii. every year thereafter (b) be carried out when the facility the subject of the sampling is operating under maximum operating conditions for the annual period; and (c) demonstrate compliance with the limits listed in Protecting air values, Table 1—Authorised point sources at each release point reference.	Point source air monitoring for each fuel burning or combustion facility will comply with Air 3.
FUEL BURNING AND COMBUSTION FACILITIES – AMBIENT AIR QUALITY MONITORING		
Air 4	The operation of fuel burning or combustion facilities must not result in ground level concentrations of contaminants exceeding the maximum limits specified in Protecting air values, Table 2—Maximum ground level concentration of contaminants to air. Protecting air values, Table 2 – Maximum ground level concentration of contaminants to air	The operation of fuel burning or combustion facilities will not result in ground level concentrations of contaminants exceeding the maximum limits specified in Table 2 –

<table>
<tr><th>Ref</th><th>Condition</th><th>Action program for compliance</th></tr>
<tr><td></td><td><table>
<tr><th>Contaminant</th><th>EPP Air Quality Objective / Maximum ground level concentration at 0° Celsius</th><th>Units</th><th>Averaging time</th></tr>
<tr><td>e.g. Nitrogen Dioxide</td><td>e.g. 250</td><td>µg/m³</td><td>1 hour</td></tr>
<tr><td>e.g. Nitrogen Dioxide</td><td>e.g. 62</td><td>µg/m³</td><td>1 year</td></tr>
<tr><td>e.g. Sulphur Dioxide</td><td>e.g. 570</td><td>µg/m³</td><td>1 hour</td></tr>
<tr><td>e.g. Carbon Monoxide</td><td>e.g. 11</td><td>mg/ m³</td><td>8 hours</td></tr>
</table></td><td>maximum ground level concentration of contaminants to air.</td></tr>
<tr><td colspan="3">AIR RECEIVING ENVIRONMENT MONITORING PROGRAM</td></tr>
<tr><td>Air 5</td><td>An air receiving environment monitoring program (AREMP) must be developed to demonstrate compliance with the limits in Protecting Air Values, Table 2—Maximum ground level concentration of contaminants to air.</td><td>An AREMP will be developed to demonstrate compliance with the limits in Table 2 - maximum ground level concentration of contaminants to air.</td></tr>
<tr><td>Air 6</td><td>The AREMP must include, but not necessarily be limited to:
(a) the delineation of the relevant air shed(s)
(b) the identification of background reference sites and impact monitoring sites within the relevant air shed(s), including sensitive places
(c) a monitoring program to be carried out annually that:
i. includes background reference and impact monitoring sites
ii. includes an assessment of meteorological conditions (wind speed and direction)
iii. is sufficient to determine compliance with the limits listed in Protecting Air Values, Table 2—Maximum ground level concentration of contaminants to air
iv. identifies the effects of the authorised contaminants released to air in the relevant air shed(s)
v. is representative of when the fuel burning or combustion facilities are operating under maximum operating conditions for the annual period
(d) an assessment of the condition of each fuel burning or combustion facility; and
(e) a description of other significant point sources in the air shed and surrounding land use including sensitive places.</td><td>The requirements of this condition will be drafted into an Air Receiving Environment Monitoring Program. As part of Blue Energy's review of environmental management documents currently being undertaken, it will be written into other procedures to ensure compliance with conditions [A5] to [A10] is achieved.</td></tr>
<tr><td>Air 7</td><td>An AREMP report must be written annually which includes the information required by condition (Air 6) and an assessment of the extent to which monitoring data for ground level</td><td>An AREMP report will be developed annually and will include the information required by</td></tr>
</table>

Ref	Condition	Action program for compliance
	concentrations complies with the air contaminant limits listed in Protecting air values, Table 2— Maximum ground level concentration of contaminants to air.	Air 6 and an assessment of compliance with air contaminant limits.
Air 8	Where monitoring data indicates that ground level concentrations listed in Protecting air values, Table 2— Maximum ground level concentration of contaminants to air have not been met, the AREMP report required by condition (Air 7) must also include an assessment of: (a) the extent to which the values of the air environment in the relevant air shed(s) are being protected (b) an assessment of whether contaminant releases to the air environment are consistent with the air management hierarchy in the Environmental Protection (Air) Policy 2008, and (c) any corrective actions that have been implemented or proposed to be implemented to become consistent with the air management hierarchy and achieve compliance with Protecting air values, Table 2— Maximum ground level concentration of contaminants to air.	Where monitoring data indicates that ground level concentrations listed in Table 2— Maximum ground level concentration of contaminants to air have not been met, the AREMP report will also include an assessment of aspects outlined in Air 8.
Air 9	A statement of compliance prepared by a suitably qualified person must accompany each AREMP report required by condition (Air 7) and if applicable, condition (Air 8) stating: (a) whether the AREMP as most recently implemented complies with the requirements of conditions (General 7 / PESCD1), condition (General 11(d)), (Air 5) and (Air 6) (b) that, to the best of the suitably qualified person's knowledge, the assessment required by condition (Air 7) and if applicable, condition (Air 8) is true, correct and complete, and (c) that, to the best of the suitably qualified person's knowledge, all information provided as part of the statement of compliance, including attachments, is true, correct and complete.	A statement of compliance prepared by a suitably qualified person will accompany each AREMP report and will include information as requested in Air 9.
Air 10	Where condition (Air 8) applies, the documents required by conditions (Air 7), (Air 8) and (Air 9) must be given to the administering authority within 5 business days after the AREMP report is written.	Where condition (Air 8) applies, the documents required will be given to the administering authority within 5 business days after the AREMP report is written.
PROTECTING LAND VALUES		
GENERAL		
Land 1	Contaminants must not be directly or indirectly released to land except for those releases authorised by conditions <<insert relevant waste to land conditions>>.	Contaminants will not be directly or indirectly released to land except for authorized releases.
TOPSOIL MANAGEMENT		

Ref	Condition	Action program for compliance
Land 2	Topsoil must be managed in a manner that preserves its biological and chemical properties.	Clearing and topsoil removal will only be undertaken where necessary for ongoing operations or drilling. Topsoil will be managed in a manner that preserves its biological and chemical properties.
LAND MANAGEMENT		
Land 3	Land that has been significantly disturbed by the petroleum activities must be managed to ensure that mass movement, gully erosion, rill erosion, sheet erosion and tunnel erosion do not occur on that land.	Land that is disturbed significantly as a result of the activities of the project will be managed to ensure that mass movement and gully, rill, sheet and tunnel erosion do not occur.
ACID SULFATE SOILS		
Land 4	Acid sulfate soils must be treated and managed in accordance with the latest edition of the Queensland Acid Sulfate Soil Technical Manual.	The area in which the PLs associated with the project are located is not associated with the acid sulfate soils trigger map.
CHEMICAL STORAGE		
Land 5	Chemicals and fuels stored, must be effectively contained and where relevant, meet Australian Standards, where such a standard is applicable.	Blue Energy will contain chemicals and fuels effectively and where relevant, meet Australian Standards, where such a standard is applicable.
PIPELINE OPERATION AND MAINTENANCE		
Land 6	Pipeline operation and maintenance must be in accordance, to the greatest practicable extent, with the relevant section of the APIA Code of Environmental Practice: Onshore Pipelines (2009).	Pipeline operation and maintenance will be in accordance with the relevant section of the APIA Code of Environmental Practice: Onshore Pipelines (2009).
PIPELINE REINSTATEMENT AND REVEGETATION		
Land 7 PPSCE 17	Pipeline trenches must be backfilled and topsoils reinstated within three months after pipe laying.	Blue Energy will backfill pipeline trenches and reinstate topsoils within three months of pipe laying.

Ref	Condition	Action program for compliance
Land 8	Reinstatement and revegetation of the pipeline right of way must commence within 6 months after cessation of petroleum activities for the purpose of pipeline construction.	Reinstatement and revegetation of the pipeline right of way will commence within 6 months after cessation of petroleum activities for the purpose of pipeline construction.
Land 9	Backfilled, reinstated and revegetated pipeline trenches and right of ways must be: (a) a stable landform (b) re-profiled to a level consistent with surrounding soils (c) re-profiled to original contours and established drainage lines; and (d) vegetated with groundcover which is not a declared pest species, and which is established and growing.	Pipeline trenches and right of ways that are backfilled, reinstated and revegetated will be as per Land 9.
PROTECTING BIODIVERSITY VALUES		
CONFIRMING BIODIVERSITY VALUES		
Biodiversity 1	Prior to undertaking activities that result in significant disturbance to land in areas of native vegetation, confirmation of on-the-ground biodiversity values of the native vegetation communities at that location must be undertaken by a suitably qualified person.	The activities to be undertaken do not involve significant disturbance to land in areas of native vegetation. Nevertheless, as detailed in this document, pre-clearance surveys will be undertaken by a suitably qualified person prior to works commencing.
Biodiversity 2	A suitably qualified person must develop and certify a methodology so that condition (Biodiversity 1) can be complied with and which is appropriate to confirm on-the-ground biodiversity values.	A suitably qualified person will develop and certify a methodology so that Biodiversity 1 can be complied with and which is appropriate to confirm biodiversity values.
Biodiversity 3	For conditions (Biodiversity 4) to (Biodiversity 9), where mapped biodiversity values differ from those confirmed under conditions (Biodiversity 1) and (Biodiversity 2), petroleum activities may proceed in accordance with the conditions of the environmental authority based on the confirmed on-the-ground biodiversity value.	Activities relating to the project will proceed in accordance with the conditions of the EA based on confirmed on the ground biodiversity value where mapped biodiversity values differ from those confirmed under conditions (Biodiversity 1) and (Biodiversity 2).
PLANNING FOR LAND DISTURBANCE		

Ref	Condition	Action program for compliance
Biodiversity 4	The location of the petroleum activity(ies) must be selected in accordance with the following site planning principles: (a) maximise the use of areas of pre-existing disturbance (b) in order of preference, avoid, minimise or mitigate any impacts, including cumulative impacts, on areas of native vegetation or other areas of ecological value (c) minimise disturbance to land that may result in land degradation (d) in order of preference, avoid then minimise isolation, fragmentation, edge effects or dissection of tracts of native vegetation; and (e) in order of preference, avoid then minimise clearing of native mature trees.	The location of the petroleum activities will been selected in accordance with the site planning principles outlined in Biodiversity 4.
PLANNING FOR LAND DISTURBANCE – LINEAR INFRASTRUCTURE		
Biodiversity 5	Linear infrastructure construction corridors must: (a) maximise co-location (b) be minimised in width to the greatest practicable extent; and (c) for linear infrastructure that is an essential petroleum activity authorised in an environmentally sensitive area or its protection zone, be no greater than 40m in total width.	Linear infrastructure construction corridors will comply with the requirements outlined in Biodiversity 5.
AUTHORISED DISTURBANCE TO ENVIORNMENTALLY SENSITIVE AREAS		
Biodiversity 6	Petroleum activities are not permitted in Category A, B or C environmentally sensitive areas	Not applicable
Biodiversity 7	Essential petroleum activities may be undertaken in areas of pre-existing disturbance in the primary protection zones of Category B environmentally sensitive areas that are 'endangered' regional ecosystems and Category C environmentally sensitive areas other than 'nature refuges' or 'koala habitat' areas, providing those activities do not have a measurable negative impact on the adjacent environmentally sensitive area.	Not applicable
Biodiversity 8	Where petroleum activities are to be carried out in environmentally sensitive areas or their protection zones, the petroleum activities must be carried out in accordance with Protection of Biodiversity Values, Table 1—Authorised petroleum activities in environmentally sensitive areas and their protection zones. Protecting biodiversity values, Table 1—Authorised petroleum activities in environmentally sensitive areas and their protection zones	The activities carried out within ESAs or their protection zones will be carried out in accordance with Protection of Biodiversity Values, Table 1.

<table>
<tr><th>Ref</th><th>Condition</th><th>Action program for compliance</th></tr>
<tr><td></td><td>
<table>
<tr><th>Environmentally sensitive area</th><th>Within the environmentally sensitive area</th><th>Primary protection zone of the environmentally sensitive area</th><th>Secondary protection zone of the environmentally sensitive area</th></tr>
<tr><td>Category A environmentally sensitive areas</td><td>No petroleum activities permitted.</td><td>Only low impact petroleum activities permitted.</td><td>Only essential petroleum activities permitted.</td></tr>
<tr><td>Category B environmentally sensitive areas that are other than 'endangered' regional ecosystems</td><td>Only low impact petroleum activities permitted.</td><td>Only low impact petroleum activities permitted.</td><td>Only essential petroleum activities permitted.</td></tr>
<tr><td>Category B environmentally sensitive areas that are 'endangered' regional ecosystems</td><td>Only low impact petroleum activities permitted.</td><td>Only essential petroleum activities permitted.</td><td>Only essential petroleum activities permitted.</td></tr>
<tr><td>Category C environmentally sensitive areas that are 'nature refuges' or 'koala habitat'</td><td>Only low impact petroleum activities permitted.</td><td>Only low impact petroleum activities permitted.</td><td></td></tr>
<tr><td>Category C environmentally sensitive areas that are 'essential habitat', 'essential regrowth habitat', or 'of concern' regional ecosystems</td><td>Only low impact petroleum activities permitted.</td><td>Only essential petroleum activities permitted.</td><td></td></tr>
<tr><td>Category C environmentally sensitive areas that are 'regional parks' (previously known as 'resources reserves')</td><td>Only essential petroleum activities permitted.</td><td>Only essential petroleum activities permitted.</td><td></td></tr>
<tr><td>Category C environmentally sensitive areas that are 'state forests' or 'timber reserves'</td><td>Only essential petroleum activities permitted.</td><td>Petroleum activities permitted.</td><td></td></tr>
<tr><td>Areas of vegetation that are 'critically limited'</td><td>Only low impact petroleum activities permitted.</td><td>Only essential petroleum activities permitted.</td><td></td></tr>
</table>
</td><td></td></tr>
<tr><td>Biodiversity 9</td><td>A report must be prepared for each annual return period for all petroleum activities that involved clearing of any environmentally sensitive area or protection zone which includes:
(a) records able to demonstrate compliance with conditions (Biodiversity 4), (Biodiversity 5) and (Biodiversity 8)
(b) a description of the works
(c) a description of the area and its pre-disturbance values (which may include maps or photographs, but must include GPS coordinates for the works); and</td><td>Blue Energy will prepare a report for each annual return period for the Project which includes information as required in Biodiversity 9.</td></tr>
</table>

Ref	Condition	Action program for compliance
	(d) based on the extent of environmentally sensitive areas and primary protection zones on the relevant resource authority(ies), the proportion of native vegetation cleared per environmentally sensitive area and primary protection zone, including regional ecosystem type, over the annual return period.	
IMPACTS TO PRESCRIBED ENVIRONMENTAL MATTERS		
Biodiversity 10	Significant residual impacts to prescribed environmental matters are not authorised under this environmental authority or the Environmental Offsets Act 2014	This Project will not result in significant residual impacts to prescribed environmental matters.
Biodiversity 11	Records demonstrating that each impact to a prescribed environmental matter did not, or is not likely to, result in a significant residual impact to that matter must be: (a) completed by an appropriately qualified person; and (b) kept for the life of the environmental authority.	Records demonstrating that each impact to a prescribed environmental matter did not, or is not likely to, result in a significant residual impact to that matter will comply with the requirements outlined in Biodiversity 11.
Biodiversity 12	An environmental offset made in accordance with the Environmental Offsets Act 2014 and Queensland Environmental Offsets Policy, as amended from time to time, must be undertaken for the maximum extent of impact to each prescribed environmental matter authorised in Protecting biodiversity values, Table 2— Significant residual impacts to prescribed environmental matters, unless a lesser extent of the impact has been approved in accord	If an environmental offset is required for the Project, it will be made in accordance with the Environmental Offsets Act 2014 and Queensland Environmental Offsets Policy and will be undertaken for the maximum extent of impact to each prescribed environmental matter authorised in Protecting biodiversity values, Table 2, unless a lesser extent has been approved.
STAGED IMPACTS		
Biodiversity 13	The significant residual impacts to a prescribed environmental matter authorised in condition (Biodiversity 10) for which an environmental offset is required by condition (Biodiversity 12) may be carried out in stages. An environmental offset can be delivered for each stage of the impacts to prescribed environmental matters.	Not applicable.
Biodiversity 14	Prior to the commencement of each stage, a report completed by an appropriately qualified person, that includes an analysis of the following must be provided to the administering authority: (a) for the forthcoming stage—the estimated significant residual impacts to each	Not applicable

Ref	Condition	Action program for compliance
	prescribed environmental matter; and (b) for the previous stage, if applicable—the actual significant residual impacts to each prescribed environmental matter, to date.	
Biodiversity 15	The report required by condition (Biodiversity 14) must be approved by the administering authority before a notice of election for the forthcoming stage, if applicable, is given to the administering authority.	Not applicable
Biodiversity 16	A notice of election for the staged environmental offset referred to in condition (Biodiversity 15), if applicable, must be provided to the administering authority no less than three months before the proposed commencement of that stage, unless a lesser timeframe has been agreed to by the administering authority.	Not applicable
Biodiversity 17	Within six months from the completion of the final stage of the project, a report completed by an appropriately qualified person, that includes the following matters must be provided to the administering authority: (a) an analysis of the actual impacts on prescribed environmental matters resulting from the final stage; and (b) if applicable, a notice of election to address any outstanding offset debits for the authorised impacts.	Not applicable
NON-STAGED IMPACTS		
Biodiversity 18	Prior to the commencement of any impacts to a prescribed environmental matter for which an environmental offset is required by condition (Biodiversity 12), a report completed by an appropriately qualified person that contains an analysis of the estimated maximum extent of impact to each prescribed environmental matter must be provided to the administering authority.	Not applicable
Biodiversity 19	The report required by condition (Biodiversity 18) must be approved by the administering authority before the notice of election, if applicable, is given to the administering authority.	Not applicable
Biodiversity 20	The notice of election for the environmental offset required by condition (Biodiversity 12), if applicable, must be provided to the administering authority no less than three months before the proposed commencement of the significant residual impacts for which the environmental offset is required.	Not applicable
PROTECTING WATER VALUES		
AUTHORISED IMPACTS TO WATERS		
Water 1	No authorised impacts to waters.	No authorised impact proposed
AUTHORISED IMPACTS TO WETLANDS		

Ref	Condition	Action program for compliance
Water 2	The extraction of groundwater as part of the petroleum activity(ies) from underground aquifers must not cause or indirectly cause environmental harm to a wetland.	The groundwater assessment undertaken for the Project Area has concluded there would be minimal impacts and consequently no environmental harm is predicted. A monitoring program for groundwater quality and levels has been proposed and will be implemented by Blue Energy to confirm the findings of the groundwater assessment.
AUTHORISED ACTIVITIES IN WATERS		
Water 3	Petroleum activities must not occur in or within 200m of a: (a) Wetland of high ecological significance (b) Great Artesian Basin Spring (c) Subterranean cave GDE	No activities will occur within 200m of the areas outlined in Water 3, as these are not mapped as being present within any of the PLs.
Water 4	Only construction or maintenance of linear infrastructure is permitted in or within any wetland of other environmental value or in a watercourse.	The Project area contains lower value watercourses and wetlands, known as wetlands of other environmental value or wetlands of general ecological significance. The development of linear infrastructure is permitted if watercourses are not of high ecological significance, of which none are mapped to occur within the PLs.
Water 5A	The construction or maintenance of linear infrastructure in a wetland of other environmental value must not result in the: (a) clearing of riparian vegetation outside of the minimum area practicable to carry out the works; or (b) ingress of saline water into freshwater aquifers; or (c) draining or filling of the wetland beyond the minimum area practicable to carry out the works.	The construction or maintenance of linear infrastructure in a wetland of other environmental value will not result in the outcomes outlined Water 5A.
Water 5B	After the construction or maintenance works for linear infrastructure in a wetland of other environmental value are completed, the linear infrastructure must not:	After the construction of maintenance works for linear infrastructure in a wetland of other

<table>
<tr><th>Ref</th><th>Condition</th><th>Action program for compliance</th></tr>
<tr><td></td><td>(a) drain or fill the wetland
(b) prohibit the flow of surface water in or out of the wetland
(c) lower or raise the water table and hydrostatic pressure outside the bounds of natural variability that existed before the activities commenced
(d) result in ongoing negative impacts to water quality
(e) result in bank instability; or
(f) result in fauna ceasing to use adjacent areas for habitat, feeding, roosting or nesting.</td><td>environmental value are completed, linear infrastructure will not result in the outcomes listed in Water 5B.</td></tr>
<tr><td>Water 6</td><td>The construction or maintenance of linear infrastructure activities in a watercourse must be conducted in the following preferential order:
(a) firstly, in times where there is no water present
(b) secondly, in times of no flow
(c) thirdly, in times of flow, providing a bankfull situation is not expected and that flow is maintained.</td><td>The construction and maintenance of linear infrastructure activities in a watercourse will be conducted as per Water 6 and will be monitored via the REMP.</td></tr>
<tr><td>Water 7</td><td>The construction or maintenance of linear infrastructure authorised under condition (Water 4) must comply with the water quality limits as specified in Protecting water values, Table 1 – Release limits for construction or maintenance of linear infrastructure.
Table 1 – Release limits for construction or maintenance of linear infrastructure
<table>
<tr><th>Water quality parameters</th><th>Units</th><th>Water quality limits</th></tr>
<tr><td rowspan="2">Turbidity</td><td rowspan="2">Nephelometric Turbidity Units (NTU)</td><td>For a wetland of other environmental value, if background water turbidity is above 45 NTU, no greater than 25% above background water turbidity measured within a 50m radius of the construction or maintenance activity.
For a watercourse, if background water turbidity is above 45 NTU, no greater than 25% above background water turbidity measured within 50m downstream of the construction or maintenance activity.</td></tr>
<tr><td>For a wetland of other environmental value, if background water turbidity is equal to, or below 45 NTU, a turbidity limit of no greater than 55 NTU applies, measured within a 50m radius of the construction or maintenance activity.
For a watercourse, if background water turbidity is equal to, or below 45 NTU, a turbidity limit of no greater than 55 NTU applies, measured within 50m downstream of the construction or maintenance activity.</td></tr>
<tr><td>Hydrocarbons</td><td>-</td><td>For a wetland of other environmental value, or watercourse, no visible sheen or slick</td></tr>
</table></td><td>The construction or maintenance of linear infrastructure authorised under Water 4 will comply with the water quality limits as specified in Protecting water values Table 1.</td></tr>
<tr><td>Water 8</td><td>Monitoring must be undertaken at a frequency that is appropriate to demonstrate compliance with condition (Water 7).</td><td>Water monitoring will be undertaken at an appropriate frequency to demonstrate</td></tr>
</table>

Ref	Condition	Action program for compliance
		compliance with Water 7. This will be monitored and completed via the REMP.
REGISTER OF ACTIVITIES IN WETLANDS AND WATERCOURSES		
Water 9	A register must be kept of all linear infrastructure construction and maintenance activities in a wetland of other environmental value and watercourses, which must include: (a) location of the activity (e.g. GPS coordinates (GDA94) and watercourse name) (b) estimated flow rate of surface water at the time of the activity (c) duration of works, and (d) results of impact monitoring carried out under condition (Water 8).	A register will be kept of all linear infrastructure construction and maintenance activities in a wetland of other environmental value and watercourses, which will include the details outlined in Water 9.
ACTIVITIES IN RIVER IMPROVEMENT AREAS		
Water 10	Measures must be taken to minimise negative impacts to, or reversal of, any river improvement works carried out in River Improvement Areas by Queensland's River Improvement Trusts.	Not currently relevant but condition left in for protection of any future river improvement area
ACTIVITIES IN FLOODPLINS		
Water 11	Petroleum activity(ies) on floodplains must be carried out in a way that does not: (a) concentrate flood flows in a way that will or may cause or threaten a negative environmental impact; or (b) divert flood flows from natural drainage paths and alter flow distribution; or (c) increase the local duration of floods; or (d) increase the risk of detaining flood flows.	Blue Energy will ensure that petroleum activities that are carried out on floodplains will not result in the outcomes listed in Water 11.
SEEPAGE MONITORING PROGRAM		
Water 12	A seepage monitoring program must be developed by a suitably qualified person which is commensurate with the site-specific risks of contaminant seepage from containment facilities, and which requires and plans for detection of any seepage of contaminants to groundwater as a result of storing contaminants by (specified date no longer than 3 months from date of grant of this environmental authority).	Not applicable. No significant chemical fuel and/or waste storages such as monocells and dams are proposed.
Water 13	The seepage monitoring program required by condition (Water 12) must include but not necessarily be limited to: (a) identification of the containment facilities for which seepage will be monitored	Not applicable. No significant chemical fuel and/or waste storages such as monocells and dams proposed.

Ref	Condition	Action program for compliance
	(b) identification of trigger parameters that are associated with the potential or actual contaminants held in the containment facilities (c) identification of trigger concentration levels that are suitable for early detection of contaminant releases at the containment facilities (d) installation of background seepage monitoring bores where groundwater quality will not have been affected by the petroleum activities authorised under this environmental authority to use as reference sites for determining impacts (e) installation of seepage monitoring bores that: i. are within formations potentially affected by the containment facilities authorised under this environmental authority (i.e. within the potential area of impact) ii. provide for the early detection of negative impacts prior to reaching groundwater dependent ecosystems, landholder's active groundwater bores, or water supply bores iii. provide for the early detection of negative impacts prior to reaching migration pathways to other formations (i.e. faults, areas of unconformities known to connect two or more formations) (f) monitoring of groundwater at each background and seepage monitoring bore at least quarterly for the trigger parameters identified in condition (Water 13(b)) (g) seepage trigger action response procedures for when trigger parameters and trigger levels identified in conditions (Water 13(b)) and (Water 13(c)) trigger the early detection of seepage, or upon becoming aware of any monitoring results that indicate potential groundwater contamination (h) a rationale detailing the program conceptualisation including assumptions, determinations, monitoring equipment, sampling methods and data analysis; and (i) provides for annual updates to the program for new containment facilities constructed in each annual return period.	

Ref	Condition	Action program for compliance
SEEPAGE MONITORING BORE DRILL LOGS		
Water 14	A bore drill log must be completed for each seepage monitoring bore in condition (Water 13) which must include: (a) bore identification reference and geographical coordinate location (b) specific construction information including but not limited to depth of bore, depth and length of casing, depth and length of screening and bore sealing details (c) standing groundwater level and water quality parameters including physical parameter and results of laboratory analysis for the possible trigger parameters (d) lithological data, preferably a stratigraphic interpretation to identify the important features including the identification of any aquifers; and (e) target formation of the bore.	Not applicable. No significant chemical fuel and/or waste storages such as monocells and dams proposed.
REHABILITATION		
REHABILITATION PLANNING		
Rehabilitation 1	A Rehabilitation Plan must be developed by a suitably qualified person and must include the: (a) rehabilitation goals; and (b) procedures to be undertaken for rehabilitation that will: i. achieve the requirements of conditions (Rehabilitation 2) to (Rehabilitation 8), inclusive; and ii. provide for appropriate monitoring and maintenance.	A Rehabilitation Plan will be developed by a suitably qualified person and will include the information outlined in Rehabilitation 1.
TRANSITIONAL REHABILITATION		
Rehabilitation 2	Significantly disturbed areas that are no longer required for the on-going petroleum activities, must be rehabilitated within 12 months (unless an exceptional circumstance in the area to be rehabilitated (e.g. a flood event) prevents this timeframe being met) and be maintained to meet the following acceptance criteria: (a) contaminated land resulting from petroleum activities is remediated and rehabilitated (b) the areas are: i. non-polluting ii. a stable landform	Blue Energy will rehabilitate significantly disturbed areas that are no longer required within 12 months, except in the event that exceptional circumstances prevent this from occurring. The rehabilitated areas will be maintained to meet the acceptance criteria in Rehabilitation 2.

Ref	Condition	Action program for compliance
	iii. re-profiled to contours consistent with the surrounding landform (c) surface drainage lines are re-established (d) top soil is reinstated; and (e) either: i. groundcover, that is not a declared pest species, is growing; or ii. an alternative soil stabilisation methodology that achieves effective stabilisation is implemented and maintained.	
FINAL REHABILITATION ACCEPTANCE CRITERIA		
Rehabilitation 3	All significantly disturbed areas caused by petroleum activities which are not being or intended to be utilised by the landholder or overlapping tenure holder, must be rehabilitated to meet the following final acceptance criteria measured either against the highest ecological value adjacent land use or the pre-disturbed land use: (a) greater than or equal to 70% of native ground cover species richness (b) greater than or equal to the total per cent of ground cover (c) less than or equal to the per cent species richness of declared plant pest species; and (d) where the adjacent land use contains, or the pre-clearing land use contained, one or more regional ecosystem(s), then at least one regional ecosystem(s) from the same broad vegetation group, and with	All significantly disturbed areas caused by petroleum activities which are not being or intended to be utilised by the landholder or overlapping tenure holder, will be rehabilitated to meet the final acceptance criteria outlined in Rehabilitation 3.
FINAL REHABILITATION ACCEPTANCE CRITERIA IN ENVIRONMENTALLY SENSITIVE AREAS		
Rehabilitation 4	Where significant disturbance to land has occurred in an environmentally sensitive area, the following final rehabilitation criteria as measured against the pre-disturbance biodiversity values assessment (required by conditions (Biodiversity 1) and (Biodiversity 2)) must be met: (a) greater than or equal to 70% of native ground cover species richness (b) greater than or equal to the total per cent ground cover (c) less than or equal to the per cent species richness of declared plant pest species (d) greater than or equal to 50% of organic litter cover (e) greater than or equal to 50% of total density of coarse woody material; and	Where significant disturbance to land has occurred in an environmentally sensitive area, the final rehabilitation criteria outlined in Rehabilitation 4 as measured against the pre-disturbance biodiversity values assessment (required by conditions (Biodiversity 1) and (Biodiversity 2)) will be met.

Ref	Condition	Action program for compliance
	(f) all predominant species in the ecologically dominant layer, that define the pre-disturbance regional ecosystem(s) are present.	
CONTINUING CONDITIONS		
Rehabilitation 5	Conditions (Rehabilitation 2), (Rehabilitation 3) and (Rehabilitation 4) continue to apply after this environmental authority has ended or ceased to have effect.	Noted.
REHABILITATION REPORTING FOR RELINQUISHMENT OF PART OF AN AUTHORITY TO PROSPECT AREA UNDER THE PETROLEUM AND GAS (PRODUCTION AND SAFETY) ACT 2004		
Rehabilitation 6	Prior to relinquishing all or part of an authority to prospect area, a rehabilitation report must be prepared which specifically relates to the area to be relinquished and demonstrates condition (Rehabilitation 2), (Rehabilitation 3) and (Rehabilitation 4) has been met.	A rehabilitation report will be developed prior to relinquishing all or part of an authority to prospect area which specifically relates to the area to be relinquished and demonstrates Rehabilitation 2 to Rehabilitation 4 have been met.
Rehabilitation 7	The report required under condition (Rehabilitation 6) must be submitted to the administering authority at least 40 business days prior to the relinquishment notice being lodged with the administering authority for the Petroleum and Gas (Production and Safety) Act 2004.	The report required in Rehabilitation 6 will be submitted to the administering authority at least 40 business days prior to the relinquishment notice being lodged.
REMAINING DAMS		
Rehabilitation 8	Where there is a dam (including a low consequence dam) that is being or intended to be utilised by the landholder or overlapping tenure holder, the dam must be decommissioned to no longer accept inflow from the petroleum activity(ies) and the contained water must be of a quality suitable for the intended on-going uses(s) by the landholder or overlapping tenure holder.	Not applicable, as there are no dams proposed as a part of the Project.
WELL CONSTRUCTION, MAINTENANCE AND STIMULATION ACTIVITIES		
DRILLING ACTIVITIES		
Well activities 1	Oil based or synthetic based drilling muds must not be used in the carrying out of the petroleum activity(ies).	No oil or synthetic based drilling muds will be used.
Well activities 2	Drilling activities must not result in the connection of the target gas producing formation and another aquifer.	Drilling activities will not result in the connection of the target gas producing formation and another aquifer.

Ref	Condition	Action program for compliance
Well activities 3	Practices and procedures must be in place to detect, as soon as practicable, any fractures that have or may result in the connection of a target formation and another aquifer as a result of drilling activities.	A groundwater and surface water monitoring program will be developed to monitor impacts to target formations and other aquifers accordingly.
STIMULATION ACTIVITIES		
Well activities 4	Stimulation activities are not permitted	No stimulation activities are proposed as a part of the Project.
Well activities 5	Polycyclic aromatic hydrocarbons or products that contain polycyclic aromatic hydrocarbons must not be used in stimulation fluids in concentrations above the reporting limit.	Not applicable. No stimulation activities are proposed.
Well activities 6	Stimulation activities must not negatively affect water quality, other than that within the stimulation impact zone of the target gas producing formation.	Not applicable. No stimulation activities are proposed.
Well activities 7	Stimulation activities must not cause the connection of the target gas producing formation and another aquifer.	Not applicable. No stimulation activities are proposed.
Well activities 8	The internal and external mechanical integrity of the well system prior to and during stimulation must be ensured such that there is: (a) no significant leakage in the casing, tubing, or packer; and (b) there is no significant fluid movement into another aquifer through vertical channels adjacent to the well bore hole.	Not applicable. No stimulation activities are proposed.
Well activities 9	Practices and procedures must be in place to detect, as soon as practicable, any fractures that cause the connection of a target gas producing formation and another aquifer.	Not applicable. No stimulation activities are proposed.
STIMULATION RISK ASSESSMENT		
Well activities 10	Prior to undertaking stimulation activities, a risk assessment must be developed to ensure that stimulation activities are managed to prevent environmental harm.	Not applicable. No stimulation activities are proposed.
Well activities 11	The stimulation risk assessment must be carried out for every well to be stimulated prior to stimulation being carried out at that well and address issues at a relevant geospatial scale such that changes to features and attributes are adequately described and must include, but not necessarily be limited to: (a) a process description of the stimulation activity to be applied, including equipment and a comparison to best international practice	Not applicable. No stimulation activities are proposed.

Ref	Condition	Action program for compliance
	(b) provide details of where, when and how often stimulation is to be undertaken on the tenures covered by this environmental authority (c) a geological model of the field to be stimulated including geological names, descriptions and depths of the target gas producing formation(s) (d) naturally occurring geological faults (e) seismic history of the region (e.g. earth tremors, earthquakes) (f) proximity of overlying and underlying aquifers (g) description of the depths that aquifers with environmental values occur, both above and below the target gas producing formation (h) identification and proximity of landholder' active groundwater bores in the area where stimulation activities are to be carried out (i) the environmental values of groundwater in the area (j) an assessment of the appropriate limits of reporting for all water quality indicators relevant to stimulation monitoring in order to accurately assess the risks to environmental values of groundwater (k) description of overlying and underlying formations in respect of porosity, permeability, hydraulic conductivity, faulting and fracture propensity (l) consideration of barriers or known direct connections between the target gas producing formation and the overlying and underlying aquifers (m) a description of the well mechanical integrity testing program (n) process control and assessment techniques to be applied for determining extent of stimulation activities (e.g. micro seismic measurements, modelling etc.) (o) practices and procedures to ensure that the stimulation activities are designed to be contained within the target gas producing formation (p) groundwater transmissivity, flow rate, hydraulic conductivity and direction(s) of flow (q) a description of the chemical compounds used in stimulation activities (including estimated total mass, estimated composition, chemical abstract service numbers and properties), their mixtures and the resultant compounds that are formed after stimulation (r) a mass balance estimating the concentrations and absolute masses of chemical compounds that will be reacted, returned to the surface or left in the target gas producing formation subsequent to stimulation (s) an environmental hazard assessment of the chemicals used including their mixtures and the resultant chemicals that are formed after stimulation including:	

Ref	Condition	Action program for compliance
	i. toxicological and ecotoxicological information of chemical compounds used ii. information on the persistence and bioaccumulation potential of the chemical compounds used; and iii. identification of the chemicals of potential concern in stimulation fluids derived from the risk assessment (t) an environmental hazard assessment of use, formation of, and detection of polycyclic aromatic hydrocarbons in stimulation activities (u) identification and an environmental hazard assessment of using radioactive tracer beads in stimulation activities (v) an environmental hazard assessment of leaving chemical compounds in stimulation fluids in the target gas producing formation for extended periods subsequent to stimulation (w) human health exposure pathways to operators and the regional population (x) risk characterisation of environmental impacts based on the environmental hazard assessment (y) potential impacts to landholder bores as a result of stimulation activities (z) an assessment of cumulative underground impacts, spatially and temporally of the stimulation activities to be carried out on the tenures covered by this environmental authority; and (aa) potential environmental or health impacts which may result from stimulation activities including but not limited to water quality, air quality (including suppression of dust and other airborne contaminants), noise and vibration.	
WATER QUALITY BASELINE MONITORING		
Well activities 12	Prior to undertaking any stimulation activity, a baseline bore assessment must be undertaken of the water quality of: (a) all landholder's active groundwater bores (subject to access being permitted by the landholder) that are spatially located within a two (2) kilometre horizontal radius from the location of the stimulation initiation point within the target gas producing formation; and (b) all landholders' active groundwater bores (subject to access being permitted by the landholder) in any aquifer that is within 200m above or below the target gas producing formation and is spatially located with a two (2) kilometre radius from the location of the stimulation initiation point; and	Not applicable. No stimulation activities are proposed.

Ref	Condition	Action program for compliance
	(c) any other bore that could potentially be adversely impacted by the stimulation activities in accordance with the findings of the risk assessment required by conditions (Well activities 10) and (RMW026).	
RMW028	Prior to undertaking stimulation activities at a well, there must be sufficient water quality data to accurately represent the water quality in the well to be stimulated. The data must include as a minimum the results of analyses for the parameters in condition (RMW029).	Not applicable. No stimulation activities are proposed.
RMW029	Baseline bore and well assessments must include relevant analytes and physio-chemical parameters to be monitored in order to establish baseline water quality and must include, but not necessarily be limited to: (a) pH (b) electrical conductivity [µS/m] (c) turbidity [NTU] (d) total dissolved solids [mg/L] (e) temperature [ºC] (f) dissolved oxygen [mg/L] (g) dissolved gases (methane, chlorine, carbon dioxide, hydrogen sulfide) [mg/L] (h) alkalinity (bicarbonate, carbonate, hydroxide and total as CaCO3) [mg/L] (i) sodium adsorption ratio (SAR) (j) anions (bicarbonate, carbonate, hydroxide, chloride, sulphate) [mg/L] (k) cations (aluminium, calcium, magnesium, potassium, sodium) [mg/L] (l) dissolved and total metals and metalloids (including but not necessarily being limited to: aluminium, arsenic, barium, borate (boron), cadmium, total chromium, copper, iron, fluoride, lead, manganese, mercury, nickel, selenium, silver, strontium, tin and zinc) [µg/L] (m) total petroleum hydrocarbons [µg/L] (n) BTEX (as benzene, toluene, ethylbenzene, ortho-xylene, para- and meta-xylene, and total xylene) [µg/L] (o) polycyclic aromatic hydrocarbons (including but not necessarily being limited to: naphthalene, phenanthrene, benzo[a]pyrene) [µg/L] (p) sodium hypochlorite [mg/L] (q) sodium hydroxide [mg/L] (r) formaldehyde [mg/L] (s) ethanol [mg/L]; and	Groundwater parameters outlined in RMW029 will all be analysed as required.

Ref	Condition	Action program for compliance
	(t) gross alpha + gross beta or radionuclides by gamma spectroscopy [Bq/L].	
STIMULATION IMPACT MONITORING PROGRAM		
RMW030	A stimulation impact monitoring program must be developed prior to the carrying out of stimulation activities which must be able to detect adverse impacts to water quality from stimulation activities and must consider the findings of the risk assessment required by conditions (Well activities 10) and (Well activities 11) that relate to stimulation activities and must include, as a minimum, monitoring of: (a) the stimulation fluids to be used in stimulation activities at sufficient frequency and which sufficiently represents the quantity and quality of the fluids used (b) flow back waters from stimulation activities at sufficient frequency and which sufficiently represents the quality of that flow back water (c) flow back waters from stimulation activities at sufficient frequency and accuracy to demonstrate that 150% of the volume used in stimulation activities has been extracted from the stimulated well; and (d) all bores in accordance with condition (RMW027).	Not applicable. No stimulation activities are proposed.
RMW031	The stimulation impact monitoring program must provide for monitoring of: (a) analytes and physio-chemical parameters relevant to baseline bore and well assessments to enable data referencing and comparison including, but not necessarily being limited to the analytes and physicochemical parameters in condition (RMW029); and (b) any other analyte or physio-chemical parameters that will enable detection of adverse water quality impacts and the inter-connection with a non-target aquifer as a result of stimulation activities including chemical compounds that are actually or potentially formed by chemical reactions with each other or coal seam materials during stimulation activities.	Not applicable. No stimulation activities are proposed.
RMW032	The stimulation impact monitoring program must provide for monitoring of the bores in condition (Well activities 15(d)) at the following minimum frequency: (a) monthly for the first six (6) months subsequent to stimulation activities being undertaken; then	Not applicable. No stimulation activities are proposed.

Ref	Condition	Action program for compliance
	(b) annually for the first five (5) years subsequent to stimulation being undertaken or until analytes and physio-chemical parameters listed in conditions (RMW029(a)) to (RMW029(t)) inclusive, are not detected in concentrations above baseline bore monitoring data on two (2) consecutive monitoring occasions.	
RMW033	The results of the stimulation impact monitoring program must be made available to any potentially affected landholder upon request by that landholder.	Not applicable. No stimulation activities are proposed.

APPENDIX B1

Likelihood of Occurrence Tables

Table D1 Likelihood of occurrence assessments for EVNT flora identified in PMST and WO searches in a 20km radius from the PLs

Status[1]		Family	Scientific name	Common name	Ecology	PL	WO records + Source[2]	Potential to occur in the PL
NCA	EPBC							
E	—	Amaranthaceae	*Ptilotus uncinellus*	–	An annual herb with stems growing up to 1.2m long and flowers and fruits from April to June. This species is known from three sites; two sites that occur 6km apart in the vicinity of the Newlands coal mine approximately 130km west of Mackay and one site ~8km to the east of the Moranbah coal mine. This species prefers south-facing slopes in woodlands of *Acacia shirleyi* on tertiary plateaux (Bean, 2010).	Lancewood	—	—
						Central	—	—
						Sapphire	1 (WO)	High— There is one record of this species ~5km to the northwest of the PL. Desktop assessments identified areas of potentially suitable habitat (South facing slopes dominated by *Acacia spp.*) for this species within the PL. Due to the presence of a local record and potentially suitable habitat for this species within the PL's it is considered that this species has a high likelihood of occurring within the PL.
NT	—	Apocynaceae	*Cerbera dumicola*	–	This is a distinctive species due to its shrubby to small tree (to 4m) habit and the foliage often having sinuate margins. This species is known from 37 populations in central coastal and subcoastal QLD, with few populations local in central QLD. This species occurs across a range of habitats including sandstone hills, plateaus, woodlands, mine rehabilitation area, sand/clay and rhyolite slopes, evergreen vine thicket and on brown sandy loam (DES, 2021d and references therein).	Lancewood	—	—
						Central	3 (WO)	High— There several local records of this species within 20km of the PL, one of which is ~5km to the west of the PL. Based on spatial imagery, ground-truthed and State mapped RE mapping, it is considered that local habitat for this species extends into the PL. Therefore, it is considered that this species has a high likelihood of occurring.
						Sapphire	7 (WO)	High – There are several local records of this species within 20km of the PL, one of which is located ~750m from the northern boundary of the PL. Based on spatial imagery, ground-truthed and State mapped RE mapping, it is considered that local habitat for this species extends into the PL. Therefore, it is considered that this species has a high likelihood of occurring.
V	V	Asteraceae	*Ozothamnus eriocephalus*	Eungella Hairy Daisy	This species is endemic to QLD and is known from the Bowen and Mackay area of Central QLD. This species is documented to occur at Pease Lookout and Dick's tableland in the Eungella National Park, Sydney Heads in Homevale National Park, Finch Hatton Gorge, Lake Elphinstone, Mt Abbott (two small populations), Gloucester island and Redcliffe vale. Within these areas, this species is known from a range of habitat types, including the margins of notophyll vine forest, margins of gallery forest, microphyll vine forest, tall open *Eucalyptus andrewsii/Eucalyptus resinifera* forest with an understory of *Allocasuarina littoralis*; tall open forest with *Eucalyptus drepanophylla, Eucalyptus acmenoides, Corymbia intermedia* and *Corymbia citriodora*; in open eucalypt forest and on rocky ridges with Eucalyptus spp. and Acacia spp. scrub. It is also known from the edge of creek banks, crevices on steep granite slopes in sunny situations. Additionally, this species occurs from moderate to high elevations ranging from 380 – 950m asl on skeletal sandy or gravelly soils or occasionally on deep red-brown clay loams derived from granites and sandstones (DES, 2021d and references therein).	Lancewood	PM	Moderate— There are several local records of this species between 22-24kms to the north of the PL (ALA, 2021) in vegetation communities also mapped to occur within the PL. Overall, for the above reasons, it is considered that this species has a high likelihood of occurring within the PL.
						Central	—	—
						Sapphire	—	—
NT	—	Combretaceae	*Macropteranthes leiocaulis*	Smooth-barked Bonewood	This species is a deciduous shrub or small tree to 25m high and occurs from the Mingela Bluff, south of Townsville, to Binjour Plateau west of Maryborough in dry rainforest and vine thicket communities. This species is similar to *Macropteranthes fitzalanii*, however is distinguished from the former species by the hairy calyx tube, the bracteoles are shorter than the calyx and the shorter flower pedicels (ATRP, 2020).	Lancewood	2 (WO)	High— There are several local records of this species within 20kms from the PL. Desktop assessments identified several vine thicket and other potentially suitable vegetation communities for this species to occur within the PL. Therefore, it is considered that this species has a high likelihood of occurring within the PL.

Status[1]		Family	Scientific name	Common name	Ecology	PL	WO records + Source[2]	Potential to occur in the PL
NCA	EPBC							
						Central	—	—
						Sapphire	—	—
LC	V	Euphorbiaceae	*Bertya opponens*	Coolabah Bertya	This species occurs in the Brigalow Belt, New England Tableland and South Eastern Queensland bioregions within Queensland, and in northern NSW (TSSC, 2016a). It has a poorly-known but likely low area of occupancy at less than 2000km2, with a patchy distribution in Queensland largely centred on the southeast and central south of the state, with a small disjunct population in the Charters Towers region in the far northern Brigalow Belt (TSSC, 2016a). It occurs in various habitats, primarily open woodlands and shrublands including those dominated by lancewood, mallee, *Eucalyptus* / *Acacia* communities and Eucalyptus / Callitris communities, and has been recorded in semi-evergreen vine thicket (TSSC, 2016a and references therein). The species is threatened by land clearing and other disturbance, inappropriate fire regimes and grazing by feral goats (TSSC, 2016a and references therein).	Lancewood	PM	High— There is one record of this species occurring ~6km to the south of the PL (ALA, 2021), which is provided by the QLD herbarium. Desktop assessments identified habitat likely to be suitable for this species to be present within the PL. Therefore, it is considered that this species has a high likelihood of occurring within the PL.
						Central	—	—
						Sapphire	—	—
NT	—	Euphorbiaceae	*Bertya pedicellata*	–	This species is distributed from Moranbah to Mundubbera inland as far as Jericho in QLD and occurs in eucalypt woodlands and forests, Acacia woodland and shrubland on rocky slopes of skeletal sandy/loamy soils. It is associated with species such as *Corymbia trachyphloia*, *Dodonaea filifolia*, *A. catenulata*, *A. curvinervia*, *A. harpophylla, A. shirleyi*, *A. rhodoxylon*, *A. sparsiflora*, *E. crebra*, and *E. decorticans* (DES, 2021d and references therein).	Lancewood	—	—
						Central	9 (WO)	High - There are several local records of this species within the vicinity of the PLs. Additionally, desktop assessments identified potentially suitable habitat for this species within the PLs. For the above reasons, it is considered that this species has a high likelihood of occurring within the PLs.
						Sapphire	6 (WO)	
V	V	Euphorbiaceae	*Omphalea celata*	–	This species is restricted to Hazelwood Gorge and Gloucester Island in central QLD. It occurs within semi-evergreen vine thicket communities and microphyll vine forests in association with watercourses, gullies and steep slopes and associates with species such as *E. raveretiana, E. tereticornis, Lysiphyllum hookeri* and *Ficus opposita* (DES, 2021d and references therein).	Lancewood	PM	Low—There are no records of this species within 20km of the PL and the closest record is approximately 35km east, adjacent to a National Park (ALA, 2021). Due to the restricted distribution of this species, which does not encompass the PL, it is considered unlikely that this species occurs within the PL.
						Central	—	—
						Sapphire	—	—
LC	V	Myrtaceae	*Eucalyptus raveretiana*	Black Ironbox	This species has a wide distribution in coastal and sub-coastal areas of Queensland, from south of Townsville to Nebo, around Rockhampton and areas 100 km west of the city. It has been recorded from about 23 sites throughout its range, in two main areas: Nebo to Ayr and Aps Creek to Rockhampton. The majority of sites are on roadsides, freehold land and leasehold land. However, it is also present in both state forests and national parks. This species typically grows along watercourses or occasionally river flats, in open forest and woodland, and is known from a variety of soils from sand through to heavy clay. Black Ironbox has been recorded as a co-dominant alongside a range other species including *Melaleuca leucadendra, Eucalyptus tereticornis, Corymbia tessellaris, E. camaldulensis, Casuarina cunninghamiana*, and *Melaleuca fluviatilis* (DAWE 2021b).	Lancewood	PM	Low— There are 2 ALA records of this species within 20km of the PLs (ALA, 2021). This species occurs in association with watercourses and alluvial soils (DAWE, 2021b) – habitats within the PLs are unlikely to be suitable for the species. Overall, it is considered that this species has a low likelihood of occurrence within the PLs.
						Central	PM	
						Sapphire	PM	Low— There are no records of this species within 20km of the PL. This species occurs in association with watercourses and alluvial soils (DAWE, 2021b) – habitats within the PL are unlikely to be suitable for the species. Overall, it is considered that this species has a low likelihood of occurrence within the PL.

Status[1]		Family	Scientific name	Common name	Ecology	PL	WO records + Source[2]	Potential to occur in the PL
NCA	EPBC							
V	E	Poaceae	*Dichanthium queenslandicum*	King Bluegrass	This species' distribution is west of Townsville to Toowoomba QLD, occurring in open eucalypt woodlands, grasslands and Acacia thickets on black clay soils. Associated species include *Acacia salicina, C. dallachiana, C. erythrophloia, E. orgadophila, Aristida leptopoda*, *Bothriochloa erianthoides*, *Moorochloa eruciformis*, *Corchorus trilocularis*, *Cyperus bifax*, *Dichanthium sericeum*, *Digitaria brownii*, *Digitaria divaricatissima*, *Eulalia fulva*, *Ipomoea lonchophylla*, *Iseilema vaginiflorum*, *Panicum decompositum*, *Panicum queenslandicum*, *Paspalidium globoideum*, *Parthenium hysterophorus* and *Thellungia advena* (DES, 2021d and references therein).	Lancewood	18 (WO), PM	Low— There are 18 records of this species within 20km of the PL. Based on ground-truthed and state mapped RE communities occurring within the PL it is considered that habitats within the PL is likely to be degraded or unsuitable for this species. Overall, it is considered that this species has a low likelihood of occurring within the PL.
						Central	PM	Low—The nearest records of this species are 20-25km from the PL (ALA, 2021), and there are several scattered records in the broader region surrounding the PL. Open eucalypt woodland is present although is likely degraded due to prior disturbances and unsuitable for this species. Overall, it is considered that this species has a low to moderate likelihood of occurring within the PL due to an absence of local records and likely unsuitable habitat.
						Sapphire	3 (WO), PM	Moderate—There are 3 records of this species within 20km of the PL and potentially suitable grassland communities are State mapped to be present within the PL, although are likely degraded due to prior disturbances from agriculture. Overall, it is considered that this species has a moderate likelihood of occurring within the PL.
LC	V	Poaceae	*Dichanthium setosum*	Bluegrass	This species occurs in inland QLD and NSW, with Queensland populations in the southern and central Brigalow Belt, the Central Queensland Highlands and the Einasleigh Uplands between Charters Towers and Georgetown. Other scattered records occur in the Cape York Peninsula and Northwest Highlands. It is found in moderately disturbed areas such as cleared woodland and grassy roadside remnants. It is typically associated with heavy black soils and red-brown loams with clay subsoil (DES, 2021d and references therein).	Lancewood	PM	Low—The nearest local record of this species is approximately 25km east of the PL (ALA, 2021). Very little suitable habitat may be present, particularly with regard to soil type. Overall, it is considered that this species has a low likelihood of occurring within the PL.
						Central	PM	Low—There are no records of this species within 20km of the PL. Very little suitable habitat may be present, particularly with regard to soil type. Overall, it is considered that this species has a low likelihood of occurring within the PL.
						Sapphire	PM	Moderate—There are no records of this species within 20km of the PL, however the PL occurs within the distribution of this species. Desktop assessments show that there are areas of potentially suitable grassland communities for this species State mapped to occur within the PL. Overall, it is considered that this species has a moderate likelihood of occurring based on the presence of potentially suitable habitat and the PL occurring within the known distribution of this species.
NT	—	Poaceae	*Digitaria porrecta*	Finger Panic Grass	This species has a clustered distribution throughout the Brigalow Belt in QLD and NSW. In Queensland, there are isolated records in the Nebo district and near Rolleston, however most records are close to Toowoomba. It occurs in tussock grassland and open eucalypt woodland, associated with *Eucalyptus populnea* and *E. tereticornis* on cracking clay soils (DES, 2021d and references therein).	Lancewood	4 (WO)	Low—There are four local records of this species occurring within 20km of the PL and potentially suitable habitat for this species may occur within the southern portion of the PL. However, it is considered that this habitat is likely to be degraded or unsuitable for this species. Overall, it is considered that this species has a low likelihood of occurring within the PL.
						Central	—	—
						Sapphire	—	—
V	V	Simaroubaceae	*Samadera bidwillii*	Quassia		Lancewood	PM	Low— There are no records of this species within 20km of the PL. The PL occurs within the mapped distribution, however very little ideal habitat is present. Overall, it is considered that this species is unlikely to occur within the PL.

Status[1]		Family	Scientific name	Common name	Ecology	PL	WO records + Source[2]	Potential to occur in the PL
NCA	EPBC							
					This species is a small shrub or tree that grows about 6m in height with red flowers and fruit from November to March. This species occurs between Scawfell Island near Mackay and Goomboorianm, north of Gympie. It usually occurs in lowland rainforest or rainforest margins, but also occurs in open forest, woodland, and adjacent to both temporary and permanent water courses (DAWE, 2021b).	Central	PM	Low— There are no records of this species within 20km of the PL. The PL occurs within the mapped distribution, however very little ideal habitat is present. Overall, it is considered that this species is unlikely to occur within the PL.
						Sapphire	PM	Low— There are no WO records of this species within 20km of the PL (DAWE, 2021a). The PL occurs within the mapped distribution, however very little ideal habitat is present. Overall, it is considered that this species is unlikely to occur within the PL.
E	—	Solanaceae	*Solanum adenophorum*	–	This is a perennial shrub growing to 40cm high. The species is endemic to Queensland in the Dingo-Nebo-Clermont region, growing in Acacia woodland on slight slopes and in deep cracking clay soils (DES, 2021d and references therein).	Lancewood	—	—
						Central	—	—
						Sapphire	2 (WO)	Moderate—There are two WO records of this species occurring within 20km of the PL and suitable habitat may be present on site, but due to prior disturbance habitats are somewhat degraded. Overall, this species is considered to have a moderate likelihood of occurring within the PL.

1. Status: LC = Least Concern, NT = Neat Threatened, V = Vulnerable, E = Endangered
2. Source: WO = Queensland Government Wildlife Online Database Extract (20km radius search area), PM = EPBC Act Protected Matters Report

Table B2 Likelihood of occurrence assessments for EVNT fauna identified in PMST and WO searches in a 20km radius from the PLs

Status[1]		Family	Scientific name	Common name	Ecology	PL	WO records + Source[2]	Potential to occur in the PL
NCA	EPBC							
BIRDS								
E	V	Accipitridae	*Erythrotriorchis radiatus*	Red Goshawk	This species prefers open forests and woodland with a mosaic of vegetation types, particularly near riverine systems and permanent water where there is an abundance of prey species (DAWE, 2021b and references therein). The home range in northern Australia has been reported up to 200km^2, with indications it may be even larger (Aumann & Baker-Gabb, 1991).	Lancewood	3 (WO), PM	Moderate— there are 3 WO records of this species within 20km of the PL and the nearest record of the species is approximately 12km north of the PL (ALA, 2021). Habitat suitability for the species is low—it requires extensive tracts of remnant savannah woodland interspersed with watercourses and riparian vegetation that supports tall eucalypts (DAWE, 2021); though these values are somewhat represented in the PL, very little habitat value for the species is present in the broader area.
						Central	PM	Low— there no WO records of this species within 20km of the PL (DAWE, 2021a) and the nearest record of the species is approximately 50km east of the PL (ALA, 2021). Habitat suitability for the species is low—it requires extensive tracts of remnant savannah woodland interspersed with watercourses and riparian vegetation that supports tall eucalypts (DAWE, 2021); though these values are somewhat represented in the PL, very little habitat value for the species is present in the broader area.

						Sapphire	PM	Low— there no WO records of this species within 20km of the PL (DAWE, 2021a) and the nearest record of the species is approximately 50km east of the PL (ALA, 2021). Habitat suitability for the species is low—it requires extensive tracts of remnant savannah woodland interspersed with watercourses and riparian vegetation that supports tall eucalypts (DAWE, 2021); though these values are somewhat represented in the PL, very little habitat value for the species is present in the broader area.
V	V, M	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	The White-throated Needletail breeds in the Northern Hemisphere but is widespread in eastern and south-eastern Australia during summer months (Higgins, 1999). There are sporadic records of this species found in inland Australia with the majority occurring along the coast and western edge of the Great Dividing Range (DAWE, 2021b). The White-throated Needletail is thought to be almost completely aerial when in Australia and large flocks typically follow low pressure systems (DAWE, 2021b and references therein). Although they occur over most types of habitat, they are probably recorded most often above wooded areas, including open forest and rainforest (Higgins, 1999).	Lancewood	1 (WO)	Low— There is one record of this species within 20kms of the PL. Activities within the PL are likely to occupy terrestrial habitats, which are not often utilised by this species. Therefore, as this species is almost completely aerial, it is unlikely to occur in terrestrial habitats within the PL. Overall, it is considered that this species has a low likelihood of occurring within the PL as the terrestrial habitat present is considered unsuitable for this species.
						Central	-	-
						Sapphire	-	-
V	V	Columbidae	*Geophaps scripta scripta*	Squatter Pigeon (southern)	The Squatter Pigeon (southern subspecies) occurs between southern Cape York (the Lynd region) and the Border Rivers region of northern NSW (DAWE, 2021b). It occupies remnant, regrowth and slightly modified open forests, preferably with an open understorey (not exceeding 33% cover of perennial tussock grasses, forbs and shrubs) on sandy or gravelly soils, and generally breeds on stony rises (DAWE, 2021b and references therein). The species is rarely encountered more than 1km from a water source.	Lancewood	6 (WO), PM	High—There are 6 WO records of this species occurring within 20km of the PL. This species is regularly recorded throughout the region and there are also several records of this species within 40km of the PL (ALA, 2021). Suitable habitat, including foraging and potential breeding habitat, exists on the PL, particularly in the wet season when ephemeral watercourses contain water.
						Central	20 (WO), PM	Present—There are 20 WO records of this species occurring within 20km of the PL and this species was incidentally observed to occur around a cattle dam during field assessments.
						Sapphire	40 (WO), PM	High—There are 40 WO records of this species occurring within 20km of the PL. This species is regularly recorded throughout the region and there are also several records of this species within 30km of the PL (ALA, 2021). Suitable habitat, including foraging and potential breeding habitat, exists on the PL, particularly in the wet season when ephemeral watercourses contain water.
E	E	Estrildidae	*Neochmia ruficauda ruficauda*	Star Finch	This species occurs only in central Queensland and the overall distribution of this species is very poorly known. There have not been any records since 1995 and it is possible that the subspecies is extinct (Curtis *et al*., 2012, Garnett et al. 2011). The distribution of this species is believed to have extended north to Bowen, west to beyond Winton and south to near Wowan (DAWE, 2021b). This species occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water. It also occurs in cleared or suburban areas such as along roadsides and in towns (DAWE, 2021b, and references therein).	Lancewood	PM	Low—The nearest record to the PL is more than 100km to the west and was recorded in 1988 (ALA, 2021). There is potentially suitable habitat within the PL based on current RE mapping, including grassy woodland. However, the southern Star Finch is generally considered extinct, having undergone a severe contraction in range as a result of habitat alteration and loss due to agriculture (DAWE, 2021b); it is considered unlikely that this species occurs in the PL.
						Central	PM	Low—The nearest record to the PLs is more than 70km to the south and was recorded in 1903 (ALA, 2021). There is potentially suitable habitat

						Sapphire	PM	within the PLs based on current RE mapping, including grassy woodland. However, the southern Star Finch is generally considered extinct, having undergone a severe contraction in range as a result of habitat alteration and loss due to agriculture (DAWE, 2021b); it is considered unlikely that this species occurs in the PLs.
E	E	Estrildidae	*Poephila cincta cincta*	Black-throated Finch (southern)	This species occurs mainly in grassy, open woodlands and forests, typically dominated by *Eucalyptus*, *Corymbia* and *Melaleuca* spp., and occasionally in tussock grasslands or other habitats, often along or near watercourses, or in the vicinity of water (DAWE, 2021b and references therein). This southern subspecies has experienced a marked range contraction since the nearby records were gathered in 1976 and is now restricted to two populations: one in the vicinity of Townsville and Charters Towers, and the second in the Central Highlands (DAWE, 2021b).	Lancewood	PM	Low—the PLs are not within a 'Black-throated Finch Important Area' (DEWHA, 2009). The nearest record is approximately 150km south-east of the PLs, although location data is highly generalised (ALA, 2021). This subspecies has undergone a marked contraction in its range in recent decades (DAWE, 2021b), and its current distribution does not include the PLs.
						Central	PM	
						Sapphire	PM	
V	V	Falconidae	*Falco hypoleucos*	Grey Falcon	This species distribution is centred on inland drainage systems—it is usually restricted to shrubland, grassland and wooded water courses and occasionally found in open woodlands near the coast (Garnett *et al*., 2011).	Lancewood	PM	Low—there are no records for this species within 20km of the PLs (DES, 2021d). There is very limited potentially suitable habitat for this species, including Acacia shrubland, and the closest records are located near Mackay, apart from an isolated, generalised record approximately 70km west of the PLs (ALA, 2021). Overall, it is considered that this species has a low likelihood of occurring within the PLs.
						Central	PM	
						Sapphire	PM	
E	E	Rostratulidae	*Rostratula australis*	Australian Painted Snipe	This species has been recorded at wetland sites throughout much of Australia but is most common in the eastern states. The Australian Painted Snipe is a distinct species but can be hard to detect due to its cryptic and crepuscular behaviour. This species typically occurs in shallow freshwater wetlands and other permanently or temporarily inundated areas, particularly where rank tussocks of grasses, sedges, rushes or reeds are present (DAWE, 2021b; Morcombe, 2003).	Lancewood	PM	Low—There are no records of this species within 20km of the PL (DES, 2021d) and the PL does not contain and suitable habitat (wetlands or areas prone to waterlogging). Overall, it is considered that this species has a low likelihood of occurring within the PL.
						Central	PM	Low—There are no WO records of this species within 20km of the PL (DES, 2021d), although there is one generalised ALA record (spatial uncertainty 10km) within 25km of the PL (ALA, 2021). The PL does not contain and suitable habitat (wetlands or areas prone to waterlogging). Overall, it is considered that this species has a low likelihood of occurring within the PL.
						Sapphire	PM	Low—There are no WO records of this species within 20km of the PL (DES, 2021d), although there is one generalised ALA record (spatial uncertainty 10km) within 12km of the PL (ALA, 2021). The PL does not contain and suitable habitat (wetlands or areas prone to waterlogging). Overall, it is considered that this species has a low likelihood of occurring within the PL.
E	CE, M, Ma	Scolopacidae	*Numenius madagascariensis*	Far Eastern Curlew	This species typically inhabits intertidal mudflats in sheltered coastal areas; however, it has also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains as well as around floodplains (Higgins & Davies, 1996).	Lancewood	PM	Low—No records of this species occur within 20km of the PLs in both WO and ALA searches (DES, 2021a; ALA, 2021), and no preferred habitat occurs within 20km of the PLs (DAWE, 2021a). The PLs do not contain the coastal habitats in which this species typically occurs. There is a low likelihood of occurrence of this species within the PLs.
						Central	PM	
						Sapphire	PM	
CE	CE, M, Ma	Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper	This species occurs around the coasts of Australia from Cairns south. It is also quite widespread inland, with scattered records occurring in the Gulf of Carpentaria. This species mainly occurs on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets, lagoons and around non-tidal swamps, lakes, and lagoons near the coast, foraging on mudflats and nearby shallow water (DAWE, 2021b and references therein).	Lancewood	PM	Low—There are no records of this species within 20km of the PLs (DES, 2021a; ALA, 2021). The PLs are inland and do not contain the coastal and aquatic habitats required for this species. It is considered that this species has a low likelihood of occurring within the PLs.
						Central	PM	
						Sapphire	PM	
V	V	Tytonidae	*Tyto novaehollandiae kimberli*	Masked Owl (northern)	In Queensland, the northern subspecies of the Masked Owl occurs along the southern rim of the Gulf of Carpentaria, Cape York Peninsula and south at least as far as the Atherton Tablelands (DAWE, 2021b and references	Lancewood	PM	Low—There are no records of this species within 20km of the PLs (DES, 2021a; ALA, 2021) and the PLs do not occur within the modelled distribution of this sub-species of the Masked Owl (Menkhorst *et al*.,
						Central	PM	

					therein). The species has been recorded in a variety of habitats including riverside forests, rainforest, open forest and paperbark swamps and is known to occupy home-ranges of over 1,000ha in the non-breeding season.	Sapphire	PM	2017). It is considered that this sub-species has a low likelihood of occurring within the PLs.
MAMMALS								
LC	E	Dasyuridae	*Dasyurus hallucatus*	Northern Quoll	Across its range the Northern Quoll utilises a wide variety of habitats; in Queensland it occupies a diversity of habitats including rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert. However, habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. Habitats usually have a high structural diversity containing large diameter trees, termite mounds or hollow logs for denning purposes, and are close to water (DAWE, 2021b).	Lancewood	PM	Moderate—There are no WO records of this species within 20km of the PL (DES, 2021a). The nearest record of this species is approximately 12km to the north of the PL with several others to the north-east (ALA, 2021) and the site is within the mapped distribution for the species (DAWE, 2021a). Potentially suitable habitat for this species is likely to be present on site and may have connectivity values to other suitable habitat for this species. It is considered that this species has a moderate likelihood of occurring within the PL based on local records and potentially suitable habitat.
						Central	PM	Moderate — The site is within the mapped distribution for the species (DAWE, 2021a), however there are no WO records of this species within 20km of the PL (DES, 2021a) and the nearest record of this species is approximately 40km north-east of the PL (ALA, 2021). Potentially suitable habitat for this species is likely to be present on site and may have connectivity values to other suitable habitat for this species. It is considered that this species has a moderate likelihood of occurring within the PL based on local records and potentially suitable habitat.
						Sapphire	PM	Moderate — The PL is within the mapped distribution for the species (DAWE, 2021a), however there are no WO records of this species within 20km of the PL (DES, 2021a) and the nearest record of this species is approximately 60km north-east of the PL (ALA, 2021). Habitat for this species is present on site within the northern portion of the PL. However, there are large portions of the PL that likely represent unsuitable or degraded habitat due to previous industry and agriculture activities. It is considered that this species has a moderate likelihood of occurring within suitable remnant vegetation within the PL due to connectivity to other habitat and the PL occurring within the modelled distribution for this species.
NT	—	Emballonuridae	*Taphozous australis*	Coastal Sheathtail Bat	This species occurs in a thin band along the northeast Queensland coast from Shoalwater Bay to Cape York within a few kilometres of the sea, including on offshore islands and through the Torres Strait (DES, 2021e). This species appears to occupy habitats closest to the sea including coastal dune communities, melaleuca swamps, mangroves and rainforests (DES, 2021e and references therein & Richards, 2002), and current knowledge of the species indicates that it is a near-obligate user of coastal cliffs and rock-faces for roosting but will also use buildings near the coast (Richards, 2002).	Lancewood	–	-
						Central	3 (WO)	Low— There are 3 WO records within 20km of the PL, although the nearest ALA record is approximately 100km east (ALA, 2021). As this is a known coastal species and there is no suitable habitat within the PL, this species is unlikely to occur here. It is unlikely that these records are accurate as its preferred habitat is immediately near the coastline.
						Sapphire	3 (WO)	Low— There are 3 WO records within 20km of the PL, although the nearest ALA record is approximately 130km north-east (ALA, 2021). As this is a known coastal species and there is no suitable habitat within the PL, this species is unlikely to occur here.
E	V	Megadermatidae	*Macroderma gigas*	Ghost Bat	The distribution of this species is discontinuous across Australia with two ranges in Queensland: coastal and near-coastal eastern Queensland, from Cape York to near Rockhampton, and western Queensland (DAWE, 2021b and references therein). It has been recorded hunting in rainforest, deciduous vine thicket, open woodland, spinifex, black soil and grassland habitats. Ghost Bats roost in caves, boulder piles, shallow escarpments and mines, and have very specific roosting requirements with respect to temperature and humidity (TSSC, 2016b).	Lancewood	PM	Low— the PLs occur within the modelled distribution for this species (Van Dyck, 2013), however there are no records of this species within 20km of the PLs (DES, 2021a). While there is potential foraging woodland, it is unlikely that roosting habitat is present. Overall, it is considered that this species has a low likelihood of occurring within the PLs.
						Central	PM	
						Sapphire	PM	

V	V	Vespertilionidae	*Nyctophilus corbeni*	Corben's Long-eared Bat	This species is distributed west of the Great Dividing Range, from south-eastern QLD down to Vic and around to SA. Within QLD, records occur approximately 80kms NE of Injune down to the QLD/NSW border, extending inland as far as 150km west of St George (ALA, 2021). It occupies a wide variety of woodlands, including those dominated by box, ironbark, cypress pine, buloke, belah, brigalow, smooth-barked apple and river red gum (TSSC, 2015b). It is insectivorous, roosts in dead trees and has been known to travel up to 4km in a single night (TSSC, 2015b; Lumsden & Bennett, 2000).	Lancewood	PM	Low— The PLs occur within the modelled distribution for this species (Van Dyck, 2013) and suitable habitat occurs within the PLs, however there are no records of this species within 20km of the PLs (DES, 2021a), with the closest records occurring over 370km south (ALA, 2021). Overall, it is considered that this species has a low likelihood of occurring within the PLs.
						Central	PM	
						Sapphire	PM	
V	V	Pseudocheiridae	*Petauroides armillatus*	Central Greater Glider	This species occurs in eastern Australian states from just north of Townsville to the Eungella Range, inhabiting eucalypt-dominated low open forests on the coast to tall forests in the ranges and low woodlands west of the Great Dividing Range (Van Dyck et al., 2013; McGregor *et al.*, 2020). Records from the dry tropics include several for different from a range of *Eucalyptus crebra* woodland communities.	Lancewood	5 (WO), PM	High—There are 5 WO records of this species within 20km of the PL (DES, 2021a), and the PL occurs within the modelled distribution for this species (Van Dyck, 2013). The area appears to offer sufficient riparian habitat and food resources for this species. Overall, it is considered that this species has a moderate likelihood of occurring within the PL.
						Central	41 (WO), PM	High—There are 41 WO records of this species within 20km of the PL (DES, 2021a), and the PL occurs within the modelled distribution for this species (Van Dyck, 2013). The area appears to offer sufficient riparian habitat and food resources for this species. Overall, it is considered that this species has a high likelihood of occurring within the PL.
						Sapphire	31 (WO), PM	High—There are 31 WO records of this species within 20km of the PL (DES, 2021a), and the PL occurs within the modelled distribution for this species (Van Dyck, 2013). The area appears to offer sufficient riparian habitat and food resources for this species. Overall, it is considered that this species has a high likelihood of occurring within the PL.
V	V	Phascolarctidae	*Phascolarctos cinereus*	Koala	This species range includes the eastern half of Queensland in sclerophyll forest and woodland (Menkhorst & Knight, 2011). While being widespread, suitable feed species and leaf moisture are the primary determinants of habitat suitability and populations are in decline due to a wide range of threats (DAWE, 2021b and references therein).	Lancewood	PM	High—There are no WO records of this species within 20km of the PL (DES, 2021a), however there have been 2 observations within 16km of the PL (ALA, 2021). The PL occurs within the modelled distribution for this species (Van Dyck, 2013) and contains eucalypt woodland, which may provide suitable food resources for this species. Overall, it is considered that this species has a high likelihood of occurring within the PL.
						Central	12 (WO), PM	High—There are 12 WO records of this species within 20km of the PL (DES, 2021a) and the PL occurs within the modelled distribution for this species (Van Dyck, 2013). It contains eucalypt woodland, which may provide suitable food resources for this species. Overall, it is considered that this species has a high likelihood of occurring within the PL.
						Sapphire	11 (WO), PM	Moderate—There are 11 WO records of this species within 20km of the PL (DES, 2021a), the closest of which is within 10km of the PL (ALA, 2021). The PL occurs within the modelled distribution for this species (Van Dyck, 2013) and contains eucalypt woodland, which may provide suitable food resources for this species. However, extensive areas of non-remnant vegetation occur within the PL resulting in degraded habitat for this species. Overall, it is considered that this species has a moderate likelihood of occurring within the PL.
LC	V	Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	This species has a wide distribution which is largely coastal, and in Queensland occurs from Rockhampton southwards. It occupies closed and open woodlands, open forests, *Melaleuca* swamps, and rainforests. It is frugivorous and nectivorous, and is a canopy-feeder (DAWE, 2021b and references therein).	Lancewood	PM	Low—there are no records of this species within 20km of the PL (DES, 2021a). The closest record is 45km north-east of the PL (ALA, 2021). Food availability in this area is likely insufficient, and therefore unlikely that this species occurs in the PL.
						Central	–	-
						Sapphire	–	-

REPTILES								
V	V	Elapidae	*Denisonia maculata*	Ornamental Snake	The species is known only from the Brigalow Belt North and parts of the Brigalow Belt South biogeographical regions. The core of the species' distribution occurs within the drainage system of the Fitzroy and Dawson Rivers. The species is known to prefer woodlands and open forests associated with moist areas, particularly gilgai mounds and depressions, but also lake margins and wetlands (DAWE 2021b and references therein), where it forages for amphibians and small reptiles.	Lancewood	PM	Moderate—There are no records of this species within 20km (DES, 2021a); the closest record of this species is 22km west of the PL (ALA, 2021). There is some potentially suitable habitat in the south of the PL, which is State mapped essential habitat for this species, however most of the PL comprise unsuitable soils. It is considered that there is a moderate likelihood of this species occurring within suitable habitat within the PL.
						Central	1 (WO), PM	High—There is one WO record within 20kms of the PL, and many other records in the broader region. Extensive areas of the PL are State mapped as essential habitat for this species. Based on the presence of a local record and habitat likely to be suitable for this species it is considered that this species has a high likelihood of occurring.
						Sapphire	5 (WO), PM	High—There are several records surrounding the PL, one of which occurs 3kms west. There is potentially suitable habitat, which is State mapped as essential habitat for this species. Based on the presence of local records and habitat likely to be suitable for this species it is considered that this species has a high likelihood of occurring.
V	V	Elapidae	*Furina dunmalli*	Dunmall's Snake	In Queensland, this species is distributed throughout the Brigalow Belt, on black, cracking alluvial clay and clay loam 200-500m above sea level. It occupies various eucalypt or *Acacia* woodlands, generally dominated by *A. harpophylla* and other *Acacia* spp., *Callitris* sp., *Allocasuarina luehmannii*, *C. citriodora*, *E. crebra*, and *E. melanophloia*. It feeds on small skins and geckos (DAWE, 2021b and references therein).	Lancewood	–	-
						Central	PM	Low—There are no records of this species within 20km; the closest record is over 100km from the PL. There is potentially suitable habitat for the species in the south-west corner, however this is degraded and fragmented, with hills comprising most of the PL.
						Sapphire	PM	Low—There are no records of this species within 20km; the closest record is over 100km from the PL. There is potentially suitable habitat, however it is highly degraded and fragmented.
V	V	Scincidae	*Egernia rugosa*	Yakka Skink	The known distribution of this species extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. This vast area covers portions of the Brigalow Belt, Mulga Lands, South-east Queensland, Einasleigh Uplands, Wet Tropics and Cape York Peninsula biogeographical regions. This species is known to occur in open dry sclerophyll forest, woodland and scrub. The core habitat of this species is within the mulga lands and Brigalow Belt South bioregions. It is most commonly found in cavities under and between partly buried rocks, logs or tree stumps, root cavities and abandoned animal burrows. This species often takes refuge in large hollow logs and has been known to excavate deep burrow systems, sometimes under dense ground vegetation. In cleared habitat, it can persist where there are shelter sites such as raked log piles, deep gullies, tunnel erosion/sinkholes and rabbit warrens (DAWE 2021b, and references therein).	Lancewood	PM	Moderate—There are no local records of this species within 20kms of the PLs (all >170kms away), however the PLs occur within the modelled distribution for this species. Desktop assessment results indicate that remnant vegetation within the PLs may support suitable for this species. For these reasons, it is considered that this species has a moderate likelihood of occurring within suitable habitat within the PLs.
						Central	PM	
						Sapphire	PM	
E	E	Scincidae	*Lerista allanae*	Retro Slider	This species is found in the Brigalow Belt between coordinates 21°00'–24°00' S and 147°00'–149°00' E. It has a restricted and fragmented distribution as a result of agricultural clearing. This small fossorial skink is found in eucalypt woodlands associated with rocky or stony clays (RE 11.8.5) and tussock grasslands on dark brown to reddish brown soils (11.8.11), as well as cleared land (DAWE, 2021b and references therein).	Lancewood	–	-
						Central	PM	Low—There are no records within 20km of the PL – the closest record is over 50km south-west. There are no areas of suitable habitat for this species and the landscape is highly fragmented.
						Sapphire	PM	Low—There are no records within 20km of the PL – the closest record is over 60km south-west. There are no areas of suitable habitat for this species and the landscape is highly fragmented.

CE	CE	Chelidae	*Elseya albagula*	Southern Snapping Turtle	This species is found primarily in the Fitzroy, Mary, Burnett and southern Burdekin catchments, in river systems with permanent water that provide complex habitat (DAWE, 2021b and references therein).	Lancewood	PM	Low—there are no records of this species within 20km of the PL, and no river systems with permanent water run through this PL. This species is unlikely to occur within the PL.
						Central	–	-
						Sapphire	PM	Low—there are no records of this species within 20km of the PL, and no river systems with permanent water run through this PL. This species is unlikely to occur within the PL.
V	V	Chelidae	*Rheodytes leukops*	Fitzroy River Turtle	This species is confined to the Fitzroy River drainage system on the central Queensland coast, in large pools with riffle zones and high water clarity. It prefers ribbonweed beds and associated riparian vegetation is *E. tereticornis*, *C. cunninghamiana*, *C. viminalis*, and *M. linariifolia* (DAWE, 2021b and references therein).	Lancewood	PM	Low—there are no records of this species within 20km of the PLs, and no river systems with permanent water run through the PLs. This species is unlikely to occur within the PLs.
						Central	PM	
						Sapphire	PM	

1. Status: LC – Least Concern, NT = Neat Threatened, V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory, Ma = Marine
2. Source: WO = Queensland Government Wildlife Online Database Extract (20km radius search area), PM = EPBC Act Protected Matters Report

Table B3 Likelihood of occurrence assessments for migratory fauna identified in PMST and WO searches in a 20km radius from the PLs

Status[1]		Family	Scientific name	Common name	Ecology	PL	WO records + Source[2]	Potential to occur in the PL
NCA	EPBC							
BIRDS								
SLC	M, Ma	Apodidae	*Apus pacificus*	Fork-tailed Swift	The Fork-tailed Swift is a non-breeding visitor to all States and territories of Australia. This species is known to utilise cliffs and beaches and to hunt above various habitat types including rainforest and open forests ahead of storm fronts (Higgins, 1999). Swifts are hardly ever seen to land except at nests, and when they do, they cling to vertical surfaces rather than perching upright like swallows (Menkhorst *et al.*, 2017). This species has been noted to forage in high-flying flocks 100s of meters above the ground or canopy (Menkhorst *et al.*, 2017).	Lancewood	PM	Low— There are no records of this species within 20kms of any of the PLs. Activities within the PL's are likely to occupy terrestrial habitats, which are not often utilised by this species. Therefore, as this species is almost completely aerial, it is unlikely to occur in terrestrial habitats within the PLs. Overall, it is considered that this species has a low likelihood of occurring within the PLs as the terrestrial habitat present is considered to be unsuitable for this species and there are no local records within 20km of the PLs.
						Central	PM	
						Sapphire	PM	
V	V, M, Ma	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	The White-throated Needletail breeds in the Northern Hemisphere but is widespread in eastern and south-eastern Australia during summer months (Higgins, 1999). There are sporadic records of this species found in inland Australia with the majority occurring along the coast and western edge of the Great Dividing Range (DAWE, 2021b). The White-throated Needletail is thought to be almost completely aerial when in Australia and large flocks typically follow low pressure systems (DAWE, 2021b and references therein). Although they occur over most types of habitat, they are probably recorded most often above wooded areas, including open forest and rainforest (Higgins, 1999).	Lancewood	1 (WO)	Low— There is one record of this species within 20kms of the PL. Activities within the PL are likely to occupy terrestrial habitats, which are not often utilised by this species. Therefore, as this species is almost completely aerial, it is unlikely to occur in terrestrial habitats within the PL. Overall, it is considered that this species has a low likelihood of occurring within the PL as the terrestrial habitat present is considered unsuitable for this species.
						Central	–	-
						Sapphire	–	-
SLC	M, Ma	Cuculidae	*Cuculus optatus*	Oriental Cuckoo	This species is widespread in the northern and eastern parts of Australia, inhabiting rainforest margins, monsoon forest, vine scrubs, riverine thickets, wetter, densely canopied eucalypt forests, paperbark swamps and mangroves (Morcombe, 2003).	Lancewood	PM	Low—there are no records of this species within 20km of the PLs. The PLs is within the range of this species but there is very little suitable habitat for this species (Morcombe, 2003).
						Central	PM	
						Sapphire	PM	

Status[1]		Family	Scientific name	Common name	Ecology	PL	WO records + Source[2]	Potential to occur in the PL
NCA	EPBC							
SLC	M, Ma	Monarchidae	*Monarcha melanopsis*	Black-faced monarch	This species is a common breeding resident of eastern Australia that migrates to Papua New Guinea during the winter months (DAWE, 2021b). It is recorded from a variety of ecosystems including rainforest, eucalypt woodland, coastal scrubs, eucalypt forest and damp gullies in rainforest, but can also occur in more open woodland, especially when migrating (Pizzey & Knight, 2012).	Lancewood	PM	Low—There are no WO records of this species within 20km of the PL, although one ALA record occurs approximately 7km east, adjacent to wetland (ALA, 2021). The PL is within the known range for the species and eucalypt woodlands present on site may provide suitable habitat. This species has been assigned a moderate likelihood of occurring within the PL.
						Central	–	-
						Sapphire	–	-
SLC	M, Ma	Monarchidae	*Myiagra cyanoleuca*	Satin flycatcher	This species has a scattered distribution throughout eastern Queensland and are mostly found in coastal areas and the Great Divide. They are found densely vegetated eucalypt forests and woodlands surrounding gullies, as well as coastal areas including mangroves and coastal woodlands (DAWE, 2021b).	Lancewood	PM	Low—there are no records of this species within 20km of the PLs (DES, 2021a); the closest record occurs approximately 40km east (ALA, 2021). The PLs are within the species' known distribution (Morcombe, 2003) and contains potentially suitable, but not preferred, habitat. This species is considered to have a low likelihood of occurring within the PLs.
						Central	PM	
						Sapphire	–	-
SLC	M, Ma	Motacillidae	Motacilla flava	Yellow Wagtail	This species is a rare but regular migrant to coastal areas within Australia. It typically inhabits open habitats, often near water and occasionally on drier inland PLins and edges of mangroves (Morcombe, 2003).	Lancewood	PM	Low—There are no records of this species within 20km of the PLs (DES, 2021a). Suitable habitats such as open waterbodies and areas prone to inundation are absent in the PLs due to slope. It is considered that this species has a low likelihood of occurring within the PLs.
						Central	PM	
						Sapphire	PM	
SLC	M, Ma	Pandionidae	*Pandion haliaetus*	Osprey	Found on the coasts, interior and many offshore islands of Australia, this species occurs in coastal habitats and terrestrial wetlands of tropical and temperate Australia. This species may travel inland along major rivers in its northern distribution (DAWE, 2021b and references therein).	Lancewood	PM	Low—there are no records of this species within 20km of the PLs and preferred habitat for this species is not present within the PLs. It is considered that this species has a low likelihood of occurring within the PLs.
						Central	PM	
						Sapphire	PM	
SLC	M, Ma	Rhipiduridae	*Rhipidura rufifrons*	Rufous fantail	This species occurs in coastal and near coastal districts of northern and eastern Australia. In Queensland there are breeding populations from the New South Wales border north to the Cairns-Atherton region, and they overwinter farther north in Cape York Peninsula and Papua New Guinea. The species inhabits wet sclerophyll, subtropical and temperate rainforests. Occasionally the species is seen in secondary regrowth following disturbance in forests. (DAWE, 2021b). This species may also be observed on farms during migration (Pizzey & Knight, 2012).	Lancewood	PM	Low—There are no WO records of this species within 20km of the PL (DES, 2021a), however there is one ALA record approximately 7km from the PL and multiple records approximately 40kms to the north-east (ALA, 2021). The PL is within the species' known distribution and contains habitat that may be utilised, but is not preferred, by the species. The majority of records occur on the Great Dividing Range in dense rainforest. It is considered that this species has a low likelihood of occurring within the PL.
						Central	–	-
						Sapphire	–	-
SLC	M, Ma	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	Widespread but patchy distribution along all coastlines of Australia. Found in coastal wetlands and inland wetlands with varying levels of salinity (DAWE, 2021b and references therein). Most commonly found in muddy or rocky shores of estuaries, deltas of streams, banks upstream, lakes, pools, billabongs, reservoirs, and dams.	Lancewood	PM	Low—There are no records of this species within 20km of the PLs and preferred habitat for this species is not present within the PLs. Overall, it is considered that this species has a low likelihood of occurring within the PLs.
						Central	PM	
						Sapphire	PM	
SLC		Scolopacidae				Lancewood	PM	

Status[1]		Family	Scientific name	Common name	Ecology	PL	WO records + Source[2]	Potential to occur in the PL
NCA	EPBC							
	M, Ma		*Calidris acuminata*	Sharp-tailed Sandpiper	This species occurs around the entire coast of Australia outside its breeding season, where it is found in a broad range of permanent or ephemeral water bodies, primarily brackish (DAWE, 2021b and references therein). It prefers muddy edges of shallow fresh or brackish wetlands, and use flooded paddocks, sedge lands and other ephemeral wetlands.	Central	PM	Low—There are no records of this species within 20km of the PLs and preferred habitat for this species is not present within the PLs. Overall, it is considered that this species has a low likelihood of occurring within the PLs.
						Sapphire	PM	
CE	CE, M, Ma	Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper	This species occurs around the coasts of Australia and is quite widespread inland, with scattered records occurring in the Gulf of Carpentaria, with wide-spread records along the coast south of Cairns. This species mainly occurs on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets, lagoons and also around non-tidal swamps, lakes, and lagoons near the coast, foraging on mudflats and nearby shallow water (DAWE, 2021b and references therein).	Lancewood	PM	Low—There are no records of this species within 20km of the PLs and preferred habitat for this species is not present within the PLs. Overall, it is considered that this species has a low likelihood of occurring within the PLs.
						Central	PM	
						Sapphire	PM	
SLC	M, Ma	Scolopacidae	*Calidris melanotos*	Pectoral Sandpiper	This species occurs around the coasts of Australia and is quite widespread inland, with scattered records occurring in the Gulf of Carpentaria and wide-spread records along the coast south of Cairns. This species mainly occurs on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets, lagoons and also around non-tidal swamps, lakes, and lagoons near the coast, foraging on mudflats and nearby shallow water (DAWE, 2021b and references therein).	Lancewood	PM	Low—There are no records of this species within 20km of the PLs and preferred habitat for this species is not present within the PLs. Overall, it is considered that this species has a low likelihood of occurring within the PLs.
						Central	PM	
						Sapphire	PM	
SLC	M, Ma	Scolopacidae	*Gallinago hardwickii*	Latham's Snipe	This species is distributed along the east coast of Australia from Cape York Peninsula south to south-eastern Australia. It occurs in permanent and ephemeral wetlands with low to dense vegetation up to 2000m above sea level (DAWE, 2021b and references therein). This species is known to occur close to humans and human activity (i.e., near roads, railways, airfields, commercial or industrial complexes) (DAWE, 2021b and references therein). Though it is described as utilising areas of permanent or temporary inundation, including streams in a wide range of habitat types, literature and records indicate that it does not occur in dense, closed-canopy rainforest and vine forest (DAWE, 2021b and references therein).	Lancewood	PM	Low—There is one record of this species approximately 8km from the PL, however this observation occurs on a wetland (ALA, 2021). Preferred habitat for this species is not present within the PL. Overall, it is considered that this species has a low likelihood of occurring within the PL.
						Central	PM	Low—There are no records of this species within 20km of the PLs and preferred habitat for this species is not present within the PLs. Overall, it is considered that this species has a low likelihood of occurring within the PLs.
						Sapphire	PM	
SLC	M, Ma	Scolopacidae	*Tringa nebularia*	Common greenshank		Lancewood	–	-
						Central	PM	Low—there are no records of this species within 20km of the PL, and preferred habitat does not occur within the PL. Overall, this species has been allocated a low likelihood of occurrence in the PL.

Status[1]		Family	Scientific name	Common name	Ecology	PL	WO records + Source[2]	Potential to occur in the PL
NCA	EPBC							
					Within Queensland, this species is widespread in the Gulf country and eastern Gulf of Carpentaria and has been recorded in most coastal regions. It utilises a broad range of habitat types—typically coastal mudflats and saltmarsh but including permanent and ephemeral water sources such as lakes, dams, rivers, creeks and billabongs (DAWE, 2021b).	Sapphire	PM	Low—there is one record of this species approximately 15km south of the PL (ALA, 2021), however preferred habitat does not occur within the PL. Overall, this species has been allocated a low likelihood of occurrence in the PL.

1. Status: LC – Least Concern, NT = Neat Threatened, V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory, Ma = Marine

2. Source: WO = Queensland Government Wildlife Online Database Extract (20km radius search area), PM = EPBC Act Protected Matters Report

APPENDIX B2

Wildlife Online Database Extracts

Queensland Government

WildNet species list

Search Criteria: Species List for a Specified Point
Species: All
Type: Native
Queensland status: Rare and threatened species
Records: All
Date: All
Latitude: -21.9001
Longitude: 148.1421
Distance: 20
Email: lheilbronn@slrconsulting.com
Date submitted: Friday 01 Oct 2021 12:01:59
Date extracted: Friday 01 Oct 2021 12:10:06

The number of records retrieved = 10

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	40
animals	mammals	Emballonuridae	*Taphozous australis*	coastal sheathtail bat		NT		3
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		V	V	11
animals	mammals	Pseudocheiridae	*Petauroides armillatus*	central greater glider		V	V	31
animals	reptiles	Elapidae	*Denisonia maculata*	ornamental snake		V	V	5
plants	land plants	Amaranthaceae	*Ptilotus uncinellus*			E		1/1
plants	land plants	Apocynaceae	*Cerbera dumicola*			NT		7/4
plants	land plants	Euphorbiaceae	*Bertya pedicellata*			NT		6/5
plants	land plants	Poaceae	*Dichanthium queenslandicum*			V	E	3/3
plants	land plants	Solanaceae	*Solanum adenophorum*			E		2/2

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.*
The codes are Extinct (EX), Extinct in the Wild (PE), Critically Endangered (CR), Endangered (E), Vulnerable (V), Near Threatened (NT), Special Least Concern (SL) and Least Concern (C).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.*
The values of EPBC are Extinct (EX), Extinct in the Wild (XW), Critically Endangered (CE), Endangered (E), Vulnerable (V) and Conservation Dependent (CD).

Records - The first number indicates the total number of records of the taxon (wildlife records and species listings for selected areas).
This number is output as 99999 if it equals or exceeds this value. A second number located after a / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Queensland Government

WildNet species list

Search Criteria: Species List for a Specified Point
Species: All
Type: Native
Queensland status: Rare and threatened species
Records: All
Date: All
Latitude: -21.8313
Longitude: 148.2909
Distance: 20
Email: lheilbronn@slrconsulting.com
Date submitted: Friday 01 Oct 2021 12:01:38
Date extracted: Friday 01 Oct 2021 12:10:11

The number of records retrieved = 7

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	20
animals	mammals	Emballonuridae	*Taphozous australis*	coastal sheathtail bat		NT		3
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		V	V	12
animals	mammals	Pseudocheiridae	*Petauroides armillatus*	central greater glider		V	V	41
animals	reptiles	Elapidae	*Denisonia maculata*	ornamental snake		V	V	1
plants	land plants	Apocynaceae	*Cerbera dumicola*			NT		3/3
plants	land plants	Euphorbiaceae	*Bertya pedicellata*			NT		9/8

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.*
The codes are Extinct (EX), Extinct in the Wild (PE), Critically Endangered (CR), Endangered (E), Vulnerable (V), Near Threatened (NT), Special Least Concern (SL) and Least Concern (C).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.*
The values of EPBC are Extinct (EX), Extinct in the Wild (XW), Critically Endangered (CE), Endangered (E), Vulnerable (V) and Conservation Dependent (CD).

Records - The first number indicates the total number of records of the taxon (wildlife records and species listings for selected areas).
This number is output as 99999 if it equals or exceeds this value. A second number located after a / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Queensland Government

WildNet species list

Search Criteria: Species List for a Specified Point
Species: All
Type: Native
Queensland status: Rare and threatened species
Records: All
Date: All
Latitude: -21.4583
Longitude: 148.1252
Distance: 20
Email: lheilbronn@slrconsulting.com
Date submitted: Friday 01 Oct 2021 12:01:09
Date extracted: Friday 01 Oct 2021 12:10:02

The number of records retrieved = 7

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Accipitridae	*Erythrotriorchis radiatus*	red goshawk		E	V	3
animals	birds	Apodidae	*Hirundapus caudacutus*	white-throated needletail		V	V	1
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	6
animals	mammals	Pseudocheiridae	*Petauroides armillatus*	central greater glider		V	V	5
plants	land plants	Combretaceae	*Macropteranthes leiocaulis*			NT		2/2
plants	land plants	Poaceae	*Dichanthium queenslandicum*			V	E	18/18
plants	land plants	Poaceae	*Digitaria porrecta*			NT		4/4

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.*
The codes are Extinct (EX), Extinct in the Wild (PE), Critically Endangered (CR), Endangered (E), Vulnerable (V), Near Threatened (NT), Special Least Concern (SL) and Least Concern (C).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.*
The values of EPBC are Extinct (EX), Extinct in the Wild (XW), Critically Endangered (CE), Endangered (E), Vulnerable (V) and Conservation Dependent (CD).

Records - The first number indicates the total number of records of the taxon (wildlife records and species listings for selected areas).
This number is output as 99999 if it equals or exceeds this value. A second number located after a / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

APPENDIX B3

EPBC Act Protected Matters Reports

Australian Government

Department of Agriculture, Water and the Environment

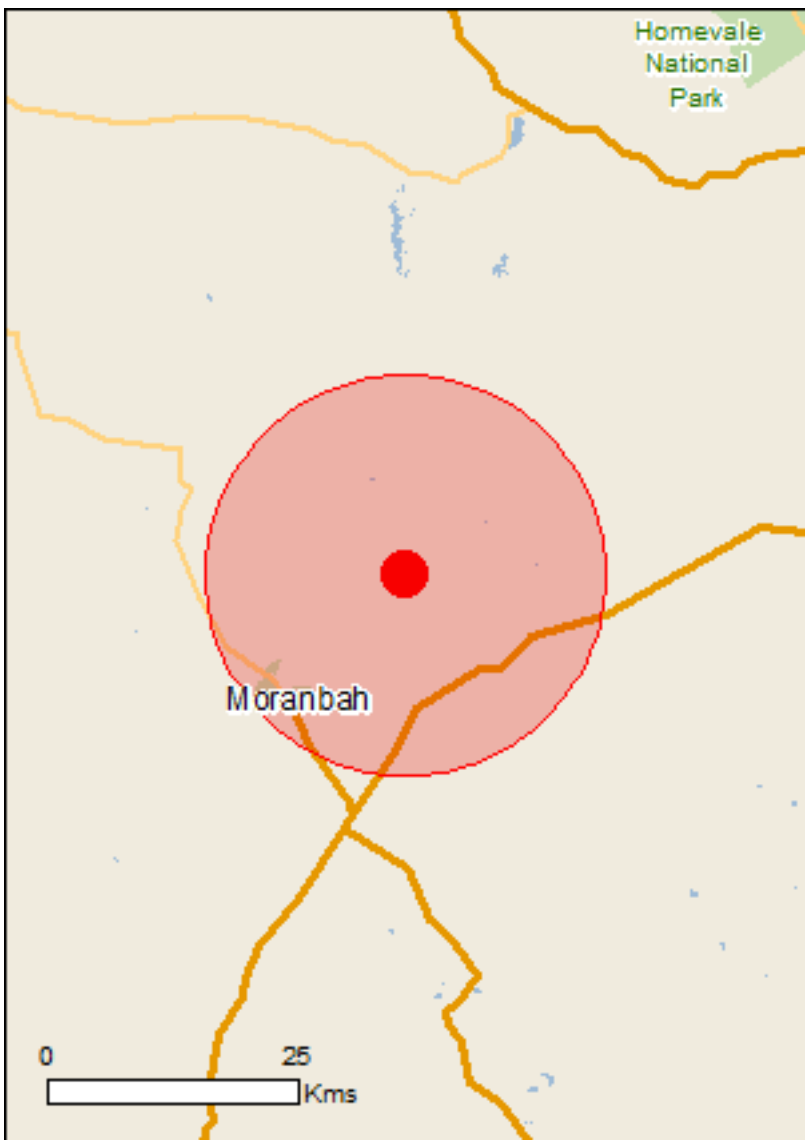
EPBC Act Protected Matters Report

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

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

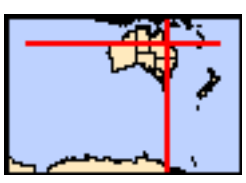
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 01/10/21 11:57:42



Coordinates

Buffer: 20.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	22
Listed Migratory Species:	10

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	20
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Nyctophilus corbeni		
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petauroides volans		
Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Plants		
Dichanthium queenslandicum		
King Blue-grass [5481]	Endangered	Species or species habitat likely to occur within area
Dichanthium setosum		
bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus raveretiana		
Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
Samadera bidwillii		
Quassia [29708]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Denisonia maculata		
Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
Egernia rugosa		
Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Elseya albagula		
Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Furina dunmalli		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Lerista allanae		
Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may occur within area
Rheodytes leukops		
Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species	[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.	
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-21.9001 148.1421

Acknowledgements

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

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

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

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

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Australian Government

Department of Agriculture, Water and the Environment

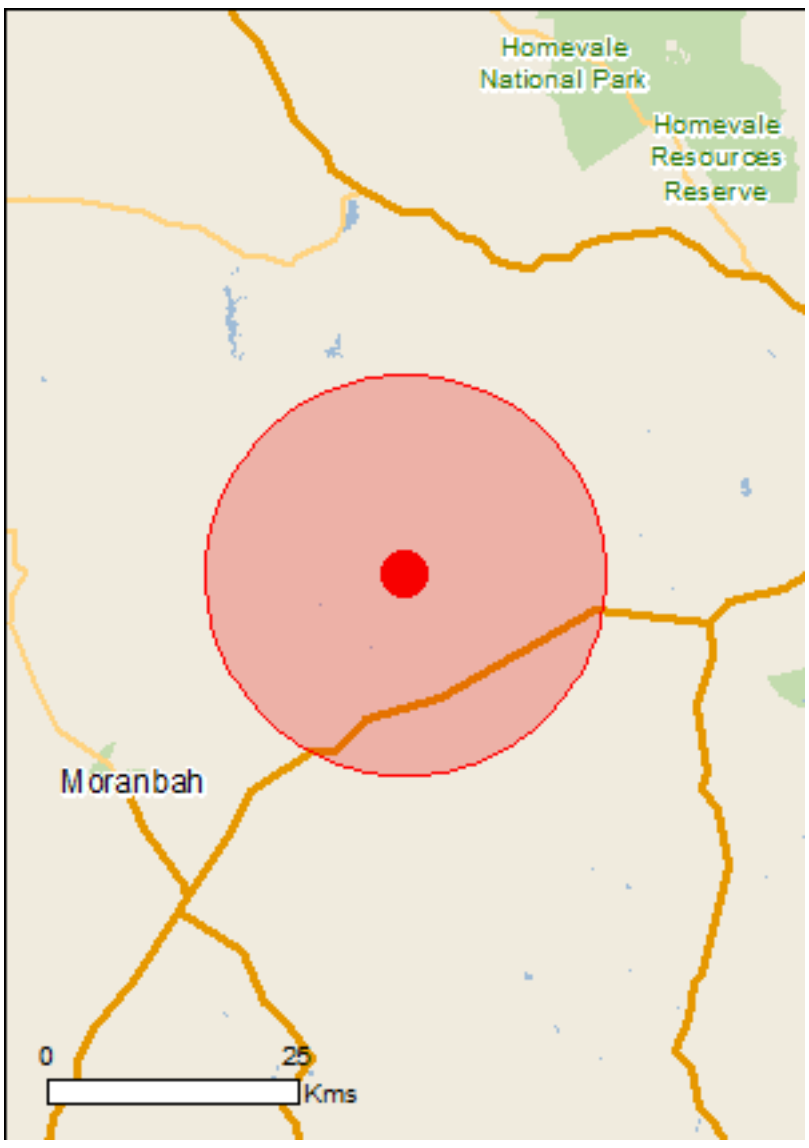
EPBC Act Protected Matters Report

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

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

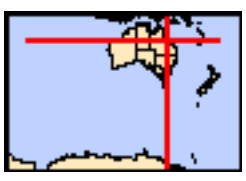
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 01/10/21 10:48:26



Coordinates

Buffer: 20.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	21
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	18
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
[Nyctophilus corbeni](#)		
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
[Petauroides volans](#)		
Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
[Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)](#)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat likely to occur within area
Plants		
[Dichanthium queenslandicum](#)		
King Blue-grass [5481]	Endangered	Species or species habitat likely to occur within area
[Dichanthium setosum](#)		
bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
[Eucalyptus raveretiana](#)		
Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
[Samadera bidwillii](#)		
Quassia [29708]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
[Denisonia maculata](#)		
Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
[Egernia rugosa](#)		
Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
[Furina dunmalli](#)		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
[Lerista allanae](#)		
Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat may occur within area
[Rheodytes leukops](#)		
Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
[Apus pacificus](#)		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
[Cuculus optatus](#)		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
[Motacilla flava](#)		
Yellow Wagtail [644]		Species or species habitat may occur within area
[Myiagra cyanoleuca](#)		
Satin Flycatcher [612]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-21.8313 148.2909

Acknowledgements

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

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

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

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

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Australian Government

Department of Agriculture, Water and the Environment

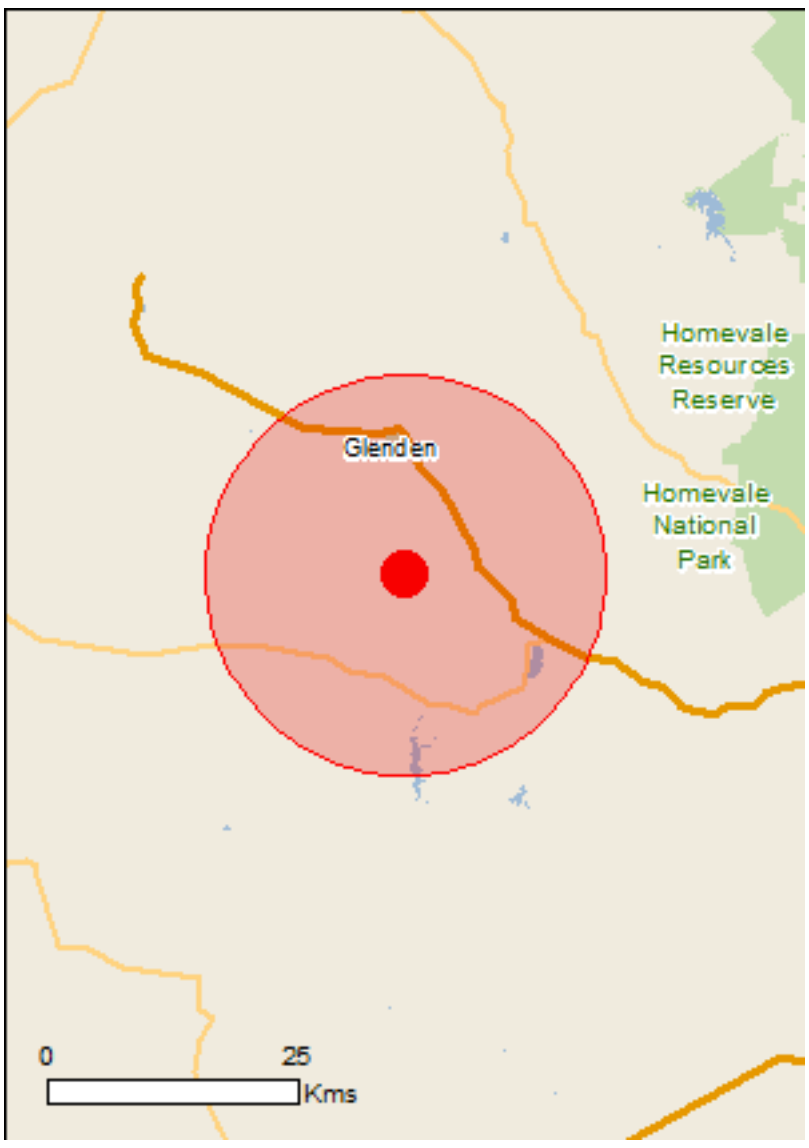
EPBC Act Protected Matters Report

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

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

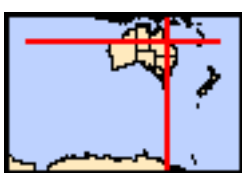
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 01/10/21 11:57:12



Coordinates

Buffer: 20.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	26
Listed Migratory Species:	13

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	25
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat may occur within area
Mammals		

Name	Status	Type of Presence
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Plants		
Bertya opponens [13792]	Vulnerable	Species or species habitat known to occur within area
Dichanthium queenslandicum King Blue-grass [5481]	Endangered	Species or species habitat likely to occur within area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus raveretiana Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
Omphalea celata [64586]	Vulnerable	Species or species habitat likely to occur within area
Ozothamnus eriocephalus [56133]	Vulnerable	Species or species habitat may occur within area
Samadera bidwillii Quassia [29708]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat likely to occur within area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Elseya albagula Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area
[Chrysococcyx osculans](#) Black-eared Cuckoo [705]		Species or species habitat may occur within area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Monarcha melanopsis](#) Black-faced Monarch [609]		Species or species habitat may occur within area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area
[Myiagra cyanoleuca](#) Satin Flycatcher [612]		Species or species habitat may occur within area
[Numenius madagascariensis](#) Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat likely to occur within area
[Rhipidura rufifrons](#) Rufous Fantail [592]		Species or species habitat likely to occur within area
[Rostratula benghalensis (sensu lato)](#) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Redcliffe Vale	QLD

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Feral deer		
Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis		
Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa		
Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica		
Prickly Acacia [6196]		Species or species habitat may occur within area
Cryptostegia grandiflora		
Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis		
Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Jatropha gossypifolia		
Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp.		
Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus		
Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Vachellia nilotica		
Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Lake Elphinstone	QLD

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-21.4583 148.1252

Acknowledgements

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

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

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

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

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

APPENDIX C

Groundwater Assessment

APPLICATION FOR ENVIRONMENTAL APPROVAL FOR CSG OPERATIONS

SAPPHIRE (PLA1034), CENTRAL (PLA1038) AND LANCEWOOD (PLA1045) Groundwater Assessment

Prepared for:

Blue Energy
Level 10/26 Wharf St
Brisbane QLD 4000

SLR Ref: 620.30617.00000-R02
Version No: -v1.0
November 2021

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 16, 175 Eagle Street
Brisbane QLD 4000 Australia
(PO Box 26 Spring Hill QLD 4004)
T: +61 7 3858 4800
E: brisbane@slrconsulting.com
www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Blue Energy (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.30228.00000-R02-v1.0	18 November 2021	J Darvell	I Epari	D Taylor

CONTENTS

CONTENTS

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

CONTENTS

1 Introduction

1.1 Overview

Blue Energy Limited (Blue Energy) ACN 054 800 378 holds tenements within Queensland's Bowen Basin in addition to other surrounding regions of Queensland, Northern Territory and South Australia. Blue Energy are an Australian proprietary company limited by shareholders and are the sole party involved in this Project. Blue Energy are applying for one Environmental Authority (EA) which will encompass three petroleum leases (PLs) for coal seam gas (CSG) operations at three of their ATP814 (Authority to Prospect) tenements in the Moranbah region (the Project). The three PL tenements will be managed and operated under the one EA are PL 1034, PL 1038 and PL 1045 and are shown in Figure 1. Regional mining leases and CSG tenements are sown in Figure 2.

The focus of Blue Energy's activities up to this point have been to explore and appraise CSG fields inside their tenements. Through this process, Blue Energy have identified PL 1034, PL 1038 and PL 1045 as appropriate sources of gas production to send to domestic and/or overseas markets. In total, all three PLs will cover an area of approximately 31,498 ha in the Bowen Basin, with the breakdown described below:

- Sapphire (PL 1034) – Total Area: 7,628 ha, Total Disturbance: 238 ha
- Central (PL 1038) – Total Area: 15,900 ha, Total Disturbance: 528 ha
- Lancewood (PL 1045) – Total Area: 7970 ha, Total Disturbance: 280 ha

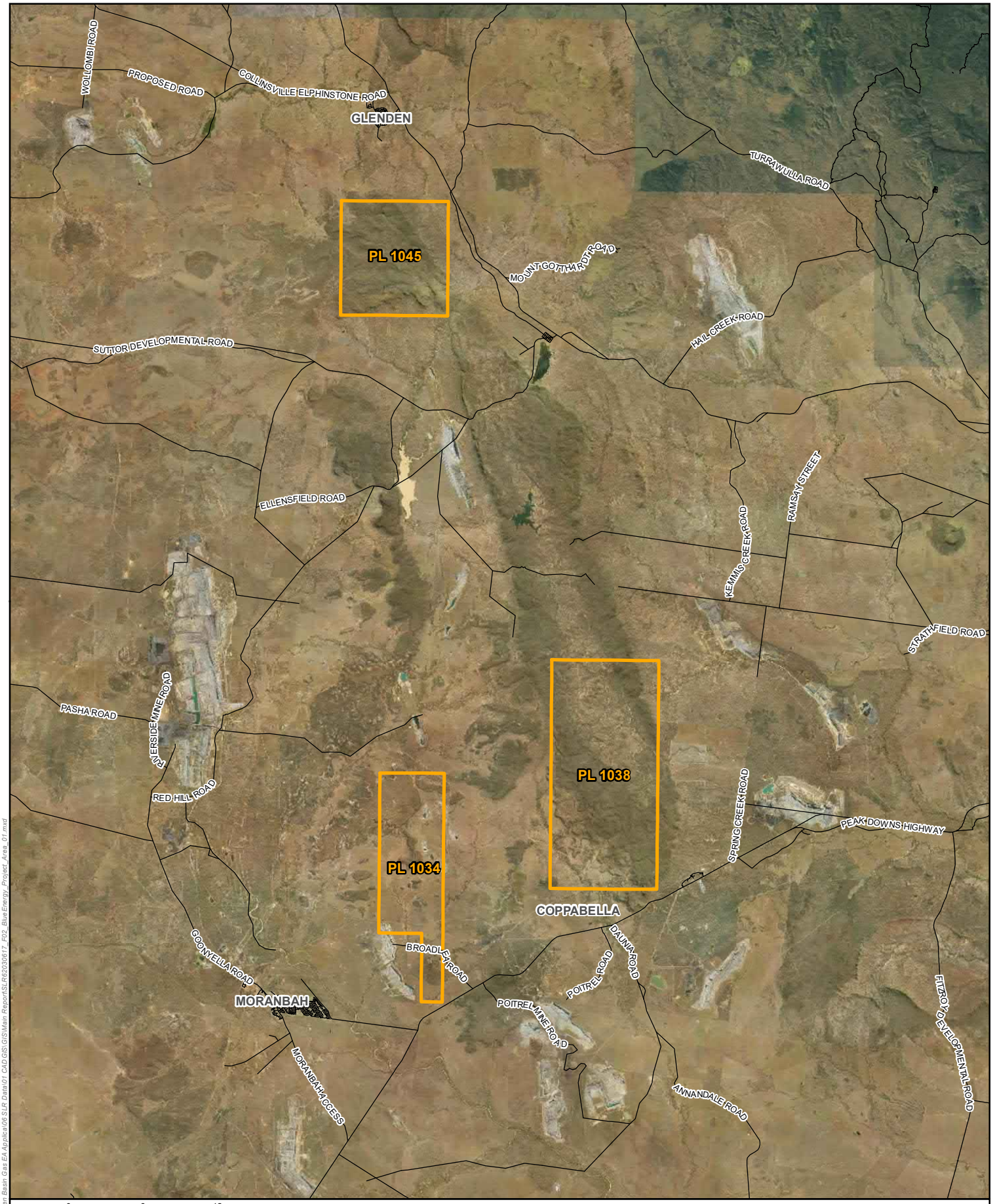
The boundaries of the PLs extend (24km northeast of Moranbah and 6.5km south of Glenden in Queensland, with locality shown in Figure 1.

Blue Energy has commenced three PLs with the Department of Resources (DoR) in which they are seeking to conduct CSG operations. It is a condition of approving these PLs, that there is a relevant EA issued under the Environmental Protection Act 1994 (QLD) (EP Act) covering the activities proposed to be carried out across the three tenures under one single EA application.

This EA application will cover CSG operations project over a 20-year development period at 530 well pad locations including the associated gas and water gathering network infrastructure. Key components of the Project include:

A total of 530 well pads (lateral, multi and vertical) across the development area split between:

Petroleum lease	Lateral Well pads	Multi Well Pads	Vertical Well pads	TOTAL
Sapphire PL 1034	32	53	32	117
Central PL 1038	78	108	78	264
Lancewood PL 1045	49	51	49	149



0 6 12 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:400,000 at A4
Project Number:	620.30617
Date:	18-Nov-2021
Drawn by:	PW
Reviewed by:	JN

LEGEND

Roads

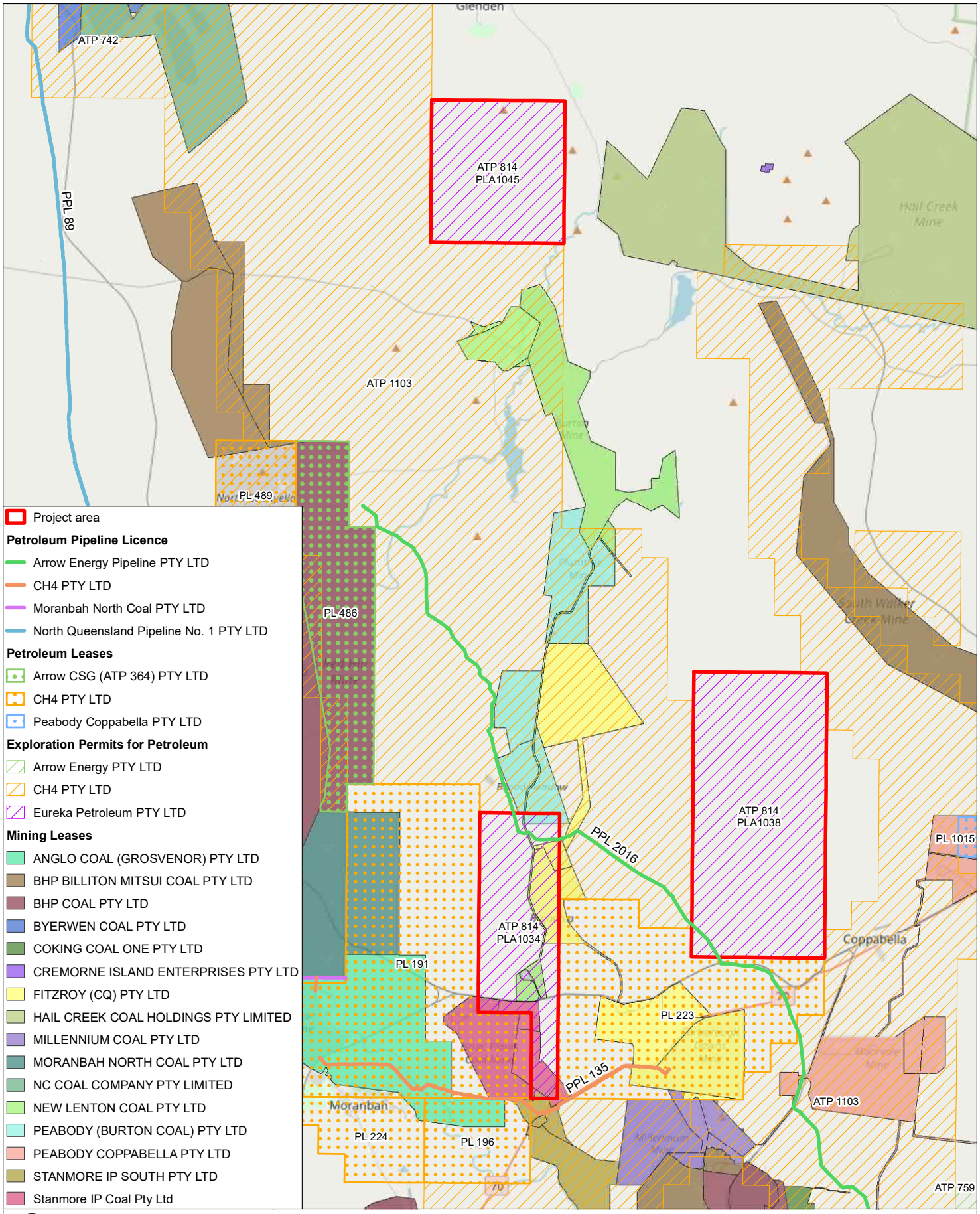
Petroleum Lease Boundary

BLUE ENERGY EA APPLICATION

Project Area

FIGURE 1

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Main Report\SLR620306017_F02_BlueEnergy_Project_Area_01.mxd



0 5 10 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:325,000 at A4
Project Number:	620.30228
Date:	13-Jan-2021
Drawn by:	PM

SLR

Data Source: QLD DRNME

BLUE ENERGY

Resource Tenements

FIGURE 2

H:\Projects-SLR\620-BNE\620.30228.00000 Blue Energy ATP814 EA Application\06 SLR Data\01 CAD\GIS\GIS\SLR620302228_ResourceTenements_001.mxd

1.2 Project Outline

1.2.1 Project name and location

The Project consists of three Blue Energy PL's with Sapphire (PL 1034) and Central (PL 1038) located approximately 10km and 24km northeast of Moranbah respectively, and Lancewood (PL 1045) located approximately 6.5km south of Glenden in Central Queensland. The petroleum lease tenements for the Project are shown in Figure 1.

The Moranbah region is a heavily developed resource area and there are pre-existing extractive activities and associated infrastructure located throughout the region. There are a number of large mines throughout the area such as Isaac Plains Mine, Goonyella Coal Mine, Broadmeadow Mine and Broadlea Mine. The Arrow Energy owned Moranbah Gas Project is one of the oldest and geographically largest CSG fields in Australia. Arrow Energy also owns PL 486 which is known as the Bowen Gas Project and is yet to be constructed (Figure 2). The Blue Energy owned tenements are located within the middle of these Arrow developments and provide good opportunity for Blue Energy to utilise existing and/or planned coal seam gas infrastructure.

1.2.2 CSG activities

Blue Energy are proposing to develop three PLs incrementally over the 20 year life of the Project. As new areas are developing and/or existing wells are expanded further, there will equally be declining areas of production where the decommissioning of wells and infrastructure is undertaken alongside progressive rehabilitation of the landscape. This will mean there will not be one very large disturbance area at any one time across each of the PLs – small areas across the PLs will be constructed, utilised and then decommissioned appropriately. Construction impacts can therefore be minimised via this approach, as well as this being the most efficient way to extract gas over the long term as it supplies a steady stream of gas to the centralised facility.

The approximate total annual expected CSG water production shown in Table 1.

Table 1 Expected CSG water abstraction volumes

Year	Produced Water – ML		
	Sapphire	Central	Lancewood
1	0	0	0
2	241	193	241
3	351	165	331
4	385	238	321
5	386	208	274
6	387	277	341
7	397	298	387
8	410	312	395
9	425	331	407
10	442	351	374
11	440	370	398

Year	Produced Water – ML		
	Sapphire	Central	Lancewood
12	412	380	414
13	391	352	417
14	377	332	412
15	366	318	391
16	356	308	375
17	348	221	363
18	340	215	354
19	333	210	345
20	326	206	337
Total	7,112	5,284	6,877
Average/year	356	264	344

The water quality will be analysed and assessed to determine disposal and/or reuse options. The most likely option for the destination of water produced will be to provide it to the surrounding mines for their own purposes with Blue Energy already having preliminary discussions with Fitzroy Coal to provide all produced water to them for coal washing and dust suppression purposes, resulting in beneficial reuse.

1.3 Scope

The scope of this report is to support a streamlined EA application for the PL1034, PL1038 and PL1045 in relation to groundwater aspects and impacts as they relate to the proposed coal seam gas activities.

This report will review the available regional and local groundwater information to describe the site-specific conditions, which will be summarised in a groundwater conceptual model. This conceptual model will then be translated into an analytical groundwater model to assess the potential impact of the proposed activities on the groundwater regime. A monitoring strategy will then be developed to address the potential groundwater impacts of the proposed activities.

2 Legislative framework

2.1 Environmental Protection Act 1994

Sections 125 and 126 of the EP Act sets out the requirements for a properly made application – CSG activities. Requirements specifically related to underground water rights is outlined in Table 2 with references to where these requirements are addressed in this report.

Standard criteria, as defined by Schedule 4 of the EP Act and relevant Environmental Protection Policies (EPP) have been considered and applied appropriately throughout the application and supporting documents.

Table 2 Key Groundwater Requirements for Environmental Authority Applications under the EP Act

EP Act Section	Requirement	Reference
126A(2)(a)	The application must also state the following - any proposed exercise of underground water rights during the period in which resource activities will be carried out under the relevant tenure	Section 1.2.1
126A(2)(b)	The areas in which underground water rights are proposed to be exercised For each aquifer affected, or likely to be affected, by the exercise of underground rights: a description of the aquifer an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers and surface water; and	Section 1.2.1 and Figure 1 Section 6.0
126A(2)(c	a description of the area of the aquifer where the water level is predicted to decline because of the exercise of underground water rights; and the predicted quantities of water to be taken or interfered with because of the exercise of underground water rights during the period in which resource activities were carried out	Section 5.0 Section 1.1.2
126A(2)(d)	The environmental values that will, or may, be affected by the exercise of underground water rights and the nature and extent of the impacts on the environmental values	Section 3.4 and 7.0
126A(2)(e)	Any impacts on the quality of groundwater that will, or may, happen because of the exercise of underground water rights during or after the period in which resource activities are carried out	Section 7.4 and
126A(2)(f)	Strategies for avoiding, mitigating or managing the predicted impacts on the environmental values stated for paragraph (d) or the impacts on the quality of groundwater mentioned in paragraph (e)	Section 8.0

2.2 Environmentally Relevant Activities

This EA application seeks authorisation to undertake resource activities that are petroleum activities as outline below in Table 3.

Table 3 Environmentally relevant activities

Environmentally Relevant Activity Environmental Protection Regulation 2019; Schedule 3	Threshold
Schedule 3 - 8 - a petroleum activity or greenhouse gas storage activity, other than an activity mentioned in any of items 1 to 7, that includes 1 or more activities mentioned in Schedule 2 for which an aggregate environmental score is stated.	NA

2.3 EPBC Act Considerations

The Environmental Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) outlines that where proposed petroleum and/or CSG actions has, will have, or is likely to have, a significant impact on a matter of national environmental significance, the proposal needs to be referred to the Department of Environment and Energy (DEE) for assessment and approval.

Matters of National Environmental Significance (MNES) include:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (Ramsar wetlands);
- Nationally threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park;
- Nuclear actions including uranium mining; and
- A water resource in relation to coal seam gas development and large coal mining development.

For the context of this report, the MNES of relevance are the water resources in relation to a coal seam gas development. They will be assessed for a potential significant impact.

“A significant impact is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all of these factors when determining whether an action is likely to have a significant impact on the environment.” (DoE, 2013)

The data (refer to Section 6) indicates that the water resources contained within the Rangal Coal Measures and Fort Cooper Coal Measures are of limited sensitivity, low value, and low quality. However, the water resources contained within the shallow alluvium and outcropping Clematis sandstone likely are of a significant degree of sensitivity, value, and quality.

Associated water production from the Rangal and Fort Cooper Coal Measures is relatively small volumetrically as a result of comparatively low water production rates from individual wells (refer to Section 7.1.3). As a result of the low production rates and the thick overlying Rewan Formation aquitard, outside of the immediate influence of wells installed into the Coal Measures groundwater drawdown impacts are observed to be negligible, particularly for the shallow alluvium aquifer.

Model outcomes presented Section 7.2 indicate that associated water production on PL1034, PL1038 and PL1045 from the Rangal and Fort Cooper Coal Measures will likely not result in significant impacts to the shallow groundwater system of the alluvium and Clematis Sandstone. Although the model results indicate a relatively high magnitude of drawdown within the Coal Measures, this is not considered to be a significant impact since the water resource within the Rangal Coal Measures (and that within the overlying Rewan Formation) on has already been established to be of limited sensitivity, low value, and low quality.

2.4 Environmental Values

The Environmental Protection Policy (Water and Wetland Biodiversity) 2019 (EPP (Water and Wetland Biodiversity)) aims to achieve objectives set out by the Environmental Protection Act 1994 (EP Act) and applies to all waters of Queensland. EPP (Water and Wetland Biodiversity) provides a framework to protect and/or enhance the suitability of Queensland waters for various beneficial uses by:

- Identifying environmental values and management goals for Queensland waters;
- State water quality guidelines and water quality objectives (WQO) to enhance or protect the environmental values;
- Provide a framework for making consistent, equitable and informed decisions; and
- Monitoring and reporting on the condition of Queensland waters.

2.4.1 Regional EVs

Groundwater resources for PL1034 are scheduled under the EPP (Water and Wetland Biodiversity) as Isaac Groundwaters (Zone 34) of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1310). The legislated environmental values (EV's) for these groundwaters are listed in Table 6. The other two leases, PL1038 and PL1045 are not schedules under the EPP (Water and Wetland Biodiversity).

Surface water resources within the vicinity of the site are scheduled under the EPP (Water and Wetland Biodiversity) as:

- Waters of the Isaac northern tributaries of the I River Sub-basin of the Fitzroy Basin water plan (WQ1301); and
- Waters of the Isaac and lower Connors Rivers main channel) of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1301).

The legislated environmental values (EV's) for these surface waters are listed in Table 4.

Table 4 Environmental values in the Isaac River Sub-basin

Environmental Value	Groundwater (WQ1310)	Surface water (WQ1301)
Aquatic Ecosystem	✓	✓
Water supply for Irrigation	✓	✓
Stock Watering	✓	✓
Aquaculture	✓	
Human Consumption		✓
Primary Recreation	✓	✓
Secondary Recreation		✓
Visual Recreation		✓
Drinking Water	✓	✓
Industrial Water Supply		✓
Cultural and Spiritual Values	✓	✓

2.4.2 Water quality objectives

The EPP (Water and Wetland Biodiversity) also provides limited water quality objectives for underground aquatic ecosystem protection in Fitzroy Basin groundwaters. These WQOs provided in the EPP (Water and Wetland Biodiversity) are classified by groundwater depth and regional chemistry zone. Under the EPP (Water and Wetland Biodiversity), groundwater at and surrounding the Project site will need to be compared to the WQO's relevant to the Zones 34 of the Isaac River Groundwaters of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1310). WQOs for these zones are presented in Table 5 (groundwaters) and Table 6 (human use EVs). In reference to the site hydrogeology it is deemed that the shallow WQOs (<30 m) are representative of the Quaternary alluvium, Tertiary sediment and Rewan Formation aquifer units with the deep WQOs (>30m) representative of the Permian coal measure aquifer units. It should be noted that where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters.

Table 5 Fitzroy Basin Water Quality Objectives (groundwater) according to water chemistry zone 34

Zone	Depth (± 30m)	Percentile	EC (µS/cm)	Hardness (mg/L as	pH	Alkalinity (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	Cl (mg/L)	SO_4 (mg/L)	HCO_3 (mg/L)	NO_3 (mg/L)	SiO_2 (mg/L)	F (mg/L)	Fe (mg/L)	Mn (mg/L)	Zn (mg/L)	Cu (mg/L)	SAR	RAH (meq/L)	EH (mV)
34	Deep	20th	3419	359	7.4	156	46	35	480	753	25	188	0.01	16	0.02	0	0	0.01	0.017	10.5	0	ID
34	Deep	50th	6100	919	7.8	275	145	115	1100	1900	138	330	2.15	25	0.155	0.05	0.05	0.025	0.03	15.6	0.24	ID
34	Deep	80th	16000	3208	8.03	536	442	491	2565	5905	398	650	14.92	36	0.4	0.246	0.291	0.317	0.03	24.65	6.25	ID
34	Shallow	20th	498	163	7.1	154	18	27	135	171	12	187	0	21	0.1	0	0	0	0	4.37	0	ID
34	Shallow	50th	498	163	7.1	154	18	27	135	171	12	187	0	21	0.1	0	0	0	0	4.37	0	ID
34	Shallow	80th	2150	674	7.75	435	84	108	747	1309	140	536	0.95	36	0.28	0.03	0.01	0.015	0.015	10.85	0	ID

ID: Insufficient data to perform statistical summaries, or the parameter was not tested

Table 6 Fitzroy Basin Groundwaters Water Quality Objectives according to human use environmental values

Environmental Value	Water Quality Objective (refer to specified codes and guidelines for full details)
Water Supply for irrigation	Australian and New Zealand Environment and Conservation Council (ANZECC, 2000) objectives for pathogens and metals are provided in Tables 8 and 9 of Dawson River Sub-basin Environmental Values and Water Quality Objectives (DEHP, 2011). For other indicators, such as salinity, sodicity and herbicides, see Australian Water Quality Guidelines (AWQG).
Farm water supply/use	Objectives as per AWQG.
Stock Watering	Objectives as per AWQG, including median faecal coliforms <100 organisms per 100 ml. WQOs for total dissolved solids and metals are provided in Tables 10 and 11, based on AWQG. For other objectives, such as cyanobacteria and pathogens, see AWQG.
Cultural and Spiritual Values	Protect or restore indigenous and non-indigenous cultural heritage consistent with relevant policies and plans.

3 Site Setting

3.1 Climate

The climate of the region is subtropical with the highest rainfall and evaporation occurring from November to March (BoM, 2021). Historical climate data was obtained for the period January 1900 to August 2021 from the Scientific Information for Land Owners (SILO) database (Queensland Government, 2021) for the location of the Project area (latitude -21.70, longitude 148.15). Table 7 outlines the total monthly average rainfall and evaporation. The data shows that the total average annual evaporation (1,971 mm/yr) is more than three times the total annual rainfall (604 mm/yr). The high annual evaporation rates are strongly related to temperature, as can be seen in Figure 3.

Table 7 Total Monthly Rainfall and Evaporation (January 1900 to August 2021)

Average Total Monthly (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall	113	106	72	32	29	31	24	19	13	29	51	86	604
Evaporation	209	171	176	142	114	92	102	131	171	213	221	229	1,971

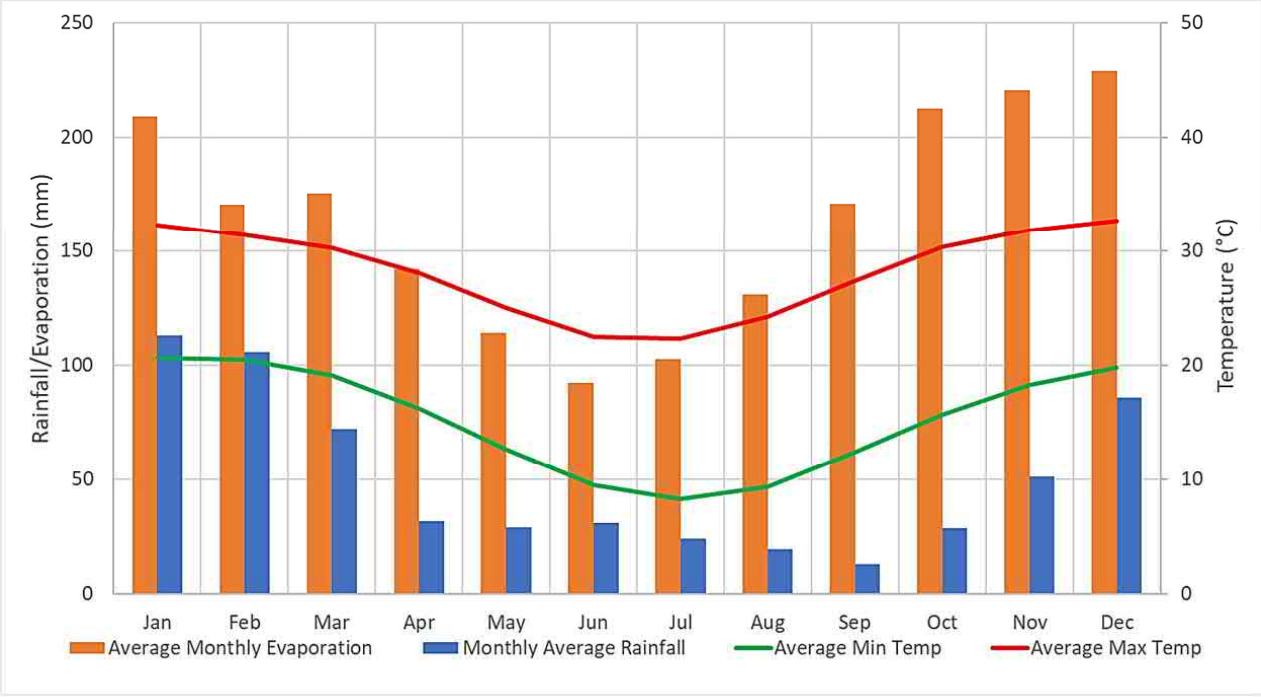


Figure 3 Average Monthly Evaporation, Rainfall and Temperature (January 1900 to August 2021)

In order to place recent rainfall years into a historical context, a cumulative rainfall departure (CRD) was calculated for the entire data period, but shown from 2000 onwards only (Figure 4). This is a summation of the monthly departures of rainfall from the long-term average monthly rainfall. A rising slope in the CRD plot indicates periods of rainfall above the long-term average, as is the case for 2010 to 2012, whereas a falling slope indicates periods when rainfall is below the long-term average (e.g. 2001 to 2007). Rainfall volumes over more recent years of the record (2017 to 2021) have been lower than average, as is indicated by the falling slope in the CRD.

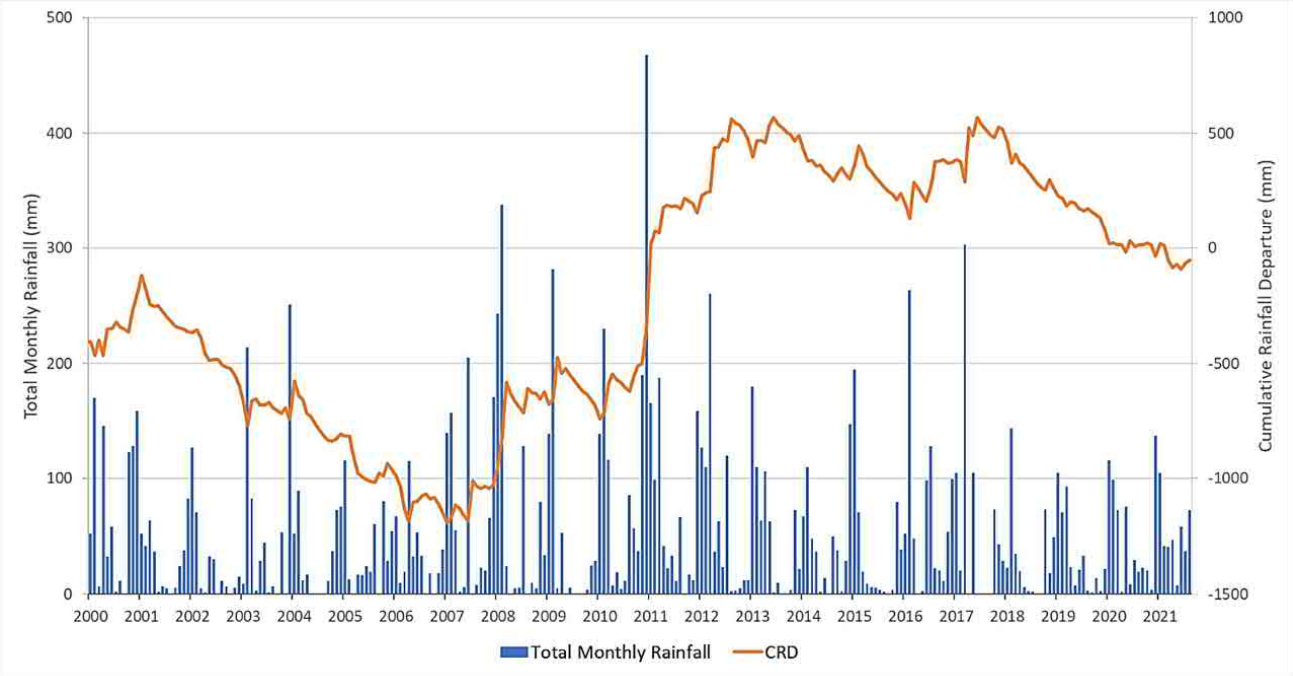


Figure 4 Cumulative Rainfall Departure and Total Monthly Rainfall

3.2 Topography

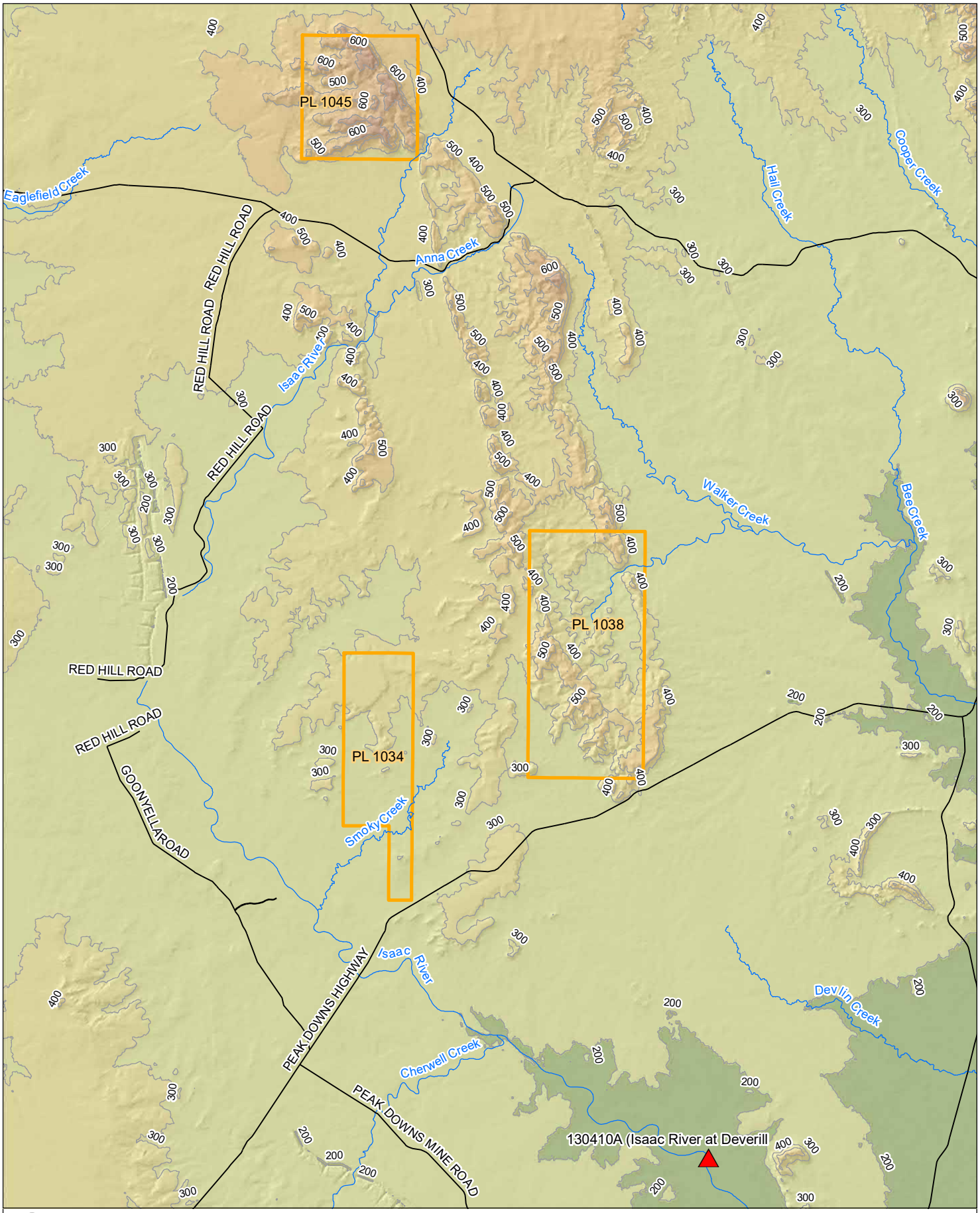
The topography of the project area consists of high plateau areas surrounded by flood plains with elevations across PLs ranging from 240 to 600 mAHD.

The topography at PL 1034 is gently undulating flood plains with elevations that range from approximately 350 mAHD in the north and mid tenement to approximately 240 mAHD in the south towards Smoky creek.

PL 1038 consists of a plateau outcrop with elevations of around 400 to 500 mAHD along the mid and south east of the tenement, surrounded by flatter flood plains with elevations of approximately 300 mAHD .

PL 1045 is predominantly a plateau outcrop with elevations of around 500 to 600 mAHD, gently sloping towards approximately 420 mAHD in the northeast and south east.

Figure 5 shows the topography of the project area.



0 2.5 5 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:375,000 at A4
Project Number:	620.30617
Date:	08-Oct-2021
Drawn by:	PM

Surface Water Monitoring Station
Project Petroleum Lease
Road
Contours 100m

Elevation (mAHD)

0 - 100	501 - 600
101 - 200	601 - 700
201 - 300	701 - 800
301 - 400	801 - 900
401 - 500	901 - 1,100

BLUE ENERGY EA APPLICATION

Topography and Drainage

Data Source: DNRME Petroleum leases and solid geology 1985.

FIGURE 5

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Groundwater\SLR620306617_GW_TopoDrainage_01.mxd

3.3 Hydrology

The Project is located in the Isaac River drainage basin sub-area of the wider Fitzroy Drainage Basin. The Isaac River, to the south-west of the Project, is the major drainage feature of the region and flows in a south-easterly direction. Figure 5 shows the local topography and drainage.

Several other smaller tributaries of Isaac River flow through the area, including Smoky Creek and Billy's Gully which flow through the south of PLA 1034. Carborough Creek, a tributary of Walker creek, flows through the northern end of PLA 1038. Isaac River is classified as a sixth order stream while its tributaries and Smoky Creek are Billy's Gully classified fourth and third order streams respectively. Walker Creek is classified as a fifth order stream while its tributary Carborough Creek is classified as a fourth order stream. Both Isaac River and Walker Creek and their tributaries are ephemeral, experiencing short periods of flow following high rainfall events.

A Department of Regional Development, Manufacturing and Water (DRDMW) gauging station is located along Isaac River at Deverill (station 130410A). The station is located approximately 29 km from PL 1034 and 1038 and 32 km downstream of the confluence with Billy's Gully. Figure 6 shows monthly maximum stream discharge at station 130410A and total monthly rainfall (SILO -21.70, 148.15) for the last 20 years. The graph shows that the Isaac River flows only during periods of high rainfall which confirms that it is ephemeral.

Based on daily flow data since 1968 (Figure 7), Isaac River flows only 27% of the time, with less than a 11% probability of flows exceeding 100 ML/day. Less than 1% of readings exceed 10,000 ML/day, which includes high flow/flood events in 2008 (January and February), 2010 (December), 2012 (March), 2016 (February) and 2017 (March).

PL 1034, 1038 and approximately 60% of PL 1045 are located within the Isaac Connors sub-catchment area of the Fitzroy Basin, the remainder of PL 1045 is within the Belyando Suttor catchment area, a sub-catchment of the Burdekin basin.

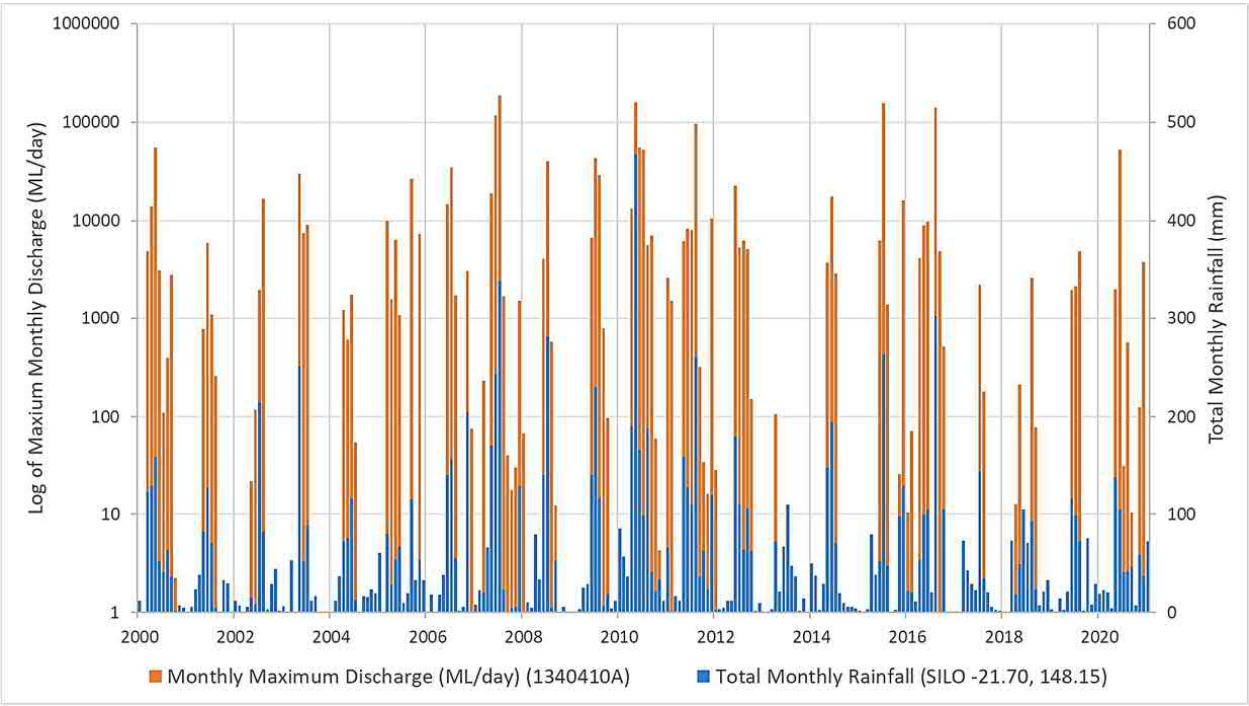


Figure 6 Isaac River (Station 1340410A) stream flow and rainfall (SILO -21.70, 148.15)

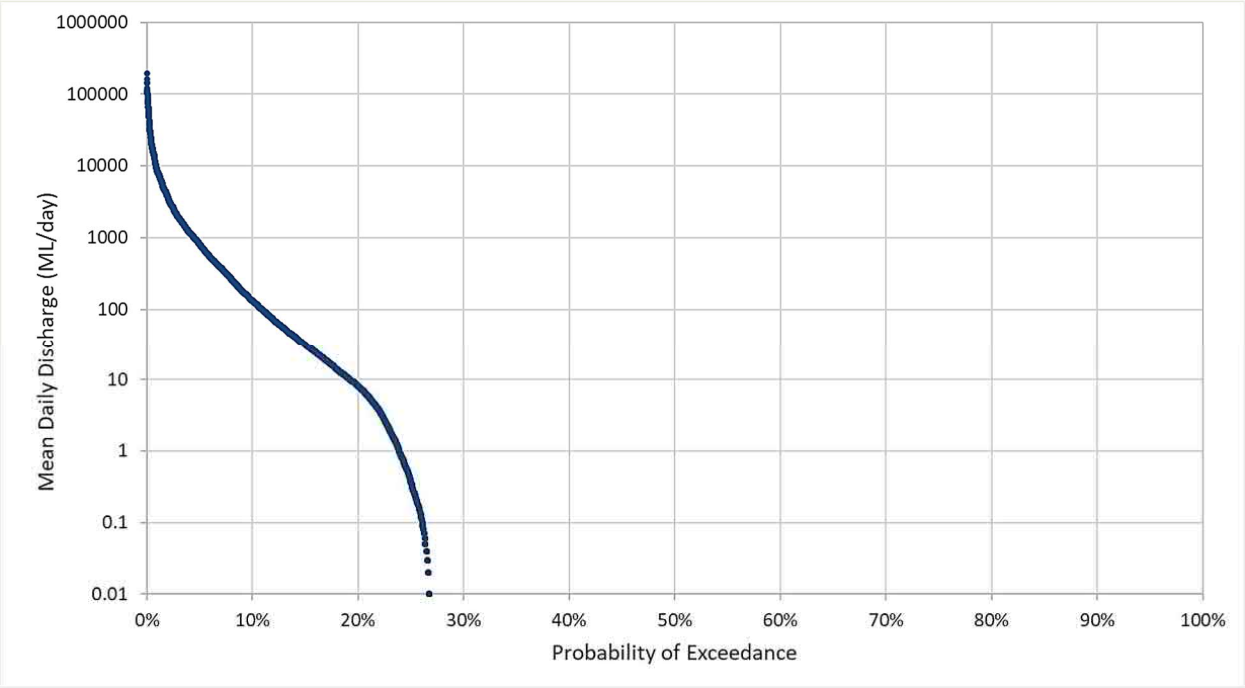


Figure 7 Isaac River (Station 130410A) Mean Daily Flow Duration Curve (full data period 1968 to 2021)

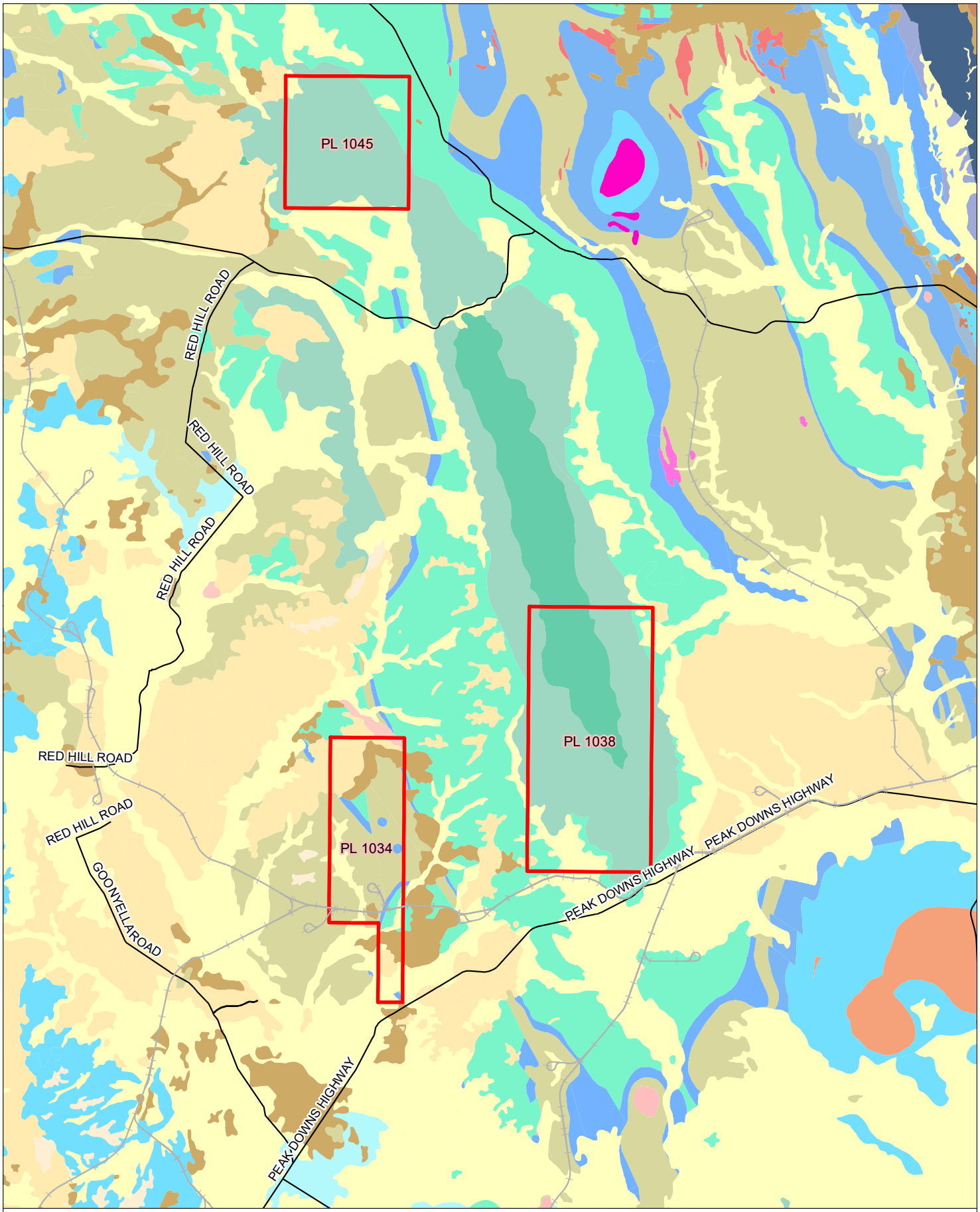
4 Geological Setting

4.1 Regional Geology

The Project is located in the geological Bowen Basin, which is one of five major foreland sedimentary basins formed along the eastern side of Australia during the Permian period. The Bowen Basin is the largest productive coal basin in Australia. The Bowen Basin stretches from Townsville to south of the Queensland-New South Wales border in a north to south direction. In the southern parts, the extent of the Bowen Basin and the hydrogeological Great Artesian Basin (GAB) overlap.

The post-depositional structure of the Bowen Basin is dominated by compressional tectonics which has formed regional scale north to northwest striking, easterly dipping thrust faults, the major structural elements in the Bowen Basin. The fault system forms platforms/shelves that are separated by sedimentary troughs. PL 1034, 1038 and 1045 are located in the northern Bowen Basin.

Surface geological mapping is shown in Figure 8 and solid geological mapping in Figure 9. The stratigraphy of the project area is discussed in Section 4.2.



0 2.5 5 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:350,000 at A4
Project Number:	620.30617
Date:	03-Nov-2021
Drawn by:	PM

SLR

- Project Petroleum Lease
- Rail
- Road

Detailed Geology

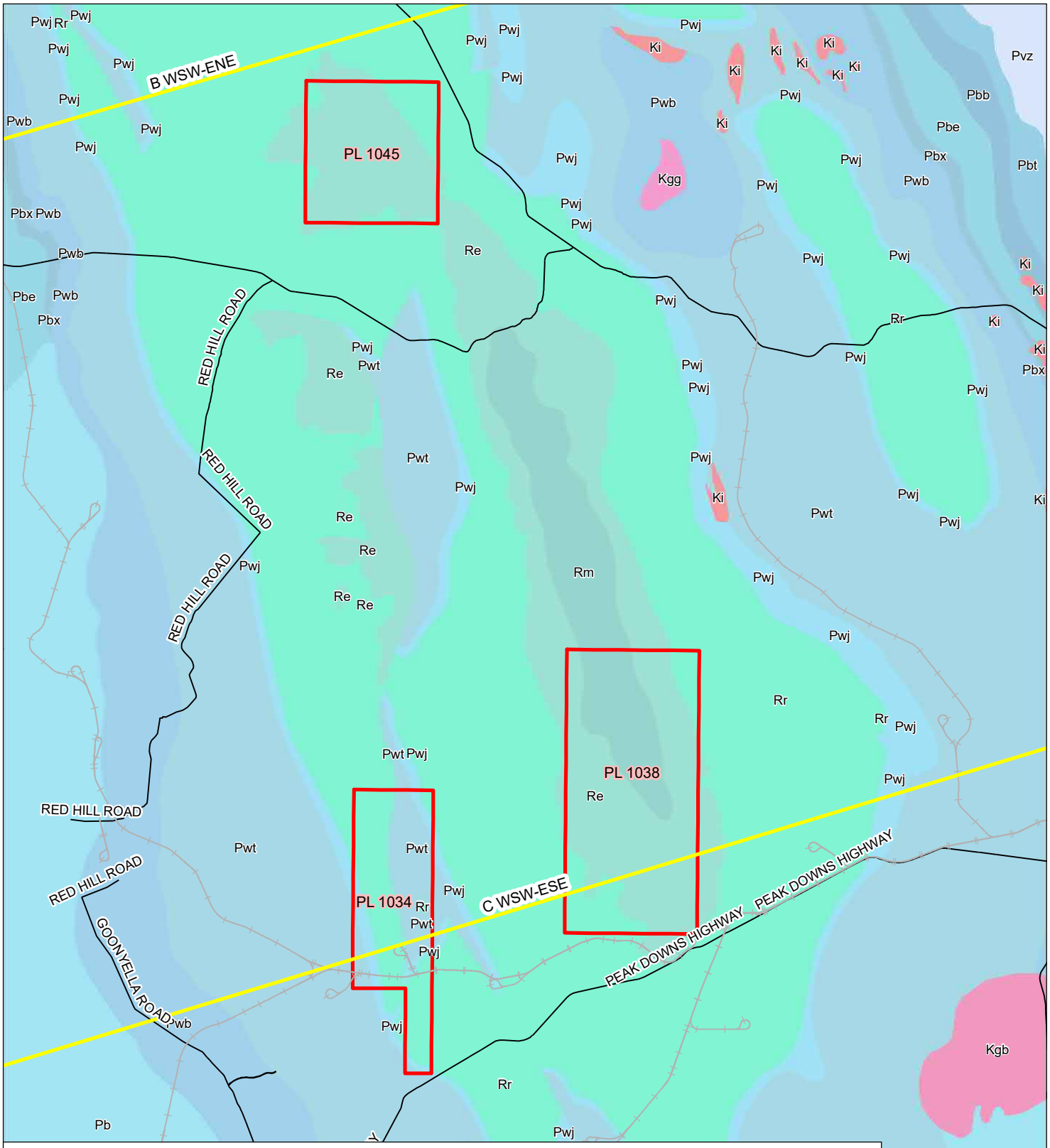
- Back Creek Group
- Blenheim Formation
- Clematis Group
- Colluvium
- Early Cretaceous Granitoid
- Exevale Formation
- Fort Cooper Coal Measures
- Gebbie Formation
- Gotthardt Granodiorite
- Ki-8554
- Ki-8555
- Ki-CQ
- Moolayember Formation
- Moranbah Coal Measures
- Mount Benmore Volcanics
- Permian Sedimentary
- Pisgah Igneous Complex
- Plevna beds
- Qr\b-QLD
- Qr\s-QLD
- Quaternary
- Rangal Coal Measures
- Rewan Group
- Td-QLD
- Teemburra Igneous Complex
- Tertiary Basalt
- Tertiary Felsics
- Tertiary Sediments/Suttor Formation

BLUE ENERGY EA APPLICATION

Surface Geology

FIGURE 8

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CADGIS\GIS\Groundwater\SLR620306617_GW_SurfaceGeology_01.mxd



Geology Solid

- Moolayember Formation (Rm)
- Clematis Group (Re)
- Rewan Group (Rr)
- Rangal Coal Measures,Bandanna Formation,Baralaba Coal Measures (Pwj)
- Fair Hill Formation,Fort Cooper Coal Measures (Pwt)
- Moranbah Coal Measures (Pwb)
- Back Creek Group (Pb)
- Blenheim Subgroup (Pbe)
- Bundarra Granodiorite (Kgb)
- Exmoor Formation (Pbx)
- Gebbie Subgroup (Pbb)
- Gotthardt Granodiorite (Kgg)
- Ki-CQ (Ki)
- Lizzie Creek Volcanic Group (Pvz)
- Tiverton Formation (Pbt)

0 2.5 5 km

- Cross Sections (Arrow Energy, 2013)
- Project Petroleum Lease
- Rail
- Road

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:350,000 at A4
Project Number:	620.30617
Date:	20-Oct-2021
Drawn by:	PM

BLUE ENERGY EA APPLICATION

Solid Geology

SLR

Data Source: DNRME Petroleum leases and solid geology 1985.

FIGURE 9

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Groundwater\SLR620.30617_GW_SolidGeology_01.mxd

4.2 Local Geology

Surface geological mapping of the project area (Figure 8) shows that outcropping units across the PLs are predominantly Triassic and Tertiary aged, covered by alluvium in some areas. The stratigraphy of the Project area relevant to PLs is shown in Table 8. The stratigraphy of the area has been conceptualised by Arrow Energy (2013), the conceptual cross sections are shown in Figure 10 and location of the cross sections shown on the solid geological mapping in Figure 9. The conceptual cross sections have been overlain with the approximate location of the PLs where they intersect (for PL 1034 and PL 1038) or the closest location to the cross section line (PL 1045).

Table 8 Stratigraphy of Project Area

Period	Stratigraphic Unit	Description	Distribution	Max Thickness (m)
Quaternary	Quaternary Alluvium/ Colluvium	Alluvium comprising sand, gravel and clay[2]. Colluvium comprising clay, sand, gravel and soil.	Surficial cover mainly associated with rivers, within all PLs.	~50[2]
Tertiary	Tertiary Sediments	Unconsolidated sediments including mud, sand, gravel, residual soils and colluvium[2].	Surficial cover in the north and south of PL 1034, and a small area in the north of PL 1038.	~120[2]
	Suttor Formation	Quartz and clayey sandstone, mudstone and conglomerate, fluvial and lacustrine sediments with minor interbedded basalt[1].	Outcropping at PL 1038 and PL 1034.	~10[1]
	Basalt	Predominantly olivine rich flows[1].	Only present at PL 1034.	~60[3]
Triassic	Moolayember Formation (Rm)	Mudstone, micaceous lithic sandstone and micaceous siltstone[2].	Only present at 1038, outcrops within the north and central PL.	~ 200[2]
	Clematis (Re)	Cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone[1].	Only Present at PL 1045 and PL 1038. Outcrops across most of PL 1045 and PL 1038.	~ 300[2]
	Rewan Group (Rr)	Lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate at base[1].	Outcrops in the north of PL 1045 and PL 1038 and in small areas of PL 1034.	~ 840[1]
Late Permian	Rangal Coal Measures	Feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams[1].	Present across all PLs at depth. Outcrops in small areas across PL 1034.	~200[1]

Period	Stratigraphic Unit	Description	Distribution	Max Thickness (m)
	Fort Cooper Coal Measures and equivalents	Lithic sandstone, mudstone, conglomerate, shale, coal and tuff[1].	Present across all PLs. Outcrops within central PL 1034.	~600[2]
	Moranbah Coal Measures and equivalents	Labile sandstone, siltstone, mudstone and coal with conglomerate in some areas[1].	Present across all PLs but does not outcrop.	~700[2]
Middle Permian	Back Creek Group	Quartzose to lithic sandstone, siltstone, mudstone, shale, conglomerate, limestone and sandy coquinite.	Present across all PLs but does not outcrop.	~400[1]

1 Geoscience Australia (2021)
2 Arrow Energy (2013)
3 DoR Bore Reports (2021)

4.2.1 Quaternary

Quaternary alluvium is associated with watercourses (primarily the Isaac River) and paleochannels within PL 1034, 1038 and 1045. The alluvial deposits unconformably overly the Tertiary sediments, Triassic and Permian units where present across the PLs. The alluvium is associated with watercourses and paleochannels that were deposited in meandering and braided stream environments. The geometry of the deposits is typical of meandering stream deposits, where the coarsest material (gravels) is deposited at the point with the highest energy (on the inside bends) and finer materials (clay and silt) is deposited on the flood plains. The base of the channel is typically made up of sands and gravels. This depositional nature as well as the channel moving over time has resulted in a thin cover of sediment, containing lenses of coarser material (AGE, 2020). Typical thicknesses of the Isaac River alluvium are approximately 10 to 30 m (AGE, 2020) but have been reported to be up to 50m (Arrow Energy, 2013). The alluvium associated with smaller drainage lines is expected to have maximum thickness of 10m, if present.

4.2.2 Tertiary

Tertiary units across the Project area comprise Tertiary sediments, the Suttor Formation and Tertiary Basalt.

The Tertiary sediments separate the alluvial deposits from the underlying bedrock in some areas. Distribution across Project PLs includes surficial cover in the north and south of PL1034, and a small area in the north of PL 1038. The unit comprises unconsolidated sediments including mud, sand, gravel, residual soils and colluvium. Typical thickness of the sediments is approximately 15m but have been reported up to 120 m (Arrow Energy, 2013).

The Suttor Formation comprises quartz and clayey sandstone, mudstone and conglomerate, fluvial and lacustrine sediments with minor interbedded basalt and has a maximum thickness of approximately 10m (Geoscience Australia, 2021). The unit outcrops in small areas at PL 1038 and PL 1034.

Tertiary basalt is only present at PL 1034. The basalt comprises vesicular olivine rich flows with calcite infill. Bore logs from registered bores directly east of PL 1034 show that the basalt has a maximum thickness of approximately 60 m and is on average between approximately 30 to 40 m. In this area, the base of the basalt can generally be recognised by the weathering horizon, which forms a thin layer (~<1m) of high plasticity clays.

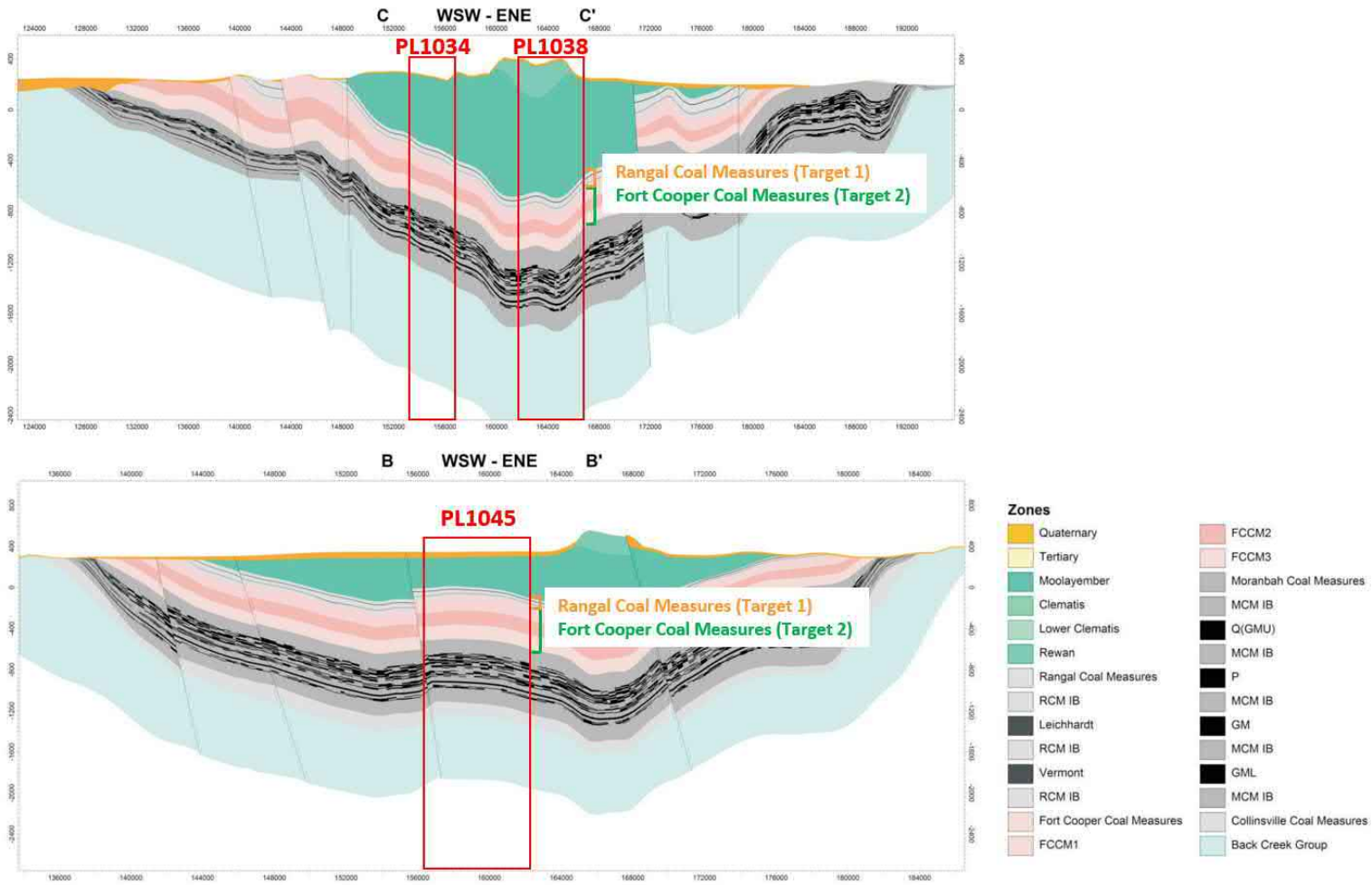


Figure 10 Conceptual Cross Sections (Modified from Arrow Energy 2013)

4.2.3 Triassic

Triassic units across the PLs include the Moolayember Formation, Clematis Sandstone and Rewan Formation.

The Moolayember Formation outcrops within the north and central PL 1038 and is comprised predominantly of mudstone, micaceous lithic sandstone and micaceous siltstone. Within the area, the unit has a maximum thickness of approximately 200 m (Arrow Energy, 2013).

The Clematis Sandstone outcrops across most of PL 1045 and PL 1038, it is not present at PL 1034. The unit is primarily comprised of cross-bedded quartz sandstone, some quartz conglomerate and minor red-brown mudstone (Geoscience Australia, 2021). Within the area, the unit has a maximum thickness of approximately 300m (Arrow Energy, 2013).

The Rewan Group underlies the Clematis Sandstone and outcrops in the north of PL 1045 and PL 1038 and in small areas of PL 1034. The unit is comprised of lithic sandstone, pebbly lithic sandstone, green to reddish brown mudstone and minor volcanolithic pebble conglomerate at base (Geoscience Australia, 2021). In the area, the unit has a typical thickness of approximately 300 m (Arrow Energy, 2015).

4.2.4 Permian

Permian units across the Project PLs include the Rangal Coal Measures, Fort Cooper Coal Measures, Moranbah Coal Measures and Back Creek Group. The coal seams of the Rangal and Fort Cooper Coal Measures are the target of the Project.

The Rangal Coal Measures are present above the Fort Cooper Coal Measures and outcrop within central PL 1034. The unit is comprised of feldspathic and lithic sandstone, carbonaceous mudstone, siltstone, tuff and coal seams (Geoscience Australia, 2021). Within the area, the unit has an estimated thickness between 25 and 200m (Arrow Energy, 2013).

The Fort Cooper Coal Measures unconformably overly the Moranbah Coal Measures. The unit is present across all PLs and outcrops within central PL 1034. The unit is mainly comprised of lithic sandstone, mudstone, conglomerate, shale, coal and tuff (Geoscience Australia, 2021). Estimated thickness ranges from 100 to 600 m (Arrow Energy, 2013).

The Moranbah Coal Measures (and equivalents) are present above the Back Creek Formation and occur across all PLs at depth. The unit comprises labile sandstone, siltstone, mudstone and coal with conglomerate in some areas (Geoscience Australia, 2021). Within the area, estimated thickness ranges from 100 to 700 m (Arrow Energy, 2013).

The Back Creek Group underly the Moranbah Coal Measures and are present across all PLs at depth. The unit consists primarily of Quartzose to lithic sandstone, siltstone, mudstone, shale, conglomerate, limestone and sandy coquinite. The Back Creek Group has an estimated thickness of approximately 400 m (Geoscience Australia, 2021).

5 Hydrogeology

5.1 Hydrogeological units

5.1.1 Quaternary

The Quaternary Alluvium is associated with watercourses (primarily the Isaac River) and paleochannels across the Project area. The alluvium forms a significant aquifer, especially within coarser grained horizons. Horizontal hydraulic conductivity estimates for the Isaac River alluvium are in the range of 0.0076 to 8.1 m/day. The variable hydraulic conductivity is due to the difference in grain size across the deposits due to the depositional nature of the meandering stream environment. The lower channel deposits comprising coarser grained sediments yield higher hydraulic conductivity estimates than the finer deposits that make up the outer areas. The coarser grained basal areas of the deposit facilitate the drainage of groundwater, meaning that in most areas the saturated interval will not become extensive except for after large rainfall events. Perched groundwater may occur within the alluvium above clay lenses and above underlying bedrock which is comprised of aquitard material (AGE, 2020).

Recharge to the alluvium is variable depending on climatic conditions. The primary recharge mechanism is via direct infiltration from rainfall. The alluvium also becomes recharged though the Isaac River which only flows after large rainfall events (discussed further in Section 3.3). High flow and flood events can have a substantial contribution of groundwater to the aquifer system. A flooding assessment conducted by AGE (2020) has shown that following a Q1000 flooding event, additional can last up to 8 years (AGE, 2020).

During dry periods, some recharge may occur via upwards flow from the underlying bedrock where the hydraulic gradient promotes upwards flow. Upwards flow from the underlying bedrock would occur through areas which facilitate the movement of groundwater such as fractures/faults or bedding planes or coal seams which unconformably underly the alluvium (AGE, 2020). The upwards movement of groundwater is supported by the observation of saline groundwater quality in the alluvium which is comparable to that of the Permian (Refer to Section 5.4.1). The observation of saline groundwater quality in the alluvium was also reported by AGE (2020) at the Isaac Downs Project (approximately 1km south of PL 1034).

Groundwater flow follows topographic gradients with groundwater movement generally following the rivers and topography (AGE, 2020).

Discharge occurs from evapotranspiration, downwards leakage and seasonal limited stream discharge (AGE, 2020).

5.1.2 Tertiary

5.1.2.1 Tertiary sediments and Suttor Formation

The Suttor Formation and Tertiary sediments outcrop at PL 1034 and 1038. The geological boundary between the Suttor Formation and Tertiary sediments is difficult to distinguish due to lithological similarity and it is often not separated during drilling programs (AGE, 2020), hence they are discussed here together. The strata of the Suttor Formation contains (as well as sediments) sedimentary deposits and interbedded basalts. The deposits vary spatially and in thickness. Where the basalt flows are thick and not interbedded with sediments these are usually logged as Tertiary basalt rather than the Suttor Formation (the Tertiary basalt is discussed in Section 5.1.2.2).

The tertiary aged sediments are not deposited by fluvial processes, instead they have been influenced primarily by colluvial and weathering processes. The Tertiary sediments are more clay dominant than the alluvium. There are coarser grained areas, although they are often dry due to their shallow depth. The sediments do not contain significant volumes of groundwater and are not considered to be a significant aquifer (AGE, 2020). Consolidated sediments of the Tertiary (i.e. interbedded sedimentary rocks of the Suttor Formation) also vary in grain size and are interbedded at different thicknesses with basalt. Where deposits are coarser and thicker, they have more potential to hold groundwater.

Horizontal hydraulic conductivity estimates presented by AGE (2020) are in the range of 0.038 to 2 m/day (weathered Triassic) and 0.0042 to 0.099 m/day (weathered Permian). These relatively low hydraulic conductivity estimates support the fact that the unit does not form a significant groundwater resource in the Project area (AGE, 2020).

Recharge to the Tertiary sediments/Suttor Formation occurs via direct rainfall infiltration and upwards movement from the underlying Permian where the hydraulic gradient permits. Discharge occurs via downwards seepage to the Permian and via horizontal seepage to the alluvium. (AGE, 2020)

Groundwater yields reported from registered bores in a 10km buffer of PLs are generally less than 1 L/s.

5.1.2.2 Tertiary Basalt

Tertiary aged basalt is present at PL 1034. Due to weathering and jointing of the basalt, the aquifer is compartmentalised in some areas and therefore exhibits heterogeneous groundwater characteristics (Arrow Energy, 2013).

Horizontal hydraulic conductivity estimates of the basalt reported by AGE (2020) are in the range of 0.1 to 6.5 m/day. The large variation in hydraulic conductivity is reflective of the nature of the fractured rock aquifer, where zones of higher permeability occur around fractures, joints and vesicles within the basalt (AGE, 2020).

Recharge to the basalt occurs via direct rainfall infiltration where the unit is outcropping, and through downwards seepage through the overlying alluvium. Discharge occurs via downwards leakage to the underlying Triassic and Permian units, groundwater use (pumping) and horizontal seepage to the alluvium where the paleochannel intersects the alluvium (AGE, 2020).

Groundwater flow within the basalt follows the topographic gradient of the paleochannel towards the south to southwest (AGE, 2020).

Groundwater yields as reported by AGE (2020) from the Tertiary basalt at Broadlea and Carborough Downs mines are variable, ranging from 0.1 to 11.4 L/s with a median yield of 1.9 L/s. Higher yields occur in fractured/vesicular areas, and towards the base of the flow where the basalt is thicker (AGE, 2020).

5.1.3 Triassic

Triassic aged strata across the Project comprise the Moolayember Formation, Clematis Sandstone and Rewan Group, these are discussed from Section 5.1.3.1 to 5.1.3.3.

5.1.3.1 Moolayember Formation

The Moolayember Formation is made up of low permeability sediments which hydraulically separate the sediments of the Bowen Basin from the overlying Surat Basin (OGIA, 2019). Regionally the formation is considered an aquitard (Evans et al., 2018).

The unit's modelled hydraulic conductivity values are reported by OGIA (2019) as 1.8 x 10^{-6} m/day (horizontal) and 5.1 x 10^{-10} m/day (vertical).

Recharge to the Moolayember Formation occurs via rainfall infiltration through the Tertiary. Discharge occurs from downwards leakage to the underlying formations.

5.1.3.2 Clematis Sandstone

The Clematis Sandstone is present across most of PL 1045 and PL 1038. The Clematis forms localised islands and are not connected to the Great Artesian Basin (GAB) system. Regionally the Clematis forms an important aquifer which is used for water supply across the Bowen Basin (OGIA, 2016). The unit is an unconfined aquifer where it outcrops, and is confined in areas where it is overlain by the Moolayember Formation and underlain by the Rewan Group (Evans et al., 2018).

Modelled hydraulic conductivity values are reported by OGIA (2019) as 0.013 m/day (horizontal) and 3.7 x 10^{-5} (vertical).

Recharge to the Clematis occurs primarily from rainfall infiltration where the unit outcrops. Discharge occurs from pumping and downwards leakage.

5.1.3.3 Rewan Group

The Rewan Group occurs across all Project PLs, outcropping in the north of PL 1045 and PL 1038 and in small areas of PL 1034. The Rewan group is comprised primarily of low permeability fine grained sedimentary layers (siltstone and shales) and is recognised as an aquitard. The unit forms a confining layer to the underlying Permian units (AGE, 2020).

Hydraulic conductivity estimates presented by AGE (2020) range from 1.8 x 10^{-6} to 0.004 m/day (horizontal) and 7.8 x 10^{-7} to 1.1 x 10^{-5} m/day (vertical). Hydraulic conductivity within the Rewan is generally low due to the fine grain size, however areas which are fractured or faulted enhance hydraulic conductivity usually to a local extent, depending on the degree of fracture connectivity (AGE, 2020).

Recharge to the Rewan occurs from direct rainfall infiltration where it outcrops, and from downwards seepage from the overlying units. Groundwater discharge is to the underlying Permian coal measures (AGE, 2020).

5.1.4 Permian

The Permian Coal Measures includes the Rangal Coal Measures, Fort Cooper Coal Measures, Moranbah Coal Measures and Back Creek Group. These units are comprised of a varying sequence of sedimentary rocks, where the coal seams form the main water bearing features due to fractures and are layered in a sequence of predominantly low permeability sediments. Hydraulic conductivities are variable and range from low to moderate permeability (discussed for each formation below). There is a degree of variability due to faulting and fracturing of formations, however it is generally expected that the hydraulic conductivity of the coal seams is three times that of the interburden and that there is a general decreasing trend with depth (AGE, 2020).

The Rangal Coal Measures are present above the Fort Cooper Coal Measures and outcrop within central PL 1034. Horizontal hydraulic conductivity estimates for the Rangal Coal Measures presented by AGE (2020) range from 6.2 x 10^{-7} to 6.0 x 10^{-3} (interburden) and 0.034 to 4.2 m/day (coal). Groundwater yields for the Rangal Coal Measures are expected to be low, but variable yields have been reported by AGE (2020) at Isaac Downs, ranging from <0.1 to 4 L/s. Higher yields that were reported however are expected to be associated with faulting (AGE, 2020).

The Fort Cooper Coal Measures unconformably overly the Moranbah Coal Measures. The unit is present across all PLs and outcrops within central PL 1034. Horizontal hydraulic conductivity estimates for the Fort Cooper Measures presented by AGE (2020) range from 8.4 x 10^{-5} to 2.5 m/day. The unit is recognised as a regional aquitard and hence there is expected to be limited groundwater movement between the overlying Rangal Coal Measures and underlying Moranbah Coal Measures (AGE, 2020).

The Moranbah Coal Measures (and equivalents) are present above the Back Creek Formation and occur across all PLs at depth. Horizontal hydraulic conductivity estimates for the Fort Cooper Measures presented by AGE (2020) range from 8.4 x 10^{-4} to 0.27 m/day. Groundwater yields for the Fort Cooper and Moranbah Coal Measures as reported by AGE (2020) were the same as the overlying unit, ranging from 0.1 to 11.1 L/s with average yields of around 1.2 to 1.9 L/s (AGE, 2020).

Recharge to the Permian Coal Measures occurs mainly where the unit subcrops, through secondary porosity features (faults, fractures joints) and where the coal seams subcrop at an angle. Discharge occurs from leakage to the underlying formations (gradual), or through where the coal measures subcrop if the hydraulic gradient allows, and from dewatering associated with mining (AGE, 2020). Groundwater flow is expected to follow the dip of the coal seams.

5.2 Aquifer Properties

Hydraulic conductivity estimates from field tests have been compiled by AGE (2020) and are summarised in Table 9.

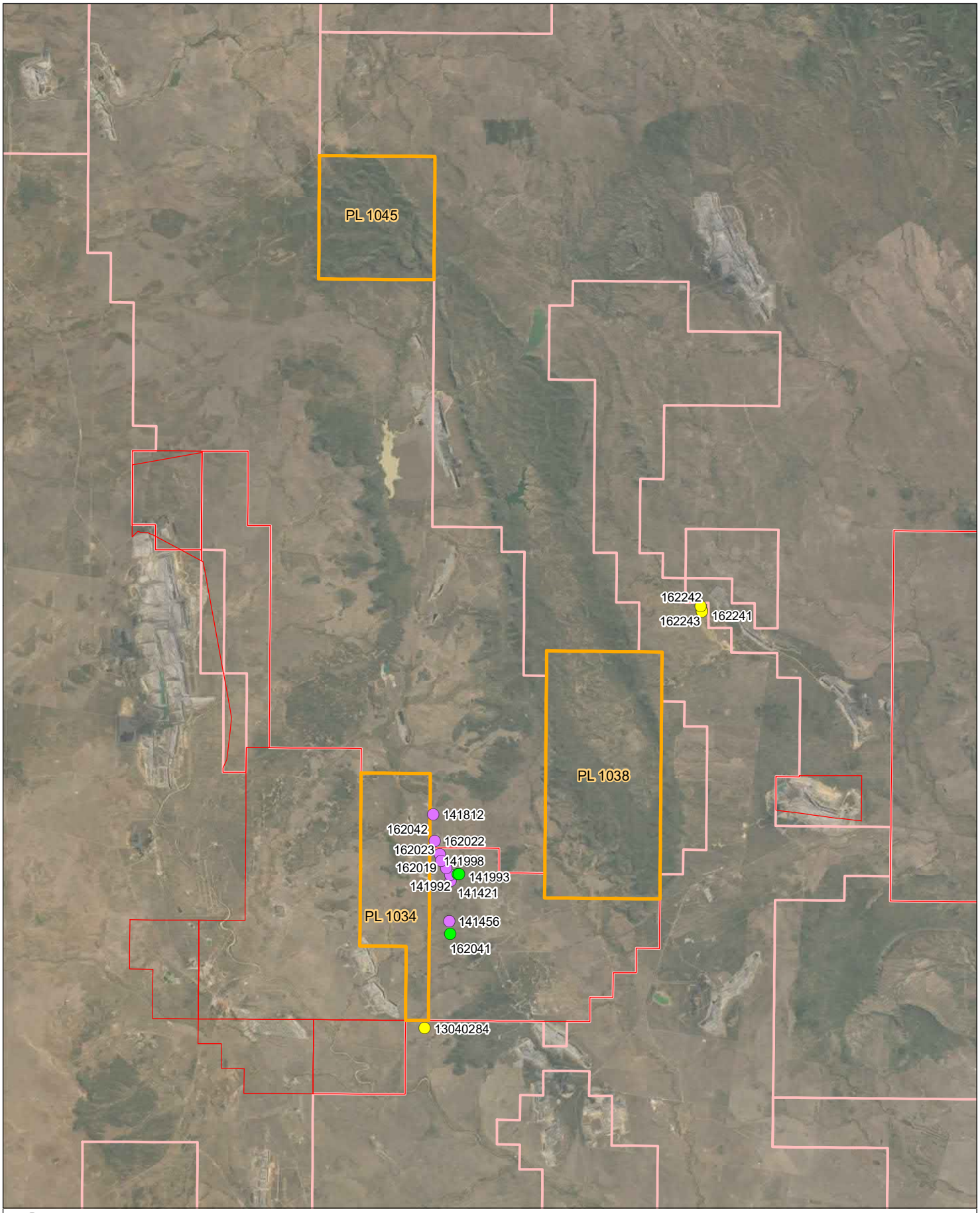
Table 9 Hydraulic conductivity estimates

Aquifer	Kh* (m/day)	Kv* (m/day)
Alluvium	0.0076 - 8.1[1]	-
Tertiary Sediments (weathered Triassic)	0.038 - 2[1]	-
Tertiary Sediments (weathered Permian)	0.0042 - 0.099[1]	-
Basalt	0.1 - 6.4[1]	-
Moolayember Formation	1.80E-06[2]	5.10E-10[2]
Clematis Sandstone	0.013[2]	3.7E05[2]
Rewan Group	1.80E-06 -0.004[1]	7.80E-07 - 1.10E-05[1]
Rangal Coal Measures (coal)	0.034 - 4.2[1]	-
Rangal Coal Measures (interburden)	6.20E-07 - 6.00E-03[1]	3.10E-07 - 4.50E-06[1]
Fort Cooper Coal Measures (Fairhill seam)	8.40E-05 - 8.40E-04[1]	-
Fort Cooper Coal Measures	0.027 - 2.5[1]	-
Moranbah Coal Measures (Goonyella Middle Seam)	8.40E-04 -0.27[1]	-

[1] Compiled by AGE (2020)
[2] OGIA (2019)
*Kh: horizontal hydraulic conductivity. Kv: vertical hydraulic conductivity

5.3 Groundwater Levels

Groundwater level data for registered bores within a 10 km radius of PLs is discussed below where available from the DoR (2021) database. Only a selection of bores are shown in order to describe groundwater level in each aquifer, these are shown in Figure 11.



0 2.5 5 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:375,000 at A4
Project Number:	620.30617
Date:	20-Oct-2021
Drawn by:	PM

Registered Bores with Groundwater Level Data Graphed by Aquifer

- Basalt
- Permian
- Rewan
- Project Petroleum
- Other Petroleum
- Authority to Prospect

Data Source: DNRME Petroleum leases and registered groundwater bores. Imagery ESRI Basemaps 2019-2020.

BLUE ENERGY EA APPLICATION

Registered Bores with Groundwater Level Data Graphed

FIGURE 11

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Groundwater\SLR620.30617_GW_Registered_Bores_Groundwater_Level_01.mxd

5.3.1 Quaternary Alluvium

There are no registered bores with groundwater level measurements screened in the alluvium within a 10 km buffer of PLs. Groundwater levels in the Isaac River alluvium is reported on by AGE (2020) for April 2019 at the Isaac Downs Project were found to be in the range of 185.0 to 192.2 mAHD (15.7 to 11.0 mBGL).

5.3.2 Tertiary

There are no registered bores with groundwater level measurements screened within the Tertiary sediments or Suttor Formation within 10 km of the Project.

Figure 12 shows groundwater level for registered bores screened in the basalt. Recent groundwater level measurements indicate that groundwater level ranges from approximately 235 to 284 mAHD (32.1 to 26.7 mBGL). The graph shows that some bores (141812, 162023, 162022, 141998) mimic the CRD, showing that they are responsive to rainfall and that these areas receive recharge from rainfall. Other bores remain stable or show less response e.g. 162042, 162019 and 162022 (although it should be noted there are some data gaps). The difference in response to rainfall could be a reflection of the nature of the fractured rock aquifer, where more fractured areas are more permeable. Bore 141421 appears to have some response to rainfall and is affected by pumping between 2005 and 2009.

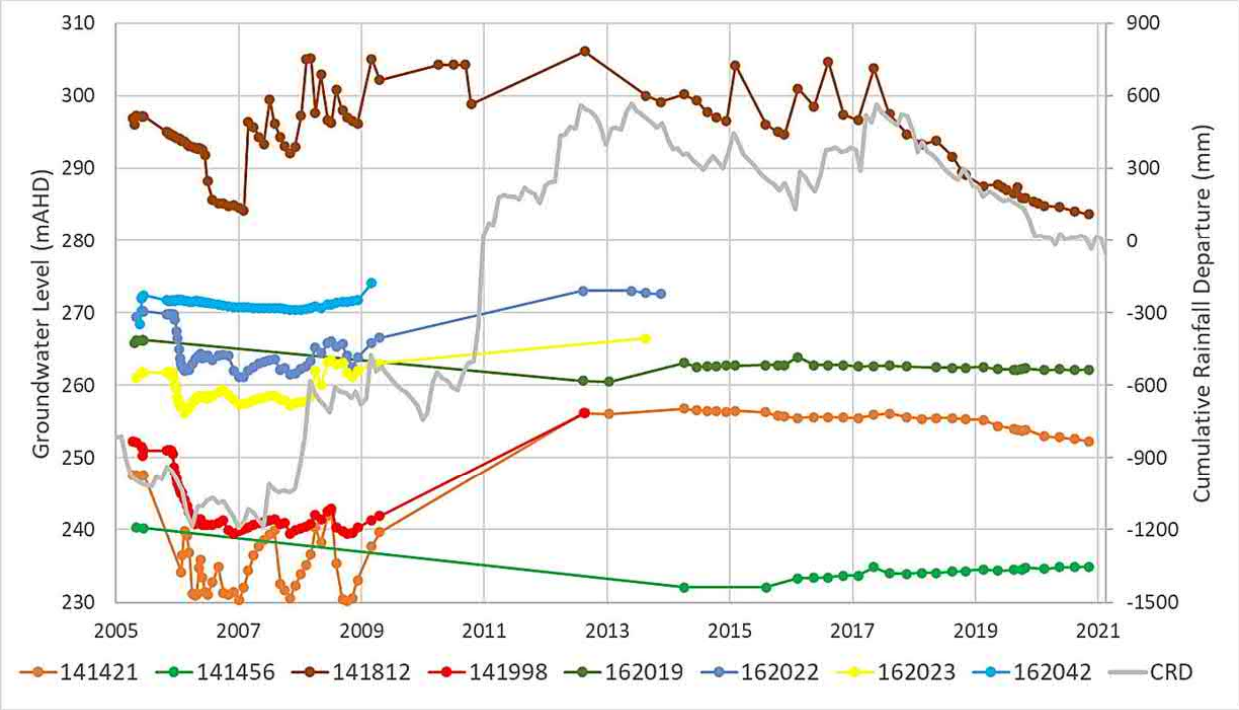


Figure 12 Groundwater level Tertiary Basalt bores

5.3.3 Triassic Rewan Formation

Figure 13 shows groundwater level for registered bores screened in the Rewan Formation. The most recent groundwater level measurements, recorded between 2005 and 2014, indicate that groundwater level ranges from approximately 232 to 251 mAHD (6.9 to 35.7 mBGL). The graphs show that bores in this formation are somewhat responsive to rainfall but also have anthropogenic influence e.g. 162041 exhibits a typical pumping recovery curve just after 2007.

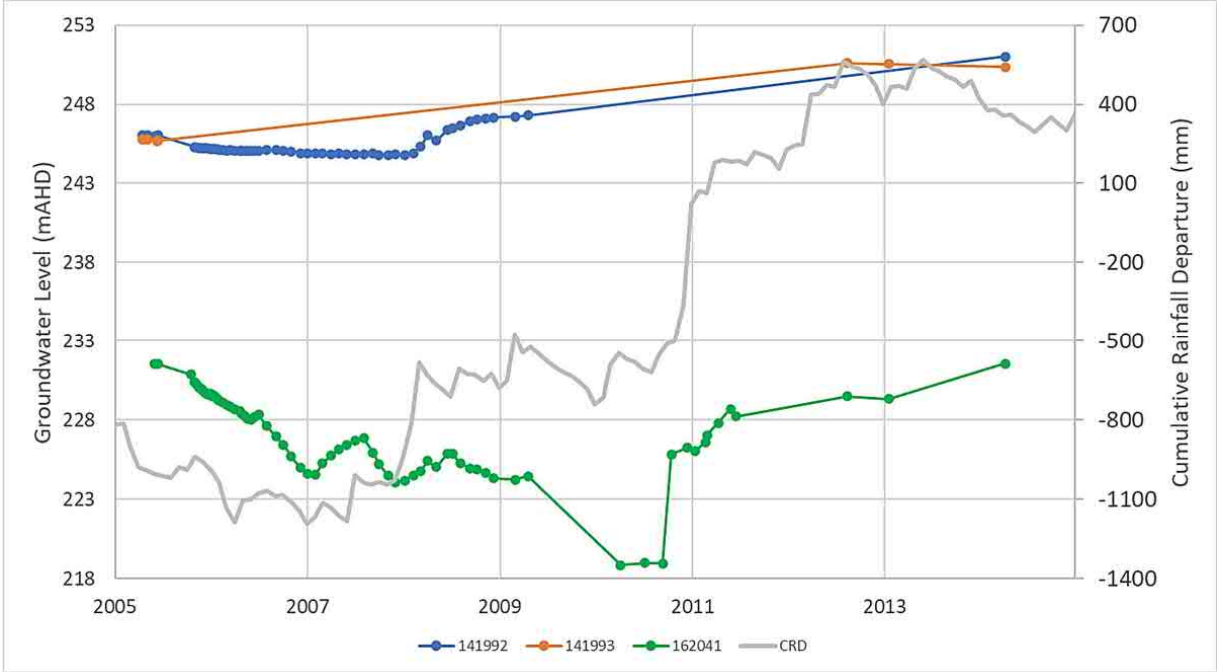


Figure 13 Groundwater level 162041 Triassic Rewan Group Bores

5.3.4 Permian

Figure 14 to Figure 16 shows groundwater level for bores screened in the Permian. Recent observations indicate that groundwater level ranges from approximately 184 to 237 mAHD (19.6 to 7.1 mBGL). The graphs show that most bores (13040284, 162241 and 162242) are somewhat responsive to rainfall but may also have some anthropogenic influence e.g. 13040284 shows a sharp decline around 2014 in line with decline in CRD (Figure 14), however is much to prominent decline to be attributed only to rainfall. Bore 162243 is influenced by pumping as the trend is opposite to the CRD Figure 16.

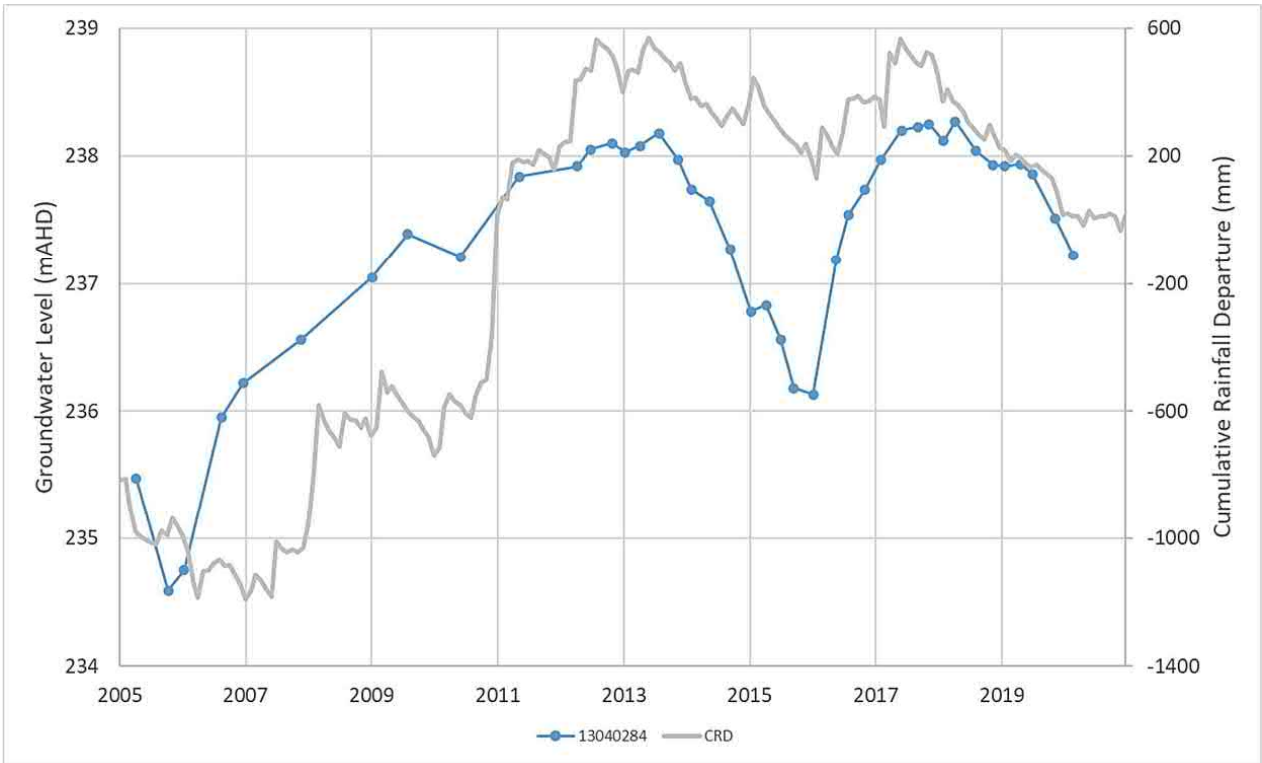


Figure 14 Groundwater level 13040284 (Permian)

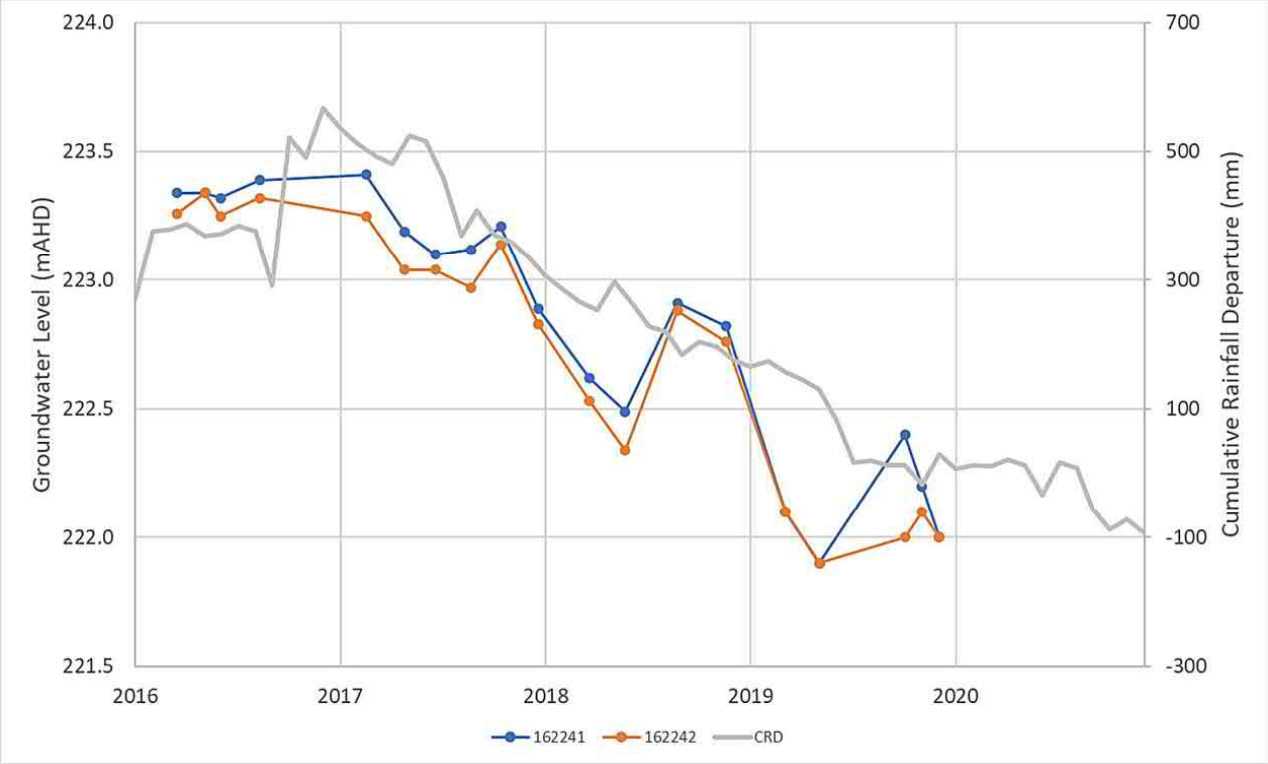


Figure 15 Groundwater level Permian bores

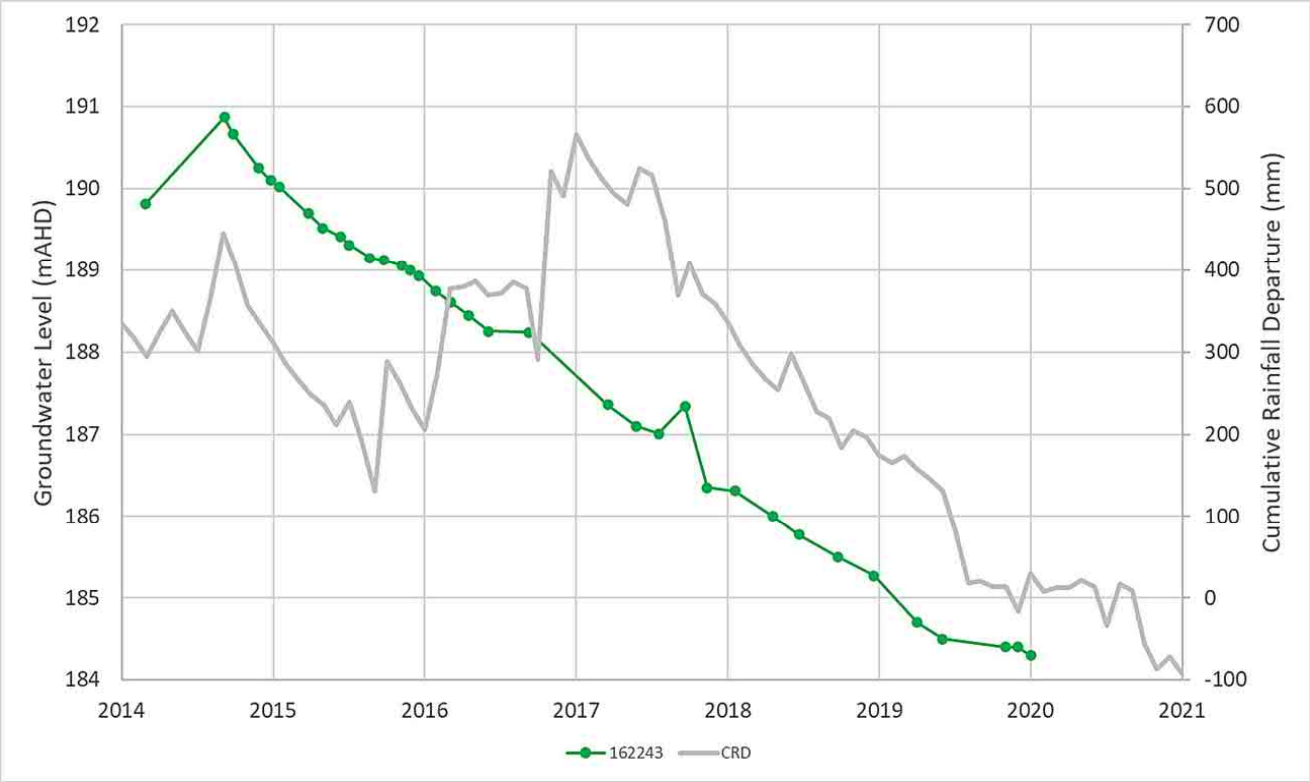


Figure 16 Groundwater level Permian bores

5.4 Groundwater Quality

Groundwater quality statistics for field EC and pH for registered bores within 10 km of PLs are shown in Table 10 and summarised below.

Table 10 pH and EC statistics for registered bores within 10 km of PLs

Statistic	pH (Field)				Electrical Conductivity (Field)			
Formation	**min**	**max**	**median**	**n =**	**min**	**max**	**median**	**n =**
Quaternary Alluvium	7.9	8.0	8.0	2	8,851	13,700	13,180	5
Tertiary	7.1	8.8	8.3	88	773	17,940	16,760	91
Rewan	7.7	9.1	8.1	19	1,390	24,600	5,390	20
Permian	7.6	8.9	8.2	27	1,060	17,450	2,940	35

[1]n = number of samples

5.4.1 Quaternary Alluvium

There are six registered bores with groundwater quality data screened in the alluvium. Groundwater monitoring results for these bores indicate a slightly alkaline pH (median 8.0, range 7.9 to 8.0) and moderately to highly brackish waters (median EC 13,180 µS/cm, range 8,851 to 13,700 µS/cm).

5.4.2 Tertiary

There are seven registered bores with groundwater quality data screened in the Tertiary. Groundwater monitoring results for these bores indicate a slightly alkaline pH (median 8.3, range 7.1 to 8.8) and fresh to saline waters (median EC 16,760 µS/cm, range 773 to 17,940 µS/cm). Typically, the groundwater in the basalts are expected to have a lower salinity than the tertiary sediments.

5.4.3 Triassic Rewan Formation

There are 57 registered bores with groundwater quality data screened in the Rewan Formation. Groundwater monitoring results for these bores indicate a slightly alkaline to alkaline pH (median 8.1, range 7.7 to 9.1) and fresh to saline waters (median EC 5,390 µS/cm, range 1,390 to 24,600 µS/cm).

5.4.4 Permian

There are 36 registered bores with groundwater quality data screened in the Permian. Groundwater monitoring results for these bores indicate a slightly alkaline pH (median 8.2, range 7.6 to 8.9) and fresh to saline waters (median EC 2,940 µS/cm, range 1,060 to 17,450 µS/cm).

5.5 Groundwater Users

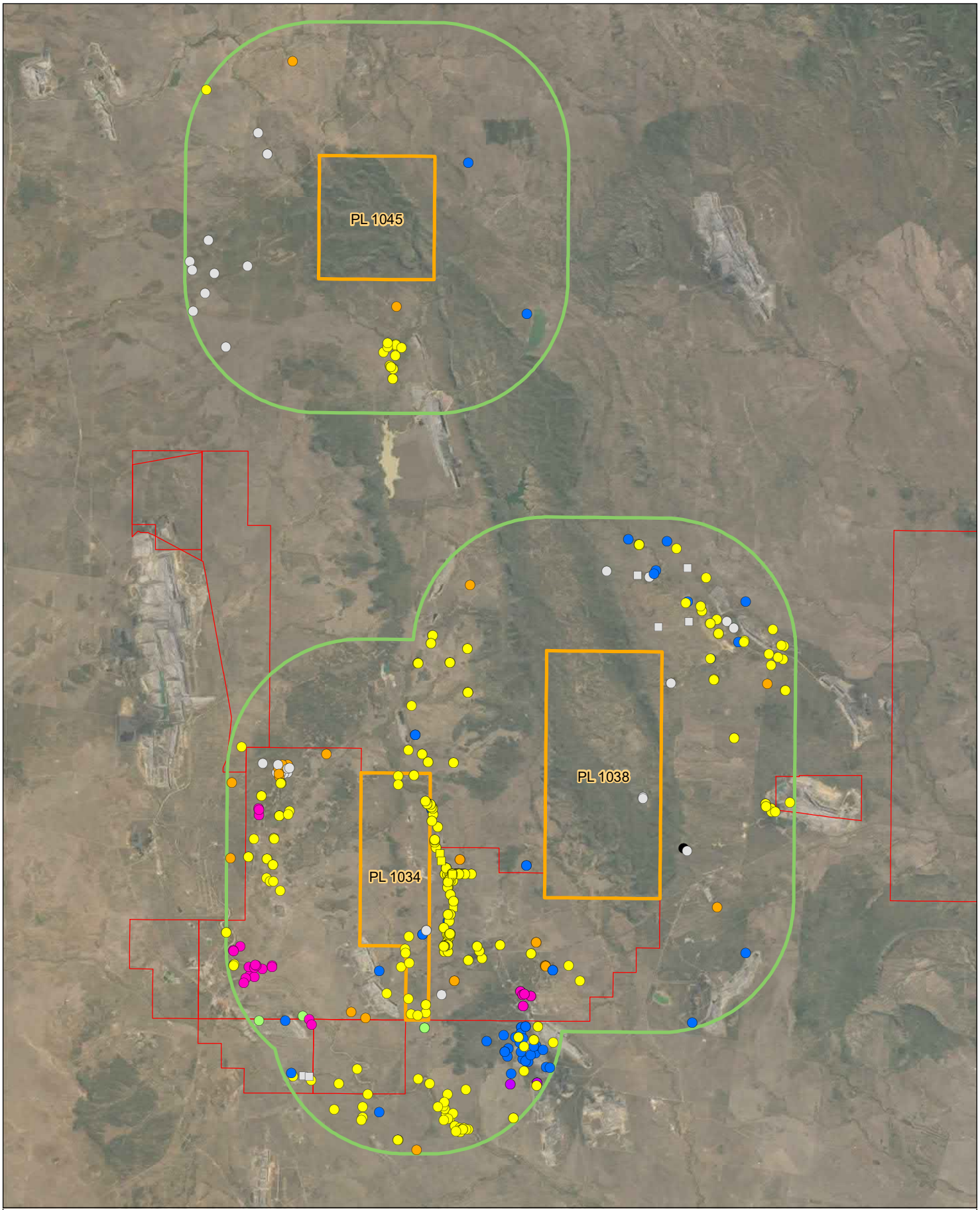
5.5.1 Anthropogenic Users

A search of the current Department of Resources (DoR) groundwater bore database (DoR, 2021) was conducted for third party bores within 10 km of PL 1034, 1038 and 1045. The assessment found that there were 404 existing registered water bores in the search area. Of these bores there are four which are located within PL1034, 2 within PL 1038 and none within PL 1045. The database shows known drill dates between 1920 and 2021. Of the 404 existing bores, 56 were listed as being used for water supply and 38 with an unknown use.

A summary of the search information is presented in Table 11 and the location of all existing bores identified presented in Figure 17.

Table 11 Number and Facility Role for Third Party Bores within 10km of Petroleum Lease Boundaries

Facility Role	Total	within PLs
Petroleum or Gas Exploration	22	-
Mineral or Coal Exploration	1	-
Water Supply	56	3
Mine Monitoring	257	-
Coal Seam Gas Monitoring	24	-
Sub-Artesian Monitoring	2	-
Water Resources Investigation	1	-
Unknown	38	3



0 2.5 5 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:375,000 at A4
Project Number:	620.30617
Date:	15-Oct-2021
Drawn by:	PM

SLR

Registered Bore Use - Existing
- Coal Seam Gas Monitoring
- Mine Monitoring
- Mineral or Coal Exploration
- Petroleum or Gas Exploration
- Stratigraphic Investigation
- Sub-Artesian Monitoring
- Water Resources Investigation
- Water Supply
- Unknown

Registered Bore Use - Abandoned but still useable
- Mine Monitoring
- Unknown

- Project Petroleum Lease
- 10km Buffer
- Other Petroleum Leases

Data Source: DNRME Petroleum leases and registered groundwater bores. Imagery ESRI Basemaps 2019-2020.

BLUE ENERGY EA APPLICATION

Existing Registered Groundwater Bores within 10km of Petroleum Lease 1034, 1038 and 1045

FIGURE 17

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Groundwater\SLR620.30617_GW_Existing_GW_Bores_01.mxd

5.5.2 Groundwater Dependent Ecosystems

Environmental use of groundwater includes direct vegetation use of groundwater, expression of groundwater at surface in the form of springs, and expression of groundwater at surface in the form of baseflow to surface streams. These are collectively termed Groundwater Dependent Ecosystems (GDEs).

The Queensland GDE mapping builds on existing information including wetland mapping, regional ecosystem mapping, spring and waterholes databases and drainage lines (Queensland Government, 2017).

The dataset contains shapefile data which show the following categories of GDEs:

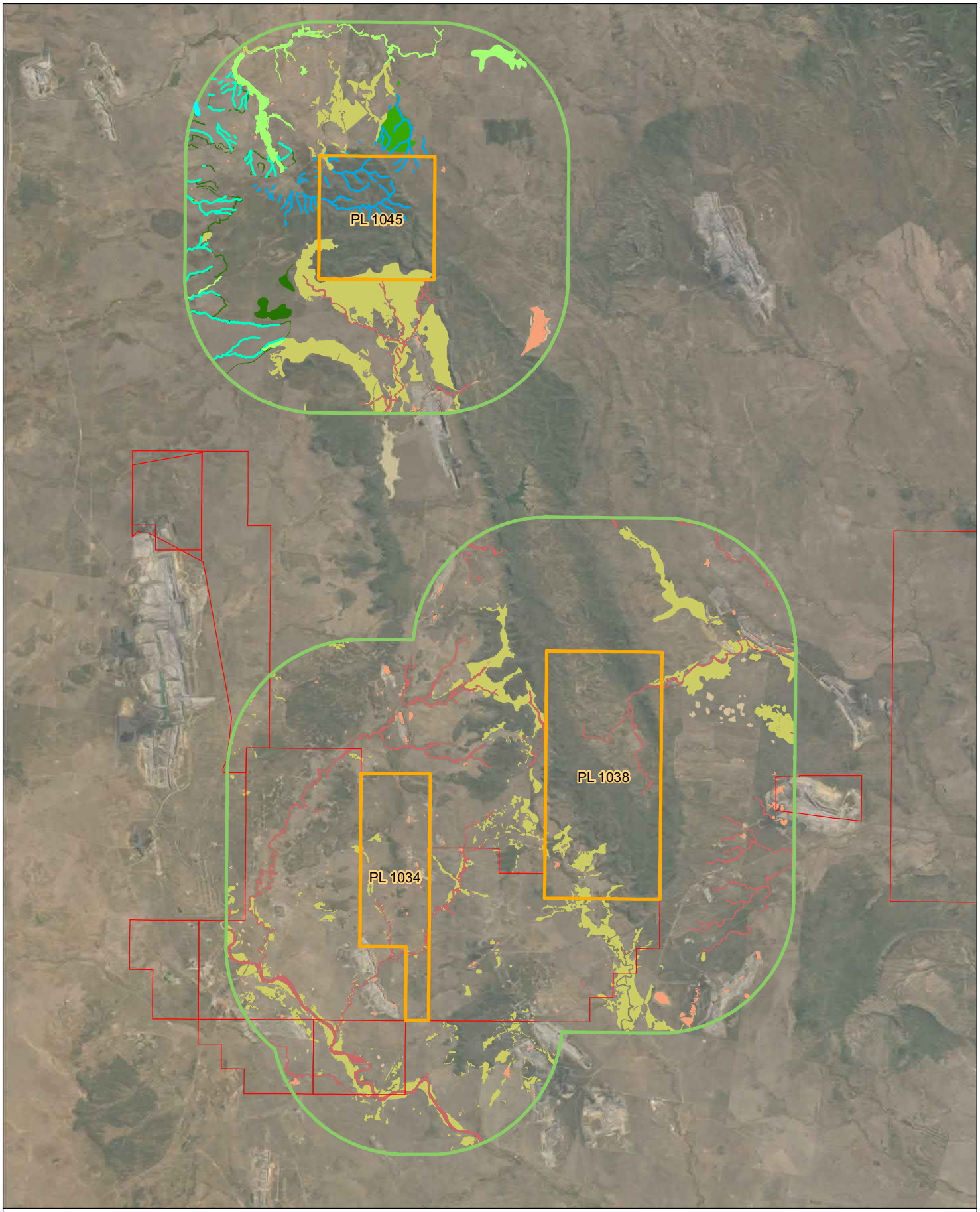
- Aquatic GDEs
- Terrestrial GDEs
- Subterranean GDEs (including stygofauna)
- Ecosystems dependent on the surface expression of groundwater
- Springs

The dataset contains information on both known and potential GDE areas. Known GDEs refers to areas that have been verified through field studies while potential GDEs refer to areas that have been mapped at a large scale primarily through analysis of GIS data. The dataset was queried to assess the presence of GDEs within a 10 km buffer of the PLs. The search showed the following GDEs in the area and are shown on Figure 18.

- Terrestrial GDEs – Potential, derived with low, moderate and high confidence (within PL 1045 and within the 10km buffer of PL 1045)
- Ecosystems dependent on the surface expression of groundwater – Potential, derived with moderate and high confidence (within PL 1045 and within the 10km buffer of PL 1045);

The search did not show any subterranean or aquatic GDEs or springs within a 10 km buffer of the site.

A search for wetlands within a 10 km buffer of the mining lease was conducted using the Wetland data version 5 – wetland areas – Queensland dataset downloaded from the QSpatial portal (DES, 2015). The search showed that there were several wetlands in the area including lacustrine, palustrine, riverine and those that were not classified (Figure 18). It should be noted that the wetland investigation was entirely desktop based and has not been ground-truthed.



0 2.5 5 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:375,000 at A4
Project Number:	620.30617
Date:	08-Oct-2021
Drawn by:	PM

Potential Surface Expression GDE
- Derived GDE - high confidence
- Derived GDE - moderate confidence

Potential Terrestrial GDE
- Derived GDE - high confidence
- Derived GDE - moderate confidence
- Derived GDE - low confidence

Wetland Areas
- Lacustrine
- Palustrine
- Riverine
- RE 1-50% wetland
- Project Petroleum Lease
- 10km Buffer
- Other Petroleum Leases

Data Source: DNRME Petroleum leases and registered groundwater bores. Imagery ESRI Basemaps 2019-2020.

BLUE ENERGY EA APPLICATION

Potential GDEs and Wetland areas within 10km of Petroleum Lease 1034, 1038 and 1045

FIGURE 18

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Groundwater\SLR620306l7_GW_GDEs_01.mxd

5.6 Conceptual hydrogeological model

Conceptualisation of hydrogeological units relevant to the project area are discussed in Section 5.1. A conceptual cross section (Arrow Energy, 2013) is shown in Figure 19. A summary of the conceptualisation of the hydrogeologic system is provided below.

The hydrostratigraphic units across the Project area include:

- Quaternary Alluvium associated with watercourses and paleochannels, which forms an aquifer in coarser horizons. Recharge is variable depending on climatic conditions but is primarily via direct infiltration from rainfall. Discharge is via evapotranspiration, downwards leakage and stream discharge (AGE, 2020).
- Tertiary aged strata including:
    - Cainozoic sediments and the Suttor Formation, which do not form good aquifers and do not contain significant volumes of groundwater. Recharge to the sediments occurs via direct rainfall infiltration, and upwards leakage where the gradient permits. Discharge occurs from downwards leakage (AGE, 2020).
    - Basalt, which has variable groundwater characteristics due to compartmentalisation. Recharge occurs via rainfall infiltration where the unit outcrops and from downwards seepage. Discharge occurs from pumping and horizontal seepage (AGE, 2020).
- Triassic aged strata including:
    - The Moolayember formation, a low permeability aquitard (Evans et al., 2018). Recharged via downwards seepage from the overlying formations. Discharge occurs via downwards seepage.
    - The Clematis Sandstone which forms an important aquifer regionally. The unit is recharged primarily from rainfall where it outcrops. Discharge occurs from pumping and downwards leakage.
    - The Rewan group, a low permeability aquitard which confines the underlying Permian. The unit is recharged from rainfall where it outcrops and from downwards seepage. Groundwater discharge is to the underlying Permian coal measures (AGE, 2020).
- Permian aged strata including the Rangal Coal Measures, Fort Cooper Coal Measures, Moranbah Coal Measures. The Permian strata are comprised of low permeability sediments which confine higher permeability coal seams. Recharge occurs primarily where the units subcrop, through faults, fractures, bedding planes and coal seams. Discharge occurs via downwards leakage, dewatering or upwards seepage where the hydraulic gradient permits (AGE, 2020).

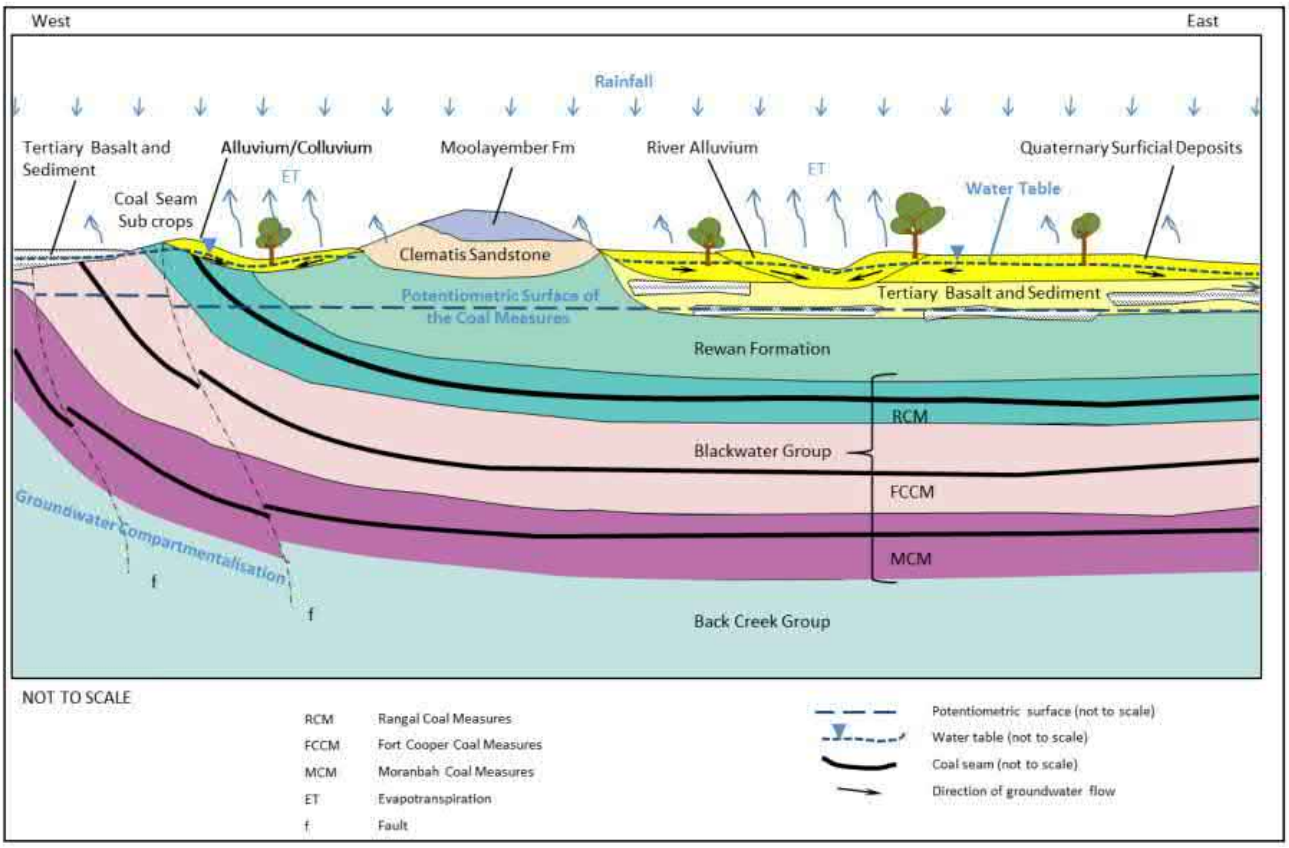


Figure 19 Conceptual Hydrogeological Model (Arrow Energy, 2013)

6 Prediction of Groundwater Impacts

Analytical modelling has been used to assess groundwater level impacts associated with gas and water production from 530 planned wells across the Project site including:

- 117 planned wells at PL 1034 (Sapphire)
- 264 planned wells at PL 1038 (Central)
- 149 planned wells at PL 1045 (Lancewood)

The assessment has been conducted to include a 40-year life, with a staggered well plan and each well running for a total of 20 years. It is assumed that wells at PL 1034 will begin at year one with wells at PL 1038 and PL 1045 beginning 5 and 7 years after respectively.

Due to differing geology across the PLs each area was modelled individually. Where the modelled drawdown overlapped the PLs are shown together (PL 1038 and PL 1045 only). It should be noted however, that this assessment included predicted impacts from the planned wells only and did not include cumulative impacts from any other surrounding operations.

6.1 Methodology

6.1.1 Software

A two dimensional analytical solution has been used to assess the potential impacts of groundwater extraction in the wells at the Project on the groundwater in the target coal measures (Rangal and Fort Cooper) and overlying aquifers (Clematis at PL 1045 and PL 1038 and Alluvium/Tertiary at PL 1034). The program Multi-Layer Unsteady state (MLU) for Windows has been used to compute drawdown associated with the proposed extraction. MLU for Windows combines:

- An analytical solution technique for well flow in layered aquifer systems;
- The superposition principle, both in space (multiple wells) and time (variable discharges); and
- The Lavenberg-Marquardt algorithm for parameter optimisation (automated curve fitting), not used in this assessment due to the lack of observation data.

This combination of techniques allows all tests to be analysed in a consistent way with a single user interface. The key assumptions/limitations of MLU include:

- All layers are assumed homogeneous, isotropic and of infinite extent; and
- Only groundwater flow resulting from pumping and injection wells can be modelled.

These assumptions are reasonable given the small scale of abstraction and extensive nature of the unit.

6.1.2 Hydrogeologic input parameters

Due to differing geology each PL was modelled separately. As the modelling software assumes layers are continuous, minor geological units including those with minimal cover (based on geological mapping) were excluded from the modelling. The alluvium and tertiary were excluded from PL 1045 and PL 1038 and the Moolayember Formation from PL 1034 as they only showed around 10 to 20 percent cover respectively as can be seen from surface geological mapping (Figure 8).

The hydrogeological input parameters used for the analytical model for each PL are shown in Table 12 to Table 14 and represent the "base case".

The thickness of the alluvium was based on an average of the typical thickness reported by AGE (2020). The thickness of the Tertiary was based on typical thickness reported by Arrow Energy, 2013. The thickness of the Clematis, Rewan, Rangal, Fort Cooper Coal Measures and Moranbah Coal Measures were estimated based on conceptual cross sections by Arrow Energy 2013 (Figure 10). The MLU modelling requires aquifers to be separated by aquitards in the model. In the model the layers were grouped into aquifers and aquitards as shown in Table 12 to Table 14. The interburden of the coal measures was grouped into aquitards while the coal seams were grouped into aquifers. The coal seams were assumed to have a thickness of 10 m.

The hydraulic parameters were estimated based on the desktop review of studies that have been conducted in the area (refer to Section 5.2) and sensitivity analysis was performed in order to test the sensitivity of the values (refer to Section 6.3).

Table 12 Layers and parameters used for the analytical model set up for PL1034 (Sapphire)

Model Layer	Formation	Type	Thickness	Kh* (m/day)	Kv* (m/day)	Sy* / Storage
Layer 1	Alluvium/Tertiary	Aquifer	30	1	-	0.1
Layer 2	Interburden (Rewan/Rangal)	Aquitard	520	-	0.00001	0.0005
Layer 3	Coal (Rangal)	Aquifer	10	0.1	-	0.00005
Layer 4	Interburden (Rangal/FCCM)	Aquitard	190	-	0.00001	0.0005
Layer 5	Coal (FCCM)	Aquifer	10	0.05	-	0.00005
Layer 6	Interburden (MCM)	Aquitard	150	-	0.00001	0.0005

*Kh: horizontal hydraulic conductivity. Kv: vertical hydraulic conductivity. Sy: Specific yield

Table 13 Layers and parameters used for the analytical model set up for PL1038 (Central)

Model Layer	Formation	Type	Thickness	Kh (m/day)	Kv (m/day)	Sy / Storage
Layer 1	Clematis	Aquifer	180	0.1	-	0.01
Layer 2	Interburden (Rewan/Rangal)	Aquitard	740	-	0.00001	0.0005
Layer 3	Coal (Rangal)	Aquifer	10	0.1	-	0.00005
Layer 4	Interburden (Rangal/FCCM)	Aquitard	190	-	0.00001	0.0005
Layer 5	Coal (FCCM)	Aquifer	10	0.05	-	0.00005
Layer 6	Interburden (MCM)	Aquitard	150	-	0.00001	0.0005

Table 14 Layers and parameters used for the analytical model set up for PL1045 (Lancewood)

Model Layer	Formation	Type	Thickness	Kh (m/day)	Kv (m/day)	Sy / Storage
Layer 1	Alluvium/Clematis	Aquifer	185	0.1	-	0.01
Layer 2	Interburden (Rewan/Rangal)	Aquitard	345	-	0.00001	0.0005
Layer 3	Coal (Rangal)	Aquifer	10	0.1	-	0.00005
Layer 4	Interburden (Rangal/FCCM)	Aquitard	250	-	0.00001	0.0005
Layer 5	Coal (FCCM)	Aquifer	10	0.05	-	0.00005
Layer 6	Interburden (MCM)	Aquitard	195	-	0.00001	0.0005

6.1.3 Water abstraction

CSG is natural occurring and is attached to the surface of coal particles, along fractures and cleats, and is held in place by water pressure. The coal is both the source and the reservoir of the gas. The gas is extracted by drilling a well into the coal formation and pumping groundwater out of the well to depressurise the formation and release the gas into the well. The volume of water that needs to be pumped to achieve the pressure reduction varies from well to well and is highly dependent on the geology intersected by the well (OGIA, 2019).

To produce gas, the water pressure in the well is reduced. Once the desired pressure is reached, pumping continues at the rate necessary to maintain the pressure, until gas production becomes uneconomical. Initially, as shown Figure 20, groundwater alone is extracted, but as the pressure drops, more and more gas is released and extracted together with water, leading to an increasing ratio of gas to water over time. The flow of water and gas together is known as 'dual phase flow'.

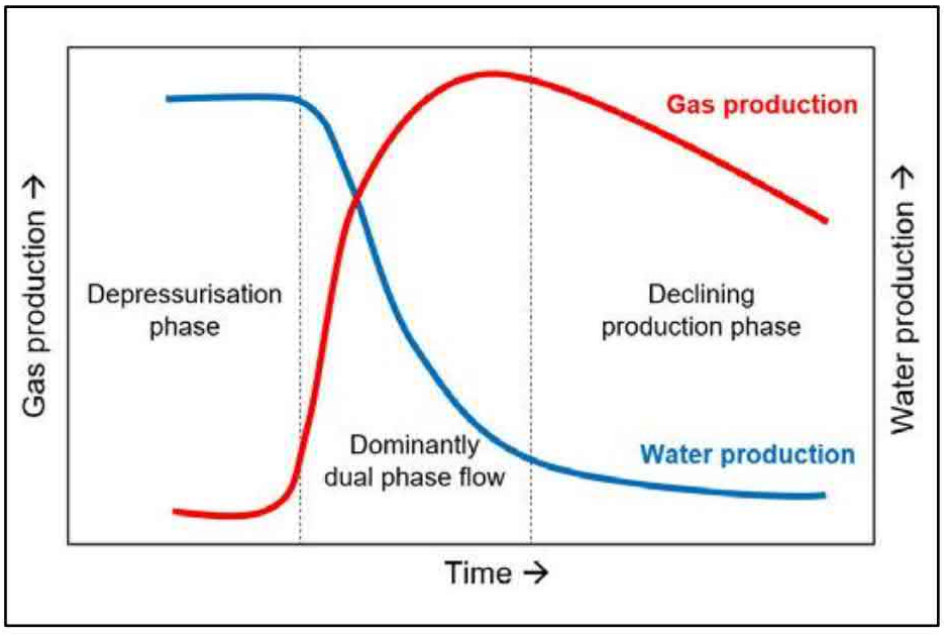


Figure 20 Typical gas and water flow profile during CSG production (OGIA, 2019)

For PL1034, 1038 and 1045, there is no test extraction data available to estimate the future expected gas and water abstraction rates. Blue Energy have supplied an estimate of annual water extraction rates for the two target formations. The estimated well water production rate is shown in Figure 21. It shows a typical CSG curve, with initial larger extraction rates, which then reduce over time and keep at a lower level. This curve was used as a best estimate for the well production rates in the groundwater analytical model.

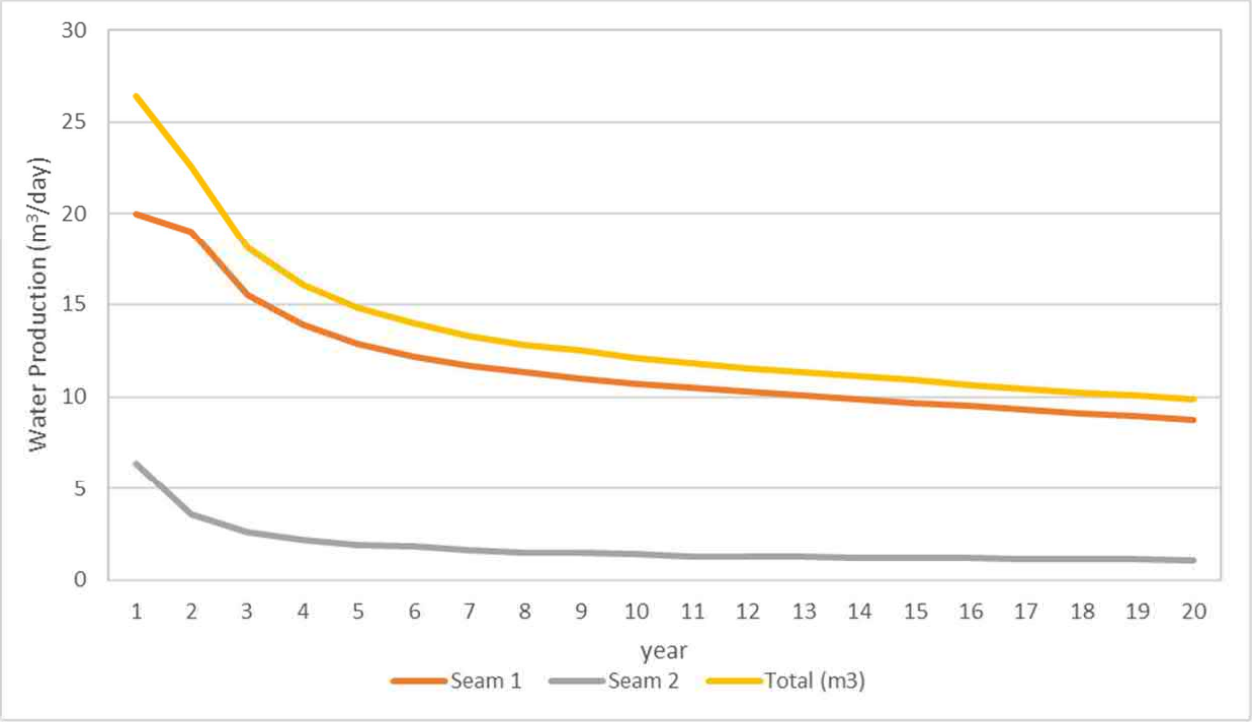


Figure 21 Water abstraction rate estimate

For the modelling each well was assumed to be screened across seam 1 (Rangal Coal Measures) and seam 2 (Fort Cooper Coal Measures). The provided water abstraction rate was assigned to each modelled well and multiplied by a factor depending on the well type (x 0.5 for vertical and horizontal wells and x 1 for multi wells). At each location the extraction curve was added at the expected starting time of the well pad (i.e. Year 3 wells will start after 730 days in the model). The well start times were staggered across PLs, with wells at Sapphire starting in year 1, the first wells starting at Central five years after and seven years after at Lancewood. Each well has a planned run time for 20 years with a total project life of 40 years.

The model was based on the assumption that the provided abstraction rate is representative for the conditions at the three PLs. Once the first wells are active, the water extraction volumes should be verified and if necessary, the parameters will be adjusted for future modelling.

6.2 Groundwater level impacts

6.2.1 Overlying Aquifers

Due to differing geology and amount of cover across PLs the aquifer above the target coal measures was modelled as alluvium/tertiary at PL 1034 and Clematis at PL 1038 and PL 1045. The modelling results showed a maximum drawdown of 0.1m in the alluvium/tertiary (Figure 22) and 1 m in the Clematis (Figure 23 and Figure 24) This means that as expected the Rewan Formation acts as a barrier to vertical flow (aquitard) and the drawdown predicted in the Rangal Coal Measures from water production in that unit will not migrate upwards into the overlying aquifer to any significant or measurable degree. Given these negligible expected impacts, the drawdowns in the overlying aquifers have not been mapped.

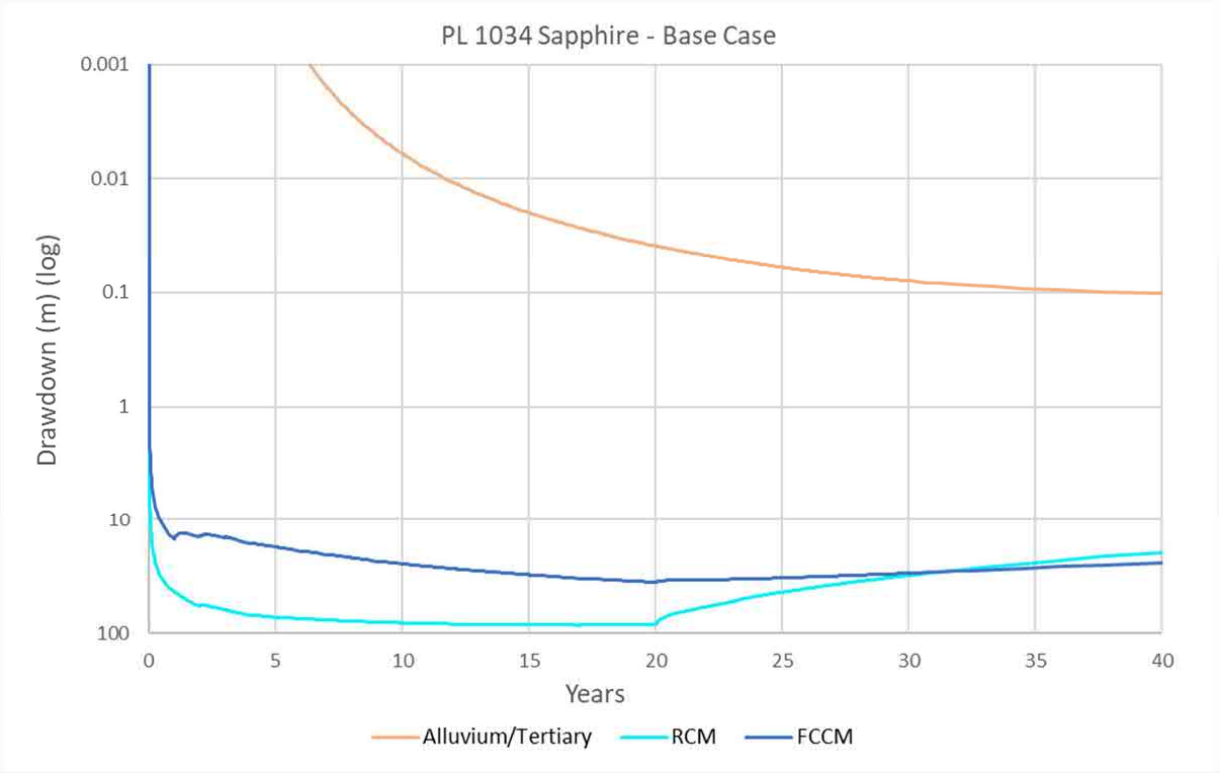


Figure 22 Drawdown at PL 1034 Sapphire – Base Case

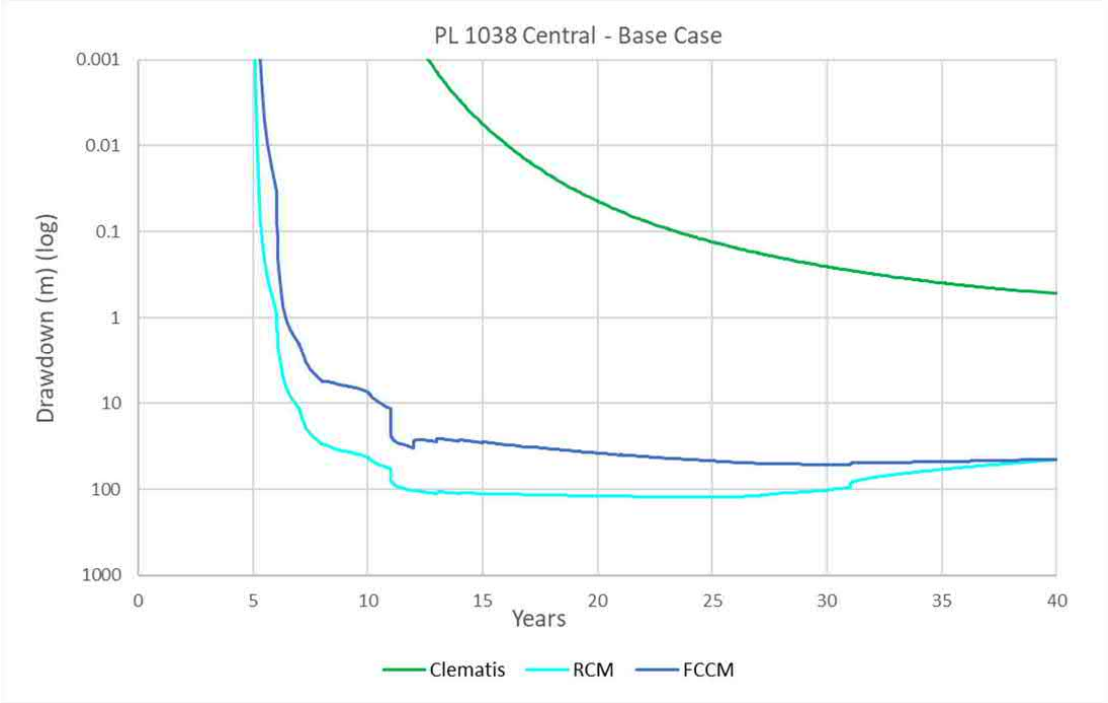


Figure 23 Drawdown at PL 1038 Central – Base Case

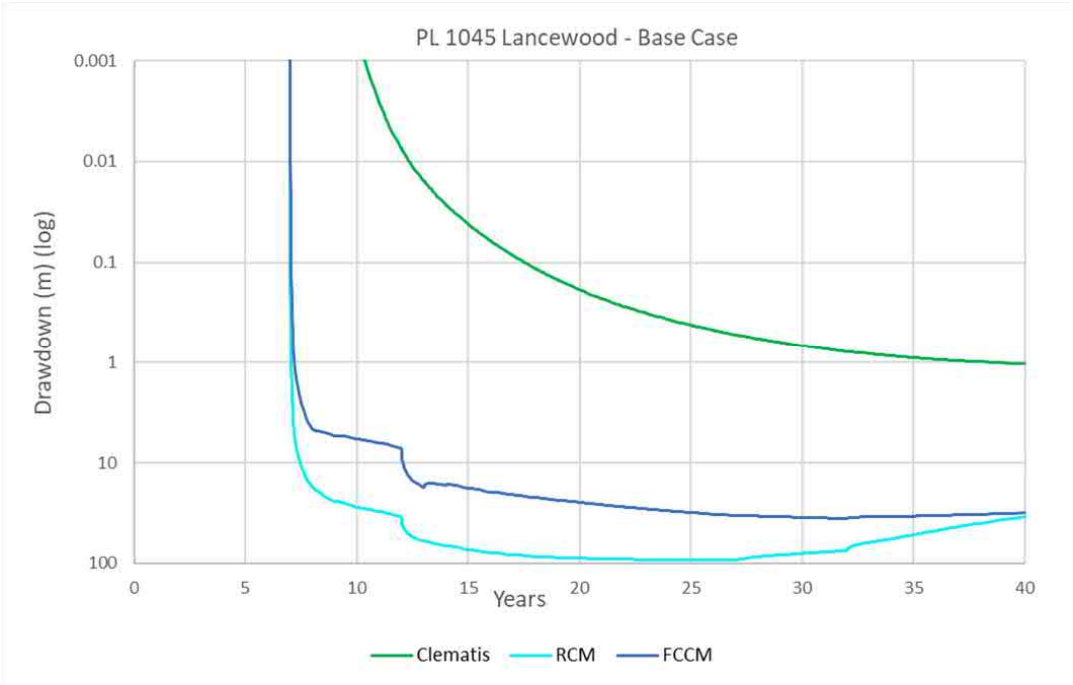


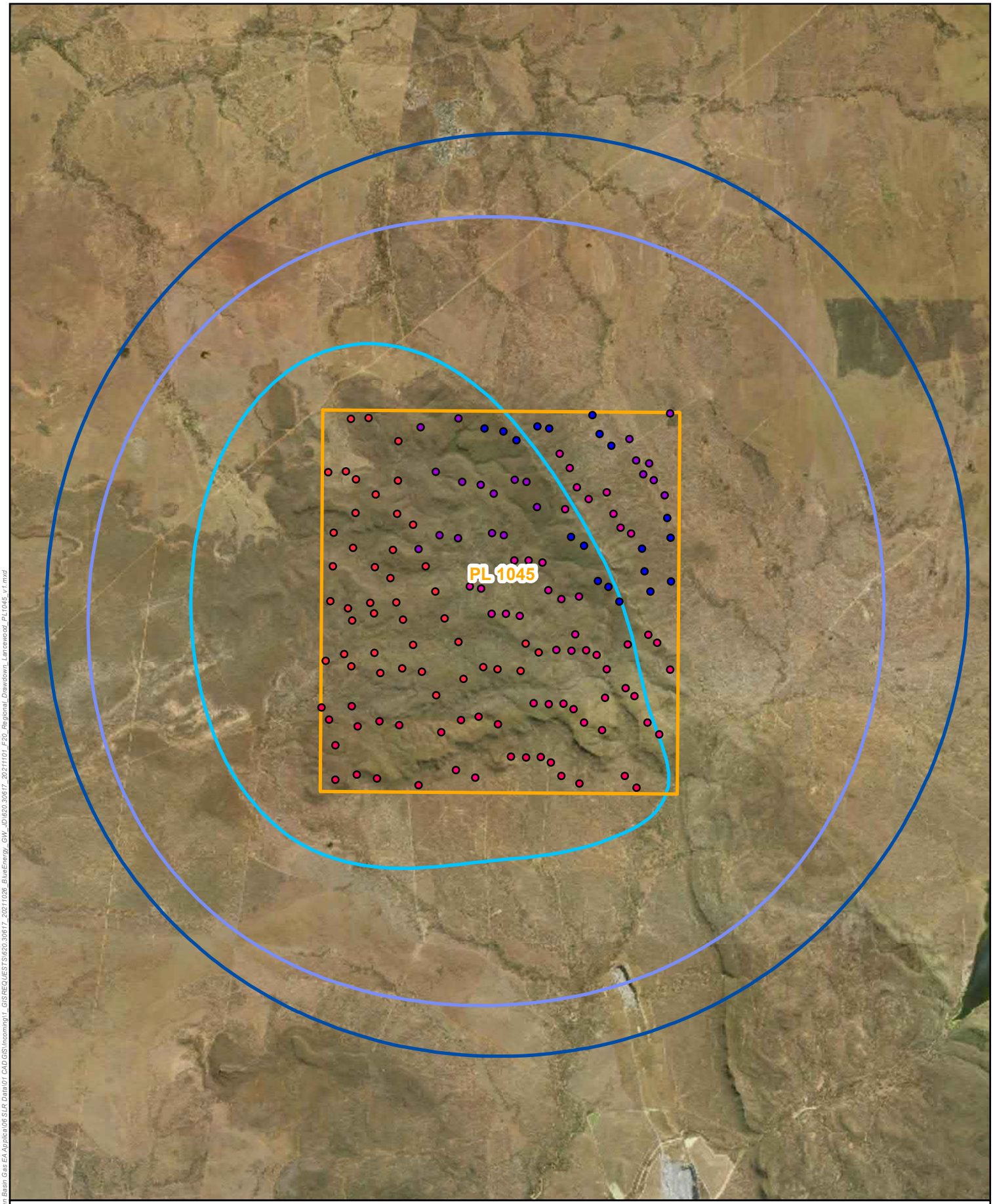
Figure 24 Drawdown at PL 1045 Lancewood – Base Case

6.2.2 Rangal Coal Measures

Figure 25 (PL1045) and Figure 26 (PL 1034 and 1038) show the 5m water level drawdown contour in the Rangal Coal Measures target coal seam at 5, 10, 20 and 40 years. The 5m drawdown contour extends to a maximum of approximately 8km at year 40 from the edge of PLs. It is apparent that the zone of impact is increasing with more well pads becoming active with each additional year, which would be expected due to increasing water production with more wells becoming active. As can be seen in Figure 26 the zone of impact converges between PL 1034 and 1038 between years 10 and 20.

6.2.3 Fort Cooper Coal Measures

Figure 27 (PL1045) and Figure 28 (PL 1034 and 1038) show the 5m water level drawdown contour in the Fort Cooper Coal Measures target at 5, 10, 20 and 40 years. The 5m drawdown contour extends to a maximum of approximately 5 km at PL 1045 and 7 km at PL 1034 and PL 1038. As can be seen for the Rangal Coal Measures, the zone of impact increases as more well pads become active (e.g. at year 10 at PL 1038 the impact is only in the north). As can be seen in Figure 28 the zone of impact between PL 1034 and 1038 has converged at year 20.



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:120,000 at A4
Project Number:	620.30617
Date:	03-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

Project Petroleum Lease

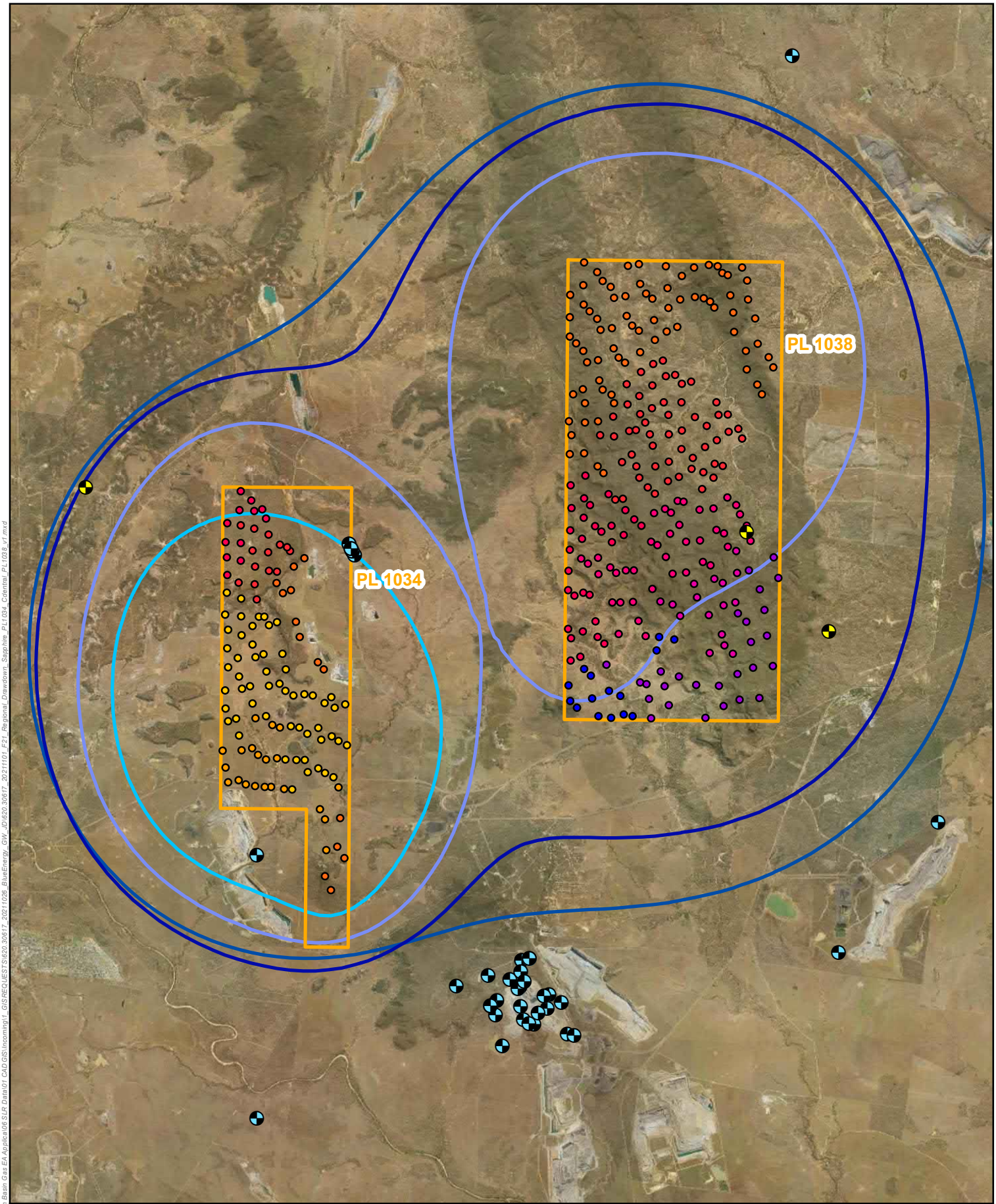
Development Years	5 Metre Drawdown
7-8	Year 10
9-10	Year 20
11-12	Year 40
13-14	
15-16	
17-18	

BLUE ENERGY EA APPLICATION

Regional Drawdown in the Rangal Coal Measures (Lancewood PL 1045)

FIGURE 25

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\Incoming\1_GISREQUESTS\620.30617_20211038_BlueEnergy_GW_JD\620.30617_20211101_F20_Regional_Drawdown_Lancewood_PL1045_v1.mxd



0 3 6 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:200,000 at A4
Project Number:	620.30617
Date:	03-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

Project Petroleum Lease

Registered Groundwater Bore Use

- Water Supply
- Unknown

Development Years

- 1-2
- 3-4
- 5-6
- 7-8
- 9-10
- 11-12
- 13-14
- 15-16
- 17-18

5 Metre Drawdown

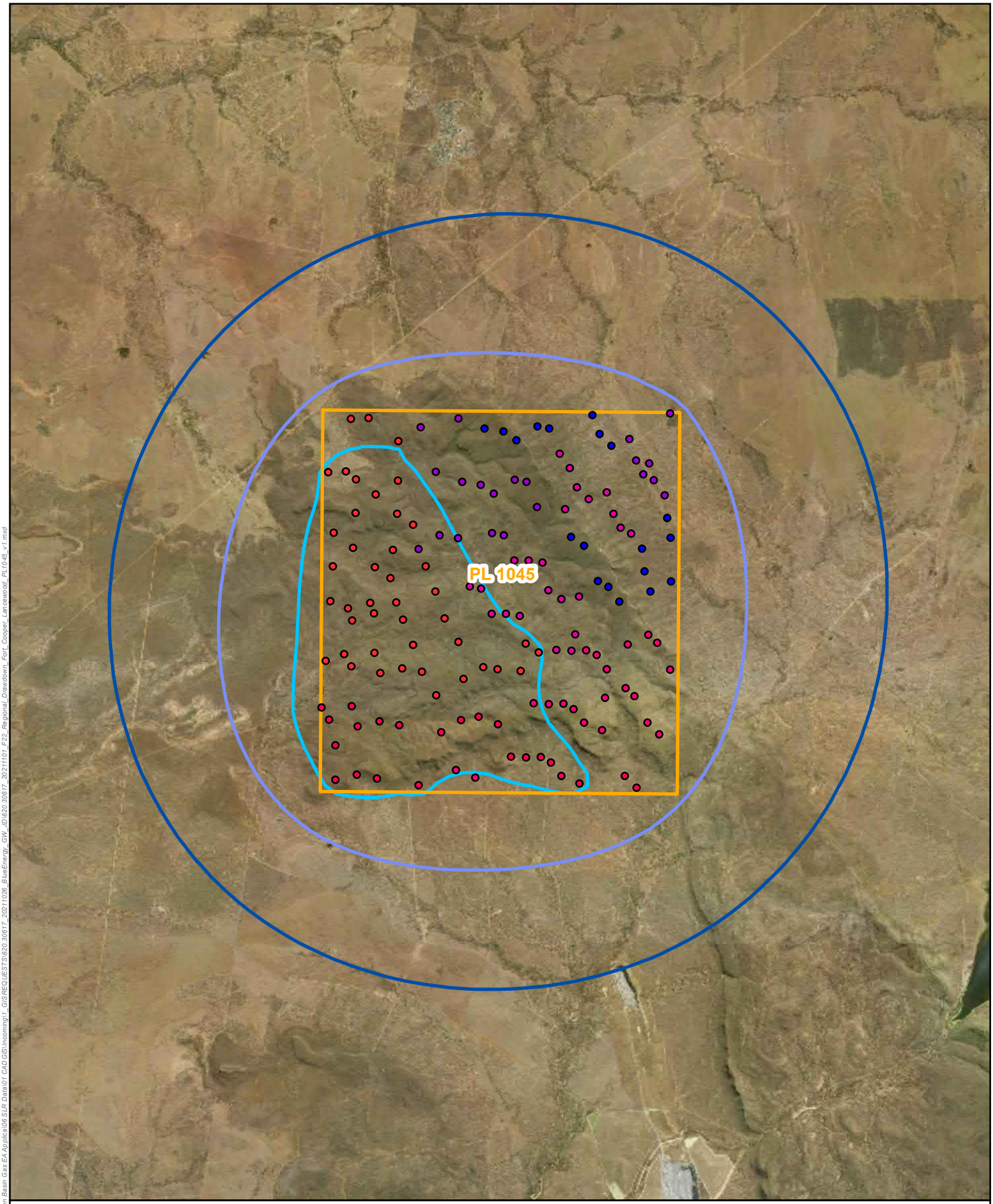
- Year 5
- Year 10
- Year 20
- Year 40

BLUE ENERGY EA APPLICATION

Regional Drawdown in the Rangal Coal Measures (Sapphire PL 1034 and Central PL 1038)

FIGURE 26

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\Incoming\1_GISREQUESTS\620.30617_20211028_BlueEnergy_GW_JD\620.30617_20211101_F21_Regional_Drawdown_Sapphire_PL1034_Cdentral_PL1038_v1.mxd



0 1.5 3 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:120,000 at A4
Project Number:	620.30617
Date:	03-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

Project Petroleum Lease

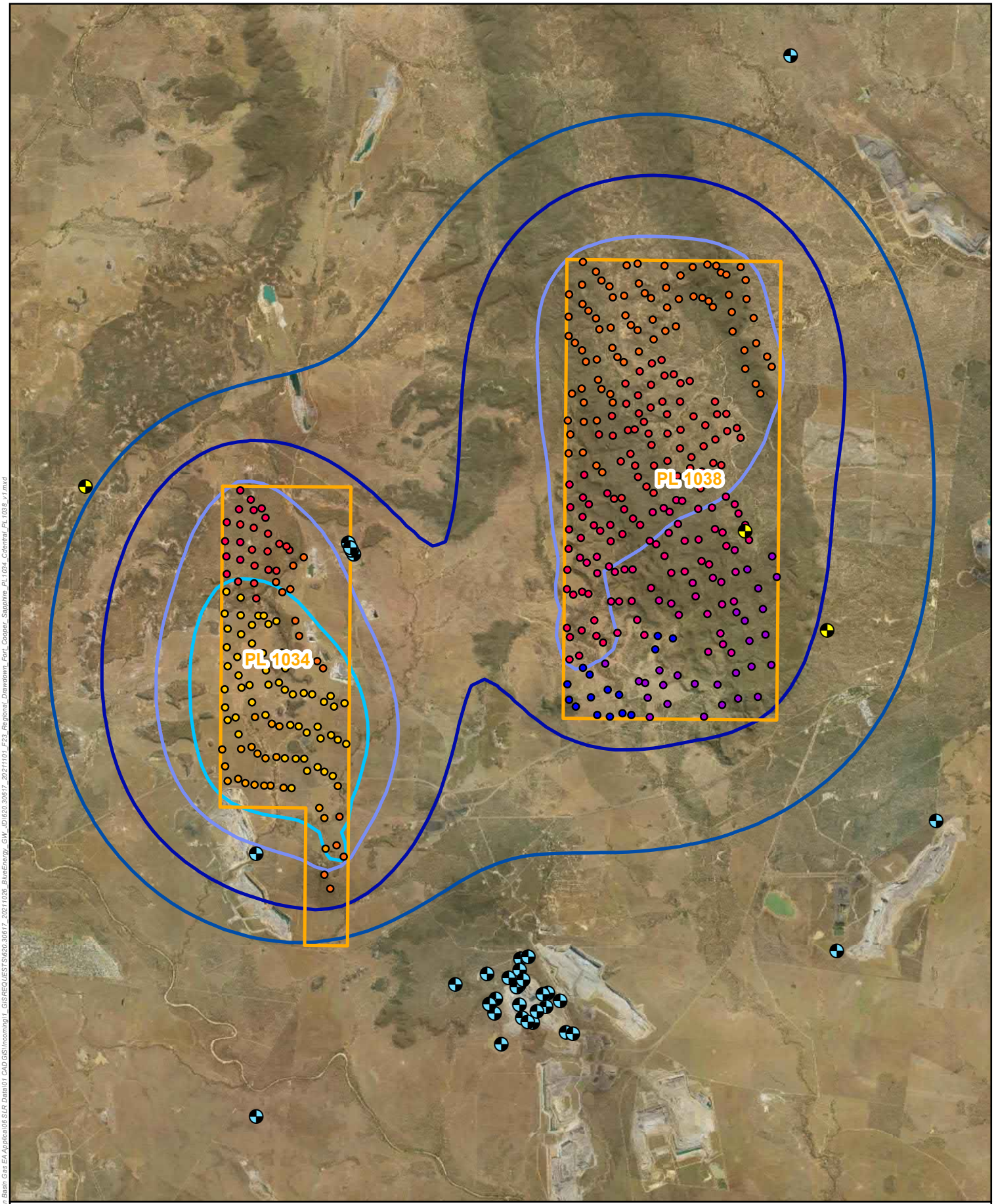
Development Years	5 Metre Drawdown
7-8	Year 10
9-10	Year 20
11-12	Year 40
13-14	
15-16	
17-18	

BLUE ENERGY EA APPLICATION

Regional Drawdown in the Fort Cooper Coal Measures (Lancewood PL 1045)

FIGURE 27

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\Incoming\1_GISREQUESTS\620.30617_20211038_BlueEnergy_GW_JD\620.30617_20211101_F22_Regional_Drawdown_Fort_Cooper_Lancewood_PL1045_v1.mxd



0 3 6 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:200,000 at A4
Project Number:	620.30617
Date:	03-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

Project Petroleum Lease

Registered Groundwater Bore Use

- Water Supply
- Unknown

Development Years

- 1-2
- 3-4
- 5-6
- 7-8
- 9-10
- 11-12
- 13-14
- 15-16
- 17-18

5 Metre Drawdown

- Year 5
- Year 10
- Year 20
- Year 40

BLUE ENERGY EA APPLICATION

Regional Drawdown in the Fort Cooper Coal Measures (Sapphire PL 1034 and Central PL 1038)

FIGURE 28

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\Incoming\1_GISREQUESTS\620.30617_20211028_BlueEnergy_GW_JD\620.30617_20211101_F23_Regional_Drawdown_Fort_Cooper_Sapphire_PL1034_Cdental_PL1038_v1.mxd

6.2.4 Water level Impacts on landholder bores

The landholder bore desktop assessment is presented in Section 5.5.1. As the desktop results have not been confirmed with a bore census, the impacts were assessed on a more general level. To assess water level impacts on landholder bores a hypothetical bore was placed in the centre of each PL in each layer in order to estimate the maximum drawdown. The MLU software is not able to export water level or drawdown information for layers considered an aquitard (the Rewan Formation), hence the drawdown was exported for the Coal Measures and overlying aquifers (Clematis at PL 1045 and PL 1038 and Alluvium/Tertiary at PL 1034). The drawdown graphs are included as Figure 22 to Figure 24.

At PL 1034 where the alluvium was modelled, this showed a maximum drawdown of 0.1 m in the alluvium, which is considered negligible. Modelled drawdown in the Clematis was also found to be negligible (maximum of 1 m).

Figure 25 to Figure 28 show existing registered landholder bores which have listed coal measures as the associated aquifer and their use as water supply or unknown. The figures show that there are 11 bores within the 5m drawdown buffer at PL 1034 and 1038, these are registered bores 105435, 131612, 131613, 131614, 131615, 46582 and 85078.

It should be noted that this assessment was desktop based and a landholder bore survey is recommended. Once the bore users are identified, including the screened formation, the analytical model can be re-run to extract the modelling results at the correct location and formation.

6.3 Sensitivity analysis

For the sensitivity analysis, three additional scenarios have been assessed to evaluate the model sensitivity, as listed in Table 15. The sensitivity analysis was conducted for Year 20 and at PL 1045 only. The results are transferrable to the other PLs in general.

As shown in Table 15 the sensitivity analysis included:

- Increasing the hydraulic conductivity of the coal measures by a factor of 10 (scenario 1)
- Decreasing the hydraulic conductivity of the coal measures by a factor of 10 (scenario 2)
- Increasing the hydraulic conductivity of the interburden (Rewan and Rangal) overlying the first target (scenario 3)

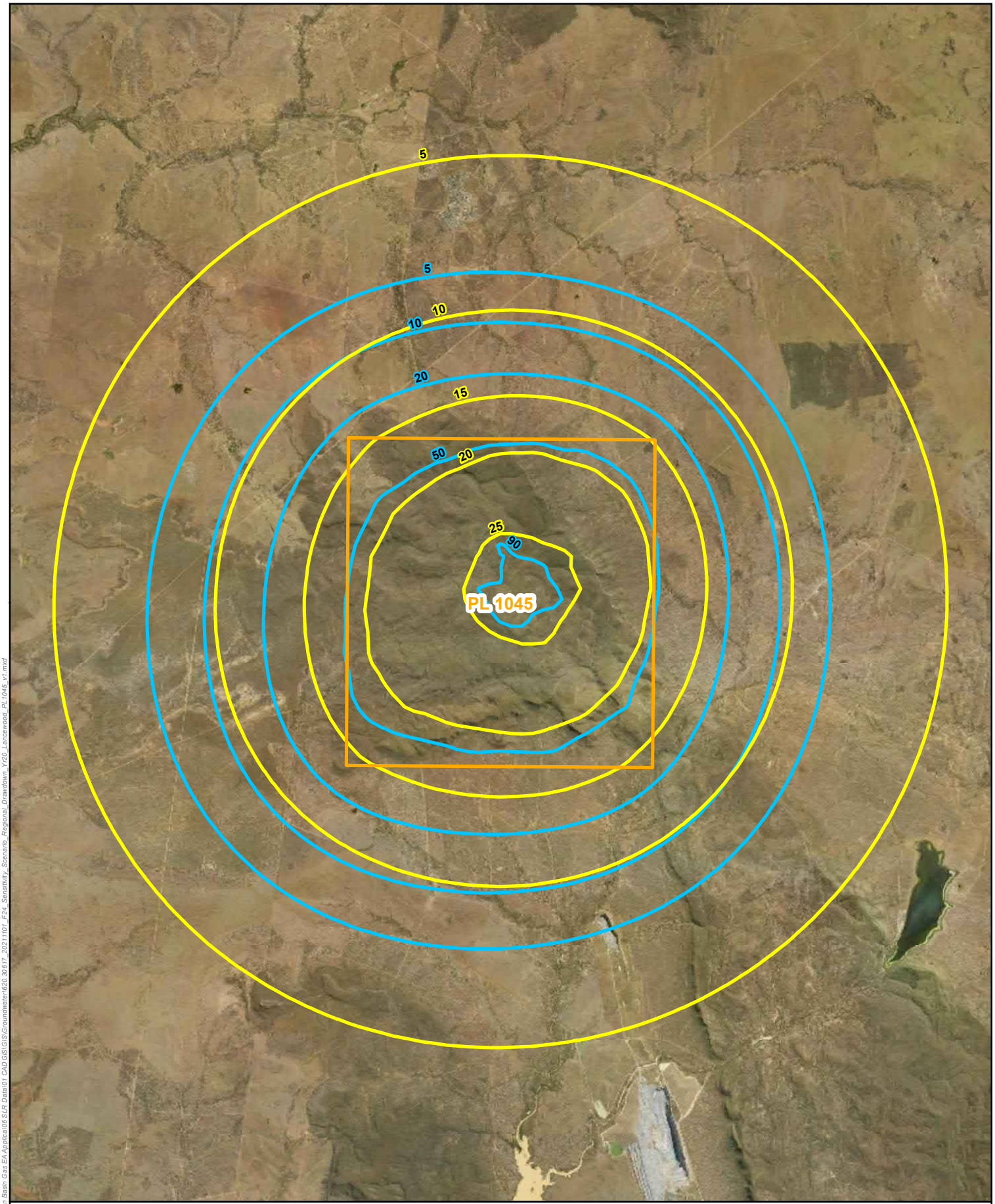
Table 15 Sensitivity analysis parameters

Scenario	Clematis	Interburden (Rewan/Rangal)	Coal (Rangal)	Interburden (Rangal/FCCM)	Coal (FCCM)	Interburden (FCCM)
Scenario	Kh (m/d)	Kv (m/d)	Kh (m/d)	Kh (m/d)	Kh (m/d)	Kh (m/d)
Base case	0.1	0.00001	0.1	0.00001	0.05	0.00001
Sens 1	0.1	0.00001	1	0.00001	0.5	0.00001
Sens 2	0.1	0.00001	0.01	0.00001	0.005	0.00001
Sens 3	0.1	0.0001	0.1	0.00001	0.05	0.00001

Sensitivity analysis was performed for three scenarios. A comparison of each scenario to the base case is presented in Table 16 and shown as Figure 29 to Figure 31.

Table 16 Sensitivity Analysis PL1045

Scenario	Description	Changes to drawdown estimate and implications for project
Base case	Refer to 6.1.2	No changes
Sensitivity 1	Coal Measure more conductive	With a Coal Measure conductance increased by a factor 10, the 5m drawdown curve extents further than in the base case. However, the maximum drawdown is smaller (20m vs 90m). Drawdown in the overlying aquifer is very slightly decreased (negligible).
Sensitivity 2	Coal Measure less conductive	With a Coal Measure conductance reduced by a factor 10, the 5m drawdown curve extents less than in the base case. The drawdown closer to the wells is higher. The impact on the overlying aquifer is very slightly increased (by a maximum of 0.5m) (negligible).
Sensitivity 3	Rewan more conductive	With a Rewan Formation conductance increased by a factor 10, the impact in the Coal measures is reduced. This can be explained with more leakage moving vertically from the Rewan to the Coal Measures. The impact on the overlying aquifer is increased (by a maximum of 3.2 m) however total drawdown is still less than 5 m.



0 2 4 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:140,000 at A4
Project Number:	620.30617
Date:	17-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

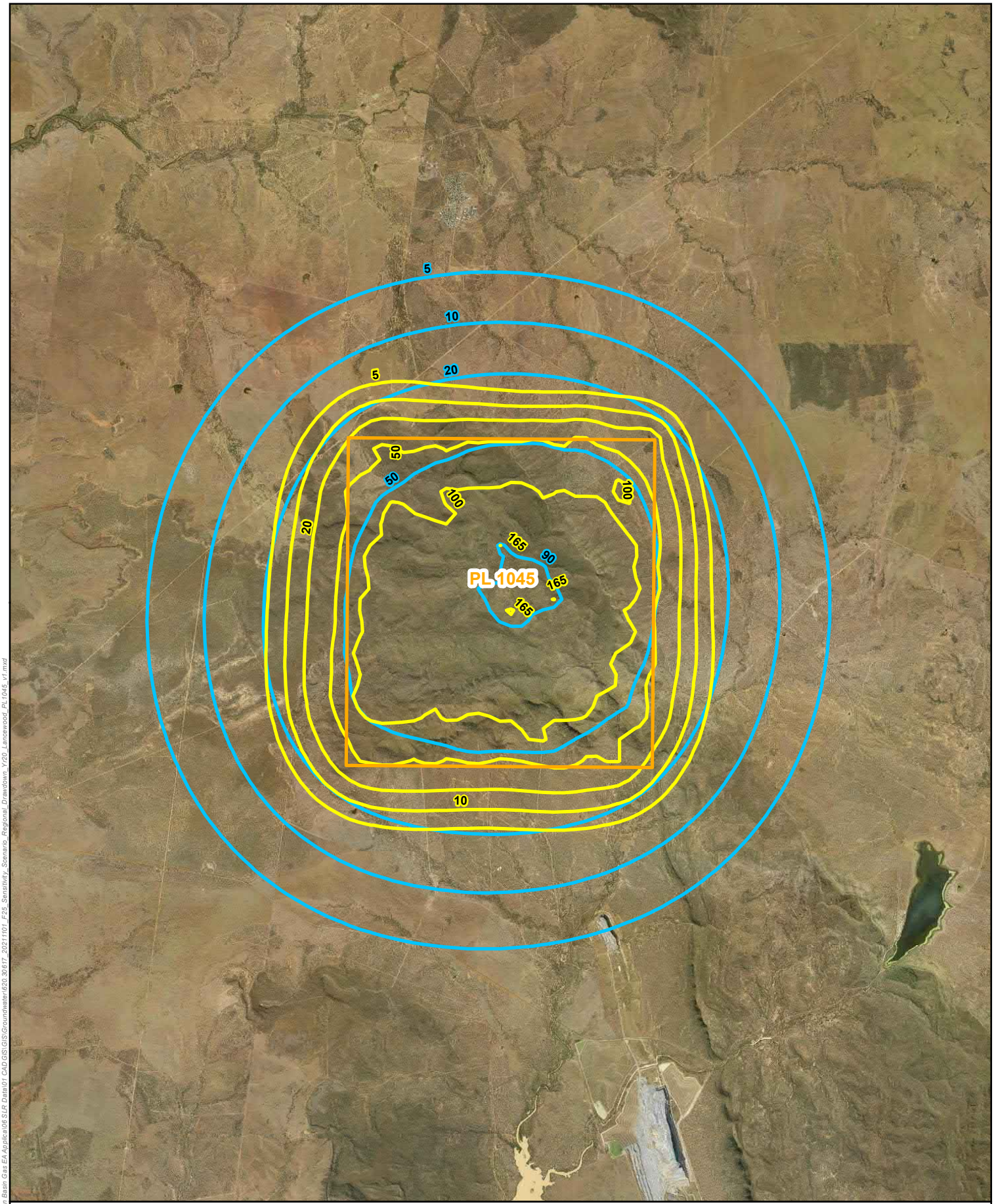
- Project Petroleum Lease
- Drawdown Sensitivity Run 1
- Drawdown Base Case

BLUE ENERGY EA APPLICATION

Sensitivity Scenario 1 Regional drawdown in the Rangal Coal Measures year 20 (PL 1045 Lancewood)

FIGURE 29

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Application\06 SLR Data\01 CAD\GIS\GIS\Groundwater\620.30617_20211101_F24_Sensitivity_Scenario_Regional_Drawdown_Yr20_Lancewood_PL1045_v1.mxd



0 2 4 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:140,000 at A4
Project Number:	620.30617
Date:	17-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

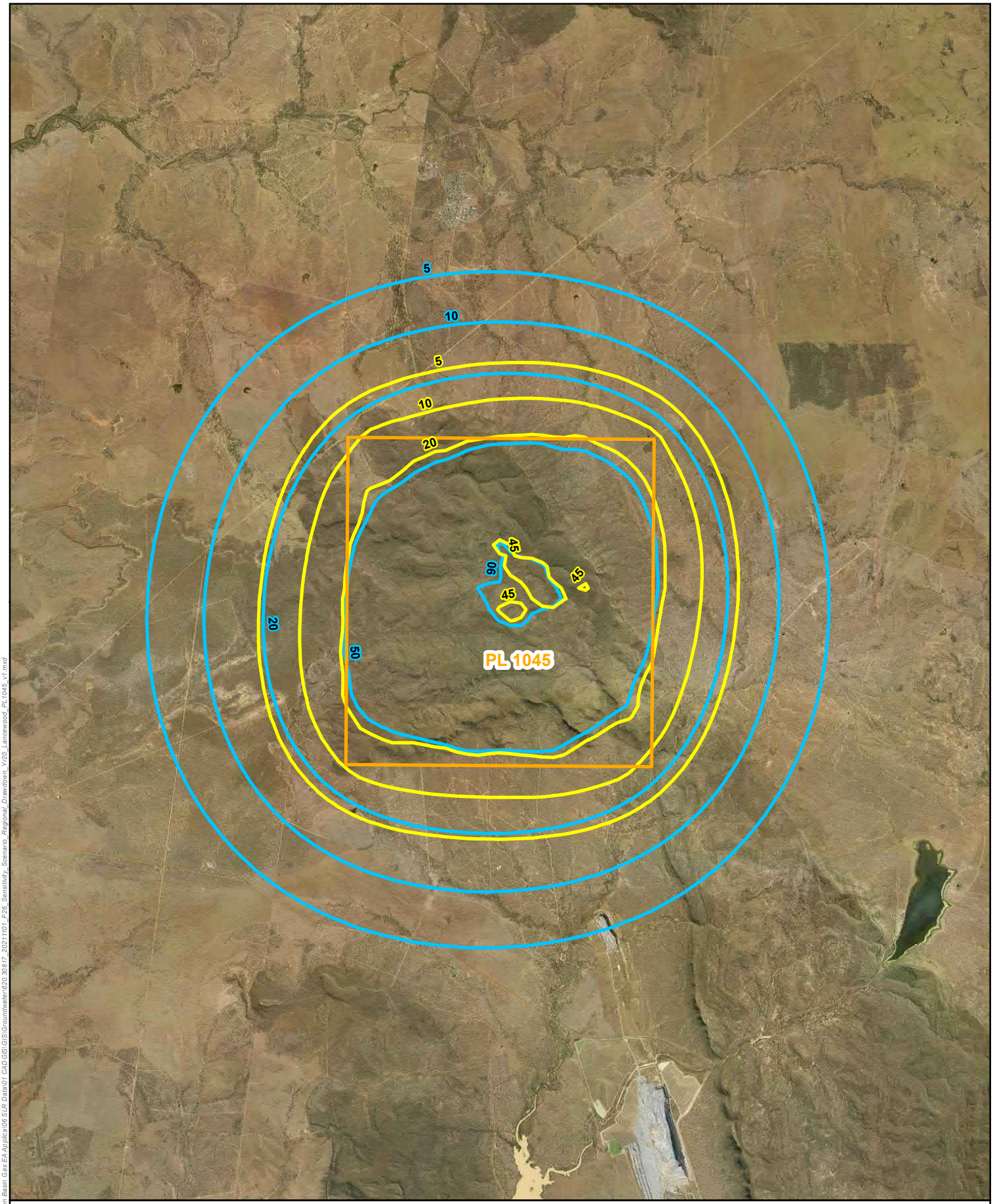
- Project Petroleum Lease
- Drawdown Sensitivity Run 2
- Drawdown Base Case

BLUE ENERGY EA APPLICATION

Sensitivity Scenario 2 Regional drawdown in the Rangal Coal Measures year 20 (PL 1045 Lancewood)

FIGURE 30

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Groundwater\620.30617_20211101_F25_Sensitivity_Scenario_Regional_Drawdown_Yr20_Lancewood_PL1045_v1.mxd



0 2 4 km

Coordinate System:	GDA 1994 MGA Zone 55
Scale:	1:140,000 at A4
Project Number:	620.30617
Date:	17-Nov-2021
Drawn by:	PW
Reviewed by:	IE

LEGEND

- Project Petroleum Lease
- Drawdown Sensitivity Run 3
- Drawdown Base Case

BLUE ENERGY EA APPLICATION

Sensitivity Scenario 3 Regional drawdown in the Rangal Coal Measures year 20 (PL 1045 Lancewood)

FIGURE 31

H:\Projects-SLR\620-BNE\620.30617.00000 Blue Energy Bowen Basin Gas EA Applica\06 SLR Data\01 CAD\GIS\GIS\Groundwater\620.30617_20211101_F26_Sensitivity_Scenario_Regional_Drawdown_Yr20_Lancewood_PL1045_v1.mxd

6.4 Water quality impacts

Water quality impacts have not been quantitatively assessed. From the water level impact assessment (Section 6.2 to Section 6.3), it is apparent that the impact on groundwater in the shallow aquifers overlying the target seams are negligible. With no groundwater interaction anticipated, water quality impacts are unlikely. The next section (Section 6.5) will discuss other pathways that could potentially impact the water quality.

6.5 Groundwater Impact Risk Assessment

A number of potential water level and quality impacts from project construction and CSG operations to the EVs presented in Section 3.4 and Section 6.5 have been identified. The impacts and associated risks and mitigation measures are presented in Table 17 below.

Table 17 Project Groundwater Impacts Risk Assessment

Activity	Impact	Likelihood	Consequence	Risk (unmitigated)	Mitigation	Risk (mitigated)
CSG well construction and completion	Loss of drill fluids / chemicals causing contamination of groundwater	Low – All CSG wells will be constructed according to the Queensland Code of Practice for the construction and abandonment of coal seam gas and petroleum wells, and associated bores in Queensland which ensure strong, stable construction with appropriate grouting to protect any groundwater contamination in other aquifers.	Moderate – drill fluids could change chemistry of overlying aquifers impacting quality for environmental and human uses / EVs	Moderate	All CSG wells constructed according to the Queensland Code of Practice for the construction and abandonment of coal seam gas and petroleum wells, and associated bores in Queensland. Implementation of groundwater monitoring plan to monitor aquifer responses to CSG operations	Low
	Poorly constructed or faulty gas wells causing inter-aquifer leakage and/or groundwater level changes		High - mixing of coal seam water could significantly increase the salinity of the overlying aquifer impacting its quality for environmental and human uses / EVs.			
CSG extraction operations	Groundwater extraction causing operational drawdown of groundwater levels and decreasing the yield rates of existing bores	High – Several landholder bores with uses listed as water supply or unknown have been identified within a drawdown zone of 5m or greater.	High – reduction in bore yields and available water column may reduce bore functionality, impacting users ability to extract sufficient groundwater for current applicable EVs	Moderate	Implementation of monitoring plan to monitor response of groundwater levels across hydrostratigraphic units to CSG operations. Carry out landholder bore survey to confirm groundwater users.	Low

Activity	Impact	Likelihood	Consequence	Risk (unmitigated)	Mitigation	Risk (mitigated)
	Increasing vertical hydraulic gradient between hydrostratigraphic units resulting in movement of water between aquifers	Low – Overlying and coal seam aquifers are separated by the approximately 300 to 700 m thick Rewan Group aquitard preventing mixing of groundwaters. Drawdown predicted to be minimal therefore vertical gradients expected to be insignificant.	High - mixing of coal seam water could significantly increase the salinity of the overlying aquifer impacting its quality for environmental and human uses.	Moderate	Implementation of monitoring plan to monitor response of groundwater levels and quality across hydrostratigraphic units to CSG operations.	Low
	Gas wells causing fugitive gas migration into groundwater	Moderate – potential for gas migration into groundwater following extraction operations.	Moderate – Coal Measures are targeted by existing groundwater users.	Moderate	Implementation of monitoring plan to monitor response of groundwater quality across hydrostratigraphic units to CSG operations. Carry out landholder bore survey to confirm groundwater users.	Low
	Operations causing aquifer compaction and land subsidence	Low –Overlying and target coal seam aquifers separated by approximately 300m to 700 thick Rewan Group aquitard	Low – due to the thickness of the aquitard any compaction of the coal seams is unlikely to result in subsidence at the ground surface.	Low	Implementation of monitoring plan to monitor response of groundwater levels across hydrostratigraphic units to CSG operations.	Low

7 Water Monitoring Strategy

7.1 Rationale

The water monitoring strategy has been developed in relation to satisfy the information requirements of the Underground Water Impact Reports and Final Reports (UWIR) guidelines (DES, 2018) as they relate to the predicted impacts of the Project. In general, the strategy is designed to detect any changes in groundwater levels and quality as a result of the proposed activities at PL 1034, PL1038 and PL1045.

A desktop assessment of water supply within and surrounding the Project area has shown that water supplies are mainly sourced the Tertiary Sediments and Coal Measures. Only two wells were targeting the Clematis or alluvium. The impact assessment showed that no impacts on the shallow alluvial aquifer are predicted (tertiary, Clematis and Alluvium), with drawdown constrained to the deep coal seam aquifers targeted by CSG activities.

No environmental users (springs, wetlands) were identified within or near to the Project area. Based on this no spring monitoring measures have been included within the monitoring strategy (refer to Section 7.4).

The impact assessment predicted that groundwater abstraction from CSG operations will result in drawdowns of greater than 5m in the target Coal Measures aquifers. Drawdown extents are predicted to be within 5-7 km of the lease boundaries (Sections 6.2.2 and 6.2.3).

7.2 Groundwater Monitoring Threshold Criteria

Monitoring of potential impacts is required for the protection of the relevant EVs presented in Section 2.4.1. To identify adverse impacts, the monitoring strategy requires the development of criteria that detect significant changes against baseline or ongoing measurements.

Site measurements should be compared against WQOs detailed in Section 2.4.2 for identify significant changes in groundwater quality and quantity. QWQG 2009 state that when comparing against WQOs the median value of site measurements (preferably a minimum of five) should be used.

The following criteria will be used to identify significant changes in water quality and quantity (consistent with guidelines):

- Adverse chemical impacts: Compare concentrations of following analytes to previous monitoring rounds. A potential adverse impact would be identified, if either:
  - value exceeds highest previous measurement by more than 25%, or
  - three subsequent monitoring events record an increase in one or more analytes concentration
- Adverse water level Impacts: Compare measured water level to previous monitoring rounds– if either
  - water level is lower than previous lowest measurement by >5m or
  - three subsequent monitoring events record a fall in water level >1m then a potential adverse impact has been identified.

7.3 Groundwater Monitoring Strategy and Timetable

The monitoring strategy for CSG operations at PL1034, PL1038 and PL1045 will cover water extracted from the coal seams and impacts within the leases. This monitoring is proposed to commence two years before the start of production testing. Baseline sampling outside of PL1034, PL1038 and PL1045 is not proposed at this stage.

7.3.1 Extracted Underground Water

Monitoring and recording of extracted underground water volumes will take place on a monthly basis and reviewed annually.

7.3.2 Groundwater Monitoring

7.3.2.1 Water Level Monitoring

Monitoring of groundwater levels is required to identify actual impact from CSG production and to verify the aquifer drawdown predicted by the impact assessment. A reference point such as bore collar will be established and surveyed to a known height datum (i.e. Australian Height Datum). Manual measurements for water levels will be made monthly for the duration of pumping (whilst production testing is occurring). The data will be reviewed after the initial 24-month monitoring period to determine any seasonal variations that need to be taken into consideration. After this period, the monitoring frequency will also be reviewed. The threshold criteria detailed in Section 7.2 will be used to determine whether changes in water levels are significant.

To monitor water levels within the Permian coal measures a dedicated monitoring network proximal to the Project area is required. It is proposed that vibrating wire piezometer (VWP) nested sites should be constructed with shallow monitoring bores targeting the shallow formations (Quaternary alluvium, Tertiary or Clematis) located next to deeper monitoring bores targeting the Permian coal measures. This will enable lateral and vertical groundwater drawdown effects of the target units to be determined.

7.3.2.2 Water Quality Monitoring

Water quality monitoring will be undertaken to determine whether CSG production is impacting on groundwater quality over the duration of the proposed CSG operation.

Review of the local surface and solid geology show that the coal measures do not subcrop within the predicted area. Due to the depth of the coal measures beneath the Project area (>500m) direct connectivity with the shallow formations (Quaternary alluvium, Tertiary or Clematis) is not expected. Nevertheless, all proposed monitoring bores should be sampled monthly for an initial 24 months to establish a water quality baseline.

The parameters suite for laboratory analysis will be in accordance with that undertaken for the baseline sampling and monitoring requirements, which are listed below. All samples will be submitted to a NATA registered laboratory for analysis.

Ongoing sampling will be undertaken on a monthly basis for the first 24 months of operation (post re-commencement of the production testing) and reviewed to determine whether a reduced sampling frequency is warranted (i.e., quarterly or bi-annually). Collected samples will be analysed for the following:

- pH, electrical conductivity and total dissolved solids
- major anions (bicarbonate, carbonate, chloride, sulphate) and cations (calcium, magnesium, sodium, potassium)

- nutrients (ammonia, nitrite, nitrate, total phosphorus)
- dissolved and total metals (aluminium, arsenic, barium, cadmium, copper, cobalt, lead, nickel, zinc, boron, strontium), and
- total petroleum hydrocarbons, BTEX, PAHs.

Groundwater samples will be collected from the monitoring bores in accordance with procedures specified in the Environmental Protection (Water) Policy 2009 Monitoring and Sampling Manual (DES, 2018) and Australian Standards Water Quality - Sampling AS 5667 (1998). That is the groundwater sampling will need to conform to applicable procedures for sampling equipment decontamination, preservation and transport, documentation and chain of custody protocol, and quality assurance / quality control.

7.3.2.3 Water Monitoring Strategy Summary

The details for the proposed Water Monitoring Strategy are summarised below in Table 18. In summary, it is recommended to install three shallow and three nested deep bores in each PL (PL1034, PL1038 and PL1045). The naming convention in this table refers to each PL as "PLxx", which means that each PL will have 6 bores as a minimum, 18 bores in total.

Shallow formations are the alluvium, tertiary or the Clematis Sandstone. No water level impacts were predicted for those formations and hence the water level monitoring will be used to verify these modelling results. Further, any changes to the groundwater quality will be monitored at these locations.

The deep formations targeted will be the Rangal Coal Measures or the Fort Cooper Coal measures. Water level monitoring at the deep bores will verify drawdown predictions. Further, water quality samples will be taken to identify any changes in groundwater quality.

The modelling predicted that a drawdown in the deep coal measures will not result in a drawdown in the shallow formation. The nested locations (a shallow and a deep bore in the same locations will assist in verifying these vertical gradients.

Table 18 Proposed groundwater monitoring program

Bore	Easting (z55 GDA94)	Northing (z55 GDA94)	Target Aquifer	Purpose
MB_PLxx-1S	TBD	TBD	Shallow (Alluvium, Tertiary or Clematis)	Monitoring of groundwater levels and quality in the shallow formation.
MB_PLxx-1D	TBD	TBD	Permian (RCM or FFCM)	Nested with MB_PLxx_1S Verify water level modelling and obtain water quality samples. (alternative a VWP with multiple sensors: Rewan, RCM, FFCM).
MB_PLxx-2S	TBD	TBD	Shallow (Alluvium, Tertiary or Clematis)	Monitoring of groundwater levels and quality in the shallow formation.
MB_PLxx-2D	TBD	TBD	Permian (RCM or FFCM)	Nested with MB_PLxx_2S Verify water level modelling and obtain water quality samples. (alternative a VWP with multiple sensors: Rewan, RCM, FFCM).
MB_PLxx-3S	TBD	TBD	Shallow (Alluvium, Tertiary or Clematis)	Monitoring of groundwater levels and quality in the shallow formation.
MB_PLxx-3D	TBD	TBD	Permian (RCM or FFCM)	Nested with MB_PLxx_3S Verify water level modelling and obtain water quality samples. (alternative a VWP with multiple sensors: Rewan, RCM, FFCM).

7.3.3 Reporting

In accordance with Underground Water Impact Report (UWIR) requirements the results of the Water Monitoring Strategy will be reported annually by Blue Energy in a standalone report for the duration of production testing. This will include a summary of the monitoring data recorded to date which will document changes in water quality and groundwater levels.

Information and details relating to the status of monitoring will be reported in an UWIR as soon as Blue Energy is accessing water and hence using their underground water rights. The UWIR is to be updated in three years (from the anniversary of the original report) and is to include:

- the annual reviews
- monitoring data collected
- the quantity of water produced, and
- other relevant information on the hydrogeological regime.

Where applicable, the groundwater analytical model will be updated to reflect the new data obtained for each annual review. Depending on the actual water extraction rates observed on site during the first years of operations, a numerical groundwater model may be required to further assess the future impacts.

7.4 Management of Springs

As per UWIR guidance (DES, 2018) a spring management strategy is required for springs within areas where the source aquifer is predicted to decline by more than 0.2 m.

On the basis there are no known springs within the Project area or the predicted area of drawdown resulting from the proposed CSG operation associated with PL1034, PL1038 and PL1045, it is considered that there is no requirement for a spring management strategy for this Project.

8 References

AGE. (2020). Isaac Downs Groundwater Impact Assessment. Report prepared for Stanmore IP South Pty Ltd.

Arrow Energy. (2013). Arrow Bowen Gas Project Environmental Impact Statement. https://www.arrowenergy.com.au/environment/project-assessment-eis/bowen-gas-project-eis

Bureau of Meteorology (BOM). (2021). Map of Climate Zones Australia. Retrieved August, 20, 2021 from http://www.bom.gov.au/climate/how/newproducts/images/zones.shtml

DES (Department of Environment and Science). (2015). Wetland data - version 5 - wetland areas – Queensland. Retrieved 14, September, 2021 from, http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=%22Wetland data - version 5 - wetland areas - Queensland%22

Department of Resources. (2021). Groundwater Database – Queensland. Retrieved September, 14, 2021, from http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=%22Groundwater Database - Queensland%22

Evans T, Pavey C, Cassel R, Ransley T, Sparrow A, Kellett J, Galinec V, Dehelean A, Bell J, Caruana L & Kilgour P. (2018). Conceptual modelling for the Galilee subregion. Product 2.3 for the Galilee subregion from the Lake Eyre Basin Bioregional Assessment. Department of the Environment and Energy, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia. https://www.bioregionalassessments.gov.au/assessments/23-conceptual-modelling-galilee-subregion

Geoscience Australia. (2021). Australian Stratigraphic Unit Database. Retrieved, September, 14, 2021, from https://asud.ga.gov.au/search-stratigraphic-units/

OGIA. (2019). Groundwater Modelling Report – Surat Cumulative Management Area. OGIA, Brisbane. https://www.resources.qld.gov.au/__data/assets/pdf_file/0008/1460627/groundwater-modelling-report-surat-cma.pdf

Queensland Government, Queensland. (2017). Groundwater dependent ecosystems WetlandInfo. Retrieved 14, September, 2021 from, available at https://wetlandinfo.des.qld.gov.au/wetlands/ecology/aquatic-ecosystems-natural/groundwater-dependent/

Queensland Government. (2021). Scientific Land Owners (SILO) database – Australian climate data from 1889 to yesterday. Retrieved August, 23, 2021, from https://www.longpaddock.qld.gov.au/silo/point-data/

ASIA PACIFIC OFFICES

ADELAIDE
60 Halifax Street
Adelaide SA 5000
Australia
T: +61 431 516 449

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE CBD
Suite 2B, 125 Bull Street
Newcastle West NSW 2302
Australia
T: +61 2 4940 0442

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Grd Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
Level 4, 12 O'Connell Street
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

WELLINGTON
12A Waterloo Quay
Wellington 6011
New Zealand
T: +64 2181 7186

SINGAPORE
39b Craig Road
Singapore 089677
T: +65 6822 2203

APPENDIX D

IAQM Methodology

Step 1 – Screening Based on Separation Distance

The Step 1 screening criteria provided by the IAQM guidance suggests screening out any assessment of impacts from construction activities where sensitive receptors are located more than 350 m from the boundary of the Site, more than 50 m from the route used by construction vehicles on public roads and more than 500 m from the Site entrance. This step is noted as having deliberately been chosen to be conservative, and will require assessments for most projects.

Step 2a – Assessment of Scale and Nature of the Works

Step 2a of the assessment provides "dust emissions magnitudes" for each of four dust generating activities; demolition, earthworks, construction, and track-out (the movement of site material onto public roads by vehicles). The magnitudes are: *Large*; *Medium*; or *Small*, with suggested definitions for each category. The definitions given in the IAQM guidance for earthworks, construction activities and track-out, which are most relevant to this Development, are as follows:

Demolition *(Any activity involved with the removal of an existing structure [or structures]. This may also be referred to as de-construction, specifically when a building is to be removed a small part at a time)*:

- *Large*: Total building volume >50,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20 m above ground level;
- *Medium*: Total building volume 20,000 m^3 – 50,000 m^3, potentially dusty construction material, demolition activities 10-20 m above ground level; and
- *Small*: Total building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10m above ground, demolition during wetter months.

Earthworks *(Covers the processes of soil-stripping, ground-levelling, excavation and landscaping)*:

- *Large*: Total site area greater than 10,000 m^2, potentially dusty soil type (eg clay, which will be prone to suspension when dry due to small particle size), more than 10 heavy earth moving vehicles active at any one time, formation of bunds greater than 8 m in height, total material moved more than 100,000 t.
- *Medium*: Total site area 2,500 m^2 to 10,000 m^2, moderately dusty soil type (eg silt), 5 to 10 heavy earth moving vehicles active at any one time, formation of bunds 4 m to 8 m in height, total material moved 20,000 t to 100,000 t.
- *Small*: Total site area less than 2,500 m^2, soil type with large grain size (eg sand), less than five heavy earth moving vehicles active at any one time, formation of bunds less than 4 m in height, total material moved less than 20,000 t, earthworks during wetter months.

Construction *(Any activity involved with the provision of a new structure (or structures), its modification or refurbishment. A structure will include a residential dwelling, office building, retail outlet, road, etc)*:

- *Large*: Total building volume greater than 100,000 m^3, piling, on site concrete batching; sandblasting.
- *Medium*: Total building volume 25,000 m^3 to 100,000 m^3, potentially dusty construction material (eg concrete), piling, on site concrete batching.

- *Small*: Total building volume less than 25,000 m^3, construction material with low potential for dust release (eg metal cladding or timber).

Track-out *(The transport of dust and dirt from the construction / demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network)*:

- *Large*: More than 50 heavy vehicle movements per day, surface materials with a high potential for dust generation, greater than 100 m of unpaved road length.
- *Medium*: Between 10 and 50 heavy vehicle movements per day, surface materials with a moderate potential for dust generation, between 50 m and 100 m of unpaved road length.
- *Small*: Less than 10 heavy vehicle movements per day, surface materials with a low potential for dust generation, less than 50 m of unpaved road length.

Note: No demolition of existing structures will be performed as part of this Development.

In order to provide a conservative assessment of potential impacts, it has been assumed that if at least one of the parameters specified in the 'large' definition is satisfied, the works are classified as large, and so on.

Step 2b – Risk Assessment

Assessment of the Sensitivity of the Area

- Step 2b of the assessment process requires the sensitivity of the area to be defined. The sensitivity of the area takes into account:
- The specific sensitivities that identified sensitive receptors have to dust deposition and human health impacts;
- The proximity and number of those receptors;
- In the case of PM_{10}, the local background concentration; and
- Other site-specific factors, such as whether there are natural shelters such as trees to reduce the risk of wind-blown dust.
- Individual receptors are classified as having *high*, *medium* or *low* sensitivity to dust deposition and human health impacts (ecological receptors are not addressed using this approach). The IAQM method provides guidance on the sensitivity of different receptor types to dust soiling and health effects as summarised in Table A-1. It is noted that user expectations of amenity levels (dust soiling) is dependent on existing deposition levels.

Table D-1 IAQM Guidance for Categorising Receptor Sensitivity

Value	High Sensitivity Receptor	Medium Sensitivity Receptor	Low Sensitivity Receptor
Dust soiling	Users can reasonably expect a high level of amenity; or The appearance, aesthetics or value of their property would be diminished by soiling, and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods as part of the normal pattern of use of the land.	Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or The appearance, aesthetics or value of their property could be diminished by soiling; or The people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land.	The enjoyment of amenity would not reasonably be expected; or Property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land.
	Examples: Dwellings, museums, medium and long term car parks and car showrooms.	*Examples: Parks and places of work.*	*Examples: Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.*
Health effects	Locations where the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day).	Locations where the people exposed are workers, and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day).	Locations where human exposure is transient.
	Examples: Residential properties, hospitals, schools and residential care homes.	*Examples: Office and shop workers, but will generally not include workers occupationally exposed to PM10.*	*Examples: Public footpaths, playing fields, parks and shopping street.*

According to the IAQM methods, the sensitivity of the identified individual receptors (as described above) is then used to assess the *sensitivity of the area* surrounding the active construction area, taking into account the proximity and number of those receptors, and the local background PM_{10} concentration (in the case of potential health impacts) and other site-specific factors. Additional factors to consider when determining the sensitivity of the area include:

- any history of dust generating activities in the area
- the likelihood of concurrent dust generating activity on nearby sites
- any pre-existing screening between the source and the receptors
- any conclusions drawn from analysing local meteorological data which accurately represent the area and if relevant, the season during which the works will take place
- any conclusions drawn from local topography
- the duration of the potential impact (as a receptor may be willing to accept elevated dust levels for a known short duration, or may become more sensitive or less sensitive (acclimatised) over time for long-term impacts), and
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document.

The IAQM guidance for assessing the sensitivity of an area to dust soiling is shown in Table A-2. The sensitivity of the area should be derived for each of activity relevant to the project (i.e. construction and earthworks).

Table D-2 IAQM Guidance for Categorising the Sensitivity of an Area to Dust Soiling Effects

Receptor sensitivity	Number of receptors	Distance from the source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Note: Estimate the total number of receptors within the stated distance. Only the *highest level* of area sensitivity from the table needs to be considered. For example, if there are 7 high sensitivity receptors < 20m of the source and 95 high sensitivity receptors between 20 and 50 m, then the total of number of receptors < 50 m is 102. The sensitivity of the area in this case would be high.

A modified version of the IAQM guidance for assessing the *sensitivity of an area* to health impacts is shown in Table A-3. For high sensitivity receptors, the IAQM methods takes the existing background concentrations of PM_{10} (as an annual average) experienced in the area of interest into account and is based on the air quality objectives for PM_{10} in the UK. As these objectives differ from the ambient air quality criteria adopted for use in this assessment (i.e. an annual average of 25 µg/m^3 for PM_{10}) the IAQM method has been modified slightly.

- This approach is consistent with the IAQM guidance, which notes that in using the tables to define the *sensitivity of an area*, professional judgement may be used to determine alternative sensitivity categories, taking into account the following factors:
- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local meteorological data which accurately represent the area, and if relevant the season during which the works will take place;
- any conclusions drawn from local topography;
- duration of the potential impact; and
- any known specific receptor sensitivities which go beyond the classifications given in this document.

Table A-3 IAQM Guidance for Categorising the Sensitivity of an Area to Dust Health Effects

Receptor sensitivity	Annual mean PM_{10} conc.	Number of receptors [a,b]	Distance from the source (m)			
			<20	<50	<100	<350
High	20-27.5 µg/m³	>100	High	Medium	Low	Low
		10-100	High	Medium	Low	Low
		1-10	Medium	Low	Low	Low
	<20 µg/m³	>100	Medium	Low	Low	Low
		10-100	Low	Low	Low	Low
		1-10	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low
	-	1-10	Medium	Low	Low	Low
Low	-	>1	Low	Low	Low	Low

Notes: (a) Estimate the total within the stated distance (e.g. the total within 350 m and not the number between 200 and 350 m); noting that only the highest level of area sensitivity from the table needs to be considered.

(b) In the case of high sensitivity receptors with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.

Risk Assessment

The dust emission magnitude from Step 2a and the receptor sensitivity from Step 2b are then used in the matrices shown in Table A-4 (earthworks and construction) and Table A-5 (track-out) to determine the risk category with no mitigation applied.

Table D-4 Risk Category from Earthworks and Construction Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table D-5 Risk Category from Track-out Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Step 3 - Site-Specific Mitigation

Once the risk categories are determined for each of the relevant activities, site-specific management measures can be identified based on whether the Site is a low, medium or high risk site.

Step 4 – Residual Impacts

Following Step 3, the residual impact is then determined after management measures have been considered.

ASIA PACIFIC OFFICES

ADELAIDE
60 Halifax Street
Adelaide SA 5000
Australia
T: +61 431 516 449

BRISBANE
Level 16, 175 Eagle Street
Brisbane QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE CBD
Suite 2B, 125 Bull Street
Newcastle West NSW 2302
Australia
T: +61 2 4940 0442

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Grd Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
Level 4, 12 O'Connell Street
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

WELLINGTON
12A Waterloo Quay
Wellington 6011
New Zealand
T: +64 2181 7186

SINGAPORE
39b Craig Road
Singapore 089677
T: +65 6822 2203