Tetris EA Application Supporting Information

Date:	25 September 2023
Document:	ATP2059-QLDS-EN-REP-001
Revision:	0

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Document Status

Revision History

Revision	Release Date	Document Status	Revision Comments	Author
A	August 2023	DRAFT	For Internal Review	P. Wilkinson
0	September 2023	Final		P. Wilkinson

Document Approval

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Terms and Abbreviations

Abbreviation	Description
ALA	Atlas of Living Australia
AQMS	Air Quality Monitoring Station
ATP	Authority to Prospect
CLR	Contaminated Land Register
CSG	Coal Seam Gas
CSG WMP	Coal Seam Gas Water Management Plan
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DES	Department of Environment and Science
DoR	Department of Resources
DRDMW	Department of Regional Development Manufacturing and Water
EA	Environmental Authority
EAR	Ecology Assessment Report
EMP	Environmental Management Plan
EMR	Environmental Management Register
EP	Equivalent Person
EP Act	Environmental Protection Act 1994
EP Regulation	Environment Protection Regulation 2008

Abbreviation	Description
EPP	Environmental Protection Policy
ERA	Environmentally Relevant Activity
ERE	Endangered Regional Ecosystem
ESA	Environmentally Sensitive Area
EV	Environmental Value
EVNT	Endangered, vulnerable or near threatened
GAB	Great Artesian Basin
GIS	Geographic Information System
GL	Gigalitre
ha	Hectare
HSEMS	Health, Safety, Environment Management System
km	kilometers
kPag	KiloPascals gauge
MAOP	Maximum Operating Pressure
Mbgl	Metres below ground level
ML	Megalitre
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
NC Act	Nature Conservation Act 1992
OC RE	Of Concern Regional Ecosystem
OGIA	Office of Groundwater Impact Assessment
PL	Petroleum Lease
PMAV	Property Map of Assessable Vegetation
PoO	Plan of Operations
Proposed infrastructure	Where a preliminary location for infrastructure has been identified and which is subject to detailed design
QLD	Queensland
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database (Queensland Herbarium (2023))
RoW	Right of Way corridor for a pipeline
SMC	Streamlined Model Conditions
SPRAT	Species Profile and Threats database (EPBC Act species)
SRI	Significant Residual Impact
Surat CMA UWIR	Surat Cumulative Management Area Underground Water Impact Report
TDS	Total Dissolved Solids
TEC	Threatened Ecological Community
WCM	Walloon Coal Measures
WONS	Weed of National Significance
WO	Wildlife Online database

Abbreviation	Description
WQO	Water Quality Objective
WTF	Water Treatment Facility

EA Supporting Information

1 Introduction

1.1 Background and Scope

Senex Assets Pty Ltd (ACN 160 649 338) (the applicant) has prepared this supporting information report to accompany the application under the Environmental Protection Act 1994 (EP Act) for a site-specific Environmental Authority (EA) for Petroleum Lease Application (PLA) 1127 (otherwise known as Project Tetris) The application is over the area of the Senex owned and operated Authority To Prospect (ATP) 2059 (ATP 2059), located approximately 16 kilometres (km) southwest of Wandoan and 57 km north-west of Miles, in the Surat Basin, Queensland (refer to Figure 1). Further clarity regarding terms used to describe this project is provided in Table 1.

Project Tetris will cover an area of approximately 18 square km (1,847.9 ha) adjacent to Senex's Project Atlas (PL 1037). Senex was awarded PL1037 by the Queensland Government through a competitive tender process for domestic market supply in September 2017 and was awarded ATP 2059 in September 2020. Production from the Atlas area will be expanded into the Project Tetris area using Senex's existing hub-and-spoke infrastructure model.

This EA Application covers the transition from exploration to production and includes the development of up to 31 CSG wells in the first eight years with a targeted production rate of between 24 and 40 terajoules per day (TJ per day). Field development is planned to move from the north and west of the block towards the southeast and provide at least 25 years of commercial gas production.

The operating life of a production well is expected to be between 20 and 50 years, with wells no longer required for operational purposes progressively decommissioned and rehabilitated throughout the Project life. Senex will use the nearby supporting infrastructure constructed as part of Project Atlas on PL 1037. Gas produced from the area of PLA 1127 will be transported via gathering lines to an existing third-party owned and operated compression facility located within the area of ATP 2059 (PFL 29) and/or a Senex owned compression facility located within the area of PL 209 (PFL 31). As a result, this application and the associated proposed development do not include gas processing or compression facilities. This will allow the block to move rapidly into development and achieve commercial production solely into the domestic gas market. Further details are provided in Section 4.2

The applicant is a wholly owned subsidiary of Senex Energy Limit (ACN 008 942 827), a company with more than three decades of experience in Australia's oil and gas industry. Senex currently holds 100% interest in ATP2059 and is the operator of the permit. Senex lodged the associated PL application with the Department of Resources (DoR) on 18 September 2023.

Table 1: Terminology

Term	Description
Project Tetris	The proposed development of ATP 2059 into a Petroleum Lease with the drilling of 26 new wells and construction of associated access and gathering
ATP 2059	The existing exploration tenure over which a Petroleum Lease is being sought
PLA 1127	The provisional PL number assigned to the project area by DoR
Project Area	The area covered by ATP 2059, the application for PLA 1127 and this EA application

1.2 Purpose

The purpose of this report is to provide sufficient detail to:

- support the EA application (site-specific) for the transition of ATP 2059 to commercial production.
- to provide the administering authority with a high level of certainty regarding the ability of Senex to mitigate any environmental impacts associated with the proposed development; and
- to assist in the development of EA conditions.

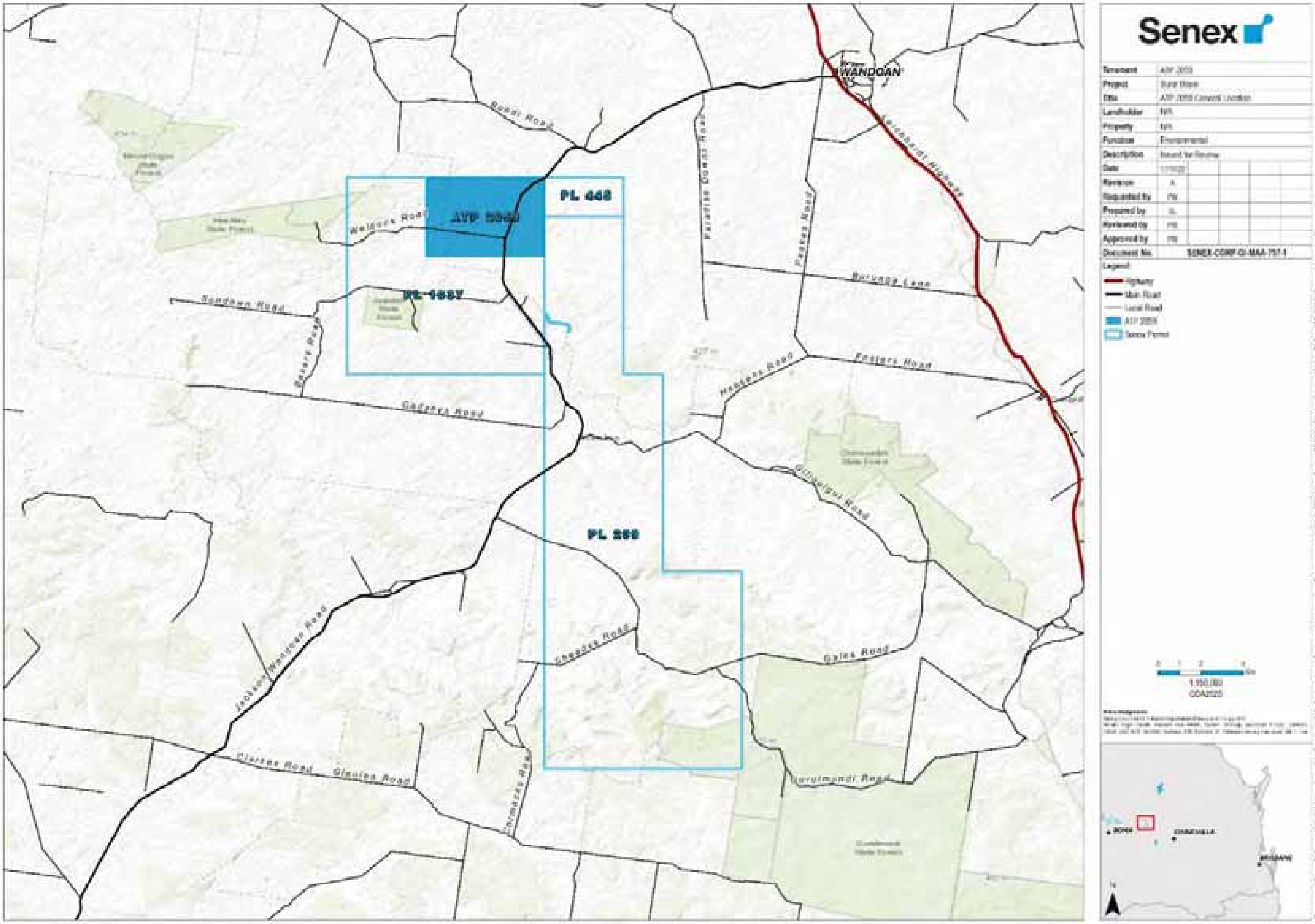
The approved form for making a site-specific application for an EA under Sections 124-126 of the *Environmental Protection Act 1994* (EP Act) is provided with this supporting report.

1.3 Associated Document References

This supporting information report is an attachment to the EA application Queensland Department of Science (DES) Site-specific application for a new environmental authority for a resource activity - Application Form (ESR/2015/1757, Version 7.00). In support of this application, the following associated Senex documents are appended:

- Environmental Management Plan Atlas Stage 3 Gas Project [SENEX-ATLS-EN-PLN-015] (Appendix A);
- Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development [OPS-ATLS-EN-PLN-001] (Appendix B); and
- ATP 2059 CSG WMP [SENEX-ATLS-PL-013] (Appendix C).

Figure 1 Regional Location of Project Tetris



2 Additional Requirements

The following section identifies the requirements for an EA Application and provides cross reference to the relevant sections of the application.

2.1 Mandatory Application Requirements

Section 125 & 126 of the EP Act sets out the requirements for a properly made application for a site- specific application – Coal Seam Gas (CSG) activities. Each requirement is outlined in Table 2, with specific reference 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 (EPPs) have been comprehensively addressed and considered throughout the application and supporting documents.

Table 2: Key Statutory Requirements

EP Act Section	Requirement	Reference
(a) Section 125 Environmental Protection Act 1994		
125(1)(a)	Application made to administering authority	Application has been made to DES
125(1)(b)	Application made in the approved form	Form ESR/2015/1757 has been included as part of the Application Package
125(1)(c)	Describe all environmentally relevant activities for the activity	refer Section 2.2
125(1)(d)	Describe the land on which each activity will be carried out	Refer Section 3
125(1)(e)	Application accompanied by the prescribed fee	Refer to Question 19 Approved Application Form ESR/2015/1757
125(1)(f)	If two or more entities jointly make the application – nominate one as the principal applicant	Not applicable.
125(1)(g)	State whether the application– (i) a standard application or (ii) a variation application or (iii) a site-specific application	This application is a site-specific application.
125(1)(h)	State whether the applicant is a registered suitable operator	The applicant is a Registered Suitable Operator (RSO). Suitable operator number is included on the EA Application Form.
125(1)(i)	Describe any development permits or approvals required under the *Planning Act or State Development Act* for the carrying out of the relevant activity for the authority	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	Not applicable - not a standard or variation application.

EP Act Section	Requirement	Reference
125(1)(k)	For a variation application – state the standard conditions the applicant seeks to change	Not applicable - not a variation application.
125(1)(l)	If the application is a variation or site-specific application – include an assessment of each relevant activity on the environmental values (EV) including:	
125(1)(l)(i) A	Description of EVs likely to be affected by proposed amendment	Sections 7 to 11
125(1)(l)(i) A	Details of any emissions likely to be generated by proposed amendment	Sections 7 to 11
125(1)(l)(i) B	Details of an emissions or releases likely to be generated by each relevant activity	Sections 7 to 11
125(1)(l)(i) C	Description of risk and likely magnitude of impacts on environmental values	Sections 7 to 11
125(1)(l)(i) D	Details of the management practices proposed to be implemented to prevent or minimize adverse impacts	Sections 7 to 11
125(1)(l)(i) E	Details of how the land the subject of the application will be rehabilitated after each relevant activity ceases	Section 4.5
125(1)(l)(ii)	Include a description of the proposed measures for minimizing and managing waste generated by any amendments to the relevant activity	Section 4.6
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	There are no known plans or EPOs over the land the subject of the application.
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	EA is for a resource activity.
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.
(b) Section 125 Environmental Protection Act 1994 – CSG Specific Requirements		
126(1)	A site-specific application for a CSG activity must also state the following:	

EP Act Section	Requirement	Reference
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 6.1
126(1)(b)	the flow rate at which the applicant reasonably expects the water will be generated;	Section 6.1
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 6.2
126(1)(d)	The proposed management of the water, including, for example, the use, treatment, storage or disposal of the water;	Section 0 to 6.5
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:	Section 6.6
126(1)(e)(i)	quantity and quality of water used, treated, stored or disposed of;	Section 6
126(1)(e)(ii)	protection of the environmental values affected by each relevant CSG activity;	Sections 7 to 11
126(1)(e)(iii)	the disposal of waste, including, for example, salt, generated from the management of the water;	Section 6.5
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 6.6
126(2)(a)(b)	The proposed management of the water can not provide for using a CSG evaporation dam in connection with carrying out a relevant CSG activity unless: The application includes an evaluation of: best practice environmental management for managing the CSG water; and alternative ways for managing the water; and the evaluation shows there is no feasible alternative to a CSG evaporation dam for managing the water	Not applicable: The application does not seek to use a CSG evaporation dam.
(c) Section 126A Environmental Protection Act–1997 - Underground Water Rights		

EP Act Section	Requirement	Reference
126A (1)	Requirements for site-specific applications – involving the exercise of underground water rights (1). This section applies if: the application relates to a site-specific environmental authority for- a resource project that includes a resource tenure that is a mineral development licence, mining lease or petroleum lease; or a resource activity for which the relevant tenure is a mineral development licence, mining lease or petroleum lease; and	This application is a relevant tenure as the activity relates to is a petroleum lease.
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	Underground water rights will be exercised in the carrying out of activities related to this petroleum lease. Refer to section 8
126A (2) (b)	The areas in which underground water rights are proposed to be exercised	Section 8
126I2) (c)	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 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 8
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 8
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 8
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

2.2 Proposed ERAs

Senex is seeking to transition from exploration and appraisal activities to production and is seeking a site-specific EA to support a PL, described further in Section 3 and Section 4. This application seeks to increase the scale and nature of activities from those authorised for ATP 2059.

The proposed increase in scale and intensity of activities has the potential to impact the environmental values (EVs) of the Project Area. An assessment of the potential impacts to EVs is presented in Sections 6 to 11.

Environmentally Relevant Activities (ERAs) proposed to be included on the EA are outlined in Table 3.

Table 3: Proposed ERAs for PLA 1127

Environmentally Relevant Activities	Locations
Non-scheduled Petroleum Activity – Petroleum Lease (PL)	PLA 1127

2.3 Regional Interest Development Approval

2.3.1 Strategic Cropping Area

About 89% of the project area is mapped as ‘Strategic Cropping Area’, an area of regional interest under the *Regional Planning Interests Act 2014* (Figure 2).

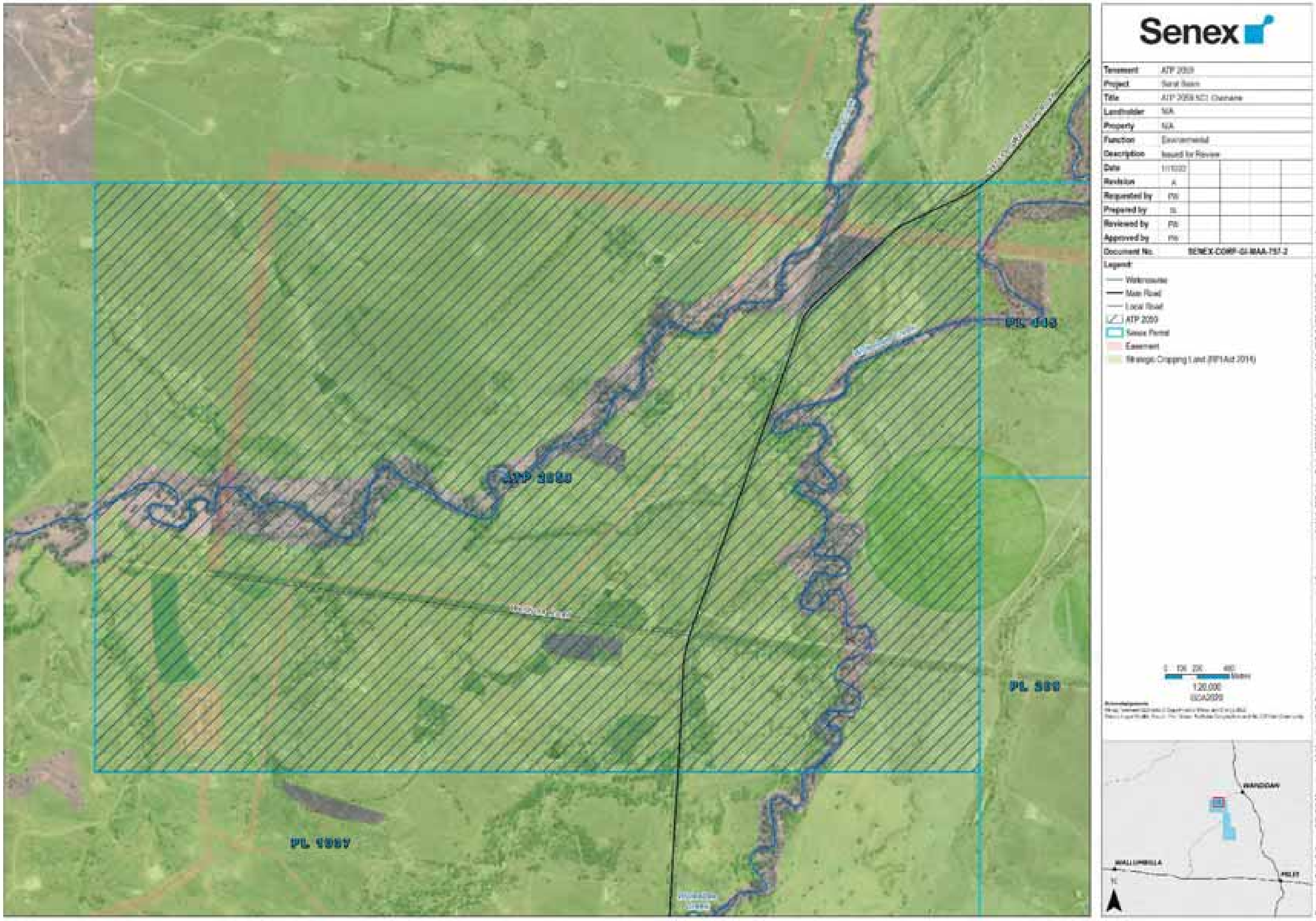


Figure 2: Strategic Cropping Area

2.4 Great Barrier Reef Catchments

The proposed project area is located in the headwaters of the Fitzroy River, which is part of a Great Barrier Reef catchment area. As a result, Section 41AA of the EP Regulation is triggered. Section 41AA relates to the release of fine sediment and inorganic nitrogen in Great Barrier Reef catchment waters and in particular, section 41AA(3) states:

> The administering authority must refuse to grant the application if the authority considers that—
>
> (a) the relevant activity will, or may, have a residual impact; and
>
> (b) having regard to the matters mentioned in the water quality offset policy, the residual impact will not be adequately counterbalanced by offset measures for the relevant activity.

An Environmental Objectives Assessment for Water has been undertaken (Table 4) and demonstrates the negligible risk that the project poses to the Great Barrier Reef (GBR) Catchments and Great Barrier Reef.

Proposed management measures for erosion and sediment control, stormwater and potential contaminants mean the risks of fine sediment and/or contaminants entering a watercourse are minimal, and the risk of any such sediment or contaminants being transported downstream to the GBR are negligible.

Table 4: Environmental Objectives Assessment

Environmental Objective (Water)	**Comment**
The activity will be operated in a way that protects environmental values of waters.	Senex will implement erosion and sediment control measures as detailed in its EMP (Appendix A) to protect identified EVs.
Performance Outcomes	
1. There is no actual or potential discharge to waters of contaminants that may cause as adverse effect on an environmental value from the operation of the activity.	Senex will implement erosion and sediment control measures as detailed in its EMP (Appendix A). Stormwater and process water management measures are such that discharges of water to surface waterways will not occur.
2. All of the following -	
(a) the storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks;	Refer to Section 4.6 and Appendix D. Senex will implement appropriate measures for secondary containment and the risk of spills or leaks impacting surface waterways are considered negligible.
(b) contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water;	The proposed gas field development is small in scale and as such potential contaminants used on site are minimal. Site design, and implementation of operational procedures mean that the risk of unplanned releases or discharge of contaminants are not expected. Further, implementation of appropriate bunding will limit the risk of contaminants leaving I site.
(c) the activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment;	Refer to section 4.2.3

(d) the disturbance of any acid sulfate soil, or potential acid sulfate soil, will be managed to prevent or minimise adverse effects on environmental values;	Acid sulfate soils and potential acid sulfate soils are not present at the site location.
(e) acid producing rock will be managed to ensure that the production and release of acidic waste is prevented or minimised, including impacts during operation and after the environmental authority has been surrendered;	N/A the project is not a mining project and will not result in the creation of acid producing rock or waste rock dumps.
(f) any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland;	No discharge to watercourses is sought as part of this application
(f) any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland;	No discharge to watercourses is sought as part of this application
(g) for a petroleum activity, the activity will be managed in a way that is consistent with the coal seam gas water management policy, including the prioritisation hierarchy for managing and using coal seam gas water and the prioritisation hierarchy for managing saline waste;	Refer to Section 6 and Appendix C
(h) the activity will be managed so that adverse effects on environmental values are prevented or minimised.	Refer to Sections 4.3 to 4.6, and 6 to 11

2.5 Environmental Authority Conditions

Streamline Model Conditions (SMCs) are being sought for this EA Application with conditions selected to align with proposed activities. A draft EA including all proposed conditions is provided as Appendix D.

3 Project Details

3.1 Project Location

The Project Area is approximately 18 km^2 and is proposed to cover the entirety of ATP 2059. The tenement is immediately south of QGC's Polaris and Cameron graticular blocks, and immediately north and east of the Senex owned and operated PL 1037 (Project Atlas) and immediately west of the Senex owned and operated PL 209 and PL 445. The project area is approximately 44 km north of the Warrego highway, between the townships of Wandoan and Wallumbilla and lies within the Maranoa Regional Council Local Government Area.

3.2 Relevant Resource Authority

The relevant resource authority is PLA 1127. The location of PLA 1127 is identified in Figure 1.

3.3 Real Property Descriptions

Properties and land parcels intersected by PLA 1127 are detailed in Table 5. None of the identified properties are listed on either the Environmental Management Register (EMR) or the Contaminated Land Register (CLR).

Table 5: Intersected Land Parcels

Lot	Plan	Tenure	Listed on CLR/EMR
23	FT41	Freehold	No
10	FT949	Freehold	No
54	FT788	Freehold	No
1	RP123884	Freehold	No
2	RP123884	Freehold	No
17	FT163	Freehold	No
19	FT60	Freehold	No
20	FT672	Freehold	No

4 Proposed Activities

PLA 1127 is intended to be a coal seam gas (CSG) development, which will be developed in conjunction with additional Senex CSG developments on PL 1037, PL 209 and PL 445. The proposed development will involve the installation of up to 31 gas wells and associated well site facilities; gas and water gathering systems for the production wells; access tracks for operational purposes; borrow pits; and ancillary supporting facilities. Common infrastructure will be used across all four lease areas to maximise the efficiency of the development and minimise expenditure and physical disturbance.

The following project components are described in detail below:

- The CSG resource;
- Field development planning;
- Project schedule and phasing;
- Infrastructure construction;
- Operations; and
- Abandonment and rehabilitation.

Table 6: Schedule of Disturbance

Tenure Number	Authorised Petroleum Activity	Scale	Intensity (Maximum size)
PLA 1127	Wells	26	26 ha
	Existing appraisal wells	5	5 ha

Cumulative disturbance associated with the existing appraisal wells, access tracks and gathering is 9.1 ha (Table 6). It is proposed that this area be included within authorised activities for PLA 1127.

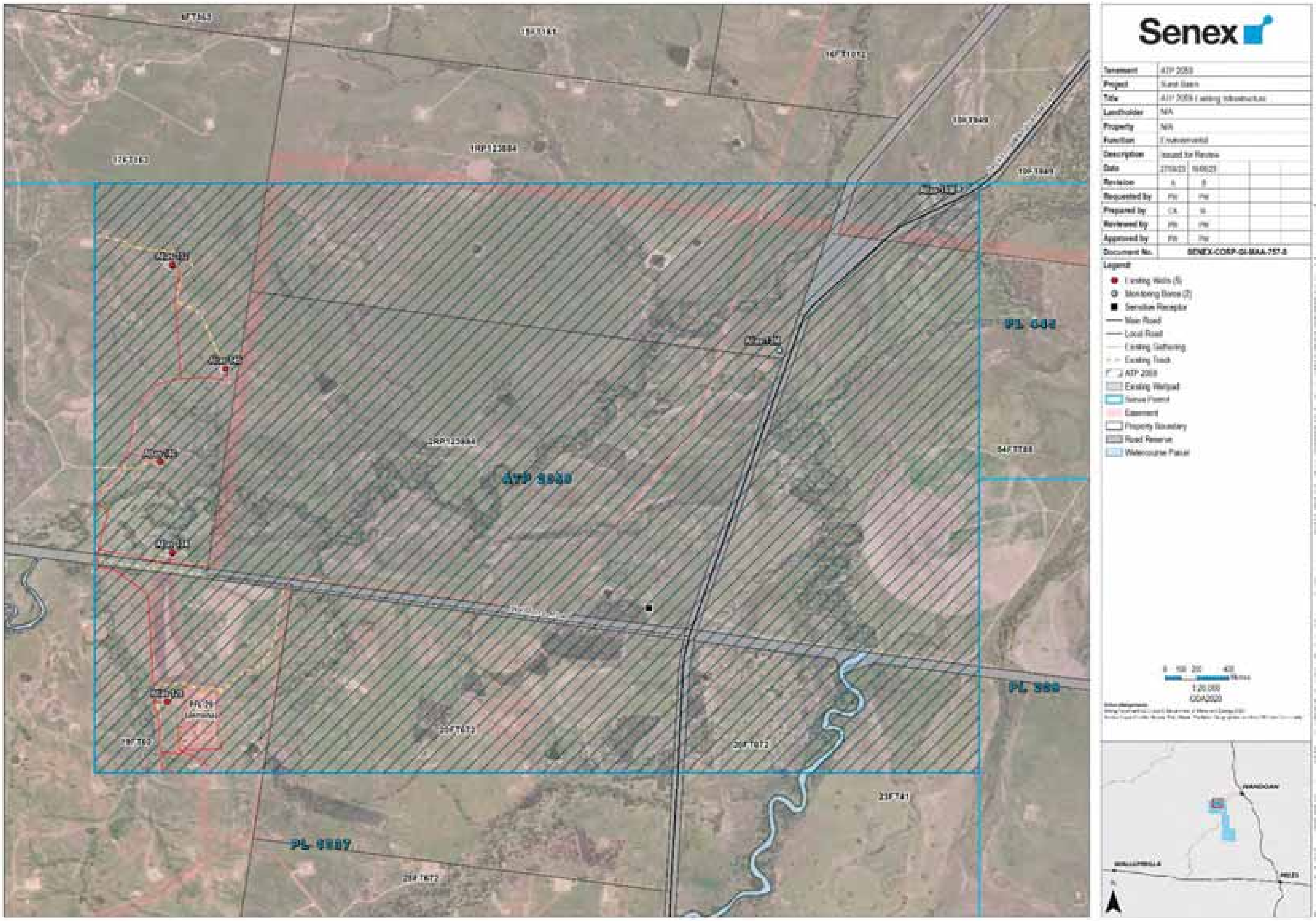


Figure 3: Existing Infrastructure

4.1 CSG Resource

The Walloon Subgroup is the production target within the project area and forms part of the Injune Creek Group. This group is defined by three key formations: the Springbok Sandstone, the Walloon Subgroup and the Eurombah Formation. These units are each used within the basis of the standard well design, with the Springbok hosting the top of the production hole assembly, the Walloons being the production interval and the Eurombah being the targeted formation for pump setting. The Project Area is located to the east of the Mimosa syncline, the area of maximum deposition.

4.1.1 Geology and Stratigraphic framework

The Walloon Subgroup underlies the Springbok sandstone and overlies the Eurombah formation (Figure 4). It is subdivided into upper (Juandah) and lower (Taroom) coal measures separated by the Tangalooma Sandstone. The (upper) Juandah Coal Measures are further subdivided into six named coal seams which in descending order are the Kogan, Macalister, split into upper and lower members, Nangram, Wambo, Iona and Argyle (Scott et al., 2004). The Macalister seams are the most significant in the upper section and have a coalesced thickness exceeding 12m, in places. The Juandah Coal Measures seams are further informally subdivided into an upper and lower section with the upper section containing the Kogan, Macalister and Nangram seams and the lower containing the Wambo, Iona and Argyle seams. Over large areas of the basin, a significant sandstone which has been named by a number of the operators separates the Nangram (upper Juandah) and Wambo (lower Juandah) intervals.

Separating the Juandah and Taroom coal-bearing sequences of the Walloon Subgroup is the Tangalooma Sandstone which is characterized by medium-grained, lithic, labile sandstones with an argillaceous matrix and numerous conglomerate streaks. The Taroom Coal Measures are composed of three coal packages which are, in descending order, the Auburn, Bulwer and Condamine seams (Scott et al., 2004).

The Walloon coal measures are distributed throughout the Atlas project area (PL 1037) immediately west and south of Project Tetris (as documented in the offset fields log data set). Individual ply and seam thicknesses vary significantly. However, the total coal thickness ranges from <5 to >30 metres. The Upper Juandah seams have a higher occurrence of thicker coal plies while the Lower Juandah Coal seams are primarily composed of thin coal plies of less than two metres. Overall, there is more coal in the Juandah Coal Measures than in the Taroom Coal Measures. Some thin coals are sporadically distributed in the Tangalooma Sandstone. Coals within the Taroom Coal Measures are similar to those in the lower Juandah Coal Measures, primarily composed of thin coal plies of less than two metres.

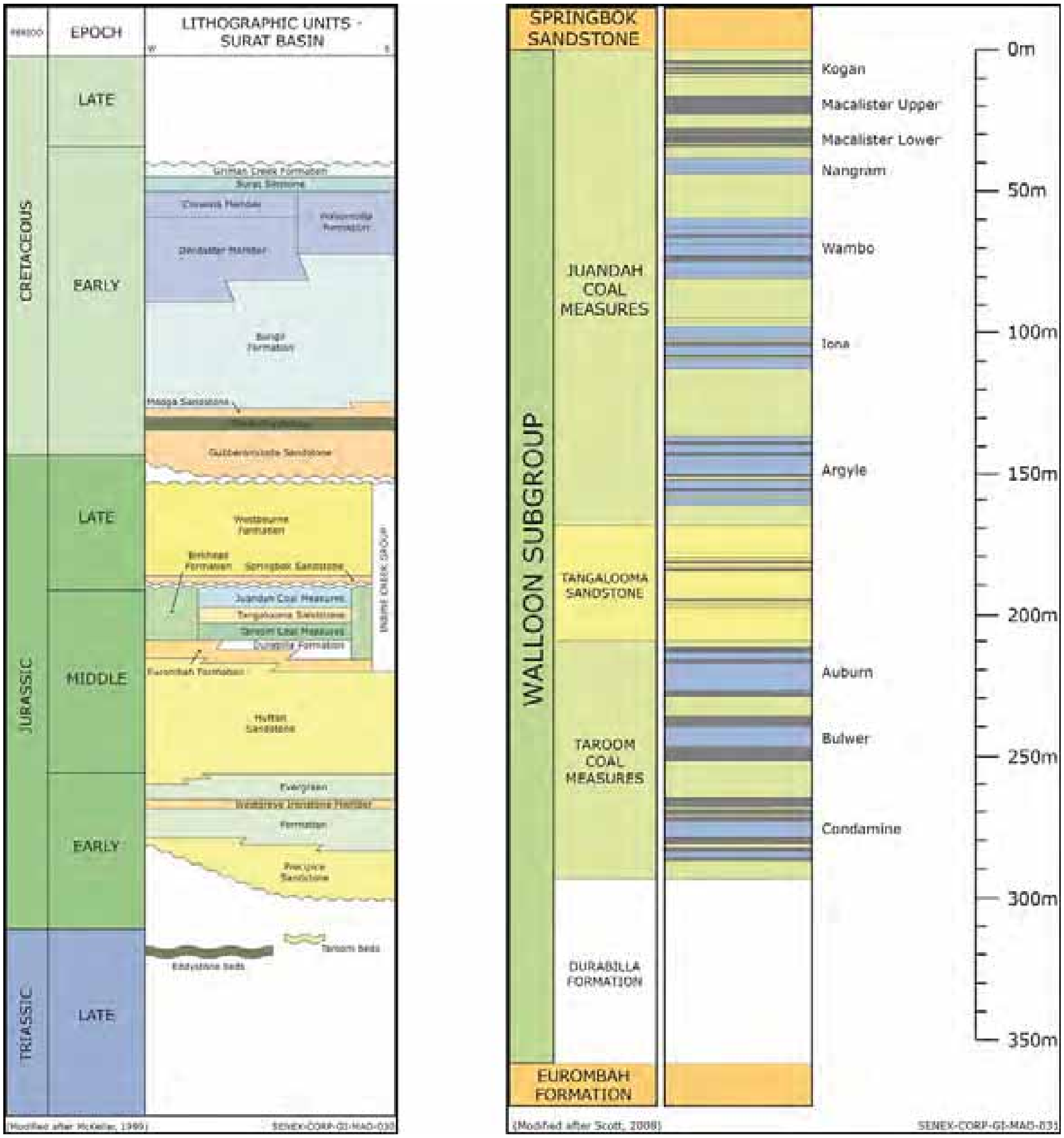


Figure 4: Walloon Sub-Group Stratigraphy

4.2 Development Activities

4.2.1 Wells

Proposed wells will generally be spaced 500 – 750 m apart and drilled to between 200m and 700 metres below ground level (mbgl). Up to 31 wells will be designed, constructed, decommissioned and rehabilitated in accordance with the Queensland Code of Practice for Constructing and Abandonment of Petroleum Wells and Associated Bores in Queensland (Department of Natural Resources, Mines and Energy (Version 2), 16 December 2019). The code outlines mandatory requirements and good practice to achieve long term well integrity and appropriately reduce the risk of environmental harm, including the design of CSG wells to prevent any cross-flow contamination between hydrocarbon bearing formations and aquifers and to ensure zonal isolation between different aquifers.

In addition, the Senex Standard Operating Procedure (OPS-QLDS-SB-PRC-001) for Drilling and Completion outlines the practices in-place to avoid well penetrations into the underlying Hutton Sandstone.

Well sites will generally require an area of about 80 m x 70 m (0.6ha), although smaller areas may be used where topography and vegetation cover allow. In some cases, additional area is required to accommodate cut and fill construction on steeper slopes or site-specific infrastructure (e.g. water tanks). In these cases, well sites may be up to 1 ha.

Well construction generally requires a drill rig and other equipment such as drill fluid pumps, storage and processing and storage for water supply, fuel and chemicals. Following initial drilling and commissioning of the well, sites will be partially rehabilitated, leaving an area of approximately 60 m x 60 m allowing an adequate area for workover rig operations.

Options for the management of residual drilling material to be used for the Project include onsite and offsite options. Where onsite management options are proposed, this will be undertaken in accordance with EA conditions and/or the End of Waste code for CSG Drilling Mud (ENEW07543018).

Following drilling and workovers the wells will be completed, and a pump installed to dewater the production reservoir. Separate connections will be provided at the well head for the gas and water streams. It is expected that produced water will be pumped to the surface by a downhole progressive cavity pump and connected from the wellhead tubing.

The standard well site facility will be fenced and generally consist of:

- A wellhead gas and water metering package;
- Gas and water separation equipment;
- Initially, natural gas power generation package to provide power for the electric motor driving the downhole pump (noting that it is possible that in future years wells may be powered by alternative sources including solar, hybrid and distributed power);
- Fuel and instrument gas scrubber to power the generator and supply gas to instruments;
- Sand/particulate filter separator for water and gas streams; and
- Surface pressure piping constructed of steel to the required specification and connection to gathering system.

It will generally take up to 6 months to dewater each production well sufficiently for gas to flow and about 18 months to reach peak production. Once depleted of gas, wells will be progressively decommissioned and rehabilitated throughout the Project life. Decommissioning of individual wells is not expected to occur until after the well has been producing for at least 15 years and may be much longer (anticipated to be between 20 and 35 years).

4.2.2 Gathering and Access

Gas and water from the wellsite facilities will be transported via the gas and water gathering system. The buried gathering system will enable gas at low pressure and water to flow through separate buried High Density Polyethylene (HDPE) pipelines, up to 650 mm diameter.

To install the gathering lines, 18 m wide right-of-way’s (RoWs) will require some vegetation to be removed, a trench to be excavated, pipeline laid, the trench backfilled, and RoW reinstated. A track will be maintained along the right-of-way for operations and maintenance purposes. Where possible, the pipeline RoW will be aligned with existing roads/tracks, fence or power lines or other linear infrastructure to minimise disturbance to native vegetation and overall impact on land users. In general, the RoW will be rehabilitated except for a 6 m wide access track.

The gas gathering system will typically operate at 70 – 400 kPag (with a Maximum Allowable Operating Pressure (MAOP) of 615 kPag). The water gathering system will typically operate at 140 – 700 kPag (with a MAOP of approximately 1350 kPag).

Water and gas will be transported to existing processing facilities on PL1037 (or planned facilities on PL209) through the gathering system.

Gathering will predominantly be installed in previously cleared areas and at the completion of the proposed project, any areas not required to remain as access tracks for the use of the landholder will be rehabilitated to the condition of the adjoining land.

4.2.3 Water Management

Groundwater will be abstracted (pumped) from CSG production wells to depressurise the target production of coal seams and it is expected that the proposed development may generate peak water flows of up to 1.6ML/d, with total cumulative produced water volumes forecast to be approximately 1.4 GL over the life of the project (Section 6 and Appendix C) .

The water management process for the produced water is expected to involve transfer to existing aggregation dams on Senex's PL 1037 or to planned infrastructure on Senex's PL209.

Treated water will be transferred to third party irrigation dam(s) (approximately 50-200 ML each) on PL1037 and/or PL209. The water will be treated to comply with the standard water quality parameters as specified in (6.1) of *ENEW07546918 End of Waste Code – Irrigation of Associated Water (including coal seam gas water)* or *ENEW07547018 – Associated water (including coal seam gas water*). After treatment the water will predominantly be used for irrigation. However, other uses such as stock water, hydrogen fuel production or other beneficial uses may also be pursued as a means of using water beneficially.

Brine from the water treatment process is proposed to be stored in dedicated brine storages on PL1037 or in future on PL209. Potential additional treatment options, together with concentration due to solar evaporation will result in a concentrated slurry or solid salt product. Where appropriate, salt or salt slurry will be trucked from site and disposed of at a Regulated Waste Facility.

Produced water will also be used for drilling and other project activities. Minor quantities of produced water may be beneficially reused in the proposed action area for dust suppression and construction activities in accordance with the Environmental Management Plan Atlas Stage 3 Gas Project [SENEX-ATLS-EN-PLN-015] (Appendix A).

Gas produced from PLA 1127 will be transported via gathering lines to an existing third-party owned and operated compression facility located within the area of ATP 2059 (PFL 29) and/or a Senex owned compression facility located within the area of PL 209 (PFL 31). As a result, this application and the associated proposed development do not include gas processing or compression facilities.

4.2.4 Ancillary supporting facilities

A range of ancillary infrastructure will be required to support proposed development activities. These may include:

- Power/communication lines (overhead or underground);
- Plant and equipment service and maintenance facilities and workshops;
- Fuel, chemical and regulated waste storage – noting that the expected volumes of regulated wastes and chemicals to be temporarily stored on site will be managed to remain below the thresholds of ERAs 8 - Chemical storage and 56 – Regulated Waste Storage;
- Washdown facilities;
- Laydown areas;
- Groundwater monitoring bores; and
- Environmental monitoring equipment and management controls.

Workers required for constructing and operating the well and infrastructure will be housed on site in temporary drilling camp(s) or may be accommodated in Wandoan, Miles or surrounding regional areas.

The temporary drilling camp(s) will comprise demountable accommodation and mess areas supported by sewage treatment systems of up to 50 equivalent persons (EP) capacity each, although workforce numbers are likely to be much lower than the capacity of the systems.

These may be no-release systems or may be capable of producing treated effluent to a quality suitable for release via irrigation to a contaminant release area. Greywater is also proposed to be irrigated where practicable. Potable water will be required primarily for workforce consumption and will be trucked onto site as required.

Power required on site (e.g. for camps, well pumps etc.) will generally be supplied using diesel generators. Where feasible, generators will be powered using produced CSG. Communication infrastructure will also be required and will likely comprise a radio tower.

4.3 Field Development Planning

Because infrastructure layouts are unable to be finalised until post-approvals due to the complex nature of land access and landholder engagement under the Queensland regulatory framework, Proponents working within the Queensland natural gas industry have developed, and are employing, adaptive environmental management frameworks to guide environmentally sensitive site selection.

Senex implements an adaptive environmental framework based on constraints planning, to inform the siting of project infrastructure and to develop specific controls and procedures to be applied to project activities at specific sites. This adaptive environmental framework, called the 'Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development' (constraints protocol) (Appendix B) aims to address uncertainties surrounding the final location of project infrastructure and activities by ensuring controls and procedures are in place that recognise the environmental and social values of the location. The framework is a decision-making tool and is an essential part of the planning and development process undertaken by Senex.

The constraints protocol formalises the assessment and evaluation of potential layout options and the development of a best fit development plan which minimises impacts to identified EVs as far as reasonably practicable.

Disturbance details included in this application are based on a conceptual development that cannot be finalised until after formal project approvals have been granted. However, mitigations, controls and commitments made in this application will be implemented, unless additional impacts are unavoidable, in which case a further application will be made seeking authorisation for additional disturbance.

Known constraints are assigned a constraints category (Table 7 and Table 8) and then overlaid on the conceptual development footprint to allow the conceptual design to be refined based on the following principles:

- Avoid – preferentially avoiding direct and indirect adverse environmental impacts;
- Minimise – minimise direct and indirect adverse environmental impacts through a reduction in the duration, intensity and/or extent of adverse impacts, where these cannot be avoided;
- Mitigate – implement mitigation and management measures to minimise direct, indirect and cumulative adverse impacts;
- Restore (remediate and rehabilitate) – actively remediate and rehabilitate impacted areas to promote and maintain long-term recovery.

Table 7: Constraint categories

Constraint category	Access permitted	Constraints[1]
No-go area	No petroleum activities	Threatened Ecological Communities MNES and MSES species habitat (apart from Koala dispersal habitat and Echidna habitat), including all areas of remnant vegetation Category A, B and C ESAs[2] Ooline plants (10 m buffer) If any are found to be present in the Project Area: • Slender Tylophora plants and a 10 m buffer; and • Populations[3] of the Dulacca Woodland Snail
High constraint area	Low impact petroleum activities, and Linear infrastructure	• Buffer zone (10 m buffer around all 'No-go areas') Protected plants under the NC Act (if any are found)
Low constraint area	All petroleum activities[4]	• Koala dispersal habitat • Echidna (NC Act - Special least concern) habitat Previously cleared areas with non-remnant vegetation with limited potential to contain MNES or MSES and its habitat

Table 8: Summary of activities permitted in each constraint category for the Atlas 3 Gas Project

Constraint category	Low impact petroleum activities	Linear infrastructure	Well pads	All petroleum activities
No-go area	No	No	No	No
High constraint area	Yes	Yes	No	No
Low constraint area	Yes	Yes	Yes	Yes

Key stages of the constraints protocol are detailed in Table 9 and the process is shown in **Error! Reference source not found.Error! Reference source not found.** Infrastructure layouts are refined at the end of each stage to ensure that infrastructure siting:

- Considers biodiversity values and environmental constraints when selecting preferential locations, aligning with planning principles to avoid, minimise, mitigate and then manage potential environmental impacts;

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[1] Disturbance of MNES and MSES will not exceed identified upper disturbance limits.

[2] Category A and category B environmentally sensitive areas (ESAs) as defined under Schedule 19 of the Environmental Protection Regulations 2019 (EP Regulation) and category C ESAs where defined in the relevant EA.

[3] Avoids field verified population of the threatened Dulacca Woodland snail (*Adclarkia dulacca*) if it is found to occur within proposed disturbance areas.

[4] All petroleum activities will be permitted within the low constraints area, however Koala juvenile and non-juvenile trees and seedlings will be avoided unless avoidable due to other constraints (e.g. environmental features and values, cultural heritage values, geological features, landholder/livestock/ agricultural requirements and existing or planned landholder, utility or community infrastructure).

- Is compliant with EA conditions and State and Federal regulatory requirements;
- Identifies any additional external environmental approvals required and that those are secured prior to the commencement of construction activities; and
- Avoids important populations threatened flora and fauna where feasible, and limits the potential to fragment or isolate populations should they occur within the disturbance area or adjacent areas.

Table 9: - Constraints Protocol Stages

Stage	Inputs/ outputs
Desktop environmental constraints analysis	• Identifying the appropriate external approvals and regulatory permits that the activities must be assessed against; • Assessing the preliminary well locations and linear infrastructure designs against mapped constraints in the GIS, high resolution aerial imagery and the Protocol; Layout refined to minimise impacts to identified constraints
Field Surveys (Scouting)	• Discussions with landholders to identify on-ground constraints (e.g. stock routes) and to confirm preferred location(s) • Survey of infrastructure locations by engineering staff to confirm constructability. • Environmental surveys of infrastructure locations to ground-truth mapped constraints including protected vegetation, fauna habitat, watercourses, prescribed environmental matters, invasive weeds, areas of regional interest etc. • Cultural heritage clearance of infrastructure locations Layout refined to minimise impacts to identified constraints
Post-survey environmental constraints analysis	• Update the constraints category mapping, if required; • Confirm any disturbance exclusion or “no-go” areas; • Within high constraint areas, identify individual MNES habitat areas to be avoided, using the prioritisation hierarchy; • Within low and high constraint areas preferentially avoid habitat features using the following priority: o Hollow-bearing trees and large hollow logs o Koala food trees o Mistletoe o Gilgai o Termite mounds and raptor nests o Other habitat such as decorticating bark and rock piles. • Determine whether any secondary approvals (e.g. protected plant clearing permits) need to be secured prior to commencing construction activities; and • Determine other construction-related environmental requirements and controls such as watercourse crossing design requirements or requirements for on ground spotter/catcher during first disturbance works. Layout refined to minimise impacts to identified constraints

Stage	Inputs/ outputs
Environmental constraints reporting	Formal report to close out the process which documents: • That infrastructure siting complies with relevant environmental approval conditions including planning considerations and any disturbance/clearing limits; • That infrastructure siting complies with requirements of relevant regulations and secondary approvals; • The extent of disturbance and any impacts on MSES and MNES and that the relevant approval allows for the proposed extent of disturbance; and • Site-specific or construction-related environmental considerations and controls.

4.3.1 Incorporation of the protocol into Management Procedures

Senex requires that proposed project infrastructure must be approved through Access to Work (ATW) process - a series of functional endorsements culminating in the key "Access to Work" approval. Among other things, this approval confirms that infrastructure locations are consistent with the constraints protocol.

The ATW Process is a strict internal process to select and approve location of wells, infrastructure and field activities and is summarised in Figure 5.

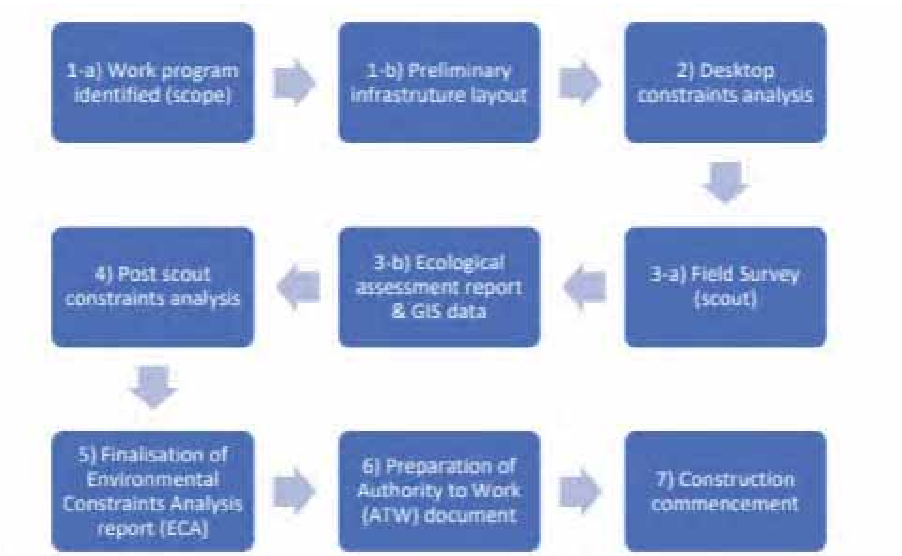


Figure 5: Constraints Protocol

4.4 Decommissioning

Decommissioning of Project infrastructure will be undertaken in accordance with Senex's Rehabilitation Plan and the relevant provisions of the Petroleum Legislation, EP Act and EA conditions.

The timing and works undertaken as part of rehabilitation activities will be dependent on the activity type and operational stage of the project and governed by EA requirements. Given the nature of the activities that are the subject of this EA application, and that the activities involve the construction and operation of infrastructure, much of the disturbance is longer-term requiring decommissioning and rehabilitation at the end of project life.

Infrastructure constructed by Senex will be removed from site except where it is to remain with the written agreement of the landholder.

Rehabilitation will be undertaken when the area for infrastructure, laydowns, hardstands or stockpile areas is no longer required for operational activities. Rehabilitation is further discussed in Section 4.6.

4.5 Rehabilitation

Senex proposes to adopt the SMCs for rehabilitation of the proposed infrastructure. Rehabilitation will be undertaken in accordance with Senex's Rehabilitation Plan Atlas Stage 3 Gas Project (SENEX-ATLS-EN-PLN-018) which addresses the requirements of the rehabilitation SMCs.

The objectives of rehabilitation are to achieve agreed final land uses that are:

- Safe to humans and wildlife
- Stable and non-polluting
- Re-profiled to contours consistent with the surrounding landform.

Proposed rehabilitation measures are summarised in the following sections.

4.5.1 Transitional Rehabilitation

Transitional rehabilitation (also known as reinstatement or partial rehabilitation) will be undertaken on disturbance associated with ongoing operational activities where part of the disturbed area is no longer required.

The aim of transitional rehabilitation is to stabilise disturbed land during the operational phase, thereby minimising potential impacts on surrounding EVs (e.g. minimising erosion and potential for weed establishment). Transitional rehabilitation will generally involve re-contouring the land surface if required, replacing topsoil, and direct seeding groundcover species (pasture or native grasses depending on the final post-disturbance land use) or allowing natural recruitment of plant species, with ongoing maintenance where required.

4.5.2 Final Rehabilitation

Final rehabilitation will be undertaken once the site is no longer required for operational activities and may involve:

- Remediating any contamination;
- Re-contouring the landform;
- Replacing subsoil and topsoil;
- Ripping as required; and
- Direct seeding pasture grass or native grass, or allowing natural recruitment of plant species.

4.6 Waste Management

4.6.1 Environmental Values

Within the project area and surrounds, solid and liquid wastes are generated from domestic and commercial premises as well as agricultural, industrial and resource activities. These wastes comprise general, recyclable and regulated wastes.

Although there are currently no prescribed EVs for waste management, those previously prescribed under the Environmental Protection (Waste Management) Policy 2000 (repealed) provide some guidance on the matter. The former EVs for waste were:

- the life, health and wellbeing of people;
- soil, air, and surface and groundwater quality; and
- land use capability, having regard to economic considerations.

4.6.2 Emissions and Releases

Wastes generated from construction and operational activities comprise:

- General waste - those not defined as regulated waste under legislation. General wastes comprise putrescible wastes (easily decomposed, recyclable by composting) and non-putrescible wastes (not easily decomposed, may be recyclable);
- Recyclable waste – this waste type is able to be reconditioned, reprocessed or reused; and
- Regulated waste - regulated wastes are those that require specific controls or actions as defined by legislation. Listed, hazardous, regulated, controlled or trackable wastes typically have unique handling and disposal requirements in order to manage specific associated hazards.

The Senex Waste Management Procedure details the relevant waste streams and management practices. However, wastes likely to be generated are presented in **Error! Reference source not found.** along with the activity likely to generate that waste and the proposed waste minimisation/management measures to be implemented where practicable. Expected volumes of waste will be determined further into the engineering design process associated with construction and operational activities.

Table 10: Waste Streams and Management

Waste Name	Description	Activity	Minimisation / Management Measures
General Wastes			
Green waste	Whole or parts of trees, bushes, grass or similar produced from vegetation clearing activities	Construction activities	Stockpiled on site or mulched to be spread for rehabilitation and erosion control or placed in surrounding area to provide fauna habitat.

Waste Name	Description	Activity	Minimisation / Management Measures
Domestic wastes	• Food scraps, tea bags, coffee grounds etc. • Food wrappers and packaging • Textile materials • Plastic wrapping films, plastic bags • Facial tissues, ear plugs • Pens and pencils • Polystyrene • Aluminium foil, waxed paper or cardboard • Non-recyclable plastics • No recyclables, hazardous wastes, liquids, chemicals or batteries.	All activities	Disposal to licensed landfill.
Pipeline tape wrap	Pipeline tape wrap protects pipelines against corrosion.	Construction and operational activities	Disposal to landfill.
Timber	Untreated timber derived from packaging and uses that cannot be reused or recycled.	All activities	In order of preference: reuse or recycle or licenced landfill.
Treatment filters and membranes	Cartridge filters generated from water treatment process.	Water treatment	Recycled/reused where practical otherwise disposed to landfill.
Uncontaminated scrap metals and wiring	Uncontaminated scrap metals and wiring. No pressurised cylinders or drums with chemical or oily residue.	All activities	Recycled where practical otherwise disposed to landfill.
Recyclable Wastes			
General Recycling	• Plastic bottles and clean food containers • Glass bottles and jars, milk cartons, aluminium bottles and cans, metal lids from jars, tin cans, plastic and paper cups. • Cardboard and paper packaging • Folders, phone books, envelopes, office paper, magazines, cereal boxes, clean paper towels. • Scrap metals (uncontaminated) • No plastic food wrap or general waste.	All activities	Recycled at local facility wherever practicable.
Intermediate bulk containers	Containers used for transport of fluids and bulk materials.	All activities	Returned to supplier once no longer required.

Waste Name	Description	Activity	Minimisation / Management Measures
Plastic (HDPE)	Waste HDPE includes dam liner material, flowlines and drip tubes from irrigation activities.	Construction and operational activities	Recycle
Scrap Metals	Uncontaminated scrap metals and wiring No pressurised cylinders or drums with chemical or oily residue.	All activities	Recycled at scrap metal recycler.
Regulated Wastes			
Asbestos and Synthetic Mineral Fibre Insulation (SMF)	Asbestos can be found in materials such as lagging, insulation, gaskets and brake pads. Examples of SMF include waste insulation and rock wool.	All activities	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	Recycling facility
Chemical waste and chemical containers (including plastic fuel, and lubricant containers)	Chemical wastes may include herbicides, pesticides, water treatment chemicals (biocides), paint and 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	Recycle
Contaminated soil	Contaminated soils are generated where local spills of hydrocarbons and other contaminants may occur.	All activities	Regulated – Treated or regulated landfill General – re-use
Cooking oil	Waste cooking oil is generated from kitchen facilities at camps.	Incidental activities	Recycle
Grease trap waste	Grease trap waste is generated from kitchen facilities at camps.	Incidental activities	Treated at licensed facility
Medical and clinical waste	Sharps and biohazard wastes are generated at camps during routine medical care and treatment.	Incidental activities	Treated at licensed facility
Oily filters, rags, absorbents	Oily filters, rags and absorbents are generated from routine equipment and vehicle servicing, repair and filter changes.	All activities	Recycle
Triethylene Glycol / Glycol / coolant	Waste Triethylene Glycol / Glycol / coolant are generated from vehicle and equipment fluid changes, and as part of the gas dehydration process.	Construction and operational activities	Treated at licensed facility
Tyres	Tyres and tubes are generated from tyre changes on work vehicles and equipment.	All activities	Licensed facility - recycle
Used spill kits	Used spill kits are generated from spill clean-up of chemicals and hydrocarbons.	All activities	Regulated landfill

Waste Name	Description	Activity	Minimisation / Management Measures
Waste oil (clean waste oil)	Small quantities of waste oil are generated routinely from vehicle and equipment oil changes.	All activities	Recycle

5 General Environment

5.1 Background

PLA 1127 is located immediately north and east of the Senex owned and operated PL 1037 (Project Atlas) and immediately west of the Senex owned and operated PL 209 and PL 445. The project area is approximately 44 km north of the Warrego highway, between the townships of Wandoan and Wallumbilla and lies within the Maranoa Regional Council Local Government Area.

None of the eight identified Lot/Plans that cover the Project Tetris area (Figure 6, and Table 5) are listed in the EMR or CLR.

Due to the character of the location, ambient noise levels are low and typical of rural areas. Ambient air quality is typical of rural airsheds and exhibits no exceedances of the relevant EPP Air criteria.

5.2 Bioregion, Topography and Soils

This site falls within the Southern Downs subregion of the Brigalow Belt bioregion and is drained by the Fitzroy River Basin.

The project area is characterised by floodplains and undulating hills with elevations of between 250 and 300m above sea level and slopes downwards to the north.

Soils from the project area comprise hard pedal yellow duplex soils in floodplain and grey self-mulching cracking clays on the undulating hills. Acid sulphate soils are not present in the Project Tetris area.

5.3 Vegetation

PLA 1127 and much of the surrounding area has been extensively cleared and converted to non-native pasture for livestock grazing. These areas tend to be dominated by native and introduced grasses, notably Buffel Grass (Cenchrus ciliaris) and Sabi Grass (Urochloa mossambicus).

Areas of remnant vegetation are generally limited to small, isolated woodland fragments and narrow, discontinuous corridors of remnant and regrowth vegetation bordering watercourses and drainage lines. These riparian woodlands are dominated by Queensland Blue Gum (Eucalyptus tereticornis) with some fringing areas of Poplar Box (Eucalyptus populneus), Brigalow (Acacia harpophylla) and Belah (Casuarina cristata).

5.4 Climate

The area surrounding Project Tetris is subject to a humid subtropical climate with warm to hot summers and mild, dry winters.

Monthly statistics from the Bureau of Meteorology monitoring station at Taroom Post Office (site number 035070) show that mean maximum temperatures range from 21.2°C in winter to 33.9°C in summer. Extremes of recorded temperatures have ranged from -5.6°C to 45.3.

Rainfall is relatively low throughout the year with the mean annual rainfall being 668mm. The highest rainfalls occur during the summer months and reduce over autumn into winter. The highest recorded monthly rainfall between 1870 and 2022 was approximately 421mm in February 1954.

5.5 Watercourses and Wetlands

The project is located in the headwaters of the Upper Dawson River sub-Basin, part of the Fitzroy River Basin. Wandoan Creek traverses the centre of PLA 1127 from west to east. A number of smaller tributaries and/or drainage lines run north or south to join it in the western half of PLA 1127. Woleebee creek runs along the eastern boundary of PLA 1127 in a northerly direction (Figure 7). Both of these creeks are mapped as terrestrial GDEs with moderate confidence and are identified as surface GDEs which are mapped as moderate confidence for 'Quaternary alluvial aquifers overlying sandstone ranges with fresh, intermittent groundwater connectivity regime'.

Watercourse flows within the project area are characteristically ephemeral, episodic in nature and typically generated only due to significant rainfall events. Very few of the waterways within the area retain pooling water during dry periods.

There are no High Ecological Value wetlands identified within the area.

5.6 Sensitive Receptors

No sensitive receptors have been identified within 1km of PLA 1127 (**Error! Reference source not found.**).

Figure 6: Project Tetris Lot/Plan details

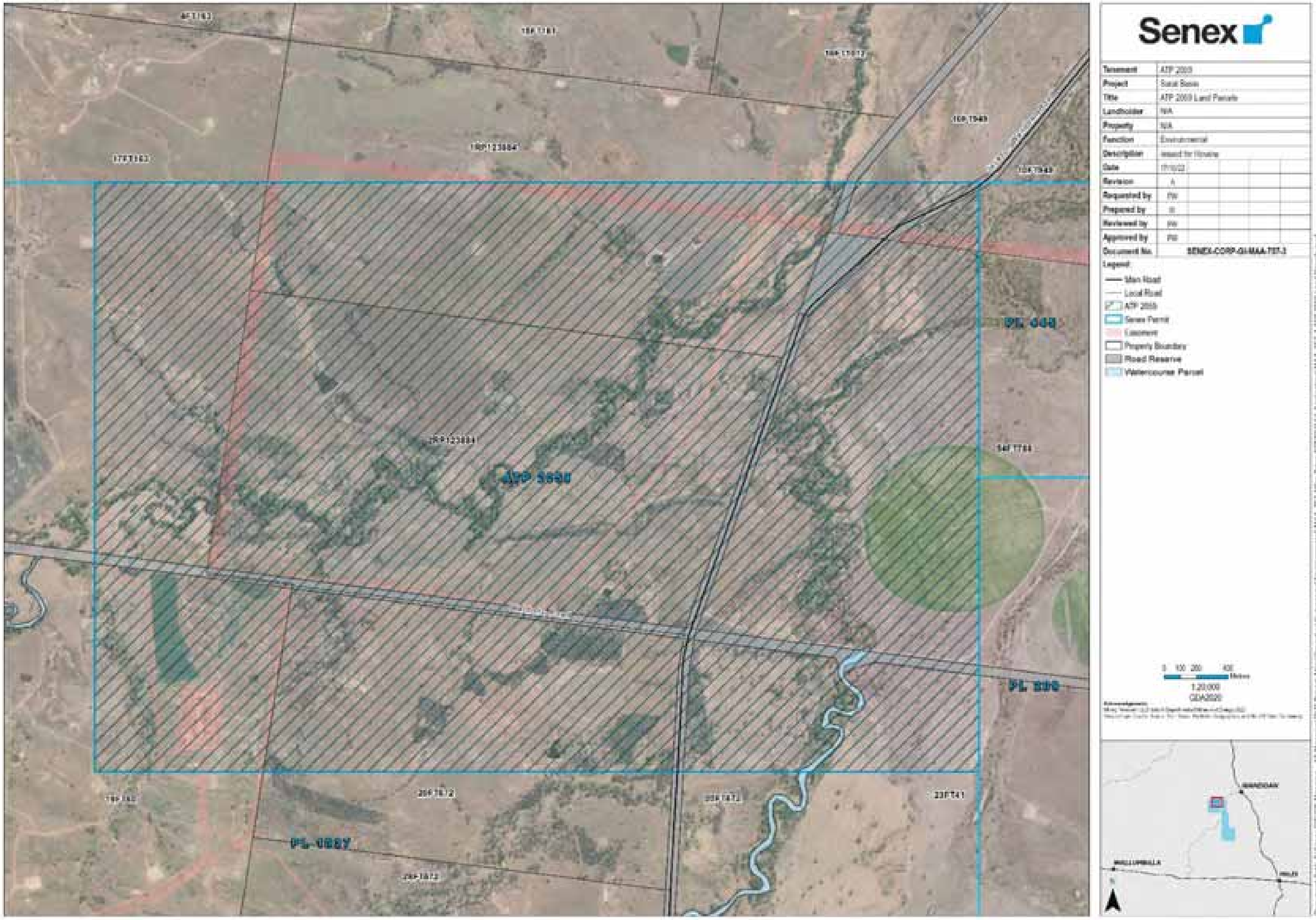


Figure 7: Project Tetris Watercourses

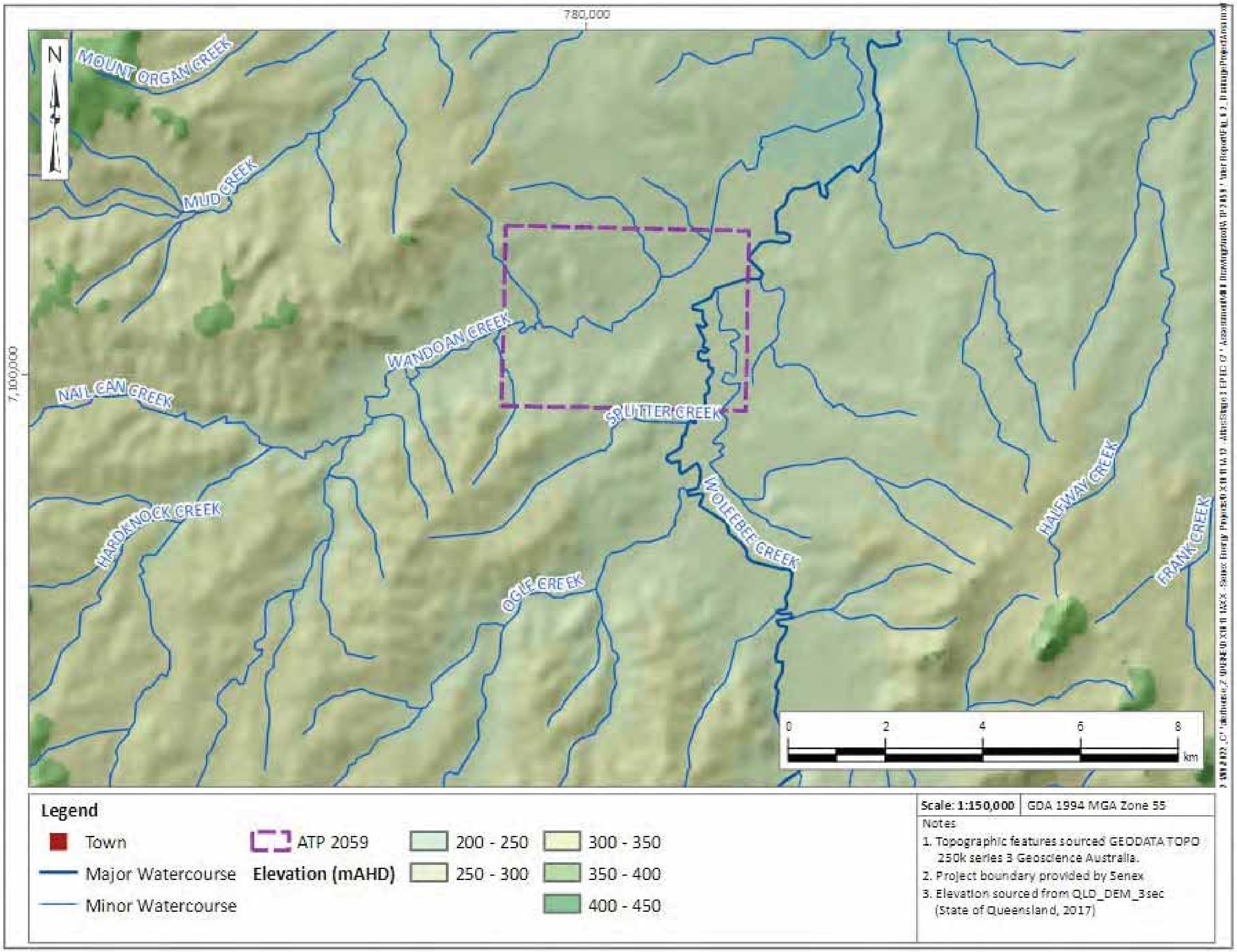
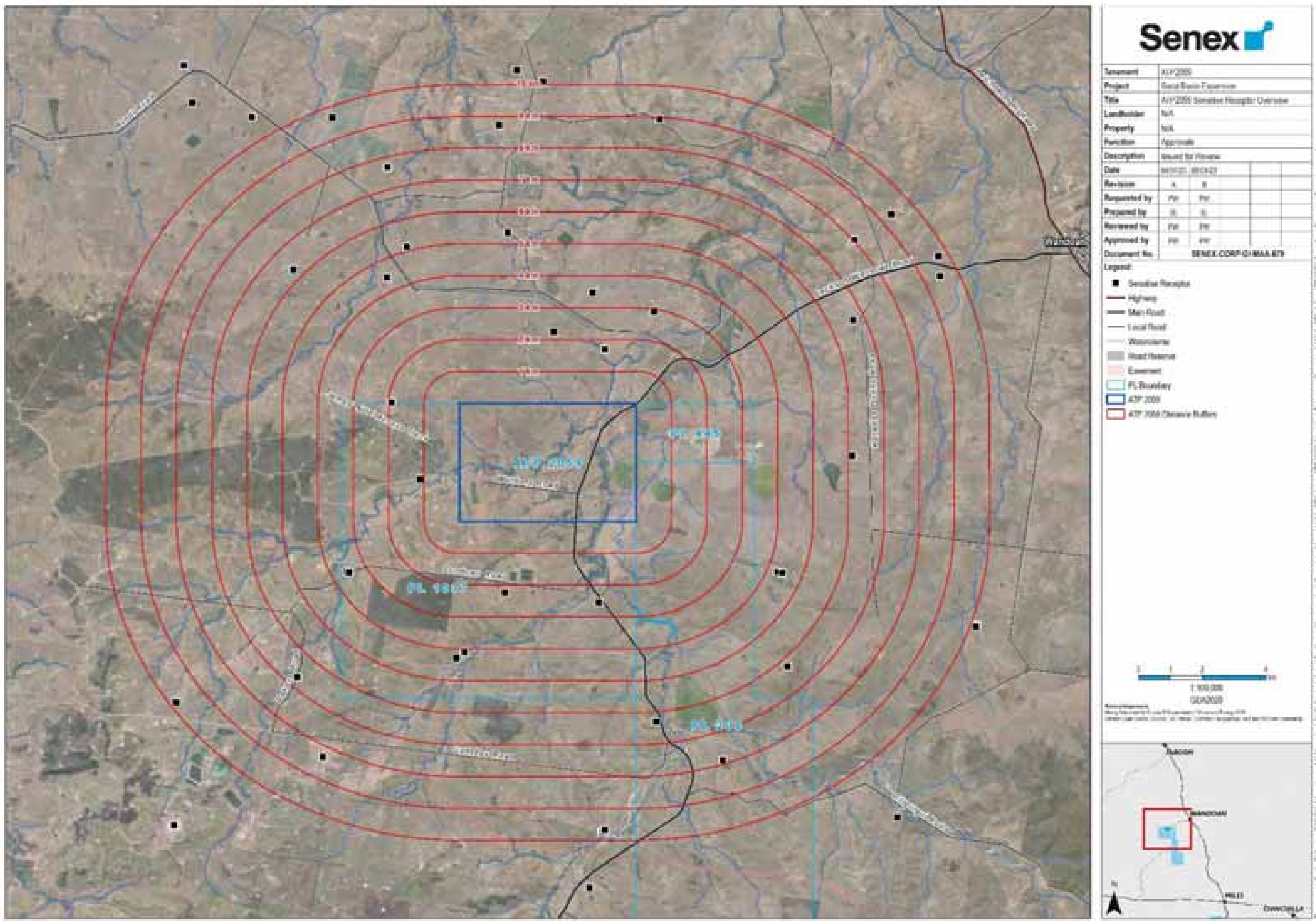


Figure 8: Sensitive receptors within 10km of PLA 1127



6 CSG Water Management

A CSG Water Management Plan (CSG WMP) has been developed for ATP 2059 in line with Queensland regulatory framework provided by the:

- *Environmental Protection Act 1994*;
- *Petroleum and Gas (Safety and Production) Act 2004*;
- *Water Act 2000*;
- Environmental Protection (Water) Policy 2009; and
- CSG Water Management Policy 2012 established under the EP Act.

This plan is reproduced in full as Appendix C and has been summarised in the following sub-sections.

6.1 Produced Water Volumes

Produced water volumes and rates have been modelled using Senex's analytical reservoir model, with probabilistic distributions applied to several key reservoir parameters (i.e., permeability, porosity, and net coal) to generate well type curves and water production forecasts. Some uncertainty is inherent in any analytical model, and reservoir models can initially over-predict water production due to factors including sensitivity to assumed porosity. Further certainty will be gained as CSG wells are drilled and tested as part of appraisal programs and as field development proceeds.

The forecast CSG water production profile for Project Tetris is provided below in Figure 9 and annual volumes and cumulative totals are provided in Figure 10.

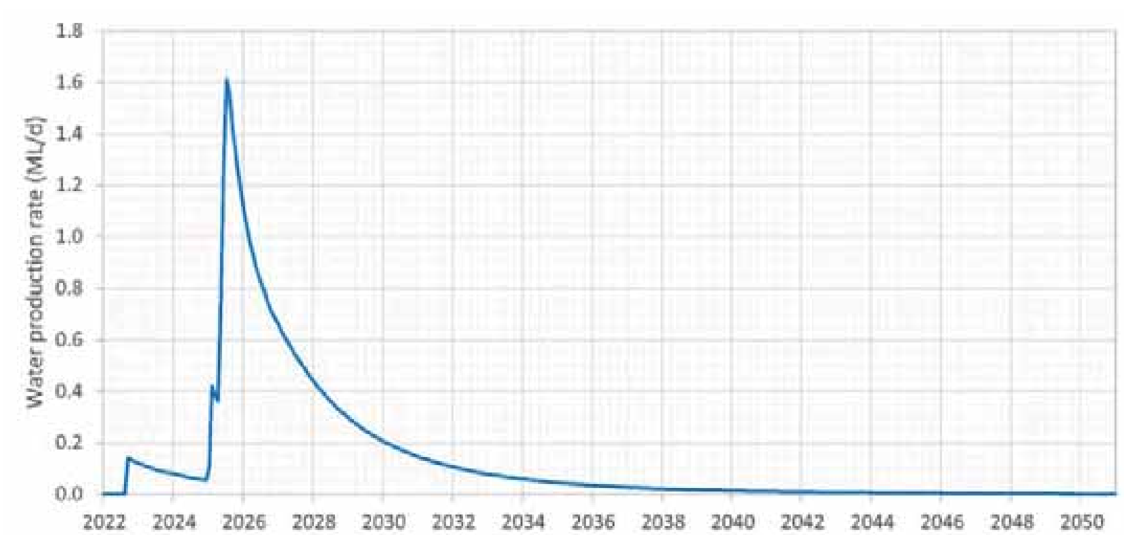


Figure 9: Project Tetris Forecast Water Production

Peak water production is forecast to be about 350 ML in 2026 at a daily rate of about 1.6 ML/d. The total volume of water forecast to be produced over the project lifespan (about 30 years) is 1.4 GL.

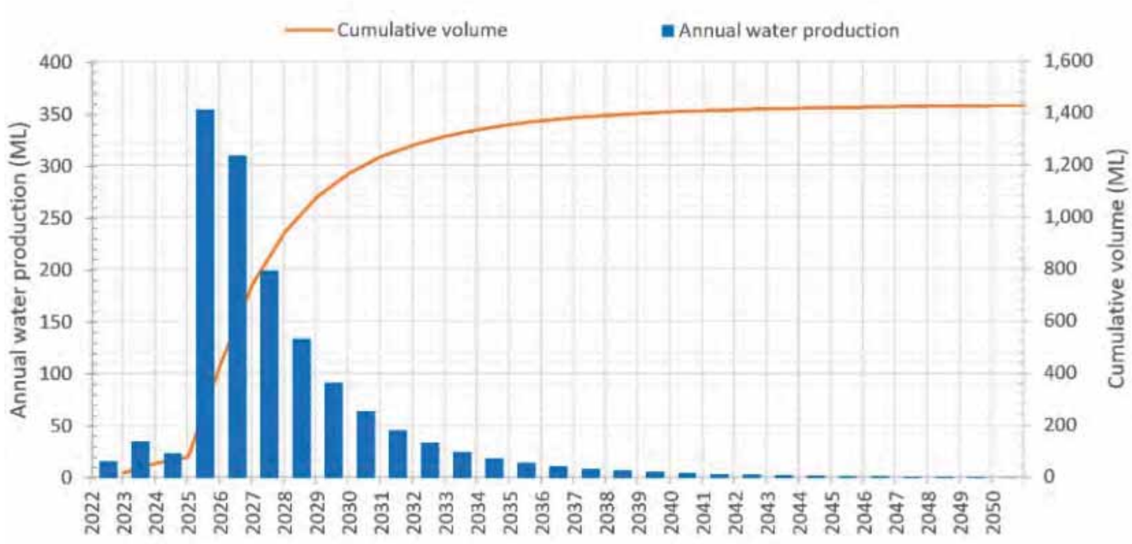


Figure 10: Project Tetris Annual Water Production

6.2 CSG Water Quality

There is currently no water quality data for the Walloon Coal Measures (WCM) from the project area, but information is available from the Office of Groundwater Impact Assessment (OGIA). A summary of the regional characteristics associated with the WCM are as follows:

- The produced water quality from the WCM can vary from fresh to saline;
- OGIA (2016a) indicate that in general, the total dissolved solids (TDS) of the WCM within the Surat Cumulative Management Area (CMA) ranges from 30 to 18,000 mg/L, with a mean TDS of 3,000 mg/L; and
- OGIA (2016a) also report that available samples from existing CSG bores in the Surat CMA at significant depth show distinct characteristics with negligible concentrations of calcium, magnesium and sulphate, and higher concentrations of sodium and fluoride, compared with the other formations.

Groundwater results from 24 WCM samples obtained from the groundwater database (GWDB) within 25km of PLA 1127 are presented in Table 11.

Table 11: Summary of WCM Water Quality Data from GWDB samples within 25 km of ATP 2059

Parameter	Unit	Count	Min	Max	Median	Average
EC	µS/cm	12	1,900	13,400	8,010	7,310
pH	-	15	5.5	8.8	7.7	7.7
Sodium Adsorption Ratio (SAR)		24	7.6	171	81	81
TDS	mg/L	18	883	17,733	5,176	5,645
Sodium	mg/L	24	262	6,860	2,024	2,651
Potassium	mg/L	4	4.3	16.3	5.9	8.1
Calcium	mg/L	24	7.9	344.3	33.5	81.1
Magnesium	mg/L	24	2.9	162.9	10.7	31.4
Bicarbonate (HCO_3)	mg/L	16	30	862	512.0	512.3
Carbonate (CO_3)	mg/L	12	15	343.2	198.8	168.1
Chloride	mg/L	24	375	11,454	2,904	4,014
Fluoride	mg/L	15	0.2	2.2	0.8	0.9
Sulphate	mg/L	16	1.0	57	4.0	8.7

6.3 CSG Water Management Strategy

The CSG water management strategy involves existing Project Atlas infrastructure including brine and produced water storages, such as aggregation dams and brine tanks, and irrigation dams. Proposed infrastructure may include water gathering systems from the producing wells and additional CSG water storage or brine dams. The CSG WMP (Appendix C) includes reference to potential water management infrastructure within the project area. However, this is intended to cover potential future scenario's and is not required at this point in time. Should water management infrastructure need to be located in the project area, Senex will submit a separate EA amendment application seeking its authorisation.

A schematic of the water management infrastructure required is presented in Figure 11.

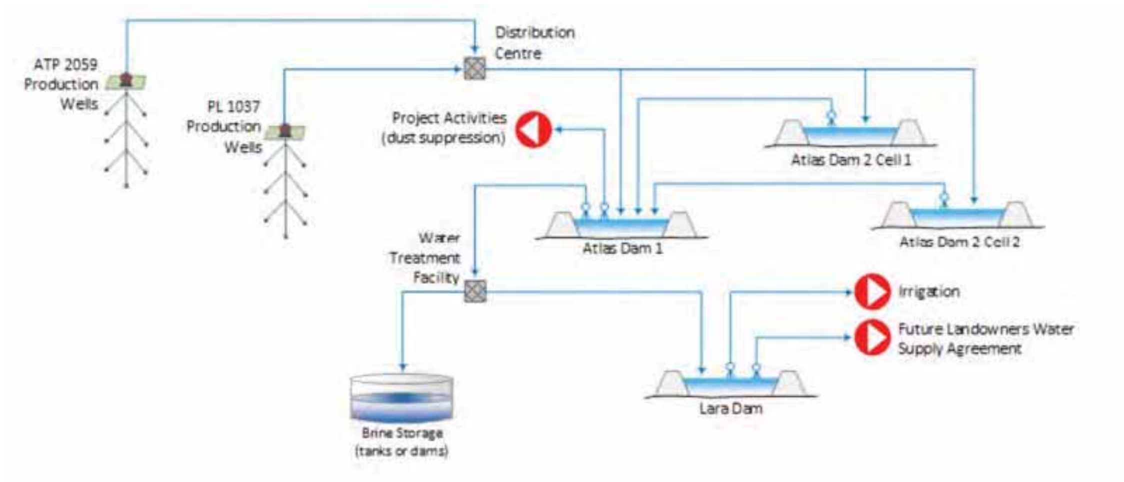


Figure 11: Water Management Infrastructure Schematic (ATP 2059 and PL 1037)

6.4 Operational Water Management infrastructure

As shown in Figure 11, produced water is aggregated into existing dams on PL 1037 where it may be used for project activities (e.g. dust suppression) or transferred to an existing third party owned and operated water treatment facility (WTF) also located on PL 1037. Produced water may in future also be stored and treated at locations on PL 209 that are yet to be constructed.

The WTF uses the following processes to remove salts and other impurities from the produced water stream:

- Pre-filtration
- Pre-treatment pH adjustment
- Membrane filtration
- Reverse osmosis
- Calcium addition

Treated water for irrigation will be transferred (via water transmission pipelines) to third party irrigation dam(s) (~50-200ML each) on PL1037 and/or PL209 in accordance with relevant End of Waste codes. Untreated produced water may also be blended with permeate where possible without compromising the ability to use the water for irrigation purposes.

6.4.1 Water Management Options

As previously mentioned, Senex currently supplies permeate for irrigation purposes and makes use of untreated produced water for project activities.

Both of the above options are considered beneficial uses of the water and as such meet the management intent of the Coal Seam Gas Water Management Policy (DEHP, 2012).

Where opportunities present themselves, Senex will continue to prioritise the beneficial use of produced water though either Landholder water supply agreements or continued use for project activities, including in immediately adjacent Senex owned tenures.

6.5 Brine Management

Based on a worst-case estimate, which does not include the beneficial re-use of untreated produced water, and a median salt concentration of 5,176 mg/L TDS, it is anticipated that about 5 tonnes of salt per ML will be generated via the Atlas WTF.

Brine from the Atlas WTF will be stored in existing brine tanks from where it will be further concentrated via solar evaporation to a concentrated slurry or solid salt.

Where appropriate, salt or salt slurry will be disposed of at a regulated waste facility (Salt Encapsulation Facility) as per the option currently considered most viable in the Coal Seam Gas brine management–action plan 2023 - 2033.

6.6 Measurable Criteria

Senex will implement all produced water and brine management strategies in accordance with the applicable EA conditions and in a manner that ensures protection and maintenance of all relevant EVs.

The EP Act 1994 requires that a site-specific application for a CSG activity must include measurable ‘criteria (termed 'management criteria, against which the applicant will monitor and assess the effectiveness of the management of all produced water and saline waste associated with the activity. Senex has developed criteria that addresses this requirement (the criteria have been developed following guidance outlined in the DES factsheet ‘CSG water management: Measurable criteria’ (DES 2013).

The management criteria (Table 12) addresses:

- The quantity and quality of the water:
    - Used;
    - Treated;
    - Stored; or
    - Disposed of.
- Protection of EVs affected by each relevant CSG activity; and
- The disposal of waste generated from the management of water.

Table 12: Water Management Criteria

Objective	Environmental Value	Tasks	Performance Indicator
No unauthorised disturbance of ESAs due to CSG water management activities	• Surface water • Land	• Secure disturbance approvals by implementing the 'Environmental Management Plan Atlas Stage 3 Gas Project' (SENEX-ATLAS-EN-PLN-015) and 'Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development' (SENEX-ATLS-EN-PLN-001). • Finalise infrastructure locations to identify area and location of disturbances. • Comply with EA conditions related to disturbance, biodiversity values and ESAs.	• Site-specific Ecology Assessment Reports • • Site-specific Desktop Constraints Reports • • Compliance with extent of approved disturbance
No unauthorised releases to the environment from the gathering network	• Groundwater • Surface water	• Select gathering routes by implementing the 'Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development' (SENEX-ATLS-EN-PLN-001_rev1). • Implement the 'Environmental Management Plan Atlas Stage 3 Gas Project' (SENEX-ATLAS-EN-PLN-015) • Develop and implement operation and maintenance plans for gathering networks. Ensure plans includes: • Operational procedures for infrastructure associated with isolation, leakage detection and venting / draining for the CSG production wellhead and gathering network; and • Monitoring procedure for wellhead and gathering network infrastructure. • Implement Senex Incident Reporting and Investigation Procedures.	• Recorded volume of unauthorized leaks / spills • Recorded detection of unauthorised leaks (i.e., groundwater level rise, groundwater quality changes) • Recorded number of incidents and associated investigations

Objective	Environmental Value	Tasks	Performance Indicator
No unauthorised releases to the environment from non-regulated structures storing CSG water	• Groundwater • Surface water	• Design, construct and operate all regulated structures in accordance with the requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DES 2016a). • Develop and maintain a regulated structure register. • Develop and implement a monitoring program to assess structure integrity and groundwater seepage. • Develop and implement a rehabilitation plan for specific regulated structures, including, if required, a brine and salt management plan. • Undertake assessment and reporting in accordance with EA requirements	• Recorded volume of unauthorised releases from regulated structure • • Compliance with requirements of the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DES 2016) • • Recorded detection of unauthorised leaks (i.e., • groundwater level rise, groundwater quality changes) • • Recorded number of incidents and associated investigations
Maximise the beneficial use of CSG water	• Groundwater • Surface water • Land	• Maintain the analytical reservoir model to predict the quantity and quality of water over the duration of ATP 2059 development. • Develop and maintain a project water balance model to optimise the size of water management infrastructure and predict changes in water quality to support the water management strategy. • Prioritise water use in accordance with the hierarchy defined in the CSG Water Management Policy (DEHP 2012). • Develop and implement a Water Quality Monitoring Program to confirm if water is fit for beneficial use. • Determine requirement for a WTF.	• Proportion of untreated CSG water beneficially used. • • Proportion of treated CSG water beneficially used. • • Monitoring data which are within the appropriate guidelines for relevant water quality objectives for the designated beneficial use.

Objective	Environmental Value	Tasks	Performance Indicator
Optimise CSG water and brine management	• Groundwater • Surface water	• Maintain the analytical reservoir model to predict the • quantity and quality of water over the duration of ATP 2059 development. • Develop and maintain a project water balance model to optimise the size of water management infrastructure and predict changes in water quality to support the water management strategy. • Continue to investigate opportunities for CSG water and brine management and prioritise these options in accordance with the CSG Water Management Policy (DEHP 2012). • Undertake ongoing assessments of optimisation options for CSG water and brine management.	

7 Surface Water and Aquatic Ecology

An assessment of potential impacts to surface and groundwater from the project has been completed by Klohn Crippen Berger (KCB 2023) and is provided as Appendix E. The findings of this report are summarized in the following sub-sections.

Where required, additional information has also been drawn from the ERM, 2023 ecology report (Appendix F).

7.1 Methodology

An aquatic ecology assessment was undertaken by ERM for the Project in 2022 and Freshwater Ecology (Freshwater Ecology 2022a), with the findings from both presented in Appendix F. This included surveys of Woleebee and Wandoan Creeks. Aquatic ecology surveys were also undertaken by Hydrobiology on PL 1037 in 2018 along reaches of Woleebee Creek to the west of ATP 2059 (KCB 2018a).

7.1.1 Desktop assessment

A desktop literature review and assessment were undertaken using the following data sources:

- Identification of Gaining Steams in the Surat CMA; Hydrogeological Investigation Report (OGIA 2017b).
- Environmental Protection Policy (Water) 2009 – Dawson River Sub-Basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Dawson River Sub-basin except the Callide Creek Catchment (State of Queensland 2011).
- DSITI Queensland Groundwater Dependent Ecosystem Mapping (State of Queensland 2018), which indicates the locations of potential groundwater dependent ecosystems (GDEs) at a catchment scale (both surface expression and terrestrial).
- The Queensland Spring Database provides a comprehensive catalogue of springs and potential GDEs at fixed locations in Queensland. The Queensland Spring Database is updated annually (Queensland Herbarium 2021).
- Queensland groundwater bore database (GWDB) for registered water bore data from private water bores and Queensland Government groundwater investigation and monitoring bores (OGIA 2022).
- Springs in the Surat CMA (OGIA 2016).

7.1.2 Field Surveys

Field work was undertaken to confirm the existing environment and EVs across the Project. A summary of these programs is provided in Figure 12 and Table 13Figure .

Figure 12: Aquatic Ecology survey sites

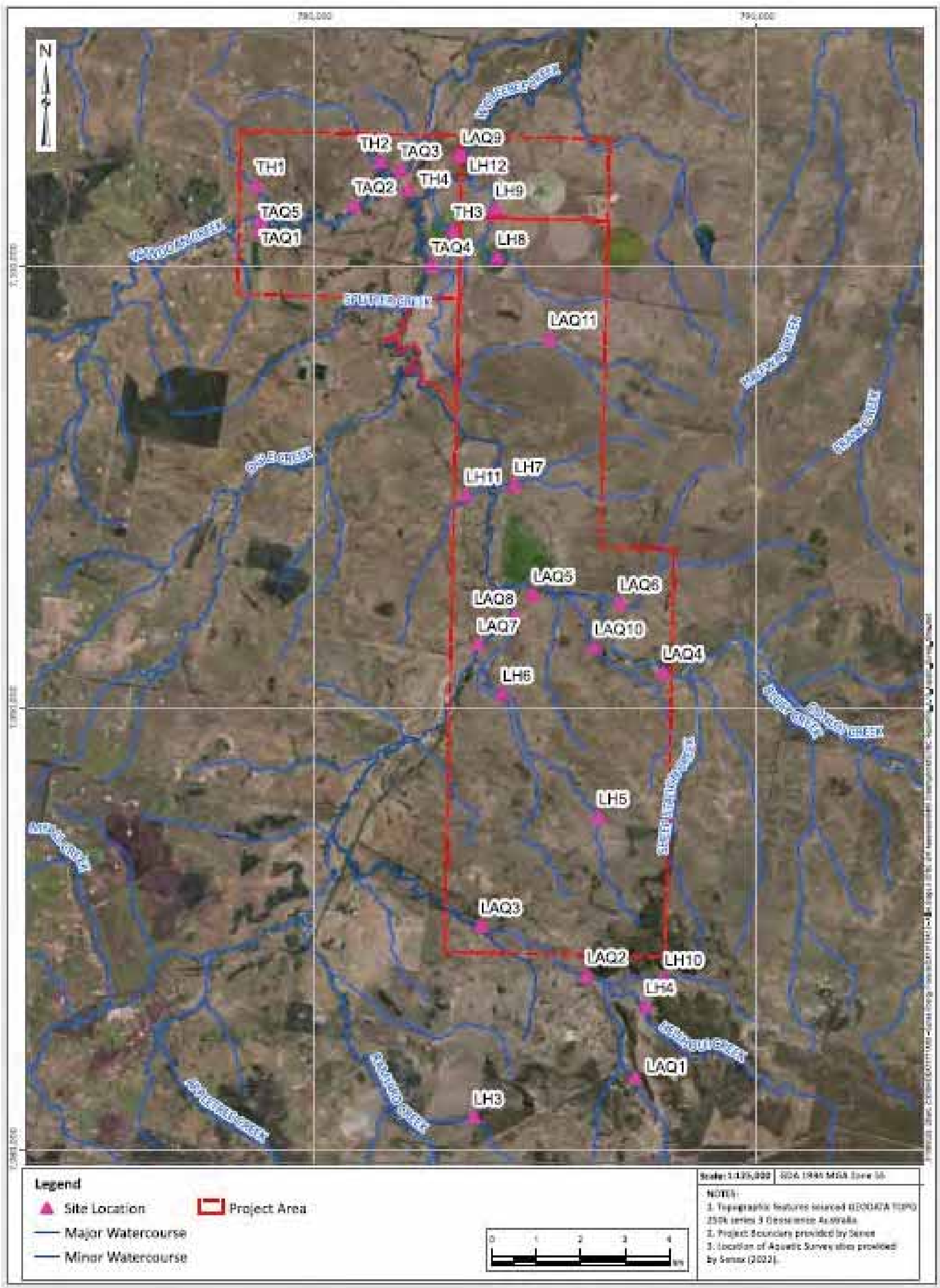


Table 13: Field Surveys and Methodology

Assessment	Category	Methodology	Relevant Guideline
Field Verification Mapping (including GDE Mapping)[5]		Verification of mapped REs	Queensland Herbarium Regional Ecosystem Description Database (REDD)
Stygofauna		Biota sorting and identification	Monitoring and Sampling Manual: Environmental Protection (Water) Policy (DES 2018)
Aquatic Ecology Survey	Habitat Assessment	Physical characteristics Habitat features	AUSRIVAS Sampling and Processing Manual (DNRM 2001)
	Aquatic Flora	Visual observation and identification	
	Macroinvertebrates	Dip net sampling Kick-sampling	AUSRIVAS Sampling and Processing Manual (DNRM 2001)
	Fish, Macrocrustaceans and Turtles	Fyke nets, backpack electrofishing and unbaited boxes.	Monitoring and Sampling Manual: Environmental Protection (Water) Policy (DES 2018) Australian Code of Electrofishing Practice (NSW Fisheries 1997)

7.2 Existing Environment

The Project area is located within the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin. The Fitzroy River Basin is the second largest externally drained basin in Australia and the largest on the eastern coast of the continent. Covering an area of 150,000 km^2, the basin contains several significant tributaries, including the Nogoa, Comet, Mackenzie and Dawson Rivers. The basin discharges into the Coral Sea east of Rockhampton.

The Dawson River sub-basin is heavily influenced by anthropogenic pressures including land use, riparian management, water infrastructure and point source pollution; and is also highly modified as a result of agricultural and grazing practices. The condition of land immediately adjacent to reaches within the State of River study (Telfer, 1995) is typically rated as being in poor to moderate condition (89% of reaches).

The divide between the Upper Dawson River sub-basin and the Condamine-Balonne Rivers sub-basin is located ~22 km to the south of the Project area.

Watercourse flows in the Project area are characteristically ephemeral and episodic in nature, and typically generated only due to significant runoff events. This is likely a consequence of the catchments being in the uppermost reaches with limited runoff area. There are no identified third-party surface water users in the vicinity of the Project.

[5] Field verification for the Project Area could not be undertaken due to wet weather. However, field verification was completed for PL1037 in 2018 (KCB, 2018) which included upstream Woleebee and Wandoan Creek which has similar characteristics to those reaches of these creeks in the Project area.

7.2.1 Surface Watercourses

Key watercourses within the vicinity of the Project area (Figure 14Figure) include:

- Wandoan Creek, which flows southwest to northeast centrally across the ATP 2059, it joins Woleebee Creek ~7.5 km to the northeast of ATP 2059.
- Woleebee Creek, which flows north from its headwaters flanking the eastern boundary of the Project area to join Juandah Creek ~15 km to the northeast. The Project area lies almost entirely within the sub-catchment of Woleebee Creek.

There are no Queensland Government surface water flow gauges within the Project area. However, one flow gauge (130344A – Juandah Creek at Windermere) is located ~16 km north of the Project area within Juandah Creek (Figure 6.1), downstream of the confluence between Woleebee Creek and Juandah Creek. Gauge data were available from October 1974 to June 2022 and shows:

- highest average daily flows occur between November and February each year with the lowest flows in June to August.
- flows are present ~40% of the gauged period, and
- the discharge is greater than 500 ML/d for ~5% of the gauged period.

This data highlights the ephemeral nature of Juandah Creek and that it is likely to flow only during and after significant runoff events. Based on this, it is expected that Wandoan and Woleebee Creek are also ephemeral and would typically flow only during significant runoff events.

7.2.2 Wetlands

The Directory of Important Wetlands in Australia (Environment Australia 2001) lists two nationally important wetlands in the Dawson River sub-basin located to the north of ATP 2059:

- Boggomoss Springs is approximately 95 km downstream of the Project (northeast): a 400-ha lacustrine / palustrine wetland with approximately one-third of its area artificially or highly modified, and the remainder of the area riverine; and
- Palm Tree and Robinson Creeks wetland areas (50,274 ha) comprise 155 lacustrine and palustrine wetlands. These wetland areas are located 80 km north (downstream) of the Project.

A review of the Project area on the DES 'Wetland Info' website (State of Queensland 2022b) identifies the following wetland types along the watercourses and riparian corridors mapped within the Project area (Figure):

- Palustrine wetlands (vegetated, non-riverine or non-channel systems) mainly associated with floodplains;
- Lacustrine wetlands (dominated by open water) identified as mainly artificial or modified dams or weirs in channels; and
- Subdominant wetlands along Wandoan and Woleebee Creeks, identified as Coastal/ Sub-coastal floodplain tree swamps (Melaleuca and Eucalypt).

7.2.3 Surface Water Quality

Available surface water quality data has also been sourced from the Queensland Government for the gauge at Juandah Creek (at Windermere). Data are available between 1985 and 2022 and summarised in Table 14.

Table 14: Summary of Water Quality Measured at Juandah Creek at Windermere (130344A)

Parameter	Count	Min	Max	Mean	Standard Deviation
Conductivity @ 25^{o}C (Field)	23	108	865	307	220
Turbidity (NTU) (field)	13	11	2000	379	543
Colour TRUE (Hazex Units)	15	5	86	32	22
pH (pH units) FLD	16	6.8	8.2	7.6	0.4
Total Alkalinity as CaCO3 (mg/L)	22	36	264	100	72
Total Diss. Solids (mg/L)	22	77	588	192	138
Calcium as Ca soluble (mg/L)	22	5	53	17	15
Chloride as Cl (mg/L)	22	8	165	33	38
Magnesium as Mg soluble (mg/L)	22	1	13	4	3
Potassium as K (mg/L)	22	3	10	6	2
Sodium as Na (mg/L)	22	13	148	42	35
Sulfate as SO4 (mg/L)	22	2	22	7	5
Aluminium as Al soluble (mg/L)	12	0	4.2	0.4	1.2
Boron as B (mg/L)	17	0	0.2	0.06	0.05
Copper as Cu soluble (mg/L)	14	0	0.05	0.03	0.02
Fluoride as F (mg/L)	21	0.05	0.2	0.12	0.05
Iron as Fe soluble (mg/L)	21	0	11.5	1.22	2.65
Manganese as Mn soluble (mg/L)	16	0	0.07	0.02	0.02
Silica as SiO2 soluble (mg/L)	21	12	44	21	7
Zinc as Zn soluble (mg/L)	14	0	0.08	0.02	0.02

Source: KCB, 2022

A water quality sample was taken by Senex from a flowing section of Woleebee Creek on February 28, 2023 north of PL 445 along the Jackson-Wandoan Road.

Piper and Durov diagrams have been prepared based on the available water quality data from the Department of Regional Development Manufacturing and Water (DRDMW) gauge downstream of the

Project, and the Woleebee Creek surface water sample (Figure 13)

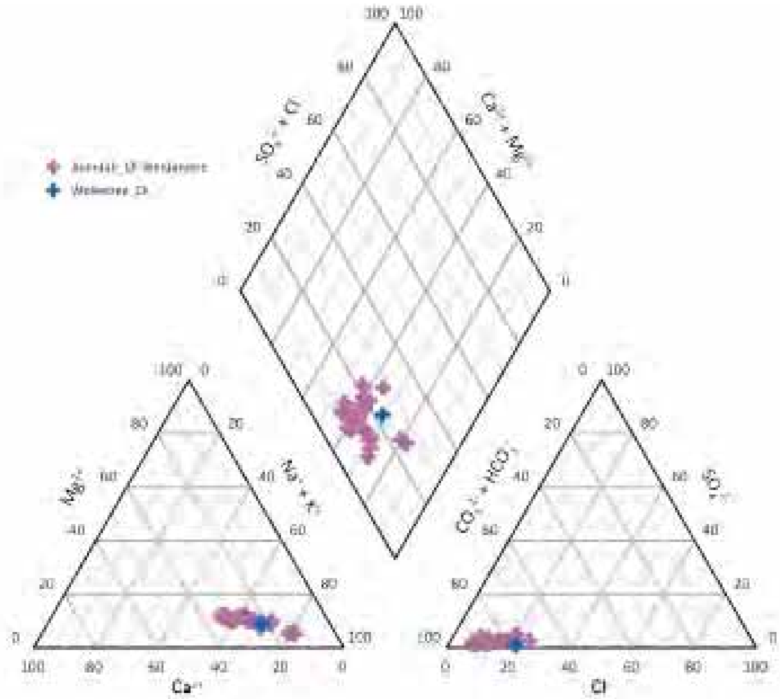
The Woleebee Creek surface water chemistry corresponds with the surface water chemistry from Juandah Creek. The surface water from both the RDMW gauge, Woleebee Creek, and pools at Wandoan Creek are characterised as a sodium-bicarbonate water type, with some sodium enrichment. The electrical conductivity, as shown in Figure 13, ranges between ~110 µS/cm and 865 µS/cm, with a median value of 307 µS/cm.

7.2.4 Surface Water users

Under the Fitzroy Basin Resource Operations Plan (ROP) (State of Queensland 2015), creeks within the Project area are within the Dawson Valley Water Management Area. Within this management area Woleebee, Horse and Juandah Creeks are a tributary of the Dawson N Zone, along the AMTD reach 356.5 to 428.0 (km); and, is described as ‘Upstream limit of Glebe Weir and Eurombah Creek Junction’.

There are no resource operations licence holders in the Dawson N Zone of the Dawson Valley Water Management Area (State of Queensland 2021a). No other surface water users have been identified within the vicinity of the Project.

Figure 13: Piper Diagram (top) and Durov Diagram (bottom) for Surface water Samples from Juandah Creek (130344A) and Woleebee Creek



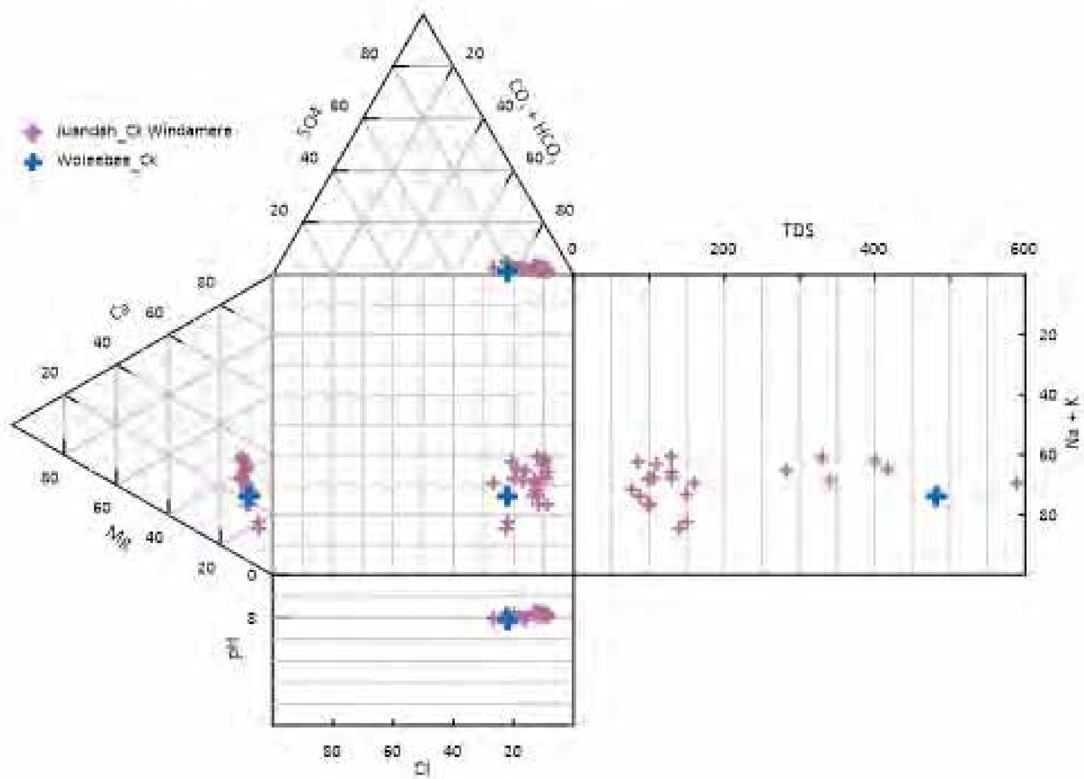

Juandah_Ck Windamere
Woleebee_Ck
TDS
Na + K
pH
Cl

Figure 14: PLA 1127 Watercourses and Wetlands

7.2.5 Environmental Values

The Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (State of Queensland 2019b) provides defined EVs and WQOs for surface and groundwater under Schedule 1 of the policy. The relevant catchments and plans are:

- The Dawson River sub-basin (State of Queensland 2011); and
- The WQ1308 plan (State of Queensland 2013) that accompanies the policy indicates that the Project area is located on the southern tributaries of the Upper Dawson.

Relevant surface water EVs are presented in Table 15 and relevant WQO's are presented in **Error! Reference source not found.**

Table 15: Environmental Values for the Dawson River sub-basin

Water	Environmental Values											
	Aquatic Ecosystem	Irrigation	Farm Supply / Use	Stock Water	Aquaculture	Human Consumer	Primary Recreation	Secondary Recreation	Visual Recreation	Drinking Water	Industrial Use	Cultural And Spiritual Values
Dawson River Sub-Basin												
Upper Dawson Southern Tributaries	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Undeveloped Areas	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓

✓ denotes the EV is selected for protection. Blank indicates that the EV is not chosen for protection.

Table 16: Objectives to Protect Aquatic Ecosystem Environmental Values Under Baseflow

Water Area / Type	Management Intent	Objectives to Protect Aquatic Ecosystem EVs
Waters in HEVa2155 and HEVa2156	Aquatic ecosystem – high ecological value	Achieve effectively unmodified water quality (20th, 50th and 80th percentiles of HEV waters), habitat, biota, flow, and riparian areas. Note: there is insufficient information available to establish effectively unmodified water quality for these waters. Refer to QWQG for details on how to establish a minimum water quality data set for deriving local 20th, 50th and 80th percentiles.
Upper Dawson River Sub-basin waters (WQ1308)	Aquatic ecosystem – moderately disturbed	Macroinvertebrates: –Taxa richness (composite): 12–21 –Taxa richness (edge habitat): 23–33 –PET taxa richness (composite): 2–5 –PET taxa richness (edge habitat): 2–5 –SIGNAL index (composite): 3.33–3.85 –SIGNAL index (edge habitat): 3.31–4.20 –% tolerant taxa (composite): 25–50% –% tolerant taxa (edge habitat): 44–56%

Water Area / Type	Management Intent	Objectives to Protect Aquatic Ecosystem EVs
Upper Dawson River Sub-basin main trunk*	Aquatic ecosystem - moderately disturbed	Native fish species observed/expected (O/E) ratio ≥ 1. Native species found to be present in ≥ 50% of sampling events in main river trunks/channels in this catchment are outlined below (additional native species may also be present): –*Nematolosa erebi* –*Macquaria ambigua oriens* –*Tandanus tandanus* –*Leiopotherapon unicolor* –*Melanotaenia splendida* –*Ambassis agassizii* –*Hypseleotris* sp. –*Pseudomugil signifer* Exotic fish species: no increase in number of exotic species relative to current number of exotic species identified in main channel. Current sampled species: –*Carassius auratus* –*Gambusia holbrooki* –*Poecilia reticulate*

*While these native fish ratios are observed/expected for main trunk of Upper Dawson River, useful to compare to catch with that of the Project area.

7.3 Survey Findings

7.3.1 Aquatic Habitat (ERM 2023)

The waterways present within the Project Area are ephemeral, with most waterways drying completely during dry periods. Very few of these waterways retain pooling water during dry periods. At the time of the field surveys (March 2022), the majority of waterways present in the Project Area had already ceased surface water flows with disconnected pools noted along the watercourses. There was some subsurface flow present at sites along most creeks that contained sandy substrates. The gaps between water pools were often separated by open grasslands and poorly defined channels.

Riparian vegetation was present and the density of such vegetation varied from moderate to non-existent, with most surveys sites having relatively low vegetation present. The in-stream habitats present were concluded to be mostly of ‘fair’ condition across the majority of sites that were surveyed (17 of 24), with the remaining seven concluded to be of ‘poor’ condition.

Habitat Type and Vegetation Community	Photographic example
Woleebee Creek Aquatic Habitat This waterbody was concluded as likely to retain subsurface (hyporheic flows) for some time after heavy rainfall. The wetland type of this habitat was riverine, with a stream order of 5. In terms of species, the habitat had a presence of Palaemonidae (freshwater Prawns) and Paratacidae (freshwater Crayfish), as well as the Eastern Long-Necked Turtle, which was captured. The overall habitat bioassessment score for this habitat was of fair condition.	

Wandoan Creek Aquatic Habitat This waterbody had subsurface flows expressing in some areas. It was concluded as overall uncertain as to whether these were hyporheic or groundwater expressions, and the watercourse was regarded as shallow and highly ephemeral. The wetland type of this habitat was riverine, with a stream order of 4. In terms of species, the habitat had a presence of Palaemonidae (Freshwater Prawns) and Paratacidae (Freshwater Crayfish). The Green-stripe Frog was also recorded. The overall habitat bioassessment score for this habitat was of fair condition.	
*Images and data in this table are accredited to KCB, 2022.	

7.3.2 Aquatic Flora and Fauna

No listed threatened species were identified during the field surveys, and survey results are summarised in Table 17.

Two EPBC Act listed threated aquatic fauna species were identified in the desktop review as potentially occurring in and adjacent to the Project Area, these being:

- White-Throated Snapping Turtle (*Elseya albagula*) – Critically Endangered; and
- Fitzroy River Turtle (*Rheodytes leukops*) – Vulnerable.

However, an assessment of their likelihood of occurrence, determined that both species were considered unlikely to occur within the Project Area.

Table 17: Summary of survey findings

Fauna	Field Survey Results
Aquatic macroinvertebrates	• Low abundance of aquatic macroinvertebrates and taxa diversity across all samples in the Project Area, likely due to the largely ephemeral nature of the waterways (typical for ephemeral streams in central Queensland). • Relatively low PET (Plecoptera, Ephemeroptera, and Trichoptera orders) taxa diversity. Relatively low Signal2 scores, indicating the aquatic macroinvertebrate assemblages were relatively depauperate.
Macrocrustaceans	Three families were detected: • Atyidae (Glass Shrimp) – recorded at only one site; • Palaemonidae (Freshwater Prawn) – recorded at all sites sampled; and • Paratacidae (Freshwater Crayfish) – recorded at all sites sampled.

Fauna	Field Survey Results
Fish	Eight species were collected from 14 sites sampled. Native species listed from most to least abundant include: • Spangled Perch (*Leiopotherapon unicolor*)-100% of sites; • Agassizs Glassfish (*Ambassis agassizii*)- 79% of sites; • Midgely's Carp Gudgeon (*Hypseleotris ineolate*) – 79% of sites; • Eastern Rainbowfish (*Melanotaenia splendida splendida*) – 71% of sites; • Bony Bream (*Nematalosa erebi*) – 50% of sites; • Eel-tailed Catfish (*Tandanus tandanus*) – one specimen; and • Sleepy Cod (Oxyeleotris ineolate) – one specimen. All the native fish species recorded are relatively common and widespread across their distributions.
Turtles and Platypus	• Single specimen of eastern long-necked turtle (*Chelodina longicollis*) was captured. This species can move long distances overland between waterholes, particularly after heavy rainfall. • No Platypuses (*Ornithorhynchus anatinus*) were recorded in the March 2022 surveys and there are no available historical records within 50 km of the Project Area. • Three sites were assessed as being average for habitat suitability for platypus, while all remaining sites were considered poor habitat suitability for platypus. • It is considered unlikely that platypus would occur across the Project Area.
Frogs	Three species of frog were recorded in the March 2022 sampling: • Green-Stripe Frog (*Cyclorana alboguttata*) – recorded at seven sites; • Broad-Palmed Rocket Frog (*Litoria latopalmata*) – recorded at one site; and • Cane Toad (*Rhinella marina*) – recorded at two sites.
Information sourced from (Freshwater Ecology, 2022).	

7.3.3 Stygofauna

Stygofauna are known to occur in alluvial, limestone, fractured rock, calcrete aquifers and coal seams in Australia. Stygofauna are subterranean aquatic animals that live in groundwater. Communities are often dominated by crustacean invertebrates, also containing oligochaetes, insects, other invertebrate groups and occasionally fish. Stygofauna are found across a range of water quality conditions (from fresh to saline), but most common in fresh and brackish water (electrical conductivity less than 5000 µS/cm) (Hose et al. 2015, cited in Freshwater Ecology, 2022).

Stygofauna have been identified in a range of habitats including Alluvial or karst landscapes, various non-karstic geological units and aquifer systems that exhibit suitable voids for colonization, including alluvial, fractured rock, calcrete aquifers and coal seams in addition to limestone (Hose et al. 2015, EPA 2016).

Prospective habitat for subterranean fauna is dependent on the presence of underground voids of suitable size and connectivity, to satisfy biological requirements. The extent of subterranean habitat present is dependent on the interconnection of subsurface crevices, fractures, and voids, within suitable geological units and aquifer systems, in addition to connectivity to recharge areas and sources of particulate organic matter for food.

Sampling for subterranean fauna was undertaken at twelve existing landholder bores within the Project area by Freshwater Ecology (2022) (Table 18). Only 2 specimens of one potential stygofauna (from a single bore) were recorded, but they could not be formally identified.

While Stygofauna have been recorded within coal seams in the Surat Basin, near Wandoan (Xstrata, 2008), these were in shallow bores. Proposed CSG production will occur from coal seams greater than 250mbgl – significantly deeper than any known occurrence of stygofauna in the Surat Basin.

In the context of the WCM within the Project area, it is unlikely that stygofauna will be present within the target coal seams. Although there is reported occurrence within coal seams of the Surat Basin, near Wandoan; these were in shallow bores (Xstrata 2008). All CSG production within the Project area will occur from the coal seams greater than 250 mbgl, which is deeper than any known occurrence of stygofauna in the Surat Basin.

Table 18: Summary of Stygofauna Sampling Results (KCB 2018c)

Bore	Aquifer Attribution*	Bore Depth (mbgl)	EC (µs/cm)	Stygofauna Present
Bore 1	Gubberamunda Sandstone / Westbourne Formation	67.4	3,724	Yes
Bore 4	Upper Springbok Sandstone	25.0	20,948	Yes

*Aquifer attribution from OGIA (2017e) and Senex baseline assessment (KCB 2018c)

There are no threatened stygofauna species listed in Queensland under the EPBC Act or NC Act.

7.3.4 GDEs

Groundwater dependent ecosystems (GDEs) are defined as ‘Natural ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services’ (Richardson et al. 2011).

Potential surface expression GDEs and subsurface GDEs are mapped by DES (State of Queensland 2018) as potentially being present in the vicinity of the Project (Figure 16). These generally correspond with the location of the mapped alluvium associated with Woleebee Creek within the Project area and Wandoan Creek, Horse Creek and Juandah Creek further afield but within 25 km of the Project Area.

7.3.4.1 Aquatic GDEs

Aquatic GDEs are ecological communities dependent on the surface expression of groundwater, including springs other than EPBC-listed springs, river baseflow systems (watercourse springs), riparian ecosystems and wetlands.

There is one watercourse spring within the Project Area associated with Wandoan and Woleebee Creeks (W279) (Table 19 and Figure 15). These watercourse springs are identified as being associated with the alluvium. This is noted as a spring of interest but not currently affected or listed as a mitigation site (OGIA 2021b).

Table 19: UWIR Watercourse Spring Details

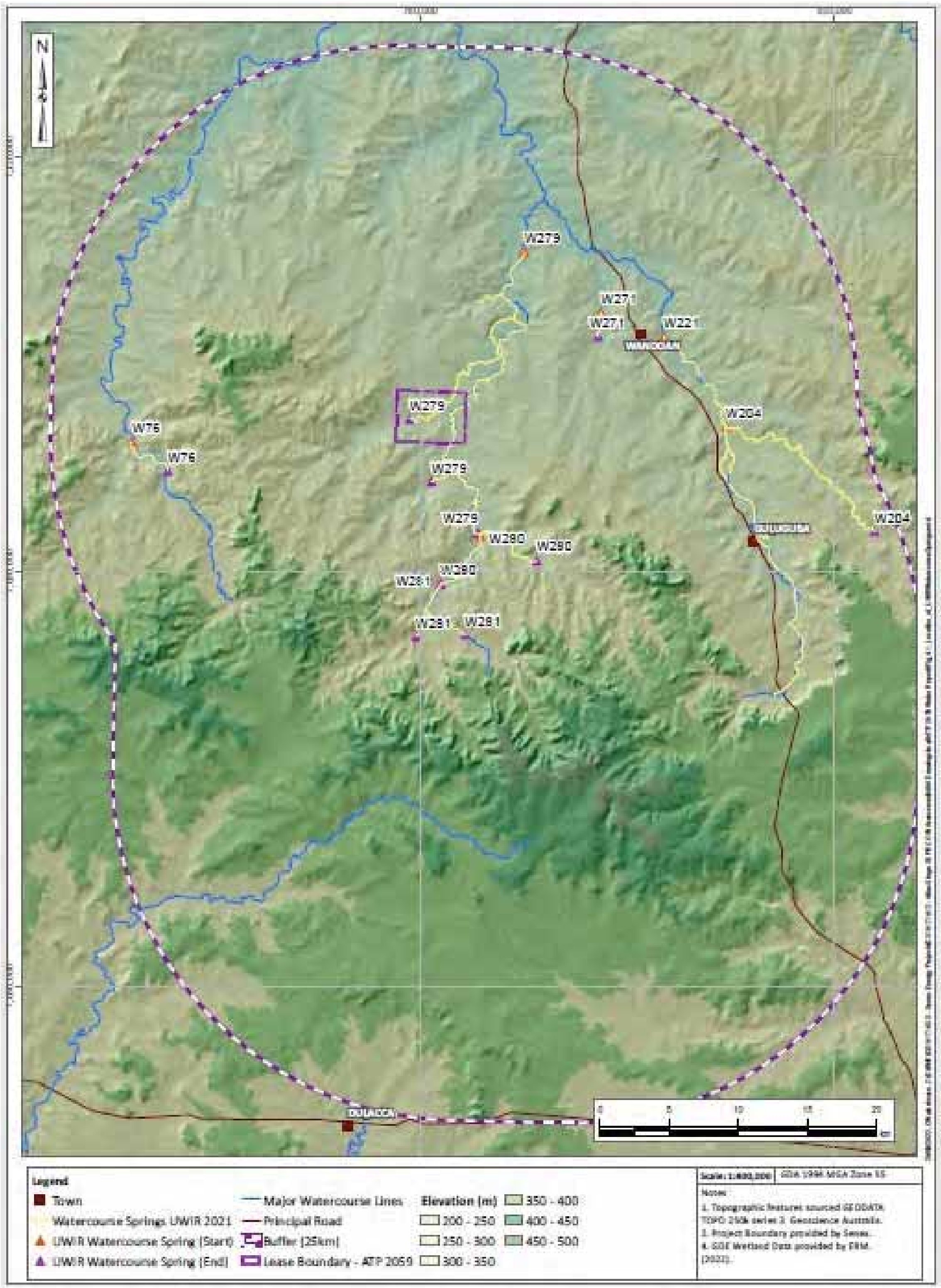
Site Number	Name	Sources Aquifer
W279	Woleebee Creek	Alluvium

The water qualities of the Westbourne Formation and Springbok Sandstone are distinct from the water quality of the alluvium, indicating a lack of connection between the units (i.e., the underlying Westbourne Formation and Springbok Sandstone do not discharge into the alluvium) with the underlying GAB units generally have a higher salinity than the alluvium.

The comparable water qualities of the surface water and alluvium indicates that the alluvium is recharged/replenished by the surface water systems during flow events following prolonged rainfall event/s.

The verification program considered it unlikely that Woleebee Creek is a baseflow-fed reach. This aligns with observations made during the 2022 ecology surveys and the assessment undertaken by CDM Smith for QGC relating to tenements to the north, which concluded the ephemeral creeks feeding Juandah Creek (which includes Woleebee Creek) are not ‘gaining’ from alluvial groundwater (CDM Smith 2021).

Figure 15: Watercourse Springs



7.3.4.2 Terrestrial GDEs

Terrestrial GDEs are surface ecosystems dependent on the subsurface presence of water (i.e., terrestrial vegetation accessing the water table below ground), including ecosystems that are intermittently and permanently dependent on groundwater.

Using terminology developed as part of the DES GDE mapping, the following potential terrestrial and aquatic GDE types have been identified from the desktop assessment as occurring within the Project area:

(a) Riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent flow.

(b) Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow.

These potential GDE types correspond with RE types that occur on alluvial landscapes, associated with watercourses and the adjacent floodplain areas (Table 20and Figure 16). Based on the DES GDE mapping rule sets, these vegetation communities rely on alluvial aquifers that form from gravel, sand, silt and/or clay deposited by fluvial processes in river channels or on floodplains.

The identified GDEs comprise mosaics of remnant and regrowth REs of varying patch sizes and ecological conditions. RE 11.3.25 (Forest Red Gum (*Eucalyptus tereticornis)* or River Red Gum (*Eucalyptus camaldulensis*) woodland fringing drainage lines) is the most widely abundant vegetation community identified that the potential to be a GDE. However, interconnected patches of other REs are present. Historic land clearing is known to have occurred throughout the Project area that has impacted the condition of terrestrial GDEs, particularly along creek lines and water courses. Grazing pressure is also likely to influence the ecological condition of RE patches and their value for maintaining biodiversity levels.

The field investigations confirmed a lack of groundwater in alluvium within the alluvial plains away from the immediate creek vicinity (during the wet season), with a water strike encountered at 38.5 mbgl, confined beneath a clay layer in the Upper Springbok Sandstone. There is 28.5 m of dry rock between the base of alluvium and the main water strike in the Upper Springbok Sandstone. Post-recovery, standing water level in the Upper Springbok Sandstone bore was recorded at 14 mbgl, which is below the base of alluvium at ~12 mbgl. This indicates that REs at these locations do not depend on groundwater and mustbe reliant on surface water and soil moisture.

Although the presence of tree species that inhabit wetter environments indicates some potential for groundwater use, the leaf water potential and isotope data, from studies undertaken by QGC directly north of the Project area on similar RE's along creek tributaries to Juandah Creek, demonstrated that trees are sourcing water largely from soil moisture stores which fluctuate with rainfall (CDM Smith 2021, cited in KCB, 2022). This is considered to be a function of the dimorphic rooting systems which access water at multiple depths.

The average rooting depth for species of Eucalyptus present at the Project area is known, based on literature reviews, to range from 9 m to 22.6 m, depending on the species and the interactions between geomorphology and plant physiological traits. Eucalypts (including Forest Red Gums) have two rooting systems (known as a dimorphic rooting system), with the ability to access deep groundwater during periods of time where shallower soil moisture is limited, they have shown physiological responses allowing them to adapt to water stress (CDM Smith 2021). The depth to the confined groundwater strike in the Springbok Sandstone is 38.5 m, with the Springbok Sandstone being dry above this depth, indicating that these Eucalypts are not accessing the water within the sandstone.

Field investigation results indicate that groundwater is present in the alluvium along the creek lines during the wet season. This suggests that potential terrestrial GDEs located along the creek systems may have moderate groundwater dependency as they occur within an alluvial system (associated with creeks) and the ecosystem is associated with streamlines. This alluvial system is replenished during prolonged wet periods when the ephemeral creek system is flowing. There is no hydraulic connectivity between the bedrock and alluvium, therefore any predicted drawdown is not going to cause drawdown in the alluvium.

Groundwater dependence of identified vegetation was inferred using established risk assessment guidelines (Serov, Kuginis, and Williams 2012, cited in KCB 2023) (Table 20). The results indicate that the potential terrestrial GDEs located along the creek systems may be groundwater dependent as they occur within an alluvial system (associated with creeks) and the ecosystem is associated with streamlines. This alluvial system, as discussed in Section 7.9, is replenished during prolonged wet periods when the ephemeral creek system is flowing, and is disconnected from the Gubberamunda Sandstone, Westbourne Formation and Upper Springbok Sandstone, which is of a higher salinity.

Figure 16: Mapped Potential GDEs and Field-validated REs

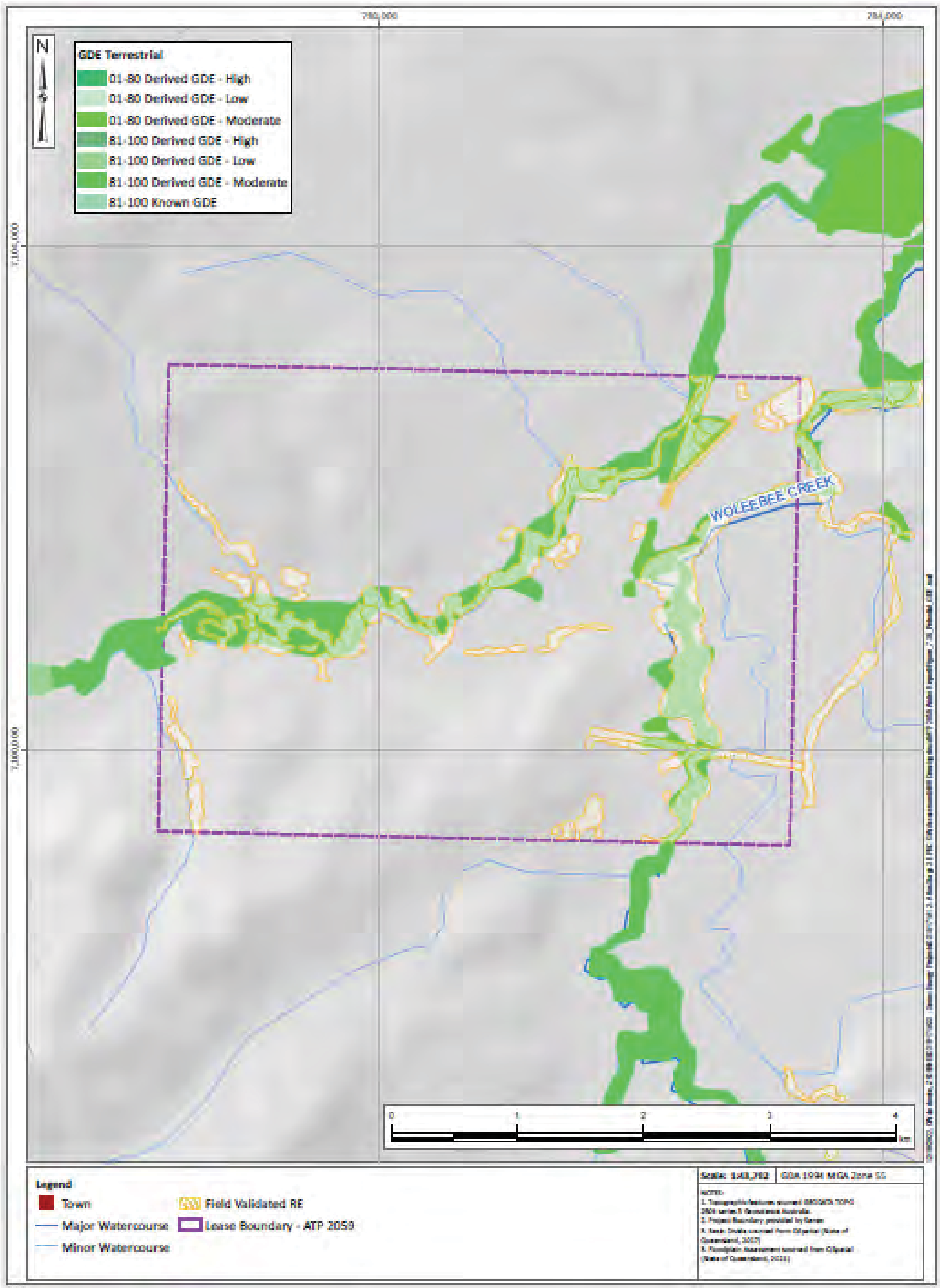


Table 20: Groundwater Dependence Assessment

Query	Assessment Findings
General	
Is the ecosystem identical or like another that is known to be groundwater dependent?	There is potential for the identified RE's to access groundwater but this has not been confirmed. The relative reliance on groundwater could not be identified for some of these dominant species, it is likely that the Eucalyptus species present are resilient to changes in groundwater availability due to their dimorphic root structure. For other dominant flora species, such as Brigalow and Belah, at least an indirect reliance on groundwater availability through water discharge should be assumed.
Does the community contain species known to require permanent saturation such as within aquifers, karsts, or mound springs or some wetlands?	No
Is the distribution of the ecosystem consistently associated with known areas of groundwater discharge; e.g., springs, mound springs or groundwater seeps in terrestrial and/or near shore marine environments?	No. Standing water is present but not considered to be groundwater (due to water quality and turbidity) and it is unlikely that groundwater would express as baseflow or watercourse springs along these creeks.
Is the distribution of the ecosystem typically confined to locations where groundwater is known or expected to be shallow? For example, topographically low areas, major breaks of topographic slope; i.e., cliffs or escarpments, alluvial and coastal sand beds aquifers, gaining streams?	Yes. The vegetation is located within the area of sandy alluvium associated with the watercourse. However, these creeks are not considered to be gaining streams, and therefore, not connection to the regional groundwater system of the bedrock.
Terrestrial GDEs	
Is the water table level near or at the surface or within the root zone of the surrounding vegetation? If roots can reach a source of fresh water, is it generally true that this water will be absorbed by the roots and transpired by the canopy.	Yes. There are two registered bores accessing the alluvium on Woleebee Creek in ATP 2059. Measurements at these bores record groundwater at ~7.5 mbgl (April 2022). Average root depth for species of Eucalyptus present is known, based on literature reviews, to range from 9m to 22.6m, depending on the species and the interactions between geomorphology and plant physiological traits (ERM 2022a)

Query	Assessment Findings
Is the vegetation community composed of species known to require permanent saturation (wet rainforest or wet sclerophyll forests) or high soil moisture levels (dry rainforest)?	No
Does the vegetation in a particular community occur along stream lines?	Yes. Field verified RE's are associated with water courses and the adjacent alluvial plains.
Is the vegetation community known to function as a refuge for more mobile fauna during times of drought?	No. Wandoan Creek is ephemeral and therefore would not likely have permanent water during the dry season or periods of limited rain.

7.3.4.3 Subterranean GDEs

Subterranean GDEs are which are subterranean ecosystems dependent on the permanent presence of subsurface water. For the purposes of this document, this includes vertebrates and invertebrates only (i.e., excludes unicellular and simple multicellular organisms) (Stygofauna). All CSG production within the Project area will occur from coal seams greater than 250 mbgl, which is deeper than any known occurrence of stygofauna in the Surat Basin and it is unlikely that stygofauna will be present within the target coal seams of the Project area (Section 7.3.3).

7.3.5 Springs

Springs have been assessed against the *Water Act 2000* spring trigger threshold of 0.2 m using the outputs and drawdown predictions from the UWIR numerical model. The Project only scenario does not result in drawdown at these locations in the potential source aquifers, the predicted cumulative drawdown is also <0.2 m meaning the spring trigger threshold is not predicted to be exceeded.

Additionally, reaches of Woleebee Creek within PL 1037 directly adjacent to ATP 2059 were assessed in 2018 (KCB 2018c) and it was identified that there is unlikely to be significant baseflow provided to this creek. The field verification also concluded that based on the difference between the alluvial groundwater and surface water major ionic chemistry signatures, and groundwater chemistry signatures from the Surat Basin units, groundwater within the alluvium is not considered to be sourced from the underlying Surat Basin unit (Westbourne Formation) at the locations assessed.

Woleebee and Wandoan Creeks are not considered to be baseflow fed with hydraulic and geochemical evidence suggesting that these creek systems are ‘losing streams’ to the underlying alluvium during periods of rainfall and creek flow.

7.3.6 Surface Water users

Under the Fitzroy Basin ROP (State of Queensland 2015), creeks within the Project area are within the Dawson Valley Water Management Area. Within this management area Woleebee, Horse and Juandah Creeks are a tributary of the Dawson N Zone, along the AMTD reach 356.5 to 428.0 (km) – also described as ‘Upstream limit of Glebe Weir and Eurombah Creek Junction’.

There are no resource operations licence holders in the Dawson N Zone of the Dawson Valley Water Management Area (State of Queensland 2021) and no other surface water users have been identified within the vicinity of the Project.

There are no identified third-party surface water users in the vicinity of the Project.

7.4 Impact Assessment

The Project does not include any:

- Planned discharge to / abstraction from the surface water systems; or
- Surface water diversions.

Nor have any surface water users been identified in the vicinity of, or immediately downstream of the Project Area.

As a result, impacts to surface water users, surface water and associated aquatic systems from proposed CSG production are anticipated to be minimal. Potential impacts could still result from general construction and day-to-day operations and are listed below. However, implementation of management controls is considered appropriate to manage the risk associated with these impacts (refer Appendices A, B and D).

- Localised transport of suspended sediment to waters during construction or site works, resulting in the potential to alter flow regimes and quality;

- Localised release of hydrotest water, effluent or trench water to land (these fluids are not intended for release to the surface water system so has limited potential for any impact to surface water quality);
- Alteration of a watercourse character or changes to riparian buffers due to construction works;
- Unplanned releases from water storage facilities have the potential to impact surface water and associated ecosystems; and

Potential impacts to GDEs as a result of aquifer drawdown are presented in Section 8.5.

8 Groundwater Assessment

An assessment of potential impacts to groundwater from the project has been completed by Klohn Crippen Berger (KCB 2023) and is provided as Appendix E. The findings of this report are summarized in the following sub-sections.

Where required, additional information has also been drawn from the ERM, 2023 ecology report (Appendix F).

8.1 Methodology

The existing environment across the Project area was considered through a desktop assessment to establish the baseline groundwater conditions, EVs, and potential receptors. This was further supported with the undertaking of a field program to collect site-specific information. This assessment included a review of the data collected for the directly adjacent PL 1037, PL 445 and PL 209.

For the identification of groundwater receptors relevant to this Project, a 25 km buffer around the greater Project area (which includes PL 445 and PL 209) was established to capture potential adjacent groundwater receptors that may be impacted by the proposed development.

8.1.1 Desktop Assessment

A desktop literature review and assessment were undertaken, with data sources including (but not limited to):

- Geological maps for the Surat Basin, including the Detailed Surface Geology – Queensland (State of Queensland 2018).
- 2021 Surat CMA regional geological model (OGIA 2021a) and Groundwater modelling report for the Surat CMA (OGIA 2021c; 2019c).
- Queensland groundwater bore database (GWDB) for registered water bore data from private water bores and Queensland Government groundwater investigation and monitoring bores (State of Queensland 2022b);
- OGIA aquifer attribution (OGIA 2022).
- OGIA subsidence assessment undertaken for the Surat Basin 2019 CMA UWIR.
- Underground Water Impact Report for the Surat CMA (OGIA 2021b).
- Hydrogeological Conceptualisation Report for the Surat CMA (OGIA 2016c).
- Identification of Gaining Steams in the Surat CMA; Hydrogeological Investigation Report (OGIA 2017).
- Springs in the Surat CMA (OGIA 2016).

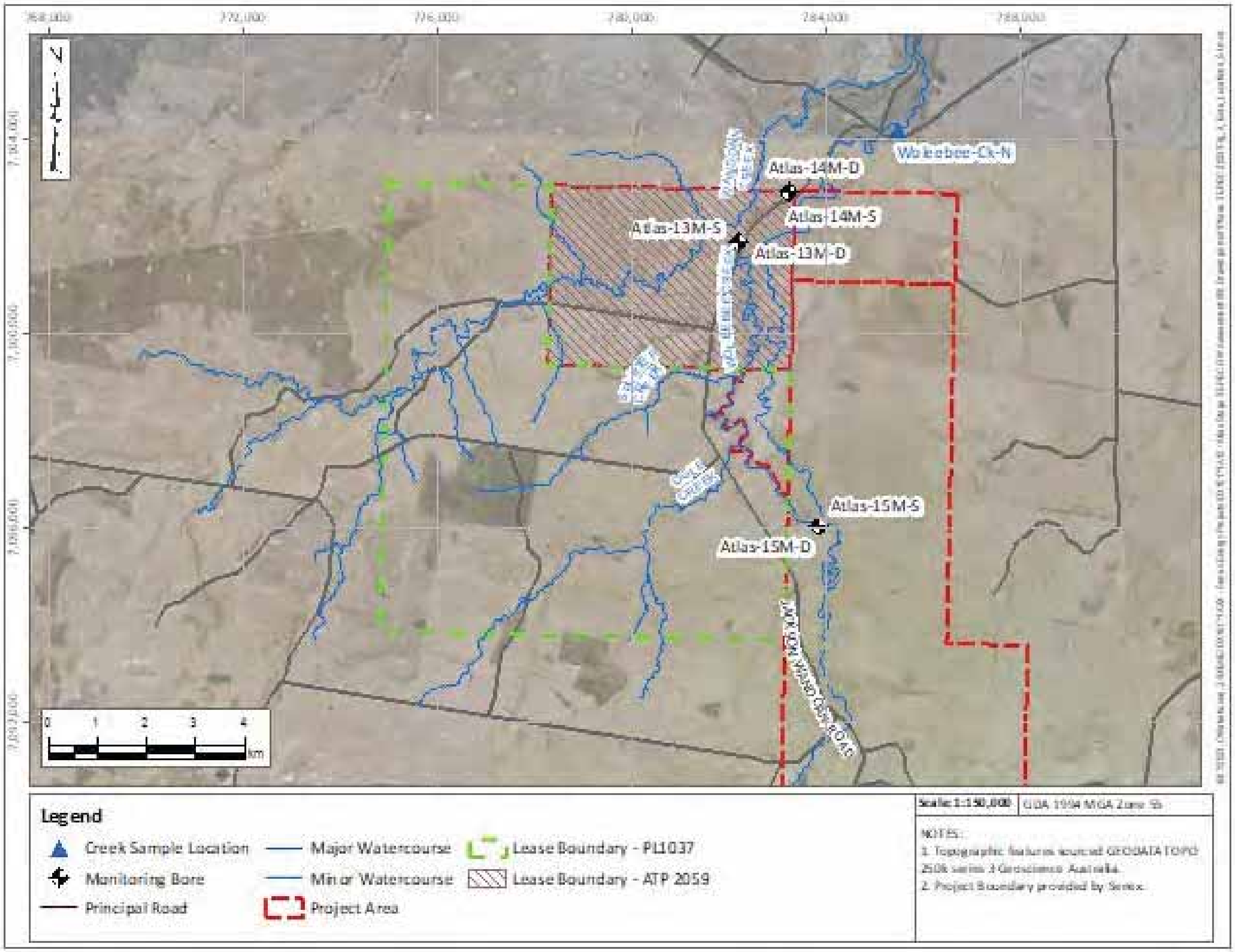
8.1.2 Field Investigations

Drilling and monitoring bore installation was completed within the Project area between December 9, 2022, and January 25, 2023. Six monitoring bores were installed at three locations (Figure 17).

The following activities were undertaken as part of the field investigation:

- The installation of three monitoring bores in the alluvium, and three in the hydrostratigraphic unit underlying the alluvium at the first water strike (total of six bores).
- Development of all bores through airlifting followed by groundwater sampling and hydraulic testing.
- Hydraulic testing of each bore (where water was present) via slug testing methods.
- The installation of Solinst Pressure Transducer Dataloggers (PTDL) in each bore and recording of groundwater levels at 12-hour intervals.
- Two additional groundwater samples were collected from each bore (where water was present) at least four weeks after installation.
- The installation of a PTDL in a former government alluvium monitoring bore RN13030810 (March 1, 2023).
- Collection of a surface water sample from Woleebee Creek on the Springbok Sandstone.

Figure 17: Site Investigation Bore Locations (KCB, 2022)



8.1.3 Subsidence

The potential for subsidence from both Project only and cumulative drawdown predictions has been assessed by applying a subsidence calculation based on the compaction at a specific location method (Sanderson 2012; Coffey 2018). This method considers the axial compression of lateral strain using Poisson's Ratio with Young's Modulus to calculate a coefficient of volume compressibility. It calculates compaction directly due to groundwater pressure changes in the geological unit at a given location. This was the same methodology applied by Arrow Energy (Coffey 2018) and has been previously accepted by the OGIA. The detailed methodology is provided in Appendix E.

8.1.4 Numerical Groundwater Modelling

The OGIA Surat CMA 2021 numerical groundwater model was used to simulate the proposed development scenario. A detailed description of the model and the modelled scenarios and outputs is provided in KCB 2023 (Appendix E) and is summarised in Section 8.4.

8.2 Existing Environment

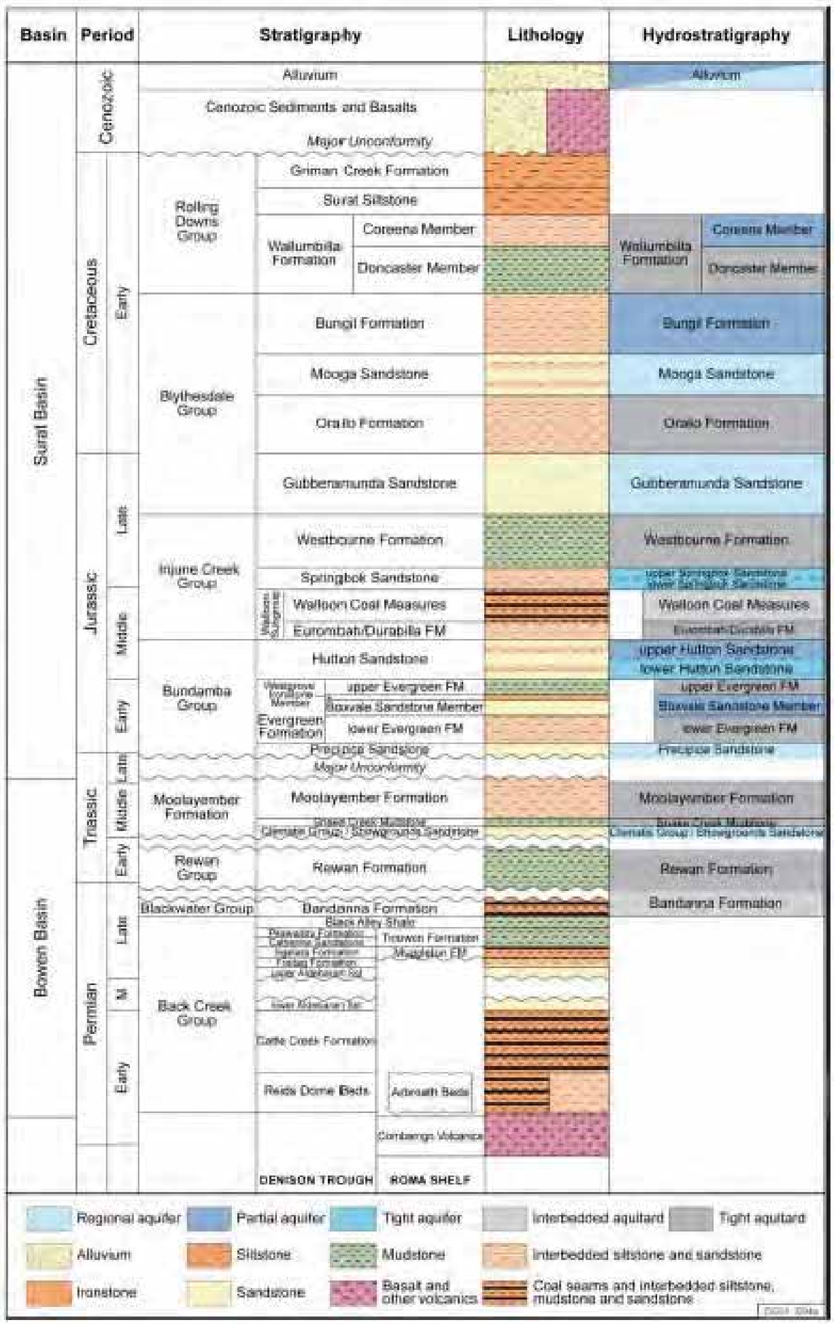
8.2.1 Hydrogeology and Regional Hydrostratigraphy

The Project area is located within the Surat Basin, a basin of Jurassic-Cretaceous age, which is underlain by the Permo-Triassic Bowen Basin. Cenozoic-age formations are present overlying the Surat Basin formations. The Surat Basin underlies approximately 180,000 km^2 of southeast Queensland; and is connected to the Eromanga Basin to the west, the Clarence-Moreton Basin to the east, and the Mulgildie Basin to the northeast. The Surat Basin is bounded to the northeast by the Auburn Arch and to the southeast by the Texas Block. The northern margin of the basin has been exposed and extensively eroded. Basin sediments generally dip southwest (OGIA 2016).

The Surat Basin forms part of the Great Artesian Basin (GAB), which comprises several aquifers and confining aquitards. Aquifers of the Surat Basin are a significant source of water used for stock, public water, and domestic supply.

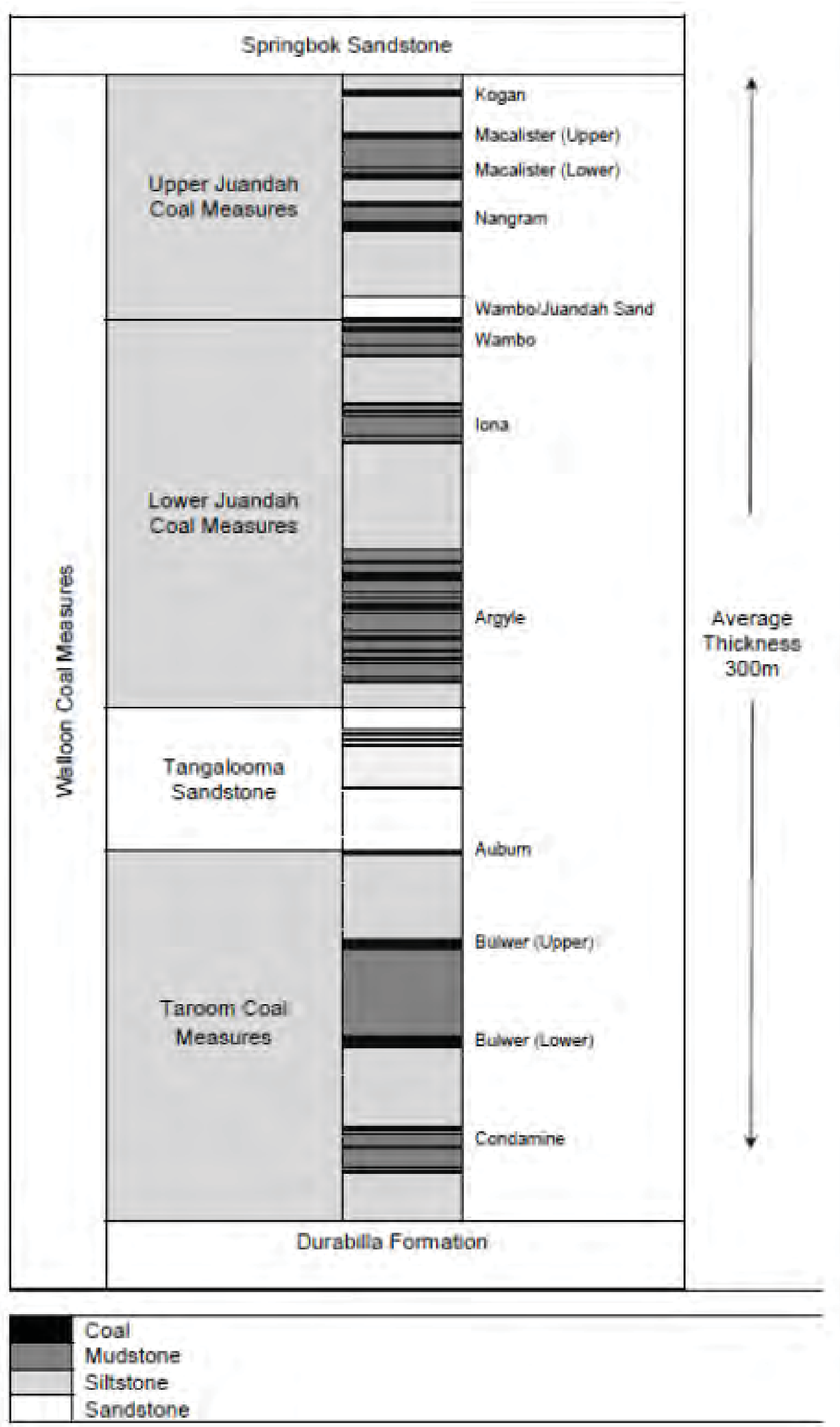
The hydrostratigraphy of the Surat and Bowen Basin is presented in Figure 18.

Figure 18: Regional Hydrostratigraphy (Source: 2021 Surat Cumulative Management Area, Underground Water Impact Report)



The target formation for production is the Walloons Coal Measures, which conformably overlies the Durabilla Formation. It was deposited in a low energy meander-belt river system, with the coal layers deposited mainly in an overbank environment (Exon 1976, cited in KCB, 2022). The WCM consists of very fine to medium-grained argillaceous sandstone, siltstone, mudstone, and coal with minor calcareous sandstone, impure limestone, and ironstone (Swarbrick 1973). Typically, the coal layers are positioned in the upper half to three-quarters of the coal measures, with mudstones, siltstones and lithic sandstones dominant in the lower part. At a regional scale the WCM is considered as a leaky aquitard (OGIA 2016). The stratigraphy of the WCM is presented in Figure 19.

Figure 19: Stratigraphy of the Walloon Coal Measures (Source: OGIA, 2016)



As per Figure 19, the Springbok Sandstone overlies the WCM and the Eurombah / Durabilla Formation underlies the WCM.

The Durabilla Formation (often referred to as the Eurombah Formation) conformably overlies the Hutton Sandstone. The depositional environment for this unit was fluvial with periods of rapid sedimentation. It is often difficult to differentiate the Durabilla Formation from the WCM. It is more restricted in extent than either the Hutton Sandstone or the WCM (Green 1997, cited in KCB 2023). The Durabilla Formation is considered an aquitard, consisting of siltstone, mudstone and fine to medium-grained poorly sorted sandstone, with almost no coal and consequently, little permeability (OGIA 2016)

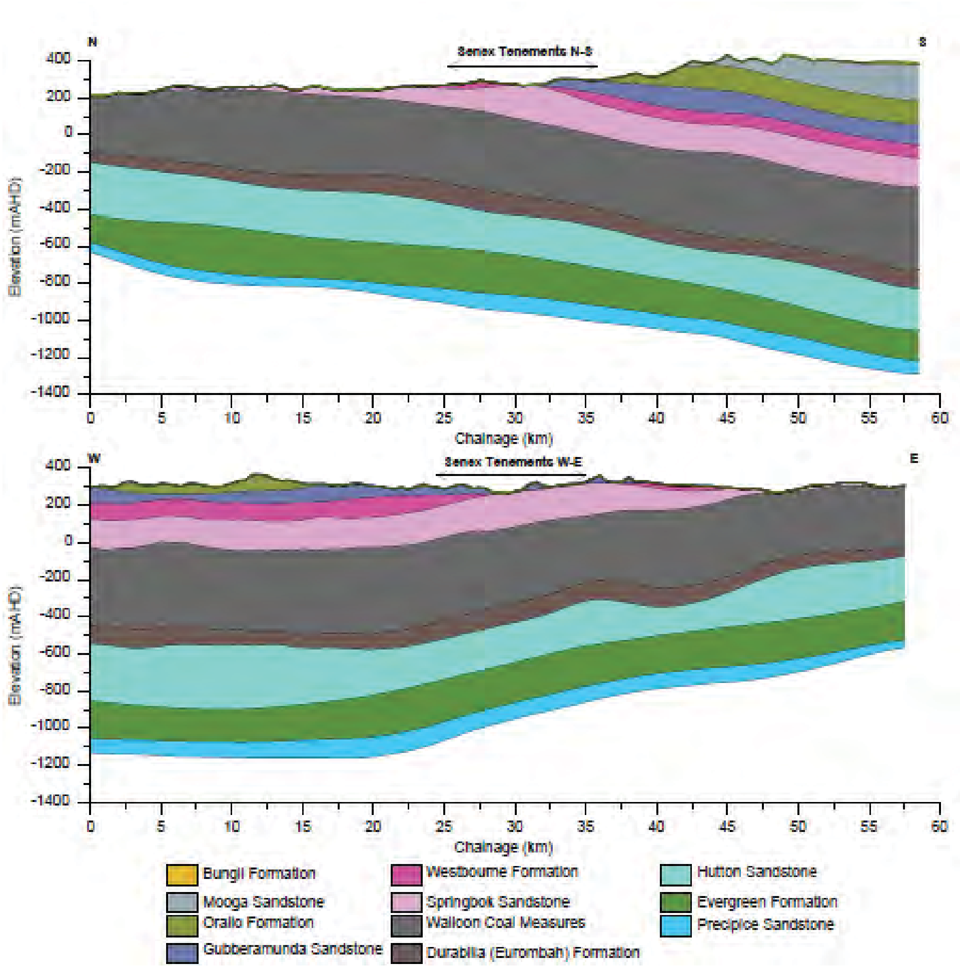
The Springbok Sandstone overlies the WCM. It was deposited by streams and includes overbank and swamp deposits in the upper part of the unit which indicates streams becoming less energetic with time (Exon 1976, cited in KCB 2023). The Springbok Sandstone consists mostly of feldspathic sandstones, commonly with calcareous cement (Green 1997, cited in KCB 2023). At the basin scale, the sandstones range from very fine to coarse-grained, although some very coarse-grained, poorly sorted pebbly beds also occur. Minor interbedded siltstones, mudstones, and thin coal seams are also present, primarily in the upper part of the unit. Within the GAB, the Springbok Sandstone is considered a usable water source, however it is highly variable in hydraulic properties and yield across the basin. The Springbok Sandstone also has a very high content of mudstone and siltstone at many locations with very low permeability (OGIA 2016).

8.2.1.1 Local Hydrogeology

The Project is situated in an area where the Westbourne and Gubberamunda Formations outcrop. Two cross-sections, oriented North-South and West-East, through the Project area, are shown on Figure 20.

There are no mapped major geological structures (e.g., faults) within the vicinity of the Project. The nearest major fault is the Burunga Fault which is located approximately 29 km to the east of ATP 2059, 17 km east of Wandoan.

Figure 20: Geological Cross-sections (Surat CMA Geological Model (OGIA 2021)



Quaternary-age alluvium is mapped within the Project area and is associated with Woleebee and Wandoan Creeks, as shown on Figure 14. The alluvium is mapped as laterally thin across the Project area, with increased lateral extent towards the north as Wandoan Creek flows into Woleebee Creek. Alluvium associated with Woleebee Creek is likely to be well-developed. Two registered bores have been identified as sourcing water from the alluvium in ATP 2059, and based on the construction logs of these bores the thickness of alluvium in these bores has been identified as up to 18 m (Streamline Hydro 2022).

Drilling and monitoring bore installation was completed by Senex in the Project area between December 9, 2022, and January 25, 2023. Six monitoring bores were installed at three locations across the Project area (Figure 17). The bore logs from these installed bores indicate that the alluvium is up to 13 m thick. Further, the bore logs for all six bores indicate clay present in the alluvium between 0 to 5 m, after which well sorted sand was encountered.

Three of the monitoring bores were screened in the alluvium, of which two bores were dry during installation and have been dry during subsequent monitoring rounds. One alluvium monitoring bore (Atlas-15M-S) had sufficient water to allow a hydraulic test to be undertaken. The hydraulic conductivity for the alluvium was determined to be between 0.12 to 0.16 m/d. This is consistent with the hydraulic conductivity associated with Horse Creek (AGE 2012)

The remaining three monitoring bores were drilled and installed in Surat Basin units adjacent to the shallow alluvium monitoring bores. Screened intervals for these monitoring bores targeted the

Westbourne Formation (Atlas-13M-D), Springbok Sandstone (Atlas-14M-D) and weathered Rock (Atlas-15M-D). The hydraulic conductivity for these formations were:

- Westbourne Formation: 0.001 – 0.002 m/d
- Springbok Sandstone: 0.002 m/d

The site-specific hydraulic conductivity estimated from the hydraulic tests completed on the new monitoring bores in the Westbourne Formation and Springbok Sandstone are within the same ranges as the OGIA hydraulic conductivity data.

8.2.2 Groundwater

8.2.2.1 Inter-Aquifer Connectivity

The Surat Basin comprises layers of aquifers and aquitards of varying hydraulic properties. The formations predominantly comprise fluvial sedimentary deposits that have formed stratifications of sand, silt and clay within and across hydrostratigraphic formations (OGIA 2016). Groundwater flow within the Surat Basin hydrostratigraphic units is predominantly horizontal, as vertical flow is restricted by the spatial extent and continuity of aquitards, and by lower permeability horizons within the aquifers (OGIA 2016).

Across the Project extent, there is potential for interaction between the WCM and aquifers above and below, specifically the overlying Springbok Sandstone and underlying Hutton Sandstone (separated from the WCM by the Durabilla Formation). The Durabilla Formation is mapped across the entire Project area, with a mean thickness of 87 m (Figure 20), which provides a significant vertical barrier between the WCM and underlying Hutton Sandstone. An upper WCM aquitard has been mapped by OGIA (the Walloon Coal Measures non-productive zone, OGIA 2021b) as being up to 25 m thick across the Project area, separating the WCM from the overlying Springbok Sandstone.

8.2.2.2 Groundwater Recharge

Groundwater recharge processes within the Surat Basin are summarised in the Hydrogeological Conceptualisation Report for the Surat Cumulative Management Area (OGIA 2016) and based on Kellett et al. (2003), and regional flow systems and potentiometry in Queensland's Surat and Southern Bowen Basins (OGIA 2021a). Key recharge processes include localised recharge, preferential pathway flow and diffuse recharge (Table 21).

Table 21: Key Groundwater Recharge Processes (Source: modified from KCB, 2021)

Recharge Process	Description	Occurrence in Project Area
Localised Recharge	Occurs beneath drainage features including rivers, creeks and alluvial and Tertiary groundwater systems where there is sufficient saturation and hydraulic head to allow water to infiltrate into aquifers.	Likely to occur as a result of localised recharge occurring beneath watercourses and alluvial systems where sufficient saturation and hydraulic head allows water to infiltrate into surficial aquifers
Preferential Pathway Flow	Arises from changes in permeability within aquifers and in overlying regolith, providing conduits for water to infiltrate. Zones of higher permeability may include fissures, faults, joints, tree roots and high-permeability beds within individual formations and along	Considered the dominant recharge pathway in the GAB.

Recharge Process	Description	Occurrence in Project Area
	bedding planes (Kellett et al. 2003; Sucklow et al. 2016).	
Diffuse Discharge	Process by which rainfall infiltrates directly though outcropping aquifers. This is expected to occur within all outcrop areas	Will occur with rainfall infiltrating directly through outcropping aquifers, such as the Gubberamunda Sandstone which outcrops in the south of ATP 2059

8.2.2.3 Groundwater Flow

Basin scale groundwater flow within the Surat Basin is typically north to south from northern outcrop areas. There is also a preference of groundwater to flow towards the north (towards Taroom) on the northern side of the Great Dividing Range with groundwater discharging into the Dawson River catchment (OGIA 2016c; 2021d). South of the Range, groundwater flow is generally southward, broadly consistent with the dip of the formation (OGIA 2021a).

Groundwater movement is slow in the GAB with flow velocities estimated at 1 to 5 m/yr (Habermehl 1980). Generally, groundwater flow and movement occurs as sub-horizontal flow, with limited vertical leakage across formations, where pressure differences may exist (OGIA 2016). Local groundwater flow conditions may be different from regional flow conditions with potential steeper gradients and increased velocities in response to hydraulic stresses such as groundwater abstraction.

8.2.2.4 Groundwater Users

There are 810 groundwater bores present with aquifer attributions provided by OGIA (OGIA 2022) within 25km of the Project Area (Table 22). Of these:

- 79 are not recorded in the registered groundwater bores database (GWDB) (State of Queensland 2022a).
- 590 are existing bores, including water supply or monitoring bores,
- 141 are either abandoned or decommissioned.
- 2 are located within the project area and target the alluvium along Woleebee Creek

Table 22: Registered Groundwater Bores

Type		Abandoned and Destroyed (AD)	Abandoned but Usable (AU)	Existing (EX)	Proposed (PR)	Unknown	Total
Artesian	Condition Unknown (AB)	-	-	6	-		
	Ceased to Flow (AC)	3	-	5	-		
	Controlled Flow (AF)	5	-	14	-		
Sub-Artesian (SF)		116	5	565	12		
Unknown		-	-	-	-	79	
	Total	124	5	590	12	79	810

AB: artesian condition unknown; AF: bores that are under artesian pressure and capped to control free flow; AC: bores that have been artesian in the past but have now become sub-artesian due to a reduction in artesian pressure; AB: likely artesian bores, however their current pressure condition is unknown; SF: bores which do not flow under any condition and where active pumping is required to abstract water.

Of the 669 existing or unknown status bores, 410 have been identified as water supply bores, 219 have been identified as not a water supply bore (e.g. monitoring bore or not currently used for water supply), 32 are potential water supply bores and eight have been recently drilled and their purpose is unknown (Table 23).

Groundwater abstraction for stock and domestic use is the dominant water use purpose within the vicinity of the Project. There are five bores noted as town water supply and ten for intensive stock use.

Table 23: Summary of Aquifer Attribution, 25km buffer of PL 209 and PL 445 (OGIA, 2022)

Formation	Number of Bores (EX, AU or Unknown)*
Other alluvium	41
Cenozoic Sediments	8
Wallumbilla Formation	5
Bungil Formation	27
Mooga Sandstone	50
Orallo Formation	61
Gubberamunda Sandstone	145
Westbourne Formation	33
Upper Springbok Sandstone	30
Lower Springbok Sandstone	15
Upper Juandah Coal Measures	100
Lower Juandah Coal Measures	48
Taroom Coal Measures	20
Durabilla Formation	5
Upper Hutton Sandstone	37
Lower Hutton Sandstone	10
Upper Evergreen Formation	1
Lower Evergreen Formation	1
Precipice Sandstone	34
Moolayember Formation	2
Rewan Group	1
Total	674

*Includes abandoned but usable (AU), existing (EX) and status unknown bores are included.

8.2.2.5 Monitoring Bores

There are 79 active monitoring bores at 56 sites within the 25 km buffer (State of Queensland 2021c) (Figure 21 and Table 24). The majority of these monitoring bores are installed as part of the UWIR and other programs such as the CSG Online or CSG Net programs, which are coordinated by the Queensland Government. In addition, there are ten seepage monitoring bores installed by Senex in the Westbourne Formation, for monitoring of potential seepage from established development infrastructure for Project Atlas (within PL 1037) as required by the EA for that project (EA0001207).

A discussion of monitoring bores and groundwater elevations for the target formation and underlying / overlying formations is provided below.

Table 24: Groundwater Monitoring Bores within 25km Buffer of ATP 2059 (from KCB 2021)

Formation	No. of Monitoring Bores
Wallumbilla Formation	1
Mooga Sandstone	3
Gubberamunda Sandstone	11
Westbourne Formation	10
Upper Springbok Sandstone	7
Lower Springbok Sandstone	2
Upper Juandah Coal Measures	9
Lower Juandah Coal Measures	11
Taroom Coal Measures	7
Durabilla Formation	2
Lower Evergreen Formation	1
Upper Hutton Sandstone	8
Lower Hutton Sandstone	3
Precipice Sandstone	4
Total	79

8.2.2.6 Senex Groundwater Monitoring network

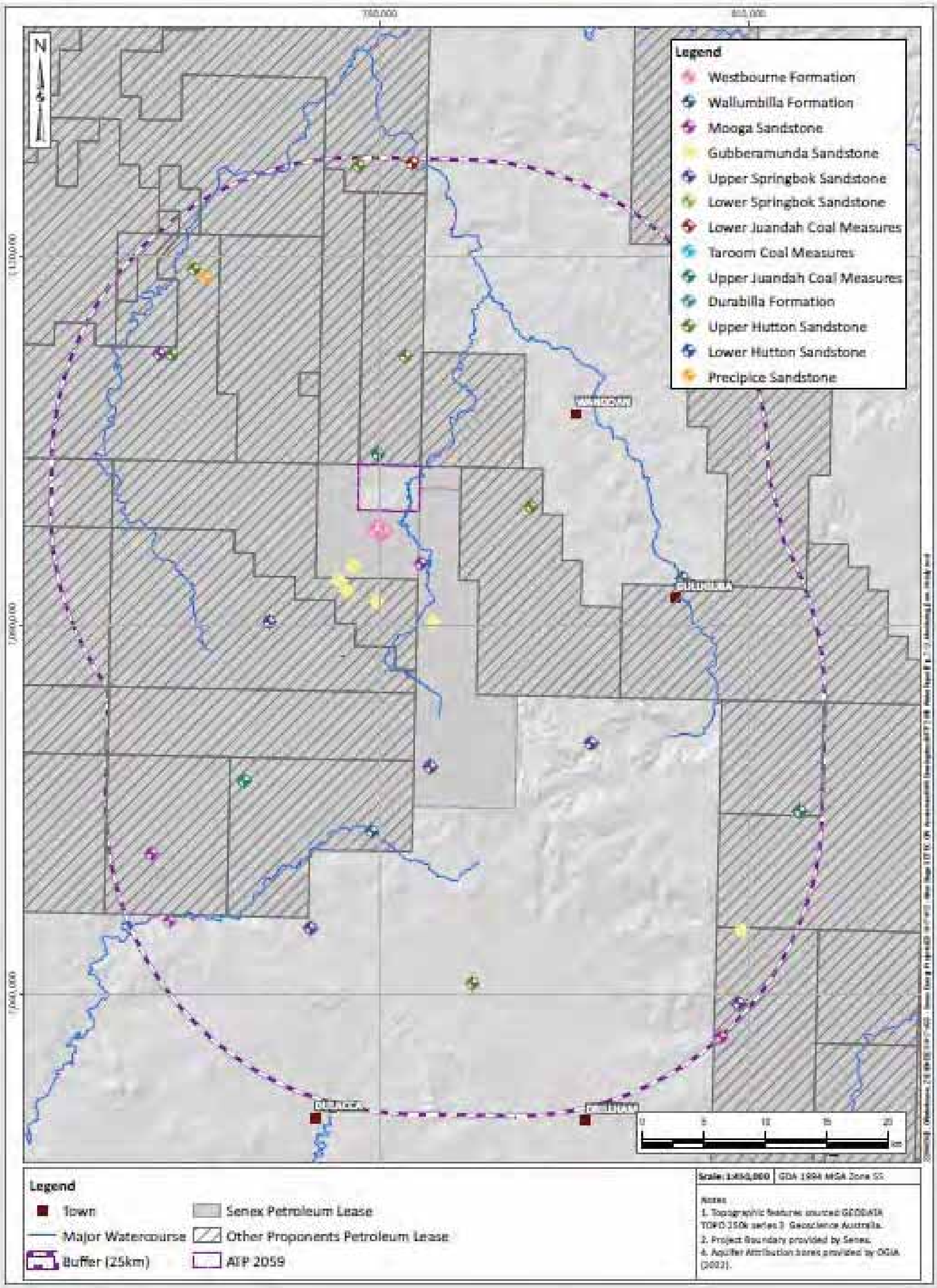
Senex has installed six groundwater monitoring bores at three nested sites across PL 445 and PL 209 (Table 25). These bores were installed in late 2022 and early 2023 to provide site specific hydrogeological information and provide long-term monitoring locations. These bores are installed in the alluvium and the underlying consolidated formations of the Springbok Sandstone and Westbourne Formation. An additional set of nested monitoring bores, one in the alluvium and one in the Springbok Sandstone, is planned for PL 445 along Woleebee Creek on the Springbok Sandstone suboutcrop. These bores will assist with long-term monitoring of potential groundwater dependent ecosystems along Woleebee Creek.

Table 25:Senex Groundwater Monitoring Network

RN	Owner	Source Aquifer	Location	Monitoring Status
160631	Senex	Upper Springbok	PL 209	Senex WMS obligation (formerly APLNG monitoring)
160764	Senex	Upper Juandah Coal Measures Lower Juandah Coal Measures Taroom Coal Measures	PL 209	Senex WMS obligation (formerly APLNG monitoring)
58824	Landholder bore	Westbourne Formation	PL 1037	Seepage background bore
180072	Senex			Seepage monitoring bore
180075	Senex			
180073	Senex			
180077	Senex			
180079	Senex			
180078	Senex			
180080	Senex			

RN	Owner	Source Aquifer	Location	Monitoring Status
180071	Senex			
180076	Senex			
180074	Senex			
180128	Senex	Westbourne Formation	ATP 2059	Senex Network
180127	Senex	Alluvium		
TBC	Senex	Springbok		
TBC	Senex	Alluvium		
TBC	Senex	Westbourne or Gubberamunda	PL 209	
TBC	Senex	Alluvium		

Figure 21: Location of Monitoring Bores in the Vicinity of the Project Area (from KCB 2021)



8.2.2.7 Walloon Coal Measures Monitoring

There are 27 WCM monitoring bores in the vicinity of the Project area (Figure 21). The majority of these locations include multi-unit monitoring bores across the different coal seams of the WCM, meaning that there are only 10 discrete locations (Figure 21):

- Nine bores in the Upper Juandah Coal Measures;
- Eleven bores in the Lower Juandah Coal Measures; and
- Seven bores in the Taroom Coal Measures.

These monitoring locations are likely operated by neighbouring CSG tenure holders and show a variety of responses which are likely due to depressurisation or testing which has commenced in these areas. Observations from available data include:

- Groundwater elevations within the WCM range between ~340 mAHD and 70 mAHD.
- Groundwater flow in the WCM is generally south to north towards Taroom. However, CSG development areas result in Total zed variations to this regional flow direction (OGIA 2021a).

Drawdown in the CSG areas is steep, with little drawdown observed outside of the operating fields. This is likely to reflect the discontinuous nature of the coal seams in these gas fields and low effective horizontal permeabilities (OGIA 2021a). This explains the variety of responses in the groundwater elevations.

8.2.2.8 Lower Springbok Sandstone Monitoring Bores

There are two Lower Springbok Sandstone monitoring bores, at two locations, with groundwater elevation data available in the vicinity of the Project area (Figure 21).

There are two Lower Springbok Sandstone monitoring bores within the 25 km buffer zone. Observations from available data include:

- Groundwater elevations range between ~269 and ~277 mAHD.
- Groundwater levels in in RN 160853 have remained stable. However, RN 160430 may be influenced by pumping in the Upper Sandstone (OGIA 2021a).

8.2.2.9 Upper Hutton Sandstone Monitoring Bores

Temporal groundwater elevations for the Hutton Sandstone are available for eight sites within the vicinity of the Project area.

The range of groundwater elevation from these monitoring bores is between ~235 mAHD and 287 mAHD. Generally, most groundwater level records present relatively static groundwater levels with the exception of RN 160807 and RN 160505 which show a gradual decline. The monitoring record for RN 58133, located north of the Project, indicates a response to local pumping. RN 160722 and RN 44000 may also be responding to local water use.

8.2.3 Groundwater Chemistry

Regional groundwater chemistry associated with each hydrostratigraphic unit occurring within the Project area has been summarized from OGIA (2016) (Table 26) and shows Total Dissolved Solids (TDS) (used as an indicator of salinity) varies widely between formations.

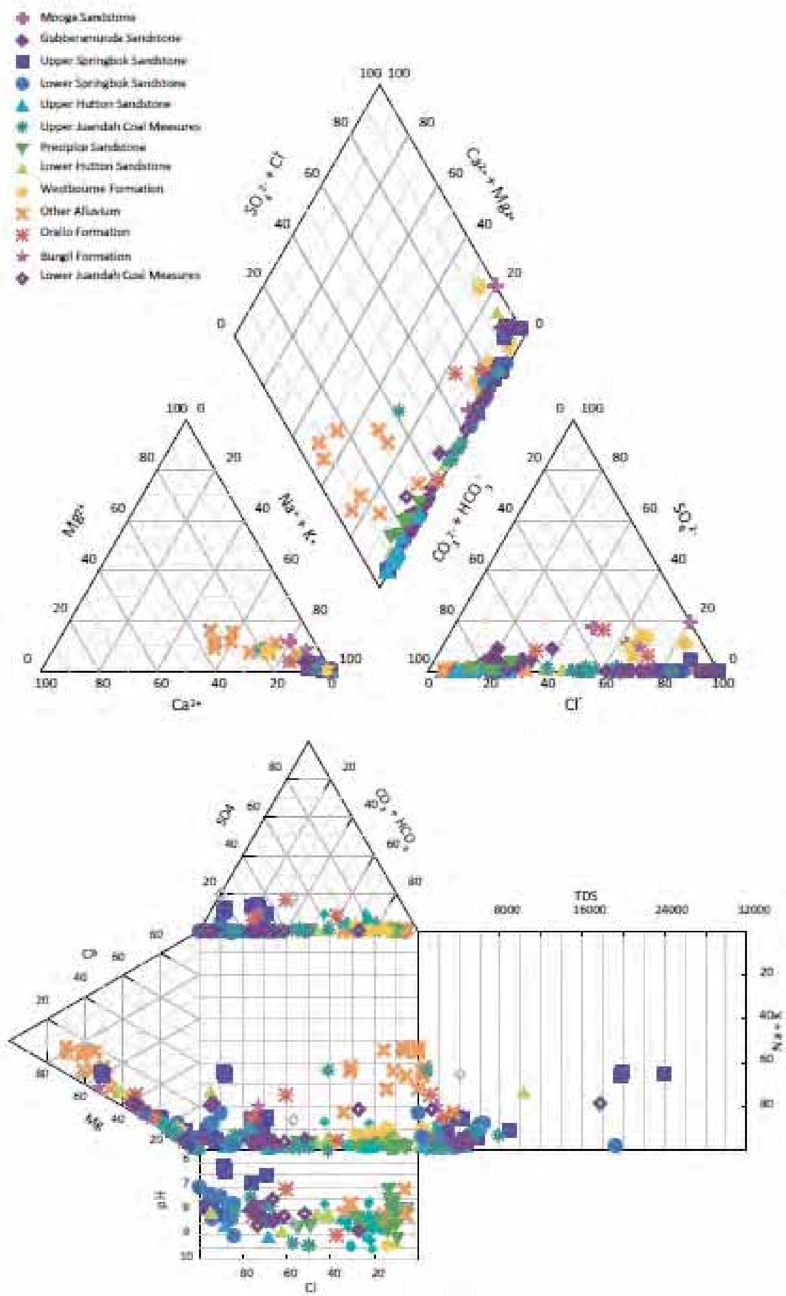
Table 26 Summary of Regional Groundwater Geochemistry (OGIA, 2016)

Hydrostratigraphic Unit	OGIA (2016b) Description
Orallo Formation	Fresh to saline conditions with TDS ranging from 75 to 20,000 mg/L, mean of 1,700 mg/L.
Gubberamunda Sandstone	Fresh to brackish water. Mean TDS of 450 mg/L with a range of between 70 and 7,500 mg/L. Mean TDS ranges between 480 to 1,160 mg/L, depending on location category.
Westbourne Formation	Characterised by fresh to saline groundwater (TDS mean of 1,500 mg/L), ranging from 150 to 19,000 mg/L.
Springbok Sandstone	Fresh to brackish water quality, with a mean TDS of 1,000 mg/L (ranging between 200 and 7,000 mg/L).
WCM	Fresh to saline groundwater, TDS ranges from 30 to 18,000 mg/L, with a mean TDS of around 3,000 mg/L.
Hutton Sandstone	TDS ranges from 70 to 16,000 mg/L, with a mean TDS of around 1,600 mg/L, low salinity calcium and magnesium bicarbonate type water in the recharge areas, to a relatively high-salinity sodium-chloride type water in discharge areas.
Evergreen Formation	Low salinity (TDS) and concentrations of sodium and chloride, TDS ranges from 80 to 670 mg/L, with a mean TDS of around 260 mg/L.
Precipice Sandstone	Precipice Sandstone has the freshest groundwater in the Surat CMA, salinity ranges from 50 to 850 mg/L with a mean salinity (TDS) of 193 mg/L.

Groundwater chemistry data has been sourced from the Groundwater Database (GWDB) for bores within a 25 km buffer of the Project. **Error! Reference source not found.** presents a Durov and piper diagram constructed from the GWDB records, and from this the following observations can be made:

- All of the samples (regardless of formation) show either a sodium-chloride signature or a sodium-bicarbonate signature water type.
- The groundwater samples from the alluvial bores have a different signature to the Surat Basin units, with a stronger sodium-bicarbonate signature.
- Fresher groundwater is observed in the samples from the alluvium, Gubberamunda Sandstone and Hutton Sandstone, with higher Electrical Condictivity (EC) in samples measured from the WCM and Springbok Sandstone.

Figure 22: Durov and Piper diagram from GWDB bores within 25km of the Project Area



8.3 Conceptual Hydrogeological Model

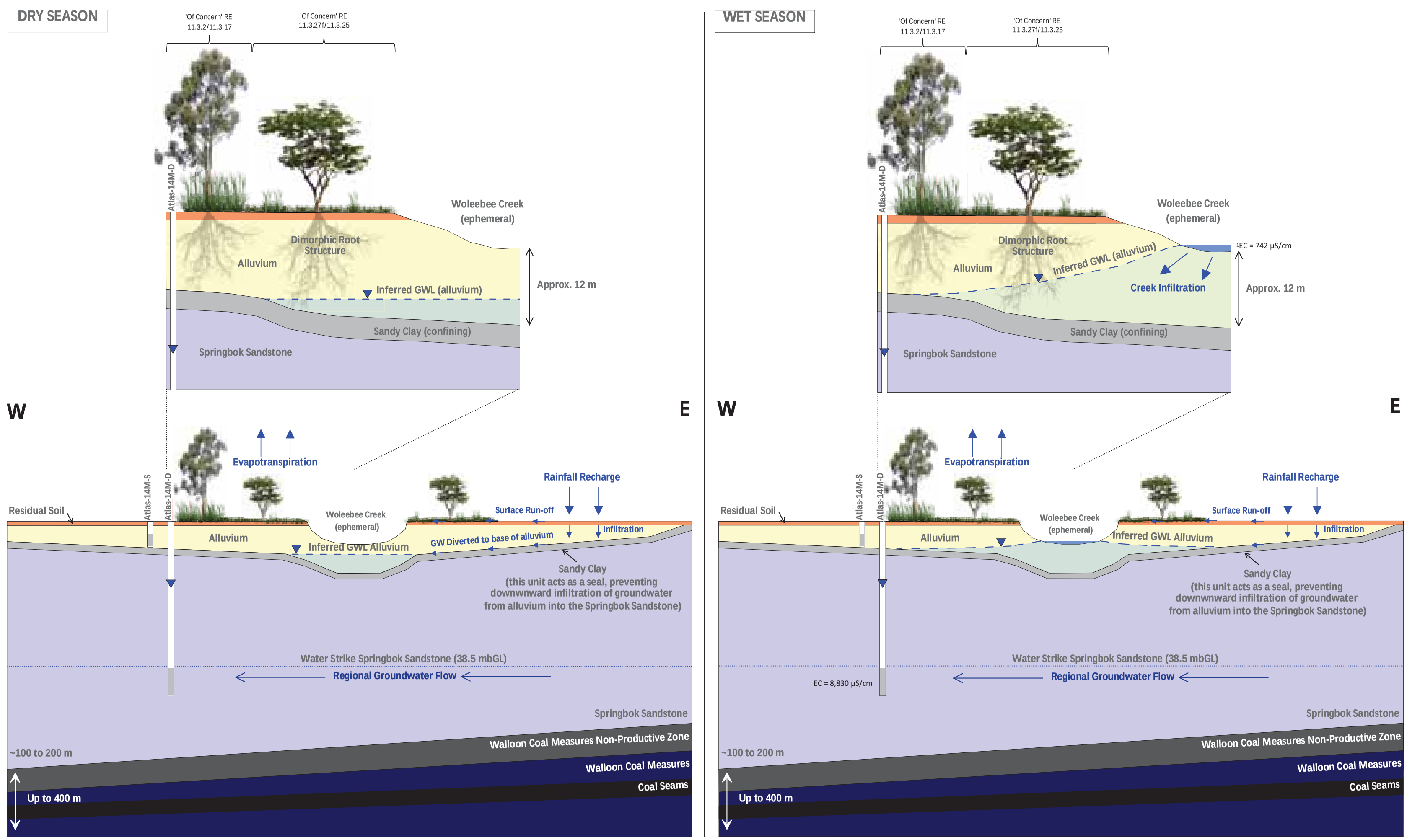
The hydrological and hydrogeological systems for ATP 2059 is shown in Figure 18 and **Error! Reference source not found.** and can be summarised as follows:

- The target for CSG production is the WCM, which occurs at ~220 to 300 m below ground level; and is ~400 m thick.
- The surface geology within ATP 2059 comprises outcrops of the Gubberamunda Sandstone and Westbourne Formation of the Surat Basin. The Upper Springbok Sandstone outcrops within the north eastern extent of ATP 2059. Quaternary-age alluvium is present along the

Woleebee and Conloi Creek systems.

- The WCM outcrop 14 km to the north and northeast of the Project area, while the Orallo Formation outcrops to the southeast.
- The WCM is separated from overlying and underlying aquifers by aquitard layers of the Upper WCM aquitard and Durabilla Formation (**Error! Reference source not found.**).
- The watercourses within the Project area, Wandoan and Woleebee Creeks, are characteristically ephemeral and typically flow only during significant rainfall events. Pooled water may remain after significant rainfall events, which provides a habitat for a limited number of aquatic species. Shallow pools were identified in the watercourses but were generally turbid with water quality results indicating that these pools are fresh and surface water sourced.
- Baseflow contributions from the alluvium and Surat Basin units to the watercourses are considered unlikely. It is likely that the groundwater system in the alluvium is replenished by surface water during prolonged wet periods when the ephemeral creek system is flowing.
- The alluvial systems present within the Project area are generally associated with Wandoan and Woleebee Creeks. Alluvial bank heights of up to 8 m have been observed along Woleebee Creek within PL 445 and alluvial depths of up to 18 m confirmed in registered bores within ATP 2059. The water quality of the alluvium indicates that it is recharged and replenished by surface water during prolonged wet periods during periods of creek flow. The water quality is distinct from groundwater in the underlying Westbourne Formation or Springbok Sandstone, which is generally more saline.
- Groundwater use within the Project area is limited to the shallowest units of the Gubberamunda Sandstone, Westbourne Formation and Springbok Sandstone, with bores used for stock and domestic purposes. Further afield, groundwater is also accessed from the deeper units for both stock and domestic purposes, and town water supply.

Figure 23: Hydrogeological Conceptualisation



1. This measurement was taken during a 2023 site investigation

8.4 Numerical Groundwater Modelling

At the request of Senex, OGIA has simulated an appraisal scenario using the 2021 Surat Basin Cumulative Management Area groundwater model based on production plans provided by Senex. A detailed description of the model and the modelled scenarios, and outputs is provided in KCB 2023 (Appendix E). The model scenarios and outputs are summarised below:

- Cumulative drawdown associated with all CSG and coal mining activities but excluding the Project (ATP 2059, PL 209, and PL 445) and the APLNG Woleebee gas field.[6]
- Drawdown associated with 31 wells on ATP 2059 and 120 wells on PL 445 and PL 209 (total of 151 wells) (Project only).

Total cumulative drawdown of the Project, plus all other CSG and coal mining projects, is calculated by adding the individual drawdown predicted by the Project only, to the cumulative scenario without the project, resulting in a cumulative drawdown scenario for the project development scenario.

8.4.1 Project Only Scenario Results

The following observations have been made based on the output of the OGIA project-only numerical model outputs (Figures 8.3 and 8.4 of Appendix E):

- Drawdown greater than 0.2 m (spring trigger threshold) is predicted in model layer 8 (Westbourne Formation) to model layer 18 (Durabilla Formation) (Figure 8.3 and Figure 8.4 of Appendix E).
- Drawdown greater than 5 m (consolidated bore trigger threshold) is predicted in model layers 10 to 18 (Lower Springbok Sandstone to Durabilla Formation).
- The highest drawdown is predicted in model layer 17, which represents the Taroom Coal Measures.
- Drawdown within the Upper Juandah Coal Measures Layer 2 (model layer 13) has the widest drawdown extent: 13.1 km beyond the Project area extent.

8.4.2 Cumulative Scenario Results

The cumulative drawdown results indicate drawdown within the vicinity of the Project area for the Westbourne Formation, Springbok Sandstone, WCM and Hutton Sandstone. The majority of the drawdown occurs towards the west of the Project, associated with neighbouring CSG developments. Drawdown also occurs to the southeast, where other CSG proponents are also operating (Figure 8.5 and Figure 8.6 of Appendix E).

8.5 Impact Assessment

This section presents the potential project impacts from the drawdown associated with the 31 wells on ATP 2059 and 120 wells on PL 445 and PL 209 (total of 151 wells). The activities on the three PLs were modelled by OGIA together as the full Atlas Stage 3 Project. Therefore, the results present an overly conservative assessment of impact from the activities on ATP 2059.

8.5.1 Impacts to Groundwater Users

Model outputs from the 'Project only' simulation are summarised in Table 27 and indicate:

- Predicted drawdown (of any magnitude) is observed in bores attributed to most

[6] The original 2021 UWIR model included the approved APLNG 'Woleebee' gas field in PL 445 and PL 209, therefore, this gas field was removed for the modelled scenarios.

hydrostratigraphic units. However, only bores in the WCM are predicted to experience a drawdown greater than 5 m.

- There are 23 bores in the WCM which have a predicted drawdown greater than 5 m. These bores are screened in the Upper Juandah Coal Measures (21 bores) and the Taroom Coal Measures (two bores). Fifteen of these bores are predicted to experience drawdown of less than 10 m, six between 10 and 20 m drawdown, and only two with a drawdown of more than 20 m. The maximum predicted drawdown in any one bore is 123.32 m (screened in the Upper Juandah Coal Measures).
- Of these 23 bores, 12 are noted by OGIA as water supply bores, ten bores are noted as 'not water supply', and one as 'potential water supply'. The location of these bores, where the water level is predicted to drawdown greater than the trigger threshold, is presented in Figure 24.
- The groundwater bores triggered in the Project only scenario, are already triggered by adjacent developments (e.g., without any contribution from the Project).

As discussed in Section 8.2.2 five bores in the vicinity of the Project are used for town water supply which target the Precipice Sandstone, the Lower Hutton Sandstone and the WCM. These bores are located near Wandoan and to the north of the Project area, approximately 14 km away. Predicted drawdown impact to these town water supply bores from the 'project only' scenario is less than 0.1m.

Table 27: ATP 2059, PL 209, PL 445 impact assessment results

Formation	Number of Bores within 25km	Number of Bores with Drawdown	Number of Bores Predicted to Exceed Trigger Thresholds	Maximum Drawdown Predicted Across the Bores (m)
Bungil Formation	29	0	0	0
Mooga Sandstone	59	0	0	0
Orallo Formation	74	0	0	0
Gubberamunda Sandstone	148	62	0	0.01
Westbourne Formation	38	13	0	0.11
Upper Springbok Sandstone	45	35	0	2.33
Lower Springbok Sandstone	15	14	0	1.11
Walloon Coal Measures	228	220	23	123.34
Durabilla Formation	5	2	0	0.02
Hutton Sandstone	47	3	0	0.01
Evergreen Formation	2	0	0	0
Precipice Sandstone	37	0	0	0
TOTAL	**747**	**349**	**23**	**n/a**

Model outputs from the Cumulative scenario are shown in **Error! Reference source not found.** and Figure 24 and indicate:

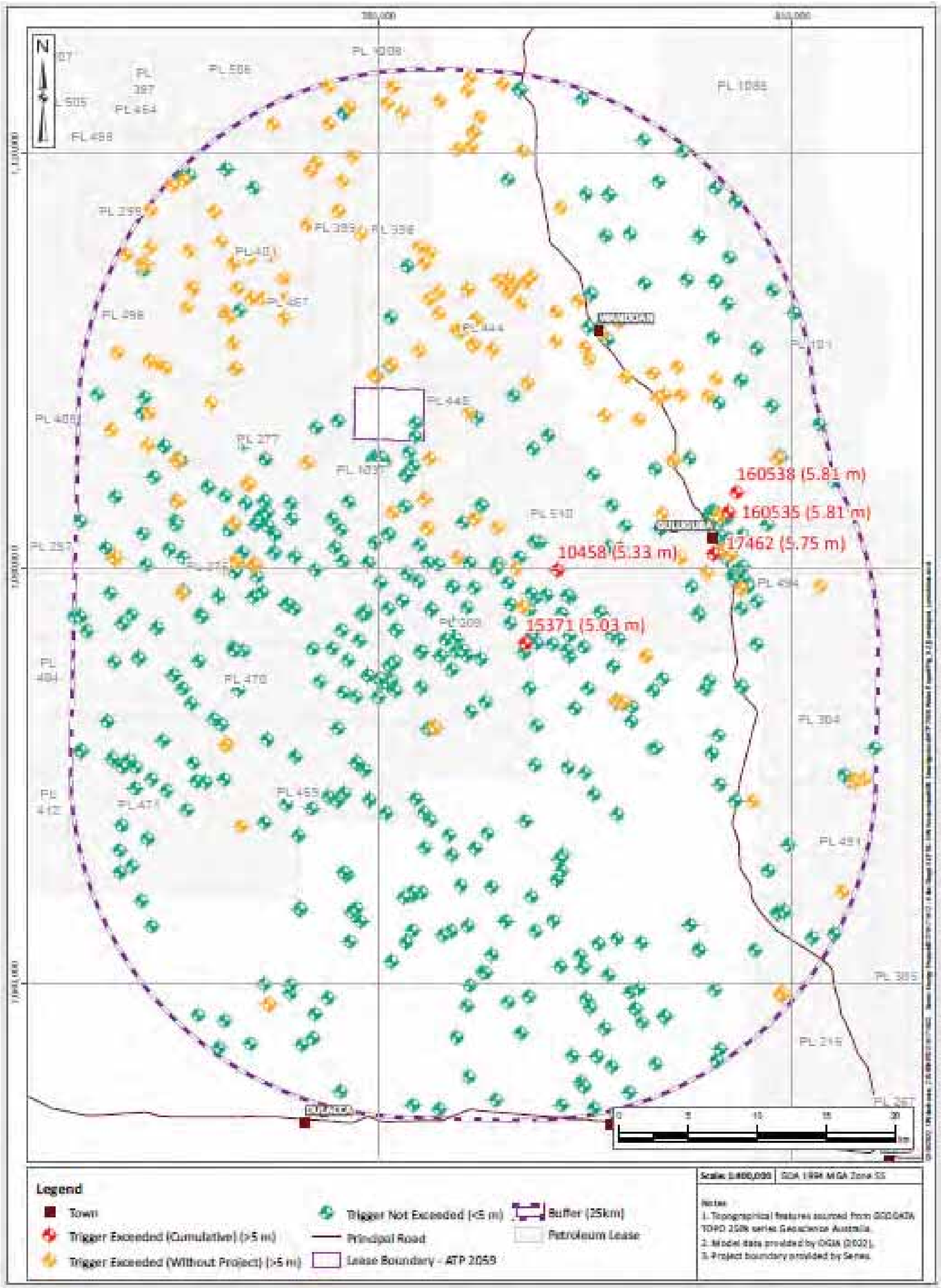
- 248 bores within 25 km of the project area are triggered (i.e., >5 m drawdown).

- The contribution of the Project development results in five additional bores being triggered in the cumulative scenario. Two are attributed to the Upper Springbok Sandstone and three are attributed to the Upper Juandah Coal Measures. The locations of these bores are presented on Figure 24.
- Of the five additional bores, none are located on tenement and are all located off-site to the east. One of these bores is noted as “Abandoned and destroyed”, two are noted as “Monitoring bores (and not water supply bores)”, and two are noted as “Existing bores”. Of the existing bores, a bore baseline assessment confirmed one of these bores is blocked and has not been used since 1996 (Arrow 2013). The maximum Project only contribution to drawdown on the only existing, usable bore is 26%.
- Of the 248 bores, the Project only contribution to drawdown of more than 1% occurs at 99 bores, and more than 10% at 36 bores. The maximum contribution from the Project is 81%, this bore is located on PL 209 which has been confirmed as not existing through the 2022 Baseline Assessment (KCB 2023).

Table 28: Cumulative Scenario Impact Assessment Results

Formation	Number of Bores within 25km	Project Only – Number of Bores Triggered	Cumulative – Number of Bores Triggered
Bungil Formation	29	0	0
Mooga Sandstone	59	0	0
Orallo Formation	74	0	0
Gubberamunda Sandstone	148	0	0
Westbourne Formation	38	0	3
Upper Springbok Sandstone	45	0	22
Lower Springbok Sandstone	15	0	14
Walloon Coal Measures	228	23	205
Durabilla Formation	5	0	4
Hutton Sandstone	47	0	0
Evergreen Formation	2	0	0
Precipice Sandstone	37	0	0
TOTAL	**727**	**23**	**248**

Figure 24: Summary of Cumulative Impacts to Groundwater Bores



8.5.2 Bore Impact Management Measures

The *Water Act 2000* outlines requirements for make good obligations of a resource tenure holder for a bore located in immediately affected areas. Tenure holders must carry out a bore assessment and enter into a make good agreement with the bore owner if the bores are located within an immediately affected area. The UWIR assigns bores to tenure holders located within immediately affected areas. There is currently one bore assigned to Senex within an immediately affected area in PL 445 (formerly assigned to Origin APLNG; RN 58910 in the Upper Juandah Coal Measures).

The results of the impact assessment to groundwater users (Section 8.5.1) indicate that development of the project may result in five additional bores experiencing water level decline < 5 m. Two of these bores are attributed to the Upper Springbok Sandstone and three are attributed to the Upper Juandah Coal Measures. These bores are not located on Senex tenements and only one appears to be existing and in a 'usable' condition.

8.5.3 Impacts to GDEs

The potential impacts discussed in the following sub-sections are based on the outputs of the two scenarios modelled by OGIA. These scenario's both included 120 proposed wells from the adjacent Senex owned PL 209 and PL 445 as well as the 31 wells proposed for PLA 1127, so represent a conservative assessment of impacts.

Outcropping geological formations in the Project area have the potential for connection to aquatic and terrestrial GDEs, either directly, or through connections to overlying alluvial deposits. The areas of interest for assessment of impacts to GDEs are the outcrop areas of:

- Westbourne Formation – this unit outcrops within ATP 2059.
- Upper Springbok Sandstone – this unit outcrops under PL 445 and to the north / northeast of PL 445 and PL 209 to the east of ATP 2059.
- Gubberamunda Sandstone – this outcrops under the southern extent of ATP 2059.

Areas of interest were identified by the 0.2 m drawdown extent for each outcrop formation. Potential drawdown greater than 0.2 m in these outcropping geological units have been compared to locations of potential GDEs and springs from the Queensland GDE mapping (State of Queensland 2018a) and field verification by ERM ecologists for GDEs located within the Project area.

In summary:

- Project only drawdown of more than 0.2 m is not predicted for the Gubberamunda Sandstone for the Project only scenario, and cumulatively the Project does not contribute to any further potential GDE areas exceeding the 0.2m trigger. Potential GDEs on the Gubberamunda Sandstone are not considered further in the GDE assessment.
- Project only drawdown in the Westbourne Formation is predicted to be less than 0.2 m on any Westbourne Formation outcrops. The Project does contribute cumulatively to additional drawdown in the outcrop area of the Westbourne Formation. This occurs in a small area of the Westbourne Formation outcrop in PL 1037 (Atlas) and neighbouring tenement PL 277 to the west (QGC).
- The groundwater in the Upper Springbok Sandstone outcrop area is predicted to have a drawdown greater than 0.2 m due to the Project development (Project only simulation), resulting in this formation being the main formation of interest for this GDE impact assessment.

8.5.3.1 Watercourse Springs

The modelled project only scenario does not result in drawdown in the potential source aquifers at potential watercourse spring locations (Section 8.2.2). The predicted cumulative drawdown is also

<0.2 m, so make good thresholds and other impact criteria are not triggered.

8.5.3.2 Terrestrial GDEs

Westbourne Formation

- There are no terrestrial GDEs mapped in the predicted 0.2 m Project only drawdown extent.
- One potential terrestrial GDE is mapped on the Westbourne Formation outcrop within the predicted 0.2 m cumulative drawdown extent (Surat_RS_01C).
- The Project alone does not result in drawdown greater than the 0.2 m trigger at GDE areas.
- Cumulative drawdown is greater than 0.2 m, with a predicted drawdown of 2.6 m. The Project contribution to this cumulative drawdown is about 6%.

Springbok Sandstone

Four potential terrestrial GDEs located on the Springbok Sandstone outcrop within the 0.2 m Springbok Sandstone Project only drawdown extent. None are within the project area (Figure 25 and Table 29).

These GDEs are described as:

- Surat_RS_01A: Quaternary alluvial aquifers overlying sandstone ranges with fresh, intermittent groundwater connectivity regime (moderate confidence in GDE status).
- Surat_RS_03A: permeable consolidated sedimentary rock aquifers with fresh, intermittent groundwater connectivity regime (low confidence in GDE status).

The identified GDEs are all located along ephemeral creek systems. Bore logs from nearby registered bores confirm the presence of alluvium at each of these locations, which likely functions as the GDE water source (Section 7.3.4). The water quality of the alluvium indicates that groundwater in this aquifer is replenished by surface water during prolonged periods of rainfall (Section 7.3.4), when the ephemeral creeks are flowing. The distinction between the alluvium water quality and underlying Westbourne Formation and Springbok Sandstone water quality (which is of higher salinity) indicates that these units are disconnected. Identified GDEs are considered to be resilient and adapt well to stress, with the larger eucalypts (including Forest Red Gums) having a dimorphic root system, well adapted to the drying and wetting ephemeral setting associated with the creek systems (Section 7.3.4).

Based on the available characteristics of the GDE physiographic setting, it is interpreted that these potential GDEs:

- May be intermittently supported by groundwater in the alluvium, which is not predicted to experience drawdown, and not hydraulically connected to the Upper Springbok Sandstone (predicted to experience drawdown); and,
- Are being triggered cumulatively by neighbouring activities without the presence of the Project (by the Wandoan Coal Project and other CSG activities).
- Contributing drawdown impacts from the Project to potential Terrestrial GDE’s associated with the Springbok Sandstone are not considered significant

Based on the above, it is concluded that the contributing drawdown impacts from the Project to potential terrestrial GDEs are not significant.

Figure 25: Mapped Potential Terrestrial GDEs and Predicted Drawdown (0.2m contours) Upper Springbok Sandstone

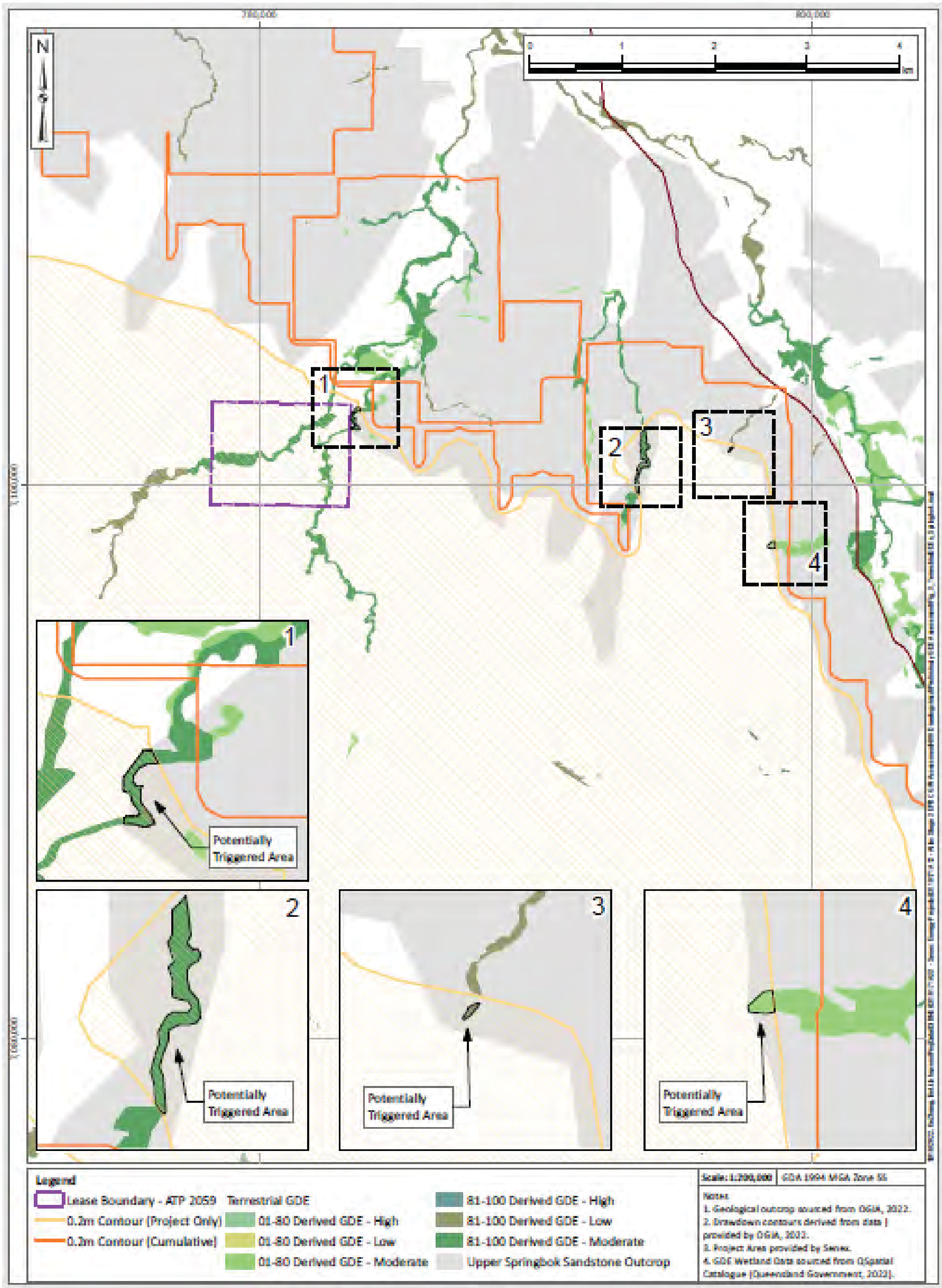


Table 29: Terrestrial GDEs within the Predicted 0.2 m Drawdown Extent on the Upper Springbok Sandstone Outcrop

No.	Location	GDE Rule ID	Source Aquifer	Project only scenario drawdown	Cumulative scenario drawdown	Proportional contribution of Project	Area of potentially affected GDE (km^2)	RE
1.	Within PL 445 at the boundary of ATP 2059 and PL 445	Surat_RS_01A	Alluvium	0.00	0.08	-	-	11.3.25 (Forest Red Gum *Eucalyptus tereticornis* woodland fringing drainage lines) however areas of RE 11.3.2 (Poplar Box *Eucalyptus populnea* woodland on alluvial plains), RE 11.3.27 (Freshwater wetlands: Coolabah (*Eucalyptus coolabah*) and/or Forest Red Gum) open woodland to woodland fringing swamps) and RE 11.3.17 (Poplar Box woodland with Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) on alluvial plains) are also present.
		Surat_RS_03A	Upper Springbok Sandstone	0.90	4.57	19.69	0.07	
2	10.3 km E of ATP 2059	Surat_RS_01A	Alluvium	0.00	0.08	-	-	RE 11.3.25 *Eucalyptus tereticornis* or *E. camaldulensis* woodland.
		Surat_RS_03A	Upper Springbok Sandstone	0.28	5.12	5.47	0.17	
				0.48	8.42	5.70	0.05	
3	13.7 km east of ATP 2059	Surat_RS_03A	Upper Springbok Sandstone	0.45	36.74	1.22	0.001	11.9.5/11.9.10
				0.32	29.3	1.09	0.01	
4	~15 km southeast of ATP 2059	Surat_RS_01A	Alluvium	0.00	0.07	-	-	RE 11.3.25 *Eucalyptus tereticornis* or *E. camaldulensis* woodland.
		Surat_RS_03A	Upper Springbok Sandstone	0.51	2.24	22.76	0.02	

8.5.3.3 Subterranean GDEs

Impacts to potential stygofauna habitats are limited to the unconfined outcrop areas. Stygofauna have been identified in PL 1037 in the Gubberamunda Sandstone/Westbourne Formations and Upper Springbok Sandstone (KCB 2018d). The impact assessment identified the following with regard to stygofauna:

- For ecological systems potentially reliant on groundwater within the shallow aquifers, the cumulative scenario does not predict any drawdown within the Gubberamunda Sandstone from the Project.
- For ecological systems potentially reliant on groundwater in the Westbourne Formation outcrop, the Project only drawdown in the Westbourne is predicted to be less than 0.2 m. The results of the numerical modelling indicate that there is negligible (at most a 2%) reduction in saturated thickness in the outcrop areas of the Westbourne Formation to the west and east of the Project area.
- Drawdown is predicted in the Upper Springbok Sandstone within outcrop areas to the north and northeast of the Project area. These areas are cumulatively triggered without the presence of the Project with the Project contributing up to 0.9m of drawdown within PL 445, this equates to a proportional drawdown contribution of the Project of ~20%. Given the overall thickness of the Springbok Sandstone of ~100 m, the reduction in saturated thickness from the Project only is negligible.

Impacts to subterranean fauna as a result of the Project development are not predicted.

8.5.3.4 Impacts from Subsidence

Depressurisation associated with CSG water extraction from the WCM may result in the compaction of coal seams. Compaction generally occurs as water is removed from the pores of saturated, high porosity layers (such as clay and silt) (IESC 2014). Most of the compaction in response to depressurisation occurs in coal seams as they contain cleats and fractures are relatively more compressible compared to interburden material (such as sandstone, siltstone and mudstone). These layers cannot maintain the increased vertical stress as water pressure reduces, and the layers compact, resulting in subsidence of the land surface (IESC 2014). Some of the compaction is elastic, allowing a degree of recovery and reversal of subsidence when groundwater pressure is returned (i.e. post-depressurisation).

Desorption of gas from the coal seams can result in additional compaction (IESC 2014). This compaction is minor and estimated to be approximately 1% of the coal thickness (Robertson 2005).

The potential for subsidence to occur is influenced by two primary factors: the magnitude of change in groundwater level; and the thickness and type of formations overlying the reservoir (OGIA 2021). The greatest effect on CSG-induced subsidence is the magnitude of depressurisation, its pattern and how it develops over time across a gas field (OGIA 2021).

Ground movement also occurs naturally (i.e. the ground movement caused by factors other than the CSG-induced subsidence) from the shrinking or expansion of high-clay-content soils due to changes in moisture content, depressurisation resulting from groundwater use in aquifers overlying the target coal formation and, land management practices, such as irrigation, tillage and land contouring. This must be factored into any monitoring and observation of CSG-induced subsidence.

<u>Project Related Subsidence</u>

The assessment of subsidence is within the legislative scope of the Underground Water Impact Report (UWIR) which is undertaken for the Surat Basin by OGIA. The UWIR is required to assess subsidence impacts that may have already occurred and are likely to occur in the future.

The subsidence resulting from the predicted cumulative drawdown scenario (including the Project) has been estimated to be up to 0.063 m, with a range of 0.006 to 0.063 m (cumulative). The subsidence estimated from the Project only drawdown scenario is predicted between 0.002 and 0.058 m. The maximum change in ground slope from CSG-induced subsidence is expected to be less than 0.002% (20 mm over a km). The cumulative and Project only drawdown subsidence predictions are provided in Figure 26.

Figure 26: Predictive Cumulative and Project Only Subsidence

It is understood that consolidated sandstone formations attenuate impacts, as the strength of these consolidated formations are likely to result in a ‘bridging effect’ and reduce the degree to which compaction at depth in the coal measures manifests as subsidence at the ground surface (OGIA 2021f). The presence of the Springbok Sandstone and the Gubberamunda Sandstone will assist with attenuating these impacts. Actual subsidence will most likely be less than that calculated.

The overall risk to EVs from subsidence is regarded as low.

8.5.4 Groundwater Impact Summary

The outcomes of the assessment are summarized below in **Error! Reference source not found.**.

Table 30: Groundwater Impact Assessment Summary

Environmental Value	Impact	Comment
Groundwater Users	Negligible	The five bores predicted to experience drawdown of >5m are already triggered by adjacent developments
Watercourse springs	Negligible	The modelled project only scenario does not result in drawdown in the potential source aquifers at potential watercourse spring locations
Terrestrial GDE – Westbourne Formation		No terrestrial GDEs mapped in the predicted 0.2 m Project only drawdown extent. Contributing drawdown impacts from the Project to potential terrestrial GDEs are not significant.
Terrestrial GDE – Springbok Sandstone		Four GDEs are identified within the project only 0.2m drawdown extent. However, all are located along ephemeral creeks and are interpreted as not hydraulically connected to the Upper Springbok Sandstone. Further, drawdown from adjacent project activities exceeds 0.2m without the contribution from PLA 1127. Contributing drawdown impacts from the Project to potential terrestrial GDEs are not significant.
Subterranean GDEs	Nil	Reduction in saturated thickness from modelled Project-only scenario is negligible (<2%). Impacts to subterranean fauna as a result of the Project development are not predicted.
Subsidence	Negligible	Consolidated sandstone formations located above the CSG target formation likely to attenuate any potential impacts through a ‘Bridging Effect’ which would attenuate any ground surface impacts from subsidence at depths.

9 Ecological Assessment

Field surveys in support of an ecological assessment for the Project Area were undertaken by Boobook Ecological Consulting Pty Ltd and Freshwater Ecology Consulting Pty Ltd which has been compiled by Environmental Resources Management Australia Pty Ltd (ERM) into a Terrestrial and Aquatic Ecology Assessment Report (EAR) for the PLA 1127 and is provided in Appendix F. The EAR describes ecological values within PLA 1127 and in turn identifies risks to biodiversity values and avoidance, mitigation and management measures, to support the development of the design, construction and operation of the Project.

9.1 Existing Environment

The main land use within the PLA 1127 is grazing of stock for beef production. This area is extensively cleared of native vegetation and converted to non-remnant pasture dominated by native and introduced grasses, notably Buffel Grass (*Cenchrus ciliaris*) and Sabi Grass (*Urochloa mossambicus*). Riparian woodland dominated by Queensland Blue Gum (*Eucalyptus tereticornis*) with some fringing areas of Poplar Box (*Eucalyptus populneus*), Brigalow (*Acacia harpophylla*) and Belah (*Casuarina cristata*), follows the winding course of major watercourses through this landscape.

The Project Area features watercourses on floodplains, surrounded by undulating hills. Watercourses (stream orders 1-4) intersect the Project Area, named watercourses include:

- Woleebee Creek runs south – north through the Project Area; and
- Wandoan Creek running from the northwestern boundary, meandering to the northern boundary of the Project Area, west of Jackson – Wandoan Road.

The Project Area is located entirely within the Brigalow Belt Bioregion and the Taroom Downs subregion.

9.2 Methodology

A summary of methodology for the EAR is provided in the following sub-sections.

9.2.1 Desktop Review

A number of desktop sources were reviewed to identify ecological values that may occur within the Project Area. A search area of the broader Senex Project Area and a 10 km buffer was used for the database searches as well as refined search for the Project Area. The Protected Matters Search Tool (PMST) and Wildlife Online (WO) results were cross-checked using Atlas of Living Australia (ALA) database locations of records in the context of the actual Project Area boundary. The search results and the full likelihood of occurrence assessment can be found in Appendix F.

Desktop information was sourced from the following databases:

- Protected Matters Search Tool (PMST) Report (DCCEEW) First accessed 15 August 2022 using 10 km buffer around the Project Area.
- Regional Ecosystem (RE) Version 12.2 mapping (DoR) to identify remnant communities listed as endangered, of concern or least concern status.
- Property Maps of Assessable Vegetation (PMAV) mapping (DoR) (published 16 September 2021).
- Queensland Government MSES mapping to identify areas of MSES as defined under the QLD State Planning Policy.
- Queensland Globe (DoR) A Google Earth based product that allows viewing of spatial data and imagery covering Queensland.
- WO (DES) A database that contains records of wildlife sightings including threatened flora and fauna species (protected under the NC Act) that have been provided to the agency by Government departments and external organisations.
- ALA (ala.org.au) Australia national biodiversity database (supported by the National Collaborative

Research Infrastructure Strategy, CSIRO). Threatened species are searched to identify known records in proximity to the Project Area.

- Darling Downs Regional Plan 2013 (Darling Downs Regional Council) The Darling Downs Regional Plan 2013 provides information relating to biodiversity, and wetland and waterway corridors.
- Species Profile and Threats Database (SPRAT) (DCCEEW) The SPRAT profiles and associated conservation advice documents were used in assessing Threatened Ecological Communities (TECs) found in field surveys, against the listed TEC guidelines.
- Previous Ecological Surveys in the Senex Atlas gasfield area (BOOBOOK, 2014, 2020, 2021a, 2021b, 2022; ERM, 2018 (all cited in ERM 2023)).

9.2.2 Field Surveys

Field surveys were conducted to identify and characterise the current presence, extent and condition of terrestrial and aquatic ecological values within the Project Area. Terrestrial field ecological surveys were undertaken in March (14-18th and 22-25th) and June (9-13th) of 2022. Aquatic field ecological surveys were undertaken in March (14-21st) 2022. Attexo Group undertook targeted Ooline and threatened flora surveys via vehicle based and foot traverses of the Project Area, over the periods 31st January – 3rd February 2023. The weather during the survey period was mild and wet with a total of 425.8 mm rainfall recorded from January to May (Bureau of Meteorology, 2022). This is significantly higher than the long term (1912-2021) median value of 204.2 mm (BOOBOOK, 2022, cited in ERM 2023). As such, wet weather caused impact to the field survey schedule and the soil remained moist with some areas waterlogged throughout the survey periods.

Although the field schedule was impacted by wet weather, it was determined that conditions during the survey periods were generally suitable for detection and identification of threatened flora. Planned targeted fauna searches were limited due to the increased rainfall. Due to this predictive mapping of threatened flora and fauna occurrence are conservative estimates of occurrence that assume species presence within areas of potentially suitable habitat (BOOBOOK, 2022b, cited in ERM 2022). As a result of the higher rainfall, it is more likely to have saturated the area and increased the surface water availability when the aquatic field surveys were completed in comparison to a typical year.

Details on field survey components, purpose and methodologies are provided in Table 31.

Table 31: Field Survey Components, purpose and methodologies

Component	Purpose / Parameters	Methodology
Baseline vegetation surveys	describe dominant flora and vegetation community structure within the Project Area Ground-truthing of the RE vegetation communities was undertaken using the quaternary level of data collection Ground-Truthing of Environmentally Sensitive Areas	Neldner *et al.*
Biocondition Assessments	determine ecological functionality of major vegetation types in the Project Area	Eyre et al. (2015)

Component	Purpose / Parameters	Methodology
Flora Species Survey	Targeted threatened species for listed EPBC Act and NC Act threatened flora. Significant weed species, Weeds of National Significance (WoNS) and Biosecurity Act 2014 Restricted Matters, were also recorded	
Fauna Species Survey	Targeted threatened species searches were undertaken for listed EPBC Act and NC Act threatened and/or migratory fauna within the Project Area	Incidental and targeted searches in accordance with species specific survey guidelines
Fauna Habitat Assessment	Data were collected for fauna habitat features to inform the likelihood of occurrence and significant impact assessments for EPBC Act and NC Act listed fauna species. Data were collected within the same plots surveyed as part of the vegetation assessments	
Aquatic Habitat Assessment	Completed at nine sites	Australian River Assessment System (AusRivAS) protocols (DNRM 2001)
Surface Water Quality	Temperature, pH, DO, EC and Turbidity	*Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES, 2018) and AS/NZ 5667.6:1998 Guidance on sampling of rivers and streams (AS/NZS 1998).
Aquatic Flora Sampling	Macrophytes	
Aquatic Invertebrate sampling	Macroinvertebrates	Stephens & Dowling (2002), Sainty & Jacobs (2003) and MacDonald & Haslam (2016).
Fish surveys	five locations sampled using backpack electrofishing. Sampling was carried out over a site reach spanning at least 100 m (where sufficient water was available).	Monitoring and Sampling Manual: Environmental Protection (Water) Policy (DES, 2018).
Turtle Surveys	Three had sufficient water to potentially support turtles. Two double winged two fyke nets (one large and one small) were set overnight. At one site, two cathedral traps were also deployed.	n/a
Platypus Habitat Assessment	Sites were assessed for the suitability for supporting platypus.	(Grant, 2007).
Frog Surveys	opportunistic visual encounter surveys and call surveys	n/a

9.2.3 Likelihood of Occurrence Assessments

A likelihood of occurrence assessment was undertaken and informed by the field survey results and desktop sources. Desktop sources identified a number of flora and fauna species listed under the EPBC Act (i.e. PMST search and NC Act WO records) that have previously been recorded or predicted to occur within a 10 km buffer of the Project Area.

The assessment ranks the likelihood of the species occurring within the Project Area through analysis of species distribution information, nearest known records and the presence of specific habitat attributes as identified through the desktop analysis and field surveys. The criteria applied are outlined in Table 32.

Table 32: Likelihood of Occurrence Criteria

	Preferred habitat exists	General habitat exists[7]	Habitat does not exist[8]
Records within the Project Area based on site surveys, and recent (within 20 year) records.	Known	Known	Known
Records in the adjoining areas[9]	Likely	Potential	Unlikely
No records in the adjoining areas, but the Project Area is within known distribution	Potential	Potential	Unlikely
No records in the adjoining areas, and the Project Area is outside of distribution	Unlikely	Unlikely	Unlikely

9.2.4 Threatened Species and Communities Habitat Mapping

Habitat and vegetation community mapping was prepared to reflect as accurately as possible actual ground conditions (based on data collected from 2022 field surveys). This habitat mapping used RE mapping to guide field investigations; however, the overall mapping results are defined by determining vegetation boundaries and floristic composition based on ground-truthed observations.

9.3 Survey Findings

9.3.1 Vegetation Communities and Broad Habitats

The Project Area has been classified into five broad habitat types (Table 33), defined based on vegetation community type, structure and is based on ground-truthed mapping using the RE verification method. The habitats in the Project Area are mostly in moderate to poor condition, with signs of degradation and fragmentation due to cattle grazing, erosion, and the presence of introduced flora species.

These habitat types have then been considered as respective foraging, breeding, roosting, denning, dispersal and movement functions for listed threatened and/or migratory species that are known, likely or have the potential to occur within the Project Area. This ground-truthed habitat mapping has been informed by these five habitat types, and subsequently used to identify areas of habitat for listed threatened species.

[7] Habitat may be considered general, but not preferred because: some desired habitat features may be present, but not all; habitat may have poor connectivity; or habitat may be known to be disturbed.
Based on sources review and/or field survey results.
[8] Based on sources review and/or field survey results.
[9] ‘Adjoining areas’ refers to a $10km^2$ buffer around the Project Area.

Table 33: Broad Habitat Types

Vegetation Community	Corresponding RE
Acacia woodlands dominated by Brigalow (*Acacia harpophylla*)	11.9.5 - *Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks.
Eucalypt dominated woodlands mainly of *Eucalyptus crebra, E. populnea* and *E. melanophloia*	11.3.2 - *Eucalyptus populnea* woodland on alluvial plains; 11.3.4 - *Eucalyptus tereticornis* and/or *Eucalyptus spp*. woodland on alluvial plains; 11.3.17 - *Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains; 11.5.1 - *Eucalyptus crebra* and/or *E. populnea*, *Callitris glaucophylla*, *Angophora leiocarpa*, *Allocasuarina luehmannii* woodland on Cainozoic sand plains and/or remnant surfaces; and 11.9.7 - *Eucalyptus populnea*, *Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks
Riparian and wetland Eucalypt woodlands dominated by *E. tereticornis*	11.3.25 - *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines; and 11.3.27f - Freshwater wetlands with *Eucalyptus coolabah* and/or *E. tereticornis* open woodland to woodland fringing swamps
Eucalypt open forest dominated by *E. populnea*	11.9.10 - *Eucalyptus populnea* open forest with a secondary tree layer of *Acacia harpophylla* and sometimes *Casuarina cristata* on fine-grained sedimentary rocks.
Cleared exotic pasture	The predominate type found throughout the Project Area. The dominant introduced grasses, are notably Buffel Grass (*Cenchrus ciliaris*) and Sabi Grass (*Urochloa mosambicensis*).

9.3.2 Regional Ecosystems

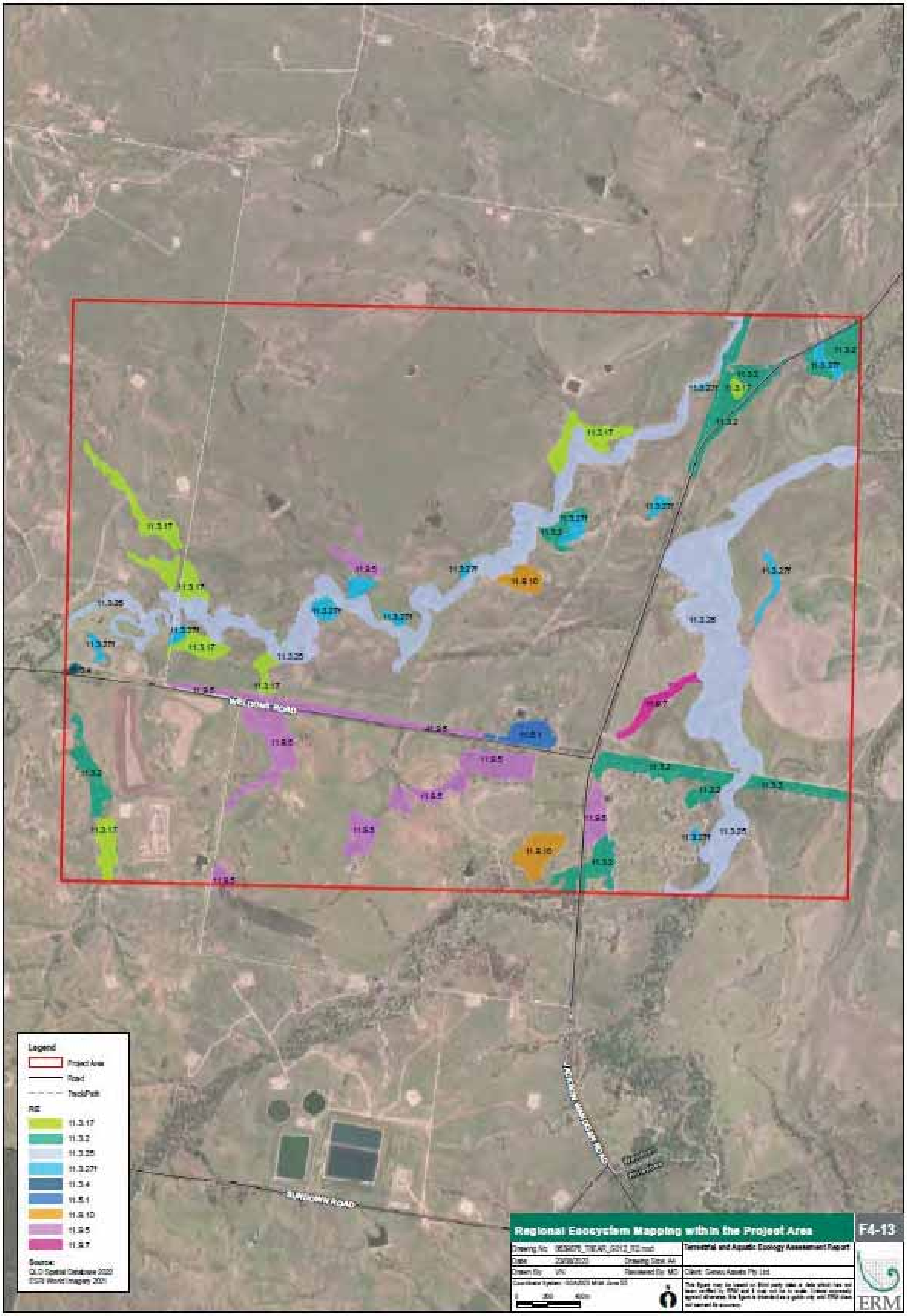
Ten REs covering a combined area of 307.9 ha have been mapped within the Project Area (Table 34 and Figure 27). Nine of these have a biodiversity status of Endangered or Of Concern under the *Vegetation Management Act 1999* (VM Act). The dominant vegetation community in the Project Area is RE 11.3.25: *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines.

Table 34: Ground-truthed Regional Ecosystems

RE Code	Description	Structure Category	VMA Class	Biodiversity Status	Area within Project Area (ha)	% of Project Area
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata open forest* on alluvial plains	Mid-dense	E	E	8.2	0.44
11.3.2	*Eucalyptus populnea* woodland on alluvial plains	Sparse	OC	OC	51.9	2.81
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains	Sparse	OC	OC	0.5	0.03
11.3.17	*Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains	Sparse	OC	E	33.8	1.83
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Sparse	LC	OC	130.5	7.06
11.3.27f	Freshwater wetlands: *Eucalyptus coolabah* and/or *E. tereticornis* open woodland to woodland fringing swamps	Other	LC	OC	13.8	0.75

RE Code	Description	Structure Category	VMA Class	Biodiversity Status	Area within Project Area (ha)	% of Project Area
11.5.1	*Eucalyptus crebra* and/or *E. populnea, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains and/or remnant surfaces	Sparse	LC	NC	4.3	0.23
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks	Mid-dense	E	E	52.6	2.85
11.9.7	*Eucalyptus populnea*, *Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks	Sparse	OC	OC	3.6	0.20
11.9.10	*Eucalyptus populnea* open forest with a secondary tree layer of *Acacia harpophylla* and sometimes *Casuarina cristata* on fine-grained sedimentary rocks	Mid-dense	OC	E	8.7	0.47
Total					**307.9**	**16.67**

Figure 27: REs Mapped within Project Area



9.3.3 Aquatic Ecology and Habitat Values

Details of the aquatic ecology surveys, findings and impact assessment are provided in section 7.

9.3.4 MNES

9.3.4.1 Threatened Ecological Communities

The presence of two TECs has been confirmed within the Project Area:

- Brigalow (*Acacia harpophylla* dominant and codominant); and
- Poplar Box grassy woodland on alluvial plains.

The ground-truthed extent of Brigalow TEC and Poplar Box TEC is considerably smaller than the total mapped extent of the component RE. This is because smaller areas of undisturbed RE 11.3.1, 11.9.5 and 11.9.5a (Brigalow TEC) and RE 11.3.2 (Poplar Box TEC) did not meet TEC size and/or condition criteria (patch size too small, ground stratum was dominated by exotic weeds and/or patch was not dominated by relevant tree species).

A brief description of the confirmed TECs is provided in Table 35.

Table 35: Description and Ground-truthed Extent of TEC within the Project Area

TEC Description	EPBC Act Status	RE Codes	Ground-truthed Extent (ha)	Number of Patches (Size Range [ha])	Comment
Brigalow (*Acacia harpophylla* dominant and codominant)	Endangered	11.9.5	22.3	9 (1.12 – 4.15)	14 patches and total of 30.28 ha aren't qualified for TEC
Poplar Box grassy woodland on alluvial plains	Endangered	11.3.2	20.7	4 (2.1 – 9.58)	11 patches and total of 3.28 ha aren't qualified for TEC
TEC condition criteria and thresholds found in: Row 1 - DoE (2013); and Row 2 - DoEE (2019).					

9.3.4.2 Terrestrial threatened flora species

No EPBC Act listed threatened terrestrial flora species were recorded within the Project Area during field surveys.

Despite no signs or observations of these species within the Project Area during field surveys using survey techniques aligned with survey guidelines, two listed threatened terrestrial flora species, Belson's Panic (*Homopholis belsonii*) (Vulnerable) and Slender Tylophora (*Vincetoxicum forsteri*) (Endangered), have been assessed as having the potential to occur within the Project Area. Because part of these species' distributions overlaps the Project Area and suitable habitat is present within the Project Area, their presence cannot be ruled out.

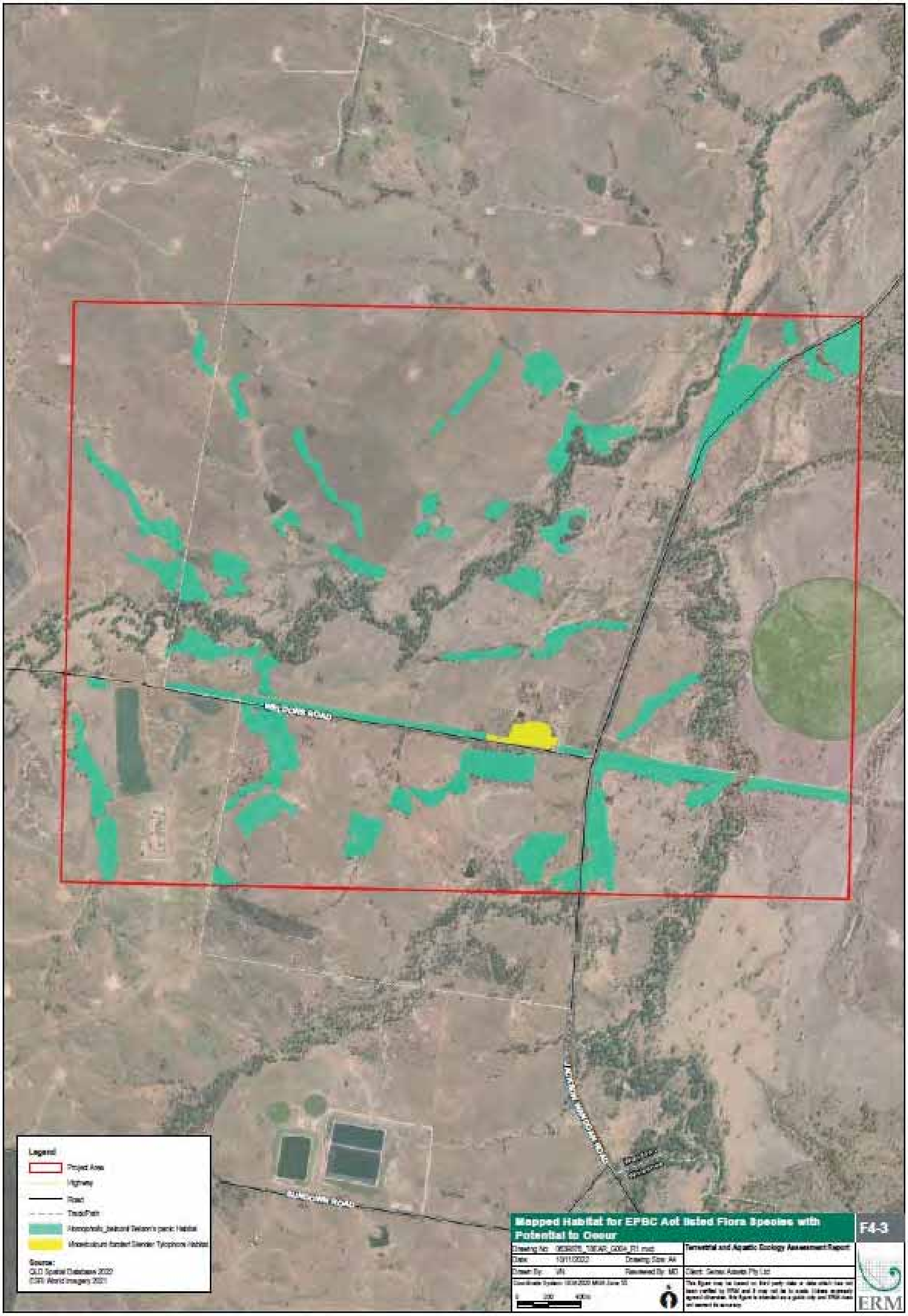
Within the Project Area, suitable habitat for Belson's Panic includes Poplar Box and Brigalow/Belah woodland on alluvium, and totals to 158.8 ha which includes:

- Eucalypt dominated woodlands mainly of *Eucalyptus crebra*, *E. populnea* and *E. melanophloia*; and
- Acacia woodlands dominated by Brigalow (*Acacia harpophylla*).

Potential Slender Tylophora mapped habitat within the Project Area totals 4.3 ha and includes Eucalypt dominated woodlands mainly of *E. crebra*, and *E. melanophloia*.

In accordance with the precautionary principle, 'potential habitat' for Belson's Panic and Slender Tylophora has been mapped and shown on Figure 28.

Figure 28: Mapped Habitat for EPBC Act Listed Flora Species with Potential to Occur



9.3.4.3 Weeds of National Significance

Desktop searches of the Queensland Government WildNet database (DES, 2022a) found six species of Weeds of National Significance (WoNS) recorded within 10 km of the Project Area (the 'adjoining areas'). These species and WoNS detected during field surveys are detailed in Table 36.

Table 36: Terrestrial WoNS detected or Potentially Occurring within the Project Area.

Scientific Name	Common Name	WoNS/ Biosecurity Act Status	Comments[10]
Parthenium hysterophorus	Parthenium Weed	WoNS, Cat. 3 Restricted Matter	Potentially occurring within the Project Area. Previously recorded within the adjoining areas.
Senecio madagascariensis	Fireweed	WoNS, Cat. 3 Restricted Matter	Potentially occurring within the Project Area. Previously recorded within the adjoining areas (DES, 2022a).
Anredera cordifolia	Madeira Vine	WoNS, Cat. 3 Restricted Matter	Potentially occurring within the Project Area. Previously recorded within the adjoining areas (DES, 2022a).
Opuntia aurantiaca	Tiger Pear	WoNS, Cat. 3 Restricted Matter	Detected during field surveys at moderate densities in Brigalow woodland around survey site 873-S74. The closest records in ALA (2022) are over 45 km away, around Yuleba North, Barakula and Taroom. No previous records in WildNet from the Project Area (DES, 2022a).
Opuntia stricta	Common Pest Pear	WoNS, Cat. 3 Restricted Matter	Previously recorded within the adjoining areas (DES, 2022a). Detected in field surveys throughout the Project Area at low densities.
Opuntia tomentosa	Velvety Tree Pear	WoNS, Cat. 3 Restricted Matter	Previously recorded within the adjoining areas (DES, 2022a). Detected in field surveys throughout the Project Area at low densities.

9.3.4.4 Threatened fauna species (known or likely to occur)

Five EPBC Act listed threatened fauna species (Glossy Black-cockatoo, Greater Glider, Koala, White-throated Needletail and Dulacca Woodland Snail) are considered known or likely to occur within the Project Area. A summary the associated habitat within the Project Area for each of these five species is provided below, and a full likelihood of occurrence assessment for all threatened fauna species identified by the desktop assessments is provided in Appendix F.

Koala

A targeted field survey was undertaken in the Project Area in 2022 in accordance with the most recent Commonwealth guidance on Koala survey and habitat mapping. Targeted searches for Koalas were completed, including spotlighting, searches for scats and scratch marks by two ecologists.

Despite targeted surveys, no Koalas were observed during the 20 days of field surveys completed from 14–

[10] Information sourced from BOOBOOK (2022)]

18 March, 22–25 March; 30 April–5 May, and 9–13 June 2023 across the wider Atlas Stage 3 Project Area. This survey effort is considered sufficient to detect koala presence in the Project Area.

Koalas are known to occur within urban and rural landscapes, utilising regrowth and remnant eucalypt dominated vegetation communities for foraging and breeding resources. Targeted searches for the species were conducted in suitable habitat throughout the Project Area. Field investigations did not directly record an individual Koala, or koala faecal pellets, but did find indirect evidence of Koalas through scratch marks on riparian Queensland Blue Gum trees in several locations along Wandoan Creek and Woleebee Creek. However, as the presence of scratch marks are an indirect method of recording presence for the species, there is uncertainty that the scratches were indeed from Koalas.

No records or evidence of Koalas occurs elsewhere in the Project Area, despite targeted searches. From this information, it is concluded that there is a general absence of Koalas in the Project Area, and it is considered that koala occurrence is very rare.

Based on these indirect observations, and in accordance with current DCCEEW habitat definitions for Koala, it has been conservatively concluded that habitat critical to the survival of the species (as per the EPBC Act) does occur within the Project Area.

Vegetated areas of the Project Area containing Koala food trees (e.g., *E. tereticornis*, *E. populnea*, *E. crebra, E. longirostrata, E. melanophloia, E. exserta* and *Corymbia citriodora subsp. variagata*) have been mapped as Koala foraging and breeding habitat as per recent habitat guidance for the species (Youngentob, K.N, et al, 2022) (Table 37).

Records for where evidence of this species has been located in the Project Area, as well as the Koala habitat mapping for foraging and breeding habitat, and dispersal habitat, are illustrated Figure 29.

Table 37: Koala Habitat Types within the Project Area

	Potential Foraging and Breeding Habitat	**Potential Dispersal Habitat**	**Potential Non-koala Habitat**
Description	• Any forest or woodland containing species that are known koala food trees, or shrubland with emergent food trees. • This includes remnant and regrowth vegetation.	• Part of the broader landscape that includes grass/bare ground, rural land-uses, dwellings/towns, buildings, farm dams, sealed or unsealed roads and existing rail infrastructure. • Contains isolated or scattered foraging or shelter trees. • Contains vegetation generally not used frequently for foraging and breeding purposes by the species.	• Not suitable habitat includes barriers defined in the DCCEEW Guidelines (natural or artificial) that prevent the movement of koalas, such as mountain ranges, water bodies or treeless areas that are greater than 2 km wide.
Presence within the Project Area	• Regrowth and remnant vegetation of: • Callitris and Eucalypt dominated woodlands; • Eucalypt dominated woodlands mainly of E. crebra, E. populnea and E. melanophloia • Riparian and wetland Eucalypt woodlands dominated by *E. tereticornis*; • Eucalypt open forest dominated by *E. populnea*; and • Open regrowth eucalypt woodland vegetation.	• Cleared areas with occasional regrowth eucalypt woodlands along drainage lines; and • Acacia woodlands dominated by Brigalow (*Acacia harpophylla*).	• None present.
Total in the Project Area	• 245.4 ha foraging and breeding habitat	• 1,602.5 ha dispersal habitat	• 0 ha non-koala habitat

Figure 29: Koala Habitat within the Project Area

Greater Glider

Greater Glider habitat consists of tall, Eucalypt forests with mature hollow-bearing trees (Eyre, 2004). Eyre *et al.*, (2022) has listed habitat for the species that are REs with confirmed Greater Glider records and contain habitat attributes such as live and dead hollowing bearing denning trees, feed and large trees and habitat connectivity.

Greater Glider habitat within the Project Area and aligns with the conservation advice description of "large contiguous areas of eucalypt forest, which contain mature hollow-bearing trees and a diverse range of the species' preferred food species" and is therefore considered habitat critical to survival of the species. This species was detected during spotlighting surveys of riparian woodland along Wandoan Creek and suitable Greater Glider foraging habitat has been identified within the Project Area based on ground-truthing of habitats listed in Eyre et al. (2022), as well as the identification of habitat attributes for the species such as mature hollow bearing trees. Therefore, Greater Glider habitat within the Project Area is considered habitat critical to survival of the species.

The total amount of Greater Glider foraging habitat within the Project Area is 174.5 ha and is shown Figure 30. The mapped Greater Glider foraging habitat includes mature Eucalypt woodland to open forests and woodlands to open forest associated with stream channels and rivers.

Glossy Black-cockatoo

The Glossy Black Cockatoo is a specialised feeder dependent on seeds of Casuarinaceae (She-oak) trees and is capable of moving among isolated trees and small habitat patches within fragmented landscapes (Pavey et al. 2016, Holmes 2012). The species' roves widely across this landscape, with some evidence of seasonal movements following maturation of She-oak fruits (Stock & Wild 2005; Hourigan 2012; BOOBOOK, unpubl. data). Breeding pairs nest in large hollows generally high up in large Eucalypt trees or stags near water and food sources (Pavey et al. 2016).

Casuarinaceae food trees are abundant within the Project Area, including Belah (occurs throughout the Project Area) and Bull Oak (*Allocasuarina luehmannii*) in scattered woodland patches on sandy soils. Potential nest trees occur in remnant Eucalypt woodland and forest and in well-developed riparian corridors across the Project Area. No evidence of feeding (chewed cones) was observed during field surveys. However, this species has previously been recorded within the Project Area (BOOBOOK 2021a).

The likelihood of occurrence has concluded this species as likely to occur within the Project Area due to the presence of suitable habitat and historical records within the locality. A total of 236.2ha of Glossy Black-cockatoo habitat has been mapped within the Project Area and consists of mature Eucalypt woodland to open forests and woodlands to open forest associated with stream channels and rivers (Figure 31).

Dulacca Woodland Snail

The Dulacca Woodland Snail inhabits vine thicket, Brigalow (*Acacia harpophylla*) woodland/open forest, ironbark (Eucalyptus spp.) woodland, Lancewood (*Acacia shirleyi*) woodland and Gum-topped Box (*E. woollsiana*) woodland (TSSC, 2016). It is largely confined to the Dulacca Downs subregion where it is found in a highly fragmented landscape, living in patches or strips of habitat retained on roadsides, shade lines and/or ridges (Stanisic et al., 2010; ALA, 2022). The Dulacca Woodland Snail is also able to exist in areas of Brigalow regrowth and even in cleared paddocks but only where logs, woody debris or other suitable microhabitat sites remain (TSSC, 2016).

The Project Area includes several small patches of suitable habitat for the Dulacca woodland snail (Brigalow woodlands), and the species has previously been collected from an area of REs 11.9.5a and 11.7.2 in south of the Project Area (ALA, 2022). A total of 52.6 ha of Dulacca Woodland Snail habitat has been mapped within the Project Area is 52.6 ha (Figure 32).

Figure 30: Greater Glider Habitat within Project Area

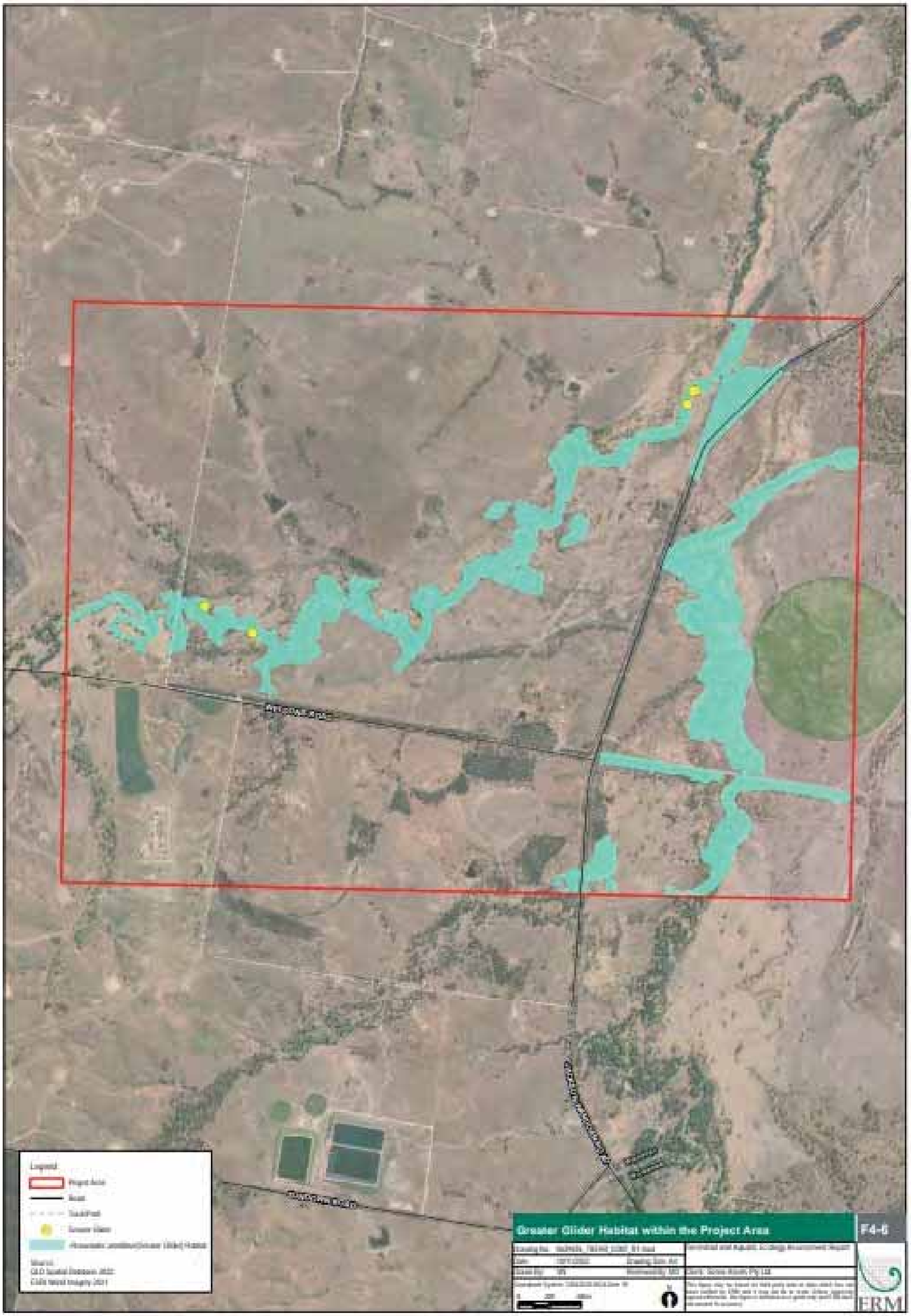


Figure 31: Glossy Black Cockatoo habitat within the Project Area

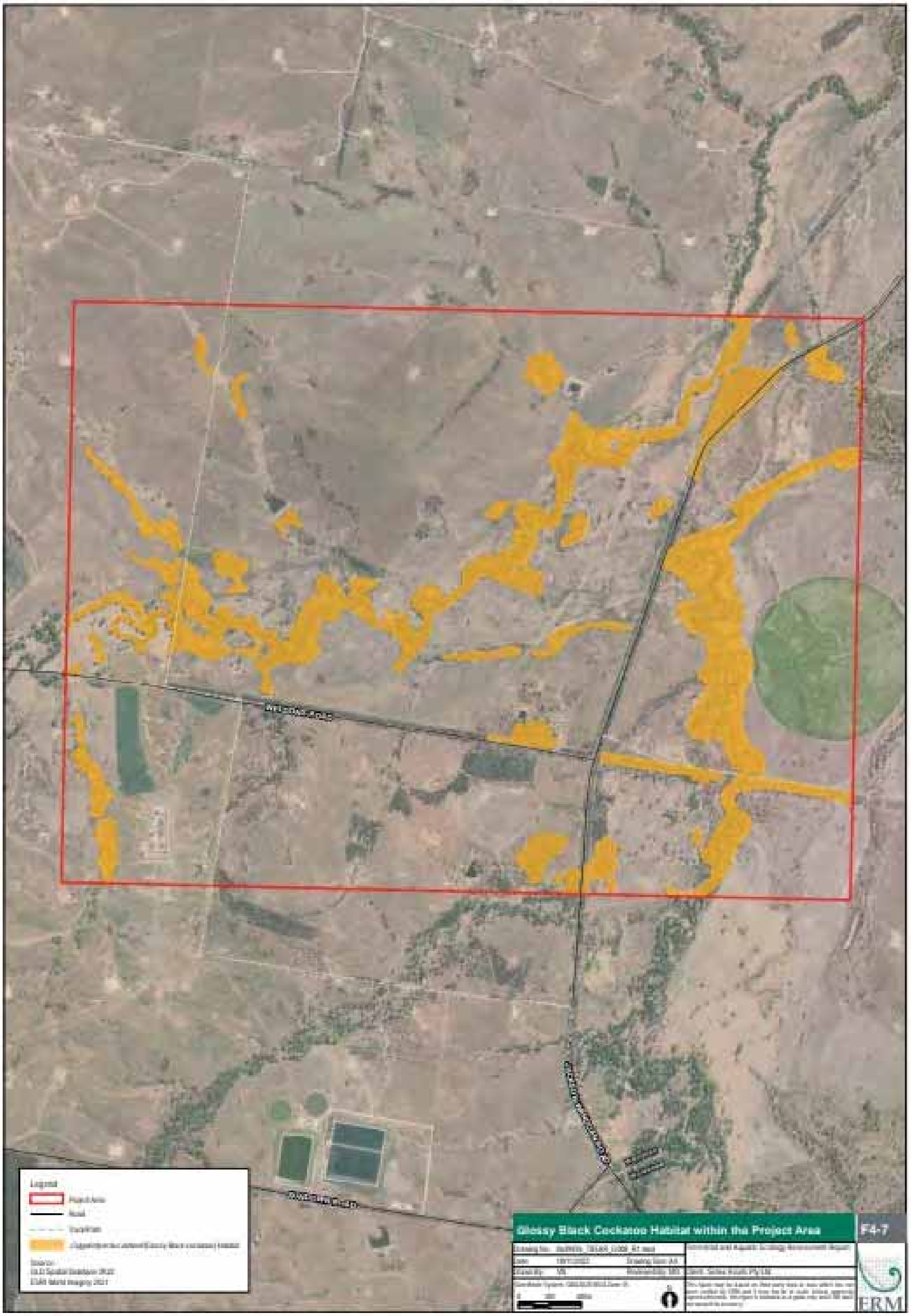
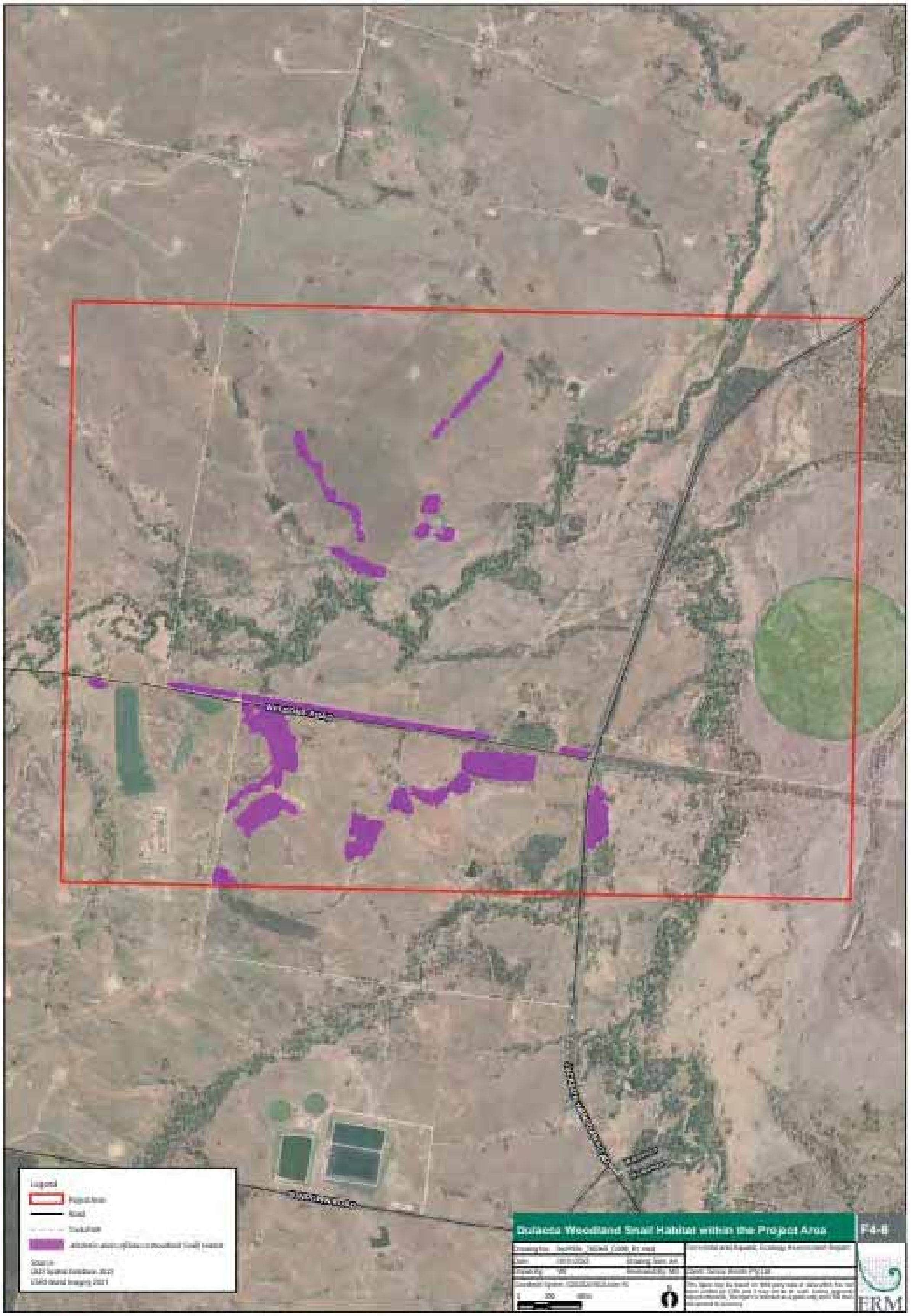


Figure 32: Dulacca Woodland Snail Habitat within Project Area



White-throated Needletail

This species is predominantly aerial when on migration in Australia, occasionally stopping to roost in large patches of rainforest, wooded vegetation and open Eucalypt forests (Coventry, 1989; Higgins, 1999), generally associated with elevated areas.

A search of the ALA database did not identify any historical known White-throated Needletail records within 10 km of the Project area. And was not observed during field investigations for the current Project.

While occasional aerial observations occur for this species (including one on 24/11/22 south of Weldons Road in the southeast of ATP 2059), the Project Area is unlikely to contain important foraging habitat for the species. Additionally, no threshold area for important habitat for this species can be determined at present and has not been identified (TSSC, 2019). The Project Area contains no rainforests and no elevated open forests with dense foliage that could be used for occasional roosting. While potential flights over the Project Area may occur from time to time, only elevated areas are regarded as roosting habitat. Thus, potential habitat has not been mapped for this species, and so no subsequent impact area has been calculated.

9.3.4.5 Listed Threatened Terrestrial Fauna Species with Potential to Occur

Two EPBC Act listed threatened fauna species have been assessed as having the potential to occur within the project area (Australian Painted Snipe and Painted Honeyeater). A summary the associated habitat within the Project Area for each of these five species is provided below, and a full likelihood of occurrence assessment for all threatened fauna species identified by the desktop assessments is shown in Appendix F.

Australian Painted Snipe

A total of 13.9 ha of potential habitat has been mapped for the Australian Painted Snipe. This includes small areas of ephemeral wetland habitat which correspond with riparian woodlands and align with the broad habitat type of Riparian and wetland Eucalypt woodlands dominated by *E. tereticornis*.

Painted Honeyeater

A total of 95.1 ha of potential habitat has been mapped for the Painted Honeyeater. This comprises larger contiguous areas of remnant and regrowth woodland and open forest with a multilayered shrubby understorey which the species prefers. This is made up of broad habitat type Eucalypt dominated woodlands mainly of *E. crebra, E. populnea* and *E. melanophloia*. Potential habitat also includes remnant and regrowth communities with abundant Acacia and Casuarina hosts of Mistletoes.

9.3.4.6 Listed Migratory Species

Two EPBC Act listed migratory species have been considered as likely to occur within the Project Area, the White-throated Needletail and the Fork-tailed Swift. The White-throated Needletail is also listed as Vulnerable under the EPBC Act. However, due to its aerial nature (Higgins, 1999), it is also unlikely to be significantly impacted by Project activities. One sighting within the area of ATP 2059 was recorded in 24/11/22, but it was not observed during field surveys.

The Fork-tailed Swift is almost exclusively aerial and occur mostly over inland plans and sometimes above foothills and coastal areas (Higgins, 1999). The Fork-tailed Swift was not observed during field surveys, and potential foraging habitat was assessed to occur over dry open habitats, where it would likely fly over. Therefore, no habitat was mapped on the ground.

9.3.4.7 Listed Migratory Species with Potential to Occur

Six listed migratory species have conservatively been determined as having the potential to occur within the Project Area (Table 38) although no signs or observations of the species were made within the Project Area.

The likelihood of occurrence for these species was based on presence of suitable habitat only (largely associated with the limited number of waterbodies and drainage features (predominately farm dams), in the project area) and/or the presence of records in the adjoining areas.

Table 38: Listed Migratory Species with Potential to Occur in Project Area

Species (Common Name)	Assessment
Common Sandpiper	Individuals may sometimes occur in the Project Area. However, there is very limited suitable habitat in the Project Area (ephemeral wetlands on drainage lines and farm dams), and this would only support occasional transient visitors.
Latham's Snipe	Individuals may sometimes occur in the Project Area. However, there is very limited suitable habitat in the Project Area (ephemeral wetlands on drainage lines and farm dams), and this would only support occasional transient visitors.
Oriental Cuckoo	There are limited areas of potential habitat in the form of remnant woodlands and non-remnant patches of native vegetation, within the Project Area.
Rufous Fantail	There is some limited potential habitat present within the Project Area in the form of remnant and non-remnant woodlands.
Satin Flycatcher	There is some limited potential habitat present within the Project Area in the form of remnant and non-remnant woodlands.
Sharp-tailed Sandpiper	Individuals may sometimes occur in the Project Area. However, there is very limited suitable habitat in the Project Area (ephemeral wetlands on drainage lines and farm dams), and this would only support occasional transient visitors.

9.3.5 Mattes of State Environmental Significance

Matters of State Environmental Significance (MSES) are defined in Schedule 2 of the Environmental Offsets Regulation 2014 and include (but are not limited to) regulated vegetation, Connectivity Areas, and Protected Wildlife Habitat.

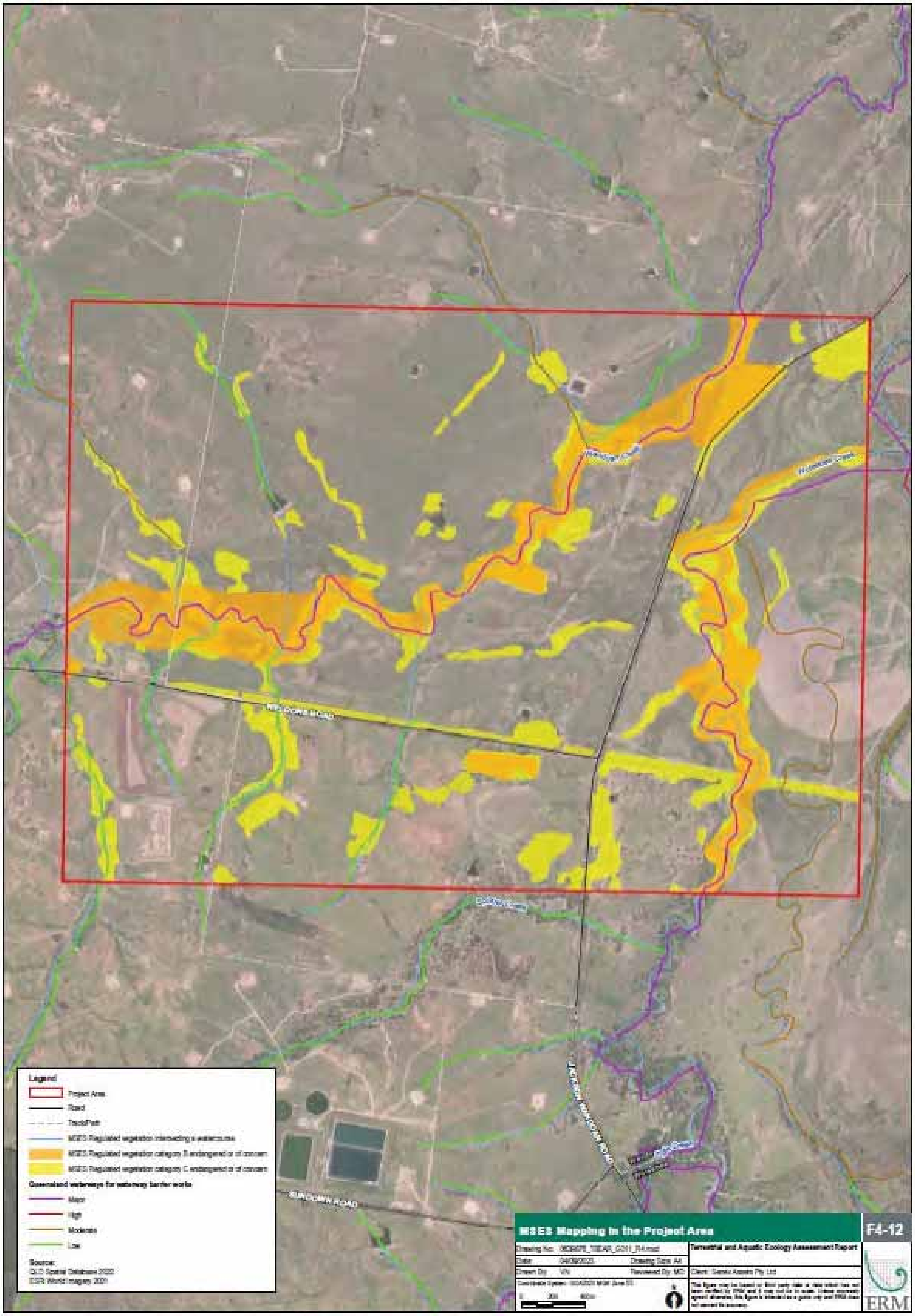
Mapped MSES in the Project Area are summarised in Table 39, illustrated in Figure 33, and are detailed in the following sub-sections.

Table 39: Prescribed MSES and Occurrence within the Project Area

Prescribed Matter	Relevance to the Project	Assessment
Regulated Vegetation	1. There is Endangered and Of Concern remnant vegetation present within the Project Area, totaling 199.5 ha (<10.8% of the Project Area). 2. Defined distance of a watercourse – watercourses intersect with regulated vegetation within the Project Area, totaling 0.3 ha. 3. Wetland – no regulated vegetation is within 100 m of a Vegetation Management Wetland within the Project Area. 4. Essential Habitat – there are no areas of essential habitat present within the Project Area.	**1 and 2 required**
Connectivity Areas	Connectivity areas within the Project Area are comprised chiefly of vegetation associated with watercourses, including Woleebee Creek. The main connectivity areas within the adjoined areas (10 km buffer of Project Area) are located to the south and east and will not be affected by the proposed development.	Not required
Wetlands and Watercourses	In accordance with the Development Assessment Mapping Systems (DAMS) mapping, there are no wetlands or watercourses mapped as high ecological significance, or high ecological value, within the Project Area.	Not required

Prescribed Matter	Relevance to the Project	Assessment
Designated Precincts in Strategic Environmental Areas	In accordance with the DAMS mapping, no Regional Interest areas are recorded over the Project Area. This mapping is in accordance with the *Regional Planning Interests Act 2014* which governs the framework for Strategic Environmental Areas.	Not required
Protected Wildlife Habitat	Habitat for five listed threatened fauna species and one Near Threatened fauna species were considered known or likely to occur within the Project Area: • Greater Glider listed as Endangered (174.5 ha habitat); • Dulacca Woodland Snail listed as Vulnerable (52.6 ha habitat); • Glossy Black-cockatoo listed as Vulnerable (236.2 ha habitat); • Golden-tailed Gecko listed as Near Threatened (308 ha habitat); • Koala listed as Endangered (245.4 ha preferred breeding and foraging habitat and 1,602.5 ha general dispersal habitat); and • Pale Imperial Hairstreak listed as Vulnerable (48.1 ha habitat).	**Required**
Protected Areas	There are no Protected Areas within the Project Area.	Not required
Declared Fish Habitat Areas and Highly Protected Zones of State Marine Parks	In accordance with DAMS mapping, there are no declared fish habitat areas within the Project Area.	Not required
Waterways Providing for Fish Passage	In accordance with DAMs mapping, there are a number of waterways defined by the Fisheries Act, that are at risk of major impacts within the Project Area. Any works will be in accordance with the Fisheries Act and relevant waterway barrier codes as per QLD legislation.	**Required if works cause a waterway barrier**
Marine Plants	There are no marine plant communities within the Project Area.	Not required
Legally Secured Offset Areas	There are no legally secured offset areas within the Project Area.	Not required

Figure 33: Mapped Regulated Vegetation



9.3.5.1 Environmentally Sensitive Areas

Category A and B Environmentally Sensitive Areas (ESAs) are defined in the Environmental Protection Regulations 2019. Category C ESAs are defined the SMCs for Petroleum.

ESAs in the Project Area (Table 40) include the riparian corridors along Wandoan Creek and Woleebee Creek (Category C). ESAs also comprise small fragments of Brigalow and/or Belah woodland, including areas with co-dominant Poplar Box, either fringing riparian corridors or scattered across the surrounding undulating downs (Category B).

Table 40: Ground-Truthed Environmentally Sensitive Areas

ESA Category		Details
Category A	National Parks Conservation Parks Special Wildlife Reserves Forest Reserves The Wet Tropics Area The Great Barrier Reef Region Marine Parks (other than those parts of a park that are general use zones)	None present within Project Area
Category B	Coordinated conservation areas Area of critical habitat or major interest identified under a conservation plan Area subject to interim conservation order An area subject to the following conventions: • Convention on the conservation of Migratory species of Wild Animals • Convention on Wetlands of International Importance, especially as waterfowl habitat • Convention concerning the protection of the world cultural and natural heritage A general use zone of a Marine Park An area to the seaward side of the highest astronomical tide A place of cultural heritage significance A Queensland Heritage place (unless there is an exemption certificate) An area recorded in the Aboriginal Cultural Heritage Register, other than the Stanbroke Pastoral Development Holding A feature protection area, State Forest Park or scientific area under the Forestry Act 1959; A declared fish habitat area A place in which a marine plant under the Fisheries Act 1994 is situated; An endangered regional ecosystem identified in the REDD database	Endangered RE (Biodiversity Status) RE 11.3.17, 11.9.5 and 11.9.10 A total of 103.3 ha exists within the Project Area, though none will be impacted

ESA Category		Details
Category C	Nature Refuges Koala Habitat Areas State Forests of Timber Reserves Regional Parks Essential habitat (mapped and validated) OC REs	Remnant and regrowth vegetation within government mapped areas of 'essential habitat' or 'essential regrowth habitat', ground-truthed habitat for threatened species, and Of Concern RE (Biodiversity Status), which comprises the following RE: 11.3.2, 11.3.4, 11.3.25, 11.3.27f and 11.9.7. A total of 308.25 ha exists within the Project Area, though none will be impacted

9.3.6 Habitat Assessments

9.3.6.1 Terrestrial Habitat

The vegetation conditions of four REs, that represented the major vegetation types in the Project Area, were assessed using the BioCondition methodology of Eyre *et al*. (2015). All BioCondition sites were in remnant vegetation, resulting in a total of nine Assessment Units (AU) being assessed.

All AU received moderate (0.40 – 0.60) to high (0.60 – 0.80) BioCondition scores, reflecting:

- Significant disturbance and consequent loss of ecosystem integrity relative to intact areas of each RE; and/or
- landscape level fragmentation with small patch size, low connectivity and a low proportion of remnant and regrowth vegetation in the surrounding landscape.

Terrestrial BioCondition site characteristics and scores are summarised in section 3.2.2 of Appendix D to Appendix F).

9.3.7 Terrestrial Flora Species

No threatened flora species listed under the NC Act were recorded during field surveys. No threatened flora species have been identified as likely to occur and five have been identified as having the potential to occur within the Project Area (Appendix B to Appendix F). A summary of the listed threatened terrestrial flora species that have the potential to occur and their associated habitat within the Project Area is presented in Table 41.

Table 41: NC Act Listed Threatened Flora with Potential to Occur in the Project Area

Scientific Name	Common Name	NC Act Status	Likelihood of Occurrence	Potential Habitat in the Project Area[11]
Homopholis belsonii	Belson's Panic	VU	Potential	• Potential habitat for this species includes the broad habitat types of Eucalypt dominated woodlands mainly of *E. crebra, E. populnea* and *E. melanophloia* and Acacia woodlands dominated by Brigalow (*Acacia harpophylla*). • 158.8 ha of potential habitat has been mapped within the Project Area.
Rutidosis lanata	Red-soil Woolly Wrinklewort	NT	Potential	• Potential habitat for this species is ecotonal transitions of the broad habitat types of Eucalypt dominated woodlands mainly of *E. crebra, E. populnea* and *E. melanophloia* and Acacia woodlands dominated by Brigalow (*Acacia harpophylla*). • 69.2 ha of potential habitat has been mapped within the Project Area.
Vincetoxicum forsteri	Slender Tylophora	EN	Potential	• Potential habitat for this species includes Eucalypt dominated woodlands mainly of *E. crebra,* and *E. melanophloia.* • 4.3 ha of potential habitat has been mapped within the Project Area.
Acacia wardellii	Thomby Range Wattle	NT	Potential	• Potential habitat is comprised of small amounts of the Eucalypt dominated woodlands mainly of *E. crebra, E. populnea* and *E. melanophloia* • 4.3 ha of potential habitat has been mapped within the Project Area.
Solanum stenopterum	Winged Nightshade	VU	Potential	• Potential habitat includes the broad habitat types of Eucalypt dominated woodlands mainly of *E. crebra, E. populnea and E. melanophloia* and Acacia woodlands dominated by Brigalow (*Acacia harpophylla*). • 158.8 ha of potential habitat has been mapped within the Project Area.
Status listing per the NC Act: EN = Endangered, VU = Vulnerable, NT = Near Threatened.				

9.3.7.1 Invasive Flora Species

Four species of weeds (invasive plants) prescribed as Category 3 restricted matter under the Biosecurity Act 2014 were detected during field surveys within the Project Area:

- Velvety Tree Pear (*Opuntia tomentosa*[12]) - common throughout the Project Area occurring at low to moderate density in remnant and regrowth woodland and in non-remnant pasture;
- Common Pest Pear (*O. stricta*) - common throughout the Project Area occurring at low to moderate density in remnant and regrowth woodland and in non-remnant pasture;

[11] Information on potential habitat sourced from BOOBOOK, 2022.
[12] Opuntia species recorded are classified as WoNS.

- Harrisia Cactus (*Harrisia martini*) - low density in two locations in the Project Area; and
- Mother-of-millions (*Bryophyllum delagoensis*) - detected in one location, each of which are in Poplar Box woodland on floodplains with numerous shallow drainage channels (BOOBOOK, 2022).

9.3.8 Terrestrial Fauna Species

9.3.8.1 Species known or likely to occur

Four reptiles, 13 mammals, 123 birds and three butterfly non-NC Act listed species were located during field surveys. Eight NC Act listed threatened species are considered as known or likely to occur within the Project Area: Dulacca Woodland Snail, Koala, Greater Glider, Glossy Black-cockatoo, Golden-tailed Gecko, Pale Imperial Hairstreak, Short-beaked Echidna and White-throated Needletail. A summary of these species and their associated habitat within the project area is provided in Table 42. Habitat mapping for the Golden-tailed Gecko and the Pale Imperial hairstreak is provided as Figure 34 and Figure 35. Additional species-specific habitat mapping is provided in section 4.5.7 of Appendix F.

Table 42: NC Act Listed Threatened Fauna Species Known or Likely to Occur within the Project Area

Scientific Name	Common Name	Status	Likelihood of Occurrence	Habitat Definition, Records and Regional Importance of the Species
		NC Act		
Adclarkia dulacca	Dulacca Woodland Snail	EN	Likely	• The Dulacca Woodland Snail has been recorded within the adjoined areas to the Project Area (a 10 km buffer) in Brigalow woodland areas (ALA, 2022). Suitable habitat of woodland consisting of Brigalow woodlands dominated by Acacia harpophylla is present within the Project Area. It has therefore been concluded as likely to occur within the Project area. • Figure 32 identifies the habitat for the Dulacca Woodland Snail in the Project Area. The total amount of habitat for this species within the Project Area is 52.6 ha.
Calyptorhynchus lathami lathami	Glossy Black-cockatoo	VU	Likely	• The Glossy Black-cockatoo has previously been recorded within the Project Area (BOOBOOK 2021a, DES 2022a), and two recent sightings (2009) have been reported within the adjoined areas of the Project Area). This is a specialised feeder dependent on seeds of Casuarinaceae (She-oak) trees. Breeding pairs nest in large hollows generally high up in large eucalypt trees or stags near water and food sources (Pavey et al. 2016). The species is capable of moving among isolated trees and small habitat patches within fragmented landscapes (Pavey et al. 2016, Holmes 2012). Casuarinaceae food trees are abundant within the Project Area including Belah (Casuarina cristata), which occurs throughout the Project Area and Bull Oak (Allocasuarina luehmannii), which occurs in scattered woodland patches on sandy soils, however no evidence of feeding (chewed cones) was observed during field surveys. Potential nest trees also occur in remnant Eucalypt woodland and forest and in well-developed riparian corridors across the Project Area (BOOBOOK, 2022). • Figure 31 identifies the habitat for the Glossy Black-cockatoo in the Project Area. The total amount of preferred habitat for this species within the Project Area is 236.2 ha.
Strophurus taenicauda	Golden-tailed Gecko	NT	Likely	• The Golden-tailed Gecko has been recorded within the adjoined areas to the Project Area (a 10 km buffer) in woodland and regrowth areas. (ALA, 2022). Suitable habitat of woodland consisting of Acacia spp. are present within the Project Area. • Figure 34 identifies the habitat for the Golden-tailed Gecko in the Project Area. The total amount of preferred habitat for this species within the Project Area is 308 ha.

Scientific Name	Common Name	Status	Likelihood of Occurrence	Habitat Definition, Records and Regional Importance of the Species
		NC Act		
Petauroides armillatus (Petauroides volans)	Greater Glider	EN	Known	• The species was detected in Queensland Blue Gum woodland in the north of the Project Area, in the remnant riparian corridors along Wandoan Creek and Woleebee Creek. The species is likely to occur wherever large trees with hollows occur in woodland connected with these corridors and also in the extensively wooded in the south of the Project Area. • Figure 30 identifies the habitat Greater Glider in the Project Area. The total amount habitat for this species within the Project Area is 174.5 ha.
Phascolarctos cinereus	Koala	EN	Likely	• The field investigations conducted throughout 2022 did not directly record an individual Koala but did find evidence of the Koala through indirect signs of scratch marks on riparian Queensland Blue Gum (Eucalyptus tereticornis) trees in several locations along Wandoan Creek. The Koala is generally found in a range of temperate to tropical forests as well as woodlands and semi-arid communities dominated by Eucalyptus spp. (Martin & Handasyde, 1999). Koalas are also known to inhabit regrowth habitat. Due to the indirect method of recording Koala presence from scratch marks, there is a level of uncertainty that the scratches were from Koalas. No Koala faecal pellets were observed. No records or evidence of Koalas occurs elsewhere in the Project Area, despite targeted searches. From this information, it is considered that koala occurrence in the Project is very rare however applying the precautionary principle it’s likelihood of occurrence has been assessed as likely. • Figure 29 identifies the preferred and general habitat for the Koala in the Project Area. The total amount of foraging and breeding habitat for this species within the Project Area is 245.4 ha, and general habitat for the species is 1,602.5 ha. It is noted that Koala habitat that is mapped as foraging and breeding is preferred habitat, and the dispersal habitat is regarded as general habitat, per the SRI Guidelines.
Jalmenus eubulus	Pale Imperial Hairstreak (Butterfly)	VU	Likely	• The Pale Imperial Hairstreak has been recently recorded in the nearby Gurulmundi State Forest. • Occurs in Poplar box and Casuarina woodland, as well as grassland in clay and loam soils. Distributed across the Darling Downs region. The species has been recorded from the Condamine floodplain around Dalby, Chinchilla and Condamine and also from two localities along Channing Creek (ALA 2022). • Figure 35 identifies the potential habitat for the Pale Imperial Hairstreak in the Project Area. The total amount of preferred habitat for this species within the Project Area is 48.1 ha.

Scientific Name	Common Name	Status	Likelihood of Occurrence	Habitat Definition, Records and Regional Importance of the Species
		NC Act		
Tachyglossus aculeatus	Short-beaked Echidna	SLC	Likely	• Recent records are present for this species in the adjoining areas. This species can be found across a wide range of habitats, including open woodland, semi-arid and arid areas as well as in agricultural areas (Aplin et al., 2016). Their foraging requirements include ant nests and termite mounds (Nicol et al., 2011). • The total amount of habitat for this species within the Project Area is 1,847.9 ha. This habitat has not been mapped as the species will inhabit the entire of the Project Area.
Hirundapus caudacutus	White-throated Needletail	VU	Known	• The White-throated Needletail was recorded flying over the Project Area in late 2022. • Species likely only to fly aerially over the Project Area (through September to April on its migration), which contains no rainforest vegetation. The Project Area does not contain habitat in the form of elevated Eucalypt forests or wooded ridges to act as foraging and roosting habitat for the species. • Habitat mapping has therefore not been undertaken for this species as it is only likely to fly aerially over the Project Area.

Status listing per the NC Act: EN= Endangered, VU = Vulnerable; NT = Near Threatened; and SLC = Special Least Concern

Figure 34: Golden-tailed Gecko Habitat within Project Area

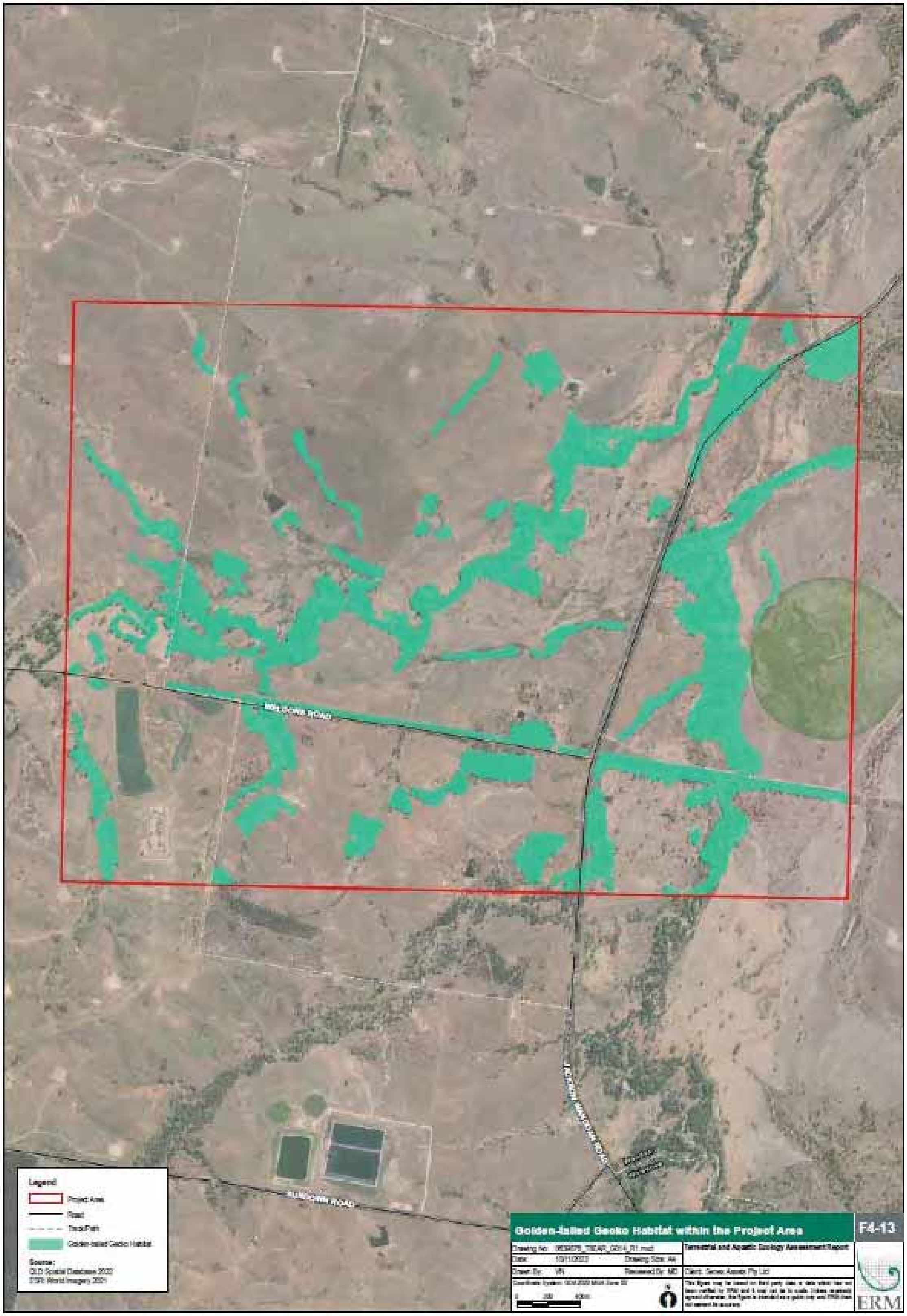
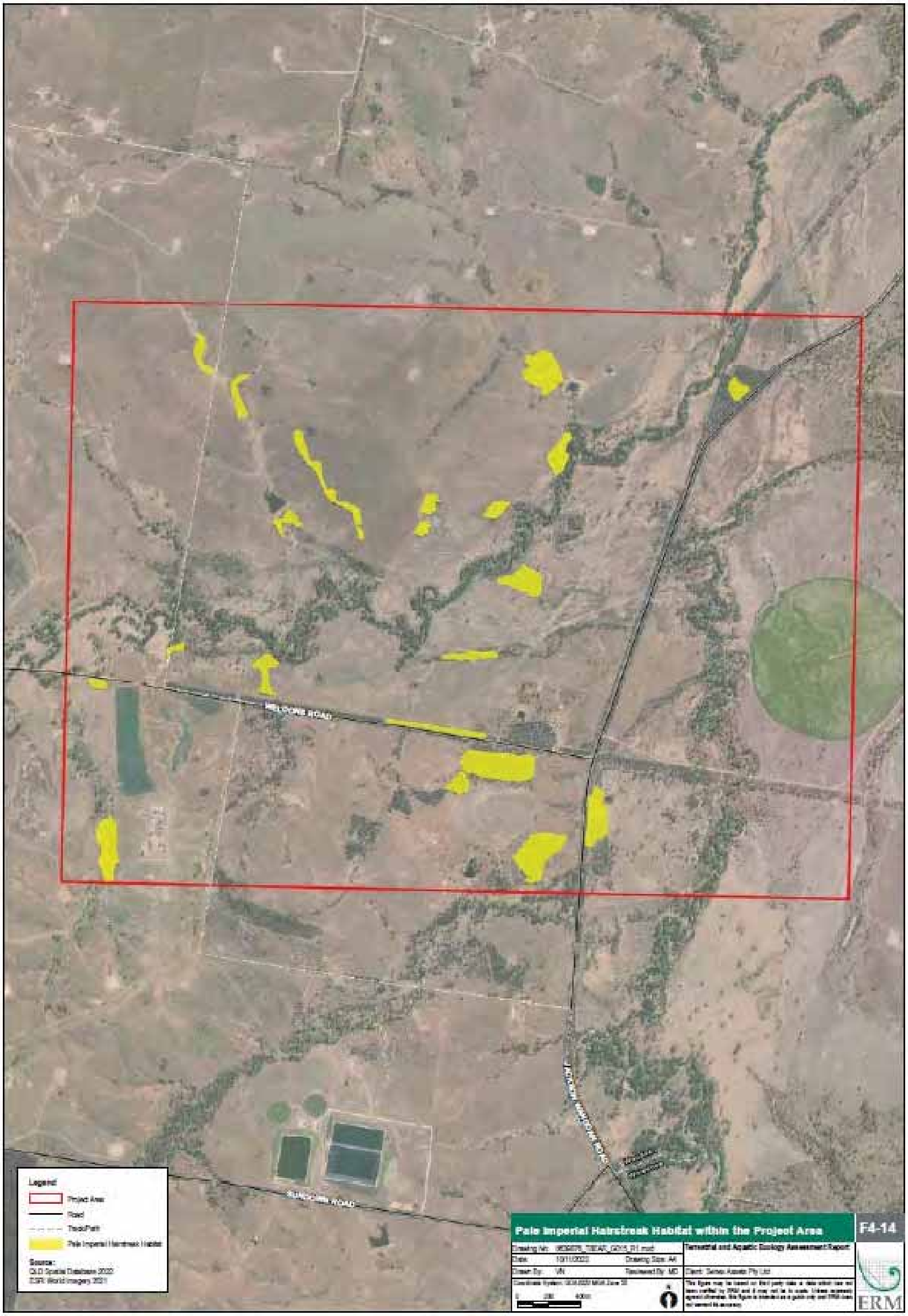


Figure 35: Pale Imperial Hairstreak Habitat in the Project Area



9.3.8.2 Species with potential to occur

Based the likelihood of occurrence, seven NC Act listed fauna species are considered to have the potential to occur within the Project Area (Table 43 and Appendix F). In essence, because part of these species' distributions overlaps with the Project Area, their presence cannot be ruled out. This is despite no signs or observations of these species within the Project Area during field surveys using survey techniques aligned with survey guidelines. In accordance with the precautionary principle, 'potential habitat' for species with habitat present was mapped.

Table 43: NC Act Listed Threatened Fauna Species with Potential to Occur within the Project Area

Species Name	Common Name	NC Act Status	Potential Habitat Mapped within the Project Area[13]
Birds			
Rostratula australis	Australian Painted Snipe	EN	• 13.9 ha of potential habitat is present within the Project Area. • Potential habitat includes small areas of ephemeral wetland habitat within the Project Area, however these may only periodically provide temporary refuges for this species. These areas correspond with riparian with riparian woodlands. This aligns with the broad habitat type of Riparian and wetland Eucalypt woodlands dominated by *E. tereticornis.*
Climacteris picumnus victoriae	Brown Treecreeper	V	• 102.88ha of peotential habitat is present within the Project Area • Potential habitat includes small patches of suitable dry Eucalyptus woodland and/or forest
Stagonople ura guttata	Diamond Firetail	E	• 307.93 ha of potential habitat is present within the project area • Potential habitat includes any Eucalypt woodlands and/or forests throughout the Project Area, including Acacia dominated areas.
Anomalopus mackayi	Five-clawed Worm-skink	V	• 60.75 of potential habitat is present within the project area. • Potential habitat includes Brigalow woodlands with coarse woody debris and deep leaf litter cover, as well as ephemeral wetlands and creek lines along with cracking clay soils in some areas.
Hemiaspis damelii	Grey Snake	E	• 74.67 of potential habitat is present within the project area • Potential habitat in the form of Brigalow and Belah woodlands are present in the Project Area, as well as ephemeral wetlands and creek lines along with cracking clay soils in some areas.

[13] Information on potential habitat sourced from BOOBOOK, 2022.

Species Name	Common Name	NC Act Status	Potential Habitat Mapped within the Project Area[13]
Grantiella picta	Painted Honeyeater	VU	• 95.1 ha of potential habitat is present within the Project Area. • Potential habitat comprises remnant and regrowth communities with abundant Acacia and Casuarina hosts of Mistletoes. Potential habitat comprises larger contiguous areas of remnant and regrowth woodland and open forest, more specifically with a multi-layered shrubby understorey which the species prefers. This is made up of broad habitat type Eucalypt dominated woodlands mainly of *E. crebra, E. populnea* and *E. melanophloia*.
Aphelocephala leucopsis	Southern Whiteface	V	• 307.93 ha of potential habitat is present within the project area. • Southern Whiteface has the potential to ustilise almost all habitats present within the Project Area, with the exception of grazed land.

Status listing per the NC Act: EN = Endangered; VU = Vulnerable.

For the full reasoning for the potential outcomes for such species, refer to Appendix B of ERM 2023.

9.3.8.3 Invasive Fauna Species

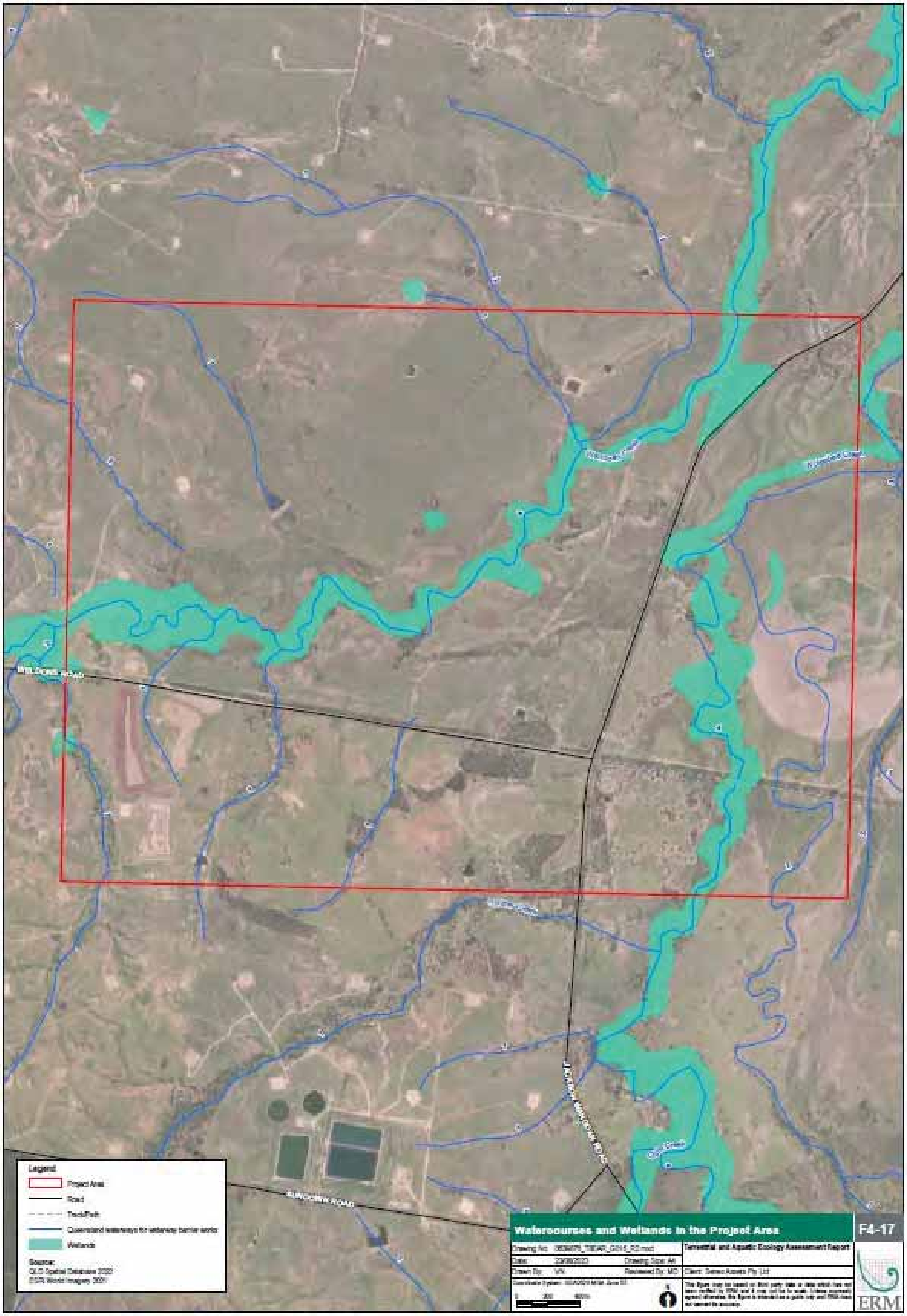
Evidence of pest fauna detected within the Project Area included infrequent Rabbit (*Oryctolagus cuniculus*) latrines, frequent Dingo or Dog (*Canis familiaris*) tracks, and Pig (*Sus scrofa*) scats and diggings. These species are listed as Category 3,4,5,6 or Category 3,4,6 restricted matter under the Biosecurity Act.

9.3.9 Watercourses and Wetlands

The Project Area is located within the upper Dawson River catchment in the Fitzroy River Basin and contains ephemeral watercourses only (stream order 1-4) (Freshwater Ecology, 2022). The largest of these is Wooleebee Creek which drains into Juandah Creek approximately 15 kilometres to the north of the Project Area, before entering the Dawson River approximately 55 kilometres north of the Project Area. The other major watercourse in the Project Area is Wandoan Creek which runs from the north western boundary, meandering to the northern boundary of the Project Area, west of Jackson – Wandoan Road

There are no Wetland Protection Areas or High Ecological Value (HEV) watercourses or Wetlands mapped within the Project Area. Figure 36 shows the relevant drainage features and wetlands mapped throughout the Project Area.

Figure 36: Watercourses and Wetlands in the Project Area



9.4 Potential Impacts

The vast majority of the Project Area is already disturbed (1,540 ha of the 1,847.9 ha area is non-remnant vegetation). Based on the identified project activities and the application of the constraints protocol, the maximum disturbance for the project will be approximately 137 ha. Project activities have been located in accordance with the Senex constraints protocol and avoid ecological constraints wherever practicable.

An overarching assessment of potential impacts to ecological values within the project area has been undertaken and is presented in Table 44. Further assessment of the potential for significant residual impacts to identified MNES and MSES are presented in the following sub-sections.

Table 44: Potential Impacts to MNES and MSES in the Project Area

Potential Impact	Stage of Development	Relevance to the Project
Clearing of native vegetation and habitat for threatened and migratory species and threatened ecological communities, leading to disturbance or displacement of fauna species from foraging or roosting habitat, or breeding place	Construction	Senex has committed to not clearing any areas confirmed as MNES TECs or areas confirmed as habitat for MNES and MSES threatened species, with the exception of up to 137 ha of Koala dispersal habitat and Short-beaked Echidna habitat. The maximum area to be disturbed represents a small portion of the overall Project Area (7.4%). A maximum of 8.5% of the previously cleared Koala dispersal habitat will be disturbed. Any further refinements to the final disturbance footprint will be made in accordance with the implementation of the Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development [SENEX-CORP-EN-PRC-019] (Appendix B).

Potential Impact	Stage of Development	Relevance to the Project
Degradation of threatened species habitats or threatened ecological communities as a result of dust, erosion or accidental release of hazardous materials (indirect impacts)	Construction and Operation	Disturbances as a result of construction (and decommissioning), such as noise and dust, have the potential to negatively impact adjacent vegetation communities and habitats. Noise disturbances have the potential to influence breeding, roosting or foraging behaviour of native fauna. Studies suggest that the consistency of noise is more important than volume, with irregular and unpredictable noise being more disruptive to wildlife (Jones et al. 2015), as may be emitted during construction. For the general native fauna community, individuals may relocate to adjacent areas during times of noise disturbance. It is noted that noise associated with the project principally relates to well drilling which on average is completed in 3 days per well. Dust generated by vehicle and machinery movements has the potential to smother vegetation directly adjacent to the works and inhibit plant growth and palatability for native fauna. There are measures available to limit dust generation and dispersion. The disturbance footprint will be designed to limit the number of watercourse crossings, particularly where remnant vegetation is associated with the watercourse. The existing aquatic habitat features within the Project Area are generally heavily disturbed drainage features. Given the limited extent water features relative to the Project Area and the typically dry nature of the area, impacts are expected to be minimal. However, there are measures available to limit erosion and runoff potential during rainfall events that may produce overland flows.
Introduction and/or spread of weed species (indirect impacts)	Construction and Operation	The introduction and/or spread of weed and pest species has the potential to negatively impact native flora and fauna communities through competition for resources and/or predation. The majority of the Project Area and surrounds is cleared, pastoral property and introduced flora are common. Three WoNs species were recorded within the Project Area: tiger pear, common pest pear and velvety tree pear, and three additional species are considered potential to occur due to records within the buffered Project Area: parthenium weed, fireweed and madeira vine. Two additional species prescribe as Category 3 restricted matters under the Biosecurity Act, Harrisia Cactus and Mother-of-millions; and three other weeds of management interest: willows cactus, African Lovegrass and Brazilian Nightshade, were detected within the Project Area during field surveys.

Potential Impact	Stage of Development	Relevance to the Project
Fauna injury during construction activities and movement of machinery/vehicles	Construction	The operation of vehicles and machinery within the Project Area has potential to lead to direct mortality or injury of resident fauna. Peak traffic period will be during the construction period with operational vehicle movements likely to be minimal. It is noted that well pad construction generally involves small crews with minimal truck movements and drill crews travel to site and stay on site whilst drilling. While many fauna groups are highly mobile (e.g. birds) and are likely to move when machinery and vehicles approach other less mobile groups (e.g. reptile and amphibians) may be more vulnerable to this impact. Similarly, there will be trenches excavated (construction only) which may provide a trapping hazard for some fauna groups (e.g. amphibians, small reptiles, small mammals).
Habitat fragmentation	Construction	The Project Area is located in a largely cleared landscape with limited tracts of vegetation to facilitate ecosystem connectivity. Dispersal opportunities within the remainder of the Project Area are largely restricted to riparian areas, primarily in association with Wandoan and Woleebee Creeks. The cleared, non-remnant areas are considered likely to impede dispersal for most (less common) reptiles, amphibians, small ground mammals and arboreal mammals. Well pad size (typically 0.6 ha) and distance between pads and flexibility in their locations as well as flexibility in the alignment of gathering so that gathering right-of ways will cross watercourses perpendicularly. Also, as the majority of the Project Area is made up of previously cleared land, the disturbance footprint will be able to be designed to avoid almost all vegetated corridors with high dispersal opportunity, consequently, the project is unlikely to have a substantial impact on connectivity and fragmentation.
Inhibiting the ability of ecological communities or species to adapt and survive predicted climate change effects	Construction and Operation	The construction and operation of the project will involve potential impacts to listed species. Climate change is a listed threatening process for many ecological communities and species in the sense that increasing temperatures may cause the risk of warmer temperatures, the potential for bushfires to occur, as well as limiting available habitat at optimal conditions. Potential risks include impeding migration pathways or inhibiting access to refuge areas for listed species or restricting areas for threatened ecological community succession. The project is not predicted to exacerbate these potential impacts of climate change.

Potential Impact	Stage of Development	Relevance to the Project
Loss of habitat, or degradation in vegetation quality from impacts associated with changes to groundwater hydrology	Construction and operation	Groundwater Dependent Ecosystems (GDEs) have been mapped and identified within and adjoining the Project Area. These GDEs occur within the riparian zones of Woleebee Creek and utilise alluvial sources of groundwater. There is potential for the drilling and gas extraction activities to impact on GDEs during construction and operation phases. Terrestrial GDEs mapped in the vicinity of the Project Area (DES, 2018) are also considered to source groundwater from the shallow alluvium, rather than the underlying Surat Basin units. However no significant impacts to GDEs are likely to occur as a result of the project (Appendix E).

9.5 Management and Mitigation Measures

Senex's Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development (the Protocol) (Section 4.3 and Appendix B) will be implemented for the Project. The Protocol aims (among other things) to guide infrastructure siting that considers biodiversity values and environmental constraints when selecting preferential locations, aligning with planning principles to avoid, minimise, mitigate and then manage potential environmental impacts.

The project aims to avoid disturbance to TEC and other remnant vegetation (which represents the majority of habitat for threatened and migratory species). Prior to undertaking activities that result in significant disturbance to land, an ecological survey to confirm on-ground biodiversity values will be undertaken by a suitably qualified person.

Other measures to be implemented are presented in Table 45.

Table 45: Management and Mitigation Measures for the Project Area

Potential Impacts	Relevant Stage	Key Management and Mitigation Measures
Clearing of native vegetation and habitat for threatened and migratory species and threatened ecological communities, leading to disturbance or displacement to fauna species from foraging or roosting habitat, or breeding place.	Construction	• The Constraints Protocol (Appendix B) will be implemented. • There will be no clearing of any areas confirmed as MNES TEC, MNES habitat, MSES or habitat for ENVT species listed under the NC Act, with the exception of Koala dispersal habitat. • Vegetation will not be cleared unless authorised under a Senex Access to Work (ATW) permit. The ATW will be approved prior to any vegetation clearance or disturbance occurring. • All infrastructure will be located preferentially in pre-disturbed areas of land. • Targeted surveys will be undertaken for threatened flora species with potential to occur, so that disturbance can be avoided where practicable, if they are found to occur or in the case of Belson's Panic (a grass known to recolonise in cleared or highly disturbed areas (Menkins, 1998)) avoided, relocated or reinstated • Habitat assessment will be undertaken for threatened fauna where infrastructure is proposed and habitat may be present. • Maximum RoW width will not exceed 18m for gathering and 24m for trunklines. • To prevent unnecessary land and vegetation disturbance, vehicles and equipment will be retained within the approved work zone. • 'No-go' areas will be GPS located and clearly marked e.g. with signage, bunting, flagging tape. • Reinstatement of areas which are not required for ongoing operational purposes. • Where identified as required, a qualified fauna spotter-catcher will conduct a search immediately prior to clearing of vegetation for the presence of fauna species. Where fauna are detected, the spotter catcher will assess and implement the most appropriate method to avoid or minimise impacts on that fauna as a result of clearing.

Potential Impacts	Relevant Stage	Key Management and Mitigation Measures
Degradation of threatened species habitats or threatened ecological communities as a result of dust, erosion or accidental release of hazardous materials (indirect impacts)	Construction and Operation	• The Senex Queensland Fauna Stock Management Procedure will be implemented. • Staff and contractors will be made aware through general site induction and training of the potential to generate dust emissions and mitigation and management measures that should be implemented. • Vehicles, plant and machinery will comply with site-specific speed limits to minimise dust generation. • Dust suppression may be used where deemed to be appropriate. • Erosion and sediment control to be managed in accordance with the Queensland Erosion and Sediment Control Plan and Contractor's erosion and sediment control procedures. • Where required, watercourse crossing points will be adequately stabilised to prevent erosion. • RoW construction period in waterways will be minimised • Construction activities must not interfere or block natural drainage e.g. disturbing channel contours.
Habitat fragmentation	Construction	• Infrastructure will be located preferentially avoiding, then minimize isolating, fragmenting, edge effects or dissecting tracts of native vegetation. • Pipeline infrastructure will maximize co-location. • RoW widths in native vegetation and waterway crossings will be minimised where possible. • Gathering lines are all below ground. • RoW rehabilitated to 6m wide access track post construction and all rehabilitated at end of project (unless landholder requests it to be retained for ongoing use purposes).
Inhibiting the ability of ecological communities or species to adapt and survive predicted climate change effects (for example through impeding migration pathways)	Construction and Operation	• All infrastructure will be located preferentially in pre-disturbed areas of land. • The Senex Protocol for constraints planning and field development will be implemented to minimise habitat fragmentation etc. • RoW widths in native vegetation and waterway crossings will be minimised. • Reinstatement of areas which are not required for ongoing operational purposes.

Potential Impacts	Relevant Stage	Key Management and Mitigation Measures
Fauna injury during construction activities and movement of machinery/vehicles	Construction and Operation	• The Senex Queensland Fauna Stock Management Procedure will be implemented. • Excavations and trenches must be inspected for trapped fauna on a daily basis during construction. • Measures to prevent fauna entrapment and facilitate escape must be implemented within open trenches. • Where identified as required, a qualified fauna spotter-catcher will conduct a search immediately prior to clearing of vegetation for the presence of fauna species. Where fauna are detected, the spotter catcher will assess and implement the most appropriate method to avoid or minimise impacts on that fauna as a result of clearing.
Introduction and/or spread of weed species	Construction and Operation	• The Senex Queensland Weed Hygiene Procedure will be implemented. • Implementation of the Senex Biosecurity Management Plan Queensland Operations (SENEX-QLDS-EN-PLN-001) and Senex Queensland Weed Hygiene Procedure (SENEX-QLD-EN-PRC-023) which includes requirements for weed washdowns, certification and record keeping for all project vehicles and machinery. • Activities will be planned so that movement of vehicles, plant, machinery and equipment avoid moving between properties as required. • Access to a landholder’s property will not occur unless authorised under a Senex Access to Work (ATW) permit. Site specific weed management requirements will be defined prior to access to any property or work site. • Weed management and control methods will depend upon the location, weed species identified, the degree of the infestation, relevant landholder agreement or conduct and compensation agreements provisions, and local, state and national regulatory requirements. • Imported material able to transport weed seed will be assessed to ensure they are free of contamination, disease and invasive weeds. Landowner approval may also be required for imported soils and gravel.

9.6 Impact Assessment

9.6.1 MNES

An assessment of potential for significant residual impacts (SRI) to MNES as a result of proposed project activities has been completed in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (SIG 1.1) (DoE, 2013), and assuming that the controls and mitigation measures detailed in Section 9.5 are implemented.

Two TECs, five listed threatened fauna species, and two migratory species identified as known or likely to occur in the project area have been assessed to determine if they will be subject to significant residual impacts as a result of proposed project activities. A summary of the results of the significant impact assessments are provided below in Table 46 with the full assessment included in Appendix F.

Table 46: MNES Significant Impact Assessment Summary

MNES	Identified Habitat within the Project Area (ha)	Maximum Disturbance Limit (ha)	Disturbance as % of identified habitat
Brigalow TEC	22.3 ha	0 ha	0
Poplar Box TEC	20.7 ha	0 ha	0
Dulacca Woodland Snail	52.6 ha	0 ha	0
Glossy Black-cockatoo	236.2 ha	0 ha	0
Greater Glider	174.5 ha	0 ha	0
Koala	Foraging and breeding habitat 245.4 ha Dispersal habitat 1,602.5 ha	0 ha for foraging and breeding Up to 137 ha for dispersal habitat	0 8.5
White-throated Needletail	0 ha	0 ha	0

9.6.2 MSES

An assessment of potential for SRI to MSES as a result of proposed project activities has been completed in accordance with the SRI Guideline (DEHP, 2014), with the outcomes summarised in Table 47and assuming that the controls and mitigation measures detailed in Section 9.5 are implemented.

Table 47: MSES Significant Residual Impact Assessment Summary

Prescribed Matter	SRI Impact Test	Will the Action Cause an SRI
Regulated Vegetation		
Endangered or Of Concern REs	Table 2.1 of the SRI Guideline states that for clearing for linear infrastructure, clearing in a regional ecosystem that is Endangered or Of Concern will result in an SRI if it is: • Greater than 25m wide in a grassland (structural category) regional ecosystem; or • Greater than 20m wide in a sparse (structural category) regional ecosystem; or • Greater than 10m wide in a dense to mid-dense (structural category) regional ecosystem. Regulated Vegetation that is Category B is present as four patches totalling 199.5 ha (<10.8%) of the Project Area, all of which will be avoided; therefore no SRI will result.	No
REs within a defined distance of a watercourse	Table 2.1 of the SRI Guideline states that for a prescribed activity to have an SRI on an RE that is within the defined distance of a watercourse, criteria 1 and 3 must be exceeded. Criteria 1 states that for clearing for linear infrastructure, clearing in a regional ecosystem that is within the defined distance of a watercourse will result in an SRI if it is: • Greater than 25 m wide in a grassland (structural category) regional ecosystem; or • Greater than 20 m wide in a sparse (structural category) regional ecosystem; or • Greater than 10 m wide in a dense to mid-dense (structural category) regional ecosystem. No Remnant vegetation will be impacted. Therefore, there will be no SRI to Regulated Vegetation intersecting a watercourse within the Project Area.	No
REs within a defined distance of a wetland	Table 2.1 of the SRI Guideline states that for a prescribed activity to have an SRI on an RE that is within the defined distance of a wetland, criteria 1 and 2 must be exceeded. Criteria 1 states that for clearing for linear infrastructure, clearing in a regional ecosystem that is within the defined distance of a wetland will result in an SRI if it is: • Greater than 25 m wide in a grassland (structural category) regional ecosystem; or • Greater than 20 m wide in a sparse (structural category) regional ecosystem; or • Greater than 10 m wide in a dense to mid-dense (structural category) regional ecosystem. Criteria 2 states that an SRI results from clearing within a RE that is within 50 m of a mapped wetland. There are no mapped wetlands within the Project Area. Criteria 1 and 2 cannot be exceeded. Therefore, no REs occur within 100 m of a wetland and so no SRI will result.	No

Prescribed Matter	SRI Impact Test	Will the Action Cause an SRI
Protected Wildlife Habitat		
Protected wildlife habitat (EN, VU) - fauna	Section 5.1 of the SRI Guideline states that an action is likely to have a significant impact on Endangered and Vulnerable wildlife if the impact to habitat is likely to: • Lead to a long-term decrease in the size of a local population; or • Reduce the extent of occurrence of the species; or • Fragment an existing population; or • Result in genetically distinct populations forming as a result of habitat isolation; or • Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat; or • Introduce disease that may cause the population to decline, or • Interfere with the recovery of the species; or • Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species. The maximum habitat to be impacted for each of the listed threatened species is: • Up to 137 ha of Koala dispersal habitat and 0 ha of preferred Koala foraging and breeding habitat (8.5% of dispersal habitat); • Up to 137 ha impact to Short-beaked Echidna habitat (not mapped as includes the entire Project Area) (7.4% of Short-beaked Echidna habitat). Whilst there is a potential impact of up to 137 ha for the short-beaked echidna (listed as Special Least Concern under the NC Act), there is no statutory requirement for offsetting for this species. Therefore, it is not required to be considered as part of the final impact assessments and calculations. Impacts to the size of the population, extent of occurrence, connectivity, contribution to threats, interference with recovery and disruption to ecologically significant locations are considered when assessed against the relevant guidelines. Given the small scale of impacts, as well as the existing disturbance within the Project Area, it is unlikely that there will be an SRI to any of these species.	No SRI triggered

10 Potential Impacts to Air Quality

The proposed project does not include any plant or equipment that would trigger the fuel burning or power generation ERAs. As such it is expected that emissions to air will be limited to fugitive emissions of particulate matter from construction and operational activities, including:

- Clear and Grade of well pads, access tracks; and gathering RoWs;
- Wind erosion of disturbed areas / stockpiles; and
- Gathering installation
- Wheel-generated dust during construction and day-to-day operations.

Vehicular emissions associated with diesel engines may result in localised increases in pollutant concentrations but given the small scale and dispersed nature of proposed activities, the potential for any criteria to be exceeded at surrounding sensitive receptors or sensitive areas is minimal and combustion-related emissions have not been considered further.

10.1 Existing Environment

SLR (2022) undertook an air quality assessment for a separate Senex project in the vicinity of ATP 2059 and provided the following assessment of existing air quality:

Air quality monitoring is performed by DES at a number of monitoring stations across Queensland. The nearest such station is located at Miles Airport, approximately 65 km southeast from the eastern end of the proposed pipeline. The Miles Airport Air Quality Monitoring Station (AQMS) was commissioned in 2015 and monitors concentration levels of PM10 and TSP.

Validated air quality monitoring data recorded by this AQMS were retrieved for the last available five years (2017-2021) for PM10 and TSP. A summary of the monitored pollutant concentrations is presented in Table 48. Figure 37 and Figure 38 show graphical summaries of the PM10 concentrations measured by the AQMS.

Table 48: Air Quality Monitoring Data at Prospect AQMS (2018-2022)

Pollutant	PM_{10}					TSP
Averaging Period	Maximum 24-hour average [1]	Annual Average [3]	90th Percentile 24-hour average	70th Percentile 24-hour average	50th Percentile 24-hour average	Annual Average
Units	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
2017[2]	52.3 (1)	10.8	21.8	12.5	8.9	18.4
2018	114.2 (5)	16.2	27.3	17.8	13.4	26.1
2019[2]	118.9 (12)	31.2	56.3	35.4	20.4	50.7
2020	283.1 (9)	15.6	28.4	16.8	11.2	25.7
2021	71.6 (4)	11.8	21.2	13.4	9.4	19.4
Criterion	50	25	-			90

1 – Figures in brackets represent number of exceedances of 24-hour average PM_{10} EPP (Air) objective

2 –Data for 2017 are based on approximately 36% data capture rate, and 2019 is based on approximately 19% data capture rate

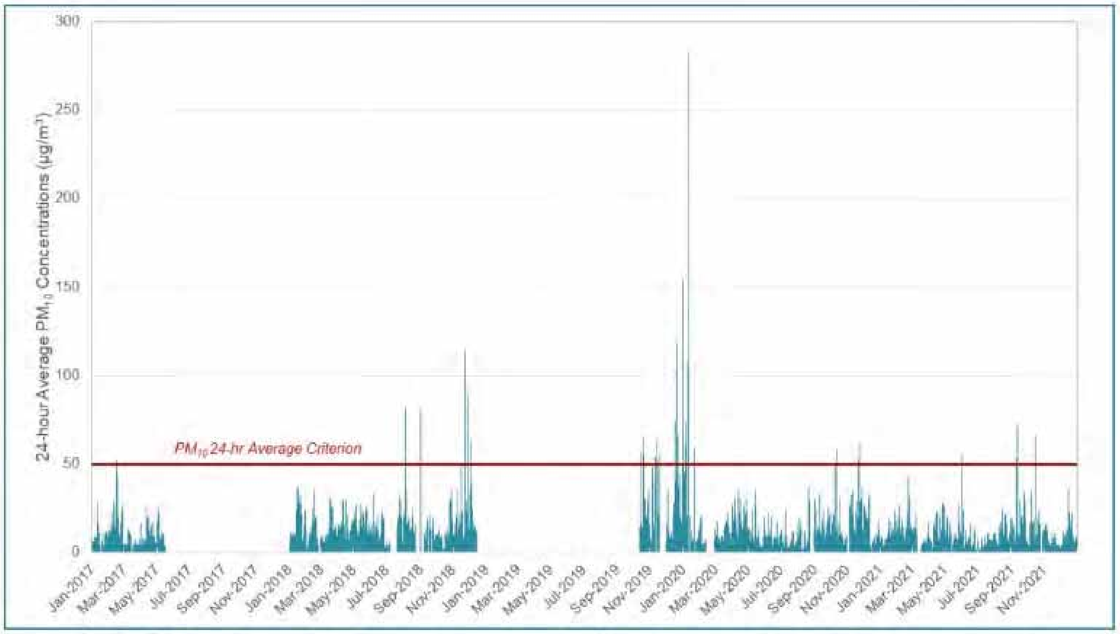
3 - Five year mean annual average PM10 concentration is 17.1 µg/m³

Exceedances of the 24-hour average PM10 criterion were recorded by the Miles Airport AQMS in all years assessed, with maximum 24-hour PM10 concentration of 283.1µg/m3 recorded in 2020 (Figure 37). The AQMS reported highest number of exceedances of the relevant criterion during 2019. However, it is noted that only 19% data capture was achieved in this year. A review of the exceedances recorded indicates that they were associated with natural events such as bushfires or dust storms, or hazard reduction burns.

No exceedances of the PM10 annual average criterion or TSP annual average criterion were recorded during any of the years analysed for this study.

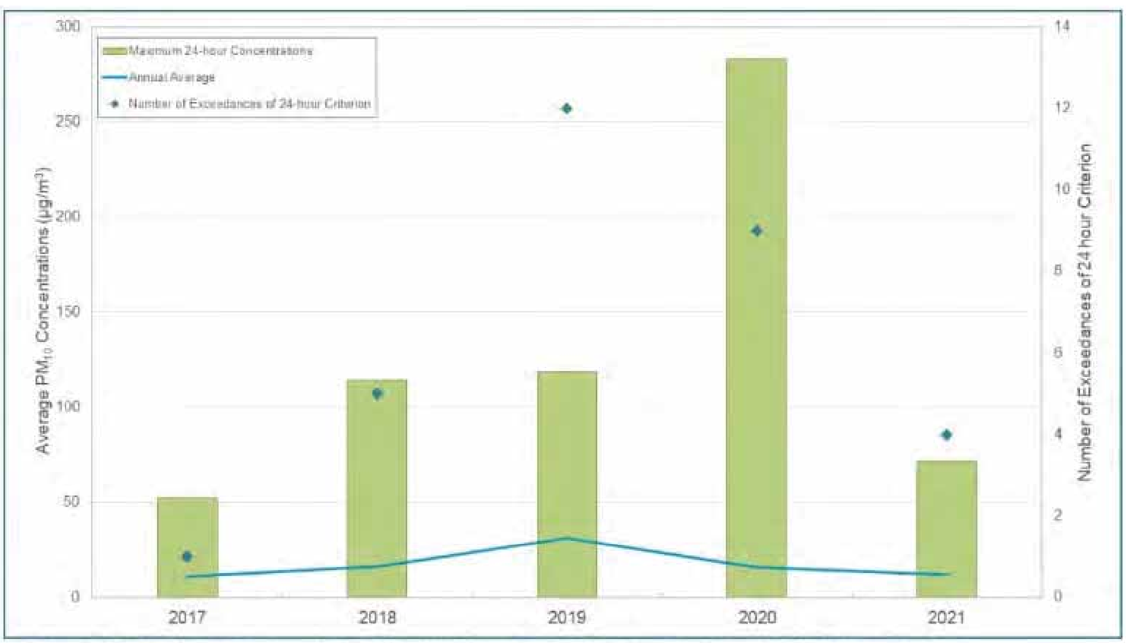
In summary, the Miles Airport AQMS data show that background particulate levels in the region can be elevated at times. Effective dust mitigation measures therefore need to be implemented during the construction works so that the project will not make any significant elevation of local dust levels that may lead to additional exceedances of relevant air quality criteria in the surrounding area.

Figure 37: Measured 24-Hour Average PM10 Concentrations at Miles Airport AQMS (2017-2021)



Note – data for 2017 is based on approximately 36% data capture rate and 2019 is based on approximately 19% data capture rate

Figure 38 Summary of Measured 24-Hour Average PM10 Concentrations at Miles Airport AQMS (2017-2021)



Note – data for 2017 is based on approximately 36% data capture rate and 2019 is based on approximately 19% data capture rate

10.2 Air Quality Objectives

The Environment Protection (Air) Policy 2019 (EPP Air) lists relevant air quality objectives in Schedule 1. Relevant Pollutants of concern and their associated air quality objectives are shown below in Table 49.

Table 49: EPP Air - Relevant Air Quality Objectives

Indicator	Environmental Value	Air Quality Objective (µg/m3)	Period
PM2.5	Health and Wellbeing	25	24 hours
		8	1 year
PM10	Health and Wellbeing	50	24 hour
		25	1 year
TSP	Health and Wellbeing	90	1 year

Section 8(2) of the EPP Air provides the following management hierarchy for activities which may generate air emissions:

- Avoid air emissions;
- Recycle air emissions;
- Minimise air emissions; and
- Manage air emissions.

10.3 Impact Assessment

As per Section 4.2 works associated with the development of PLA 1127 are limited to 31 wells, with associated access and gathering. No sensitive receptors have been identified within 1km of PLA 1127 (Figure 8), and earthworks associated with proposed development activities are minor and short-term. Further, development will be sequential with access to well pads being prepared first, followed by drilling and completion activities and then gathering installation.

As a result, particulate emissions from the proposed development are expected to be minimal, with negligible nuisance value.

11 Noise Assessment

The proposed project does not include any plant or equipment that would trigger the fuel burning or power generation ERAs. As such it is expected that noise emissions from project activities will be limited to the following construction and operational activities:

- Clear and Grade of well pads, access tracks; and gathering RoWs;
- Drilling and completion;
- Gathering installation; and
- Vehicular noise from day-to-day operations.

Operational vehicular will predominantly be from light vehicles and together with the small scale and dispersed nature of proposed activities, the potential for any noise criteria to be exceeded at surrounding sensitive receptors or sensitive areas is minimal and operational noise emissions have not been considered further.

11.1 Existing Environment

Due to the character of the location (Section 5) ambient noise levels are low and typical of rural areas. As a result, the deemed backround noise levels (Table 50) have been adopted as per the Guideline Noise Assessment: Prescribing noise conditions for environmental authorities for petroleum activities (ESR/2016/1935, version 2.03).

Table 50: Deemed Background Noise Levels (source: ESR/2016/1935, v2.03)

Time Period	Deemed Background Noise Level (dB(A))
7:00 am – 6:00 pm	35
6:00 pm – 10:00 pm	30
10:00 pm – 6:00 am	25
6:00 am – 7:00 am	30

11.2 Acoustic Quality Objectives

Acoustic quality objectives relevant to construction activities are described in Schedule 1 of the EPP Noise and in Table 51 which outlines thresholds under which noise is not considered a nuisance in the Streamline model conditions.

Table 51: Noise Nuisance Limits

Time Period	Metric	Short Term Noise Event	Medium Term Noise Event	Long Term Noise Event[14]
7:00 am – 6:00 pm	LAeq,adj,15 min	45 dBA	43 dBA	40 dBA
6:00 pm – 10:00 pm	LAeq,adj,15 min	40 dBA	38 dBA	35 dBA
10:00pm—6:00am	LAeq,adj,15 min	28 dBA	28 dBA	28 dBA
	Max LpA, 15 mins	55 dBA	55 dBA	55 dBA
6:00am—7:00am	LAeq,adj,15 min	40 dBA	38 dBA	35 dBA
Noise from drilling[15] activities undertaken from 10:00 pm – 6:00 am	LAeq,adj,15 min	30 dBA[16] (measured indoors at any sensitive receptor, 35dBA outdoors)		

11.3 Impact Assessment

As per section 4.2 works associated with the development of PLA 1127 are limited to 31 wells, with associated access and gathering. No sensitive receptors have been identified within 1km of PLA 1127 Figure 8). Clear and grade, and drilling and completions are short-term transient activities. Further, development will be sequential with access to well pads being prepared first, followed by drilling and completion activities and then gathering installation.

As a result, acoustic emissions from the proposed development are expected to be minimal, and Senex will be able to comply with the proposed limits in Table 51.

[14] The noise limits in Schedule C, Table 1 have been set based on the following deemed background noise levels (LABG):
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
[15] Measured indoors at any sensitive receptor, or 35dBA externally allowing for a conservative 5dB attenuation of the external noise level by means of façade reduction.
[16] Drilling activities undertaken from 10:00 pm – 7:00 am must be temporary and mobile in nature, and must not contribute to long-term background noise creep.

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Appendix A: Environmental Management Plan Atlas Stage 3 Gas Project

Senex

Environmental Management Plan

Atlas Stage 3 Gas Project

Date:	1 August 2023
Document:	SENEX-ATLAS-EN-PLN-015
Revision:	2

Contents

Figures

Document Status

Revision History

Revision	Release Date	Document Status	Revision Comments	Author
A	03/11/2022	Issued for Review	Document creation	M Harris
1	15/11/2022	Issued for Use		M Harris
2	31/07/2023	Issued for Use	Updated to address EPBC RFI	J. Claridge

Document Approval

Approved by	Jacob Cumpstay Environment Manager	**Signed**	Date 01/08/2023

1 Introduction

Senex Energy Pty Ltd (**Senex**), through its subsidiaries Senex Assets Pty Ltd and Senex Assets 2 Pty Ltd, is progressing development of Atlas Stage 3 Gas Project on Authority to Prospect (**ATP**) 2059, Petroleum Lease (**PL**) 445, the northern half of PL209 and parts of PL1037, and any subsequent or replacement petroleum authorities over the areas so described (together, the **Project Area** shown in Figure 1) in the central part of the Surat Basin; an established gas producing region. Atlas Stage 3 Gas Project will involve developing production wells and supporting infrastructure to produce gas for domestic and international markets.

The Project Area totals 12,304 ha and is located approximately 44 kilometres north of the Warrego Highway, between the townships of Wandoan and Wallumbilla (**Figure 1**). The potential disturbance within the Project Area relates to the Field Development Area (FDA), plus a required brine storage dam which will be located in an area devoid of MNES. The term Project Area is used to describe the Project and its location more broadly in this Environmental Management Plan (**EMP**). The FDA is approximately 9,772 ha and is located within the Project Area.

The operating life of a production well is expected to be between approximately 15 to 35 years, with wells no longer required for operational purposes progressively decommissioned and rehabilitated throughout the Project Area life. The Atlas Stage 3 Gas Project will be progressively developed over approximately 5 to 10 years and will result in approximately 200 PJ of additional resource of natural gas to be produced for domestic and international markets.

Proposed activities will build upon infrastructure to be established for appraisal activities and will include but not be limited to constructing and operating:

- 151 wells and associated well site facilities;
- Gas and watering gathering system for the producing wells;
- Produced water management facilities including water aggregation dams, reverse osmosis treatment facility, and brine dam;
- Several temporary accommodation facilities required for construction and drilling activities;
- Laydown, stockpile and site office areas (approximately 45 ha in areas previously cleared of original native vegetation);
- Borrow pits (approximately 11 ha in areas previously cleared of original native vegetation);
- Other-ancillary facilities and infrastructure with a footprint of (approximately 30 ha disturbance in areas previously cleared of original native vegetation) including:
  - power/communication lines (overhead or underground);
  - plant and equipment service and maintenance facilities and workshops;
  - construction support, warehousing and administration buildings;
  - fuel and chemical storage;
  - washdown-facilities;
  - ancillary infrastructure such as communications infrastructure, water supply and holding tanks and dams and energy supply;
  - groundwater-monitoring bores;
  - environmental monitoring equipment and management controls; and
  - ecological, topographic, cadastral, geological, geophysical and geotechnical surveys;
- Operating wells, gathering system and associated facilities established for the appraisal program; and
- Access tracks will be required for operational purposes for the life of the well and will be located within the right of way with the buried pipeline.

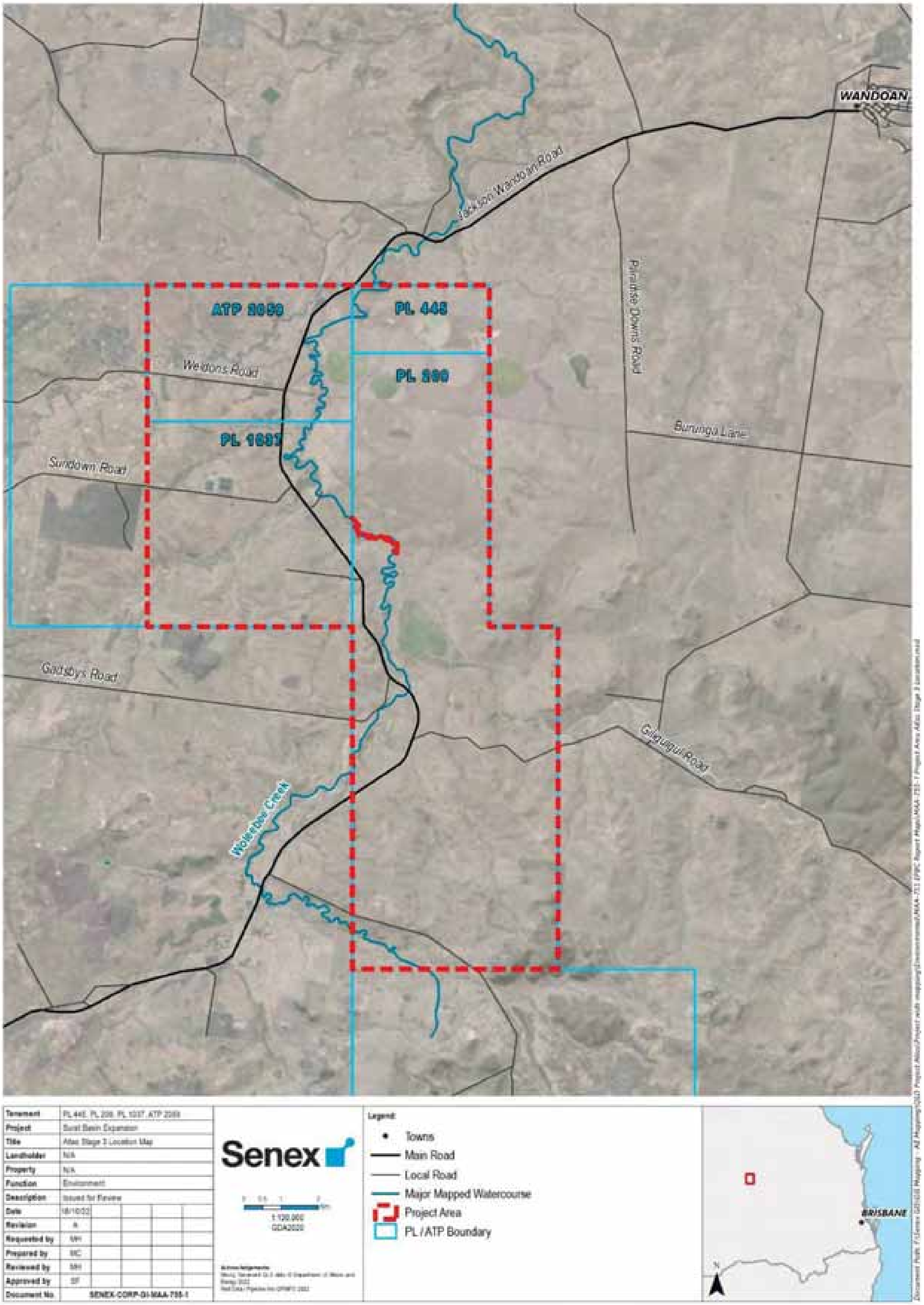


Figure 1: Atlas Stage 3 Gas Project Area and Location

1.1 Purpose and Scope

This EMP describes how Senex will manage potential environmental impacts associated with conducting appraisal and production activities in the Project Area and ensure compliance with the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (**EPBC Act**) and Environmental Authority (**EA**) conditions, industry guidelines and other regulatory requirements.

The objectives of this EMP are to ensure:

- Potential project related impacts are avoided, minimised, mitigated and restored;
- Potential impacts upon the surrounding environment, including “matters of national environmental significance” (**MNES**), are identified and addressed within an internal planning process and incorporated into field management procedures;
- Activities that have, or are likely to have, temporary impacts on the environment are monitored and managed; and
- Activities which have, or are likely to have, long term significant impacts on the environment or land use are managed and mitigated.

Broadly, this EMP covers:

- Specific requirements for compliance with government regulatory requirements, EA and other approval conditions;
- Activities authorised to be undertaken in the Project Area;
- Communication and documentation of environmental compliance undertakings for all activities; and
- Environmental management measures to be implemented to minimise identified potential environmental impacts.

1.2 Supporting Plans and Procedures

The EMP will be updated:

- To reflect new or additional permit conditions, regulatory requirements; and
- As required by a risk assessment or changed project outcomes.

Senex contractors will be provided with a copy of this EMP and will be required to comply with its contents.

This EMP is supported by several internal plans, procedures and processes including but not limited to the following:

- Senex Health, Safety and Environmental Management System [SENEX-CORP-HS-STD-001] (**HSEMS**) which outlines procedures for incident notification, response, investigation and reporting procedures and which references the:
    - o Incident Management Procedure [SENEX-CORP-HS-PRC-004]; and
    - o Senex Spill Response Plan [SENEX-CORP-ER-PLN-006]; and

  includes contingency procedures for emergency environmental incidents;
- Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development [OPS-ATLS-EN-PLN-001] (the **Constraints Protocol**), comprising a GIS analysis tool and integrated within infrastructure development and land access planning processes;
- Senex Action Item Tracking Register (**AITR**) database which tracks complaints, grievances and all other items required to be actioned;
- Queensland Operations Biosecurity Management Plan [SENEX-QLDS-EN-PLN-001];
- Queensland Weed Hygiene Procedure [SENEX-QLDS-EN-PRC-023];

- Senex Waste Management Procedure Qld [SENEX-QLDS-EN-PRC-022];
- Rehabilitation Plan Atlas Stage 3 Gas Project [SENEX-ATLS-EN-PLN-018];
- Queensland Erosion and Sediment Control Procedure [SENEX-QLDS-EN-PRC-003];
- Queensland Fauna and Stock Management Procedure [SENEX-QLDS-EN-PRC-021];
- Atlas Stage 3 Gas Project Significant Species Management Plan (ERM 2023);
- Atlas Stage 3 Water Monitoring and Management Plan [SENEX-ATLS-EN-PLN-017];
- ATP 2059 Coal Seam Gas Water Management Plan [SENEX-ATLS-EN-PLN-013];
- PL 445 and PL 209 Coal Seam Gas Water Management Plan [SENEX-ATLS-EN-PLN-014];
- Atlas Stage 3 Gas Project Chemical Risk Assessment Report (KCB 2023); and
- Atlas Stage 3 Gas Project EPBC Water Resource Impact Assessment (CKB 2023).

1.3 Terms of Reference

The following terms and abbreviations are used throughout this EMP.

Term	Definition
AITR	the Senex Action Item Tracking Register.
AREMP	an Air Receiving Environment Monitoring Program.
AS	Australian Standards.
ATP	Authority to Prospect.
ATW	Access to Work documentation.
BUA	Beneficial Use Approval.
CCA	Conduct and Compensation Agreement.
Constraints Protocol	Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development [OPS-ATLS-EN-PLN-001].
DAF	the Department of Agriculture and Fisheries.
DES	the Department of Environment and Science.
DTMR	the Department of Transport and Main Roads.
EA	Environmental Authority.
EMP	this Environmental Management Plan for Project Atlas.
EMS	Senex's Environmental Management System.
EP Act	the *Environmental Protection Act 1994* (Qld).
EP Regulation	the *Environmental Protection Regulation 2019* (Qld).
EPBC Act	the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).
ESA	Environmentally Sensitive Areas.
HDPE	high density polyethylene.
HPV	High Point Vent.
HSEMS	the Senex Health, Safety and Environment Management System.
LPD	Low Point Drain.
MAOP	maximum allowable operating pressure.
MNES	matters of "national environmental significance" as that term is defined under the EPBC Act.

Term	Definition
NC Act	the *Nature Conservation Act 1992* (Qld).
P&G Act	the *Petroleum and Gas (Production and Safety) Act 2004* (Qld).
PCP	progressive cavity pump.
PL	Petroleum Lease.
Project Area	PLs 1037, 109 and 445, and ATP 2059, and includes any subsequent or replacement petroleum authorities.
RO	reverse osmosis.
ROW	Right of Way.
RTU	remote terminal unit.
SCADA	supervisory control and data acquisition.
SDS	the Safety Data Sheets.
Senex	Senex Assets Pty Ltd and Senex Assets 2 Pty Ltd.
Water Act	the *Water Act 2000* (Qld).
ADR	the *Accepted development requirements for operational work that is constructing or raising waterway barrier works*
WRR Act	the *Waste Reduction and Recycling Act 2011* (Qld).
WSA	Water Supply Agreement.

2 Legislative Requirements

2.1 State Legislation

The principal legislation regulating petroleum and gas activities for the project is the *Petroleum and Gas (Production and Safety) Act 2004* (Qld) (**P&G Act**). The principal environmental legislation is the *Environmental Protection Act 1994* (Qld) (**EP Act**) and associated regulation and protection policies.

The EP Act introduces the 'general environmental duty' which specifies that a person must not perform their duties in a manner which will cause, or is likely to cause, environmental harm unless the person takes all reasonable and practical measures to prevent or minimise the harm.

The EA authorises petroleum activities under the EP Act, and Senex and all contractors undertaking petroleum activities within the Project Area must comply with the conditions of the EA, to meet their respective obligations under the EP Act.

Fisheries resources and development in fisheries habitat areas in Queensland are regulated under the *Fisheries Act 1994* (Qld). The most relevant provisions in the *Fisheries Act 1994* (Qld) relate to installation of temporary and permanent waterway barriers ("waterway barrier works"), which may be assessable development under the *Planning Act 2016* (Qld).

The *Nature Conservation Act 1992* (Qld) (**NC Act**) provides a framework for the creation and management of protected areas and the protection of native flora and fauna, which are classified as being either endangered, vulnerable, near threatened or least concern, and are referred to as "protected plants" and "protected animals", respectively.

There is a general prohibition on using, taking, keeping and interfering with protected plants and animals in Queensland, although there are various exemptions where the take may be lawful (depending on the purpose and the location in which the activity occurs).

The *Waste Reduction and Recycling Act 2011* (Qld) (**WRR Act**) establishes the framework for waste management and resource recovery in Queensland, including the waste and resource management hierarchy, the "user pays" principle, the proximity principle and product stewardship principles. Waste management strategies must be aligned with the hierarchy and principles under this Act.

The *Water Act 2000* (Qld) (**Water Act**) provides a framework for planning and regulating the use and control of water in Queensland. The Act provides a wide range of tools to regulate in-stream (that is, watercourses, lakes and springs) and overland water flow and groundwater within the context of "sustainable management and efficient use" of water.

Obligations also exist under other Queensland legislation for carrying out petroleum activities on the project area, a number of which are identified in the following sections of this EMP. It remains the duty of Senex employees and contractors to meet all obligations under Queensland legislation before undertaking activities in the project area. The Senex Environment Manager should be contacted where assistance is required.

2.2 Commonwealth Legislation

The EPBC Act is the principal piece of environmental legislation administered by the Commonwealth Government. It provides a legal framework to protect and manage, among other matters, nationally and internationally important flora, fauna, ecological communities and heritage places defined in the EPBC Act as MNES.

The EPBC Act requires the principles of ecologically sustainable development to be considered for a new development proposal if that proposal is likely to a result in a significant impact on the environment.

3 Roles and Responsibilities

Senex is responsible for the ongoing management of activities in the Project Area. All Senex employees and contractors are responsible for conforming to applicable Australian and Queensland laws and regulations and for conducting work in accordance with permit requirements and this plan.

Roles and responsibilities of Senex personnel and contractors in relation to this EMP are summarised in the table below.

Role	Responsibility
Senex Environmental Manager	• Secure and manage environmental and associated approvals. • Overall responsibility for environmental compliance, including monitoring, data collection and reporting. • Report incidents to the Department of Environment and Science (**DES**) and other Government agencies / stakeholders as required. • Ensure resources are available to manage environmental obligations and responsibilities. • Ensure that all personnel are competent to perform their assigned duties and have received appropriate training and inductions. • Implement an environmental compliance system that includes audits and assurance to help ensure compliance with Approval conditions and other regulatory requirements. • Keep up to date environmental management documentation including this EMP and associated plans, such as Significant Species Management Plan and procedures.
Senex Land Access Manager	• Secure land access for Senex activities including land access agreements/land access rules or Conduct and Compensation Agreements (**CCA**) with landholders whose properties will be impacted by Senex activities. • Engage with landholders and liaise with Senex Site Supervisor(s) to ensure activities are undertaken in accordance with the Queensland Land Access Code 2016 and conditions of any land access agreements/land access rules or CCAs. • Compile and distribute Access to Work documentation (**ATW**) prior to commencement of activities on site.
Senex Site Supervisors (Drilling, Completions, Civil Construction etc.)	• Represent Senex on site. Responsible for ensuring this EMP and other relevant environmental procedures are implemented on site, including any site-specific requirements identified during the planning phase. • Ensure that Senex staff and contractors comply with regulatory requirements including all relevant Approval conditions and requirements of the ATW. • Induct the Contractor Site Supervisor into relevant requirements of the EA, EMP, and supporting plans and procedures applicable to their activities on site. • Conduct inductions of any visitors to site. • Ensure toolbox and other safety talks adequately address environmental matters to be considered on site as relevant to the work being undertaken including those identified in the ATW (for example, property-specific weed hygiene requirements). • Ensure that the Contractor Site supervisor is adequately supervised. • Ensure activities do not harm or disturb cultural heritage objects or areas of significance. • Ensure that the requirements under any native title agreement are adhered to. • Ensure compliance with landholder agreements or CCA conditions as

Role	Responsibility
	defined in the ATW. • Ensure vehicle and machinery weed washdown requirements are complied with as specified in this EMP and supporting procedures and plans. • Empower all project staff to stop work when the potential for environmental harm is perceived. • Report to the Senex Environmental Manager on environmental matters and provide all relevant reporting and monitoring documentation as required. • Report to the Land Access Manager on landholder and property matters.
Contractor Site Supervisor	• Adequately identify and address any risks associated with the Contractor's activities prior to commencing and develop a construction methodology that has due regard for identified risks. • Ensure that appropriate training and inductions in the requirements of this EMP, EA conditions and other regulatory requirements as relates to their activities have been carried out for all Contractor personnel. • Ensure that Contractor personnel are adequately supervised. • Implement this EMP on site, including any site-specific requirements identified in Site Environmental Requirements documents, the ATW or as directed by the Senex Site Supervisor. • Ensure all activities are carried out in accordance with the requirements set out in the EMP, EA conditions, regulatory requirements and as specified in other relevant documents including tender documentation and contract with Senex. • Immediately notify the Senex Site Supervisor if cultural heritage sites, objects or human remains are found. • Immediately notify the Senex Site Supervisor of any incidents and non-compliances with the EA, EPBC Act approval, this EMP, supporting plans or procedures. • Report to the Senex Site Supervisor as instructed and provide all reporting and monitoring information to the Senex Site Supervisor as required. • Ensure that records are maintained of all monitoring activities. • Empower all project staff to stop work when the potential for environmental harm is perceived. • Implement a program of internal environmental audit against this EMP and supporting plans and procedure.
Contractor Personnel	• Undertake training and induction as required to competently undertake activities on the project area. • Carry out all activities in compliance with this EMP, Approval conditions, site environmental requirements identified in planning, the ATW or as directed by the Contractor Site Supervisor and/or Senex Site Supervisor. • Immediately notify the Contractor Site Supervisor if cultural heritage sites, objects or human remains are found. • Immediately notify the Contractor Site Supervisor of any incidents and non-compliances with the EA, EPBC Act approval, this EMP, supporting plans or procedures.
Senex Environment Team and/or Field Environment Representative	• Assist the Senex Site Supervisor as required in ensuring that all petroleum activities, including those undertaken by Contractors, are conducted in accordance with the EMP and in compliance with EA conditions. • Promote environmental awareness amongst the workforce and hold site meetings on environmental matters as required. • Assist the Senex Site Supervisor in providing training in the form of toolbox talks and pre-works meetings on environmental matters. • Notify the Senex Site Supervisor and Environment Manager of any environmental incidents and non–compliances with EA conditions, the EMP and associated plans and procedures within specified timeframes in the

Role	Responsibility
	Senex Health, Safety and Environmental Management System [SENEX-CORP-HS-STD-001] and liaise with the Construction Site Supervisor to investigate and report on the incident or noncompliance. • Ensure that all records, environmental approvals, and permits are managed, maintained and stored as appropriate and copies of the EMP, Approval conditions and supporting procedures and plans are available as required. • Co-ordinate implementation of rehabilitation plans and programs as required for the Project Area. • Undertake monitoring in accordance with this EMP, supporting plans and procedures and Approval conditions as directed by the Senex Environment Manager. • Complete Environmental Audits as directed by the Environment Manager.

4 Environmental Training and Inductions

Environmental awareness training and inductions appropriate to the level of risk and type of work being performed will be provided to personnel, contractors and visitors as relevant. Senex contractors and consultants are made aware of the requirements of this EMP and associated procedures through the contracts and procurement process. Senex staff will undergo formal induction into the requirements of the EMP and associated plans and procedures.

4.1 General Training and Inductions

Training and inductions will cover:

- Environmental obligations and responsibilities under the EP Act, *Environmental Protection Regulation 2019* (Qld) (**EP Regulation**) and the EA;
- Environmental obligations and responsibilities under the EPBC Act.
- Requirements of this EMP and other project management plans and procedures;
- Environmental hazards and control measures;
- Emergency, incident and spill response procedures and incident notification procedures, including duty to report environmental incidents;
- Weed management and hygiene procedures;
- Water and waste management obligations; and
- Interactions with flora and fauna.

Relevant site-specific environmental information will be considered during site planning and disseminated through contract documentation to Contractors, through Site Environmental Requirement plans, ATW documentation to site personnel and to all during toolbox sessions. Information may include:

- Land access requirements;
- Areas identified as containing weeds or being clean and weed free, and procedures for moving between these areas;
- Weed hygiene certification requirements;
- Environmentally sensitive areas, including no-go areas that must be avoided;
- Any areas for which specific management measures must be implemented prior to working adjacent to or within; and
- Any significant flora and fauna species (including MNES) identified as potentially present in the work areas.

Records of training and inductions will be maintained to demonstrate achievement of competence. Training and induction material will be reviewed following change, incident investigations and hazard studies. Separate training and inductions are provided covering the topics of safety, cultural heritage and land access.

4.2 Fire Prevention Training

Fire on site has the potential to cause significant damage and/or injury to personnel, property, stock and the environment. The likelihood of fire starting in rural locations can be influenced by the condition of ground cover (for example, tall, dry grass), the type and working condition of machinery, and human behaviour such as inappropriate disposal of cigarette butts.

Fire prevention will be covered as part of safety training and/or toolbox meetings to ensure all personnel are fully aware of the potential for fire to start in the area in which work is being performed. Fire-fighting equipment and procedures will be in place at all Senex operated sites. Measures to aid in the prevention of fires may include:

- Provision of appropriate fire-fighting equipment at Senex work sites;
- Training of personnel in fire-fighting procedures appropriate to the workplace;
- Fitting of Senex vehicles and/or other machinery with fire extinguishers which comply with the relevant Australian standards;
- Ensuring Senex vehicles and/or machinery have efficient exhaust systems free from leaks and, where appropriate, spark arresters; and
- Inspection of the underneath of vehicles for, and removal of, collected flammable material as required (for example, after working in long grass).

5 Description of Petroleum Activities

5.1 Petroleum Appraisal Activities

Appraisal wells are drilled to determine the location, extent, thickness, permeability, gas content and gas saturation of coal seams present in the target area. The location of well sites, access tracks and associated infrastructure will be site-specific depending on location and characteristics of the hydrocarbon reservoir and local environmental conditions.

Appraisal testing involves drilling a cluster of wells in one area, with one central well and several wells surrounding it. The data is used in future gas field development planning to optimise well spacing, water and gas infrastructure, water treatment options and pump sizes.

The location of the wells and all associated infrastructure will be selected by implementing the Constraints Protocol. Well pads are up to approximately 0.6 ha to safely accommodate the drilling rig and associated equipment.

Water is required by the drilling process and may be pumped or trucked to site.

The CSG produced from wells will be locally cold vented where it cannot be used commercially or technically used as fuel in the carrying out of authorised activities in accordance with the P&G Act.

Beneficial use options for produced water generated through appraisal activities may comprise providing stock water, subject to commercial arrangements.

5.2 Production Wells

Senex expects that production well drilling campaigns will be between approximately 15 to 35 wells per annum, with a total of 151 wells being drilled. They will be drilled and constructed in accordance with the Queensland codes of practice for constructing and abandoning CSG wells. The wells will be spaced between 500 to 750 m apart.

The location of the wells and all associated infrastructure will be selected by implementing the Constraints Protocol.

The initial wellsite will generally be constructed in an area of up to approximately 80 m by 70 m, to allow the initial drilling and completion of the well (installing surface facilities). Following the initial drilling and commissioning of the well, the well site will be partially rehabilitated, leaving an area of approximately 60m x 60m to allow an adequate area for workover rig operations that will be required throughout the well’s life.

It will take up to 6 months to dewater each production well sufficiently for gas to flow; approximately 18 months to reach peak production; and an estimated 8 years for gas to free- flow.

Once depleted of gas, wells will be capped, rehabilitated and abandoned. This is not expected to occur for at least 15 years from drilling a well and may be much longer (more than 25 years).

5.3 Drilling and Operations

For appraisal and production wells, drilling and completions wastes will either be collected in an appropriately sized storage container to be removed from site and disposed of at an appropriately licensed facility; or they may be managed on site as authorised by the standard conditions. Drilling muds may be reclaimed for use throughout the drilling program.

Following the well drilling phase, the wells will be completed, and a pump installed to dewater the production reservoir. Separate connections will be provided at the well head for the gas and water streams. Produced water will be pumped to the surface by a downhole progressive cavity pump (**PCP**), driven by an electric motor, and connected from the wellhead tubing.

The standard well site facility will generally consist of:

- A wellhead gas and water metering package to achieve full time gas and water metering for each well. This prevents pumps running dry, enables early diagnoses of pump or other equipment failure and identification of potential flow line ruptures/leaks, while monitoring efficiency of low point drain operation.

- Gas and water separation in the downhole wellbore annulus area. A well head gas/water separator may be incorporated into the metering package if additional separation is required.
- Natural gas power generation package to provide power for the electric motor driving the downhole pump.
- Fuel and instrument gas scrubber to power the generator and supply gas to instruments.
- (Optional) Sand/particulate filter separator for water and gas streams.
- Remote terminal unit (**RTU**)/supervisory control and data acquisition (**SCADA**) and solar panel/battery package for site communication and status.
- Equipment being located on sleepers (concrete or timber) to minimize disturbance and reduce/eliminate the need for foundations.
- Prefabricated cattle panels for perimeter fencing around the production facilities to allow maintenance as required. The area may be graveled to allow operating access in wet weather.
- Surface pressure piping constructed of steel to the required specification. Transition to the gathering system material (high density polyethylene (**HDPE**)) will occur either at or below grade.

Once depleted of gas, wells will be capped, rehabilitated and abandoned. This is not expected to occur for at least 15 years from drilling a well; and may be much longer (more than 25 years).

5.4 Gas and Water Gathering System

Gas and water from the wellsite facilities will be delivered to a compression facility and water treatment/storage facilities via the gas and water gathering system. These may be owned and /or operated by another entity, including third parties over time.

The buried gathering system will enable gas at low pressure and water to flow through separate HDPE pipelines. The pipelines will typically be between 63 mm and 650 mm in diameter and buried with a minimum depth of cover of 750 mm for pipe greater than 160 mm in diameter. Pipe equal to or less than 160 mm in diameter may have a 600 mm depth of cover where a risk assessment confirms an alternate burial depth can effectively minimise disruption to land use and ensure safety and pipeline integrity are appropriately managed. Pipelines will transport water in a separate HDPE pipeline installed underground to water management facilities.

To install the gathering lines, Right of Ways (**ROW**) between 12 and 18 m wide (with 24 m ROWs required for approximately 15 km of major gathering trunklines) will require vegetation to be removed. Pipeline ROWs will be preferentially aligned with existing roads/tracks, fence or power lines or other linear infrastructure to minimise disturbance and overall impact on land users. Once constructed, the ROW will be rehabilitated (transitional rehabilitation) except for areas required for an access track (approximately 6 m wide).

Horizontal directional drilling (**HDD**) may be used in the crossing of watercourses with protected vegetation and/or habitat, such as Woleebee Creek.

The gas gathering system will typically operate at 70 – 400 kPag with a Maximum Allowable Operating Pressure (**MAOP**) of 615 kPag. The water gathering system will typically operate up to 1,000 kPag depending on the terrain.

Although the gas and water will be transported in separate pipelines, the water will contain some entrained gas; and the gas will be saturated and contain carry over water (from well site separation) and water from condensation (from changes in temperature). As a result of the entrained gas, the water gathering system will have high point vents (**HPV**) installed to remove the accumulated gas at high points in the gathering line. The gas gathering system will have low point drains (**LPD**) to remove water that accumulates in pipeline low points. The purpose of the LPDs and HPVs is to restore the flow efficiency of the respective pipelines resulting in a more consistent and overall lower wellhead operating pressure. Not every high-point and low-point will require a vent or drain (respectively). The requirement will be assessed on a case-by-case basis. The LPDs and HPVs aim to restore the pipeline flow efficiency of the respective flowlines resulting in a more consistent and overall lower wellhead operating pressure.

5.5 Produced water management facilities

Produced water has the potential to be beneficially used for a range of purposes in both treated and untreated (raw) forms. Produced water management options are considered in the context of the *Coal Seam Gas Water Management Policy 2012—ESR/2016/2381 (formerly EM738)*, which identifies the hierarchy of disposal options. The preferred option is beneficial use with a view to maximising benefits to the community. Where produced water can be beneficially used it is no longer considered a waste under the EP Act.

Produced water will generally be collected from the water gathering systems into an aggregation dam/s. Water for beneficial use, where treatment is not required, will be drawn from the aggregation dams. Where practical, Senex will use untreated CSG produced water to support ongoing development / construction activities such as dust suppression, drilling, construction and hydro-testing. Any untreated produced water used as part of project activities will be undertaken in accordance with the *End of Waste Codes (ENEW07546918 and ENEW07547018)* produced water with moderately low salinities (<4 dS/m) will generally be processed by calcium and pH amendment only, however for higher salinities treatment by reverse osmosis (**RO**) or blending with available fresh water will be undertaken as required. Where suitable, water use options to be considered include stock watering and irrigation.

A single RO treatment plant is expected to be required, with a capacity in the range of 1.5 ML/d to 4.5 ML/d and has a footprint of up to 4 ha. The RO treatment of water will produce concentrated brine. A brine storage dam of up to 300 ML (up to 30 ha) may be constructed near the water treatment facility. This dam is expected to contain the entire production of brine from the project, taking into account evaporation. The salt will eventually be removed from site following solar or thermal evaporation.

Senex prioritises utilising the CSG produced water for beneficial use by establishing Landowner Water Supply Agreement (**WSA**).

5.6 Dams

New pre-engineered above ground tanks and/or purpose-built earthen dams with impervious liners and leakage detection/collection systems may be established on PL1037 and/or PL209. These new storages are part of the proposed action. To minimise impacts and improve operational efficiency, some of the water from the gathering system will be transferred to centrally located aggregation dams that are already established for Senex Assets Pty Ltd's 'Project Atlas'. Treated water will be transferred to third party irrigation dam(s) (approximately 50-200ML each) on PL1037 and/or PL209. The water will be treated to comply with the standard water quality parameters as specified in State codes. Dam locations will depend on gas well locations, in addition to environmental and social factors including soil types, conservation values, catchment areas, land uses, cultural heritage, and landholder agreements. Senex will ensure that all dams are designed and constructed in accordance with the prescribed standards (with appropriate reference to the DES guidelines and manuals: *Structures which are dams or levees constructed as part of environmentally relevant activities (ESR/2016/1934)* and *Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/1933)*).

Specific dam designs will be developed by a suitably qualified and experienced person and will be assessed for its consequence category. Where required, information on dam design, construction and post-construction specifications will be lodged with DES as required at relevant stages prior to its operation, in accordance with EA conditions.

Once dams are no longer required they shall be decommissioned and rehabilitated or as in agreement with the landholder and in accordance with approval conditions.

5.7 Roads and Access Tracks

Access tracks are required to allow the construction and operation of gas wells and supporting infrastructure. Established access tracks will be used wherever possible with purpose-built access tracks constructed where existing tracks are not suitably located. Appropriate erosion and sediment controls are to be installed maintained for both construction and ongoing use of access tracks. A typical access track consists of a 6 m carriageway but may be wider in certain areas to provide for truck turnarounds.

Where access tracks are required to cross waterways the *Accepted development requirements for* *operational work that is constructing or raising waterway barrier works* (**ADR**) will be complied with. If the waterway crossings proposed cannot comply with the ADR, Senex will obtain a Development Approval under the Planning Act.

Once construction is complete, the access track disturbance is rehabilitated to the minimum width possible whilst ensuring safe use of the track or road. Rehabilitation requirements for waterway crossings are specified in the ADR.

5.8 Ancillary Facilities

Ancillary facilities will be required to enable the field to function efficiently. Facilities for service and maintenance of plant and equipment and storage of fuel and chemicals will be established in cleared areas. Typically, these areas will be cleared, graded and set up with the following equipment and facilities:

- Workshop areas;
- Fuel and chemical storage;
- Laydown yard with warehouse;
- Borrow pits;
- Communication tower;
- Roads and well lease tracks; and
- Vehicle weed washdown facilities.

Laydown/hardstand areas will be required for temporary storage of equipment and materials. These areas will also be required for storage of chemicals (for example, oils, lubricants, diesel and other fuels etc.) and for the maintenance and refueling of plant and machinery. Regulated, recyclable and general wastes will be temporarily stored in designated locations at laydown areas as required and will be transported off site by licensed contractors for reuse, disposal or recycling at licensed facilities.

The expected volumes of regulated wastes and chemicals to be temporarily stored on site will be managed to remain below the thresholds of ERAs 8 - Chemical storage and 56 - Regulated Waste storage. Notifiable Activity 5 Chemical Storage (Schedule 3, EP Act) may be triggered depending on the volumes of various chemicals stored on site.

Borrow pits will be typically required as a source of gravel and other materials used on an as required basis for the construction of well sites, access tracks and laydown/hardstand areas.

5.9 Camps and Sewerage Treatment

Temporary camp(s) will be required to accommodate drilling and construction crews. The need for temporary camps is dependent on the proximity, available services and amenities of the towns to the Project Area. The camps may provide accommodation, mess facilities, communications, vehicle maintenance and parking areas, fuel handling and storage areas, and collect general, recyclable and regulated waste streams.

Sewage treatment plants will generally form part of the camp infrastructure and may be closed or open systems. Any irrigation of treated effluent and/or greywater on site will be undertaken in accordance with the requirements outlined in the EA, and other relevant Local and State Government approvals.

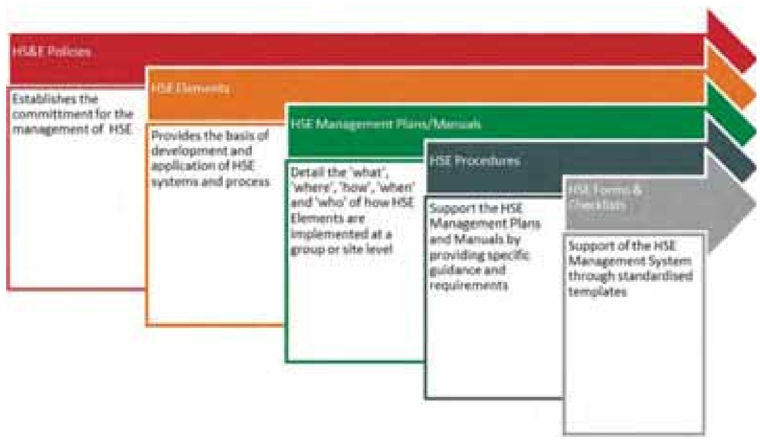
6 Environmental Management

6.1 Health, Safety and Environment Management System

The Senex HSEMS provides a framework that establishes expectations and parameters to drive continuous improvement in HSE performance. The HSEMS is applicable to all Senex worksites and personnel working for or on behalf of Senex.

The HSEMS (**Figure 2**) has a hierarchical document structure, with Health, Safety and Environment policies setting the corporate commitments for HSE management. The HSEMS framework includes 10 HSE elements, of which environmental impacts and effects is one. Potential environmental impacts and effects of Senex operations and activities are identified and managed, using a risk based and systematic approach.

Figure 2: Health, Safety and Environment Management System



Senex is committed to conducting its operations and activities in an environmentally sound and responsible manner. Activities are planned and managed to minimise disturbance to the environment by utilising environmental standards consistent with development in technology, industry codes of practice and relevant statutory requirements.

Environmental impacts are to be identified and measures are set in place to mitigate, measure and review impacts and environmental performance. This EMP is a component of the HSEMS.

By implementing the HSEMS, Senex aims to:

- Conduct operations in compliance with all relevant environmental legislation, regulations, licences, permits, standards, approvals and authorities;
- Clearly allocate responsibilities for environmental performance at all levels within Senex and its contractors;
- Develop environmental competency through instructing and educating employees and contractors;
- Continuously improve environmental performance through setting appropriate objectives and targets, providing sufficient financial and human resources to meet these objectives and targets, and applying research and development outcomes, cleaner production principles and using environmentally sustainable products and resources;
- Apply best industry practice in the management, supply and delivery of oil and gas product; and
- Communicate with stakeholders and the community about environmental commitments, its application and Senex's performance.

6.2 Senex Environmental Policy

Senex's Environmental Policy (Appendix A) governs the development and implementation of Senex's Environmental Management System (**EMS**), and, along with the EMP, are the key tools used by Senex to carry out petroleum activities in an environmentally acceptable manner.

7 Environmental Management Controls

7.1 Site Assessment and Internal Approval Process

To assist in meeting EA conditions and EPBC approval conditions, prior to carrying out any disturbance, construction or operational activities on the Project Area, approval must be obtained from the Senex cultural heritage, land access and environmental managers. Approval for disturbance is to be initiated using the Constraints Protocol. Site selection also considers engineering requirements, geological constraints, cultural heritage requirements and landholder requirements. As part of the site selection and approval process a site survey will be conducted.

The site survey findings will be captured in Site Environmental Instructions prepared for specific activities and areas. This report is used to decide whether the activity can proceed in that location and inform development of appropriate impact mitigation measures. Requirements for other approvals such as vegetation clearing permits, waterway barriers works permits and the requirement for offsets will also be determined at this stage.

Once all clearances, permits and approvals are in place, including any measures required under this EMP, final approval will be granted for the work to proceed by way of the ATW permit.

All personnel and contractors will familiarise themselves with ATW requirements prior to commencing works.

Management measures in the following sections have been developed to be consistent with the "SMART" principle which is defined as:

- S – Specific (what and how)
- M – Measurable (baseline information, number/value, auditable)
- A – Achievable (timeframe, money, personnel)
- R – Relevant (conservation advices, recovery plans, threat abatement plans)
- T – Time-bound (specific timeframe to complete).

7.2 Housekeeping Measures

The following housekeeping measures will be undertaken within the Project Area.

Category	Measures
Environmental Controls	• No firearms, traps, nets or pets are permitted on site or in camp. Traps can be authorised for use by the Environment Manager for ecological assessments. • No fires are permitted on site or in camp. • Feeding of native animals is not permitted. • Personnel must stay within areas approved for operations (cleared work zones) and not drive off approved access tracks or enter exclusion areas or ‘no-go’ zones. • All rubbish and waste materials including cigarette butts are to be disposed of in the appropriate bins, or in the absence of bins, removed daily from site. All personnel are responsible for ensuring that sites remain litter free. • Only water from a Senex approved source will be used. • Adequate and properly maintained firefighting equipment will be present on site and potential ignition sources controlled.

7.3 Vehicle Management

The following vehicle management controls will apply within the Project Area.

Category	Controls
Performance Criteria	• All site vehicles regularly inspected and maintained in accordance site safety requirements and manufacturers specifications as evidenced by inspection and service records. • All vehicles are to be operated in a safe manner. • All access to private property is in accordance with landholder agreements and CCAs, as identified in the ATW. • Signage is in place to warn third parties of access restrictions to construction and operational areas, with warnings when potentially dangerous activities are being undertaken. • All works on public roads is in accordance with relevant approvals from local council or Department of Transport and Main Roads (**DTMR**).
Management Measures	• Vehicles and personnel will only enter and exit the site at designated access points from designated access tracks and roads. Vehicles, plant, machinery and equipment must remain on formed access tracks at all times unless agreed otherwise as specified in the CCA and identified in the ATW. • All gates must be left in the condition in which they are found. Damage caused to gates or fences by Senex activities is to be reported to the Senex Site Supervisor immediately. • Vehicles must carry adequate firefighting equipment including a fire extinguisher. • The integrity of private roads and tracks must be maintained at all times. • All vehicles must be maintained weed free.
Monitoring and Reporting	Heavy equipment and vehicle movements will be managed according to local council/DTMR requirements.

7.4 Pest and Weed Management

The following pest and weed management controls will apply within the Project Area.

Category	Controls
Performance Criteria	• No spread of invasive plants (declared weeds) or high priority pest flora or fauna species within or outside of works area due to Senex activities (refer definitions and species in Atlas Biosecurity Management Plan [SENEX-QLDS-EN-PLN-001]. • Invasive plants (declared) and high priority weeds managed in accordance with ATWs, CCAs, Land Access Code 2016 requirements, *Biosecurity Act 2014* (Qld) and other regulatory requirements, and relevant Senex supporting procedures and plans. • Valid weed hygiene certification maintained at all times for vehicles, plant, machinery and equipment.
Management Measures	• Activities must be planned so that movement of vehicles, plant, machinery and equipment avoid moving between properties, corridors or areas with weed infestations. • Site specific weed management requirements must be defined prior to access to any property or work site. • Pest and weed management control activities will be undertaken as directed by Senex. • Weed management and control methods will depend upon the location, weed species identified, the degree of the infestation, relevant landholder agreement or CCA provisions, and local, state and national regulatory requirements.

Category	Controls
	• All vehicles, plant and equipment must be maintained weed free.
Relevant Plans and Procedures	• Queensland Operations Biosecurity Management Plan [SENEX-QLDS-EN-PLN-001] • Queensland Weed Hygiene Procedure [SENEX-QLDS-EN-PRC-023].
Monitoring and Reporting	• The Senex Site Supervisor must be notified of any pest sightings or weed infestations found on site, including infestations which have been reported by others (for example, drilling staff and landholders). • Records of all weed notifications and inspection data are to be maintained by the Senex Environment Manager. • Records of weed washdown and certification must be always kept in the vehicle and made available to landholders on request and presented to the Senex Site Supervisor upon initial entry to site.

7.5 Chemical Use and Fuel Storage

The following chemical use and fuel storage controls will apply within the Project Area.

Category	Controls
Performance Criteria	• No uncontrolled release of chemicals, oil or fuel. • All chemicals, oil and fuel handled, stored and effectively contained, and transported appropriately and in accordance with relevant Australian Standards (**AS**) and Australian Dangerous Good Code. • All chemicals to be used on site for drilling and well production (such as work overs) are on the Queensland Well Production and Drilling Chemical Register [SENEX-QLDS-EN-REG-001] maintained by the Senex Environment Team.
Management Measures	• All fuel, oil and chemicals are to be stored, transported and handled in accordance appropriate standards including AS 3780:2008 – The storage and handling of corrosive substances, AS 1940:2004 – The storage and handling of flammable and combustible liquids, AS 3833:2007 – Storage and handling of mixed classes of dangerous goods in packaged and intermediate bulk containers. • All drilling chemicals that are to be used on site must be approved on the Senex Queensland Well Production and Drilling Chemical Register. If a chemical is not listed on the register, a chemical risk assessment must be conducted, consistent with the IESC checklist requirements (methods). Chemicals can be added to the register where it is likely that that drilling fluid will not adversely impact a **MNES** i.e. with the outlined controls, the overall risk is not significant. • Bulk fuel tanks stored outside a bunded area must be contained within a self-bunded tank with safety valves. • Appropriate spill response equipment must be available on site and/or with vehicles, and regularly maintained. • An inventory of all chemicals maintained on each site is to be maintained by the Senex Site Supervisor. • Safety Data Sheets (**SDS**) are to be maintained on site at all times and for all chemicals. • Storage areas must be sealed, bunded, and adequately ventilated. • Storage and refueling areas will be preferentially located away from watercourses, sensitive areas and any source of ignition as determined by the Senex Site Supervisor. • Incompatible substances are to be segregated according to SDS specifications. • All flammable liquids used are to be stored and dispensed only from approved containers. • Substances not in use are to be sealed and safely stored in a secure area. • Substance storage/containment and disposal must be in accordance with the

Category	Controls
	SDS (including personal protective equipment, ventilation, spill containment and precautions to avoid fire). • Containment bunds and/or sumps will be drained periodically of accumulated rainwater to prevent overflow and subsequent pollution of the surrounding land and watercourses.
Relevant Plans and Procedures	• Health, Safety and Environmental Management System [SENEX-CORP-HS-STD-001] • Queensland Well Production and Drilling Chemical Register [SENEX-QLDS-EN-REG-001] • Senex Spill Response Plan [SENEX-CORP-ER-PLN-006] • Senex Hazardous Substances and Dangerous Goods Procedure [SENEX-CORP-HS-PRC-010] • Senex Personal Protective Equipment Procedure [SENEX-CORP-HS-PRC- 12].
Monitoring and Reporting	• All chemical, oil and fuel storage areas are to be inspected at least weekly for temporary storage, and monthly for permanent storage areas during the operating phase by the Contractor Site Supervisor and/or the Senex Site Supervisor. • All spills are to be contained immediately and managed through the Senex Spill Response Procedure. • Emergency events will be managed in accordance with the contingency procedures in the Atlas Emergency Response Plan. • Incident details must be recorded immediately and notified through the Senex Incident reporting systems, reported and investigated accordingly.

7.6 Cultural Heritage

The following cultural heritage controls will apply within the Project Area.

Category	Controls
Performance Criteria	• No loss or disturbance of items or areas of cultural value due to Senex activities. • No valid complaints related to impacts on cultural heritage from the local community or traditional owners.
Management Measures	• Corporate cultural heritage inductions. • Cultural heritage clearance is to be undertaken prior to commencing any works other than preliminary walk-over type surveys (for example, ecology surveys and bore baseline assessments) within the Project Area. • No works are to be undertaken or access permitted within areas marked as cultural heritage 'no go' areas. • The Senex Site Supervisor must be notified immediately if any cultural heritage sites, objects or remains are located. Should this occur, work must cease immediately.
Relevant Plans and Procedures	Cultural Heritage and Native Title Management Procedure (Queensland) [SENEX-CORP-NT-PRC-002].
Monitoring and Reporting	• Any incidents including access into cultural heritage no-go zones or damage to any items or areas of cultural heritage value must be reported to the Senex Site Supervisor who in turn will report to the Approvals Manager. • Non-compliance and incident reporting will be closed out by management to ensure prompt rectification, as required.

7.7 Produced Water Management

The following produced water management controls will apply within the Project Area.

Category	Controls
Performance Criteria	• Contaminants are not directly or indirectly released to water. • No accidental or uncontrolled release of water to waterways or drainage lines. • No use of produced water on site except in accordance with EA conditions, or approved End of Waste Codes as relevant.
Management Measures	• No discharges of water to land or surface waters will occur without authorisation from the Senex Site Supervisor having consulted with the Senex Environment Manager. • Produced water[1] may be re-used in drilling and well hole activities. • Produced water may be used for dust suppression and construction purposes provided the use: o does not result in negative impacts on the composition and structure of soil or subsoils; o is not directly or indirectly released to waters; o does not result in runoff from the construction site; and o does not harm vegetation surrounding the construction site. • The use of produced water for dust suppression must: o not cause on-site ponding or runoff; o be directly applied to the area requiring suppression; o not harm vegetation surrounding the area being dust suppressed; and o not cause visible salting.
	• Produced water may be disposed of for domestic purposes or stock purposes and must meet the irrigation or livestock watering criteria as relevant to those purposes in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018 revision; online resource)*. It must be disposed of in accordance with the BUAs where approved by Senex Site Supervisor having consulted with the Senex Environment Manager. • Operate water treatment facilities (if required) to meet required treated water quality for intended use. • Pipeline wastewater (for example, hydrostatic test water and flush water from low point drains), may be released to land provided, if it meets the following water quality parameters: o electrical conductivity does not exceed 3000 μS/cm; o sodium adsorption ratio (SAR) not exceeding 8; o pH between 6.0 and 9.0; o heavy metals (measured as a total) meets the respective short-term trigger value in section 4.2.6, Table 4.2.10- Heavy metals and metalloids in Australian and New Zealand Guidelines for Fresh and Marine Water Quality; and o does not contain biocides. • Pipeline wastewater must be released in a way that does not result in visible scouring or erosion or pooling or run-off or vegetation die-off. • Dams must only be constructed as authorised by the ATW and under the design and conditions specified by the Senex Project Execution and Environment teams. • All dams must be constructed, operated and maintained in accordance with accepted engineering standards; and be designed with a floor and sides made of material that will contain the wetting front and any entrained contaminants within the bounds of the containment system during both its operational life and including any period of decommissioning and rehabilitation.

[1] Definitions for all items in bold are provided in Appendix B of the EA.

Category	Controls
	• For regulated structures, the consequence category must be assessed in accordance with the DES *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* and the DES Guideline *Structures which are dams or levees constructed as part of environmentally relevant activities*. • Water production forecast (quality and quantity) shall be determined and reviewed via an appropriate reservoir model. • When no longer required, dams must be decommissioned to no longer accept inflow from the petroleum activities and be either: o rehabilitated; or o approved by DES and the landholder, as per EA requirements.
Relevant Plans and Procedures	• DES *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (ESR/2016/1933)*. • DES Guideline *Structures which are dams or levees constructed as part of Environmentally Relevant Activities' (ESR/2016/1934)*. • Register of Regulated Dams maintained for each regulated dam. • Atlas Stage 3 Water Monitoring and Management Plan [SENEX-ATLS-EN-PLN-017]. • ATP 2059 Coal Seam Gas Water Management Plan [SENEX-ATLS-EN-PLN-013]. • PL 445 and PL 209 Coal Seam Gas Water Management Plan [SENEX-ATLS-EN-PLN-014]. • Atlas Stage 3 Gas Project EPBC Water Resource Impact Assessment (Klohn Crippen Berger 2023) (Doc No. DX10171A12).
Monitoring and Reporting	• Visual inspection of areas where produced water is used will be undertaken during and post-application as required to ensure conditions are being met. • Monitoring and inspections including of water levels, water quality and early signs of loss of structural or hydraulic integrity will be undertaken by a suitably qualified and experienced person to ensure conditions are being met. • Dams must be monitored for early signs of loss of structural or hydraulic integrity as specified in the initial hazard assessment.

7.8 Noise and Vibration

The following noise and vibration controls will apply within the Project Area.

Category	Controls
Performance Criteria	• Noise generated by activities do not cause environmental nuisance at any sensitive receptor, per limits specified in the EA. • No noise-related complaints received.
Management Measures	• Potentially impacted sensitive receptors will be identified in the ATW. • Prior to construction and other noisy activities, landholders will be notified of the nature and expected duration of noisy activities. • Construction hours will be in accordance with EA conditions and requirements of the *Environmental Protection (Noise) Policy 2019* (EPP Noise). • Noise impacts and requirements for noise mitigation will be considered during the engineering design and site planning processes. Noise impacts will be minimised by adopting measures in the EPP Noise hierarchy as appropriate (for example, locating activities at suitable distances from noise sensitive places). Facility specific noise modelling will be undertaken during the design phase, where required. • Noise modelling or assessment will be undertaken for temporary and operational activities to assess expected noise emissions at potential sensitive receptors. • Operators of construction equipment will be made aware of potential noise

Category	Controls
	impacts and will be required to employ techniques and/or equipment to minimise noise emissions where necessary. • Where blasting is required, a blast management plan will be developed in accordance with AS 2187, and EA conditions for blasting operations.
Relevant Plans and Procedures	• Prior to conducting any blasting activities, a blast management plan will be developed in accordance with AS 2187, and EA conditions for blasting operations. • Incident Reporting and Investigation Procedure [SENEX-CORP-HS-PRC-004].
Monitoring and Reporting	• Noise complaints will be recorded in the Senex Stakeholder Management database and appropriate corrective actions taken (commensurate to the magnitude of the impact and non-conformance). • Noise must be measured in accordance with the prescribed standards in the Environmental Protection Regulation 2019. • Noise monitoring during construction activities will be undertaken where required as part of the investigation of noise incidents or complaints. Where required, noise monitoring will be carried out in accordance with EA conditions and provisions of the EPP Noise. • Where noise levels exceed those prescribed in the EA, corrective actions will be defined as part of the incident investigation. • Non-compliance and incident reporting will be closed out by senior management to ensure prompt rectification and change management as required and appropriate.

7.9 Air Quality

The following air quality controls will apply within the Project Area.

Category	Controls
Performance Criteria	• No environmental nuisance at any sensitive place (as provided by EA conditions) identified or reported due to dust or other air quality emissions. • At authorised point sources, fuel burning and combustion facilities do not result in releases to air that exceed authorised EA limits.
Management Measures	• Site specific modelling or assessments will be undertaken to assess potential air emissions at the design state for the operating infrastructure to assess air quality at potential sensitive receptors and to meet approval requirements. • An air receiving environment monitoring program (**AREMP**) will be prepared and implemented in accordance with EA conditions, if required. • Landholders or residents of any adjacent sensitive places will be advised of planned works prior to the commencement of activities. • Staff and contractors will be made aware through general site induction and training of the potential to generate dust emissions and mitigation and management measures that should be implemented. • Vehicles, plant and equipment will be regularly maintained to ensure all machinery is in good working order and does not generate excessive air emissions. Plant and equipment must be operated in their proper and effective condition. • Vehicles will be operated in a fuel-efficient manner and will not be left turned on or idling at the site for longer than required. • Vehicles, plant and machinery must comply with site-specific speed limits to minimise dust generation. • Disturbed areas and access roads will be watered using a water cart/truck on an as-required basis to minimise the potential for environmental nuisance due to dust. Watering frequency may be increased where required (for example, during periods of high risk (prolonged dry periods and under windy conditions), if excessive levels of dust is visible or as reasonably requested by

Category	Controls
	the landholder). Dust suppression using produced water must comply with EA conditions. • Odour complaints shall be recorded in the Senex Stakeholder Management Database and appropriate corrective actions taken (commensurate to the magnitude of the impact). • Fugitive emissions shall be mitigated through appropriate well design and construction that is undertaken in accordance with accepted industry standards. **Venting:** • Short duration cold venting during workover operations in lieu of flaring due to land agreements.
Relevant Plans and Procedures	• Health, Safety and Environmental Management System [SENEX-CORP-HS-STD- 001] • Incident Reporting and Investigation Procedure [SENEX-CORP-HS-PRC-004] • An AREMP will be prepared and implemented as required.
Monitoring and Reporting	• In accordance with AREMP. • In the event of an environmental nuisance complaint, an incident report will be raised in accordance with the Senex Incident Reporting and Investigation Procedure and investigated. Where undertaken, dust/air quality must be monitored in accordance with EA requirements. • Any complaints relating to air quality including environmental nuisance will be recorded and actioned in a timely manner through the Senex Stakeholder Management database.

7.10 Waste Management

The following waste management controls will apply within the Project Area.

Category	Controls
Performance Criteria	• No contaminants are directly or indirectly released to land. • Waste is managed at all Senex sites in accordance with the waste and resource management hierarchy and the waste and resource management principles under the EP Regulation and the WRR Act.

Management Measures	• Waste is appropriately managed to avoid or minimise the potential for:
	  ◦ Release of hazardous 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; or
	  ◦ Impacts to the environment, land use or well-being of people resulting from inappropriate storage, handling or disposal of waste.
	• All waste generated must be stored, handled and transported in accordance with the waste and resource management hierarchy, waste and resource management principles, appropriate standards and regulatory requirements as outlined in the Senex Waste Management Procedure – Qld Operations [SENEX-QLDS-EN-PRC-022].
	• The SDS for materials should be referenced to assist with the appropriate identification for handling and disposal of waste material.
	• All wastes must be transported in covered or sealed containers to prevent the loss of waste materials during transport.
	• All sites will be kept free from litter.
	• Items of general waste are not to be disposed of in sump or pits.
	• Waste material (including domestic waste) must be collected and stored in covered bins to prevent loss and scavenging by animals.

Category	Controls

	• Recyclable materials will be segregated (for example, glass and cans, scrap metals, used chemical and fuel drums and timber pallets) in designated containers for recycling.
	• All wastes regulated wastes are to be transported offsite by a licensed contractor to a suitably licensed facility for reuse, recycling or disposed unless authorised under the EA as being able to be disposed of on-site.
	• All waste materials must be removed from site once activities are completed.
	• Green waste may be used on site for both rehabilitation and sediment and erosion control.
	• Only licensed waste contractors may collect, transport and dispose of regulated waste from the site.
	Drilling Material
	• All drilling and exploration waste fluids and muds must be contained in an appropriately constructed containment structure for disposal, remediation or re-use where possible.
	• If sumps are to be used to store residual drilling material or drilling fluids, they must be decommissioned (no longer used) following the completion of drilling activities.
	• Adequate freeboard must be maintained on the sump at all times to prevent overflow during storage for the duration of drilling activities.
	• Where drilling muds are removed from site they must be disposed of to a licensed facility or authorised EA process.
	• Waste fluids[2], (other than residual drilling material or drilling fluids stored in sumps) must be contained in either above ground containers or a dam.
	• Produced water may be re-used for drilling and well-hole activities or where approved, re-used under a BUA or End of Waste Code. Any proposed re-use must first be confirmed with the Senex Environment Team.
	Residual Drilling Material
	• Residual drilling material must be stored in sumps for the duration of drilling, after which it must be removed from site for disposal. The exception to this is where drilling material meets approved quality criteria and can be disposed of using the mix-bury-cover method as approved by Senex Environment Team; or the drilling material is approved by the Senex Environment Team as being of acceptable quality for disposal to land.
	Sewage from Mobile or Temporary Facilities
	• Treated sewage effluent or greywater can be released to land in accordance with EA conditions. Any proposed release to land must be confirmed with the Senex Environment Team.
	• Treated sewage effluent or greywater must meet or exceed secondary treated Class B standards for a treatment system between 150 and 1500 EPs equivalent persons.
	• Treated sewage effluent or greywater must meet or exceed secondary treated Class C standards for a treatment system <150 equivalent persons.
	• Release of treated sewage effluent of greywater must be:
	  ◦ to a designated (fenced and signed) area;
	  ◦ not result in pooling or run-off or aerosols or spray drift or vegetation die- off; and
	  ◦ the contaminated release area must be kept vegetated with groundcover (not weeds).
	• Waste gases, predominantly methane but also carbon dioxide, are expected to be generated at each well head. Cold venting will occur during some activities while the well is being worked over underbalanced during service activities. These will be of short duration.

[2] Definitions for all items in bold are provided in Appendix A of the EA.

Category	Controls
Relevant Plans and Procedures	• Senex Waste Management Procedure – Qld Operations [SENEX-QLDS-EN-PRC-022]. • Waste Tracking Procedure [SENEX-QLDS-EN-PRC-006]. • Atlas Stage 3 Gas Project Chemical Risk Assessment Report (KCB 2023).
Monitoring and Reporting	• Records will be maintained for all waste removed from the site, including waste type and volume or weight as outlined in the Waste Tracking Procedure. • Waste tracking documentation will be maintained by the Contractors Supervisor and provided to the Senex Site Supervisor for all trackable waste removed from site. • All waste records will be provided to the Senex Environment Manager by the Senex Site Supervisor on a monthly basis or upon request.

7.11 Land Disturbance and Flora Management

The following land disturbance and flora management controls will apply within the Project Area.

Category	Controls
Performance Criteria	• No land disturbance or vegetation clearing is undertaken without appropriate authorisation and approval. • Clearing of vegetation and protected plants is in accordance with relevant permits or exemptions issued under the *Nature Conservation Act 1992*, MNES as required by the EPBC Act and relevant EA conditions.
Management Measures	• During project planning, the Constraints Protocol will be used to avoid and minimise disturbance to biodiversity values. • Clearing of native vegetation must be minimised to that necessary for construction and operational activities in line with the Constraints Protocol and EA approval conditions. • Within Environmentally Sensitive Areas (**ESA**), infrastructure must be preferentially located in areas of non-remnant vegetation, and, water storage facilities will be preferentially located more than 300 m from a Category B ESA and 200 m from a Category C ESA. • Prior to undertaking activities that result in significant disturbance to land, an ecological survey must be undertaken by a suitably qualified person. • Vegetation must not be cleared unless authorised under a Senex ATW. The ATW must be approved prior to any vegetation clearance or disturbance occurring. • Positive visual markings or pegs are to be used to identify the extent of any vegetation to be removed. • Any sensitive areas, such as ESAs or threatened plants/communities adjacent to the work area should be communicated via toolboxes to project staff and contractors. • 'No-go' areas will be GPS located and clearly marked (for example, with bunting and/or flagging tape). No-go areas will be prohibited to enter for construction staff and contractors and will only be accessed by authorised persons for relevant activities. • Measures to minimise stormwater entering significantly disturbed land must be implemented and maintained. • Sediment and erosion control measures to prevent soil loss and deposition beyond significantly disturbed land will be implemented and maintained. • Mature trees, including hollow bearing trees, will preferentially be avoided, or clearing will be minimised. • Hollow bearing trees, where cleared, will be retained as habitat. • Cleared vegetation/green waste that cannot be used on-site for rehabilitation and/or sediment erosion control should be stockpiled to facilitate re-spreading

Category	Controls
	or salvaging. • Vehicles or equipment are to remain within authorised work zones, particularly during vegetation clearing activities to prevent unnecessary land and vegetation disturbance.
Relevant Plans and Procedures	• Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development [OPS-ATLS-EN-PLN-001]. • Rehabilitation Plan Atlas Stage 3 Gas Project [SENEX-ATLS-EN-PLN-018]. • Queensland Erosion and Sediment Control Procedure [SENEX-QLDS-EN-PLN-003]. • Atlas Stage 3 Gas Project Significant Species Management Plan (ERM 2023). • Site Environmental Instructions issued for each phase of the project.
Monitoring and Reporting	• Each site will be ground-truthed and the extent and biodiversity value recorded (including GIS coordinates of the area) during pre-clearance surveys by a suitably qualified ecologist. • This data will be retained on Senex record management and GIS systems. • Vegetation clearance works will be supervised by the Senex Site Supervisor or designated representative. • Coordinates of areas cleared of vegetation and/or where ground disturbance takes place will be recorded in GIS format by the Construction Site Supervisor and provided to the Senex Site Supervisor and managed by the GIS team.

7.12 Fauna and Stock Management

The following fauna and stock management controls will apply within the Project Area.

Category	Controls
Performance Criteria	• Impacts to fauna habitat minimised in accordance with approved management plans. • No injury, entrapment or death of wildlife or domestic stock, as a result of Senex's activities.
Management Measures	• Active work areas, pits, sumps and other areas hazardous to fauna and stock must be fenced or covered to prevent access. • Clearing of mature or hollow bearing trees will be avoided or otherwise undertaken in accordance with relevant Construction Environmental Management Plan. • Measures to prevent fauna entrapment and facilitate escape must be implemented during the construction where required (for example, open excavations). • Excavations and trenches must be inspected for trapped fauna on a daily basis. • Where identified as required, a qualified fauna spotter-catcher will conduct a search immediately prior to clearing of vegetation for the presence of fauna species. Where fauna is detected, the spotter catcher will assess and implement the most appropriate method to avoid or minimise impacts on that fauna as a result of clearing. • Stockpiled timber, where left for more than 24 hours, should be to be inspected for fauna prior to mulching. • Natural vegetation buffers along creeks and rivers shall not be disturbed unless authorised under an ATW and only at the location specified. • Where activities may impose barriers to the movement of fauna for extended period of time, reasonable measures will be implemented to facilitate fauna movement around or through active work areas, such as breaks in stockpiled cleared vegetation at least every 50m. • Any waterway barrier works (works that pose a barrier to water flow and fish

Category	Controls
	movement) must only be undertaken where authorised under an ATW and only at the location indicated on the Site Environmental Instruction. • Any restrictions placed on stock movements in the vicinity of work areas will be agreed with landholders and identified in the ATW so that any disruption is minimised.
Relevant Plans and Procedures	• Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development [OPS-ATLS-EN-PLN-001]. • Atlas Stage 3 Gas Project Significant Species Management Plan (ERM 2023). • Rehabilitation Plan Atlas Stage 3 Gas Project [SENEX-ATLS-EN-PLN-018]. • Queensland Fauna and Stock Management Procedure [SENEX-CORP-EN-PRC-021]. • Incident Reporting and Investigation Procedure [SENEX-CORP-HS-PRC-004]. • Site Environmental Instructions issued for each phase of the project.
Monitoring and Reporting	• Fauna and stock deaths must be immediately communicated to the Contractor Site Supervisor or Senex Site Supervisor as appropriate and then the Senex Environment Manager/ Senex Land Manager-Queensland • Fauna spotter-catcher update on interactions and reporting must be provided as required to the Senex Site Supervisor then to the Senex Environment Manager. • Reports on fauna interactions are to be provided to regulatory authorities as required.

7.13 Watercourse and Wetlands

The following watercourse and wetlands controls will apply within the Project Area.

Category	Controls
Performance Criteria	• Water quality during construction and maintenance does not exceed authorised release limits. • The construction or maintenance of linear infrastructure in proximity to a wetland or watercourse are compliant with the relevant EA conditions.
Management Measures	• Petroleum activities within any wetland area or watercourse must be carried out in accordance with an approved ATW. Watercourse crossings will be limited to those strictly necessary for construction or operation of infrastructure and only at locations approved in the ATW. • Other than linear infrastructure, petroleum activities must be 200 m from a wetland, lake or spring; or 100 m from the outer bank of a watercourse on ATP 2059. • Construction and maintenance of linear infrastructure must be conducted in accordance with the following preference: when no water is present, in times of no flow, in times of flow but in a way that does not impede low flow. • Construction and maintenance of infrastructure resulting in a significant disturbance to a wetland or watercourse must be undertaken by a suitably qualified person in accordance with the guideline Activities in a watercourse, lake or spring associated with a resource activity or mining operations. • Any waterway barrier works (works that pose a barrier to water flow) must only be undertaken where authorised under an ATW and only at the location specified. • Measures to minimise stormwater entering significantly disturbed land must be implemented and maintained. • Sediment and erosion control measures to prevent soil loss and deposition beyond significantly disturbed land will be implemented and maintained. • Where required, watercourse crossing points will be adequately stabilised to

Category	Controls
	prevent erosion. • Positive visual markings or pegs are to be used to identify the extent of any vegetation to be removed. • 'No-go' areas will be GPS located and clearly marked (for example, with bunting and/or flagging tape). • Construction activities must be managed to minimise interference with overland flow paths. • Clean stormwater will be diverted around construction works or passed through construction works in a controlled manner. • For linear Infrastructure (for example, pipelines) – construction or maintenance activities in wetlands or a watercourse must only be carried out under the authorization of an ATW and under the supervision of a Senex environment representative to ensure conditions of the EA are achieved.
Relevant Plans and Procedures	• Site Environmental Instructions issued for each phase of the project. • Queensland Erosion and Sediment Control Plan [SENEX-QLDS-EN-PRC-003]. • ATW for the specific scope of work. • Atlas Stage 3 Water Monitoring and Management Plan [SENEX-ATLS-EN-PLN-017]. • ATP 2059 Coal Seam Gas Water Management Plan [SENEX-ATLS-EN-PLN-013]. • PL 445 and PL 209 Coal Seam Gas Water Management Plan [SENEX-ATLS-EN-PLN-014]. • Atlas Stage 3 Gas Project EPBC Water Resource Impact Assessment (Klohn Crippen Berger 2023) (Doc No. DX10171A12).
Monitoring and Reporting	• Records of all erosion and sediment control and water quality checks will be maintained by the Senex Site Supervisor and provided weekly during period of activity in the wet season and monthly at other times to the Senex Environment Manager. • Watercourse crossings must be monitored for erosion and sedimentation during construction, with at least weekly inspections during dry conditions, and daily inspections during rainfall of >50 mm in one day or >100 mm over 4 days or as soon as watercourse access is re-established after flooding • Senex will undertake inspections and monitoring associated with the water storage dams and tanks to assess integrity of the structures and monitor any potential impacts to waters. • Construction or maintenance works on linear infrastructure in wetlands or watercourses must be monitored by a Senex Environment representative to ensure compliance with the EA conditions.

Category	Controls
	Table 1: Release limits for construction or maintenance of linear infrastructure

Water Quality Parameters	Units	Assessment procedure
Turbidity	Nephelometric Turbidity Units (NTU)	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.
		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
Hydrocarbons		For a wetland of other environmental value, or watercourse, no visible sheen or slick.

7.14 Soil and Erosion Management

The following soil and erosion management controls will apply within the Project Area.

Category	Controls
Performance Criteria	• Compliance with the Queensland Erosion and Sediment Control Procedure [SENEX-QLDS-EN-PRC-003] and any contractor erosion and sediment control procedures. • No notifiable incidents relating to sediment releases from site. • Mass movement, gully erosion and tunnel erosion do not occur. • Topsoil managed in accordance with management measures.
Management Measures	• Works on site will not commence until any relevant Contractor erosion and sediment control procedures have been approved by the Senex Site Supervisor and been installed as required on significantly disturbed land. • Measures to minimise stormwater entering significantly disturbed land must be implemented and maintained. • Sediment and erosion control measures to prevent soil loss and deposition beyond significantly disturbed land will be implemented and maintained. • Sediment and erosion control must be managed in accordance with the Senex Queensland Erosion and Sediment Procedure [SENEX-QLDS-EN-PRC-003] and the Contractor's erosion and sediment control procedures. • Erosion and sediment control structures must be inspected periodically as required and after rain events and maintenance carried out where required. • All contaminated soils will be managed and remediated in accordance with EP Act requirements. • Where soil is moved to the site, a weed declaration will be provided. **Erosion and Sediment Control** • Ensure stormwater passes through the site in a controlled manner and at non- erosive flow velocities. Divert clean water from the work site where practical. • Minimise the duration that disturbed soils are exposed to the erosive forces of wind rain and flowing water. • Minimise work-related soil erosion and sediment runoff.

Category	Controls
	• Minimise negative impacts to land or properties adjacent to the activities (including roads). • Be periodically inspected at worksites as required, before expected rainfall events, and after rain events and maintenance undertaken where required as per the Queensland Erosion and Sediment Control Procedure [SENEX-QLDS-EN-PRC-003]. **Topsoil** • Soil stripping (where necessary) will not be undertaken in periods of high wind, rainfall or within the immediate period after rainfall to help avoid soil degradation. • Topsoil (approx. upper 100 to 200 mm depending on soil type), which contains the bulk of the natural seed bank and organic matter will be stockpiled separately from subsoil. • Topsoil is to be stockpiled in mounds no greater than 2 metres height. • Topsoil will not be mixed with subsoil either during stockpiling or during re-placement on disturbed areas. • Topsoil stockpiles will be located away from watercourses, natural drainage and flow lines to minimise erosion and waterway sedimentation. • Erosion and sediment controls are to be established around topsoil stockpiles to minimise the loss of soil during rain and slumping events. Stockpiles and sediment controls are to be routinely checked. • Once construction activities are complete, soil horizons will be reinstated in the order in which they are excavated to the extent practicable.
Relevant Plans and Procedures	• Queensland Erosion and Sediment Control Procedure [SENEX-QLDS-EN-PRC- 003]. • Site Environmental Instructions issued for each phase of the project.
Monitoring and Reporting	• Regular inspections to monitor for potential erosion and sedimentation during construction works will be undertaken. These inspections will include at least weekly inspections during dry conditions, and daily inspections during rainfall of >50 mm in one day or >100 mm over 4 days or as soon as site access is re-established. • Records of all erosion and sediment control and water quality monitoring will be maintained by the Senex Site Supervisor and provided weekly during period of activity in the wet season and monthly at other times to the Senex Environment Manager.

8 Environmental Incident and Notification

8.1 Emergency and Incident Response

The following emergency and incident response controls will apply within the Project Area.

Category	Controls
Performance Criteria	• All emergencies on site managed in accordance with the project Emergency Response Plan. • All incidents are reported, notified and investigated in accordance with the HSE management system and Senex Incident Reporting and Investigation Procedures [SENEX-CORP-HS-PRC-004]. • All spills are managed in accordance with the Senex Spill Response Plan [SENEX-CORP-ER-PLN-006].
Management Measures	• Personnel who observe an environmental incident including a spill must immediately notify the Contractor Site Supervisor who will then notify the Senex Site Supervisor. • In the event of a chemical, oil or fuel spill, the spill will be contained and cleaned up as outlined in the Senex Spill Response Plan [SENEX-CORP-ER-PLN-006]. • Contractors must have in place procedures for spill response which are in accordance with the Senex Spill Response Plan [SENEX-CORP-ER-PLN-006] and will include details requirements for: o minimising release; o containing spilled material; o raising the alarm and response; o locations of spill kits; and o management of contaminated material if necessary. • Any spills will be assessed by the Senex Site Supervisor supported by the Senex Environment Manager as required to determine appropriate remediation options such as the removal of contaminated material. • Incident reports must contain information required by the HSE Management System and Incident Reporting and Investigation Procedure [SENEX-CORP-HS-PRC- 004]. • Emergency Response drills will be performed to ensure readiness and identify opportunities for improvement.
Relevant Plans and Procedures	• HSE Management System [SENEX-CORP-HS-STD-001]. • Senex Spill Response Plan [SENEX-CORP-ER-PLN-006]. • Senex Incident Reporting and Investigation Procedure [SENEX-CORP-HS-PRC-004].
Monitoring and Reporting	• Refer to Section 8.2 for reporting and notification requirements for environmental incidents. • Regular inspection of spill response kits and general emergency preparedness.

8.2 Environmental Incident Notification

Senex requires that all incidents including spills are reported and fully investigated in accordance with their specific level of potential risk. The Senex Incident Reporting and Investigation Procedure [SENEX-CORP-HS-PRC-004] defines the process for the investigation and reporting of incidents and ensures that Senex meets all regulatory notification requirements. Senex's Spill Response Plan [SENEX-CORP-ER-PLN-006] provides the standard protocols that must be used to respond in an appropriate and timely manner in the event of a spill. The procedure details the following steps:

- Prevention – take actions to reduce or eliminate the likelihood of effects of an incident.
- Preparedness – take steps before an incident to ensure effective response and recovery.
- Response – contain, control or minimise the impacts of an incident.
- Recovery – take steps to minimise disruption and recovery times.

Figure 3: Incident Reporting Steps

Activities that have caused or are likely to cause environmental nuisance or environmental harm under the EP Act must be notified to DES. Additionally, the EA requires the following notification process to be complied with in the event of an incident.

Events that must be notified under the EA conditions include:

- A person carries out activities or becomes aware of an act of another person arising from or connected to those activities which causes or threatens serious or material environmental harm;
- The activity negatively affects (or is reasonably likely to negatively affect) the water quality of an aquifer;
- The activity has caused the unauthorised connection of 2 or more aquifers; and
- Activation of the contingency procedures[3] (within 5 business days of activation).

All notification of environmental incidents or events will be reported in accordance with the process in the Senex Regulatory Reporting Requirements [SENEX-CORP-ER-CHA-002].

[3] Contingency measures must be prepared prior to petroleum activities commencing under Schedule B of the EA.

9 Rehabilitation

9.1 Well Pads

The timing and works undertaken as part of rehabilitation activities will be dependent on the activity type and operational stage of the project and governed by EA requirements. Some project activities such as drilling are temporary in nature, enabling transitional rehabilitation (also called progressive rehabilitation) to be undertaken once the disturbance area is no- longer required for operational activities. Other infrastructure and disturbance is longer-term requiring decommissioning and rehabilitation at the end of project life.

Significantly disturbed areas that are no longer required for ongoing petroleum activities will be rehabilitated within 12 months and be maintained to meet the relevant EA conditions and Senex acceptance criteria.

All infrastructure constructed by Senex will be removed from site except where it is to remain with the written agreement of the landholder. All decommissioning and rehabilitation activities will be undertaken in accordance with Senex acceptance criteria and EA conditions.

Specific rehabilitation requirements are outlined in the Rehabilitation Plan Atlas Stage 3 Gas Project [SENEX-ATLS-EN-PLN-018].

When no longer required for appraisal or production purposes, a well is 'plugged and abandoned'; a process that involves decommissioning the well and rehabilitating the site. This involves isolating the groundwater aquifers within the well using cement plugs as the sealing medium. The final cement plug is brought to surface and the wellhead is cut off approximately 1.5 metres below the surface, capped with a metal identification plate and buried. The land is then rehabilitated to its pre-disturbed state or as agreed with the landholder. These works are undertaken in accordance with the P&G Act requirements and the *Code of Practice for constructing and abandoning coal seam gas wells and associated bores in Queensland – Department of Natural Resources and Mines (Queensland): Edition 2.0, October 2013*.

After completing primary drilling of the well, but usually before the completion rig is mobilised, drilling fluids and muds in sumps will be disposed of in accordance with EA conditions. Waste fluids and muds will be either removed from the Atlas area for disposal at a licensed facility or disposed of using mix-bury-cover or other method of disposing to land that is certified as not causing environmental harm.

The disturbance area associated with well construction is then reduced through transitional rehabilitation after well completion to a hardstand area of approximately 0.36 ha. This is maintained for the operational life of the well. Transitional rehabilitation of well lease pads generally involves ripping any compacted areas, partial respreading of topsoil and direct seeding with species that will provide an appropriate level of groundcover and that are suitable considering the intended post-disturbance land use.

Once the well lease pad is no longer required for ongoing petroleum activities, final rehabilitation will be undertaken as follows:

- Decommissioning/removing the well head, pumps and other infrastructure.
- Cut and fill batters profiled to re-contour the land surface and drainage lines.
- Compacted hardstand areas are ripped.
- Stockpiled topsoil is respread.
- Topsoil is seeded with pasture grasses, or native species depending on the final land use.

9.2 Drilling Sumps

Drilling muds vary in profile and composition, depending on the depth, rock type, and drilling speed, however, drilling muds generally consist of water, clay materials, and some trace chemical additives (for example, salts), and do not contain oil-based or synthetic compounds.

When used, drilling mud sumps are decommissioned once drilling activities have ceased. Where possible, drilling materials should be re-used or recycled. Drilling activities should be planned in a manner that allows maximum re-use of drilling materials, whenever possible. Clean drilling materials that do not contain harmful contaminants may also be disposed of on- site by using the mix-bury-cover method (in accordance with approved quality criteria).

Drilling materials that do not meet the quality acceptance criteria should be removed for appropriate disposal by a licensed waste contractor.

9.3 Gas and Water Gathering Pipelines

Pipelines trenches will be backfilled and topsoil reinstated within three months after pipe laying. During backfilling of pipeline trenches, soils should be replaced so that the topsoil and subsoil are consistent with the immediately surrounding area, this will allow for natural regeneration. Following soil replacement, areas will be revegetated. Areas required for operational purposes (that is, access tracks and areas above pipelines) should be revegetated with pasture grasses, or native grasses and ground cover species depending on the final land use. Remaining areas no longer required for operational activities or maintenance will be rehabilitated to the post-disturbance land use.

Final rehabilitation of the gas and water gathering lines will occur after decommissioning of all pipelines. Where it is practical and safe to do so, the pipelines will be abandoned and left in- situ in accordance with the *APGA Code of Practice- Upstream Polyethylene Gathering Networks- CSG Industry, and Australia Standard (AS) 2885 section 10.6 and section 8 of the Australian Pipeline Industry Association Code of Environmental Practice*. The pipelines will be left in-situ to avoid disturbing the re-established vegetation through excavation and removal. The overall objective is to leave the ROW in a condition that is as near as practical to pre-existing environmental conditions. If the pipelines are to be abandoned and left in-situ, an abandonment plan will be developed in accordance with *APGA Code of Practice – Upstream Polyethylene Gathering Networks – CSG Industry*. When abandoning in-situ, the pipeline section shall be abandoned in such a way to ensure that ground subsidence and the risk of contamination of the soil or groundwater is minimised.

The pipelines are to be disconnected from all sources of hydrocarbons that may be present in other pipelines, processing plant, meter stations, control lines and other appurtenances, and shall be purged of all hydrocarbons and vapour with a non-flammable fluid and then capped. Disposal of the purging fluid shall meet all relevant environmental and safety requirements. The pipeline will be decommissioned in a manner that minimises potential impacts to the environment, land use and third parties and guidance should be taken from AS 2885. All above ground pipes and supports along the pipeline should be cut-off at a minimum depth of 750mm below the natural surface, or at pipeline depth as determined by AS 2885.3. These pipes should be removed and capped off below the surface. All above ground signs and markers above the pipeline should be removed.

When it’s either unsafe or not practical, decommissioning will be undertaken via removal, and the removal methods should be considered similar to those for pipeline construction and shall comply with the relevant requirements of AS 2885.1.

After decommissioning of the pipeline compacted hardstands, access tracks and stockpile areas should be ripped to aid binding of the soil layers, increase water retention, helping water infiltrate into the soil, and thus increase seed germination success. Seeding will be undertaken on the remaining areas with an appropriate seed mix, depending on the post-disturbance land use to be achieved.

9.4 Access Tracks

Temporary access tracks no longer required for ongoing operational activities or not to be retained by the landholder will be closed and reinstated to a condition compatible with the surrounding land use. This will generally involve ripping to remove compaction, re-spreading stockpiled topsoil and revegetating. Landholder tracks in existence prior to construction will have access re-instated and will not be blocked in anyway. Where tracks are to be retained by landholders, any wheel ruts should be graded and erosion-control measures such as diversion drains installed to an agreed condition.

9.5 Waterway Crossings

Waterway crossings will be rehabilitated by re-contouring disturbed areas to match the surrounding once petroleum activities in the location have ceased. The surface will usually be lightly scarified before spreading the topsoil, to promote vegetation re-growth and protect against the topsoil loss. Temporary waterway barriers will be removed and reseeding undertaken to minimise erosion and promote regeneration of riparian vegetation.

9.6 Infrastructure, Camps, Laydown, Hardstand and Stockpile Areas

Rehabilitation will be undertaken when the area for infrastructure, laydowns, hardstands or stockpile areas is no longer required for operational activities. Once infrastructure is removed or transported off site, gravel is generally removed from the hardstand and any areas of contamination remediated or excavated for disposal at an off-site licensed facility. Compacted areas should be ripped and the area seeded with a species mix determined by the post-disturbance land use.

9.7 Dams

Produced water will be managed using holding dams and brine storage dams. Prior to decommissioning, landholders will be given the option to retain the dams for their own water storage purposes. Any residue in the dam must be quantified and tested to demonstrate that it is safe and fit the intended use of the dam.

Where brine storage dams are to be decommissioned, any saline residue or salt resulting from reverse osmosis will be stored in a tank for off-site disposal to an appropriately licensed facility. Holding dams will have all water removed (preferably through beneficial use options). Once any liquid is removed, dams will be rehabilitated to remove any source of potential contaminants and the land returned to a useable form. The process for decommissioning and rehabilitation the produced water holding and brine storage dams generally involve the following:

- Remove and recycle or dispose of synthetic liners.
- Assess any land contamination that may have occurred. In the case where some leakage of the liner system has occurred a contaminated land assessment should be undertaken as per the current National Environment Protection (Site Assessment) Measure.
- Remediate soils through removal to a soil remediation area or in-situ treatment of contaminated soils where required or dispose of the contaminated soils to an off-site licensed facility.
- Retain clay materials where clay has been used as part of the containment system for reuse if reasonably practicable.
- Rehabilitate the site by pushing in dam embankments and filling in depressions to re- contour landforms to match surrounding topography. Any retained subsoil could be used to infill dams and topsoil can be respread.
- Revegetate the area by direct seeding with appropriate species based on post- disturbance landform.

10 Environmental Monitoring and Auditing

Monitoring, auditing of, and reporting on, contractor and Senex on-site activities provides a direct measure of Senex's compliance with environmental regulations and EA conditions, together with an indication of the effectiveness of the HSEMS, EMP and supporting procedures and plans.

Environmental inspection, monitoring and auditing will be undertaken by the Senex Site Supervisor and Senex Environmental representative on a periodic basis to assess whether activities are in compliance with the requirements of these systems and documents.

10.1 Complaints and Grievances

Complaints and grievances will be recorded and responses (actions) tracked. Records of complaints will be kept and must include the date, complainant's details, source, reason for the complaint, description of investigation and actions undertaken in resolving the complaint.

Depending on the nature of the complaint or grievance the responsibility and associated timeframes for addressing and closing out the complaint or grievance will be assigned to the relevant Senex personnel. Any investigations required to be carried out will be undertaken with input from relevant personnel. Results of any investigation including proposed mitigation or management measures will be recorded and the complainant informed of how Senex either proposes to, or has, resolved the issue.

10.2 Monitoring

All monitoring must be undertaken by a suitably qualified person who has professional qualifications, training or skills or experience relevant to the monitored subject matter as defined in the approval conditions. Monitoring to be undertaken on the project area includes the following:

- Monitoring implementation of the EMP and supporting procedures and plans by the Senex Site Supervisor or the Senex Environmental representative as appropriate;
- Regular inspection of construction and operational activities by the Senex Site Supervisor or the Senex Environmental representative as appropriate;
- Environmental monitoring of over time for weed infestations with reference to the Atlas Biosecurity Management Plan [SENEX-QLDS-EN-PLN-001] and rehabilitation progress (for example, photo-monitoring and audits);
- Reporting and analysis of regulated discharges, emissions and waste disposal; and
- Any other prescribed monitoring in accordance with the conditions of the EA.

10.3 Auditing

Environmental audits will be undertaken as both scheduled and unscheduled activities. The audit program may include the use of external auditors and will include regular (for example, annual) environmental compliance audits to assess compliance with this EMP, EA conditions and other regulatory requirements. The audit program will include audits of Contractor procedures and management plans and will be undertaken by the Senex Site Supervisor or Senex Environmental representative as appropriate.

11 Record Keeping and Reporting

Senex and its contractors will maintain an appropriate and auditable record system. Environmental reporting information will include as relevant:

- Inspection / monitoring reports;
- Photographic records;
- Training and induction attendance and associated dates;
- Incident reports;
- Remedial actions taken following incident reports;
- Records of waste removal including waste tracking certificates; and
- Audit reports.

All records and data required to be maintained by EA conditions will be retained for a minimum of 5 years.

The annual reporting to DES (annual return) will require providing details of activities conducted during the annual return period, demonstrating actions such as:

- The area of significant disturbance from the project;
- Rehabilitation undertaken;
- A list of all valid complaints relating to environmental issues made including the date, source, reason for the complaint and a description of investigations undertaken in resolving the complaint; and
- The results of all monitoring undertaken.

Appendix A – Senex Environmental Management Policy

See next page.

Environmental Management Policy

Document Number

SENEX-CORP-EN-POL-001

Senex
Senex Energy Limited

ENVIRONMENTAL MANAGEMENT POLICY

Senex Energy Limited (Senex) is an environmentally responsible company committed to conducting our business in a manner which ensures high standards of environmental management performance.

Senex will achieve this commitment through applying our core values to promote and maintain a culture of sustainability and continuously review and improve our environmental performance across the business.

We will achieve our environmental goals by actively focusing on:

- Assessing the potential impacts of our operations and activities on the local environment to limit disturbance;
- Operate in a safe and environmentally responsible manner;
- Empowering employees and contractors to achieve environmentally responsible operations and to improve environmental performance; and
- Maintaining and continuously improving environmental standards, systems and controls across all activities and operational areas.

Senex will ensure effective implementation of this policy through:

- Ensuring that environmental goals and standards are understood and adopted at all levels across the Company;
- Instructing and educating employees and contractors where appropriate of their environmental responsibilities;
- Reporting environmental incidents, determining the cause and where appropriate implementing changes to prevent a recurrence;
- Measuring our performance through regular monitoring, environmental audits and reporting; and
- Ensuring compliance with relevant laws, regulations and where appropriate industry codes.

Ian Davies
Managing Director
Senex Energy Limited

Approved – 15 December 2016 Review Date – 15 December 2018

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Appendix B: Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development

Atlas Stage 3 Environmental Constraints Protocol for Planning and Field Development

Date:	21 August 2023
Document:	OPS-ATLS-EN-PLN-001
Revision:	1

Table of Contents

Document Status

Revision History

Revision	Release Date	Document Status	Revision Comments	Author
0	10/07/2023	Issued for Use	Project specific Constraints Protocol	J Claridge
1	21/08/2023	Issued for Use	Inclusion of MSES. No change to MNES, constraint categories or protocol steps	J Claridge

Document Approval

Approved by	Jacob Cumpstay Environment Manager	**Signed**	Date 21/08/23

Definitions

Term	Definition
Biodiversity values	environmentally sensitive areas, prescribed environmental matters and wetlands.
Constraints checklist	used for quality assurance purposes to ensure all relevant environmental constraints are considered as early in the infrastructure siting process as possible
Constraints maps	created and updated by the Technical Officer, the maps will assist in initial environmental desktop constraints analysis for proposed infrastructure locations. Information includes (as required): • Aerial imagery; • Flood plains; • Elevation data (Lidar and/or contours); • Ecological and watercourse/wetland constraints; • Areas of Regional Planning Interest (e.g. Strategic Cropping Land); • Existing infrastructure; • Native title; • Cultural heritage; • Sensitive receptors; and • Landholder status.
Ecology Survey Report	report detailing the findings of the ecological surveys undertaken as part of the environmental site assessment
Environmentally Sensitive Areas	environmental values include: • Category A and Category B environmentally sensitive areas (ESAs) as defined under Schedule 19 of the Environmental Protection Regulation 2019 (EP Regulation); • Category C ESAs where defined in a relevant Environmental Authority.
Invasive plant	as defined under the *Biosecurity Act 2014* (QLD).
Linear infrastructure	infrastructure including (but not limited to) gas and water gathering lines, low- and high-pressure gas and water pipelines, roads and tracks, power lines and other service lines.
Low impact petroleum activity	low impact petroleum activities means petroleum activities which do not result in the clearing of native vegetation, earthworks or excavation work that cause either, a significant disruption to the soil profile or permanent damage to vegetation that cannot be easily rehabilitated immediately after the activity is completed. Examples of such activities include but are not necessarily limited to: • chipholes • coreholes • geophysical surveys • seismic surveys • soil surveys • topographic surveys • cadastral surveys • ecological surveys • installation of environmental monitoring equipment (including surface water).

Term	Definition
MNES	matter of national environmental significance under the *Environment Protection and Biodiversity Protection Act 1999* (Cth).
MSES	matter of state environmental significance under the *Environmental Offset Act 2014* (Qld).
Significant disturbance to land	defined in Schedule 12 of the *Environmental Protection Regulation 2019* (Qld) as land that has been disturbed and human intervention is needed to rehabilitate it to a condition required under the relevant environmental authority, or to the condition it was in immediately before the disturbance.
Site-specific environmental conditions and maps	conditions and restrictions (and associated maps) governing how construction activities on site should be carried out to ensure compliance with Environmental Authority conditions and regulatory requirements.
Strategic cropping area	an area of regional interest defined under the *Regional Planning Interests Act 2014* (Qld).

1 Introduction

1.1 Project Background

The Atlas Stage 3 Gas Project is to develop, operate, decommission and rehabilitate up to 151 coal seam gas wells; gas and water gathering systems for the producing wells; access tracks; brine and produced water storages; borrow pits; and ancillary supporting facilities on Authority to Prospect (ATP) 2059, Petroleum Lease (PL) 445, the northern portion of PL209 and parts of PL1037 in the central part of the Surat Basin, Queensland.

The Project Area is entirely within the Brigalow Belt Bioregion and occurs across a boundary between the Taroom Downs subregion in the north and Southern Downs southern downs subregion in the south.

The northern components of the Project Area feature watercourses on floodplains, surrounded by undulating hills. Towards the southern areas of the Project Area the landscape features steeper slopes and outcropping towards the south-eastern boundary. Several watercourses intersect the Project Area, with named watercourses including Woleebee Creek, Conloi Creek, Hellhole Creek and Wandoan Creek.

It is noted that terrestrial and aquatic habitats demonstrated varying levels of degradation, including cattle grazing, clearing, erosion and invasive species and the majority of aquatic habitats surveyed are of limited ecological value.

The main land use within the Project Area is grazing of stock for beef production. Some flood plain areas have been developed for centre-pivot agriculture.

The majority of the Project Area is cleared areas with non-native pastures.

1.2 Purpose

The Environmental Protocol for Field Development and Constraints Analysis (the Protocol) provides a framework for identifying, assessing and managing potential impacts to Matters of National Environmental Significance (MNES) associated with development of the Atlas Stage 3 Gas Project.

The Protocol will ensure that infrastructure siting and gas field development takes place in accordance with:

- Federal regulatory requirements – the *Environment Protection and Biodiversity Conservation Act 2009* (EPBC Act);
- Project commitments in the referral and preliminary documentation;
- Relevant management plans including:
  - Atlas Stage 3 Gas Project Significant Species Management Plan (ERM 2023a)
  - Environmental Management Plan Atlas Stage 3 Gas Project [SENEX-ATLAS-EN-PLN-015]
  - Atlas Stage 3 Gas Project Terrestrial and Aquatic Ecology Assessment Report (ERM 2023b).
- Atlas Stage 3 Gas Project Chemical Risk Assessment Report (KCB 2023).

1.3 Scope

The Protocol has been developed to ensure that the planning and site selection for infrastructure associated with the Atlas Stage 3 development is undertaken with rigorous consideration of relevant MNES listed under the EPBC Act ,MSES as defined in Schedule 2 of the Environmental Offsets Regulation 2014 (EO Regulation), Category A and Category B environmentally sensitive areas (ESAs) as defined under Schedule 19 of the Environmental Protection Regulation 2019 (EP Regulation) and Category C ESAs where defined in a relevant EA. The Protocol applies to Senex's Atlas Stage 3 Gas Project where construction will involve significant disturbance to land. This includes but is not limited to the following CSG infrastructure:

- Well lease pads;
- Access tracks;
- Gas and water gathering systems;
- Brine and produced water storages;
- Ancillary supporting facilities; and
- Borrow pits.

The Protocol also recognises that, in addition to MNES and MSES constraints, landholder, engineering and cultural heritage constraints must also be considered during infrastructure planning. These constraints are assessed through processes aligned with this Protocol and are discussed in more detail in Section 3.

2 Constraints Framework

2.1 Approach and Protocol Objectives

Senex will apply the following hierarchy of management principles to avoid, minimise and manage land disturbance impacts on MNES and MSES during the planning and implementation of new petroleum activities for the Atlas Stage 3 Gas Project. These are:

1. Avoid – preferentially avoiding direct and indirect adverse environmental impacts;
2. Minimise – minimise direct and indirect adverse environmental impacts through a reduction in the duration, intensity and/or extent of adverse impacts, where these cannot be avoided;
3. Mitigate – implement mitigation and management measures to minimise direct, indirect and cumulative adverse impacts;
4. Restore (remediate and rehabilitate) – actively remediate and rehabilitate impacted areas to promote and maintain long-term recovery.

The Protocol is most relevant during the planning, design and the construction phases of the Atlas Stage 3 Gas Project but is also to be used for the operational and decommissioning / rehabilitation phases of the Project.

Limited Atlas Stage 3 Gas Project infrastructure is proposed within parts of PL1037 (i.e. a single brine storage dam and connections). This limited infrastructure will be sited in previously cleared areas and subject to Senex's *Queensland Environment Protocol for Field Development and Constraints Analysis* [SENEX-CORP-EN-PRC-019].

The Protocol for the Atlas Stage 3 Gas Project specifically addresses the ATP 2059, PL 445 and PL 209 gas tenements and the part of PL 209 that is east of Woleebee Creek. This area is referred to as the 'Field Development Area'.

The Protocol is triggered by the initiation of a work program by the Project Infrastructure Development Team and involves the steps described in Section 3.

2.2 Constraint Categories

Constraint categories have been developed that will determine the siting of infrastructure for the Atlas Stage 3 Gas Project as presented in Table 1. A summary of the activities that are permitted in each category are provided in Table 2.

The constraint categories are mapped in Figure 1. Constraint layers will be continually updated with the findings from site ecological surveys (Section 3.3) and any other detailed ecological assessments undertaken as part of ongoing gas field development. Constraint mapping will be stored within Senex's GIS.

Table 1 – Constraint categories

Constraint category	Activities permitted	Constraints[1]
No-go area	No petroleum activities	• Threatened Ecological Communities listed in Section 2.5 • MNES and MSES species habitat listed in Section 2.5 (apart from Koala dispersal habitat and Echidna habitat), including all areas of remnant vegetation • Category A, B and C ESAs[2] • Ooline plants (10 m buffer) • If any are found to be present in the Project Area: - Slender Tylophora plants and a 10 m buffer and - Populations[3] of the Dulacca Woodland Snail
High constraint area	Low impact petroleum activities[4], and Linear infrastructure[4]	• Buffer zone (10 m buffer around all 'No-go areas') • Protected plants under the NC Act (if any are found)
Low constraint area	All petroleum activities[5]	• Koala dispersal habitat • Echidna (NC Act - Special least concern) habitat • Previously cleared areas with non-remnant vegetation with limited potential to contain MNES or MSES and its habitat

[1] Disturbance of MNES and MSES will not exceed upper disturbance limits identified in Table 3.

[2] Category A and category B ESAs as defined under Schedule 19 of the EP Regulation and category C ESAs where defined in the relevant EA.

[3]Avoids field verified populations of the threatened Dulacca Woodland snail (*Adclarkia dulacca*),if it is found to occur within proposed disturbance areas in the Atlas tenements.

[4]Definitions for these activities are provided in the definitions section.

[5]All petroleum activities will be permitted within the low constraints area, however Koala juvenile and non-juvenile trees and seedlings will be avoided unless unavoidable due to other constraints (e.g. environmental features and values, cultural heritage values, geological features, landholder / livestock / agricultural requirements and existing or planned landholder, utility or community infrastructure).

Table 2 – Summary of activities permitted in each constraint category for the Atlas 3 Gas Project

Constraint category	Low impact petroleum activities	Linear infrastructure	Well pads	All petroleum activities
No-go area	No	No	No	No
High constraint area	Yes	Yes	No	No
Low constraint area	Yes	Yes	Yes	Yes

2.3 Constraint Mapping

The constraint categories mapping (Figure 1) was created using the constraints identified in Table 1. Constraint data were sourced from government, other open-source datasets, and Senex datasets including ecological survey findings.

Notable ecology field surveys for the development of the initial constraints map were:

- BOOBOOK Ecological Consulting (2022) Broadscale Ecological Assessment Report. Senex Atlas 3 Gasfield Project – Survey of Terrestrial Ecological Values;
- Targeted Ooline survey 31/1-3/2/2022; and
- Freshwater Ecology (2022) Aquatic Ecology Assessment. Senex – Atlas Stage 3 Gas Project.

The habitat mapping, vegetation mapping and other ecological survey data (such as protected flora records) forms the basis of the individual constraint layers for the Project that are used to develop the constraints category mapping. Habitat mapping rules and habitat descriptions are presented in Appendix A.

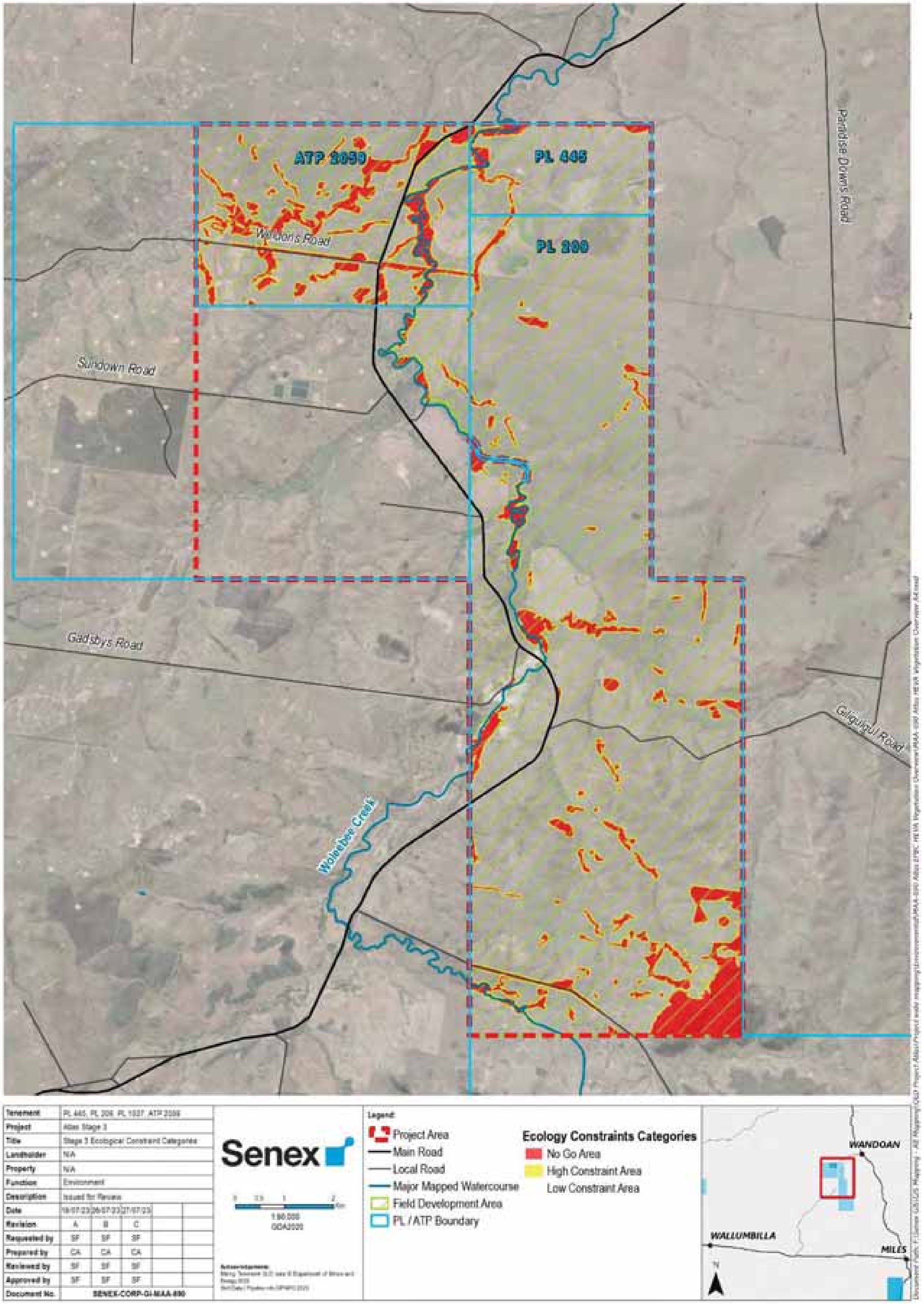
Using the precautionary principle, the initial habitat mapping has been developed using conservative habitat mapping rules that will be subject to further ground-truthing during the ecology survey which will be completed prior to the commencement of any clearing or other works. These surveys are referred to in this report as pre-clearance surveys (Section 3.3).

The development of constraint layers is designed to be an iterative process with regular refinement as new data becomes available.

In addition to MNES and MSES constraints in this document, there are other constraints that are outside the scope of this Protocol that must be considered during infrastructure siting.

These constraints include landholder agreements, constructability restrictions, presence of sensitive receptors and cultural heritage (indigenous) requirements.

The development needs will be balanced against all constraints, including the implementation of this Protocol, while ensuring that activities are compliant with all legal obligations.



Tenement	PL 445, PL 209, PL 1037, ATP 2059					
Project	Atlas Stage 3					
Title	Stage 3 Ecological Constraint Categories					
Landholder	N/A					
Property	N/A					
Function	Environment					
Description	Issued for Review					
Date	18/07/23	26/07/23	27/07/23			
Revision	A	B	C			
Requested by	SF	SF	SF			
Prepared by	CA	CA	CA			
Reviewed by	SF	SF	SF			
Approved by	SF	SF	SF			
Document No.	SENEX-CORP-GI-MAA-890					

Figure 1 Mapping of Constraint Categories for the Atlas Stage 3 Gas Project

2.4 Habitat Descriptions and Mapping Rules

For MNES protected under the EPBC Act, two listed threatened ecological communities (TEC) and 22 listed threatened species (19 fauna and 3 flora) were identified as known, likely to occur or potential to occur in the Project Area, due to direct field observations within the Project Area or recent historical records.

Habitat descriptions, survey requirements and mapping rules for MNES and MSES species and communities assessed as ‘potential’, ‘likely’ or ‘known’ to occur are presented in Appendix A and Appendix B.

This information will be used in undertaking further field surveys during the development of the gas field and siting of infrastructure using the constraints protocol in this document.

At the Commonwealth level a Significant Species Management Plan (ERM 2023a) has also been prepared for the Atlas Stage 3 Gas Project that describes how potential impacts to MNES significant communities and species associated with the proposed activities for the Project are managed.

2.5 Maximum Disturbance Limits

Ecological surveys and assessments have been undertaken across the Field Development Area including Ground Truthed Regional Ecosystem (GTRE) mapping, targeted fauna surveys and fauna habitat assessments. The surveys have been conducted to an acceptable level of detail for the purpose of confirming known, likely and potential species and covered the relevant sections of the Field Development Area (Boobook 2022). The surveys comply with the recommendations within the targeted fauna survey guidelines that are relevant to determining known, likely and potential presence of MNES and MSES across the Field Development Area. Additional (pre-clearance) surveys including vegetation (including TEC and threatened flora) and active fauna surveys and habitat assessments will be undertaken as part of this Protocol (Appendix B).

Additionally, the Atlas Stage 3 Gas Project will avoid areas confirmed as TECs, areas of remnant vegetation and habitat for threatened species, except for Koala dispersal habitat and Echidna habitat (refer to Table 3).

Direct disturbance will not exceed the limits in Table 3.

Table 3 – Threatened species and communities likelihood of occurrence and maximum disturbance limits

Species / Community	EPBC Act Status	NC Act Status	Likelihood of Occurrence	Total Potential Habitat in Field Development Area	Maximum Area of Impact (ha)
Listed Threatened and/or Migratory Birds					
Australian Painted Snipe (*Rostratula australis*)	E	E	Potential	69.7 ha	0 ha
Brown Treecreeper (south-eastern) (*Climacteris picumnus victoriae*)	V	V	Potential	272.1 ha	0 ha
Diamond Firetail (*Stagonopleura guttata*)	V	V	Potential	938.5 ha	0 ha
Glossy Black-cockatoo (*Calyptorhynchus lathami lathami*)	V	V	Likely	659 ha	0 ha

Species / Community	EPBC Act Status	NC Act Status	Likelihood of Occurrence	Total Potential Habitat in Field Development Area	Maximum Area of Impact (ha)
Painted Honeyeater (*Grantiella picta*)	V	V	Potential	Not mapped. This nomadic species forages on mistletoe in remnant, regrowth and other non-remnant vegetation, including shadelines and scattered trees and shrubs in cleared areas.	NA
Southern Squatter Pigeon (*Geophaps scripta scripta*)	V	V	Potential	164.3 ha	0 ha
Southern whiteface (*Aphelocephala leucopsis*)	V	V	Potential	938.5 ha	0 ha
White-throated Needletail (*Hirundapus caudacutus*)	V	V	Likely	0 ha mapped as a likely flyover visitor only	NA
Listed Threatened Mammals					
Corben's Long-eared Bat (*Nyctophilus corbeni*)	V	V	Potential	259.7 ha	0 ha
Greater Glider (central and southern) (*Petauroides volans*)	E	V	Known	528 ha	0 ha
Koala (*Phascolarctos cinereus*)	E	E	Known	698.5 ha foraging and breeding habitat	0 ha
				9,072.6 ha dispersal habitat.	530 ha
Northern Quoll (*Dasyurus hallucatus*)	E	-	Potential	226.7 ha	0 ha
Short-beaked Echidna (*Tachyglossus aculeatus*)	-	SLC	Likely	9,072.6 ha	530 ha
Yellow-bellied Glider (south-eastern) (*Petaurus australis australis*)	V	V	Potential	145.9 ha	0 ha
Listed Threatened Reptiles					
Collared Delma (*Delma torquata*)	V	V	Potential	259.7 ha	0 ha
Common Death Adder (*Acanthophis antarcticus*)	-	V	Potential	259.7 ha	0 ha
Dunmall's Snake (*Furina dunmalli*)	V	V	Potential	259.7 ha	0 ha
Five-clawed worm-skink (*Anomalopus mackayi*)	V	E	Potential	209.6 ha	0 ha
Grey Snake (*Hemiaspis damelii*)	E	E	Potential	279.6 ha	0 ha

Species / Community	EPBC Act Status	NC Act Status	Likelihood of Occurrence	Total Potential Habitat in Field Development Area	Maximum Area of Impact (ha)
Yakka Skink (*Egernia rugosa*)	V	V	Potential	228 ha	0 ha
Listed Threatened Invertebrates					
Dulacca Woodland Snail (*Adclarkia dulacca*)	E	V	Likely	305.2 ha	0 ha
Pale Imperial Hairstreak (*Jalmenus eubulus*)	-	V	Likely	180.2 ha	0 ha
Listed Threatened Ecological Communities					
Brigalow TEC	E	-	Known	95.8 ha	0 ha
Poplar Box TEC	E	-	Known	32.3 ha	0 ha
Listed Threatened Flora					
Belson's Panic (Ho*mopholis belsonii*)	V	V	Potential	366.3 ha	0 ha
Ooline (*Cadellia pentastylis*)	V	V	Known	118.7 ha	0 ha
Slender Tylophora (*Vincetoxicum forsteri*)	E	E	Potential	122.7 ha	0 ha
Winged Nightshade (*Solanum stenopterum*)	-	E	Potential	380.8 ha	0 ha

2.6 Updating Constraints or the Protocol

Constraint layers will be continually updated with the findings from site ecological surveys (Section 3.3), based on updates identified above and any other detailed ecological assessments undertaken as part of ongoing gas field development.

3 Protocol Steps

The Protocol will be initiated through work programs and follow the steps outlined in the figure below and described in the following subsections.

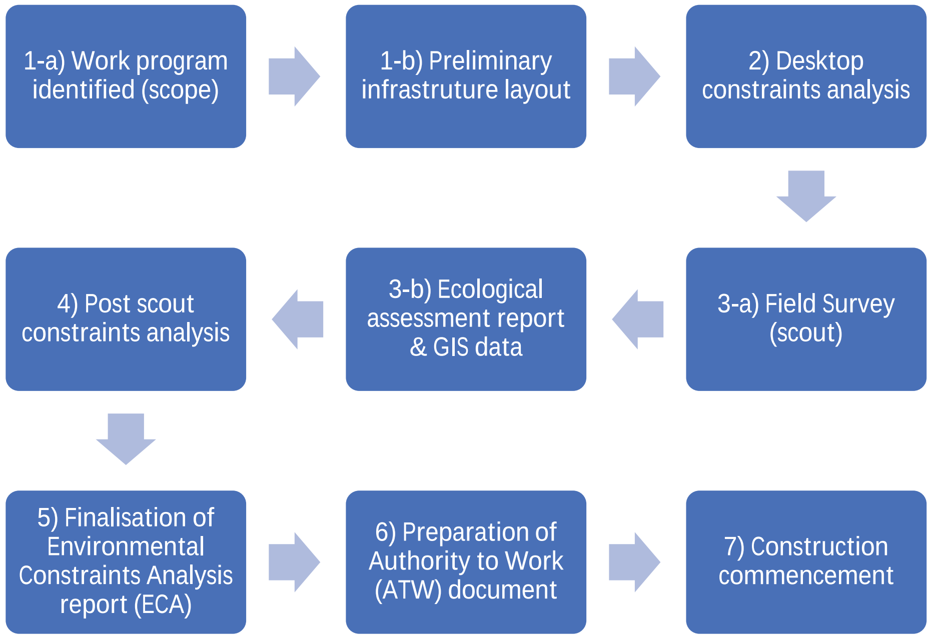


Figure 2 Key steps in the Protocol

3.1 Work Program Identified & Preliminary Infrastructure Layout

Following subsurface technical analysis of the development area, a nominal well spacing will be generated and a preliminary infrastructure layout, comprising proposed CSG wells, linear infrastructure corridors and other supporting infrastructure will be created. The proposed infrastructure layout is typically defined on a per property basis and tagged with a unique workpack identifier. A broader work program is made up of multiple workpacks. The subsequent steps below will be focused and applied on either an individual workpack or broader work program basis, dependent on the specific development being proposed.

3.2 Desktop Constraints Analysis

Post development of a work program, a desktop constraints analysis will be completed. This analysis involves review of available GIS mapping and constraint layers relating to the proposed infrastructure location(s). The GIS mapping layers generally comprise publicly available State and Federal Government data supplemented by site-specific GIS data gathered during survey activities.

The desktop constraints analysis involves:

- Identifying the appropriate external approvals and regulatory permits that the activities must be assessed against;
- Assessing the preliminary well locations and linear infrastructure designs against mapped constraints in the GIS, high resolution aerial imagery and the Protocol; and
- Refining well locations and linear infrastructure corridors to ensure compliance with the Protocol and minimise impacts on known constraints, including mapped MSES and MNES.

To ensure rigorous assessment of all applicable values, the desktop constraints analysis will update spatial constraints data based on the latest available ecology survey findings. The result of the desktop constraints analysis is the production of environmental constraints maps for internal review. These maps include a constraint category map.

Proposed infrastructure will be assessed against the constraints categories to ensure compliance with Table 1 (constraint categories) and Table 3 (total disturbance limits).

Depending on the specific nature of any environmental or other constraint(s) identified during the desktop assessment, the proposed infrastructure location may be revised and the new location selected or design revised to avoid or minimise the impacts on the constraining environmental values. When refining well locations and linear infrastructure, priority will be given to values with a higher protection status (i.e. Critically Endangered has priority over Endangered status) and then the sensitivity of the value to disturbance.

A preliminary infrastructure layout will be used for the planning of the field surveys outlined in Section 3.3.

The infrastructure design versions, constraints maps and associated notes are retained on file for quality assurance purposes.

3.3 Field Surveys (Scouting)

Once a preferred infrastructure location is defined through the desktop constraints analysis, field surveys are undertaken to confirm the suitability of the location and identify any additional constraints not originally known during the desktop constraints analysis phase. A scouting area will extend a minimum of 30 m beyond the Project infrastructure footprint.

This includes, in general chronological order:

1. Discussions with landholders to identify on-ground constraints (e.g. stock routes) and to confirm preferred location(s)
2. Survey of infrastructure locations by engineering staff to confirm constructability.
3. Environmental surveys of infrastructure locations to ground-truth mapped constraints including protected vegetation, fauna habitat, watercourses, prescribed environmental matters, invasive weeds, areas of regional interest etc.
4. Cultural heritage clearance of infrastructure locations.

As part of the Field Survey phase an on-ground environmental survey by a suitably qualified ecologist is undertaken. This survey is often referred to as a pre-clearance environmental or ecology survey. The pre-clearance survey includes ecological ground-truthing to confirm the likelihood of habitat for threatened fauna, the likelihood of occurrence of threatened flora and fauna, regional ecosystems and ecological communities, prescribed environmental matters, and validation of mapped watercourses. The Ecological Assessment Methodology presented in Appendix B outlines the pre-clearance ecological survey methods.

The ecology survey results are documented in a scope specific ecology report.

Should site surveys identify constraints or constraint boundaries different from the desktop environmental constraints analysis, infrastructure locations may be modified or revised, returning to Step 2 (Section 3.2).

3.4 Post-Survey Environmental Constraints Analysis

The results of the field surveys are used to further refine the proposed infrastructure locations. The ecology survey results including the spatial ecology GIS data is used to:

- Update the constraints category mapping, if required;
- Confirm any disturbance exclusion or “no-go” areas;
- Within high constraint areas, identify individual habitat areas to be avoided, using the prioritisation hierarchy outlined in Section 3.2;
- Within low and high constraint areas preferentially avoid habitat features using the following priority:
    - Hollow-bearing trees and large hollow logs
    - Koala food trees
    - Mistletoe

- Gilgai
- Termite mounds and raptor nests
- Other habitat such as decorticating bark and rock piles.

- Determine whether any secondary approvals (e.g. protected plant clearing permits) need to be secured prior to commencing construction activities; and
- Determine other construction-related environmental requirements and controls such as watercourse crossing design requirements or requirements for on ground spotter/catcher during first disturbance works.

Where there are significant changes to the proposed infrastructure layout additional site surveys may need to be undertaken for the updated infrastructure areas.

Key environmental restrictions for infrastructure siting or construction activities arising from the environmental surveys and desktop constraints analysis feed into the Senex Authority to Work documentation which is strictly complied with during construction.

3.5 Environmental Constraints Analysis Report

Upon finalisation of the infrastructure layout, a formal Environmental Constraints Analysis (ECA) Report is prepared documenting:

- That infrastructure siting complies with relevant environmental approval conditions including planning considerations and any disturbance/clearing limits;
- That infrastructure siting complies with requirements of relevant regulations and secondary approvals;
- The extent of disturbance and any impacts on MSES and MNES and that the relevant approval allows for the proposed extent of disturbance; and
- Site-specific or construction-related environmental considerations and controls.

The report includes a list of Site-specific Environmental Conditions and associated maps that are included in the final Access to Work documentation, issued upon sign-off by the Project Manager to relevant staff and contractors prior to commencing construction.

The Environmental Constraints Analysis Report is used to demonstrate compliance with relevant regulations, as part of the overarching Senex Environmental Compliance Management System.

The Environmental Constraints Analysis Report, together with GIS layers, field survey information and ecological assessment reports will demonstrate compliance with this Protocol.

4 Delivery

Key deliverables, timing and roles and responsibilities are detailed in Table 4 below.

Table 4 – Deliverables, roles and responsibilities

Step	Deliverable	Timing (estimate)	Role
1. Desktop constraints analysis	Constraints mapping and completed checklist.	2 weeks	Senex Environmental Adviser
2. Field surveys - environmental	Ecology Survey Report (or similar for other environmental considerations.	4 weeks (from completion of landholder discussions and constructability surveys)	Undertaken by Senex and/ or third-party ecologist (suitably qualified ecologist)
3. Post-survey environmental constraints analysis	Key environmental restrictions included in preliminary Environmental Constraints Analysis Report.	2 weeks	Senex Environmental Advisor
4. Environmental constraints reporting	Environmental Constraints Report. Site-specific Environmental Conditions and associated maps for inclusion into final Access to Work documentation.	2 weeks	Senex Environmental Advisor and approved by the Environment Manager

5 References

BOOBOOK Ecological Consulting (2022) Broadscale Ecological Assessment Report. Senex Atlas 3 Gasfield Project – Survey of Terrestrial Ecological Values.

ERM (2023a) Senex Atlas Stage 3 Project Significant Species Management Plan.

ERM (2023b) Atlas Stage 3 Gas Project Terrestrial and Aquatic Ecology Assessment Report.

Freshwater Ecology Pty Ltd (2022) Aquatic Ecology Assessment. Senex – Atlas Stage 3 Gas Project.

Klohn Crippen Berger (KCB) (2023) Atlas Stage 3 Gas Project Chemical Risk Assessment Report.

Senex (2023) Environmental Management Plan Atlas Stage 3 Gas Project [SENEX-ATLAS-EN-PLN-015]

Appendix A – Species Habitat Descriptions and Mapping Rules

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
Threatened Ecological Communities					
Brigalow (*Acacia harpophylla* dominant and codominant)	E	-	This community occurs within Queensland and New South Wales and is characterised by *Acacia harpophylla* being either dominant in the tree layer, or co-dominant with other species – notably *Casuarina cristata*, other species of Acacia, or species of Eucalyptus (Butler 2007, cited in DCCEEW 2023a).	RE 11.9.5, 11.9.5a	In Queensland, Brigalow TEC is identified by 16 REs, 12 of which are present in the Queensland Brigalow Belt Bioregion: ■ 11.3.1 ■ 11.4.3 ■ 11.4.7 ■ 11.4.8 ■ 11.4.9 ■ 11.4.10 ■ 11.5.16 ■ 11.9.1 ■ 11.9.5 ■ 11.9.6 ■ 11.11.14 ■ 11.12.21 REs identified within the Project Area are 11.3.1, 11.9.5 and 11.9.5a that meet the condition thresholds as defined in the Approved Conservation Advice for the Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community (DoE 2013): ■ The patch is 0.5ha or more in size ■ Exotic perennial plants comprise less than 50% of the total vegetation cover of the patch, as assessed over a minimum sample area of 0.5 ha
Poplar Box Grassy Woodland on Alluvial Plains	E	-	This community is typically a grassy woodland with a canopy dominated by *Eucalyptus populnea* and understorey mostly of grasses and other herbs, mostly	RE 11.3.2	In Queensland Poplar Box Grassy Woodland TEC is identified by five REs: ■ 11.3.2

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			occurring in gently undulating to flat landscapes and occasionally on gentle slopes on a wide range of soil types of alluvial and depositional origin (Webb et al. 1980).		■ 11.3.17 ■ 11.4.7 ■ 11.4.12 ■ 12.3.10 Only RE 11.3.2 was identified within the Project Area. Under the Conservation Advice (including listing advice) for the Poplar Box Grassy Woodland on Alluvial Plains (DEE 2019) there are four recognised quality categories that are assessed for determination whether a patch meets the TEC definition ■ **Minimum patch size of 1ha** if ≥ 90% of perennial vegetation cover in the ground layer is native and ≥ 30 native plant species per patch in the ground layer ■ **Minimum patch size of 5 ha** if ≥ 70% of perennial vegetation cover in the ground layer is native AND ≥ 30 native plant spp. per patch in the ground layer ■ **Minimum patch size of 5 ha** if ≥ 50% of perennial vegetation cover in ground layer is native, and either ≥ 20 perennial native plant species per patch in the ground layer OR ≥ 10 mature trees per ha with ≥ 30cm diameter-at-breast height ■ **Minimum patch size of 5ha** if < 50% of perennial vegetation cover in ground layer** is native, then the patch must have: ≥ 20 native plant spp. per patch in the ground layer AND ≥ 10 mature trees+ per ha with ≥ 30cm dbh AND smaller trees+, saplings or seedlings suggestive of periodic recruitment
Threatened Flora					
Belson's Panic (*Homopholis belsonii*)	V	V	It occurs on rocky hills supporting White Box (*Eucalyptus albens*) and in Wilga (*Geijera parviflora*) woodland; flat to gently undulating alluvial areas supporting Belah	REs: 11.3.2, 11.3.17, 11.9.5, 11.9.5a 11.9.7, 11.9.10	General habitat comprises all remnant and regrowth of nominated RE. The species occurs in Poplar Box and Brigalow dominated woodlands (Boobook 2022). Dry woodland habitats on poor soils, including:

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			(*Casuarina cristata*) forest; and soils and plant communities of Poplar Box (*E. populnea*) woodlands. It may also be associated with shadier areas of Brigalow (*Acacia harpophylla*), Myall (*A. melvillei*), and Weeping Myall (*A. pendula*) communities; in Mountain Coolibah (*E. orgadophila*) communities; and on roadsides. Infrequently found in in areas which receive irregular or intermittent flooding, and more commonly found at elevations of 342–500 m in Queensland and 200–520 m in NSW.		■ Rocky, basaltic hills supporting *Eucalyptus albens* and/or *Geijera parviflora* woodland with assorted shrubs and grasses; ■ Flat to gently undulating alluvial areas supporting *Casuarina cristata* forest and *Acacia harpophylla* or *G. parviflora* (may be subject to intermittent inundation); and ■ Drainage lines supporting *C. cristata* and sandy country dominated by Cypress Pine-Bloodwood-Ironbark-She-Oak Forest. The distribution of this species overlaps with the EPBC Act-listed TEC Brigalow (*Acacia harpophylla* dominant and co-dominant). There are limited areas of potential habitat for this species in the form isolated patches of Poplar Box, Belah and Brigalow woodlands or open forests present within the Project Area.
Ooline (*Cadellia pentastylis*)	V	V	Ooline grows in semi-evergreen vine thickets (SEVT) and sclerophyll vegetation on undulating terrain of various geology, including sandstone, conglomerate and claystone. The species forms a closed or open canopy, as a dominant or commonly with White Box (*Eucalyptus albens*) and White Cypress Pine (*Callitris glaucophylla*), with an open understorey and leaf litter dominating the forest floor. It also occurs in Brigalow, Belah, Poplar Box and Bendee (*Acacia catenulata*) communities.	Essential REs: 11.9.4, 11.9.5, 11.9.5a General REs: 11.3.25, 11.5.1, 11.9.2, 11.9.10, 11.10.7 and non-remnant preclear: 11.9.5/11.5.5 (80/20), 11.9.10/11.5.5 (60/40).	Essential habitat comprises all remnant and regrowth of nominated RE within Southern Downs bioregion. General habitat comprises remnant and regrowth of nominated RE and adjacent non-remnant areas of nominated preclear RE, within Southern Downs bioregion (Boobook 2022). It grows on undulating plains, valley slopes, hillsides and scarps, often in association with Brigalow and SEVT communities (DAWE 2023; DES 2022a) usually on upper or mid-slopes. In the Project Area, Ooline occurs in areas of Brigalow woodland and adjacent cleared exotic grassland in the south-east corner. Semi-evergreen vine thicket, Brigalow, Belah, Poplar Box and Bendee communities. The distribution of this species overlaps with the following EPBC Act-listed TECs: ■ Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions, ■ Brigalow (*Acacia harpophylla* dominant and co-dominant), and

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
					■ White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland. This species is present in the far south-eastern corner of the Project Area (South of Giligulgul Road). It was observed as retained isolated trees and clumps or in remnant Brigalow woodlands. Ecological surveys in this area identified 35 plants. This species is locally abundant in Brigalow woodland around the plateau in the south-eastern corner of the Project Area. It was observed as isolated trees and clumps or as a common tree in Brigalow woodland in Gurulmundi State Forest, Stones Country Resource Reserve and adjacent properties. Thirty-five (35) specimen records occur within the Project Area and another six (6) records occurred within the 10 km desktop search area (DES 2022b). Based on field surveys, the area of known Ooline occurrence is restricted to a limited portion of the Project Area in the south-east corner, within Brigalow woodlands and adjacent cleared exotic pasture areas as isolated trees.
Slender Tylophora (*Vincetoxicum forsteri*)	E	E	*Vincetoxicum forsteri* has rarely been collected and is known to be present within eight localities in the Dubbo area and Mt Crow, near Barraba in NSW, and "Myall Park" near Glenmorgan in Queensland. Conservation of this species occurs within Goobang National Park, Eura State Forest, Goonoo SF, Pilliga West SF and Coolbaggie Nature Reserve. *Vincetoxicum forsteri* inhabits dry scrub, open forest and woodlands associated with *Melaleuca uncinata*, *Eucalyptus fibrosa*, *E. sideroxylon, E. albens, Callitris endlicheri*, *C. glaucophylla, Allocasuarina luehmannii,*	REs: 11.5.1, 11.5.5, 11.10.7	General habitat comprises all remnant and regrowth of nominated RE. The species occurs in shrubby dry sclerophyll woodland and forest (Boobook 2022). Open eucalypt forests and woodlands containing *Melaleuca uncinata*, *Eucalyptus fibrosa*, *E. sideroxylon, E. albens, Callitris endlicheri*, *C. glaucophylla, Allocasuarina luehmannii, Acacia hakeoides, A. lineata, Myoporum spp.,* and/or *Casuarina spp*. The distribution of this species overlaps with the following EPBC Act-listed TECs: ■ Brigalow (*Acacia harpophylla* dominant and co-dominant), and ■ White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			Acacia hakeoides, A. lineata, Myoporum spp., and *Casuarina spp*. (OEH 2002; Forster et al. 2004).		Suitable habitat (dry eucalypt woodland) exists as several small fragments through the Project Area and a larger area in the southeast corner. Suitable habitat includes areas of dry eucalypt woodland, with riparian and wetland eucalypt communities considered unsuitable for this species.
Winged Nightshade (*Solanum stenopterum*)	-	E	Occurs in Poplar Box or Belah woodland and in grassland, including disturbed areas, on clay and loam soils (DES 2023). Occurs in scattered localities from Ashford in northern NSW north to Gayndah and from the Lockyer Valley west to around Jackson (ALA 2022). The species has been recorded from the Condamine floodplain around Dalby, Chinchilla and Condamine and also from two localities along Tchanning Creek (ALA 2022).	REs: 11.3.2, 11.3.17, 11.9.2, 11.9.5, 11.9.7 and 11.9.10	Potential habitat includes the broad habitat types of Eucalypt dominated woodlands mainly of E. *crebra*, E. *populnea* and E. *melanophloia* and Acacia woodlands dominated by Brigalow (*Acacia harpophylla*). Mapped General Habitat comprises all remnant and regrowth of nominated RE. The species habitat preferences are unclear, however, in this region it has been recorded from remnant and regrowth vegetation on clay and clay-loam soils.
Threatened and/or Migratory Birds					
Australian Painted Snipe (*Rostratula australis*)	E	E	The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. The Australian painted snipe can use modified habitats, such as low-lying woodlands converted to grazing pasture, sewage farms, dams, bores and irrigation schemes, however they do not necessarily breed in such habitats (DAWE 2023).	REs: 11.3.27f, mapped wetland areas in other RE and non-remnant vegetation.	General habitat comprises wetland areas and wetland associated RE. The species favours wetland areas with dense low vegetation, muddy banks and shallow water (Boobook 2022). **Breeding habitat**: Shallow wetlands with bare mud and both upper parts of the understorey (i.e. shrubs and tall grasses) and canopy cover nearby. Nest records are all, or nearly all, from or near small islands in freshwater wetlands. Nests can also occur in and near swamps, canegrass swamps, flooded areas including samphire, grazing land, among cumbungi, sedges, grasses, salt water couch, saltbush and grass, in ground cover of water-buttons and grasses, at the base of tussocks, and under low saltbush. **Foraging habitat**: Terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
					claypans. They have also been observed in inundated grasslands as well as dams and bore drains. **Temporary foraging and dispersal habitat**: Shallow, ephemeral water bodies, including gilgai. Small areas of foraging habitat present within small ephemeral wetlands on drainage lines. These may provide temporary refuge for the species and support occasional transient visitors to the Project Area, when water is present.
Brown Treecreeper (south-eastern) (*Climacteris picumnus victoriae*)	V	V	Brown Treecreepers (south-eastern) inhabit open dry eucalypt forest and woodlands, mainly areas that are dominated by stringybarks or other rough-barked eucalypt species. The understorey is usually open and grassy, sometimes with few shrubs. They can also occur in open forest, woodlands and mallee that is subject to periodic inundation. This species is usually absent from areas with a dense shrubby understorey and heavily degraded woodland areas. According to the species' conservation advice (DCCEEW 2023b), habitat critical to the survival of the brown treecreeper (south-eastern) includes areas that have: ■ Relatively undisturbed grassy woodland with native understorey. - Habitat structure should be quite open at ground level so that birds are able to feed on or near the ground and maintain vigilance against predators.	REs: 11.3.2, 11.3.4, 11.3.17, 11.3.19, 11.3.25, 11.3.27f, 11.3.39, 11.5.1, 11.5.5, 11.9.2, 11.9.7, 11.9.10, 11.10.7, 11.10.11	General habitat may compromise of Callitris and Eucalypt woodlands; Eucalypt open forest, Eucalypt woodlands. **Breeding and roosting habitat:** Open dry eucalypt forest and woodlands with hollows, in either live trees, dead standing trees or tree stumps. **Foraging habitat:** Forests and woodlands with an open, grassy understorey. Areas with fallen timber provide greater foraging opportunities. Patches of suitable *Callitris* / *Eucalyptus* woodlands of exist along the Eastern boundary of the Project Area, just North and South of Jackson-Wandoan Road. Additionally open Eucalypt forest occurs along the Gurulmundi Road in the Southern boundary of the project area. Small patches of open Eucalypt forest exist both north and south of Weldons Road.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			- The required degree of openness is mostly likely to be created by moderate levels of disturbance by fire and/or grazing. ■ Large living and dead trees which are essential for roosting and nesting sites and for foraging; ■ Fallen timber which provides essential foraging habitat; and ■ Hollows in standing dead or live trees and tree stumps are also essential for nesting.		
Diamond Firetail (*Stagonopleura guttata*)	V	V	Found in grassy Eucalypt, Acacia or Casuarina woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. According to the species' conservation advice (DCCEEW 2023c), habitat critical to the survival of the diamond firetail includes areas of: ■ Eucalypt, Acacia or Casuarina woodlands, open forests and other lightly timbered habitats; ■ Low tree density, few large logs, and little litter cover but high grass cover	REs: All RE (11.3.2, 11.3.4, 11.3.17, 11.3.19, 11.3.25, 11.3.27f, 11.5.1, 11.5.5, 11.9.2, 11.9.5, 11.9.5a 11.9.7, 11.9.10, 11.10.7, 11.10.11)	General habitat comprises *Eucalyptus*, *Acacia* or *Casuarina* woodlands and open forests. **Breeding habitat:** Nests are globular structures built either in prickly shrubby understorey, or higher up in associated woodlands or open forests, especially under bird of prey nests. **Roosting habitat:** Birds roost in dense shrubs of woodlands or open forests, or in smaller nests built especially for roosting. **Foraging habitat:** Forages in grassy understorey of Eucalypt, Acacia or Casuarina woodlands and open forest. Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Suitable habitat includes any *Eucalyptus* and *Acacia* woodlands and forests throughout the Project Area. Species also occurs in Acacia dominant areas.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			for foraging, roosting and breeding; and ■ Drooping she-oak (*Allocasuarina verticillata*) within the Mt Lofty Ranges.		
South-eastern Glossy Black-cockatoo (*Calyptorhynchus lathami lathami*)	V	V	The Glossy Black-cockatoo are uncommon but widespread. They can be found from Mitchell, Queensland, through eastern New South Wales to East Gippsland, Victoria. This species occupies areas of Eucalypt and she-oak woodlands and are limited to areas that support sufficient she-oak foraging habitat as well as large tree hollows for nesting. The Glossy Black-cockatoo feed almost exclusively on the seeds of she-oaks (*Allocasuarina* spp. and *Casuarina* spp.), including: ■ *A. littoralis,* ■ *A. torulosa,* ■ *A. inophloia,* ■ *A. diminuta,* ■ *A. gymnanathera,* ■ *A. verticillata,* ■ *A. luehmannii,* ■ *C. equisetifolia,* ■ *C. cunninghamiana,* ■ *C. glauca*, and ■ *C. cristata.*	REs: Remnant and regrowth: 11.3.17, 11.5.1, 11.5.5, 11.9.5, 11.9.5a, 11.9.10, 11.10.7, 11.10.11 Remnant only: 11.3.2, 11.3.4, 11.3.25, 11.3.27f, 11.9.7	General habitat comprises remnant eucalypt dominated RE that typically include large hollow bearing trees along with remnant and regrowth RE with potential feed trees (*Casuarinaceae* spp.) (Boobook 2022). Potential foraging and breeding habitat exists in the northern and southern portions of the Project Area, in the form of Eucalypt woodland and Belah (She-oak) woodland. Additionally, some scattered patches exist within the central portion of the Project Area. Potential nest trees occur in remnant eucalypt woodland and forest and in well-developed riparian corridors across the Project Area. Evidence of feeding in the form of chewed *Casuarina* cones should also be considered evidence of foraging behaviour. **Breeding habitat:** Eucalypt woodlands containing large hollows in either living or dead trees. Are known to nest in *Eucalyptus crebra, E. nubile, E. blakelyi*, and *E. camaldulensis*, but may nest in other species. Potential nest hollows for the subspecies have the following traits (Cameron 2006): ■ >8 m above ground; ■ Located in branches >30 cm in diameter; ■ Branch or stem no more than 45° from vertical; and ■ Minimum entrance diameter of >15 cm. **Foraging habitat**: She-oak woodlands and stands of trees consisting of at least one or two species of she-oak feed trees.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			Their reliance on particular species varies between regions and they can show preference for certain trees within a species (DCCEEW 2022a).		
Painted Honeyeater (*Grantiella picta*)	V	V	The Painted Honeyeater lives in dry, open forests and woodlands. The species usually occurs in areas with a diversity of flowering and fruiting mistletoe and flowering Eucalypts. This species inhabits riparian woodlands of Black Box and River Red Gum, Acacia dominated woodlands, as well Paperbarks, Casuarinas, Callitris and Box-Ironbark-Yellow Gum woodlands with a large number of mature trees as these host more mistletoe. It will sometime occupy trees on farmland and gardens, provided there is a high supply of mistletoe. The species prefers habitat with more mature trees that host more mistletoes, particularly mistletoes in the genus *Amyema*. It is more common in wider blocks of remnant woodland than in narrower strips. According to the national recovery plan for the species (DAWE 2021), habitat critical to the survival of the Painted Honeyeater includes areas of: ■ Known or likely breeding habitat in Boree/Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) woodlands, box-gum woodlands and box-ironbark forests on the inland slopes of the Great Dividing Range in	Not mapped. This nomadic species forages on mistletoe in remnant, regrowth and other non-remnant vegetation, including shadelines and scattered	General habitat includes any areas of eucalypt or acacia woodlands that contains an abundance of mistletoe. This nomadic species forages on mistletoe in remnant, regrowth and other non-remnant vegetation, including shadelines and scattered trees and shrubs in cleared areas (Boobook 2022). Areas with a high abundance of mistletoe species in either eucalypt or acacia woodlands provide foraging habitat for this species. Mistletoe is present sparingly in Eucalypt woodlands across the Project Area that could be utilised as habitat for this species. Limited potential habitat of Brigalow woodland is also present. **Breeding habitat**: Boree/Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) woodlands, box-gum woodlands and box-ironbark forests on the inland slopes of the Great Dividing Range in New South Wales, Victoria and southern Queensland. Forests and woodlands with high quantities of mistletoe and where parasitism rates are high, preferably remnant vegetation. Typically nest in mature trees that have been parasitised with mistletoe, sometimes using the mistletoe as a nesting substrate. **Foraging and roosting habitat**: All preferred foraging species within known and likely foraging habitat particularly mistletoes of the genus *Amyema* growing on forest and woodland eucalypts and acacias.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			New South Wales, Victoria and southern Queensland; and ■ All preferred foraging species within known and likely foraging habitat particularly mistletoes of the genus *Amyema* growing on forest and woodland eucalypts and acacias.		
Southern Squatter Pigeon (*Geophaps scripta scripta*)	V	V	This species inhabits open-forests to sparse, open-woodlands and scrub that are mostly dominated by *Eucalyptus*, *Corymbia* or *Callitris* species, including remnant, regrowth or partly modified vegetation communities that are within 3 km of water bodies (Squatter Pigeon Workshop 2011). Typically, these habitats are on well-draining, gravelly, sandy or loamy soils and have patchy, tussock-grassy understories. This species also prefers to forage and dust-bathe on bare ground under an open canopy of trees (Squatter Pigeon Workshop 2011). Although this species forages and nests on the ground, it roosts in trees. Waterbodies suitable for the subspecies include permanent or seasonal rivers, creeks, lakes, ponds, waterholes and artificial dams.	REs: 11.3.2, 11.3.4, 11.3.17, 11.3.19, 11.3.25, 11.3.27f, 11.5.1, 11.5.5, 11.9.2, 11.9.7, 11.9.10, 11.10.7, 11.10.11	General habitat comprises remnant and regrowth of eucalypt dominated woodland and open forest within largely wooded landscapes. The species favours grassy woodland areas with patchy ground cover. Excludes small isolated fragments, narrow corridors and the largely cleared landscape north of Giligulgul Road (Boobook 2022). There is a lack of foraging and breeding habitat to the north of Project Area due to it being largely cleared with dense pastoral grasses, however suitable dry woodland habitat remains on and around the plateau in the south-eastern part of the Project Area. **Breeding and foraging habitat**: Open forest to sparse, open woodland or scrub vegetation on land zones 5 and 7. Stony rises on sandy, gravelly soils, within 1 km of a suitable, permanent waterbody (including farm dams and watercourses). Nests in low depressions in the soil surface next to tussock grasses and sparsely lined with grass. **Foraging only habitat**: Any remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species, on sandy or gravelly soils, within 3 km of a suitable, permanent or seasonal waterbody. **Dispersal habitat**: Any forest or woodland occurring between patches of foraging or breeding habitat, and suitable waterbodies.
Southern Whiteface	V	V	This species has a wide distribution across much of Australia, including southern Queensland west of the Great Dividing	REs: All RE (11.3.2, 11.3.4, 11.3.17, 11.3.19,	General habitat may compromise of any woodlands and open forests in the Project Area.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
(*Aphelocephala leucopsis*)			Range. It inhabits a variety of open woodlands and shrublands that have a grassy and/or shrubby understorey and are usually dominated by Acacia and Eucalypt species. According to the species' conservation advice (DCCEEW 2023d), habitat critical to the survival of the Southern Whiteface includes areas of: ■ Relatively undisturbed open woodlands and shrublands with an understorey of grasses or shrubs, or both; ■ Habitat with low tree densities and an herbaceous understory litter cover which provides essential foraging habitat; and ■ Living and dead trees with hollows and crevices which are essential for roosting and nesting.	11.3.25, 11.3.27f, 11.5.1, 11.5.5, 11.9.2, 11.9.5, 11.9.5a 11.9.7, 11.9.10, 11.10.7, 11.10.11)	Species will utilise almost all woodland habitats present within the Project Area, excluding any cleared grazed land dominated by exotic pasture grasses. **Breeding and roosting habitat:** Open woodlands and shrublands with an understorey of grasses or shrubs and tree hollows, in either live or dead standing trees. **Foraging habitat:** This species forages almost exclusively on the ground, with preference for areas with low tree densities and an understorey consisting of herbs and leaf litter in open woodlands and shrublands.
White-throated Needletail (*Hirundapus caudacutus*)	V, Mi	V	This species occurs over most types of habitat, but are recorded most often above wooded areas, including open forest, rainforest and heathland, and may also fly between trees or in clearings, below the canopy, but they are less commonly recorded flying above woodland (Higgins 1999). Whilst rare, they have been recorded on wooded ends of ridges, roosting after dark high in the eucalypt tree canopies (Tarburton, 1993).	No habitat mapped, flyover visitor only	This species may occur aerially over any wooded or cleared area, with a preference for wooded landscapes (Boobook 2022). Species likely to only fly aerially over the Project Area and in occasional flocks during the migratory period from September to April, following storm fronts. The Project Area does not contain habitat in the form of elevated eucalypt forests or wooded ridges to act as roosting habitat for the species. **Breeding habitat:** Does not breed in Australia. **Foraging habitat**: Flies aerially at 'cloud level' and forages over a range of habitats from heavily treed forests to open habitats, including

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
					farmland, heathland and mudflats. May forage closer to the ground in open habitats. **Roosting habitat**: Tall mature forests and woodlands, in trees amongst dense foliage and in hollows often associated with ridgelines. May also roost aerially.
Threatened Mammals					
Corben's Long-eared Bat (*Nyctophilus corbeni*)	V	V	This microbat species has a scattered distribution mostly within the Murray-Darling Basin, but with some records outside of this area. The species occupies a variety of inland woodland, including box / ironbark / cypress pine woodlands, Buloke woodlands, Brigalow woodland, Belah woodland, smooth-barked apple woodland, river red gum forest, black box woodland, and various types of tree mallee. It is more common in box, ironbark and cypress pine woodland on the western slopes and plains of New South Wales and southern Queensland. Its stronghold seems to be the Pilliga scrub. The species is more abundant in extensive stands of vegetation in comparison to smaller woodland patches and in habitat with a dense, cluttered understorey. It roosts in tree hollows, crevices and under loose bark.	REs: All RE except SEVT (11.3.2, 11.3.4, 11.3.17, 11.3.19, 11.3.25, 11.3.27f, 11.5.1, 11.5.5, 11.9.2, 11.9.5, 11.9.5a 11.9.7, 11.9.10, 11.10.7, 11.10.11)	General habitat comprises larger contiguous areas of remnant and regrowth woodland and open forest. The species favours areas with a multilayered shrubby understorey. Excludes small, isolated fragments, narrow corridors and the largely cleared landscape north of Giligulgul Road (Boobook 2022). There is a small amount of potential foraging habitat present in the form of wooded areas in the south of the Project Area, with connectivity to woodland outside of the Project Area. Suitable habitat in the Project Area is associated with larger patches of remnant eucalypt and acacia woodlands. **Breeding habitat**: Little information is available on the breeding behaviour and habitat for the species. No information is available on maternity roosts where larger groups may form. **Foraging and roosting habitat**: Forests and woodlands dominated by *Allocasuarina luehmannii, Acacia harpophylla, Casuarina cristata, Eucalyptus camaldulensis*, and various other types with dead hollow-bearing trees or trees with exfoliating bark. Foraging tends to be located around patches of trees in the landscape. Roosting occurs within dead trees including ironbarks, cypress and bulloak, and occasionally under peeling bark. **Foraging only habitat**: Remnant, and regrowth woodlands and low woodlands.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
Greater Glider (southern and central) (*Petauroides volans*)	E	V	The Greater Glider is an arboreal nocturnal marsupial, largely restricted to Eucalypt forests and woodlands. It is primarily folivorous, with a diet mostly comprising eucalypt leaves, and occasionally flowers. It is more common in tall, moist montane forests which have an abundance of medium to large hollows. This species prefers forests with a diversity of Eucalypt species, including winter flowering species. The tree species favoured by greater gliders varies regionally. They occur at elevations of up to 1,200 m above sea level. Greater Gliders den and nest in tree hollows, with a preference for large hollows (>10 cm in diameter) in living trees, but will also use hollows in dead standing trees. Multiple den trees are used by individuals; up to 20 dens can be used in high quality habitat (DCCEEW 2022b). There is no information available that differentiates foraging, breeding and denning habitat for the species however, for denning and nesting it prefers tall mature forests with large tree hollows. The species is absent from regrowth habitats with insufficient hollows. According to the species' conservation advice (DCCEEW 2022b), habitat critical to the survival of the Greater Glider (southern and central) may be broadly defined as:	REs: 11.3.2, 11.3.4, 11.3.17, 11.3.19, 11.3.25, 11.3.27f, 11.5.1, 11.5.5, 11.9.2, 11.9.7, 11.9.10, 11.10.7, 11.10.11	General habitat comprises remnant only woodland within the well-connected riparian corridors along Wandoan Creek and Woleebee Creek in the north of the Project Area, as well as larger contiguous areas of remnant eucalypt woodland and open forest south of Giligulgul Road. The species requires large hollow-bearing trees in areas with eucalypt feed trees. Excludes small, isolated fragments and regrowth areas (Boobook 2022). Potential foraging and denning habitat of tall, mature Eucalypt forests present within the Project Area, specifically along the riparian areas. The species was detected in Queensland Blue Gum (*Eucalyptus tereticornis*) woodland in the north of the Project Area, in the remnant riparian corridors along Wandoan Creek and Woleebee Creek. The species is likely to occur wherever large trees with hollows occur in woodland connected with these corridors and also in the extensively wooded area in the south of the Project Area. **Breeding, denning and foraging habitat**: Connected eucalypt-dominated woodlands containing 2-4 medium to large hollows in live den trees per 2 ha of suitable forest habitat (Eyre 2002). **Foraging and dispersal only habitat:** All other connected eucalypt-dominated woodlands within 120 m of breeding / denning habitat.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			■ Large contiguous areas of eucalypt forest, which contain mature hollow-bearing trees and a diverse range of the species' preferred food species in a particular region; ■ Smaller or fragmented habitat patches connected to larger patches of habitat, that can facilitate dispersal of the species and/or that enable recolonisation; ■ Cool microclimate forest/woodland areas (e.g., protected gullies, sheltered high elevation areas, coastal lowland areas, southern slopes); ■ Areas identified as refuges under future climate changes scenarios; and ■ Short-term or long-term post-fire refuges (i.e., unburnt habitat within or adjacent to recently burnt landscapes) that allow the species to persist, recover and recolonise burnt areas. Forest areas that are currently unoccupied by the Greater Glider may still represent habitat critical to survival of the species if there is potential for hollow-bearing trees to develop as the forest ages and this could allow future colonisation of the area.		
Koala (*Phascolarctos cinereus*)	E	E	Koalas naturally inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by eucalypt species. It can also	REs: 11.3.2, 11.3.4, 11.3.17, 11.3.19, 11.3.25, 11.3.27f, 11.5.1,	General habitat comprises all areas of eucalypt dominated remnant and mature regrowth woodland and open forest within the Project Area. The species requires eucalypt feed trees, shelter trees with dense canopies and access to riparian vegetation (Boobook 2022).

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			occur in *Acacia*, *Melaleuca*, or *Casuarina* dominated communities, provided that there are sufficient food trees in the area. The species occurs in both coastal and inland areas. The Koala is an obligate folivore, with its diet limited to several species of *Eucalyptus*, *Corymbia* and *Angophora* species, and as such is limited to forests and woodlands with sufficient coverage of feed trees. Primary food tree species vary between regions, with preferences for individual trees within a species. Despite their reliance on eucalypt trees for food, they utilise a large variety of trees for shelter and refuge which are also highly important for refuge from predators (and refuge for females and juveniles from males) and thermoregulation. Koalas occupy a range of landscapes, including highly fragmented habitat, isolated paddock trees, roadside vegetation and semi-urban environments. They are able to disperse across highly fragmented and otherwise unsuitable areas.	11.5.5, 11.9.2, 11.9.7, 11.9.10, 11.10.7, 11.10.11	Foraging and breeding habitat of Eucalypt forests, and preferred food trees including *E. tereticornis, E. populnea, E. crebra, E. longirostrata, E. melanophloia, E. exserta* and *Corymbia citriodora subsp. variegata*, as well as dispersal opportunities, are present within the Project Area. There is foraging and breeding habitat present in the form of Eucalypt dominated woodlands and open forests in the Project Area, particularly along riparian areas. **Breeding, foraging and refuge habitat**: Koala habitat can be broadly defined as any forest or woodland containing species that are known Koala food trees, or shrubland with emergent food trees. **Foraging and dispersal habitat:** Other vegetation containing at least one koala food tree and shelter trees. The species is known to traverse a matrix of landscape features from remnant and regrowth vegetation to paddock trees, grasslands and semi-urban areas.
Northern Quoll (*Dasyurus hallucatus*)	E	-	Northern Quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. This species occurs in a range of habitats, including open dry sclerophyll forests and woodlands, riparian woodlands,	REs: All RE (11.3.2, 11.3.4, 11.3.17, 11.3.19, 11.3.25, 11.3.27f, 11.5.1, 11.5.5, 11.9.2, 11.9.5, 11.9.5a 11.9.7,	Essential habitat comprises contiguous areas of woodland and forest within 1 km of rocky scarps (Boobook 2022). General Habitat comprises contiguous areas of remnant and regrowth woodland and forest within 5 km of cliffs and rocky scarps and connected to these refuges by continuous native vegetation (Boobook 2022).

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			low dry vine thickets, the margins of notophyll vineforests, rainforests, sandy lowlands, beaches, shrublands, grasslands, sugarcane farms, desert and in urban areas. They are most abundant in hilly or rocky areas close to permanent water, however, may also occupy non-rocky lowland habitats. The preferred habitat of rocky areas close to permanent water are very scarce across the Project Area, however, dry sclerophyll forests associated with remnant Eucalypt woodlands are present. Frequent cool burns and the absence of old growth forests (with hollows) or high elevation rugged terrain or rock falls limits the potential habitat available for the species.	11.9.10, 11.10.7, 11.10.11)	Excludes small, isolated fragments, narrow corridors and the largely cleared landscape north of Giligulgul Road. Potential suitable rocky areas for breeding, denning and foraging habitat are limited to the far south-eastern corner of the Project Area in the plateau with eucalypt woodland/open forest habitat types. Forested uplands with high relief and/or containing abundant rock outcrops may support the species (Oakwood 2008). The nearest recent records are from the Carnarvon Range (ALA 2022). **Breeding and denning habitat:** Structurally complex habitat encompassing some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal, as well as connection to permanent water. Similar non-rocky habitat with tree hollows and hollow logs. Dens are made in rock crevices, tree hollows, hollow logs or occasionally termite mounds. **Foraging and dispersal habitat**: Eucalypt forest and woodlands, rainforests, shrubland, grasslands, sandy plains, beaches and desert close to denning habitat and permanent water.
Short-beaked Echidna (*Tachyglossus aculeatus*)	-	SLC	This species can be found across a wide range of habitats, including open woodland, semi-arid and arid areas as well as in agricultural areas (Aplin et al., 2016). Their foraging requirements include ant nests and termite mounds (Nicol et al., 2011).	All areas	The species is likely to occur in low densities utilising all broad habitat types as general habitat. Echidnas are usually found among rocks, in hollow logs and in holes among tree roots. During rainy or windy weather, they often burrow into the soil or shelter under bushes and tussocks of grass. The species is a generalist and occurs across a variety of habitats throughout the Project Area, which includes open woodland, semi-arid and arid areas.
Threatened Reptiles					
Collared Delma (*Delma torquata*)	V	V	This species normally inhabits eucalypt-dominated woodlands and open-forests in Queensland RE Land Zones. The RE it	REs: All RE except SEVT (11.3.2, 11.3.4, 11.3.17,	General habitat comprises larger contiguous areas of remnant and regrowth woodland and forest. The species requires areas with abundant leaf litter and woody debris or rocks.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			prefers are ones dominated by Poplar Box (*Eucalyptus populnea*) on alluvial plains, Lemon-scented Gum (*Corymbia citriodora*) open forest on coarse-grained sedimentary rocks and Poplar Box/Brigalow (*Acacia harpophylla*) open forests on fine-grained sedimentary rocks. There is no delineation between breeding, dispersal and foraging habitat for this species. However, microhabitat requirements include presence of rocks, logs and specific mats of leaf litter typically 30-100 mm thick.	11.3.19, 11.3.25, 11.3.27f, 11.5.1, 11.5.5, 11.9.2, 11.9.5, 11.9.5a 11.9.7, 11.9.10, 11.10.7, 11.10.11)	Excludes SEVT and small isolated fragments, narrow corridors and the largely cleared landscape north of Giligulgul Road (Boobook 2022). Suitable habitat with abundant litter, rocks and woody debris occurs in the large contiguous area of forest and woodland associated with the escarpment and plateau in the south-eastern corner of the Project Area. The species is unlikely to occur in the northern part of the Project Area, where woodland fragments are small, narrow and disturbed, with few suitable habitat features for this species. Open-forests, woodlands and adjacent exposed rocky areas in QLD RE Land Zones 3, 9 and 10.
Common Death Adder (*Acanthophis antarcticus*)	-	V	This species lives in woodlands, open forests and heathlands; requires abundant shelter/ambush predation cover e.g. low shrubs, rocks, logs and dense leaf litter (Wilson, 2022). Suitable habitat with abundant litter, rocks and woody debris occurs in the large contiguous area of forest and woodland associated with the escarpment and plateau in the south-eastern corner of the Project Area.	REs: All RE (11.3.2, 11.3.4, 11.3.17, 11.3.19, 11.3.25, 11.3.27f, 11.5.1, 11.5.5, 11.9.2, 11.9.5, 11.9.5a 11.9.7, 11.9.10, 11.10.7, 11.10.11)	Potential habitat comprises large logs, rocky outcrops and abundant woody debris occurs in the large contiguous area of forest and woodland associated with the escarpment and plateau in the south-eastern corner of the Project Area. This includes all broad habitat types except for the cleared exotic pasture as well as small isolated fragments, narrow corridors and the largely cleared landscape north of Giligulgul Road. Mapped General Habitat comprises larger contiguous areas of remnant and regrowth woodland and forest. The species favours areas with abundant low shrubs, leaf litter and woody debris.
Dunmall's Snake (*Furina dunmalli*)	V	V	This species is found in forests and woodlands on black alluvial cracking clay and clay loams dominated by Brigalow (*Acacia harpophylla*), other Wattles (*A. burowii, A. deanii, A. leioclyx*), native Cypress (Callitris spp.) or Bull-oak (*Allocasuarina luehmannii*).	REs: All RE (11.3.2, 11.3.4, 11.3.17, 11.3.19, 11.3.25, 11.3.27f, 11.5.1, 11.5.5, 11.9.2, 11.9.5, 11.9.5a 11.9.7,	General habitat comprises larger contiguous areas of remnant and regrowth woodland and forest. The species favours areas with abundant leaf litter and woody debris. Excludes small, isolated fragments, narrow corridors and the largely cleared landscape north of Giligulgul Road (Boobook 2022). There is some suitable habitat with abundant litter, rocks and woody debris present in the south-eastern corner of the Project Area.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			It can also occur in various Blue Spotted Gum (*Corymbia citriodora*), Ironbark (*Eucalyptus crebra* and *E. melanophloia*), White Cypress Pine (*Callitris glaucophylla*) and Bulloak open forest and woodland associations on sandstone derived soils. There is no delineation between breeding, dispersal and foraging habitat for this species. Microhabitat features preferred includes fallen timber and ground litter.	11.9.10, 11.10.7, 11.10.11)	Forests and woodlands on deep-cracking black clay and clay loam soils or sandstone derived soils in QLD REs 11.3.1, 11.3.19, 11.3.39, 11.5.1, 11.5.5, 11.9.2, 11.9.5, 11.9.5a, 11.10.7, and 11.10.11.
Five-clawed worm-skink (*Anomalopus mackayi*)	V	E	This species is associated with deep cracking clays that provide individuals with shelter. Habitat areas include Bluegrass and/or Mitchell Grass dominated grassland and other grasslands categorised as RE 11.3.21; River Red Gum - Coolibah-Bimble/Poplar Box and Weeping Myall grassy woodlands; White Box grassy woodland; Myall woodland, and Brigalow (*Acacia harpophylla* dominant and co-dominant). There is no delineation between breeding, dispersal and foraging habitat for this species. However, microhabitat requirements include cracking clay soils or self-mulching friable basalt soils and woody debris.	General habitat comprises native grasslands and woodlands on alluvial, cracking clay soils or self-mulching, friable basalt soils in QLD REs 11.3.21, 11.3.25, 11.8.5, 11.8.15, 13.3.3, 13.3.4 and associated non-remnants.	Areas of potential habitat are limited on the site, with an absence of native grasslands with deep, cracking clays. Potential habitat includes area of Brigalow woodlands, with coarse woody debris and deep leaf litter cover. Ephemeral wetlands and creek lines are also present along with cracking clay soils in some areas.
Grey Snake (*Hemiaspis dameli*)	E	E	This species inhabits Brigalow *Acacia harpophylla* and Belah *Casuarina cristata* woodlands on dark brown to black cracking clay soils but are also found in Queensland	REs: 11.3.1, 11.9.5, 11.9.5a, 11.3.17, 11.3.27f, 11.9.10	General habitat comprises Brigalow and Belah woodlands, Queensland Bluegrass and Mitchell Grass grasslands on alluvial plains with cracking clay soils and Red Sodosols, and adjacent ephemeral wetlands and other waterbodies.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			Bluegrass *Dichanthium sericeum* and/or Mitchell Grass *Astrebla* spp. grasslands on alluvial plains with cracking clay soils, and red sodsol soils on the western downs of Queensland. Closely associated with waterbodies, particularly ephemeral wetlands and floodplains. Shelters in and under soils cracks, rocks, logs, flood debris and abandoned burrows. Forages for frogs in and around temporary water bodies, including small gullies and ditches, ephemeral wetlands, and floodplains. Uses soil cracks and crevices for cover when hunting.		Brigalow and Belah are present within the north and far south-eastern parts of the Project Area. Ephemeral wetlands and creek lines are also present along with cracking clay soils in some areas. **Foraging habitat**: Temporary water bodies, including small gullies and ditches, ephemeral wetlands, and floodplains, particularly where soil cracks and crevices are present.
Yakka Skink (*Egernia rugosa*)	V	V	The yakka skink 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 known from rocky outcrops and sand plain areas with dense ground vegetation. There is no delineation between breeding, dispersal and foraging habitat for this species. However, microhabitat features required for this species include cavities under and between partly buried rocks, logs and tree stumps as well as abandoned animal burrows.	REs: 11.3.2, 11.3.17, 11.3.19, 11.5.1, 11.5.5, 11.9.2, 11.9.5, 11.9.7, 11.9.10, 11.10.7, 11.10.11	General Habitat comprises larger contiguous areas of remnant and regrowth woodland and open forest. The species requires loamy soils with large logs, accumulations of woody debris and/or rocky outcrops. Excludes SEVT and small isolated fragments, narrow corridors and the largely cleared landscape north of Giligulgul Road (Boobook 2022). Dry sclerophyll forests and vegetation within the Brigalow belt south bioregion is present within the Project Area. Suitable habitat with large logs, rocky outcrops and abundant woody debris occurs in woodland on and around the plateau in the south-eastern corner of the Project Area. Open-forests to low-woodlands and scrub in QLD RE Land Zones (LZ) 3, 4, 5, 7, 8, 9 and 10. Colonies have been found in large hollow logs, cavities or burrows under large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes.
Threatened Invertebrates					

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
Dulacca Woodland Snail (*Adclarkia dulacca*)	E	V	This species occurs in a small number of isolated populations in the areas between Miles and Dulacca, and south to Meandarra (TSSC 2016c). This species inhabits a variety of remnant and scattered habitats, such as vine thicket and Brigalow woodland patches on rocky outcrops with clay to loam soils, as well as ironbark and *Acacia shirleyi* woodlands on ridges and *Eucalyptus woollsiana* woodland. The Dulacca Woodland Snail is also able to exist in areas of brigalow regrowth and even in cleared paddocks but only where logs, woody debris or other suitable microhabitat sites remain (TSSC 2016c). This species can also shelter under loose bark at the base of trees. The Dulacca Woodland Snail requires both canopy cover (from trees and/or shrubs) and rocks or woody debris to maintain adequate microhabitat humidity levels for breeding and to avoid desiccation (TSSC 2016c). It is likely that the species can aestivate during dry periods, however, the possible extent of these periods is not known. The mobility of this species is limited, however, it will move between areas of suitable microhabitat.	REs: Essential: 11.9.4, 11.9.5, 11.9.5a General: 11.9.10, 11.10.	**Essential habitat** comprises remnant and regrowth Brigalow woodland and forest, and SEVT. The species favours areas with abundant leaf litter and woody debris. **General habitat** comprises woodland and open forest of the nominated RE that are connected to patches of essential habitat (Boobook 2022). Potential habitat of fragmented, isolated patches of Brigalow woodlands are present in areas across the Project Area.
Pale Imperial Hairstreak (*Jalmenus eubulus)*	-	V	This butterfly species is endemic to the Brigalow Belt, distributed from far northern NSW to the Eungella area of central Qld (ALA 2022). Usually associated with mature Brigalow (*Acacia harpophylla*) open forests and	REs: 11.3.17, 11.9.5, 11.9.5a, 11.9.10	The species is usually located in mature Brigalow dominated open forests and woodlands, able to disperse across moderately fragmented landscapes, outside of Brigalow habitats.

Species / Community	EPBC Act status	NC Act status	Community or habitat description	Habitat mapping rules[1]	Habitat definition rules / site specific considerations
			woodlands (Eastwood et al. 2008; Valentine and Johnson 2012). The species has a naturally fragmented habitat and is capable of dispersal over moderate distances, with vagrant individuals found far from patches of Brigalow habitat (Eastwood et al. 2008).		Mapped General Habitat comprises Brigalow (*Acacia harpophylla*) dominant remnant woodland.

1. GTRE and the habitat mapping rules are used to identify survey locations for specific species in the detailed pre-clearance ecological surveys to confirm the presence of habitat identified in the habitat definition rules and site specific considerations.

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Appendix B – Detailed Ecological Assessment Methodology

The purpose of this Ecological Assessment Methodology is to define the ecology survey methods to be applied prior to the commencement of any clearing or other works. These surveys are referred to in this report as pre-clearance surveys.

1.0 Vegetation Community Assessment

Baseline assessments of the vegetation communities, including ground-truthed regional ecosystem (GTRE) mapping and threatened ecological community surveys, have been conducted to an acceptable level of detail and covered the relevant sections of the Field Development Area (Boobook 2022). Acceptable survey effort has been applied to classify and map habitat areas for known, likely, and potentially occurring species and communities. The habitat mapping is sufficiently detailed and supported by sufficient coverage of sampling points, however, as the Project will be developed over approximately 5 to 10 years and the pre-clearance surveys will closely inspect each proposed disturbance footprint, there is the potential for vegetation and ecological communities to change at the time the pre-clearance surveys are completed.

The pre-clearance surveys will be completed prior to disturbances in the Project Area to reassess the vegetation, ecological communities and habitat present at the time of disturbance. The ecology survey area will extend a minimum of 30 m beyond the Project infrastructure footprint. The following sections detail the pre-clearance methodology that will be implemented for the Project.

1.1 Regional Ecosystem Assessment

All vegetation within and immediately surrounding (i.e. within the 30 m survey buffer area) each proposed infrastructure footprint will be assessed, including the extent, classification and extent of ground-truth vegetation communities in accordance with the *Methodology for surveying and mapping regional ecosystems and vegetation communities in Queensland, version 6.0* (Nelder et al. 2022). Where necessary, this will include tertiary and quaternary vegetation assessments, however it is likely that quaternary assessments will suffice in most situations, due to the assessments previously undertaken (Boobook 2022).

Quaternary site assessments will be necessary to verify Regional Ecosystems (REs) and previous vegetation mapping and confirm dominant characteristic species. During quaternary site assessments, the following information will be recorded (Neldner et al. 2022):

- Location;
- Dominant species present;
- Condition status (i.e., remnant, high-value regrowth, regrowth, non-remnant);
- Other notes, which may include land zone, structural codes, ecologically dominant layer (EDL) height, EDL cover, description of extent; and
- Time-encoded digital photographs will be taken as a reference.

Tertiary site assessments will be undertaken where Quaternary site assessments find that the vegetation present is indicative of a different RE to that which is currently mapped or remnant vegetation or High Value Regrowth is present where this is not currently mapped. Tertiary site assessments will be undertaken within a 10 m x 50 m quadrat, recording the following information (Neldner et al. 2022):

- Location;
- Vegetation structure, mean height and percentage cover for each structural layer;
- Species composition of woody species, individual woody species cover by layer and basal area measure of abundance (of woody stems using the Bitterlich stick method);
- Species composition of the dominant or conspicuous species in the ground layer;

- Aspect and slope;
- Soil type;
- Landform;
- Disturbance type and severity;
- RE and remnant status; and
- Time-encoded digital photographs will be taken as a reference.

Condition status for woody vegetation will be evaluated using the definitions of remnant vegetation under the Queensland *Vegetation Management Act 1999* (VM Act):

- Remnant: woody vegetation that has not been cleared or vegetation that has been cleared but where the dominant canopy has greater than 70 % of the height and greater than 50 % of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy.
- High-value regrowth (HVR): areas previously cleared or disturbed (e.g. by wildfire) over 15 years ago and containing woody vegetation floristically and structurally consistent with the RE but typically less than 70 % of the height and less than 50 % density of the RE.
- Regrowth or non-remnant: areas previously cleared or otherwise significantly disturbed.

1.2 Threatened Ecological Community (TEC) Assessments

Threatened Ecological Community assessments will be undertaken to confirm the presence and condition of TECs identified as known or potential in the Project Area, namely:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) – Endangered; and
- Poplar Box Grassy Woodland on Alluvial Plains – Endangered.

The results of the regional ecosystem assessment will be used to assess a patch of vegetation against the descriptors and condition thresholds in the relevant Conservation Advice. The relevant TECs, listed above, can be identified in any season and no specific timing of surveys is required to conduct these assessments.

1.3 Targeted Threatened Flora Surveys

Targeted flora surveys of all known, likely or potential threatened flora species will be conducted within all proposed disturbance footprints and adjacent (30 m buffer) areas.

These surveys shall be conducted by a suitably qualified person using the random meander method, as detailed by *Cropper (1993)*. All threatened flora species and the locations of all individuals will be recorded and specimens collected of any unknown individuals, or if the species needs to be further confirmed by the Queensland Herbarium.

Where a threatened flora species is detected, a population survey shall be undertaken to determine the extent and density of the population.

2.0 Fauna Habitat Assessment

Fauna habitat baseline assessments have been conducted to an adequate level of detail to enable known, likely and potentially present species to be identified and a comprehensive Project impact assessment has been completed (ERM 2023).

Senex has committed to not clearing any areas confirmed as habitat for threatened species (listed in this Constraints Protocol), with the exception of Koala dispersal habitat and Echidna habitat.

The pre-clearance surveys will be completed prior to disturbance in each area and will extend for a minimum of 30 m beyond the proposed infrastructure footprint. The pre-clearance surveys will reassess the habitat present at the time of disturbance in order to refine mapped habitat areas and will also survey and record micro-habitat features and breeding sites to facilitate avoidance and minimisation of impacts to potentially utilised micro-habitat features and breeding sites. Recorded micro-habitat features will include:

- Hollow-bearing trees;
- Dead standing trees;
- Hollow logs;
- Termite mounds;
- Woody debris;
- Surface rocks;
- Gilgais;
- Soil cracks / cracking clay;
- Rocky outcrops, crevices, overhangs and caves;
- Mistletoes;
- Nests;
- Animal burrows;
- Watercourses, wetlands and dams (including proximity); and
- Any other significant habitat features, or values present, such as dense leaf litter, heavily decorticating bark, dense grass/shrub shelter, seeding grass cover, fruiting plants, nectar and pollen producing plants and koala food trees.

3.0 Active Threatened Fauna Surveys

Active fauna surveys of all known, likely or potential threatened fauna species will be conducted where suitable potential habitat is mapped or found to be present within or within 30 m of a proposed disturbance footprint (refer to the constraints mapping and the habitat descriptions in Appendix A). If any sedentary and limited mobility fauna species (e.g., Dulacca Woodland Snail) is recorded outside of its mapped potential habitat, additional surveys will be undertaken where habitat aligns with the habitat in which the new record was found to occur.

When disturbance is proposed within 30 m of suitable habitat active searches will be completed. The active searches will be in accordance with relevant survey guidelines in effect at the time of the survey or other equivalent survey methodology taking into account the fact that no known, likely or potential species will be considered absent due to non-detection (i.e. all known, likely and potentially present MNES fauna will be assumed to be present). All suitable habitat will be avoided and infrastructure siting and mitigation measures will be designed to minimise the risk of indirect impacts. The active fauna surveys will include the methods detailed in the table below.

Table 1 Active fauna survey methodology

Method	Target fauna	Description
Active searches	Birds, mammals, reptiles, amphibians and invertebrates	Active searches will be conducted by scanning trees, the ground and habitat features; overturning rocks, logs and other woody debris; searching under peeling bark; raking leaf litter and soil at the base of trees; and flushing birds from dense shrubs and groundcover. Care shall be taken to minimise disturbance to individuals and habitat features at all times.
Scat and sign searches	Birds, mammals, reptiles and invertebrates	Searches for signs, including tracks, scratch marks, scats, bat roosts (in hollows of dead trees and branches for Corben's Long-eared Bat), dens, nests, bones, fur, feathers, burrows, latrine sites, basking sites, foraging diggings, signs of feeding (including orts (chewed she-oak cones) and Yellow-bellied Glider feeding scars), and dead snail shells.

Method	Target fauna	Description
Diurnal bird surveys	Birds	Area searches or transects, recording sightings and calls.
Incidental observations	Birds, mammals, reptiles, amphibians and invertebrates	All fauna observed incidentally within and in close proximity to the proposed disturbance footprint will be recorded.

4.0 References for Detailed Ecological Assessment Methodology

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Appendix C: ATP 2059 CSG WMP

ATP 2059 Coal Seam Gas Water Management Plan

Document Number:

SENEX-ATLS-EN-PLN-013

Revision: A

Position	Name	(tick one column only)		Signature	Date
		Approve	Review		
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REVISION HISTORY

Revision	Revision Date	Document Status	Revision Comments	Author	Approved By
A	October 14 2022	Final	Document creation	KCB	

1. INTRODUCTION

1.1. ATP 2059 – Project Description

Senex Energy Pty Ltd (Senex), on behalf of its subsidiary Senex Assets Pty Ltd, proposes to develop, operate, decommission and rehabilitate new coal seam gas (CSG) wells and associated infrastructure on Authority to Prospect (ATP) 2059 (referred to herein as ATP 2059 or the Project).

ATP 2059 covers an area of approximately 18 km^2 and is located approximately 14 km southwest of Wandoan in Southern Queensland as presented in Figure 1.1.

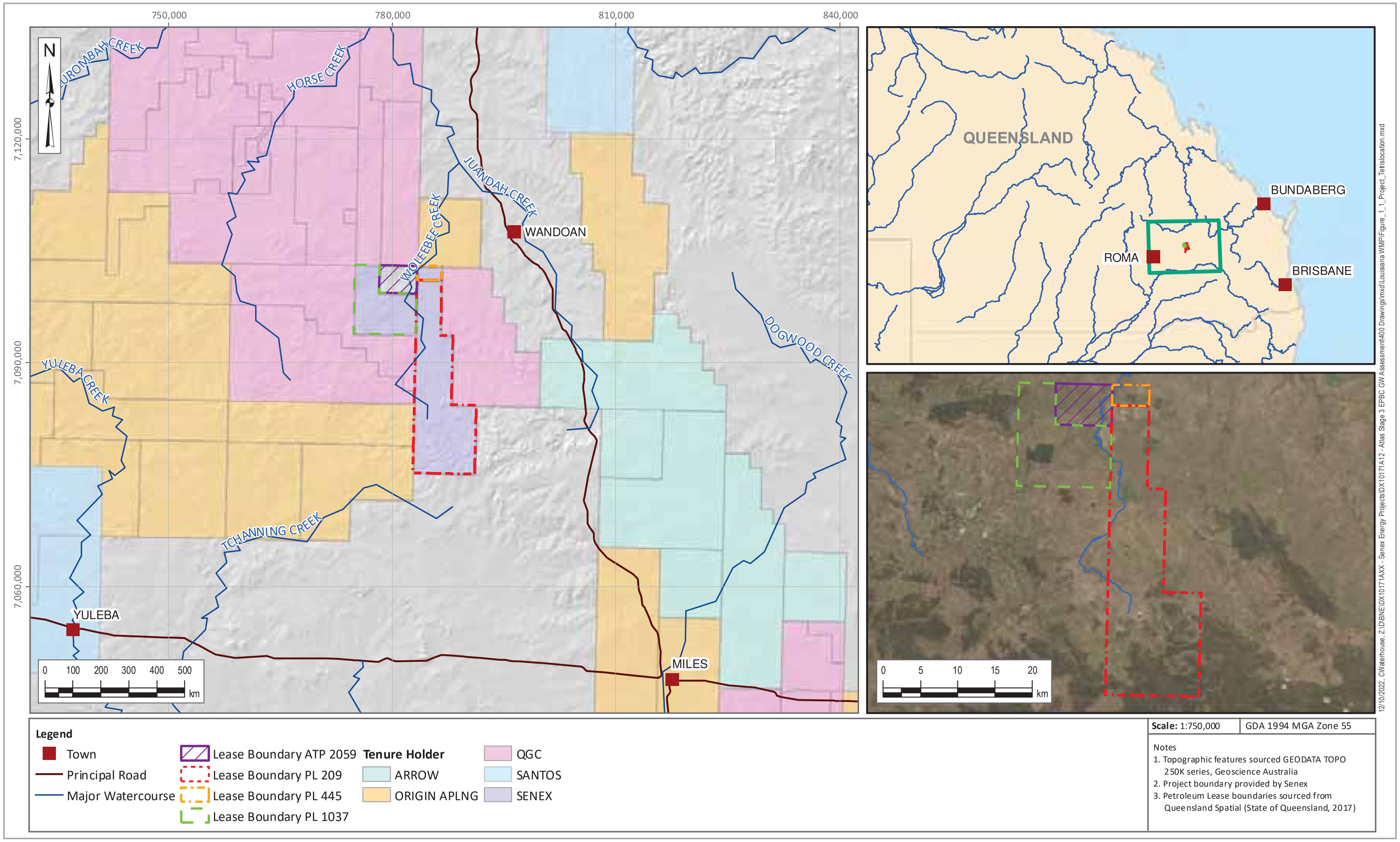
Proposed production activities and infrastructure are expected to include the following components:

- Up to 31 CSG production wells;
- Gas and water gathering lines;
- Water separation infrastructure;
- Water storage and water management facilities;
- Access roads and tracks;
- Maintenance facilities, workshop, construction support and administration buildings (during construction and operation);
- Temporary accommodation;
- Utilities – power generation, water supply;
- Communications; and
- Borrow pits.

ATP 2059 is located adjacent to Senex's existing Project Atlas, which comprises operational CSG fields and associated infrastructure on PL 1037. Where practicable, and to the extent authorised by current and future approvals, the infrastructure required for ATP 2059 will integrate with existing infrastructure constructed as part of Project Atlas. As such, details of the project components, including location and size, will be progressively determined over the life of ATP 2059 based on the integration with the existing Project Atlas infrastructure. This integration is expected to maximise operational efficiency and reduced the impacts of ATP 2059.

Senex also plan to develop gas wells to the east of ATP 2059 within PL 445 and PL 209. Where practicable, and to the extent authorised by current and future approvals, the infrastructure required for ATP 2059 may integrate with future infrastructure within PL 445 and PL 209.

Figure 1.1: ATP 2059 Location within the Surat Cumulative Management Area (OGIA)



1.2. Aims and Objectives of the Plan

The Coal Seam Gas Water Management Plan (CWMP) covers all activities associated with managing produced water from the project area once the water has been recovered to the ground surface; including managing saline waste by-product (brine) resulting from treating produced water.

The aim of the CWMP is to provide a tool to assist Senex personnel to manage produced water. The plan sets objectives to maximise the beneficial use of water and identify any potential impacts that may require mitigation.

Other key objectives of the CWMP include:

- Providing a transparent document outlining Senex's philosophy and approach to water management;
- Demonstrating adherence to regulatory policy;
- Documenting the risks and challenges in relation to CSG water management;
- Providing a strategic management tool adaptive to changes in:
  - Source water quantity and quality;
  - Demand, location and volume;
  - Technology;
  - Environmental receptors/constraints; and
  - Community concerns, and regulatory requirements.
- Allowing for continual improvement and implementing good practice CSG water management.

The CWMP will consider managing CSG water for the life of the project and will be updated as required so that the most appropriate and effective management approach is applied.

1.3. Definitions and Acronyms

APGA	Australian Pipelines and Gas Association
ATP	Authority to prospect
ATW	Access to work
BOM	Bureau of Meteorology
CMA	Cumulative management area
CSG	Coal seam gas, where gas is stored within coal deposits or seams
CWMP	Coal seam gas water management plan
DCCEEW	Department of Climate Change, Energy, the Environment and Water

DEHP	Department of Environment and Heritage Protection
DES	Department of Environment and Science
DoEE	Department of Environment and Energy
E&A	Exploration and appraisal
EA	Environmental authority
EOW	End of waste
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESA	Environmentally sensitive areas
EV	Environmental value
FEED	Front end engineering and design
FSV	Full storage volume
GDE	Groundwater dependent ecosystem
HDPE	High density polyethylene
MNES	Matters of National Environmental Significance
MOV	Maximum operating volume
MSES	Matters of State Environmental Significance
OGIA	Office of Groundwater Impact Assessment
Petroleum Act	*Petroleum Act 1923* (Qld), the *Petroleum Gas (Production and Safety) Act 2004* (Qld)
PL	Petroleum lease granted under the *Petroleum Act 1923* (Qld) or the *Petroleum Gas (Production and Safety) Act 2004* (Qld)
PPL	Petroleum Production Licence granted under the *Petroleum Gas (Production and Safety) Act 2004* (Qld)
Project Area	means the coal seam gas field, approximately 18 km^2 on ATP 2059
SCA	Strategic cropping area
Surat Basin	means the sedimentary geological basin of Jurassic to Cretaceous in southern Queensland and northern New South Wales
TD	Total depth
TDS	Total dissolved solids

WCM	Walloon Coal Measures (the target gas production unit)
WQO	Water quality objectives
WSA	Water supply agreement
WTF	Water treatment facility

2. REGULATORY FRAMEWORK

This CWMP has been prepared in accordance with key policies and legislation in Queensland for managing CSG produced water. A summary of the key policies and legislation relevant to development of ATP 2059 is provided in the following sections.

2.1. Petroleum and Gas (Safety and Production) Act 2004

The *Petroleum and Gas (Production and Safety) Act 2004* (State of Queensland 2020a) is an Act relevant to exploring for, recovering and transporting by pipeline, petroleum and fuel gas, and ensuring the safe and efficient undertaking of those activities. The key purpose of this Act is to facilitate and regulate the undertaking of responsible petroleum activities and the development of a safe, efficient, and viable petroleum and fuel gas industry.

This act identifies underground water rights for petroleum tenures, and states that the holder of a petroleum tenure may take or interfere with underground water in the area of the tenure if the taking or interference happens during the course of, or results from, the carrying out of another authorised activity for the tenure. There is no limit to the volume of water that may be taken under the underground water rights and the tenure holder may use associated water for any purpose within, or outside, the area of the tenure.

2.2. Environmental Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Commonwealth of Australia 2022a) is the central piece of environmental legislation at the Commonwealth level. It provides for the protection of environmental values, including matters of national environmental significance (MNES). Actions that are likely to have a significant impact on MNES are subject to the assessment and approval process under this Act. Water resources in relation to large coal mining and CSG development projects are a MNES. The Project may have potential to have a significant impact on water resources, and as such is being referred to the Department of Climate Change, Energy, the Environment and Water (DCCEEW).

The regulatory guideline relevant to ATP 2059, developed from the amendment to the EPBC Act identifying water resources as being a MNES, is the Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources (Commonwealth of Australia 2022b).

2.3. Water Act 2000

The *Water Act 2000* (State of Queensland 2021b) is intended to provide for the sustainable management of water and the management of impacts on underground water, among other purposes. The Water Act provides a framework for the following:

- The sustainable management of Queensland's water resources by establishing a system for the planning, allocation and use of water;
- The sustainable and secure water supply and demand management for the south-east Queensland region and other designated regions;
- The management of impacts on underground water caused by the exercise of underground water rights by the resource sector; and
- The effective operation of water authorities.

The Act includes water in a watercourse, lake or spring, underground water (or groundwater), overland flow water, or water that has been collected in a dam.

The Water Act 2000 provides for managing impacts on underground water caused by the exercising of underground water rights by resource tenure holders, which are regulated under the Petroleum and Gas (Production and Safety) Act 2004. The Act also outlines the requirements for make good agreements, associated with impacts to underground water.

2.4. Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) (State of Queensland 2022) has an objective 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 (ecologically sustainable development).

Table 2.1 presents the primary requirements for the management of CSG water from the EP Act and identifies the sections in this CWMP to address each requirement.

Table 2.1: EP Act (State of Queensland 2022) Requirements (S126) and Report Section Reference

EP Act - S126 - Requirements for site-specific applications - CSG activities	CWMP Section Reference
1) A site-specific application for a CSG activity must also state the following:	
a) The quantity of CSG water the applicant reasonably expects will be generated in connection with carrying out each relevant CSG activity;	Section 3.1
b) The flow rate at which the applicant reasonably expects the water will be generated;	Section 3.1
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 3.2 & Section 5.4
d) The proposed management of the water including, for example, the use, treatment, storage or disposal of the water;	Section 4
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	Section 6
(i) The quantity and quality of the water used, treated, stored or disposed of;	Section 5 & Section 6
(ii) Protection of the environmental values affected by each relevant CSG activity;	
(iii) The disposal of waste, including, for example, salt, generated from the management of the water; and	Section 6
f) The action proposed to be taken, if any, if the management criteria are not complied with, to ensure the criteria will be able to be complied with in the future.	Section 6
2) 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 the following: (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.	Not relevant as no CSG evaporation dams are proposed.

2.4.1 Environmental Protection (Water) Policy 2009

Under the EP Act 1994, the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019b) was established as subordinate legislation to achieve the object of the Act in relation to Queensland Waters. The purpose of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* is achieved by:

- Identifying environmental values (EVs) and management goals for Queensland waters;
- Stating water quality guidelines and water quality objectives (WQOs) to enhance or protect the EVs;
- Providing a framework for making consistent, equitable and informed decisions about Queensland waters; and
- Monitoring and reporting on the condition of Queensland waters.

Further details on EVs are provided in Section 5.5.

2.4.2 CSG Water Management Policy 2012

The *CSG Water Management Policy 2012* (State of Queensland 2012) primary objective is associated with the management and use of CSG water under the EP Act 1994. The role of the policy is to:

- Clearly state the government's position on the management and use of CSG water;
- Guide CSG operators in managing CSG water under their environmental authority; and
- Ensure community understanding regarding the government's preferred approach to managing CSG water.

3. CSG WATER PRODUCTION

This section of the CWMP describes the anticipated volume and quality of water expected to be produced as part of ATP 2059.

3.1. CSG Water Production

CSG water will be produced as a by-product of depressurisation of coal seams to produce CSG for ATP 2059. The target coal seams are the Walloon Coal Measures (WCM).

Produced water volumes and rates have been modelled using Senex's analytical reservoir model, with probabilistic distributions applied to several key reservoir parameters (i.e., permeability, porosity, and net coal) to generate well type curves and water production forecasts. Some uncertainty is inherent in any analytical model, and reservoir models can initially over-predict water production due to factors including sensitivity to assumed porosity. Further certainty will be gained as CSG wells are drilled and tested as part of appraisal programs and as field development proceeds. As Senex acquires more production data, the model will be enhanced with historical matching of actual production data, resulting in revised production forecasts being produced. These revised production forecasts will be incorporated into the water balance model along with the actual observations of water disposal volumes, rainfall, and dam levels.

Senex has confidence that this integrated and iterative approach will ensure that produced water is managed responsibly, and beneficial use is optimised. Type curves will be updated throughout the life of the project as more information becomes available.

Figure 3.1 presents the CSG water production profile forecast for ATP 2059. Peak CSG water production is expected to occur in 2025.

Figure 3.1: ATP 2059 Forecast Water Production

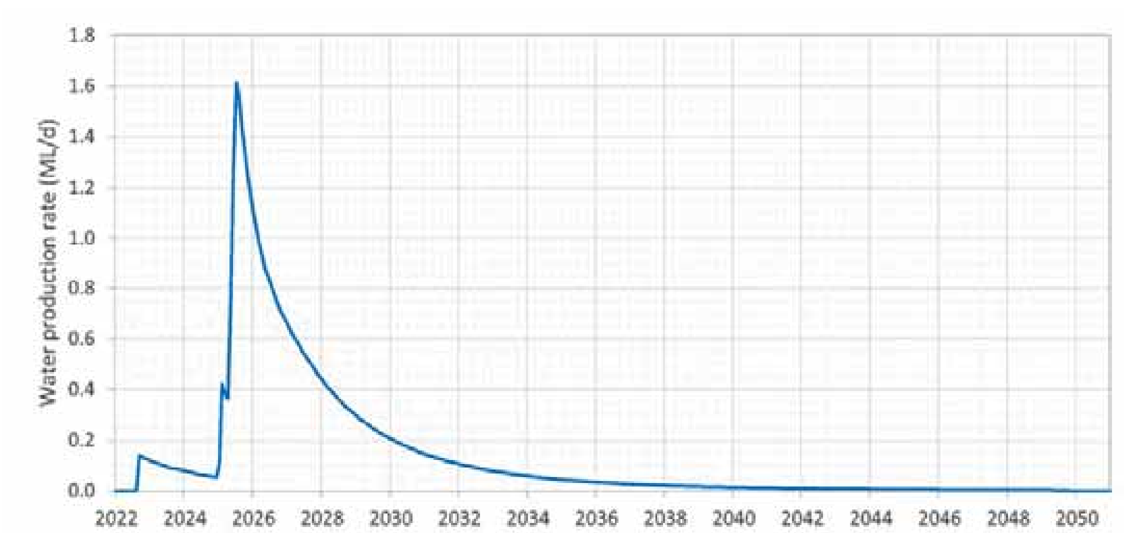
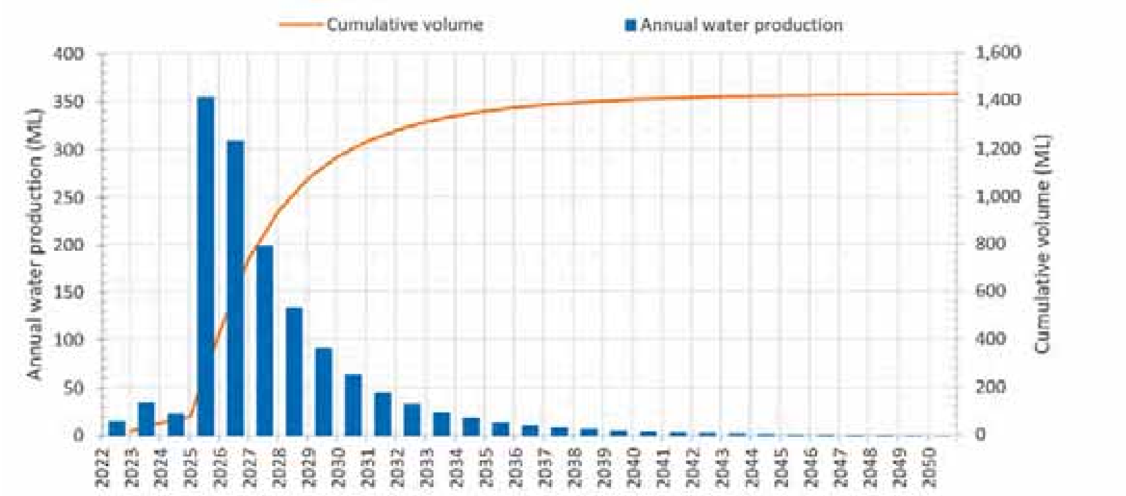


Figure 3.2 presents the annual water production forecast and cumulative water production. The total volume of water forecast to be produced over the development lifetime (~30 years) is approximately 1.4 GL.

Figure 3.2: ATP 2059 Annual Water Production



3.2. CSG Water Quality

There is no water quality data for the WCM from the ATP 2059 area. Data related to the site-specific water quality will become available as CSG wells are drilled as part of appraisal programs and into production. A summary of the regional characteristics associated with the WCM are provided below.

The produced water quality from the WCM can vary from fresh to saline. OGIA (2016a) indicate that in general, the total dissolved solids (TDS) of the WCM within the Surat Cumulative Management Area (CMA) ranges from 30 to 18,000 mg/L, with a mean TDS of 3,000 mg/L. OGIA (2016a) also report that available samples from existing CSG bores in the Surat CMA at significant depth show distinct characteristics with negligible concentrations of calcium, magnesium and sulphate, and higher concentrations of sodium and fluoride, compared with the other formations.

Table 3.1 presents analysis results from the groundwater database (GWDB) for 24 WCM samples within 25 km of ATP 2059. Most of these samples are from third-party groundwater bores located to the north of ATP 2059. Table 3.2 presents analysis results from PL 1037.

Table 3.1: Summary of WCM Water Quality from Available GWDB Samples within 25 km of ATP 2059

Parameter	Unit	Count	Min	Max	Median	Average
EC	µS/cm	12	1,900	13,400	8,010	7,310
pH	-	15	5.5	8.8	7.7	7.7
Sodium Adsorption Ratio (SAR)		24	7.6	171	81	81
TDS	mg/L	18	883	17,733	5,176	5,645
Sodium	mg/L	24	262	6,860	2,024	2,651
Potassium	mg/L	4	4.3	16.3	5.9	8.1
Calcium	mg/L	24	7.9	344.3	33.5	81.1
Magnesium	mg/L	24	2.9	162.9	10.7	31.4
Bicarbonate (HCO_3)	mg/L	16	30	862	512.0	512.3
Carbonate (CO_3)	mg/L	12	15	343.2	198.8	168.1
Chloride	mg/L	24	375	11,454	2,904	4,014
Fluoride	mg/L	15	0.2	2.2	0.8	0.9
Sulphate	mg/L	16	1.0	57	4.0	8.7

Table 3.2: Summary of WCM Water Quality from PL 1037

Parameter	Unit	Min	Max	Average
EC	µS/cm	8,780	12,500	10,039
pH	-	8.4	9.1	8.8
SAR		107	163	128
TDS	mg/L	5,500	8,120	6,477
Sodium	mg/L	1,920	2,900	2,300
Potassium	mg/L	13	63	50
Calcium	mg/L	4	18	10
Magnesium	mg/L	6	9	7
HCO_3 as $CaCO_3$	mg/L	480	700	550
CO_3 as $CaCO_3$	mg/L	23	280	150
Chloride	mg/L	2,700	4,160	2,300
Fluoride	mg/L	1.1	1.8	1.4
Sulphate	mg/L	<1	2	1.2

4. CSG WATER MANAGEMENT

4.1. CSG Water Management Strategy

The CSG water management strategy for ATP 2059 has been developed based on the Department of Environment and Heritage Protection (DEHP) (now the Department of Environment and Science (DES)) prioritisation hierarchy. This hierarchy is presented in the Coal Seam Gas Water Management Policy (DEHP 2012). The prioritisation hierarchy for managing and using CSG water is:

Priority 1 – CSG water is used for a purpose that is beneficial to one or more of the following:

- The environment;
- Existing or new water users; or
- Existing or new water-dependent industries.

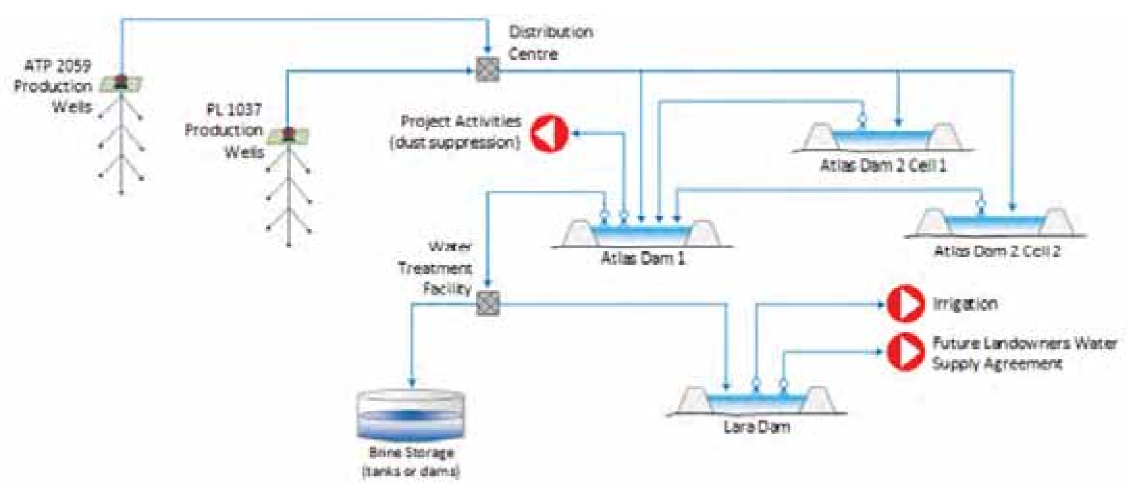
Priority 2 – After feasible beneficial use options have been considered, treating and disposing of CSG water in a way that firstly avoids, and then minimises and mitigates, impacts on EVs.

4.2. Water Management Infrastructure

4.2.1 Overview

This section provides an overview of the infrastructure proposed to manage CSG produced water. As detailed in Section 1.1, water management infrastructure for ATP 2059 is expected to include water gathering systems from the producing wells, brine and produced water storages, including aggregation dams and brine tanks, and irrigation dams. Where practical, the water management infrastructure required for ATP 2059 will integrate with existing Project Atlas infrastructure in PL 1037. A schematic of the existing PL 1037 wells and any additional water management infrastructure required for ATP 2059, is presented in Figure 4.1, with each component summarised in the following sections.

Figure 4.1: Water Management Infrastructure Schematic (ATP 2059 and PL 1037)



4.2.2 Infrastructure Location Planning

The exact locations of additional water management infrastructure within the ATP 2059 area are not yet known. However, to avoid, minimise and manage potential impacts across the ATP 2059 area, and to support well field layout for all surface infrastructure, including wells and gathering pipelines, Senex will implement the 'Environmental Protocol for Field Development and Constraints Analysis' (Senex 2018; SENEX-QLDS-EN-PRC-019) (the Constraints Protocol). The Constraints Protocol aims to ensure that infrastructure siting:

- Considers biodiversity values and environmental constraints, such as sensitive receptors, when selecting preferential locations; and aligning with planning principles to avoid, minimise, mitigate, and then manage potential environmental impacts; and
- Identifies any additional external environmental approvals required and that those are secured prior to the commencement of construction activities.

The Constraints Protocol also recognises that, in addition to environmental constraints, landholder, engineering, and cultural heritage constraints must be considered during infrastructure siting.

The process involves a desktop constraints analysis, site surveys, post-survey environmental constraints analysis, and preparing a report that includes a list of site-specific environmental conditions and associated constraints maps. These are included in the final Access to Work (ATW) documentation, issued upon sign-off by the Project Manager to relevant staff and contractors prior to commencing construction.

4.2.3 CSG Production Wells, Water Gathering and Distribution System

CSG water production is required as part of the CSG extraction process. Groundwater is abstracted (pumped) from CSG production wells to depressurise the target production coal seams. Depressurisation generates gas flow and sustains a groundwater flow from the well to maintain the target producing operational pressure for each CSG production well.

Flow from the well is separated into water and gas by either:

- Wellbore separation (where water is pumped up the tubing and produced gas flows to the surface in the annulus of the well); or
- Where wellbore separation is ineffective, a surface separator may be installed that will separate any hydrocarbons from the produced water.

Each well will have a wellhead gas and water metering package to achieve real-time continuous gas and water metering.

CSG production wells will be drilled and constructed in accordance with the 'Code of Practice for the construction and abandonment of petroleum wells and associated bores in Queensland' (State of Queensland 2019a).

Gas and water from the wellsite will be delivered to gas and water processing facilities via separate underground high-density polyethylene (HDPE) pipelines operating as low-pressure gas and water gathering systems. Gathering systems shall be designed and installed in accordance with APGA Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry Version 4.0 (APGA 2016).

All produced water will initially be collected from the water gathering systems into existing PL 1037 aggregation dams (Section 4.2.4).

4.2.4 Operational Water Storage Facilities

As detailed in Section 1.1, CSG produced water storage facilities for ATP 2059 will use existing Project Atlas infrastructure in PL 1037 which includes:

- Aggregation dams for storing untreated CSG produced water:
  - Atlas Dams 1 and 2: existing purpose-built earthen dams comprising an impervious liner. Atlas Dam 1 has a storage capacity of 330 ML and Atlas Dam 2 is a dual celled dam with storage capacities of 330 ML and 550 ML in Cells 1 and 2, respectively.
- Irrigation dams located adjacent to dedicated irrigation areas:
  - Lara Dam: existing irrigation dam with a storage capacity of 100 ML.
- Brine storage tanks.
  - Brine Tanks 1 and 2: existing brine tanks each with a full storage volume (FSV) of 57 ML, a maximum operating volume (MOV) of 44 ML and a surface area of 1.65 ha; and
  - Additional brine storage: two brine tanks or a brine dam (with a comparable storage volume and surface area) required to meet the PL 1037 forecasted production rate (refer to Section 4.5).

Any additional CSG water storage or brine dams associated with ATP 2059 (i.e., if required and in addition to the PL 1037 dams and brine tanks) will be designed and assessed using the 'Manual for Assessing Hazard Categories and Hydraulic Performance of Structures' prepared by DES (DES 2016a). If a dam is identified to be in the 'significant 'or 'high-hazard' category, it is considered a regulated dam and detailed dam design reports must be submitted to DES following granting of the EA (that provides in principle approvals of dam construction).

The following will apply with respect to any regulated dams required for the Project:

- Senex will design dams in accordance with relevant legislation and Queensland standards and DES guidelines;
- Senex will submit dam designs separately and specifically for registration;
- An independent third-party will be engaged to certify dams to ensure design, construction and hydraulic performance meet the design plan;
- Dams will be constructed under the supervision of a suitably qualified and experienced person and in accordance with the relevant DES schedule of conditions relating to dam design, construction, inspection and mandatory reporting requirements;

- Senex will implement a seepage monitoring program for water storage dams, where required. The seepage monitoring program will identify infrastructure and procedures that are in place to detect loss of containment as early as possible;

- Senex will routinely monitor water quality in dams, and in the respective dam's shallow groundwater monitoring bores, installed as part of the seepage monitoring program (if required);

- Senex will monitor dam levels to provide early warning of overtopping and / or unidentified water losses; and

- Senex will monitor the integrity and assess the available storage of dams annually.

Any low-hazard dams required for CSG water storage will be designed in accordance with accepted engineering standards. The dams will be designed with a floor and sides comprising material capable of containing the water for the life of the project.

The following will apply with respect to any additional brine storages associated with ATP 2059 (i.e., if required and in addition to existing PL 1037 brine tanks 1 and 2):

- Senex will design storages in accordance with relevant legislation and accepted Australian engineering standards.

- Senex will implement a seepage monitoring program for any additional brine storages, where required. The seepage monitoring program will identify infrastructure and procedures that are in place to detect loss of containment as early as possible.

- Senex will monitor storage levels to provide early warning of overtopping and / or unidentified water losses; and

- Senex will monitor the integrity and assess the available storage of storages annually.

4.2.5 Water Management Process

The water management process for the produced water is:

- Water from the ATP 2059 gathering system will be transferred to the centrally located aggregation dams including the existing Atlas Dams 1 and 2 on PL 1037.

- The existing Project Atlas water treatment facility (WTF) on PL 1037 consisting of pre-filtration, pre-treatment pH adjustment (if required), membrane filtration, reverse osmosis and calcium addition will treat water from the aggregation dams. The existing WTF has a treatment capacity of approximately 1.5 ML/d, with approximately 88% recovery. The treatment capacity of the existing WTF will be increased to 4.5 ML/d to ensure adequate capacity for the produced water from the existing Project Atlas. Additional water from PL 445 and PL 209 will be accommodated within the expanded existing WTF.

- Treated water (permeate) will be transferred to irrigation dams including the existing Lara Dam on PL 1037. Additional untreated water may be blended into permeate in the irrigation dam where possible without compromising the quality of the water in relation to its suitability for irrigation.

- An alternative to treatment of the produced water may be blending with fresh water sourced from a third-party, to provide water of a suitable quality for irrigation.
- Blended water from the irrigation dam will be provided to third-parties for use on pivot and fixed irrigators on pasture grass or crops.
- Brine from the water treatment process will be stored in brine storages (including the existing Brine Tanks 1 and 2), from where it will be further concentrated via solar evaporation to a concentrated slurry or solid salt. Where appropriate, salt or salt slurry will be trucked from site and disposed of at a Regulated Waste Facility. Further detail related to brine and salt management is included in Section 4.4.

4.3. Water Management Options

The water management strategy and associated schematic for ATP 2059 (Figure 4.1), has been developed to beneficially use water. This includes providing produced water for the following activities:

- Project activities, such as drilling and completions, dust suppression, etc; and
- Landowner Water Supply Agreements (WSA), including water for irrigation and stock watering.

4.3.1 Project Activities

Where practical, Senex will use untreated produced water to support ongoing development / construction activities such as: dust suppression; drilling; well completions and workovers; facilities construction; and hydro-testing gathering networks.

Any untreated produced water used as part of project activities will be undertaken in accordance with the:

- ‘End of Waste Guideline’ (DES 2022)
- ‘Streamlined Model Conditions for Petroleum Activities’ (DES 2016b); and
- Project EA, particularly Schedule G (water) and Schedule B (waste), which provides specific conditions related to beneficial use for irrigation, dust suppression and construction.

The general beneficial use approval document establishes the criteria for using untreated produced water for dust suppression, construction, and landscaping and vegetation requirements. Compliance with water quality criteria is required to use untreated produced water for landscaping and vegetation; however, no criteria are specified for dust suppression and construction. Using produced water for dust suppression and construction purposes will be undertaken with consideration to Senex’s ‘Environmental Management Plan’ (SENEX-ATLAS-EN-PLN-001).

Untreated produced water from ATP 2059 is expected to be used for dust suppression (up to 30 ML/yr or 0.1 ML/d for PL 1037 and ATP 2059).

4.3.2 Landowner Water Supply Agreements

Senex anticipates using the CSG produced water for beneficial use by establishing Landowner Water Supply Agreement (WSAs). An estimate of current groundwater use in the vicinity of the Project area is ~1,345 ML/year (see section 5.4.2), which includes groundwater abstraction for stock and domestic and agricultural purposes (OGIA 2017b).

Senex also plan to dispose of a portion of the CSG produced water volume from the Project through supporting third party sustainable irrigation practices. Senex is aware that agricultural users have different water demand profiles and water requirements, with some requiring water for stock watering and others for irrigation. For these reasons, Senex plan to adopt a portfolio management approach to water management, identifying the opportunity to address beneficial use demands with anticipated produced water volumes.

Prior to providing produced water to any third party irrigation schemes, Senex will address the requirements of the 'End of Waste Guideline' (DES 2022).

4.4. Brine and Salt Management

The DEHP Hierarchy within the *CSG Water Management Policy* (DEHP 2012) also provides a prioritisation hierarchy for managing saline waste, which comprises:

- Priority 1 – Brine or salt residues are treated to create useable products wherever feasible.
- Priority 2 – After assessing the feasibility of treating the brine or solid salt residues to create useable and saleable products, disposing of the brine and salt residues in accordance with strict standards that protect the environment.

The management of brine is addressed through the State Environmental Authority requirements in Schedule B (waste) and Schedule I (dams). These schedules also address spills, leaks, and seepage monitoring and management. Senex's approach to any brine management will remain consistent with industry accepted practice.

Treatment of produced water via RO will produce treated water (permeate) and RO reject (brine). Brine will be transferred from the WTF to the brine storages, which are and will be located taking consideration of the Queensland requirements for buffers around watercourses, MNES, matters of state environmental significance (MSES) and environmentally sensitive areas (ESAs).

Based on a median salt concentration of 5,176 mg/L TDS (Table 3.1), it is anticipated that approximately 5 tonnes of salt per mega litre of produced water will be generated. Brine requires specific considerations for storage and disposal and will be stored in engineered storages, constructed to contain the entire production of brine from the Project. The brine storages will be designed and constructed under the supervision of a suitably qualified and experienced person and in accordance with the relevant Australian standards relating to tank or dam design, construction, and inspection.

Stored brine will undergo solar evaporation resulting in a highly concentrated slurry or solid salt. Where appropriate this concentrate will be transferred to a Regulated Waste Facility for disposal. Senex will continue to investigate cost effective and / or commercial saline disposal alternatives.

Site rehabilitation requirements are addressed in Schedule J (Rehabilitation) of the EA. Senex will be responsible for the rehabilitation of any dams or infrastructure under the approval or, where appropriate, transferring dams to landholders in accordance with the approved EA conditions and, ensuring no legacy issues develop following the cessation of Project production.

4.5. Water Balance

A water balance model has been developed in GoldSim to determine timing for the long-term water management strategy for ATP 2059. The model has been designed and configured to simulate the operation of the existing PL 1037 water management system (as detailed in Figure 4.1) with the ability to add in additional water management infrastructure as/if required due to the increased water production forecasts (i.e., PL 1037 plus ATP 2059 water production forecast). The model uses:

- Combined water production forecasts for PL 1037 and ATP 2059 as presented in Figure 4.2 based on the 2022 forecasts.
- Existing Project Atlas water storage volumes and surface areas (i.e., Atlas Dams 1 and 2, Brine Tanks 1 and 2, and Lara Dam).
- Rainfall and evaporation – based on SILO Data Drill historical rainfall data, Morton's lake and wet evaporation data and dam surface area.
- Dust suppression – based on 0.1 ML/d which is reduced by 50% if a daily rain event of 5-10 mm occurs and by 100% if a daily rain event of >10 mm occurs.
- Irrigation use – based on irrigation rates of 6 ML/yr/ha for an irrigation area of 105 ha (i.e., centre pivots 1 to 4) which is also reduced by 50% if a daily rain event of 5-10 mm occurs and by 100% if a daily rain event of >10 mm occurs.

The water balance model uses a probabilistic simulation approach where long term daily climate data for the region from 1889 to 2021, is disaggregated into 130 continuous climate sequences over the ATP 2059 lifetime (31 years) (i.e., sequence 1 (S1): 1889 – 1919 inclusive, S2: 1890 – 1920, S3: 1891 – 1921.S103: 1991 – 2021). This results in 103 distinct solutions for each time step within the 31-year simulation period, with statistics used to present the results in terms of exceedance percentiles. For example, P5 represents the 5th percentile of non-exceedance where there is a 5% chance of water volumes being less because of dry climate conditions (or a 95% chance of volumes being greater), P50 represents the 50th or median percentile because of average climate conditions and P95 represents the 95th percentile non-exceedance where there is a 95% chance of water volumes being less because of wet climate conditions (or a 5% chance of volumes being greater). This monitors the resilience of the model under different climatic conditions.

The water balance model is based on a daily timestep and considers the changing volume over time in the aggregation dams, brine tanks and irrigation dam. Storage curves are referenced to determine the changing free water surface and corresponding daily evaporation rate, with Morton's lake evaporation rates from the wet surface areas, considered in each time step.

The water balance model provides a prediction of stored water volumes over time using the water production forecast and can be used to estimate the timing that additional storage or beneficial use applications may be required.

Senex does not propose to discharge to watercourses, however, should this disposal option be required in the future, Senex would pursue an amendment to the EA supported by the necessary site-specific studies to support the application.

Outcomes of the modelling, using 103 climate scenarios, are provided in Figure 4.3 to Figure 4.5 for the median and wet climate conditions (i.e., P50 and P90).

Results from water balance modelling conclude that to provide sufficient containment under the P95 climate scenario, augmentation of the existing PL 1037 water management infrastructure is recommended as follows:

- PL 1037 water production forecast:
  - Additional brine storage (online 2024 and required because the current PL 1037 water production forecast is expected to be larger than the water production forecast used in the original approval):
    - two additional brine tanks (i.e., four brine tanks in total) each with a FSV of 57 ML, MOV of 44 ML and a surface area of 1.65 ha; or
    - brine dam with a comparable storage volume and surface area.
- PL 1037 plus ATP 2059 water production forecast:
  - Increase WTF capacity up to 2.5 ML/day from 2024.
  - Additional brine storage (online 2024):
    - one additional brine tank (i.e., five brine tanks in total) with a FSV of 57 ML, MOV of 44 ML and surface area of 1.65 ha; or
    - brine dam with a comparable storage volume and surface area.
  - Increase irrigation area from Lara Dam from 105 ha up to 125 ha which includes the additional 20 ha associated with the future centre pivot 5 also from 2024 onwards.

Understanding of well performance will improve as ATP 2059 progresses, and more production data becomes available. It is important and highly recommended that the water balance modelling and proposed changes to the existing water management infrastructure on PL 1037 be updated as further production data becomes available and if the PL 1037 or ATP 2059 water production rates change.

Figure 4.2: ATP 2059 and PL 1037 Water Production Rates and Cumulative Volume

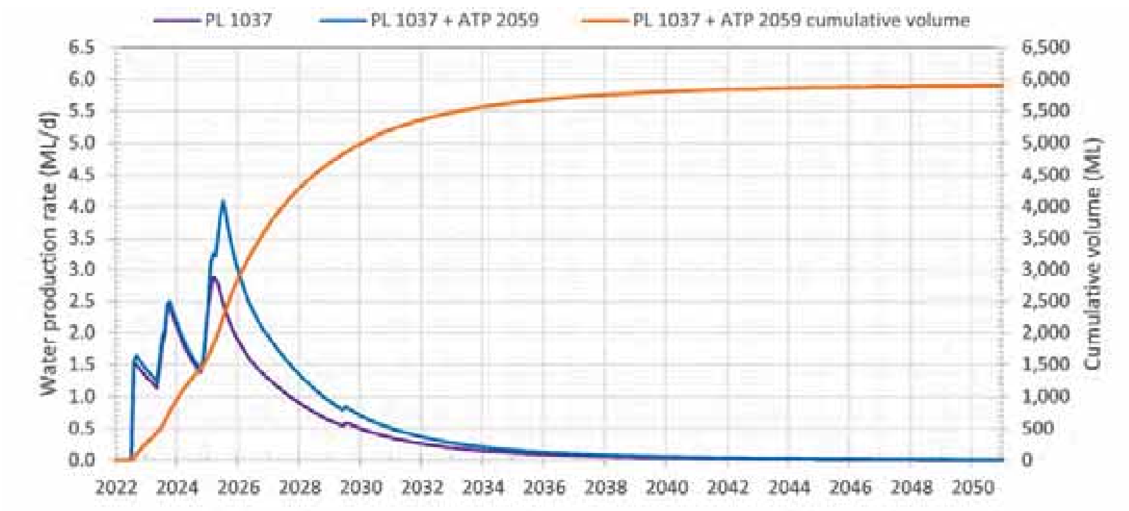


Figure 4.3: Water Balance Model Results – Atlas Dams 1 and 2 (P50 and P95)

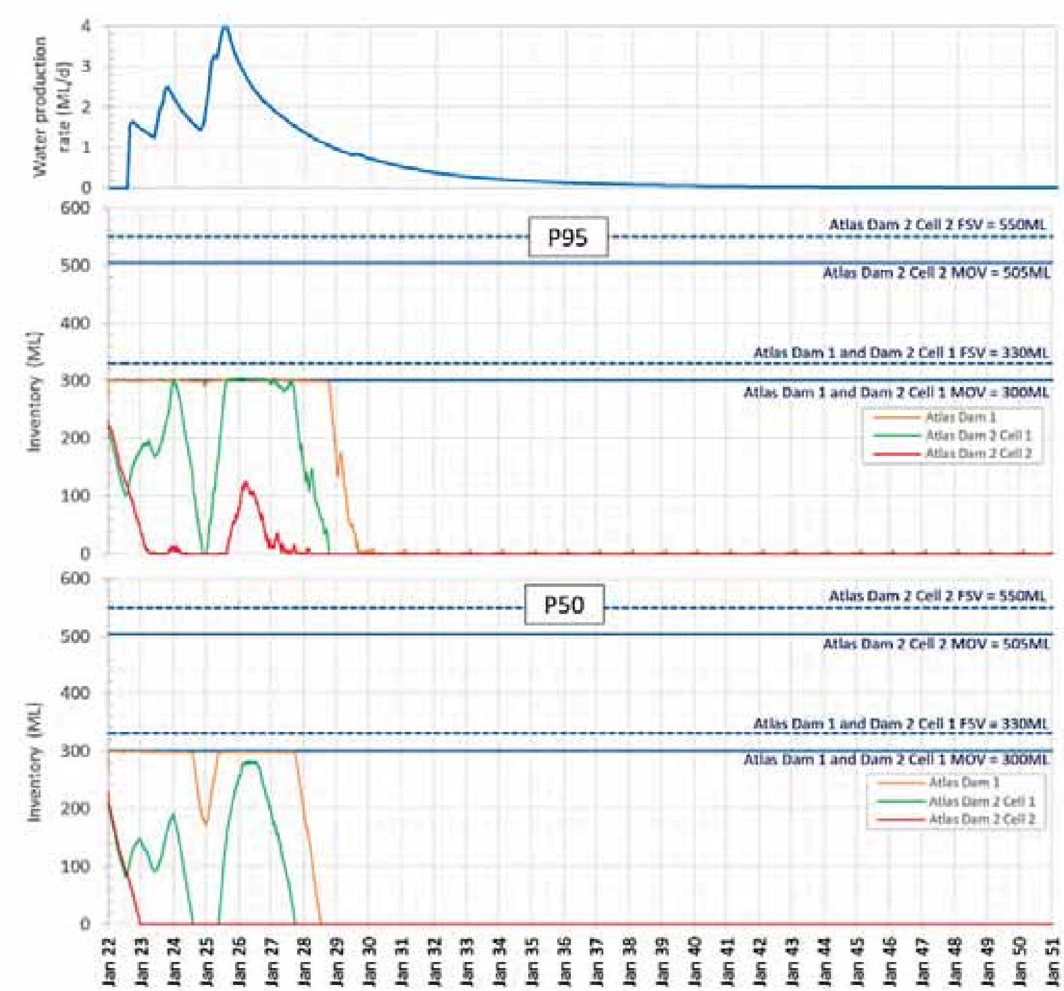


Figure 4.4: Water Balance Model Results – Brine Tanks (P50 and P95)

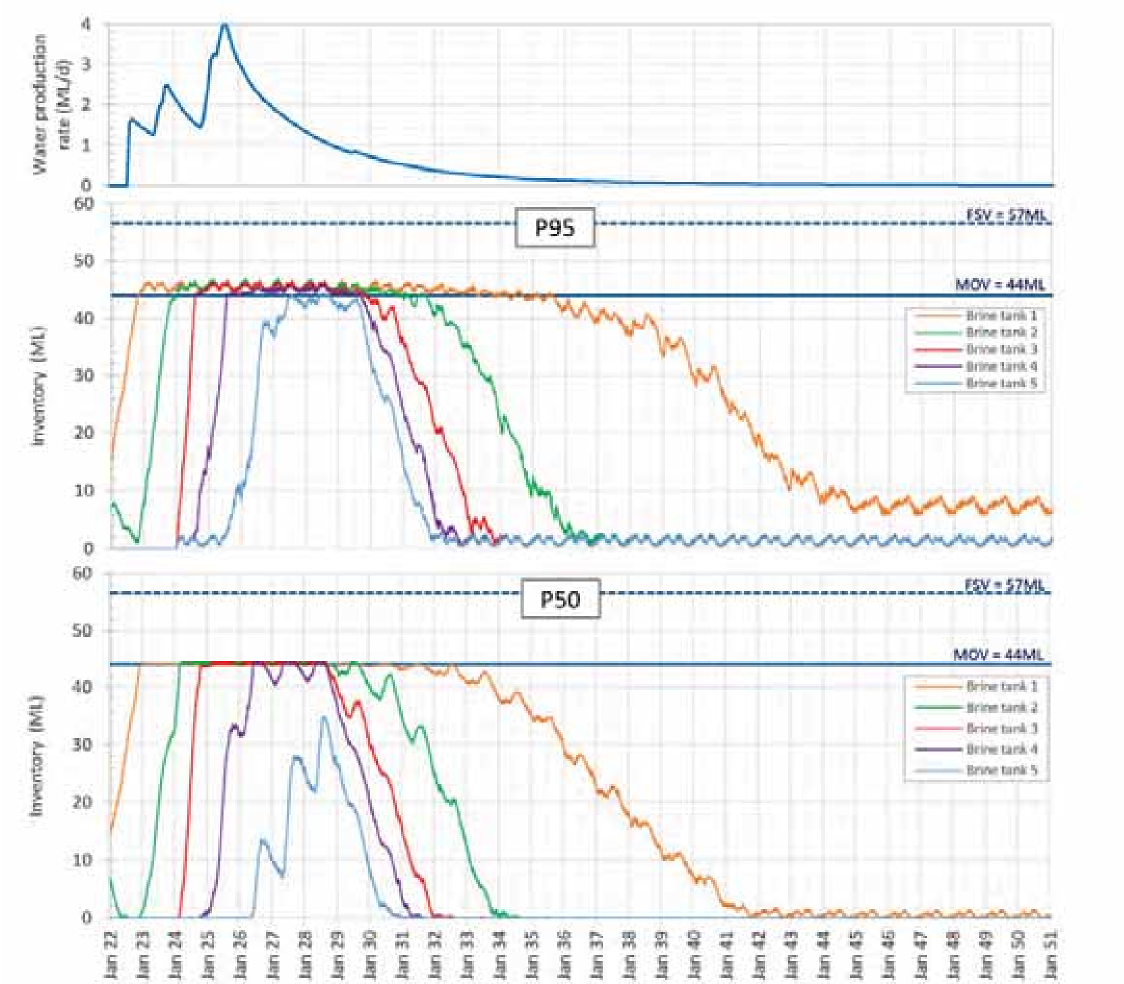
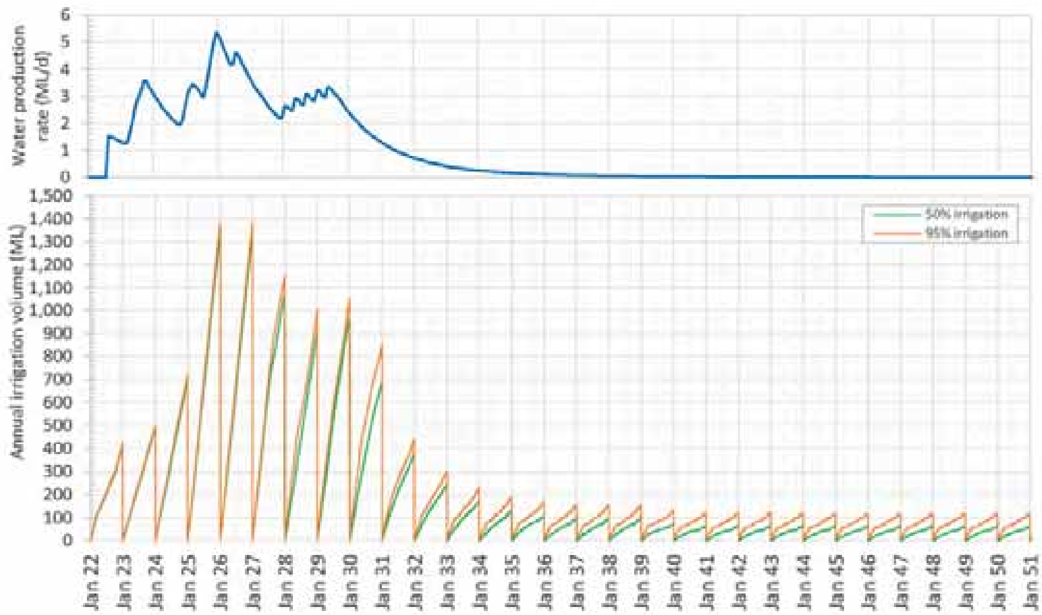


Figure 4.5: Water Balance Model Results – Beneficial Reuse (P50 and P95)



5. EXISTING ENVIRONMENT AND ENVIRONMENTAL VALUES

5.1. Climate

The climate of the Project area is classified as subtropical with no dry season, using the modified Köppen classification system (BoM 2005).

A summary of the climate statistics (sourced from the BoM) are detailed below for the climate station at Roma Airport[1] (43091), with rainfall statistics for Wandoan Post Office (35014):

- Mean maximum temperatures range between 34.6°C in the summer months and 20.4°C in the winter months. Mean minimum temperatures range between 20.1°C in the summer months and 3.8°C in the winter months.
- Daily evaporation rates are generally high and exceed rainfall throughout the year.
- In general, the highest rainfall occurs during December to February, with the lowest rainfall occurring during April to September.

5.2. Land

5.2.1 Topography and Drainage

Elevations across ATP 2059 range between 250 mAHD[2] and 290 mAHD. Topographic highs are located towards the northwest and southwest of ATP 2059. ATP 2059 is located within the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin.

5.2.2 Regional Geology

ATP 2059 overlies two distinct, but interconnected geological basins, the Permo-Triassic Bowen Basin and the Jurassic-Cretaceous Surat Basin. The Surat Basin occupies approximately 180,000 km^2 of southeast Queensland and is connected to the Eromanga Basin in the west, the Clarence-Moreton Basin in the east and Mulgildie Basin to the northeast (KCB 2016).

The Surat Basin comprises predominantly Jurassic to Cretaceous aged alternating sandstone, siltstone and mudstone layers. This sequence, at its maximum, is more than 2,500 m thick in the Mimosa Syncline to the west of ATP 2059. ATP 2059 targets the WCM; a thick sequence of siltstone, mudstone and fine-to-medium-grained sandstone that contains the main CSG producing coals in the Surat Basin. While the total thickness of the WCM can be up to 650 m, the average thickness of this unit is approximately 300 m and the total coal thickness is generally less than 30 m (OGIA 2016a).

5.2.3 Land Use

Land use within and surrounding ATP 2059 is predominantly focused on primary agricultural resources. Rural/agricultural production associated with cattle grazing and feed-lotting along

[1] Temperature and evaporation data not available for Wandoan Post Office climate station

[2] Metres above Australian Height Datum

with petroleum activities are the dominant land uses within the region. The majority of ATP 2059 is currently freehold.

The Juandah State Forest is located 1.7 km southwest of ATP 2059 in PL 1037, comprising an area of approximately 398 ha. In addition, the eastern extent of the Hinchley State Forest (25 ha) is located within the northern extent of the PL 1037, 2.5 km west of ATP 2059.

The Jackson Wandoan road, which is also a travelling stock route, passes through the ATP.

The tenure is surrounded by existing petroleum tenures held by Shell (QGC) and Australia Pacific LNG. There are a range of mining projects present in the greater region, which are at varying stages of development, as well as an exploration permit for greenhouse gas over the ATP.

Approximately 89% of the ATP is mapped as Strategic Cropping Area (SCA), an “area of regional interest” under the Regional Planning Interests Act 2014 (RPI Act). There are no other areas of regional interest located within the ATP. Senex will comply with the requirements of the RPI Act.

5.2.4 Environmentally Sensitive Areas

Within ATP 2059, there are Category B and C Environmentally Sensitive Areas (ESA) (DEHP 2016c) as summarised in *Table 5.1*.

Table 5.1: Environmentally Sensitive Areas within the Production Area

ESA Matter	Comment
Category B ESA that are ‘endangered’ regional ecosystems – regrowth and remnant (Biodiversity Status)	There are areas of remnant and regrowth vegetation that are endangered regional ecosystem (biodiversity status) within the ATP.
Category C ESA that are ‘of concern’ regional ecosystems	There are ‘of concern’ regional ecosystems (biodiversity status) within the ATP. The majority of ‘of concern’ regional ecosystems are associated with riparian areas.

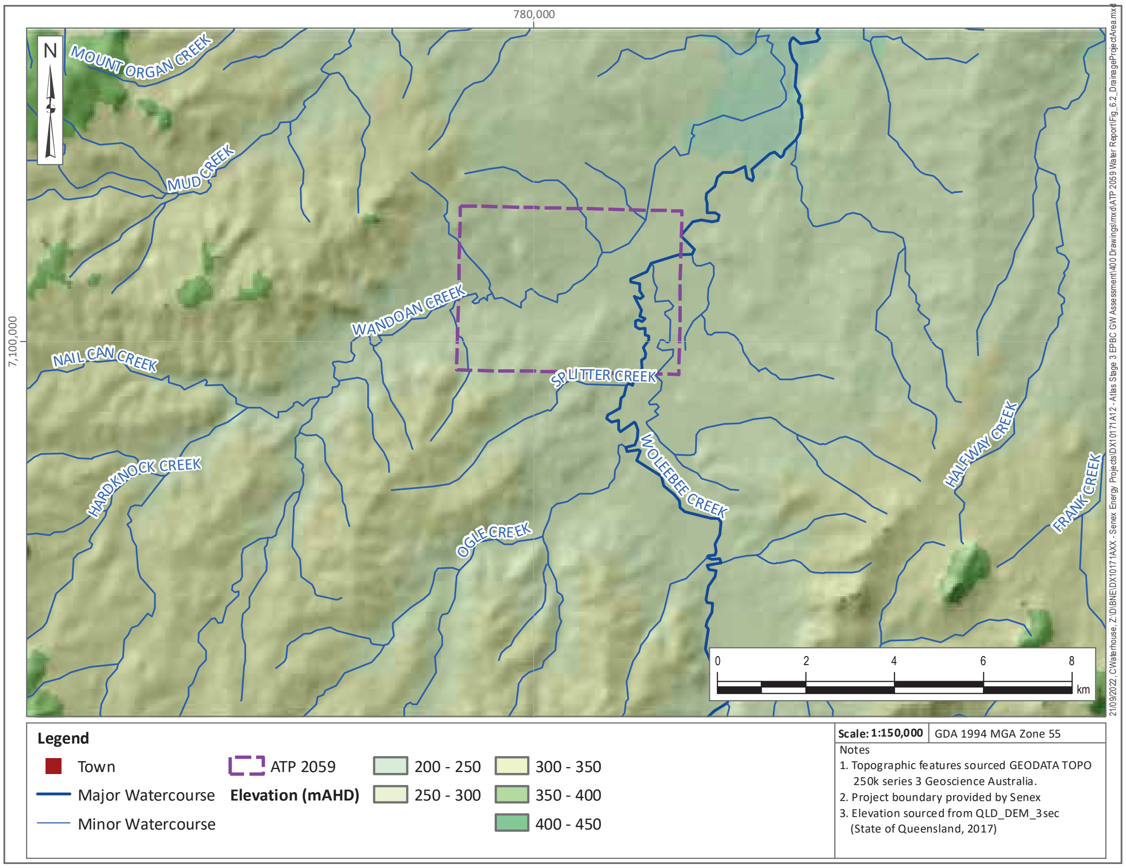
5.3. Surface Water

ATP 2059 is located within the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin. Key watercourses within the vicinity of ATP 2059 include Wandoan Creek, which flows northeast from its headwaters flanking the south-eastern boundary of ATP 2059 to join Woleebee Creek off-lease to the northeast (Figure 5.1). Woleebee Creek flows north along the eastern boundary of ATP 2059.

The watercourses across ATP 2059 are characteristically ephemeral and typically flow only during significant runoff events, likely due to being located in higher reaches of the catchments with limited runoff area. Watercourses within ATP 2059 are classified as Stream Orders 1 to 5 using the Strahler method, with the majority being Stream Order 1 (minor streams) (State of Queensland 2021a). Woleebee Creek is Stream Order 5.

Catchments within the Upper Dawson River sub-basin are influenced by anthropogenic activities including land use, riparian management, water infrastructure and point source releases.

Figure 5.1: Drainage within ATP 2059



5.3.1 Aquatic Ecology

Aquatic ecology identified in ATP 2059 was associated with a series of disconnected remnant pools. The aquatic species associated with these pools are common and widespread in central Queensland streams. The aquatic ecosystems in the area are impacted by grazing and cropping land uses with disturbed riparian areas and elevated sediment and nutrient inputs. However, the aquatic habitat in ATP 2059 has local value on a tributary scale, with persistent waterholes providing important refugia for aquatic fauna and flora during dry conditions. These refugia are sensitive to impacts, given the inability for biota to move to better conditions during dry periods, but they already experience high levels of suspended sediments and nutrient inputs from existing land uses.

5.4. Hydrogeology

ATP 2059 is located within the geographical extent of the Surat Basin, a basin of Jurassic-Cretaceous age, which is underlain by the Permo-Triassic Bowen Basin. Cenozoic-age formations are present overlying the Surat Basin formations. The surface geology within the vicinity of ATP 2059 is shown in Figure 5.2.

The Surat Basin forms part of the Great Artesian Basin (GAB), which is comprised of several aquifers and confining aquitards. Aquifers of the Surat Basin are a significant source for water used for stock, public water and domestic supply. The hydrostratigraphy of the Surat and Bowen Basin (OGIA 2021a) are shown in Figure 5.3.

The main aquifers within the GAB, from the deepest to the shallowest, are the Precipice Sandstone, Hutton Sandstone, Springbok Sandstone, Gubberamunda Sandstone, Mooga Sandstone and Bungil Formation. These aquifers are typically laterally continuous, have significant water storage, are permeable and are extensively developed for water supply. However, in some areas, they have more of the character of aquitards than aquifers (OGIA 2016b). The major aquitards are the Evergreen Formation, Eurombah Formation, Westbourne Formation, Surat Siltstone and Griman Creek Formation (Figure 5.3). WCM is the target formation for CSG production for ATP 2059.

ATP 2059 is situated in an area where the Gubberamunda Sandstone and Westbourne Formation outcrop. The WCM outcrop is mapped as occurring ~17 km north of ATP 2059.

North-south and west-east oriented cross sections are presented in Figure 5.4: Geological Cross Sections (Surat CMA Geological Model (OGIA 2021a)), with the section locations provided on Figure 5.2. These sections show the hydrostratigraphic units dipping towards the south from the outcrop. Generally, all units are laterally extensive and continuous across the Project area.

Quaternary-age alluvium has been mapped as occurring within ATP 2059 and is associated with Wandoan, Woleebee and Woleebee Creeks as shown Figure 5.2. The alluvium generally occurs as narrow bands bounding the creeks and increases in lateral extent towards the northeast of ATP 2059 as Wandoan Creek flows into Woleebee Creek.

Figure 5.2: Regional Surface Geology Map

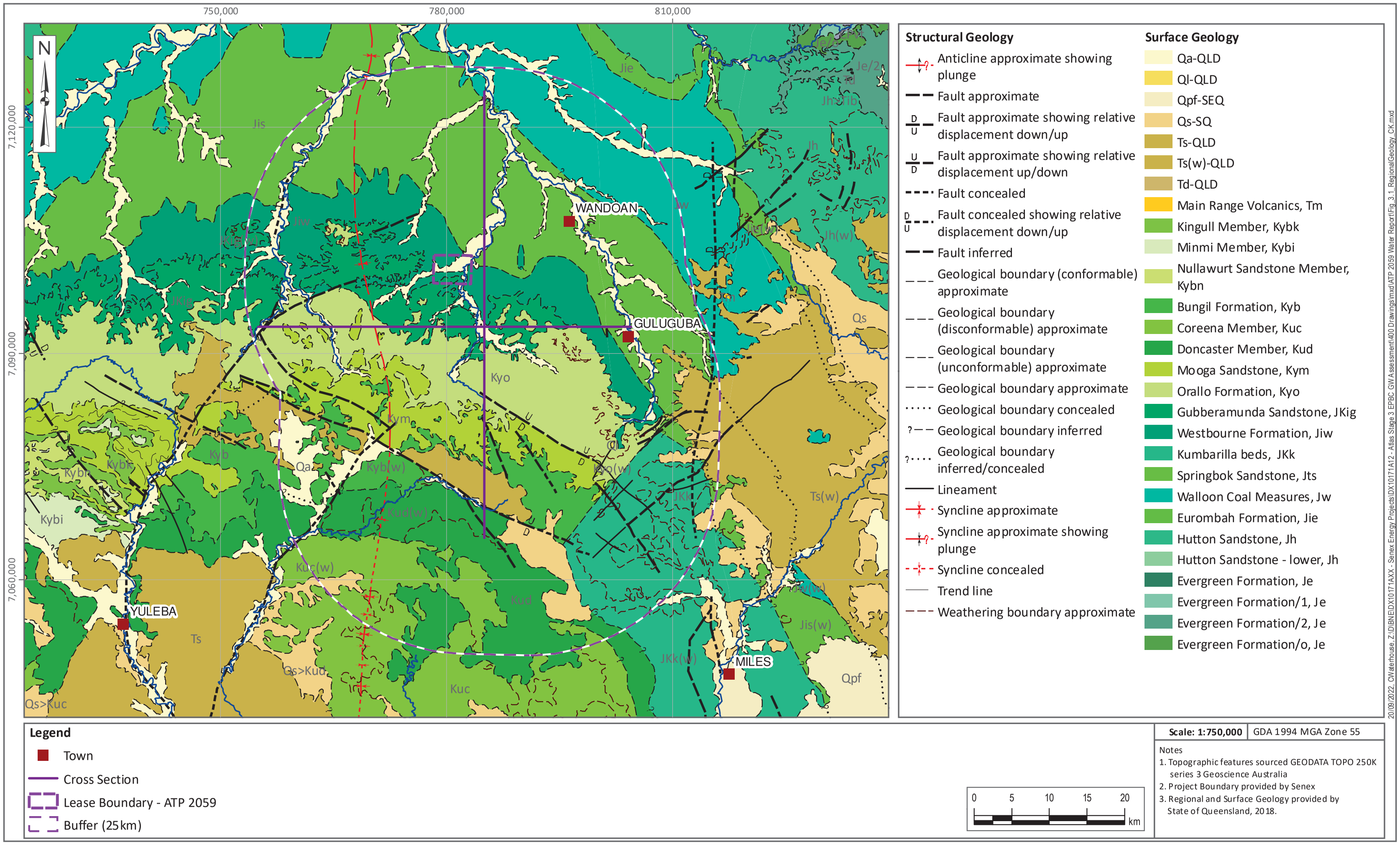


Figure 5.3: Regional Hydrostratigraphy (OGIA 2021a) with Relevant Hydrostratigraphic Units Indicated

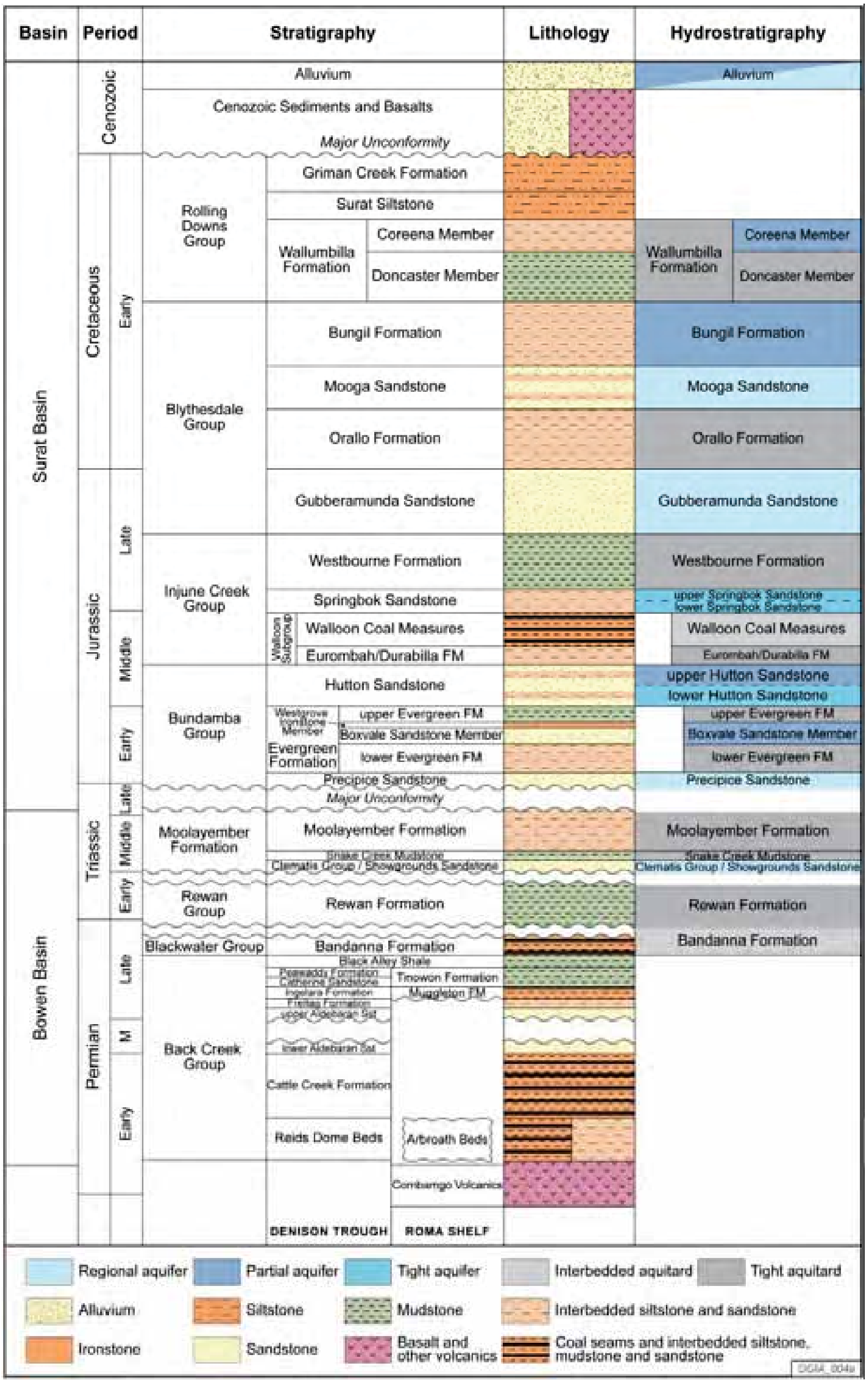
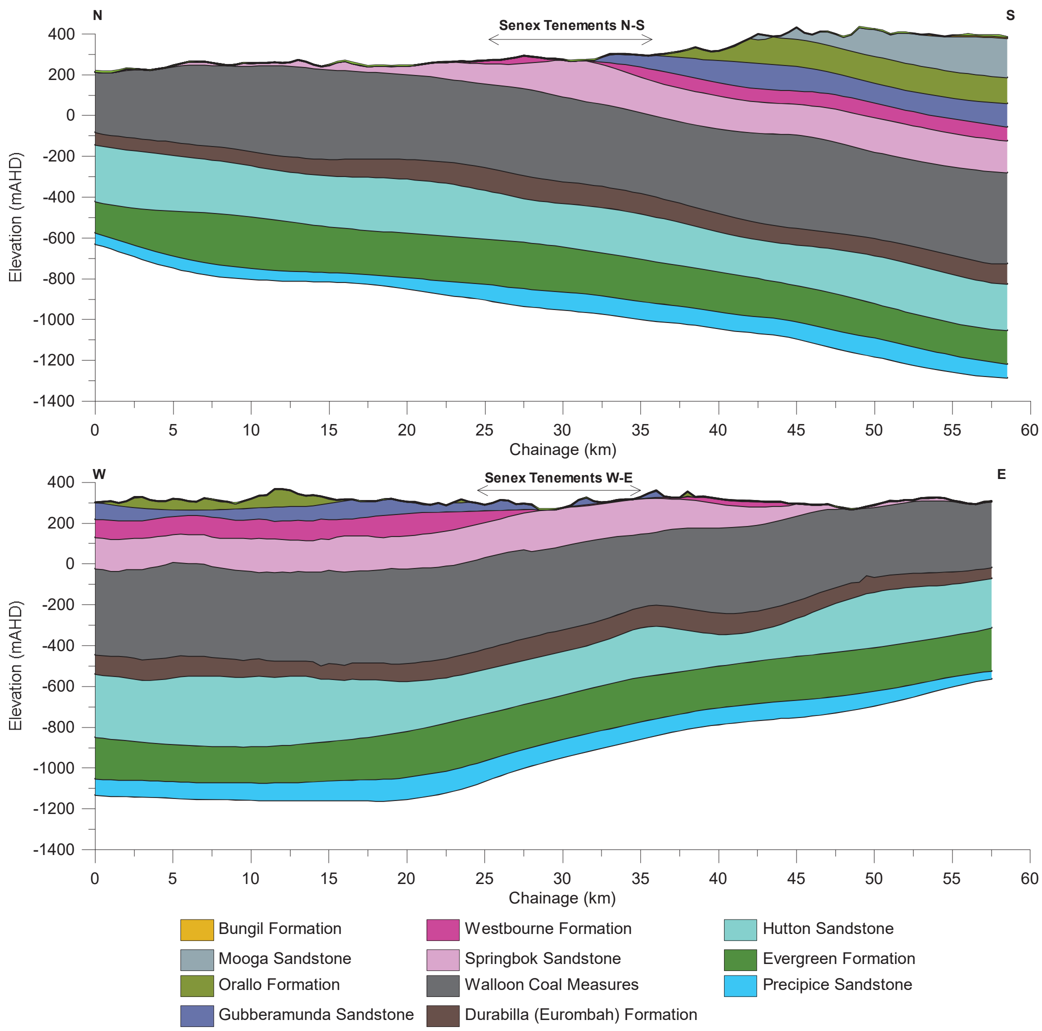


Figure 5.4: Geological Cross Sections (Surat CMA Geological Model (OGIA 2021a))



5.4.1 Groundwater Quality

Table 5.2 presents a summary of the regional groundwater chemistry associated with each hydrostratigraphic unit occurring within the ATP 2059 area from OGIA (2016c). Generally, Total Dissolved Solids (TDS) is used as an indicator of salinity and displays a broad range across the Basin.

Table 5.2: Summary of Regional Groundwater Chemistry for Each Hydrostratigraphic Unit

Hydrostratigraphic Unit	OGIA (2016a) Description
Orallo Formation	Fresh to saline conditions with TDS ranging from 75 to 20,000 mg/L, mean of 1,700 mg/L.
Gubberamunda Sandstone	Fresh to brackish water. Mean TDS of 450 mg/L with a range of between 70 and 7,500 mg/L. Mean TDS ranges between 480 to 1,160 mg/L, depending on location category.
Westbourne Formation	Characterised by fresh to saline groundwater (TDS mean of 1,500 mg/L), ranging from 150 to 19,000 mg/L.

Hydrostratigraphic Unit	**OGIA** (2016a) **Description**
Springbok Sandstone	Fresh to brackish water quality, with a mean TDS of 1,000 mg/L (ranging between 200 and 7,000 mg/L).
WCM	Fresh to saline groundwater, TDS ranges from 30 to 18,000 mg/L, with a mean TDS of around 3,000 mg/L.
Hutton Sandstone	TDS ranges from 70 to 16,000 mg/L, with a mean TDS of around 1,600 mg/L, low salinity calcium and magnesium bicarbonate type water in the recharge areas, to a relatively high-salinity sodium-chloride type water in discharge areas.
Evergreen Formation	Low salinity (TDS) and concentrations of sodium and chloride, TDS ranges from 80 to 670 mg/L, with a mean TDS of around 260 mg/L.
Precipice Sandstone	Precipice Sandstone has the freshest groundwater in the Surat CMA, salinity ranges from 50 to 850 mg/L with a mean salinity (TDS) of 193 mg/L.

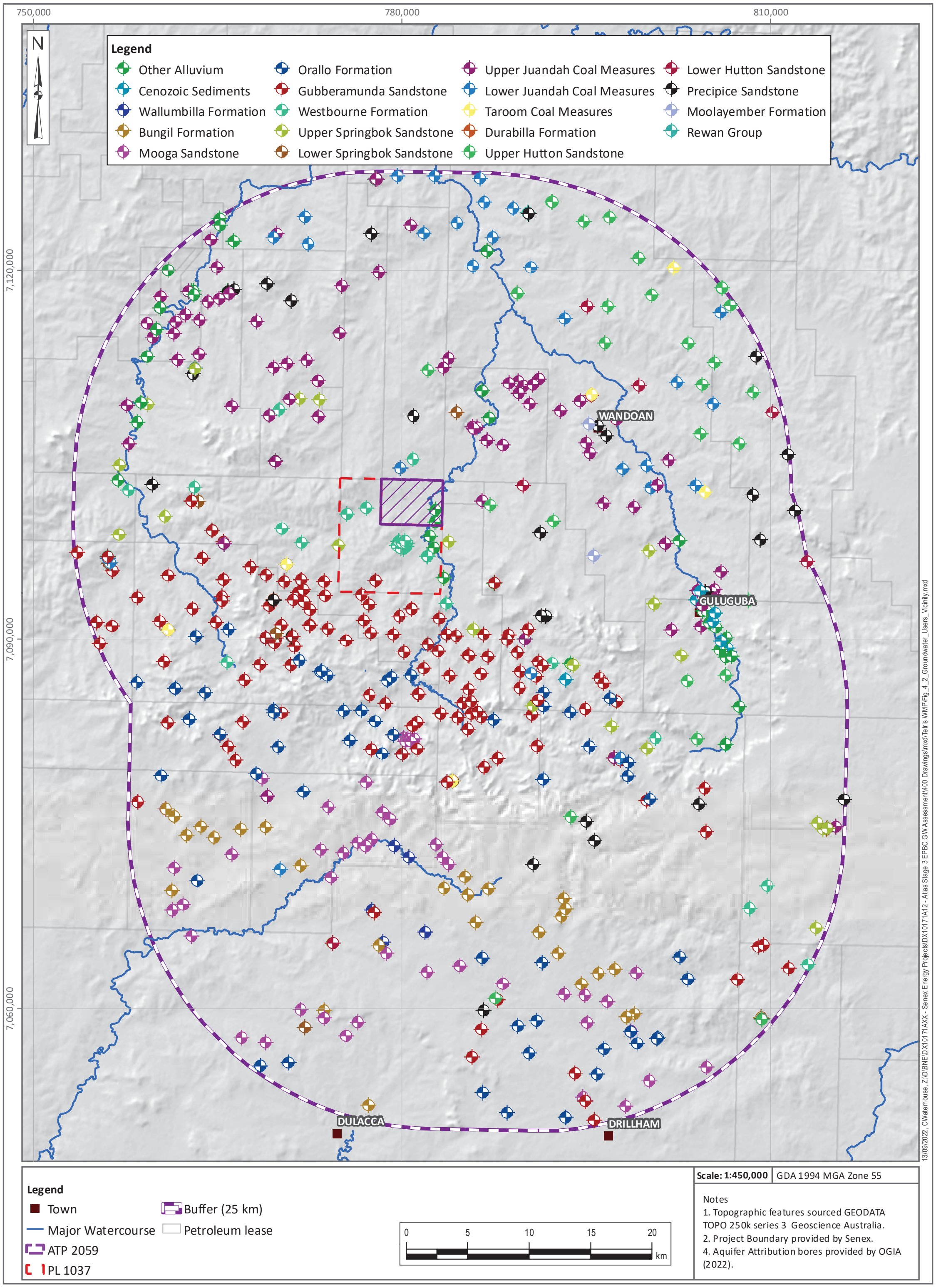
5.4.2 Groundwater Use

Groundwater occurring within the vicinity of ATP 2059 is associated with aquifers of the Surat Basin, which forms part of the GAB. Groundwater is used within the vicinity of the Project site for stock and domestic, agriculture and town water supply purposes.

Groundwater in the GAB is managed within the *Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017* (State of Queensland 2017), under the Water Act 2000.

There are 410 registered third-party groundwater bores that have been identified (within a 25 km radius of ATP 2059) as being used for water supply purposes (OGIA 2022). The location of all existing registered bores is shown on Figure 5.5.

Figure 5.5: Location of Groundwater Users within the Vicinity of ATP 2059



5.4.3 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are defined by Department of Environment and Energy (DoEE) (2015) as:

‘Natural ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (Richardson et al. 2011). The broad types of GDE are (Eamus et al. 2006):

- ecosystems dependent on surface expression of groundwater,
- ecosystems dependent on subsurface presence of groundwater,
- subterranean ecosystems.’

Potential surface expression GDEs and subsurface GDEs are mapped by DES (2018) as potentially being present in the vicinity of ATP 2059 (Figure 5.6). These generally correspond with the location of the mapped alluvium associated with Wandoan and Woleebee Creeks within the ATP 2059 area and Horse Creek and Juandah Creek further afield.

There is one watercourse spring within the ATP 2059 area associated with Wandoan and Woleebee Creeks. These watercourse springs are identified as being associated with the alluvium. These are noted as springs of interest but not currently affected or listed as a mitigation site (OGIA 2021b).

Table 5.3: UWIR Watercourse Spring Details

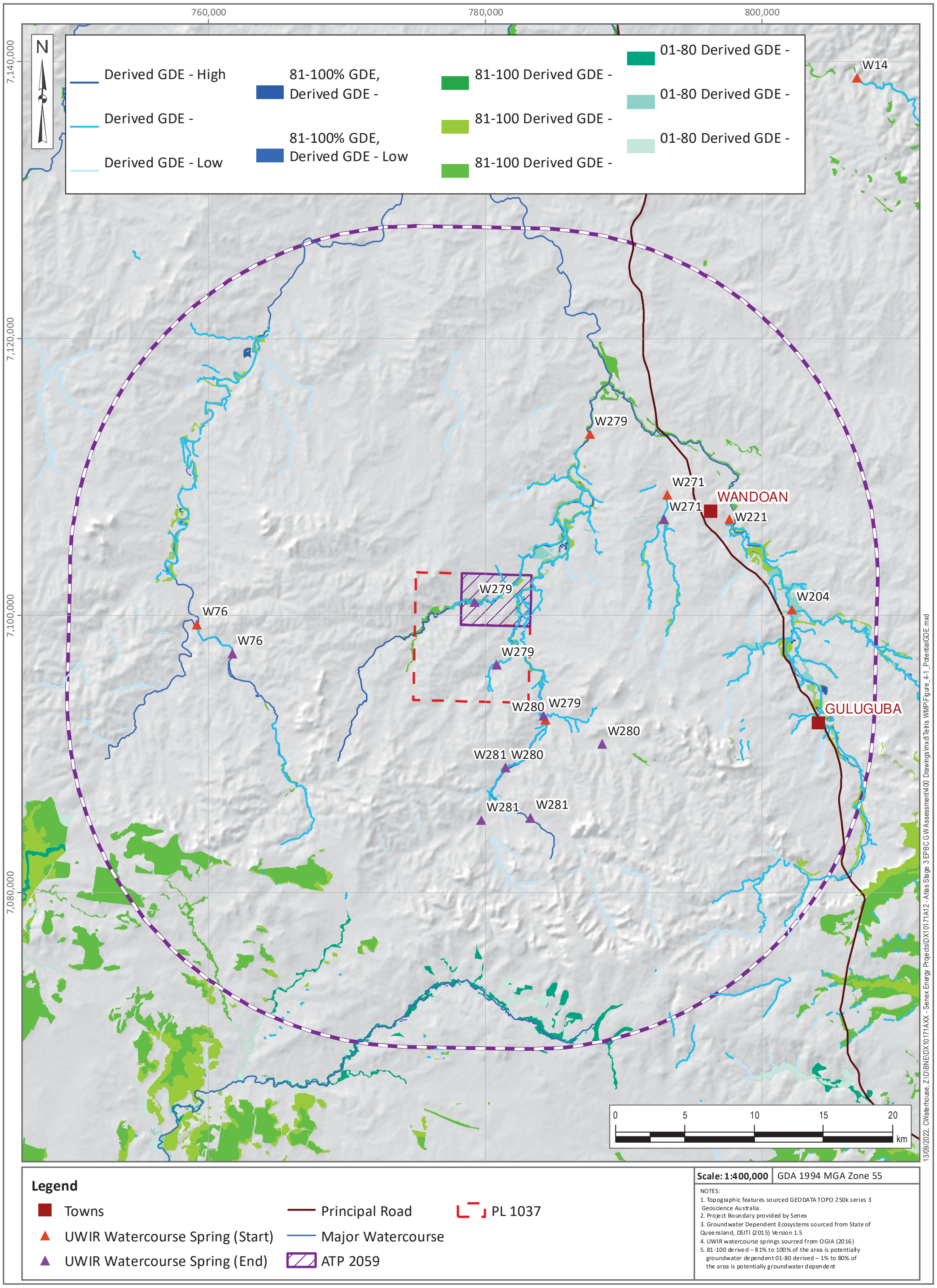
Site Number	Name	Source Aquifer
W279	Woleebee Creek	Allluvium

A report published by OGIA in 2017 re-maps potential gaining streams (or baseflow-fed reaches, watercourse springs) within the Surat CMA (OGIA 2017a). This report identified sections of Woleebee Creek, Horse Creek and Juandah Creek as potentially gaining streams.

Reaches of Woleebee Creek within the ATP 2059 area were assessed during the Senex field verification program in June/July 2018 (KCB 2018). The assessment was conducted during the dry season and no flow was observed within the area surveyed. Pools of water were encountered in the lower reaches of Woleebee Creek which were considered to be rainfall derived surface water, based on their non-clear appearance and field water quality (547 µS/cm). The field verification identified that there is unlikely to be significant baseflow provided to this creek, however it is likely that during some periods, groundwater levels in the alluvium will rise into the sandy base of the creek. The field verification also concluded that based on the difference between the alluvial groundwater and surface water major ion chemistry signatures, and groundwater chemistry signatures from the Surat Basin units, groundwater within the alluvium is not considered to be sourced from the underlying Surat Basin unit (Westbourne Formation).

Terrestrial GDEs mapped in the vicinity of ATP 2059 (DES 2018) are also considered to source groundwater from the shallow alluvium, rather than the underlying Surat Basin units.

Figure 5.6: Location of UWIR Watercourse Springs and Mapped Potential GDEs



5.5. Environmental Values and Water Quality Objectives

5.5.1 Environmental Values – Water

The EP Act 1994 (State of Queensland 2020b) defines an EV as:

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

As detailed in Section 0, the EP Act, the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019b) was established as subordinate legislation to achieve the object of the Act in relation to Queensland Waters. The purpose of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* is achieved by:

- Identifying EVs and management goals for Queensland waters; and
- Stating water quality guidelines and WQOs to enhance or protect the EVs; and
- Providing a framework for making consistent, equitable and informed decisions about Queensland waters; and
- Monitoring and reporting on the condition of Queensland waters.

The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019b) provides defined EVs and WQOs for the Dawson River sub-basin under Schedule 1 of the policy (State of Queensland 2013a). EVs for the Upper Dawson are presented in Table 5.4 and includes both the values for surface water and groundwater. The WQ1308 plan (State of Queensland 2013b) that accompanies the policy indicates that the ATP 2059 area is located on the southern tributaries of the Upper Dawson (Taroom area).

Table 5.4: EVs for the Dawson River Sub-Basin waters within the vicinity of ATP 2059 (State of Queensland 2013a)

Water	Environmental Values											
	Aquatic Ecosystem	Irrigation	Farm Supply / Use	Stock Water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Upper Dawson—Taroom area (WQ1308)												
Southern tributaries—developed areas	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Groundwater	✓	✓	✓	✓			✓		✓	✓	✓	✓
Undeveloped areas	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓

✓ denotes the EV is selected for protection. Blank indicates that the EV is not chosen for protection.

5.5.1.1. Water Quality Objectives

WQOs for groundwater are provided to protect EVs (State of Queensland 2013a). A summary of the WQOs for groundwater in the Upper Dawson are provided below:

- WQOs for aquatic ecosystems applicable to groundwater where groundwater interacts with surface water, the groundwater quality should not compromise identified EVs and WQOs for those waters.

- For drinking water, local WQOs exist which relate to before and after water treatment and are based on a number of guidelines / legislation including the Australian Drinking Water Guidelines (NHMRC 2021).

- WQOs to protect or restore indigenous and non-indigenous cultural heritage should be consistent with relevant policies and plans.

- For irrigation, WQOs exist for metals, pathogens and other indicators in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).

- For stock watering, objectives exist for faecal coliforms, total dissolved solids, metals, and other objectives based on guidelines presented in ANZG (2018).

- For farm use / supply, objectives are as per the guidelines in ANZG (2018).

WQOs for surface water are also provided to protect EVs (State of Queensland 2013a). A summary of the relevant WQOs for surface water in the Upper Dawson are provided below:

- Where the aquatic ecosystem has high ecological value the WQO is to maintain the existing water quality, habitat, biota, flow and riparian areas.

- For the upper Dawson River sub-basin waters and main trunk the aquatic ecosystem is described as moderately disturbed and specific water quality guidelines have been produced (Table 2 of State of Queensland 2013).

- For the protection for human consumption, objectives as per the Australian drinking water guidelines (ADWG, 2011) (NHMRC 2021)and Australia New Zealand Food Standards Code (Commonwealth of Australia 2017).

- For suitability for industrial use there are no WQOs as water quality requirements vary within the industry.

- For secondary contact and visual recreation, objectives as per NHMRC (2021).

- For drinking water, local WQOs exist which relate to before and after water treatment and are based on a number of guidelines / legislation including the ADWG (NHMRC 2021).

- WQOs to protect or restore indigenous and non-indigenous cultural heritage should be consistent with relevant policies and plans.

- For irrigation, WQOs exist for metals, pathogens and other indicators in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).

- For stock watering, objectives exist for faecal coliforms, total dissolved solids, metals, and other objectives based on guidelines presented in ANZG (2018).

- For farm use / supply, objectives are as per the guidelines in ANZG (2018).

- For primary contact recreation objectives as per NHMRC (2021) and for fresh water objectives exist for cynobacteria / algae.

5.5.2 Environmental Values – Other

There are no declared EVs relating to land for ATP 2059. The EVs of the land, relevant to CSG water management within the ATP 2059 area to be protected or enhanced are:

- integrity of undisturbed land and ecosystems within the ATP 2059 area;
- integrity of the topsoil as a resource to be used in rehabilitation;
- stability of disturbed land and ensuring it is non-polluting;
- integrity of soil stability and structure for erosion protection;
- suitability of the land for continued agricultural use post-closure;
- integrity of regional ecosystem communities and the habitat values they provide within the ATP 2059 area;
- integrity of habitat for endangered, vulnerable, near threatened and special least concern species;
- integrity of Category B and C ESAs; and
- integrity of movement corridors provided by riparian zone vegetation.

6. MANAGEMENT, COMPLIANCE AND MONITORING

6.1. Management and Compliance

Senex will implement all produced water and brine management strategies in accordance with the applicable EA conditions and in a manner that ensures protection and maintenance of all relevant EVs.

The EP Act 1994 requires that a site-specific application for a CSG activity must include measurable criteria (termed 'management criteria'), against which the applicant will monitor and assess the effectiveness of the management of all produced water and saline waste associated with the activity. Senex has developed criteria that addresses this requirement (the criteria has been developed following guidance outlined in the DES factsheet 'CSG water management: Measurable criteria' (DES 2013).

The management criteria addresses:

- The quantity and quality of the water:
    - Used;
    - Treated;
    - Stored; or
    - Disposed of.
- Protection of EVs affected by each relevant CSG activity; and
- The disposal of waste generated from the management of water.

Table 6.1: ATP 2059 Water Management Criteria

Objective	Environmental Values	Tasks	Performance Indicator
No unauthorised disturbance of ESAs due to CSG water management activities	▪ Land ▪ Surface water	Secure disturbance approvals by implementing the 'Environmental Management Plan' (SENEX-ATLAS-EN-PLN-001) and Environmental Constraints Protocol for Planning and Field Development' (SENEX-QLDS-EN-PRC-019). Finalise infrastructure locations to identify area and location of disturbances. Comply with EA conditions related to disturbance, biodiversity values and ESAs.	Site-specific Ecology Assessment Reports Site-specific Desktop Constraints Reports Compliance with extent of approved disturbance
No unauthorised releases to the environment from the gathering network	▪ Groundwater ▪ Surface water	Select gathering routes by implementing the 'Environmental Constraints Protocol for Planning and Field Development' (SENEX-QLDS-EN-PRC-019). Implement the Environmental Management Plan' (SENEX-ATLAS-EN-PLN-001) Develop and implement operation and maintenance plans for gathering networks. Ensure plans includes: ▪ Operational procedures for infrastructure associated with isolation, leakage detection and venting / draining for the CSG production wellhead and gathering network; and ▪ Monitoring procedure for wellhead and gathering network infrastructure. Implement Senex Incident Reporting and Investigation Procedures.	Recorded volume of unauthorised leaks / spills Recorded number of incidents and associated investigations

Objective	Environmental Values	Tasks	Performance Indicator
No unauthorised releases to the environment from non-regulated structures storing CSG water	▪ Groundwater ▪ Surface water	Tanks – construction and maintenance in accordance with EA conditions; install remote monitoring equipment for water levels; and implement leak detection monitoring and site inspections. Ponds – implement site inspection / leak detection monitoring program in accordance with EA requirements (surface water and groundwater seepage). Implement Senex Incident Reporting and Investigation Procedures.	Recorded volume of unauthorised leaks / spills Recorded detection of unauthorised leaks (i.e., groundwater level rise, groundwater quality changes) Recorded number of incidents and associated investigations
No unauthorised releases to the environment from regulated structures storing CSG water	▪ Surface water ▪ Groundwater	Design, construct and operate all regulated structures in accordance with the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES 2016a). Develop and maintain a regulated structure register. Develop and implement a monitoring program to assess structure integrity and groundwater seepage. Develop and implement a rehabilitation plan for specific regulated structures, including, if required, a brine and salt management plan. Undertake assessment and reporting in accordance with EA requirements.	Recorded volume of unauthorised releases from regulated structure Compliance with requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES 2016) Recorded detection of unauthorised leaks (i.e., groundwater level rise, groundwater quality changes) Recorded number of incidents and associated investigations

Objective	Environmental Values	Tasks	Performance Indicator
Maximise the beneficial use of CSG water	▪ Groundwater ▪ Surface water ▪ Land	Maintain the analytical reservoir model to predict the quantity and quality of water over the duration of ATP 2059 development. Develop and maintain a project water balance model to optimise the size of water management infrastructure and predict changes in water quality to support the water management strategy. Prioritise water use in accordance with the hierarchy defined in the *CSG Water Management Policy* (DEHP 2012). Develop and implement a Water Quality Monitoring Program to confirm if water is fit for beneficial use. Determine requirement for a WTF.	Proportion of untreated CSG water beneficially used. Proportion of treated CSG water beneficially used. Monitoring data which are within the appropriate guidelines for relevant water quality objectives for the designated beneficial use.
Optimise CSG water and brine management	▪ Groundwater ▪ Surface water	Maintain the analytical reservoir model to predict the quantity and quality of water over the duration of ATP 2059 development. Develop and maintain a project water balance model to optimise the size of water management infrastructure and predict changes in water quality to support the water management strategy. Continue to investigate opportunities for CSG water and brine management and prioritise these options in accordance with the *CSG Water Management Policy* (DEHP 2012). Undertake ongoing assessments of optimisation options for CSG water and brine management.	Results from the project water balance identifying the preferred CSG water and brine management options.

6.2. Monitoring

6.2.1 CSG Water and Treated CSG Water Quality Monitoring

Untreated produced water quality will be monitored on a quarterly frequency. The water quality data will be used to:

- Inform the WTF operation; and
- Ensure the water quality is suitable for the designated beneficial use and in accordance water quality objectives in the *End of Waste Code Associated Water (including coal seam gas water)* (DES 2019a), and the *End of Waste Code Irrigation of Associated Water (including coal seam gas water)* (DES 2019b), and conditions provided in the 'Streamlined Model Conditions for Petroleum Activities' (DES 2016b) that are aligned with the beneficial use of produced water.

Treated produced water quality will be monitored on a weekly frequency. The water quality data will be used to:

- Ensure the water quality is suitable for the designated beneficial use or water supply arrangement and in accordance water quality objectives in the End of Waste (EOW) codes (as noted above); and
- Confirm the water treatment method is effectively treating the CSG water.

6.2.2 Water Storage Monitoring

Senex will undertake inspections and monitoring associated with the water storage dams and tanks to assess integrity of the structures and monitor any potential impacts to EVs. The monitoring requirements are provided in Table 6.2. Event-based monitoring will also be undertaken as and when required.

Table 6.2: Water Storage Monitoring Requirements

Activity	Frequency	Reporting
Monitoring and Inspections		
Seepage monitoring program and water quality	Water and quality levels – quarterly.	Any evidence of seepage reported in accordance with EA conditions.
Regulated structure water quality monitoring	Annually	Provided to DES in accordance with relevant EA conditions and Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DES 2016a).
Dam embankments and spillways inspection	Annually	Any evidence of deterioration reported in accordance with relevant EA conditions.
Dam compliance inspection	Annual inspection checking dam status, defects, and unsafe conditions, with a comprehensive inspection every five years. The comprehensive	Inspection report submitted to DES in accordance with relevant EA conditions.

Activity	Frequency	Reporting
	inspection covers the annual inspection requirements and a full operational check of all equipment, surveillance data, function check and maintenance inspection.	
Documentation		
Regulated structure register	Completed as dams are constructed	Regulated structure register

6.2.3 Groundwater Monitoring

6.2.3.1. Seepage Monitoring Program (Shallow Groundwater)

Installation and monitoring of shallow groundwater bores surrounding water storage dams will be undertaken to monitor for dam seepage in accordance with the relevant EA conditions, and *'Streamlined Model Conditions for Petroleum Activities'* (DES 2016b). This will be conducted in conjunction with monitoring the water quality within the water storage pond. The seepage monitoring program will:

- Be undertaken by a suitably qualified person, and in accordance with 'Groundwater Sampling and Analysis – A Field Guide' (Sundaram et al. 2009) and the 'Monitoring and Sampling Manual: Environmental Protection (Water) Policy (DES 2018);
- Be undertaken on a quarterly basis;
- Ensure all water quality samples are analysed / tested at a laboratory with NATA accreditation;
- Identify water quality associated with the water stored within the dam;
- Identify the background groundwater quality in the vicinity of the dam as a reference site;
- Provide information to develop trigger levels and detection limits associated with dam seepage; and
- Be documented and updated should new containment facilities be constructed.

There are ten existing shallow groundwater monitoring bores present surrounding the water storage dam on PL 1037 monitoring the underlying Westbourne Formation. Monitoring programs will also be developed for other project activities, such as additional water storages, where required.

6.2.3.2. Regional (Deep) Groundwater Monitoring

Regional groundwater monitoring in relation to CSG water production is undertaken through the Surat CMA UWIR Water Management Strategy, however this is outside the scope of this CWMP in relation to the management of CSG water.

6.2.4 Land and Soils Monitoring

Senex will undertake land and soil monitoring where CSG water management activities have the potential to significantly impact on EVs.

6.3. Corrective Action

Senex is committed to maintaining compliance with management criteria. However, should any incidents or non-compliance of the management criteria occur, Senex will investigate and report on the non-compliance. Findings and recommendations will be adopted to assist with future compliance and enable continual improvement in water management and environmental performance.

6.4. Reporting

6.4.1 Monitoring Results

An annual review of the monitoring undertaken in accordance with the CWMP and EA conditions will be completed.

Water quality results will be reviewed following sampling events against the relevant water quality guidelines and EA conditions and, where required, reported to the appropriate administering authority.

6.4.2 Reviews

A review and update of the CWMP will be periodically undertaken to capture changes to the project description that influences the management of CSG water and / or optimisation of the CSG water and brine management.

7. REFERENCES

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Appendix D: Draft Environmental Authority Conditions

Streamlined Condition	Associated Standard Condition	Details	Proposed Condition Number	Proposed Condition	Justification
General 1 - 6		*The environmental authority will contain conditions that explicitly authorise particular activities to be carried out on the relevant resource authorities. This will include a scoping table and thresholds for scale and intensity.*	*A1 - A4 (inclusive of Table A1)*	This environmental authority authorises the carrying out of the following resource activities: a) The petroleum activities listed in Schedule A, Table 1 – Scale of Activities to the extent they are carried out in accordance with the activity's corresponding scale or intensity or both (where applicable); and b) Petroleum activities, including but not limited to: (i) Linear infrastructure; (ii) Borrow pits / extracting, other than by dredging; and (iii) Laydown areas. c) The specified relevant activities prescribed by this Environmental Authority at the locations specified on the cover pages of this environmental authority; d) Incidental activities that are not otherwise specified relevant activities. (A2) The activities in Condition A1 are authorised subject to the conditions of this environmental authority. (A3) This environmental authority does not authorise environmental harm unless a condition contained in this environmental authority explicitly authorises that harm. Where there is no condition, the lack of a condition shall not be construed as authorising harm. (A4) The following types of petroleum activities are not authorised: a) processing or storing petroleum or petroleum by-products that are not associated with well operations; b) extracting earthen materials (other than drilling waste rock) of more than 100,000t/year; c) extracting by dredging of more than 1000t/year of material from the bed of naturally occurring surface waters; d) drilling wells with fluids that are oil-based or synthetic oil-based; e) carrying out stimulation activities.	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure. Table A-1 to include 31 wells (31 ha);
General 7	PESCD 1	All monitoring must be undertaken by a suitably qualified person	A5	A5 Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
General 8		If requested by the administering authority in relation to investigating a complaint, monitoring must be commenced within 10 business days.	A6	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
General 9		All laboratory analyses and tests must be undertaken by a laboratory that has NATA accreditation for such analyses and tests.	A7	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	A8	Notwithstanding condition (A7), 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.	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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: (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.rvey Handbook, 3rd edition (National Committee on Soil and Terrain, 2009)	A9	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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 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	A10	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 well integrity (c) unauthorised releases of any volume of prescribed contaminants to waters (d) unauthorised releases of volumes of contaminants, in any mixture, to land greater than: i. 200 L of hydrocarbons; or 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. (e) 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 (f) monitoring results where two out of any five consecutive samples do not comply with the relevant limits in the environmental authority.	Condition amended to remove references to dams, stimulation, and brine based on the following: 1. No dams are proposed to be constructed 2. No brine is planned to be produced or stored in the project area; and 3. Hydraulic Stimulation is not proposed
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.	A11	Retain streamlined model condition	
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	A12	Retain streamlined model condition	
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	A13	Retain streamlined model condition	
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.	A14	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
General 17	PESCC 4	All plant and equipment must be maintained and operated in their proper and effective condition.	A15	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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 (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	A16	Replace with: Exploration, appraisal and development wells must be signed with a unique reference name or number in such a way that it is clearly observable.	Dams, sewage treatment, fuel burning, gas processing and water treatment do not form part of the proposed project.
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.	A17	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	A18	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.

General 21		Petroleum activities must not cause environmental nuisance at a sensitive place, other than where an alternative arrangement is in place.	A19	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	A20	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
General 23		All plans, procedures, programs, reports and methodologies required under this environmental authority must be written and implemented.	A21	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
General 24		All documents required to be developed under this environmental authority must be kept for five years.	A22	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	A23	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	A24	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	B1	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	B2	Replace with: 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 of the environmental authority to be disposed of or used on site	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	B3	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Waste 4		Green waste may be used on-site for either rehabilitation or sediment and erosion control, or both.	B4	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	B5	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	B6	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Waste 6A - Additional		--			
Waste 6B - Additional		--	B7	Despite condition (B6), where the acceptable standards for release to land cannot be met, release of pipeline waste water must not occur until: a) a suitably qualified person has prepared a written Receiving Environment Report; b) does not result in visible scouring or erosion; c) does not cause pooling or ponding; d) does not cause vegetation die off; e) does not cause visible salting	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Waste 6C - Additional		--	B8	The Receiving Environment Report in (B7) must at minimum address water quality criteria, which has been determined in accordance with assessment procedures outlined in Schedule B, Table 1 – Assessment procedures for water quality criteria and must include: a) a water monitoring program to monitor that the outcomes of B7 are being achieved; and b) the frequency of water quality monitoring	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Waste 7		Produced water may be re-used in: (a) drilling and well hole activities; or (b) stimulation activities.	B9	Produced water may be re-used in drilling and well hole activities.	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	B10	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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 (c) does not result in runoff from the construction site; and (d) does not harm vegetation surrounding the construction site	B11	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Waste 9A - additional		--	B12	Produced water may be used for irrigation provided the following criteria are met: a) The 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	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Waste 9B - additional		--	B13	Irrigation of produced water is authorised provided a written report is provided to the chief executive which: a) Certifies that the outcomes in condition B10 will be achieved; b) States water quality criteria, which has been determined in accordance with assessment procedures outlined in Schedule B, Table 1 – Assessment procedures for water quality criteria; c) Includes a water monitoring program to monitor that the outcomes listed in B10 are being achieved	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	B14	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	B15	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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 and removed from the contaminant release area as needed, but not less than every three months	B16	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	-	Remove	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Waste 14		Sewage pump stations must be fitted with a: (a) stand-by pump; and (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	-	Remove	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	B17	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	B18	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Waste 17		Records must be kept to demonstrate compliance with condition (Waste 15) and (Waste 16)	B19	Records must be kept to demonstrate compliance with condition (B17) and (B18)	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.

Waste 18		***Use conditions (Waste 18) to (Waste 21) where the environmental authority application requests and provides an environmental assessment of onsite waste disposal.*** 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	-	Waste disposal not proposed - do not include SMC waste 18 - SMC Waste 21	Waste disposal not proposed
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	-	Waste disposal not proposed - do not include SMC waste 18 - SMC Waste 21	Waste disposal not proposed
Waste 20		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	-	Waste disposal not proposed - do not include SMC waste 18 - SMC Waste 21	Waste disposal not proposed
Waste 21		Waste disposal must not result in litter escaping the boundary of the landfill facility.	-	Waste disposal not proposed - do not include SMC waste 18 - SMC Waste 21	Waste disposal not proposed
Noise 1		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.	C1	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Noise 2		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 LAeq, adj, 15 min	C2	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	-	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Noise 4	PESCC 21	A Blast Management Plan must be developed for each blasting activity in accordance with Australian Standard 2187.	-	Remove	No blasting proposed
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.	-	Remove	No blasting proposed
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.	-	Remove	No blasting proposed
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 complies with all of (Air 1(a)) and (Air 1(b)) and (Air 1(c)), or with (Air 1(d)): (a) an automatic ignition system is used, and (b) a flame is visible at all times while the waste gas is being flared, and (c) there are no visible smoke emissions other than for a total period of no more than 5 minutes in any 2 hours, or	D1	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	-	Do not include	Fuel burning and associated emissions are not proposed
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	-'	Do not include	Fuel burning and associated emissions are not proposed
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	-	Do not include	Fuel burning and associated emissions are not proposed
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	-	Do not include	Fuel burning and associated emissions are not proposed
Air 5		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.	-	Do not include	Fuel burning and associated emissions are not proposed
Air 6		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	-	Do not include	Fuel burning and associated emissions are not proposed
Air 7		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 concentrations complies with the air contaminant limits listed in Protecting air values, Table 2—Maximum ground level concentration of contaminants to air.	-	Do not include	Fuel burning and associated emissions are not proposed
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	-	Do not include	Fuel burning and associated emissions are not proposed
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.	-	Do not include	Fuel burning and associated emissions are not proposed
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.	-	Do not include	Fuel burning and associated emissions are not proposed
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>.	E1	Contaminants must not be directly or indirectly released to land except for those releases authorised by the conditions of this environmental authority.	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Land 2		Top soil must be managed in a manner that preserves its biological and chemical properties.	E2	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	E3	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Land 4		Acid sulfate soils must be treated and managed in accordance with the latest edition of the Queensland Acid Sulfate Soil Technical Manual.	E4	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Land 5		Chemicals and fuels stored, must be effectively contained and where relevant, meet Australian Standards, where such a standard is applicable.	E5	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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).	E6	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Land 7	PPSCE 17	Pipeline trenches must be backfilled and topsoils reinstated within three months after pipe laying	E7	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.

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.	E8	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	E9	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	F1	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.	F2	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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 values.	F3	Where mapped biodiversity values differ from those confirmed under conditions (F1) and (F2), petroleum activities may proceed in accordance with the conditions of the en	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	F4	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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	F5	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Biodiversity 6	***Use conditions (Biodiversity 6) and (Biodiversity 7) where the environmental authority application does not request access to Category A, B or C environmentally sensitive areas or their protection zones, or is silent on impacts to these values.*** Petroleum activities are not permitted in Category A, B or C environmentally sensitive areas.	-	Do not include Biodiversity 6 and 7.	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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. < Or, if access to Category A, B or C environmentally sensitive areas or their protection zones is requested in the application and approved, delete conditions (Biodiversity 6) and (Biodiversity 7) and insert (Biodiversity 8) as relevant to the scope of the approval request >	-	Do not include Biodiversity 6 and 7.	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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.*	F6	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Biodiversity 8A - Additional		F7	Despite condition F6 of this environmental authority, activities specified in Schedule F, Table 2 - Authorised petroleum activities in ESAs and protection zones are authorised under this approval (insert Schedule F Table 2 - Authorised petroleum activities in ESAs and protection zones.	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Biodiversity 9	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 (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	F8	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Biodiversity 9A - additional	--	F9	Where petroleum activities are to be located in, or within protection zones of, Category B and C ESAs specified in Condition (Biodiversity 8A), the holder of this environmental authority must be able to demonstrate that no reasonable or practicable alternative exists	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Biodiversity 9B - additional	--	F10	Where petroleum activities are to be located in, or within protection zones of, the Category B and C ESAs specified in Condition (Biodiversity 8A), disturbance to land must only be located and carried out in areas according to the following order of preference: a) pre-existing cleared areas or significantly disturbed areas within the protection zones of Category C ESA and Category B ESA respectively; b) undisturbed areas within the protection zones of Category C ESA and Category B ESA respectively; c) pre-existing areas of significant disturbance within a Category C ESA (e.g. areas where significant clearing or thinning has been undertaken within a RE, and/or areas containing high densities of weed or pest species which has inhibited re-colonisation of native regrowth); d) areas where clearing of a Category C ESA or Category B ESA is unavoidable	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Biodiversity 10	Significant residual impacts to prescribed environmental matters, are not authorised under this environmental authority or the Environmental Offsets Act 2014 unless the impact(s) is specified in Protecting biodiversity values, Table 2—Significant residual impacts to prescribed environmental matters	F11	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Biodiversity 11	Records demonstrating that each impact to a prescribed environmental matter not listed in Protecting biodiversity values, Table 2—Significant residual impacts to prescribed environmental matters 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	F12	Retain streamlined model condition	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
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 accordance with condition (Biodiversity 14) [for staged offsets] OR condition (Biodiversity 18) [for non-staged offsets]	-	Remove	No SRI to PEMs predicted
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.	-	Remove	No SRI to PEMs predicted
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 prescribed environmental matter; and (b) for the previous stage, if applicable—the actual significant residual impacts to each prescribed environmental matter, to date	-	Remove	No SRI to PEMs predicted
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.	-	Remove	No SRI to PEMs predicted
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.	-	Remove	No SRI to PEMs predicted
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	-	Remove	No SRI to PEMs predicted
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.	-	Retain streamlined model condition	No SRI to PEMs predicted
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.	-	Retain streamlined model condition	No SRI to PEMs predicted
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.	-	Retain streamlined model condition	No SRI to PEMs predicted
Water 1	< Insert site-specific conditions authorising impacts to waters, if approved	G1	Contaminants must not be directly or indirectly released to waters.	This condition reflects the requirements of Senex's other upstream EAs and is proposed to maintain consistent conditions of approval across Senex's tenure.
Water 2	The extraction of groundwater as part of the petroleum activity(ies) from underground aquifers must not directly or indirectly cause environmental harm to a wetland.	G2	Retain streamlined model condition	
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	G3	Retain streamlined model condition	
Water 4	Only construction or maintenance of linear infrastructure is permitted in or within any wetland of other environmental value or in a watercourse.	G4	Retain streamlined model condition	
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	G5	Retain streamlined model condition	

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: (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.	G6	Retain streamlined model condition	
Water 6	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	G7	Retain streamlined model condition	
Water 7	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.	G8	The construction or maintenance of linear infrastructure authorised under condition (G4) must comply with the water quality limits as specified in Protecting water values, Table 1—Release limits for construction or maintenance of linear infrastructure.	
Water 8	Monitoring must be undertaken at a frequency that is appropriate to demonstrate compliance with condition (Water 7).		Retain streamlined model condition	
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)	G9	Retain streamlined model condition	
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.	-	Remove	proposed development is not in a River Improvement Area
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	G10	Retain streamlined model condition	
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 << Insert the specified date no longer than 3 months from date of grant of this environmental authority >	-	Remove - no dams proposed as part of development	Not relevant - no dams 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 (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.	-	Remove - no dams proposed as part of development	Not relevant - no dams proposed
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.	-	Remove - no dams proposed as part of development	Not relevant - no dams proposed
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	H1	Retain streamlined model condition	
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 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.	H2	Retain streamlined model condition	
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 the equivalent biodiversity status or a biodiversity status with a higher conservation value as any of the regional ecosystem(s) in either the adjacent land or pre-disturbed land, must be present.	H3	Retain streamlined model condition	
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 (f) all predominant species in the ecologically dominant layer that define the pre-disturbance regional ecosystem(s) are present	H4	Retain streamlined model condition	
Rehabilitation 5	Conditions (Rehabilitation 2), (Rehabilitation 3) and (Rehabilitation 4) continue to apply after this environmental authority has ended or ceased to have effect.	H5	Conditions (H2), (H3) and (H4) continue to apply after this environmental authority has ended or ceased to have effect.	
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.	H6	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 (H2), (H3) and (H4) has 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.	H7	The report required under condition (H6) 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.	
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.	-	Remove - no dams proposed as part of development	No dams proposed
Well Activities 1	Oil based or synthetic based drilling muds must not be used in the carrying out of the petroleum activity(ies).	I1	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not proposed
Well Activities 2	Drilling activities must not result in the connection of the target gas producing formation and another aquifer	I2	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not proposed
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.	I3	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not proposed
Well Activities 4	Stimulation activities are not permitted **OR**	I4	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not proposed
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.	-	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not 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.	-	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not proposed
Well Activities 7	Stimulation activities must not cause the connection of the target gas producing formation and another aquifer	-	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not 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.	-	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not 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.	-	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not proposed
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.	-	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not 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 (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. microseismic 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: 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	-	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not proposed
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 (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 (PMW026)	-	Remove - hydraulic stimulation not proposed	Hydraulic stimulation not proposed
Proposed Definitions				
As per the SMC definitions with the exception of the following:				
Essential Petroleum Activities	"**essential petroleum activities**" means activities that are essential to bringing the resource to the surface and are only the following: • low impact petroleum activities • geophysical, geotechnical, geological, topographic and cadastral surveys (including seismic, sample /test / geotechnical pits, core holes) • single well sites not exceeding 1 hectare disturbance and multi-well sites not exceeding 1.5 hectare disturbance • well sites with monitoring equipment (including monitoring bores): o for single well sites, not exceeding 1.25 hectares disturbance o for multi-well sites, not exceeding 1.75 hectares disturbance • well sites with monitoring equipment (including monitoring bores) and tanks (minimum 1 ML) for above ground fluid storage: o for single well sites, not exceeding 1.5 hectares disturbance o for multi-well sites, not exceeding 2.0 hectares disturbance • associated infrastructure located on a well site necessary for the construction and operations of wells: o water pumps and generators o flare pits o chemical / fuel storages o sumps for residual drilling material and drilling fluids o tanks, or dams which are not significant or high consequence dams to contain wastewater (e.g. stimulation flow back waters, produced water) o pipe laydown areas o soil and vegetation stockpile areas o a temporary camp associated with a drilling rig that may involve sewage treatment works that are no release works o temporary administration sites and warehouses o dust suppression activities using water that meets the quality and operational standards approved under the environmental authority • communication and power lines that are necessary for the undertaking of petroleum activities and that are located within well sites, well pads and pipeline right of ways without increasing the disturbance area of petroleum activities • supporting access tracks • gathering / flow pipelines from a well head to the initial compression facility • activities necessary to achieve compliance with the conditions of the environmental authority in relation to another essential petroleum activity (e.g. sediment and erosion control measures, rehabilitation).		"**essential petroleum activities**" means activities that are essential to bringing the resource to the surface and are only the following: • low impact petroleum activities • geophysical, geotechnical, geological, topographic and cadastral surveys (including seismic, sample /test / geotechnical pits, core holes) • single well sites not exceeding 1 hectare disturbance and multi-well sites not exceeding 1.5 hectare disturbance • well sites with monitoring equipment (including monitoring bores): o for single well sites, not exceeding 1.25 hectares disturbance o for multi-well sites, not exceeding 1.75 hectares disturbance • well sites with monitoring equipment (including monitoring bores) and tanks (minimum 1 ML) for above ground fluid storage: o for single well sites, not exceeding 1.5 hectares disturbance o for multi-well sites, not exceeding 2.0 hectares disturbance • associated infrastructure located on a well site necessary for the construction and operations of wells: o water pumps and generators o flare pits o chemical / fuel storages o sumps for residual drilling material and drilling fluids o tanks, or dams which are not significant or high consequence dams to contain wastewater (e.g. stimulation flow back waters, produced water) o pipe laydown areas o soil and vegetation stockpile areas o a temporary camp associated with a drilling rig that may involve sewage treatment works that are no release works o temporary administration sites and warehouses o dust suppression activities using water that meets the quality and operational standards approved under the environmental authority • Monitoring bores and/or equipment required to monitor activities or potential impacts associated with activities authorised under an environmental approval • communication and power lines that are necessary for the undertaking of petroleum activities and that are located within well sites, well pads and pipeline right of ways without increasing the disturbance area of petroleum activities • supporting access tracks • gathering / flow pipelines from a well head to, or between, any one or more of the following: o the initial compression facility; o water storage facility o the initial compression facility and/or to, or between, water storage facilities • activities necessary to achieve compliance with the conditions of the environmental authority in relation to another essential petroleum activity (e.g. sediment and	The development of Coal Seam Gas resources, necessarily involves the depressurisation of coal seams through the extraction of water to reduce pore pressures and allow gas to desorb from the coals and be extracted via wells. The ability to manage produced water effectively and in accordance with the relevant EA conditions, is an essential part of CSG activities. Management of produced water is usually via dams or other storages (including tanks). The ability to interlink water storages to balance water flows across producing gas fields is essential to the safe and effective operation of the storages, and subsequently the efficient and ongoing production of gas. The proposed change above, recognises that produced water management is essential to CSG activities and expands the definition of gathering / flow lines to incorporate pipeline between water storages and/or compression facilities and water storages. Proposed condition Biodiversity 5 limits linear infrastructure corridor widths to 40m. Senex commits to meeting this limit for gathering / flow lines as per the proposed amended definition of essential petroleum activities, and where possible will co-locate gathering and flow lines while limiting linear corridors to 40m in width or less (i.e. the proposed amendment would not authorise any additional disturbance beyond that which would already be authorised by the proposed conditions. The inclusion of monitoring bores as a line item of their own (rather than associated with a well pad) gives Senex the ability to install water monitoring bores, surface water flow gauges or sampling points as per requirements of Queensland or Commonwealth environmental approvals to support: • seepage monitoring; • groundwater impact monitoring; or • gauge impacts of activities on existing hydraulic regimes. Senex believes this change aligns with the intent of the existing definition, but adds additional clarity around monitoring equipment, requirements and associated

Appendix E: ATP 2059 Water Report – EA Amendment (October 2022)

Klohn Crippen Berger

Senex Energy Pty Ltd.

Atlas Stage 3 Gas Project

ATP 2059 Water Report

EA Amendment

Final

ISO 9001 14001 45001

DX10171A12

October 2022

Klohn Crippen Berger

25 October, 2022

Senex Energy Pty Ltd.
Level 30, 180 Ann Street
Brisbane
QLD 4001

Steve Fox
Atlas Approvals

Dear Mr. Fox:

ATP 2059 Water Report
Atlas Stage 3 Gas Project
Final

KCB Australia Pty Ltd. (KCB) is pleased to provide Senex Energy Pty Ltd. (Senex) with this Water Report to support the EA Amendment of ATP 2059 for the Atlas Stage 3 Gas Project. Should you have any queries regarding this report, please do not hesitate to contact the undersigned at cwaterhouse@klohn.com or 07 3004 0244.

Yours truly,

KCB AUSTRALIA PTY LTD.

Carly Waterhouse
Project Manager

CW:JJ

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EXECUTIVE SUMMARY

Senex, on behalf of its subsidiary, Senex Assets Pty Ltd (ABN 50 008 942 827), is currently authorised to conduct petroleum exploration activities in accordance with its environmental authority (EA) (EA; EA0002524) within authority to prospect (ATP) 2059. ATP 2059 is located 14 km southwest of Wandoan in Southern Queensland. Senex proposes to develop, operate, decommission and rehabilitate new coal seam gas (CSG) wells and associated infrastructure on ATP 2059.

The Project will include the installation of up to 31 CSG production wells and associated well site facilities; gas and water gathering systems for the production wells; access tracks for operational purposes; brine and produced water storage, including aggregation dam capacity, and produced water/irrigation dams; borrow pits; and ancillary supporting facilities. An application to convert ATP 2059 from an ATP to a Petroleum Lease (PL) under the *Queensland Petroleum and Gas (Production and Safety) Act 2004* (State of Queensland 2020d) is underway. Senex proposes to apply for an EA amendment to authorise CSG production activities associated with the Project.

In support of the EA amendment, a water assessment for ATP 2059 has been completed and the outcomes of the assessment are presented in this report. The key findings from the assessment are summarised below.

The Project is located within the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin. Key watercourses within the Project area include Woleebee Creek and Wandoan Creek. Watercourse flows in the Project area are characteristically ephemeral, episodic in nature, and typically generated only due to significant rainfall events. This is likely a consequence of the Project area being in the uppermost reaches of the catchments with limited runoff area. There are no identified third-party surface water users in the vicinity of the Project.

The target formation for CSG production for the Project is the Walloon Coal Measures (WCM), a formation within the Surat Basin. The Surat Basin forms part of the Great Artesian Basin (GAB), which is comprised of several aquifers and aquitards. Aquifers of the Surat Basin are a significant source for water used for public water, agricultural, stock and domestic supply, with the majority of use in the vicinity of the Project for stock and domestic purposes. There are 669 registered existing potential groundwater bores within the Project boundary and in the 25 km buffer zone outside of the Project.

Groundwater dependent ecosystems (GDEs) are identified within the Project area including potential watercourse springs and potential terrestrial GDEs. Evidence exists that indicate these systems are reliant on the groundwater in the alluvium rather than deeper GAB formations. The distinction between the alluvium groundwater quality and underlying Westbourne Formation and Springbok Sandstone groundwater quality (which is of higher salinity) indicates that these units are disconnected. The comparable water qualities of surface water int the watercourses and the underling alluvium groundwater indicates that the alluvium is recharged/replenished by the surface water systems during flow events.

The Project is located within the Surat Cumulative Management Area (CMA), which was declared in 2011. The Office of Groundwater Impact Assessment (OGIA) was established under the *Water Act 2000* and is responsible for predicting regional impacts on water pressures in aquifers; developing water monitoring and spring management strategies; and assigning responsibility to individual petroleum tenure holders for implementing specific parts of the strategies within CMAs. These predictions, strategies and responsibilities are set out in the Surat CMA Underground Water Impact Report (UWIR), prepared and maintained by OGIA.

Outputs from the Surat CMA numerical model have been used to consider drawdown impacts to groundwater. Based on the information provided by Senex, OGIA have modelled a 'Project only' scenario, which includes only CSG development from the Project and a 'Cumulative' scenario, which includes the simulation of Senex CSG production as well as all current and proposed developments for Origin, QGC, Arrow and Santos from within the Surat CMA.

For the 'Project only' scenario, the predicted long-term drawdown impacts associated with the Project are limited to the Westbourne Formation, Springbok Sandstone, WCM and Durabilla Formation.

Potential impacts to water-dependent assets have been considered with respect to the Queensland *Water Act 2000* trigger threshold for springs (0.2 m drawdown) and bores (5 m drawdown in consolidated aquifer; 2 m drawdown in unconsolidated aquifer) using the predicted drawdown for both the 'Project only' and Cumulative scenarios.

For the 'Project only' scenario, 23 third-party groundwater bores in the WCM are predicted to experience a decline greater than the trigger threshold. These groundwater bores are predicted to be already triggered by adjacent developments (without contribution from the Project). There are five additional bores triggered as part of the cumulative scenario (i.e., the contribution of the Project development results in five additional bores being triggered in the cumulative scenario; these bores would not have been triggered without the presence of the Project). Two of these bores are attributed to the Upper Springbok Sandstone and three are attributed to the Upper Juandah Coal Measures. Of the five additional bores, none are located on the Project tenement, and all are located off-site to the east. One of these bores is noted as "Abandoned and destroyed", two are noted as "Monitoring bores (and not water supply bores)", and two are noted as "Existing bores". Of the existing bores, a bore baseline assessment confirmed one of these bores is blocked and has not been used since 1996 (Arrow 2013). The maximum Project only contribution to drawdown the only existing, usable bore is 26%.

Based on the available characteristics of the GDE physiographic setting, it is interpreted that these potential GDEs may be intermittently supported by groundwater in the alluvium (which is not predicted to experience drawdown). The alluvium not considered to be hydraulically connected to the Upper Springbok Sandstone which is predicted to experience drawdown. These GDEs are being triggered cumulatively by neighbouring activities without the presence of the Project (by the Wandoan Coal Project and other CSG activities).

Non-drawdown related impacts may potentially occur as a result of CSG activities. These may include impacts associated with drilling and construction of CSG production wells, CSG produced water storage facilities, localised incidental CSG activities such as fuel spills or improper storage of chemicals and beneficial use activities, such as irrigation and stock watering. These potential impacts are mitigated and managed by adopting the appropriate standards and implementing appropriate controls. Direct impacts to surface water are not anticipated. Proposed activities of the Project do not include direct abstraction or discharges from / to watercourses.

To minimise the predicted potential impacts from the Project, Senex will adopt of number of mitigation, management and monitoring measures. As part of their CSG water management strategy, Senex propose to beneficially use produced water, through landholder water supply agreements. Other measures include adherence to relevant EA conditions as well as mandatory requirements and guidelines, such as the '*Code of Practice for the construction and abandonment of petroleum wells and associated bores in Queensland*' (State of Queensland 2019a), applicable Australian Standards for storing and handling applicable materials, '*Manual for Assessing Consequence Categories and Hydraulic Performance of Structures*' (DES 2016a), and '*Streamlined Model Conditions for Petroleum Activities*' (DES 2016b).

Senex will report to the relevant government authorities in accordance with conditions and approvals, as required. Senex will also report to OGIA in relation to the Surat CMA UWIR requirements as a petroleum lease holder within the CMA.

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CLARIFICATIONS REGARDING THIS REPORT

This report is an instrument of service of KCB Australia Pty Ltd (KCB). The report has been prepared for the exclusive use of Senex Energy Pty Ltd. (Client) for the specific application to the Atlas Stage 3 EA Amendment, and it may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

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2. The Executive Summary is a selection of key elements of the report. It does not include details needed for the proper application of the findings and recommendations in the report.
3. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.
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6. This report is electronically signed and sealed and its electronic form is considered the original. A printed version of the original can be relied upon as a true copy when supplied by the author or when printed from its original electronic file.

TABLE OF ABBREVIATIONS

ACA	Aquatic Conservation Assessments
AEP	Annual exceedance probability
ALUM	Australian Land Use and Management
ANZECC	Australian and New Zealand Conservation Council
APLNG	Australia Pacific LNG Pty Limited
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ATP	Authority to Prospect
ATW	Authority to Work
BOT	Back on Track
CBAS	Chemicals and Biotechnology Assessments Section
CMA	Cumulative Management Area
CRD	Cumulative rainfall departure
CSG	Coal seam gas
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEE	Department of the Environment and Energy
DEHP	Department of Environment and Heritage Protection
DES	Department of Environment and Science
DSITI	Department of Science, Information Technology, and Innovation
DST	Drill stem tests
EA	Environmental authority
EC	Electrical Conductivity
EOW	End of Waste
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERA	Environmentally relevant activity
ESA	Environmentally sensitive areas
EV	Environmental Value
EVNT	Endangered, vulnerable and near threatened
GAB	Great Artesian Basin
GDE	Groundwater dependent ecosystems
GWDB	Groundwater Database

HEV	High Ecological Value
KCB	Klohn Crippen Berger
MNES	Matters of national environmental significance
MSES	Matters of state environmental significance
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NSMC	Null space Monte Carlo
NWQMS	National Water Quality Management Strategy
OECD	Organisation for Economic Co-operation and Development
OGIA	Office of Groundwater Impact Assessment
PL	Petroleum Lease
QFAO	Queensland Floodplain Assessment Overlay
QWC	Queensland Water Commission
RDMW	Regional Development, Manufacturing and Water
RE	Regional ecosystem
ROP	Resource Operations Plan
RoW	Right-of-way
SDS	Safety Data Sheets
TDS	Total Dissolved Solids
UWIR	Underground Water Impact Report
Water Act	*Water Act 2000*
WCM	Walloon Coal Measures
WMS	Water Monitoring Strategy
WQO	Water quality objectives
WSA	Water Supply Agreements

1 INTRODUCTION

KCB Australia Pty (KCB) has been commissioned by Senex Energy Pty Ltd, to undertake groundwater and surface water assessments for ATP 2059 (the Project).

1.1 Project Background

Senex, on behalf of its subsidiary, Senex Assets Pty Ltd (ABN 50 008 942 827), proposes to develop, operate, decommission and rehabilitate new coal seam gas wells and associated infrastructure on Authority to Prospect (ATP) 2059, in the central part of the Surat Basin, Queensland. The proposed action hereby referred to as the Project is located approximately 14 km southwest of the township of Wandoan in Southern Queensland (Figure 1.1) and within the Surat Cumulative Management Area[1] (CMA) (Section 2.2.2).

Senex propose to develop a coal seam gas (CSG) field within ATP 2059. Senex holds an environmental authority (EA; EA0002524) to prospect on ATP 2059. An application to convert ATP 2059 from an ATP to a PL under the *Queensland Petroleum and Gas (Production and Safety) Act 2004* (State of Queensland 2020d) is underway. Senex proposes to apply for an EA amendment to authorise CSG production activities associated with the Project.

Proposed production activities for the Project include the installation of up to 31 CSG production wells and associated well site facilities; gas and water gathering systems for the production wells; access tracks for operational purposes; brine and produced water storage, including aggregation dam capacity, and produced water/irrigation dams; borrow pits; and ancillary supporting facilities. The operational duration of individual wells is anticipated to be between 20 and 50 years (minimum of 15 years). Further details of the proposed Project activities are provided in Section 3.

Senex also plan to develop gas wells to the east of ATP 2059 within PL 445 and PL 209. Where practicable, and to the extent authorised by current and future approvals, the infrastructure required for ATP 2059 may integrate with future infrastructure within PL 445 and PL 209.

The Project is located adjacent to Senex's Project Atlas (PL 1037). Where practicable, and to the extent authorised by current and future approvals, the infrastructure required for ATP 2059 may integrate with existing and future infrastructure within PL 1037.

This report presents the potential project impacts from the drawdown associated with the 31 wells on ATP 2059 and 120 wells on PL 445 and PL 209 (total of 151 wells). The activities on the three PLs were modelled together as the full Atlas Stage 3 Project. The results are therefore present an overly conservative assessment of impact from the activities on ATP 2059.

[1] Surat Cumulative Management Area (CMA) was declared in 2011 under the *Water Act 2000*

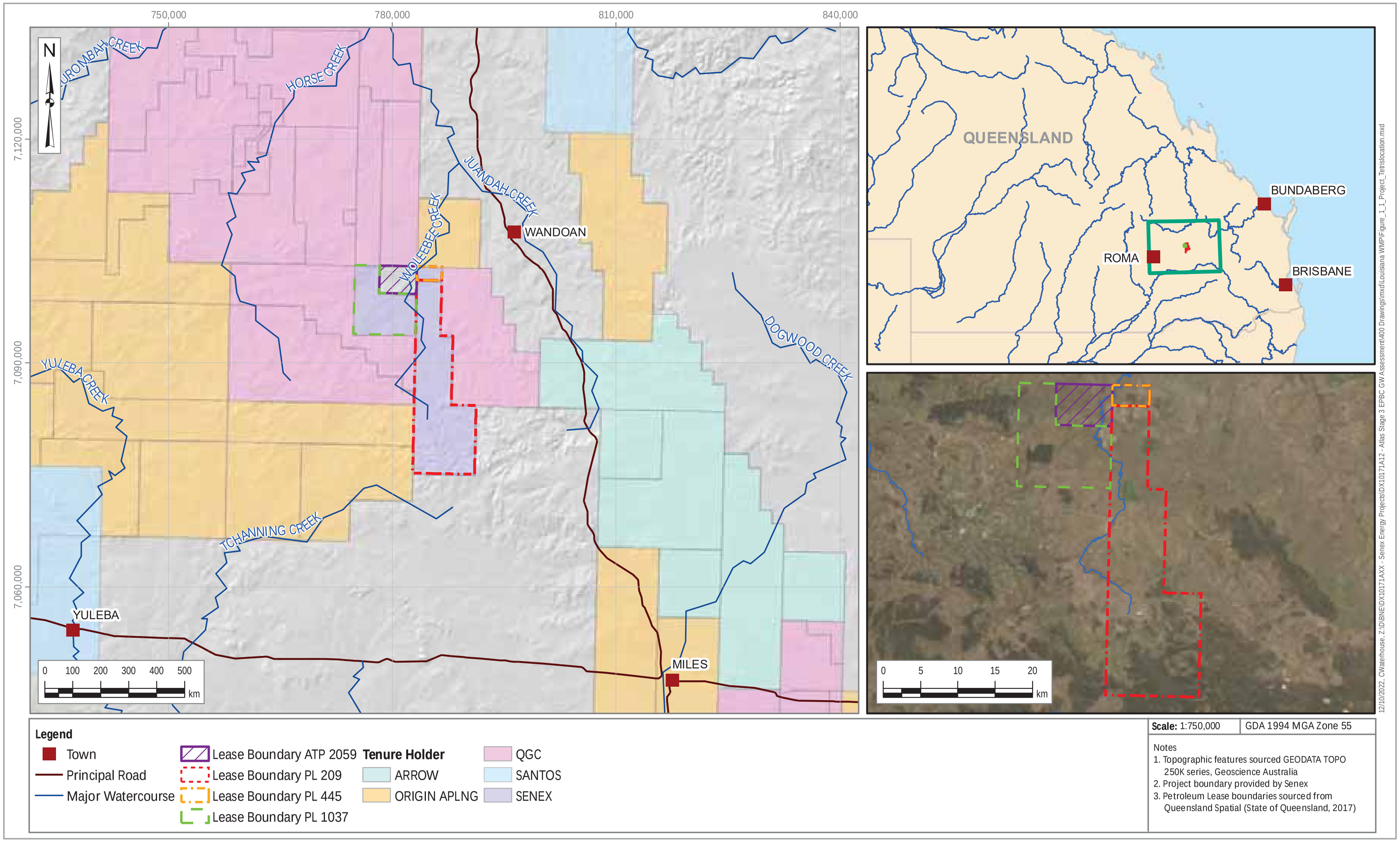

Figure 1.1 Project Location

1.2 Report Structure

This report has been prepared to accompany the Environmental Authority amendment application to the Queensland Department of Environment and Science (DES) and is provided as supporting information with content related to groundwater and surface water, including a description of baseline conditions and impact assessments, which has been undertaken in accordance with relevant legislation and guidelines (Section 2.2).

This report is structured to include the following:

Section 1: Introduction to the Project, report purpose and structure.

Section 2: Regulatory Framework, including an overview of the relevant Queensland and Commonwealth legislation related to water and CSG development / production.

Section 3: Project Description.

Section 4: Methodology, including the existing environment and environmental values, and impact assessment.

Section 5: Existing Environment, including a review of the climate, topography, land use,

Section 6: Hydrological setting and summary of surface water receptors and users.

Section 7: Hydrogeological setting and summary of groundwater receptors and users.

Section 8: Numerical Groundwater Modelling, including predicted extent of groundwater drawdown.

Section 9: Impact Assessment, which includes both Project only and Cumulative impacts.

Section 10: Monitoring, Mitigation and Management.

2 REGULATORY FRAMEWORK

This water report has been prepared with consideration to key policies and legislation from the Commonwealth of Australia and the State of Queensland. This section provides an overview of applicable legislation / policies to this assessment.

2.1 Commonwealth Legislation

2.1.1 Environment Protection and Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* (Commonwealth of Australia 2022b) is the central piece of environmental legislation at the Commonwealth level. It provides for the protection of environmental values, including matters of national environmental significance (MNES). Actions that are likely to have a significant impact on MNES are subject to the assessment and approval process under this Act. Amendments to the *EPBC Act* have resulted in water resources being identified as a MNES in relation to large coal mining and CSG development projects. The Project may have potential to have a significant impact on water resources, and as such may be referred to the Department of Climate Change, Energy, the Environment and Water (DCCEEW).

The regulatory guideline relevant to the Project, developed from the amendment to the *EPBC Act* identifying water resources as being a MNES, is the *Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources* (Commonwealth of Australia 2022a).

2.2 State Legislation

2.2.1 Petroleum and Gas (Production and Safety) Act 2004

The *Petroleum and Gas (Production and Safety) Act 2004* (State of Queensland 2020e) is an Act relevant to exploring for, recovering and transporting by pipeline, petroleum and fuel gas, and ensuring the safe and efficient undertaking of those activities. The key purpose of this Act is to facilitate and regulate the undertaking of responsible petroleum activities and the development of a safe, efficient and viable petroleum and fuel gas industry.

This Act identifies underground water rights for petroleum tenures, and states that the holder of a petroleum tenure may take or interfere with underground water in the area of the tenure if the taking or interference happens during the course of, or results from, the carrying out of another authorised activity for the tenure.

The Act prescribes mandatory compliance with the Queensland Department of Natural Resources, Mines, and Energy's (DNRME – now known as the Department of Resources or DoR) '*Code of Practice for the construction and abandonment of petroleum wells, and associated bores in Queensland Version 2*' (State of Queensland 2019a). The purpose of this code is to ensure that all petroleum wells, CSG wells and associated bores are constructed, maintained and abandoned to a minimum acceptable standard resulting in long-term well integrity, containment of petroleum and gas and the protection of groundwater resources.

2.2.2 Water Act 2000

General Purpose of the Water Act

The *Water Act 2000* (State of Queensland 2021g) is an Act to provide for the sustainable management of water and the management of impacts on underground water, among other purposes. This Act provides a framework for:

- The sustainable management of Queensland's water resources by establishing a system for the planning, allocation and use of water;
- The sustainable and secure water supply and demand management for designated regions;
- The management of impacts on underground water caused by the exercise of underground water rights by the resource sector; and
- The effective operation of water authorities.

This Act covers water in a watercourse, lake or spring, underground water (or groundwater), overland flow water, or water that has been collected in a dam.

Water Act and CSG Related Activities

The *Water Act 2000* provides for the identification and management of potential impacts on underground water caused by the exercise of underground water rights by resource tenure holders, which are regulated under the *Petroleum and Gas (Production and Safety) Act 2004.* The Act also outlines the requirements for make good agreements, if required, associated with the impacts to underground water.

Chapter 3 of the *Water Act 2000* has a stated purpose to provide for the management of impacts on underground water caused by the exercise of underground water rights by resource tenure holders, which includes petroleum tenure holders. To achieve the stated purpose, a regulatory framework is provided which requires:

- Resource tenure holders to monitor and assess the impacts of the exercise of underground water rights on water bores and to enter into make good agreements (MGA) with the owners of the groundwater bores as necessary;
- The preparation of underground water impact reports (UWIR) that establish underground water obligations, including obligations to monitor and manage impacts on aquifers and springs; and
- Managing the cumulative impacts of the activities of two or more resource tenure holders' underground water rights on underground water.

Under this regulatory framework, where there is an area of concentrated development, a cumulative management area (CMA) can be declared. The Project is located within the Surat CMA, which was declared by the Queensland Government in 2011. The OGIA was established under the *Water Act 2000* and is responsible for: predicting regional impacts on water pressures in aquifers; developing water monitoring and spring management strategies; and assigning responsibility to individual petroleum tenure holders for implementing specific parts of the strategies within CMAs.

These predictions, strategies and responsibilities are set out in the Surat CMA UWIR, prepared and maintained by OGIA.

The Surat CMA UWIR was first published by Queensland Water Commission (QWC) in 2012 (QWC 2012) to assess the cumulative impacts to the Surat Basin and southern Bowen Basin, as a result of the expansion of CSG production by multiple, adjacent developers. A second and third UWIR was published by OGIA in 2016 (OGIA 2016c) and 2019 (OGIA 2019c), with the most recent published in December 2021 (OGIA 2021g).

OGIA also provide tenure holders with their obligations to comply with the Surat CMA UWIR Water Monitoring Strategy (WMS). The WMS includes:

- Installation, maintenance and collection of data from the groundwater monitoring network including water pressure and water chemistry;
- Monitoring of associated water volumes;
- A program for baseline assessment; and
- Tenure holder reporting of the data and activities relating to the above components.

OGIA has also provided Senex with groundwater modelling outputs from the 2021 UWIR numerical model to inform this assessment, which is detailed further in Sections 4.2 and Section 8.

Trigger Thresholds

Under Section 362 of the *Water Act 2000*, a bore trigger threshold, for a consolidated aquifer, of 5 m applies (2 m for an unconsolidated aquifer). The 5 m threshold represents the maximum allowable groundwater level decline in a groundwater bore, due to a petroleum tenure holder's activity, prior to triggering an investigation into the water level decline.

Under Section 379 of the *Water Act 2000* a spring trigger threshold for an aquifer applies. This includes vent springs / complexes and watercourse springs (i.e., gaining streams). This threshold value (0.2 m) represents the maximum allowable decline in the water level of an aquifer in connection with a spring, at the spring location, prior to triggering an investigation into the water level decline. The threshold value may change for an area if a regulation or prescribed threshold exists.

2.2.3 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (State of Queensland 2018b) is an Act with the objective 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 (ecologically sustainable development).

This Act states that 'to carry out an environmentally relevant activity (ERA) an environmental authority (EA) is required'. A resource activity, specifically a petroleum activity, is defined as an ERA.

Senex holds an environmental authority (EA; EA0002524) to prospect on ATP 2059. An application to convert ATP 2059 from an ATP to a PL under the *Queensland Petroleum and Gas (Production* *and Safety) Act 2004* (State of Queensland 2020d) is underway[2]. Senex proposes to apply for an EA amendment to authorise CSG production activities associated with the Project.

To apply for this amendment, the application must include the following items as detailed in Section 125 (Requirements for application generally) of the Act:

- Include an assessment of the likely impact of each relevant activity on the environmental values (EVs), including:
  - A description of the environmental values likely to be affected by each relevant activity;
  - Details of any emissions or releases likely to be generated by each relevant activity;
  - A description of the risk and likely magnitude of impacts on the environmental values;
  - Details of the management practices proposed to be implemented to prevent or minimise adverse impacts; and
  - Details of how the land, the subject of the application, will be rehabilitated after each relevant activity ceases.

Under the *Environmental Protection Act 1994*, streamlined model conditions for petroleum activities have been developed for incorporation into EA's. These are provided in a guideline published by DES (DES 2016b). The streamlined conditions are based on acceptable management approaches and constraints to protect environmental values.

2.2.4 Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The purpose of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019b) is to achieve the object of the *Environmental Protection Act 1994* in relation to waters and wetlands; protecting Queensland's water environment while allowing for development that is ecologically sustainable.

2.2.4.1 CSG Water Management Policy 2012

The Coal Seam Gas Water Management Policy 2012 (DEHP 2012) primary objective relates to the management and use of CSG water under the *Environmental Protection Act 1994*. The role of the policy is to:

- Clearly state the government's position on the management and use of CSG water;
- Guide CSG operators in managing CSG water under their environmental authority; and
- Ensure community understanding about the government's preferred approach to managing CSG water.

The *End of Waste Code Irrigation of Associated Water (including coal seam gas water)* (State of Queensland 2019d) and *End of Waste Code Associated Water (including coal seam gas water)* (State of Queensland 2019c) support the objective of the *Coal Seam Gas Water Management Policy 2012*, by specifying the standards required to be met where associated water is to be used

[2] The term ATP 2059 in this report includes any renewal, replacement, substitution, consolidation, subdivision, variation, or extension of the ATP2059 tenement (including by way of a potential commercial area).

for beneficial purposes. These requirements and conditions are designed to ensure that irrigation of CSG water carries no greater risk than what is acceptable for any other irrigation scheme.

2.2.5 Water Supply (Safety and Reliability) Act 2008

The *Water Supply (Safety and Reliability) Act 2008* (State of Queensland 2017c) is an Act that provides for the safety and reliability of water supply. The purpose of this Act is achieved primarily by providing:

- A regulatory framework for providing water and sewerage services in the State, including functions and powers of service providers;
- A regulatory framework for providing recycled water and drinking water quality, primarily for protecting public health;
- The regulation of referable dams;
- Flood mitigation responsibilities; and
- The protection of the interests of customers of service providers.

The key component of the Act relevant to the Project relates to the regulation of referable dams.

2.2.6 Sustainable Planning Act 2009

The *Sustainable Planning Act 2009* (State of Queensland 2017b) has a purpose to achieve ecological sustainability by managing the process by which development takes place, including ensuring the process is accountable, effective and efficient and delivers sustainable outcomes; managing the effects of development on the environment, including managing the use of premises; and continuing the coordination and integration of planning at the local, regional and State levels.

This act is relevant to the Project in terms of the proposed infrastructure associated with CSG production.

2.3 Environmental Values and Water Resource Management

2.3.1 Overview

The *Environmental Protection Act 1994* (Queensland Government 2022) defines an Environmental Value (EV) as:

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

Under the *Environmental Protection Act 1994*, the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019b) is established as subordinate legislation to achieve the object of the Act in relation to Queensland Waters. The purpose of the *Environmental Protection (Water) Policy 2009* is achieved by:

- Identifying EVs and management goals for Queensland waters;

- Stating water quality guidelines and water quality objectives (WQOs) to enhance or protect the EVs;
- Providing a framework for making consistent, equitable and informed decisions about Queensland waters; and
- Monitoring and reporting on the condition of Queensland waters.

Surface Water Environmental Values

The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019b) provides defined EVs and WQOs for surface and groundwater under Schedule 1 of the policy. The catchments and plans of relevance of the Project are:

- The Dawson River sub-basin (State of Queensland 2011).
- The WQ1308 plan (State of Queensland 2013) that accompanies the policy indicates that the Project area is located on the southern tributaries of the Upper Dawson.

Relevant EVs for surface water are presented in Table 2.1.

Table 2.1 Environmental Values for the Dawson River Sub-Basin within the Vicinity of the Project (State of Queensland 2011)

Water	Environmental Values											
	Aquatic Ecosystem	Irrigation	Farm Supply / Use	Stock Water	Aquaculture	Human Consumer	Primary Recreation	Secondary Recreation	Visual Recreation	Drinking Water	Industrial Use	Cultural And Spiritual Values
Dawson River Sub-Basin												
Upper Dawson Southern Tributaries	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Undeveloped Areas	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓

✓ denotes the EV is selected for protection. Blank indicates that the EV is not chosen for protection.

Water Quality Objectives – Surface Water

WQOs for surface water (State of Queensland 2011; 2020a) are also outlined to protect EVs. A summary of the relevant WQOs for surface water in the Upper Dawson are provided below:

- Where the aquatic ecosystem has high ecological value the WQO is to maintain the existing water quality, habitat, biota, flow, and riparian areas.
- For the Upper Dawson River sub-basin waters and main trunk, the aquatic ecosystem is described as moderately disturbed and specific water quality guidelines have been produced (Table 2 of State of Queensland 2011).

- For the protection for human consumption, objectives as per the Australian drinking water guidelines (ADWG) (NHMRC 2011) and Australia New Zealand Food Standards Code (Commonwealth of Australia 2016).
- For suitability for industrial use there are no WQOs as water quality requirements vary within the industry.
- For secondary contact and visual recreation, objectives as per NHMRC (NHMRC 2011).
- For drinking water, local WQOs exist which relate to before and after water treatment and are based on several guidelines / legislations including the ADWG (NHMRC 2011).
- WQOs to protect or restore indigenous and non-indigenous cultural heritage should be consistent with relevant policies and plans.
- For irrigation, WQOs exist for metals, pathogens, and other indicators in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).
- For stock watering, objectives exist for faecal coliforms, total dissolved solids, metals, and other objectives based on established guidelines (ANZG 2018).
- For farm use / supply, objectives are as per the guidelines in (ANZG 2018).
- For primary contact recreation objectives as per NHMRC (NHMRC 2011) and for fresh water objectives exist for cyanobacteria / algae.

Groundwater Environmental Values

Groundwater EVs for the Upper Dawson are presented in Table 2.2.

The WQ1308 plan for the Upper Dawson (State of Queensland 2013) that accompanies the policy provides groundwater EV status for groundwaters in the Southern tributaries. The EVs presented in Table 2.2 indicate that groundwater EVs extend to all categories listed, except for aquaculture, human consumption, and secondary recreation.

Table 2.2 Groundwater Environmental Values for the Dawson River Sub-Basin within the Vicinity of the Project (State of Queensland 2011)

Water	Environmental Values											
	Aquatic ecosystem	Irrigation	Farm supply / use	Stock water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural and spiritual values
Dawson River Sub-Basin												
Groundwater	✓	✓	✓	✓			✓		✓	✓	✓	✓

✓ means the EV is selected for protection. Blank indicates that the EV is not chosen for protection.

Water Quality Objectives – Groundwater

A summary of the WQOs for groundwater in the Upper Dawson are provided below:

- For WQOs of aquatic ecosystems applicable to groundwater where groundwater interacts with surface water, the groundwater quality should not compromise identified EVs and WQOs for those waters.
- For drinking water, local WQOs exist which relate to before and after water treatment and are based on a number of guidelines / legislation including the ADWG (NHMRC 2021).
- WQOs to protect or restore indigenous and non-indigenous cultural heritage should be consistent with relevant policies and plans.
- For irrigation, WQOs exist for metals, pathogens and other indicators in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).
- For stock watering, objectives exist for faecal coliforms, total dissolved solids, metals, and other objectives based on guidelines presented in ANZG (2018).
- For agricultural use / supply, objectives are as per the guidelines in ANZG (2018).

2.3.2 Water Resource and Resource Operations Plans

Water Plan (Great Artesian and Other Regional Aquifers) 2017

Groundwater in the Great Artesian Basin is managed within the *Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017* (State of Queensland 2017e), under the *Water Act 2000*. The purpose of the plan is:

- To define the availability of water in the plan area;
- To provide a framework for sustainably managing water and the taking of water; and
- To identify priorities and mechanisms for dealing with future water requirements.

Water Plan (Fitzroy Basin) 2011

The surface water resource of the Upper Dawson sub-basin is managed under the Queensland Water Resource Plan framework as part of the *Water Plan (Fitzroy Basin) 2011* (State of Queensland 2021h) . The purpose of the plan is to:

- Define the availability of water in the plan area;
- Provide a framework for sustainably managing water and the taking of water;
- Identify priorities and mechanisms for dealing with future water requirements;
- Provide a framework for establishing water allocations;
- Provide a framework for reversing, where practicable, degradation in natural ecosystems;
- Regulate the taking of overland flow water; and
- Regulate the taking of groundwater.

Fitzroy Basin Resource Operations Plan

The Fitzroy Basin Resource Operations Plan (ROP) (State of Queensland 2015) provides the process to implement the *Water Plan (Fitzroy Basin) 2011* (State of Queensland 2021h). The key function of the ROP is to provide the operating and environmental management rules and monitoring requirements to resource operations licence holders.

2.4 Application Requirements – Water

Section 126 and 126A of the *Environmental Protection Act 1994* outlines the application requirements related to CSG activities. Section 227 and 227A relates to requirements of amendment applications and require items in Section 126 and 126A to be addressed in applications.

The requirements of Section 126 relate to the management of CSG water. These are addressed in the CSG Water Management Plan (SENEX-ATLS-EN-PLN-013).

Section 126A outlines the requirements for applications involving the exercise of underground water requirements. These requirements are outlined in Table 2.3 and include reference to sections of the report where these items are addressed.

Table 2.3 Key *Environmental Protection Act 1994* Statutory Requirements

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 3
126A(2) (b)	The areas in which underground water rights are proposed to be exercised.	Figure 1.1 Section 3
126A(2) (c)	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; ▪ 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 7 Section 3
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 2, 6, 7 and 9
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 9
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

Application Requirements – Guideline

DES have published a guideline under the Act for 'Application Requirements for Activities with Impacts to Water' (State of Queensland 2021b), which outlines the information to be provided to support an EA application for activities with impacts to water. The requirements of this guideline have been considered and addressed as part of this assessment.

3 PROJECT DESCRIPTION

3.1 Project Location

ATP 2059 covers an area of approximately 18.5 km^2 and is located approximately 14 km southwest of the township of Wandoan (shown in Figure 1.1). The CSG target coal seam for the Project is the Walloon Coal Measures (WCM).

The Project is located adjacent to Senex's Project Atlas (PL 1037), PL 445 and PL 209; and other CSG tenure holders including QGC and APLNG, which are summarised in Table 3.1 and presented in Figure 3.1.

Table 3.1 Adjacent CSG Tenure Holders (OGIA 2019b)

<table>
<tr><th>Tenure Holder</th><th>Tenure</th><th>Gas Field</th><th>Location</th><th>Commencement</th><th>Cessation</th></tr>
<tr><td rowspan="3">Senex</td><td>PL 1037</td><td>Atlas</td><td>Directly S</td><td>2018</td><td>2060 - 2065</td></tr>
<tr><td>PL 209</td><td>Louisiana</td><td>Directly E</td><td>2023</td><td>2058</td></tr>
<tr><td>PL 445</td><td>Louisiana</td><td>Directly E</td><td>2023</td><td>2023 - 2073</td></tr>
<tr><td rowspan="6">QGC</td><td>PL 398</td><td>Polaris</td><td>Directly N</td><td rowspan="2">Prior 2018</td><td rowspan="2">2060 - 2065</td></tr>
<tr><td>PL 399</td><td>Polaris</td><td>Directly NW</td></tr>
<tr><td>PL 401</td><td>Portsmouth</td><td>NW</td><td>Prior 2018</td><td>2060 - 2065</td></tr>
<tr><td>PL 277</td><td>Mamdal</td><td>W and S</td><td>Prior 2018</td><td>2060 - 2065</td></tr>
<tr><td>PL 276</td><td>Ross</td><td>~8km</td><td>Prior 2018</td><td>2050 - 2055</td></tr>
<tr><td>PL 510</td><td>Paradise Downs</td><td>~2.5 km E</td><td>2020 - 2024</td><td>2060 - 2069</td></tr>
<tr><td rowspan="3">APLNG</td><td>PL 444</td><td>Sandpit</td><td>Directly NE</td><td>Application – not indicated</td><td></td></tr>
<tr><td>PL 470</td><td>Ramyard</td><td>~15 km S</td><td>2020</td><td>2050 - 2055</td></tr>
<tr><td>PL 469</td><td>Ramyard Central</td><td>~20 km S</td><td>2025 - 2029</td><td>2050 - 2059</td></tr>
</table>

The Project is located adjacent to the proposed Wandoan Coal Project (tenure holder: Glencore), which was granted Mining Lease (ML) 50229, 50230 and 50231 in 2017 (OGIA 2021a). ML 50230 partially overlies PL 445 (east of ATP 2059, Figure 3.1). The Wandoan Coal Project is a proposed open-cut thermal coal mine targeting the Juandah Coal Measures, which is anticipated to commence in 2024 and with peak development (all mining areas in operation) expected around 2056 (OGIA 2021a). Development of the mine is currently on hold subject to market conditions (OGIA 2021a).

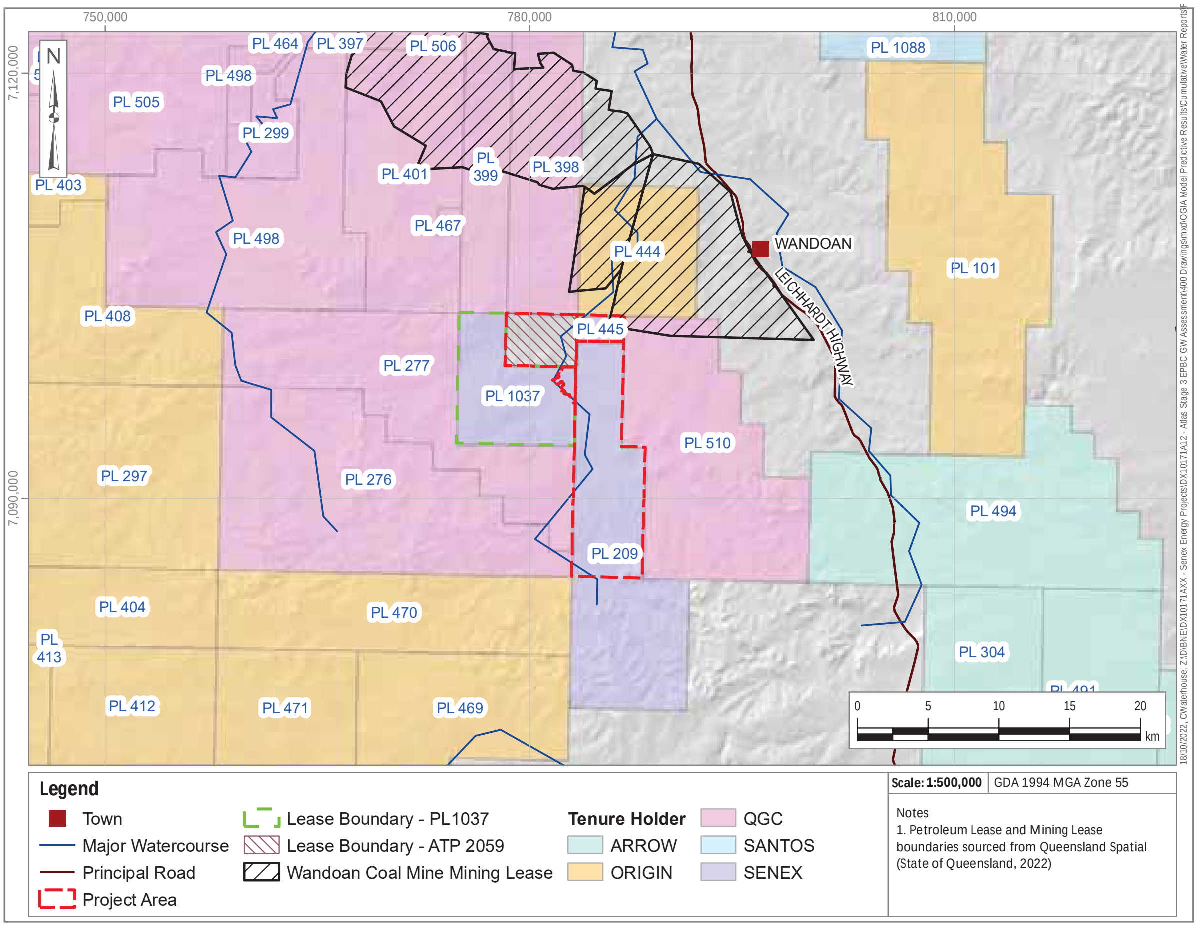

Figure 3.1 Neighbouring Petroleum and Mining Leases

3.2 Project Components

Gas field production, planned to commence in 2023, will include but not be limited to the following activities:

- Drilling, installation, operation and maintenance of 31 CSG production wells targeting the Walloon Coal Measures (WCM) of the Surat Basin;
- Installation, operation and maintenance of gas and water gathering systems for the producing wells;
- Installation, operation and maintenance of associated supporting infrastructure (e.g., access tracks, laydown areas, stockpiles, borrow pits, and ancillary supporting facilities);
- Installation, operation and maintenance of water and brine storage and management facilities, and
- Decommissioning and rehabilitation of infrastructure and disturbed areas.

Details of the Project components, including location and size, will be confirmed progressively over the life of the Project. The existing water storage and water management facilities on PL 1037 will be utilised for this Project.

3.3 Project Activities and Infrastructure

3.3.1 CSG Production Wells and Water Production

The *Petroleum and Gas (Production and Safety) Act 2004* (State of Queensland 2020c) identifies underground water rights for petroleum tenures. Senex intend to exercise their underground water rights as the petroleum tenure holder of ATP 2059.

Groundwater abstraction is required as part of the gas production process. Groundwater is abstracted (pumped) from production wells to depressurise the target production coal seams. Depressurisation generates gas flow and sustains groundwater flow from the well to maintain the target producing operational pressure for each production well. A summary of the proposed development is provided as follows:

- A total of 31 production wells will be drilled and constructed in accordance with the 'Code of Practice for the construction and abandonment of petroleum wells, and associated bores in Queensland Version 1' (State of Queensland 2019a). (see Section 2.2.1). The final location of the wells will be selected and established in accordance with the Senex Environmental Protocol for Field Development and Constraints Analysis (SENEX-QLDS-EN-PRC-019) (the Constraints Protocol) (see Section 10.5).
- Hydraulic fracturing is not planned as part of the Project.
- Water and gas will be produced from all CSG production wells.
- Subject to relevant approvals, gas production and its associated water extraction will commence after 2023, and the gas field will be progressively developed over a period of approximately 5 to 10 years.
- Senex estimate that up to six months will be required to reduce water levels in each production well for gas to flow and approximately 18 months to reach optimum gas production. Once depleted of gas, wells will be progressively decommissioned and rehabilitated throughout the Project life. Decommissioning of individual wells is not expected to occur until after the well has been producing for at least 15 years and may be much longer (anticipated to be between 20 and 50 years).

Produced water volumes and rates are predicted using an analytical modelling tool, developed by Senex, with probabilistic distributions applied to several key reservoir parameters (i.e., permeability, porosity and net coal). The model predictions generate production profiles (type curves). These production profiles are used in field development planning to provide a water forecast. Type curves are updated during the life of the Project as more information (e.g., key reservoir parameters) become available.

Figure 3.2 presents the predicted water production rate for ATP 2059, with a 2023 commencement date. Peak CSG water production is predicted to occur in 2025 at an average daily rate of ~1.6 ML/d. The estimated annual total CSG water production for the life of ATP 2059, as well as the cumulative water production volume, is presented in Figure 3.3. It is estimated that ~1.4 GL of groundwater will be abstracted during the Project life (~30 years).

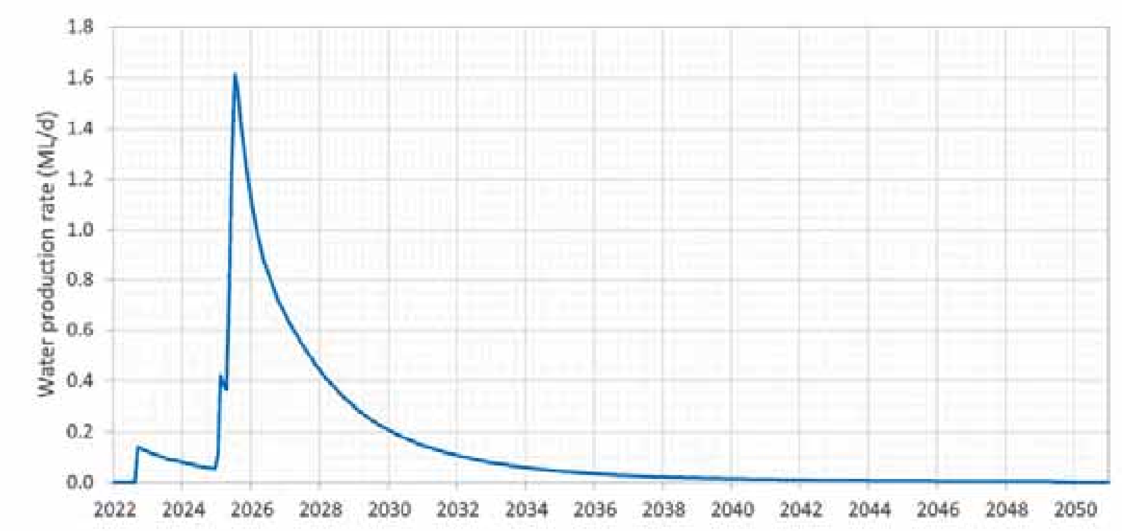

Figure 3.2 Proposed CSG Water Production Rate for ATP 2059 (31 CSG Production Wells)

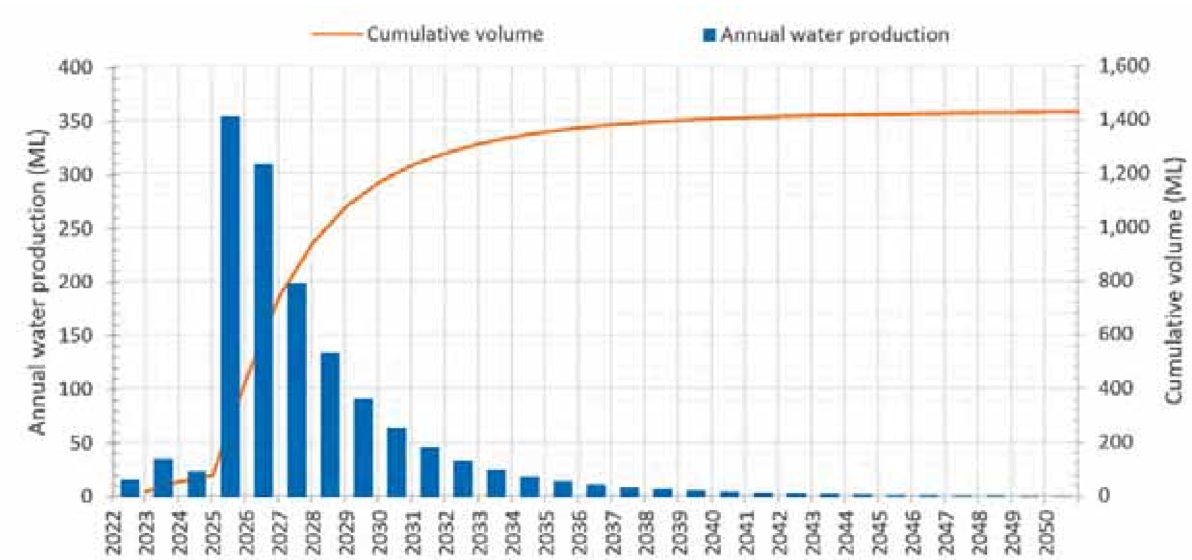

Figure 3.3 Proposed Annual CSG Water Production and Cumulative Volume for ATP 2059 (31 CSG Production Wells)

3.3.1.1 CSG Water Management

CSG produced water for the Project will be collected via water gathering systems. Where practicable, and to the extent authorised by current and future approvals, the proposed action will integrate with infrastructure constructed as part of Project Atlas on PL 1037 and Atlas Stage 3 on PL 445 and PL 209. Such integration will maximise operational efficiency and reduce the impacts of the proposed action.

The water management process for the produced water is expected to involve:

- Water gathering systems from the producing wells, brine and produced water storages, including aggregation dams and brine tanks, and irrigation dams. Where practical, the water management infrastructure required for ATP 2059 will integrate with existing and future PL 1037, PL 445 and PL 209 infrastructure.

- Water will be treated through the existing Project Atlas water treatment facility which has adequate capacity to accommodate the Project development.
- New aggregation dams will be established on PL 1037 and/or PL 209 to service the total Atlas Stage 3 water production. Where additional aggregation storage is required, measures will range from pre-engineered above ground tanks to purpose built earthen dams with impervious liners and leakage detection/collection systems.
- Subject to water production rates and other field development characteristics, an additional water treatment facility may also be constructed on PL 209.
- Treated water will be transferred to existing and new irrigation dam(s) (approximately 50-200 ML each) on PL 1037 and/or PL 209.
- In total, up to 30 ha of brine storage and up to 30 ha water storage will be established as a result of the proposed action.
- Brine from the water treatment process will be stored in a new brine storage dam[3] (up to 300 ML) which will be developed on PL 1037 and is part of the proposed action. Additional brine storage (up to 300 ML) may also be required on PL 209 if a water treatment facility is established.

The infrastructure and flow process associated with water management is provided in Figure 3.4.

Senex's strategy for CSG water management for the Project has been developed based on the DES Prioritisation Hierarchy (DEHP 2012). The water management options have been developed to maximise beneficial use of water.

The ATP 2059 CSG Water Management Plan (SENEX-ATLS-EN-PLN-013) provides further information relating to the management of CSG water and associated water storage.

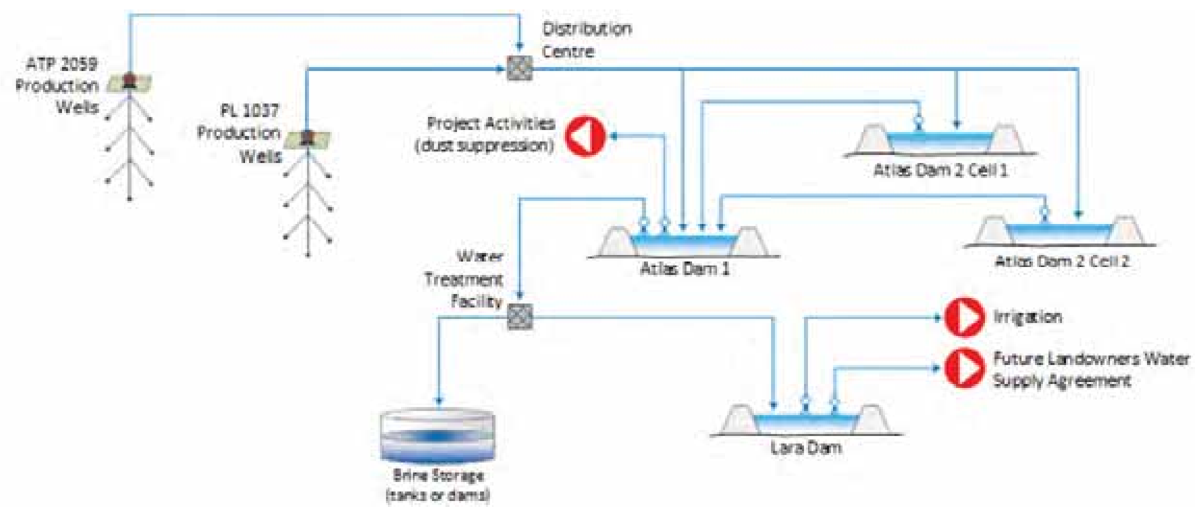

Figure 3.4 Water Management Infrastructure Schematic

[3] The treatment of CSG produced water using desalination technologies results in brine.

3.3.1.2 Infrastructure Location Planning

The exact locations of water management infrastructure within the Project area are still to be finalised. To support well field layout for all surface infrastructure, including wells and gathering pipelines, and to avoid, minimise and manage potential impacts across the Project area, Senex will implement the 'Environmental Protocol for Field Development and Constraints Analysis' (Senex 2018b; SENEX-QLDS-EN-PRC-019) (the Constraints Protocol). The Constraints Protocol aims to ensure that infrastructure siting:

- Considers biodiversity values and environmental constraints, such as sensitive receptors, when selecting preferential locations; and aligning with planning principles to avoid, minimise, mitigate and then manage potential environmental impacts; and
- Identifies any additional external environmental approvals required and that those are secured prior to the commencement of construction activities.

With respect to EVs, the protocol addresses avoiding or minimising and managing potential impacts to:

- Biodiversity values contributing to environmentally sensitive areas (ESA), matters of state environmental significance (MSES) and MNES;
- Habitat for wildlife, including threatened MSES and MNES threatened communities, flora and fauna; and
- Wetlands, watercourses, springs and groundwater dependent ecosystems.

The Constraints Protocol also recognises that, in addition to environmental constraints, landholder, engineering and cultural heritage constraints must be considered during infrastructure siting.

The process involves a desktop constraints analysis, site surveys, post-survey environmental constraints analysis and preparing a report that includes a list of site-specific environmental conditions and associated constraints maps. These are included in the final Access to Work (ATW) documentation, issued upon sign-off by the Project Manager to relevant staff and contractors prior to commencing construction.

Further field investigations may be undertaken to confirm the suitability and baseline conditions prior to finalising the locations of infrastructure.

4 METHODOLOGY

4.1 Existing Environment and Environmental Values

The existing environment across the Project area was considered through a desktop assessment to establish the baseline groundwater conditions, EVs, and potential receptors. This was further supported with the undertaking of a field program to collect site-specific information. This assessment included a review of the data collected for the directly adjacent PL 1037, PL 445 and PL 209.

The assessment area, for the purposes of this report, includes the surface water features within the Project area, hydrogeological units underlying the Project within the Surat Basin and overlying Quaternary deposits. For the identification of groundwater receptors relevant to this Project, a 25 km buffer around the greater Project area (which includes PL 445 and PL 209) was established to capture potential adjacent groundwater receptors that may be impacted by the proposed development.

Primary data and information utilised in this assessment is listed below.

4.1.1 Information and Data Sources

A preliminary desktop assessment utilised data and information provided by Senex, OGIA and publicly available reports and data. Primary data and information utilised in this assessment includes:

Datasets:

- Geological maps for the Surat Basin, including the Detailed Surface Geology – Queensland (DNRM 2015).
- 2018 Surat CMA regional geological model (OGIA 2019d) and Groundwater modelling report for the Surat CMA (OGIA 2019a).
- Queensland groundwater bore database (GWDB) for registered water bore data from private water bores and Queensland Government groundwater investigation and monitoring bores (OGIA 2022).
- OGIA aquifer attribution (OGIA 2019b).
- The Queensland Spring Database provides a comprehensive catalogue of springs and potential GDEs at fixed locations in Queensland. The Queensland Spring Database is updated annually (Queensland Herbarium 2021).
- DSITI Queensland Groundwater Dependent Ecosystem Mapping (State of Queensland 2018c), which indicates the locations of potential groundwater dependent ecosystems (GDEs) at a catchment scale (both surface expression and terrestrial).

Reports

- Underground Water Impact Report for the Surat CMA (OGIA 2021g).
- Surat CMA and its groundwater systems (OGIA 2021e).

- Geology and 3D geological models for Queensland's Surat and southern Bowen Basins: Stratigraphic framework, data, methods and results (OGIA 2021b).
- Springs in the Surat CMA (OGIA 2016a).
- Identification of Gaining Steams in the Surat CMA; Hydrogeological Investigation Report (OGIA 2017b).
- Environmental Protection Policy (Water) 2009 – Dawson River Sub-Basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Dawson River Sub-basin except the Callide Creek Catchment (State of Queensland 2011).

4.1.2 Field Programs

Field programs were undertaken to confirm the existing environment and EVs across the Project. A summary of these programs is provided in the following sections.

4.1.2.1 Ecological Survey and GDE Mapping

Terrestrial and aquatic ecology field surveys were undertaken by ERM (ERM 2022b) and Freshwater Ecology (Freshwater Ecology 2022a). This included the mapping of potential GDEs within the Project area and verification of vegetation communities which may be reliant on groundwater (ERM 2022a, Appendix VI).

4.1.2.2 Bore Baseline Assessment

A bore baseline assessment was required to be undertaken by Senex, as part of the *Water Act 2000*, on the existing water bores within ATP 2059 tenure. A baseline Assessment Plan was prepared and approved by DES, and the assessments were undertaken in accordance with the requirements and methodology outlined in the 'Baseline Assessment Guideline' (State of Queensland 2021f).

4.1.2.3 Field Verification Mapping

Surface water and groundwater features mapped within the Project area include several watercourses, alluvium associated with the watercourses, a potential baseflow fed reach and potential terrestrial GDEs.

Due to wet weather, field verification of ATP 2059 could not be undertaken. However, field verification mapping has been undertaken for neighbouring PL 1037 in 2018 for EPBC approvals (KCB 2018d). The 2018 field verification included upstream Woleebee and Wandoan Creek which are present in the Project area, and which have similar characteristics to the reaches present in ATP 2059. The 2018 field verification program included:

- Field mapping and surface water sampling (where possible) of Wandoan Creek, and Woleebee Creek;
- Data collection and observation related to the nature and extent of the alluvium, creek flow, groundwater-surface water connectivity and assessment of inferred hydrogeological conditions in the areas of mapped potential GDEs (DES 2018d); and

- Groundwater and surface water sample collection in the area of Woleebee Creek, a potentially gaining stream (identified in OGIA (2017b)), to assist in the assessment of any potential watercourse springs and identification of the source aquifer.

The observations from the field verification mapping are described further in Section 6.5.2, 7.3.2, and 7.9.

4.1.2.4 GDE Subterranean Fauna

Sampling for subterranean fauna was undertaken at twelve existing landholder bores within neighbouring PL 445 and PL 209. The sampling was undertaken in accordance with available technical sampling guidelines (DES 2018c; EPA 2016b). Sampling was undertaken by Freshwater Ecology (Freshwater Ecology 2022b)(Appendix V).

Biota sorting and identification were completed by Blue Earth Environmental. In-situ groundwater quality was considered high and suitable for the presence of stygofauna.

Stygofauna sampling was undertaken by Hydrobiology on neighbouring PL 1037 at four existing landholder bores in 2018 for the Project Atlas approvals (KCB 2018d). The sampling was undertaken in accordance with available technical sampling guidelines (DES 2018c; EPA 2016b).

4.1.2.5 Aquatic Ecology Survey

Aquatic ecology surveys were undertaken by ecologists from Freshwater Ecology (2022a). Survey sites were chosen along Wandoan and Woleebee Creek in ATP 2059 (see Section 6.9).

Aquatic Habitat Assessment

Aquatic habitat assessment was undertaken in accordance with the Queensland AUSRIVAS Sampling and Processing Manual (DNRM 2001) describing each survey watercourse reach and its immediate surrounds. Planform and cross-sectional sketches recorded bank full height, bank full width, depth, wetted width and normal width, as well as key habitat features. Georeferenced photographs including upstream, downstream, left bank, and right bank directions were taken at each site, and throughout lengths of the traversed dry creek sections. A record was kept of condition and micro- and macro-habitat features of the creek sections between sites.

To assist with interpreting habitat classification, the River Bioassessment Program scores (bioassessment scores; out of 135) were calculated for all sites based on nine AUSRIVAS categories, including:

- Habitat availability (pool/riffle, run/bend ratio);
- Bank stability;
- Streamside cover;
- Bed substrate composition and embeddedness;
- Channel alteration; and
- Presence of scouring and/or deposition.

From these scores, an aquatic habitat condition rating was calculated and categorised into Poor, Fair, Good or Excellent habitat conditions.

Aquatic Flora

An inventory of aquatic flora species identified during the field program was compiled based on visual observation and identification. Species were identified in the field using available literature, and the presence and site coverage (i.e., extensive, moderate, some, little) of aquatic flora were determined. Species were categorised by growth form (i.e., free floating, floating attached, submerged, emergent).

Macroinvertebrates

Macroinvertebrate sampling was undertaken using a combination of AUSRIVAS protocols and replicated samples, to assess which method may provide the most representative understanding of macroinvertebrate communities in the Project area. AUSRIVAS protocols are intended to be used at a catchment or regional scale, whereas for smaller scale studies, control and replicate sites are likely to be more appropriate. Samples were obtained from each site for each of the aquatic habitats present:

- Edge habitat – sample collected by sweeping a 250 µm mesh dip-net along bank habitat, proportionally incorporating the spatial occurrence of key microhabitats present within the sampled stream reach; and
- Bed habitat – benthic (bed) samples were obtained using the kick-sampling method, which consisted of kicking and disturbing the bed and sweeping the disturbance with a 250 µm mesh dip-net to capture dislodged macroinvertebrates.

Habitat conditions were recorded, detailing macroinvertebrate habitat conditions, including physical characteristics (width, depth, velocity), substrate composition (silt, sand, mud, gravel) and microhabitat structure (detritus, sticks, logs, plants).

For Queensland, live-picking macroinvertebrates from the sample is the method required for the Queensland AUSRIVAS modelling program (DNRM 2001). AUSRIVAS sampling protocols require that a habitat type should be sampled if it accounts for more than 10% of the study reach. Macroinvertebrates were collected from both the edge and bed habitats (where available) at all sites from freshwater watercourses (impoundments and wetlands are not appropriate comparisons).

All picked specimens were placed into sample jars and preserved with 70% ethanol for later identification.

All preserved samples were processed under laboratory conditions by AUSRIVAS-accredited scientists, who performed identification and enumeration of macroinvertebrates. Organisms were generally identified to family level, with the exception of lower phyla (nematoda, nemertea etc.), oligochaetes (freshwater worms), acarina (mites) and microcrustacea (ostracoda, copepoda and cladocera). Chironomids were identified to sub-family level, in accordance with standard AUSRIVAS protocols (DNRM 2001).

Fish, Macrocrustaceans and Turtles

Fish surveys were conducted in line with the approach outlined in the Monitoring and Sampling Manual: Environmental Protection (Water) Policy (DES 2018a). All electrofishing sampling was undertaken by senior electrofishing operators and in accordance with the Australian Code of Electrofishing Practice (NSW Fisheries 1997).

Sampling methods at each site included fyke nets, backpack electrofishing and unbaited boxes. Fish were identified to species level, enumerated, measured and assessed for obvious wounds, lesions or deformities. After completion of processing, all native species were released at the point of capture.

Unbaited box trapping is a passive fish sampling technique that targets small bodied pelagic and benthic species. Five to ten unbaited box traps were strategically placed at all sites for between 30 minutes and 2 hours.

Backpack electrofishing

Backpack electrofishing was undertaken in waterways that held water, using a LR20B electrofishing unit. Sampling was carried out over a site reach spanning at least 100 m (where sufficient water was available), with care being taken to sample all macro and microhabitat types. Settings for the backpack electrofisher varied between sites, depending on water conductivity, depth, fish size and species. All electrofishing was undertaken in compliance with the Australian Code of Electrofishing Practice (NSW Fisheries 1997) with the minimum power setting used to effectively attract and stun the fish.

Fyke netting

Fyke nets were deployed at sites that had sufficient water levels. Nets were deployed with sufficient breathing area above the water for air-breathing fauna that might be captured (i.e., turtles).

4.2 Impact Assessment

4.2.1 Groundwater

Based on information provided by Senex (e.g. number and location or wells, productions scheduling and durations), OGIA completed predictive simulations for Senex using the regional groundwater flow model that underpins the Surat CMA UWIR 2021 (OGIA 2021g). Modelling included simulations to predict groundwater drawdown from the Project only scenario, and a cumulative scenario, which is inclusive of other surrounding CSG proponents' developments, inclusive of the proposed Project. Outputs from the modelling have been processed by KCB for this assessment. The results of the modelling have been processed and considered as part of this assessment (Sections 8 and 9).

The assessment criteria used to consider the groundwater drawdown impacts associated with the Project refers to the *Water Act 2000*, trigger thresholds, as outlined in Section 2.2.2:

- Bore trigger threshold, represents the maximum allowable groundwater level decline in a groundwater bore, due to petroleum tenure holders' activities, prior to triggering an investigation into the water level decline.
  - For a consolidated aquifer – 5 m
  - For an unconsolidated aquifer – 2 m
- Spring trigger threshold represents the maximum allowable decline in the water level of an aquifer in connection with a spring, at the spring location, prior to triggering an investigation into the water level decline.
  - Spring – 0.2 m

An assessment of the potential impacts also includes the development of the conceptual understanding of the system, in particular, hydraulic connection between identified receptors and the hydrostratigraphic units being drawdown/depressurised.

Other potential impacts associated with the Project in relation to groundwater are presented in Section 9 with the relevant mitigation, management and monitoring measures to address these potential impacts provided in Section 10.

4.2.2 Surface Water

Potential impacts to surface waters as a result of the Project could results from:

- Unexpected discharge of CSG produced water to watercourses, with the potential to impact the quality, quantity and ecotoxicological value.
- Impacts on streamflow quality or quantity due to the drawdown in aquifers may potentially provide baseflow to watercourses.
- Localised transport of suspended sediment to waters during construction or site works, resulting in the potential to alter flow regimes and quality.
- Localised release of hydrotest water, effluent or trench water to land.

- Alteration of a watercourse character or changes to riparian buffers due to construction works.

The proposed Project does not include any discharges to surface water or interaction with surface water bodies and therefore direct impacts to surface water from Project activities are not anticipated. A review of other potential impacts to surface water as a result of the Project are discussed in Section 9.1.2. These impacts are managed and mitigated by adopting and implementing the appropriate monitoring, management and mitigation strategies (Section 10). Further discussion of these potential impacts is included in the following sections.

5 EXISTING ENVIRONMENT

5.1 Topography

The topography of the Project area is presented in Figure 5.1. Elevations across the area range between 250 mAHD[4] and 290 mAHD, with the topographic lows associated with the presence of Wandoan Creek which flows easterly across ATP 2059. The higher topographic areas are generally located to the northwest and southwest. The Project is located within the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin.

5.2 Climate

The Project area is classified under the modified Köppen classification system (BOM. 2005) as subtropical with no dry season. Climate statistics for Roma Airport weather station (43091) and rainfall statistics for Wandoan Post Office weather station (35014) are presented in Table 5.1. Mean maximum temperatures range between 34.6°C in the summer months and 20.4°C in the winter months. Mean minimum temperatures range between 20.1°C in the summer months and 3.8°C in the winter months. Daily evaporation rates are generally high and exceed rainfall throughout the year. The highest rainfall occurs during December to February, with the lowest rainfall occurring during April to September.

Table 5.1 Climate Statistics for Roma Airport and Wandoan Post Office, Site Numbers 43091 and 35014 (BOM 2022a; 2022b)

Statistic Element	Roma Airport (43091)				Wandoan Post Office (35014)
	Mean maximum temperature (°C)	Mean Minimum temperature (°C)	Mean Daily evaporation (mm)	Mean Rainfall (mm)	Mean Rainfall (mm)
Period of Record	*1992 to 2022*	*1992 to 2022*	*1992 to 2022*	*1985 to 2022*	*1955 to 2022*
January	34.6	21.0	10.3	66.9	83.4
February	33.0	20.0	8.6	89.6	76.3
March	31.6	17.5	7.8	58.9	53.9
April	28.2	12.4	6.2	31.9	36.4
May	23.9	7.6	4.4	32.1	35.4
June	20.5	5.2	3.2	29.0	33.7
July	20.4	3.8	3.5	21.3	28.9
August	22.8	4.7	4.6	22.4	26.9
September	26.8	9.3	7.0	25.2	28.9
October	30.0	13.6	8.6	49.8	51.7
November	32.3	17.2	9.2	60.4	64.7
December	33.6	19.4	9.7	77.6	94.7
Annual	**28.1**	**12.6**	**6.9**	**567.7**	**590.1**

Note: Roma Airport statistics to 27 February 2022, Wandoan Post Office Statistics to 27 February 2022 (Accessed 08 June 2022).

[4] Metres above Australian Height Datum

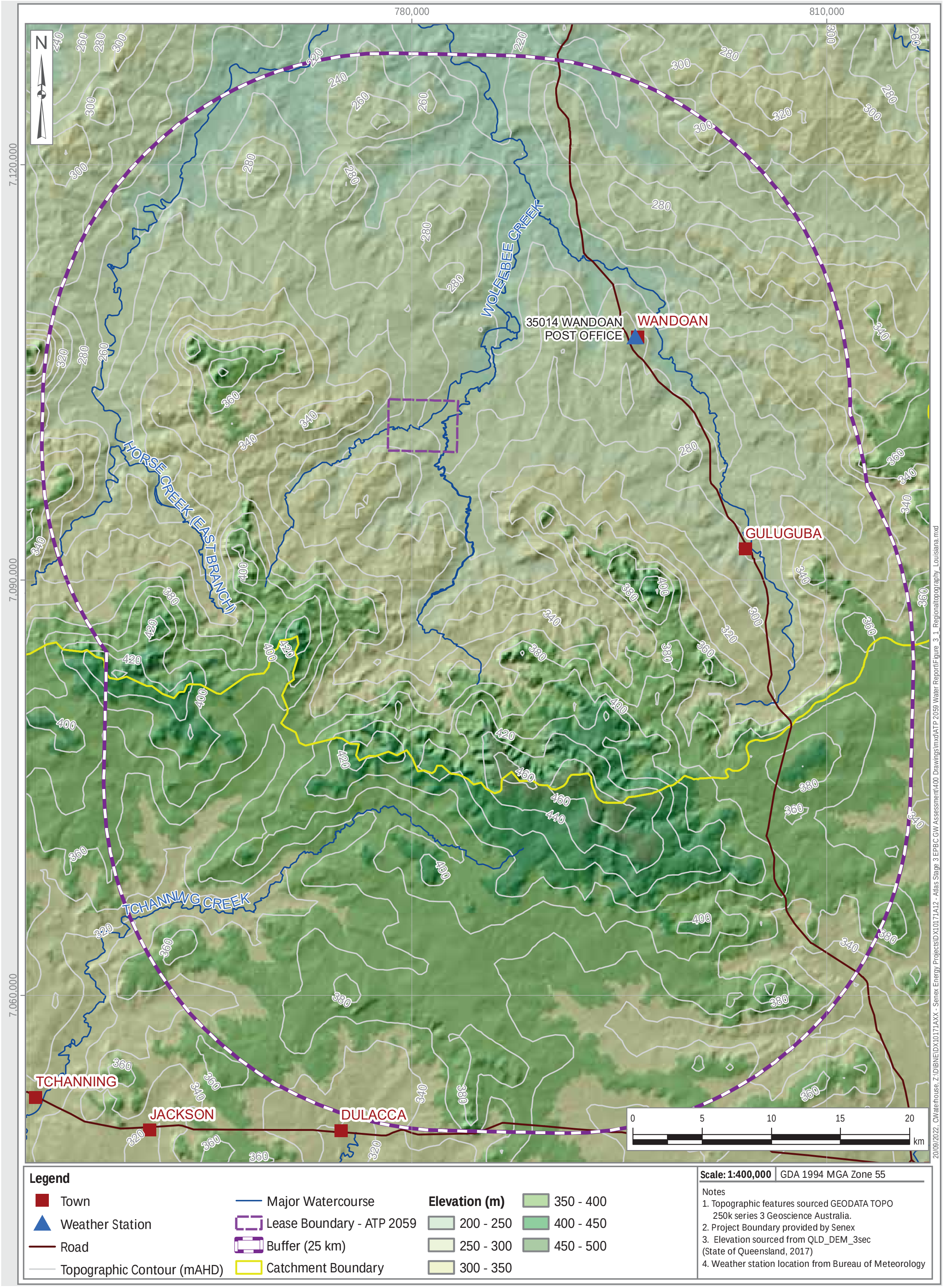

Figure 5.1 Project Area Regional Topography

Synthetic rainfall data were used to analyse rainfall trends due to incomplete rainfall data for the Project area (SILO 2022). SILO is an enhanced synthetic climate database that provides daily time series data for point locations and comprises actual station records augmented by interpolated estimates where observed data are missing.

Figure 5.2 presents daily rainfall between 1960 and 2022, as well as a cumulative rainfall departure (CRD) trend for the same period. CRD trends represent a running deviation of long-term actual rainfall against the overall average. This provides season-scale identification of trends (wet / dry) as well as longer term (e.g., decadal) deviation from average conditions. CRDs are useful for correlating rainfall events to aquifer responses. Observations from the CRD trend include:

- The overall rainfall trend is characterised by the cycle between the wet and dry seasons, with annual fluctuations of approximately 200 mm evident across the record.
- The trend shows a period of increasing rainfall between 1960 and 1986, a declining between 1986 and 1994, an increasing period to 1999 and a declining period to 2009.
- Between 2010 and 2012, a series of large rainfall events dominate the record, resulting in above average rainfall conditions, which is followed by a period of decline to present day.

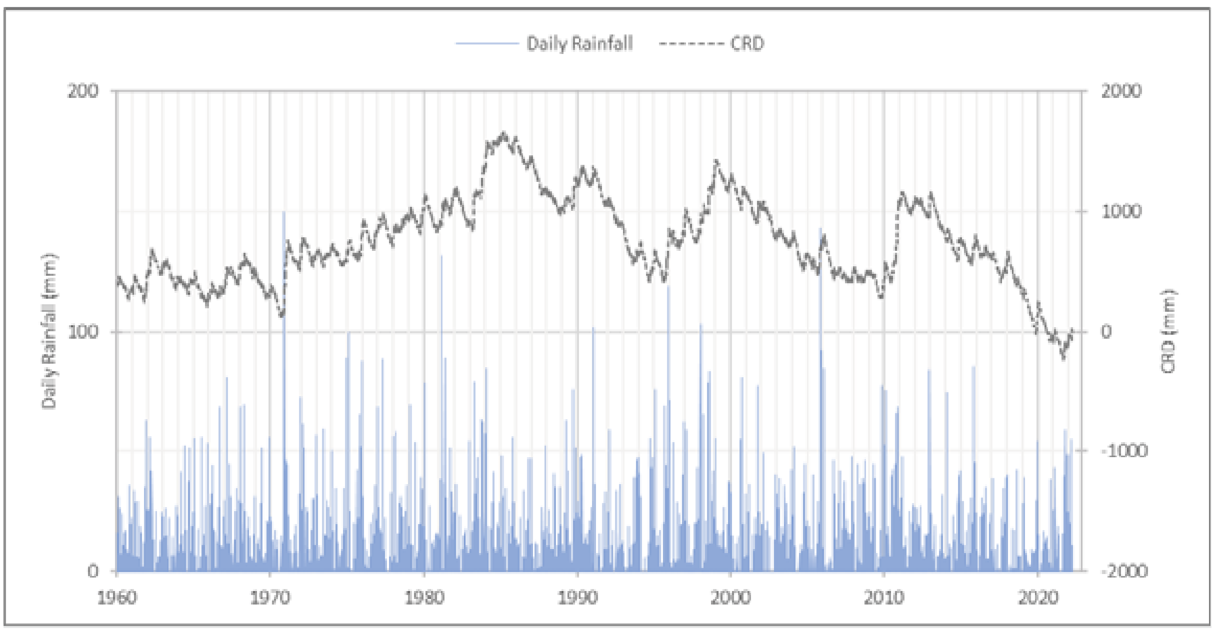

Figure 5.2 Daily Rainfall and CRD Trend for SILO grid location -26.15, 149.90 (SILO 2022)

5.3 Land Use

Land use information specific to the Project area has been sourced from the Queensland Land Use Mapping Program (QLUMP) (State of Queensland 2017a). The land use dataset classifies land use type using the Australian Land Use and Management (ALUM) Classification system which provides a nationally consistent method to collect and present land use information in Australia. This classification system categories 32 land use classes and subclasses. There are six primary classes used in the ALUM classification system. These are further divided into secondary and tertiary classes. A description of the primary classes (ABARES 2016) is detailed below:

- Conservation and natural environments – Land is used primarily for conservation purposes, based on the maintenance of essentially natural ecosystems already present.
- Intensive uses – Land is subject to substantial modification, generally in association with closer residential settlement, commercial or industrial uses.
- Production from dryland agriculture and plantations – Land is used mainly for primary production, based on dryland farming systems.
- Production from irrigated agriculture and plantations – Land is used mainly for primary production, based on irrigated farming.
- Production from relatively natural environments – Land is used mainly for primary production based on limited change to the native vegetation.
- Water – Although primarily land cover types, water features are regarded as essential to the classification.

Figure 5.3 presents the land use across the Project area with a summary of the land use distribution (area and percentage) directly within the ATP 2059 lease provided in Table 5.2. There are only four types of land use within the Project area. The dominant land use is production from relatively natural environments, specifically grazing native vegetation.

Table 5.2 Summary of the ATP 2059 Current Land Use

Land Use Category			Area (km^2)	Percentage of Total Area
Primary	Secondary	Tertiary		
Production from dryland agriculture and plantations	Cropping	Cropping	3.60	19.06%
Production from relatively natural environments	Grazing native vegetation	Grazing native vegetation	14.79	78.30%
Water	Reservoir/dam	Reservoir/dam	0.45	2.37%
Conservation and Natural Environments	Other Minimal Use	Other Minimal Use	0.05	0.27%
Total			**18.89**	**100%**

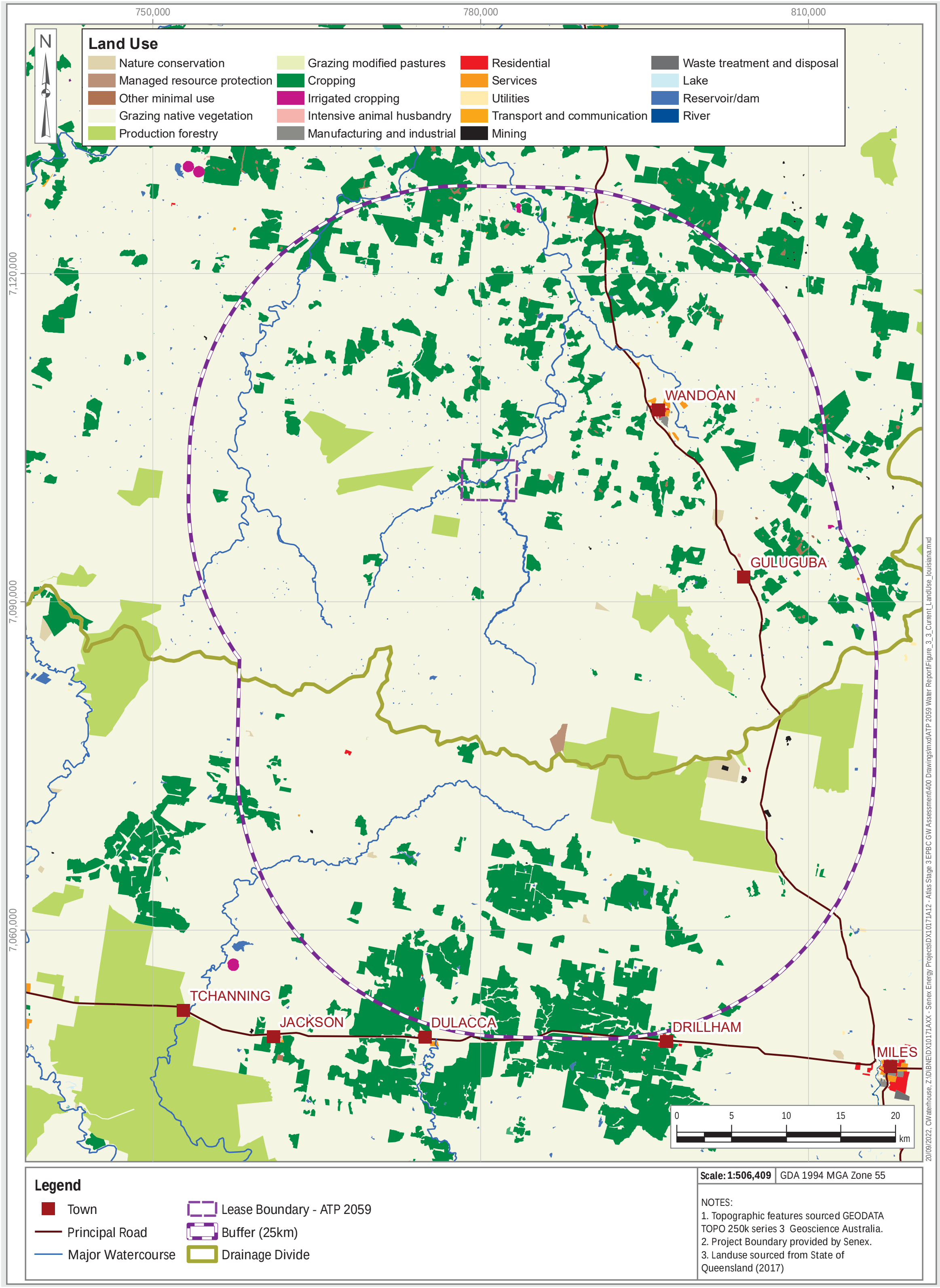

Figure 5.3 Summary of the ATP 2059 Current Land Use

6 HYDROLOGICAL SETTING

6.1 Location and Catchment Context

The Project area is located within the Upper Dawson River sub-basin, which is part of the Fitzroy River Basin. The Fitzroy River Basin is the second largest externally drained basin in Australia and the largest on the eastern coast of the continent. Covering an area of 150,000 km^2, the basin contains several significant tributaries, including the Nogoa, Comet, Mackenzie and Dawson Rivers. The basin discharges into the Coral Sea east of Rockhampton.

The divide between the Upper Dawson River sub-basin and the Condamine-Balonne Rivers sub-basin is located ~22 km to the south of the Project area.

6.2 Key Surface Water Bodies

6.2.1 Watercourses

Major watercourses are shown on Figure 6.1, key watercourses within the vicinity of the Project area include (Figure 6.2):

- Wandoan Creek, which flows southwest to northeast centrally across the ATP 2059, it joins Woleebee Creek ~7.5 km to the northeast of ATP 2059.
- Woleebee Creek, which flows north from its headwaters flanking the eastern boundary of the Project area to join Juandah Creek ~15 km to the northeast.
- The Project area lies almost entirely within the sub-catchment of Woleebee Creek (Figure 6.2).

Watercourses within the Project area are classified as Stream Orders 1 to 5 using the Strahler method, with the majority being Stream Order 1 (minor streams) (State of Queensland 2021e). Woleebee Creek is stream order 5.

Other watercourses of interest in the 25 km buffer include:

- Horse Creek and Horse Creek-East Branch, located to the southwest of ATP 2059, flows in a general northerly direction to join Juandah Creek in the north; and
- Juandah Creek, which flows towards the north to join the Dawson River, 3 km south of Taroom. Juandah Creek is joined by Woleebee Creek, Horse Creek (from the south) and Bungaban Creek from the east before joining the Dawson River.

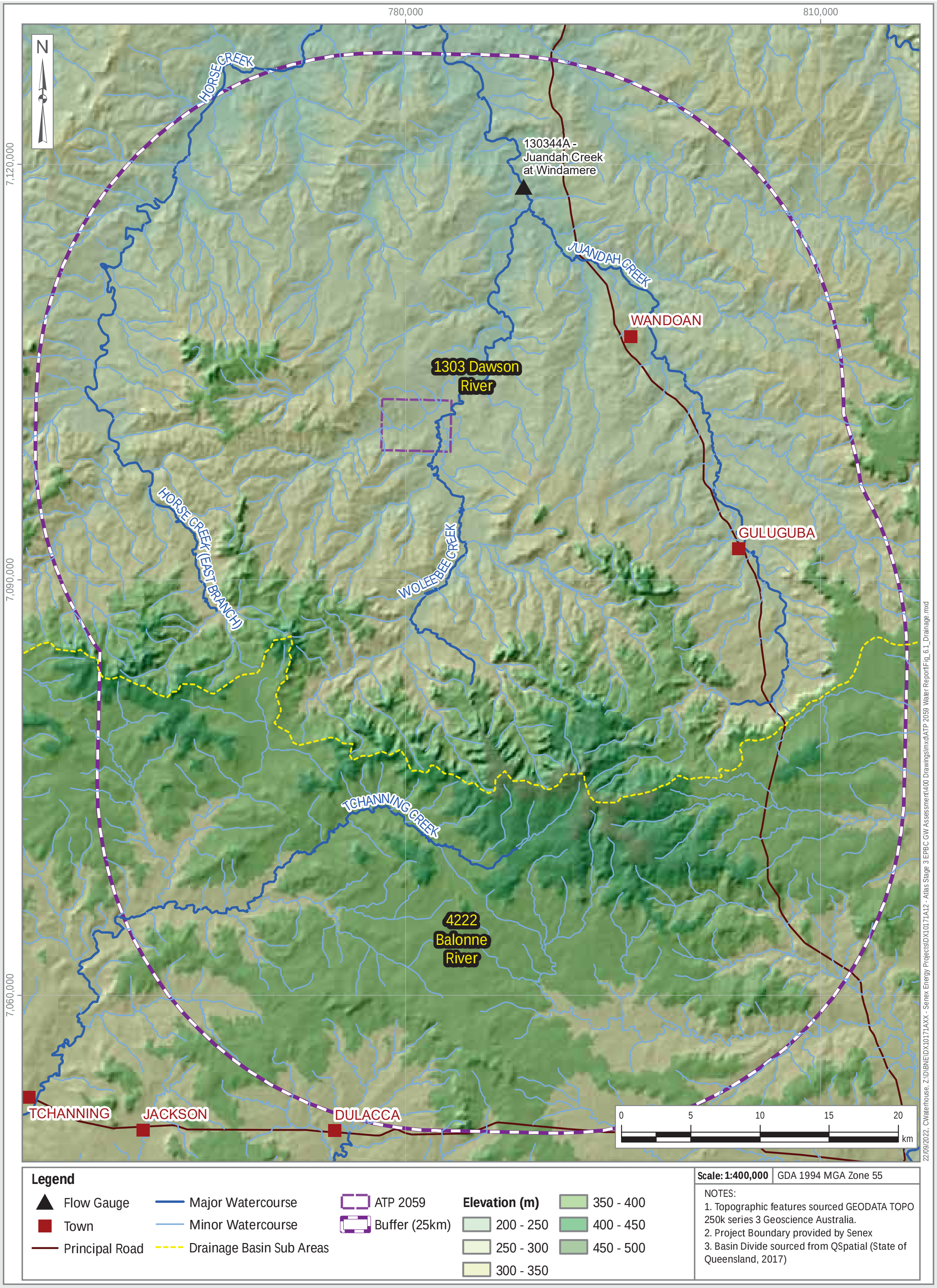

Figure 6.1 Regional Drainage and River Basin Divide

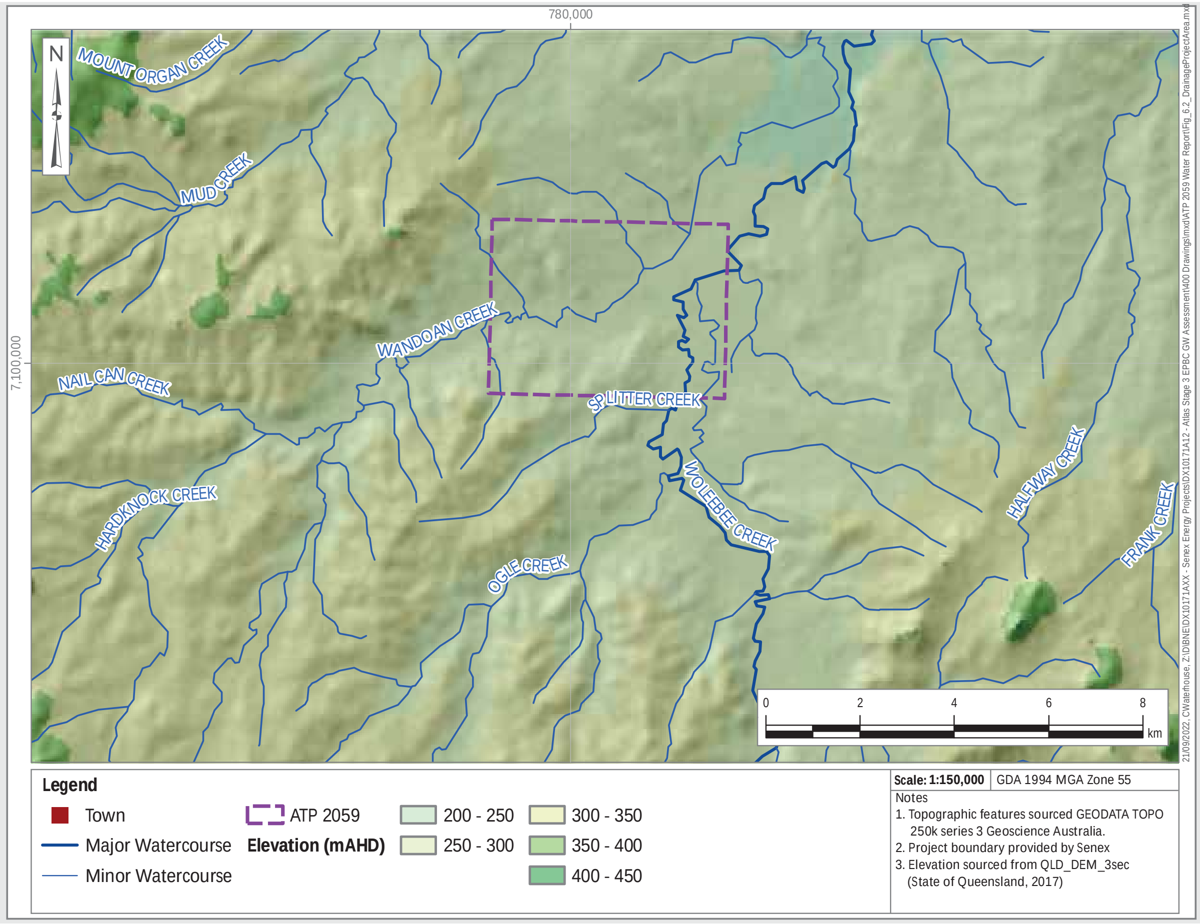

Figure 6.2 Drainage within the Project Area

6.2.2 Wetlands

The Directory of Important Wetlands in Australia (Environment Australia 2001) lists two nationally important wetlands in the Dawson River sub-basin located to the north of ATP 2059:

- Boggomoss Springs is approximately 95 km downstream of the Project (northeast): a 400-ha lacustrine / palustrine wetland with approximately one-third of its area artificially or highly modified, and the remainder of the area riverine.
- Palm Tree and Robinson Creeks wetland areas (50,274 ha) comprise 155 lacustrine and palustrine wetlands. These wetland areas are located 80 km north of the Project, and upstream of the Dawson River.

A review of the Project area on the DES 'Wetland Info' website (State of Queensland 2022b) identifies the following wetlands within the Project area (Figure 6.3):

- Palustrine wetlands (vegetated, non-riverine or non-channel systems) mainly associated with floodplains;
- Lacustrine wetlands (dominated by open water) identified as mainly artificial or modified dams or weirs in channels; and

- Subdominant wetlands along Wandoan and Woleebee Creeks (comprising of 50% or less of the area), identified as Coastal/ Sub-coastal floodplain tree swamps (Melaleuca and Eucalypt).

Figure 6.3 Location of Wetlands

6.3 Geomorphology

6.3.1 Wandoan Creek

Wandoan Creek flows through the Project area from the west to the northeast and connects at Woleebee Creek downstream of the Project area. It is classified as stream orders 1 to 4, with stream orders 3 and 4 occurring within the Project area. The creek is ephemeral, and the catchment comprises of a large alluvial floodplain gently sloping towards the creek channel. Generally, the creek comprises shallow creek banks (1 to 2 m high), is highly meandering and is 10 to 15 m wide.

Figure 6.4 shows photographs of Wandoan Creek where pooling water was observed; and, scouring of the creek banks and debris within the creek. The aquatic ecology assessment undertaken by Freshwater Ecology (2022a) identified that pooled water in Wandoan Creek was mostly turbid and less than 1 m deep. Bank heights were identified at approximately 5 m at three sites along Wandoan Creek while the creek bed substrate consists mainly of sand (Freshwater Ecology 2022a).

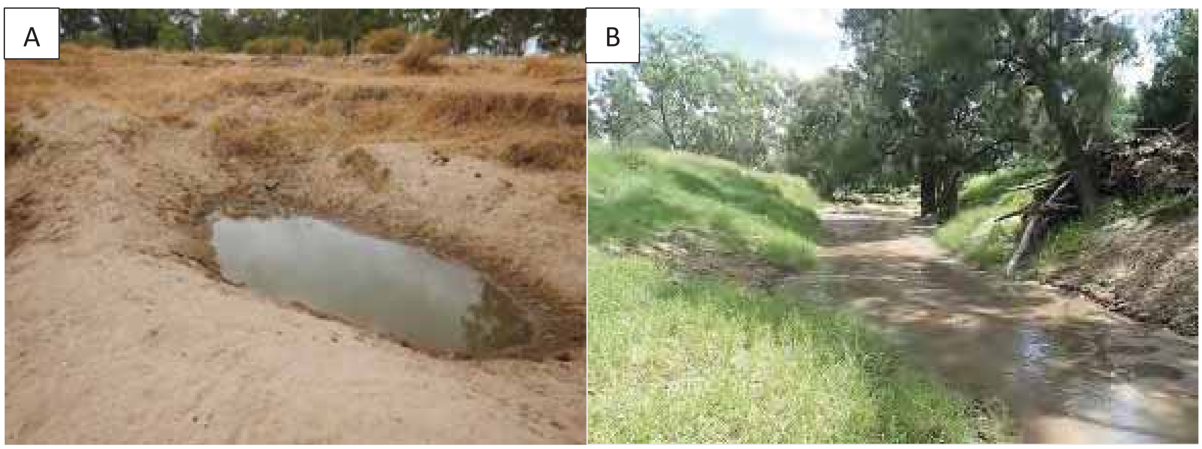

Figure 6.4 Banks Gently Sloping towards Wandoan Creek and Evidence of Pooling (A) (KCB 2018d), Wandoan Creek at Aquatic Ecology Sampling Location TAQ1 (B) (Freshwater Ecology 2022a)

6.3.2 Woleebee Creek

Woleebee Creek flows through the eastern extent of the Project area from south to north along the eastern flank. It is ephemeral, classified as Stream Order 5 (major streams) and has been identified as a potential gaining stream (OGIA 2017b). Typical creek profiles from the 2022 aquatic ecology survey for Woleebee Creek are shown in Figure 6.5.

Woleebee Creek was assessed in 2009 as part of environmental assessments for QGC (Golder Associates 2009a). The creek was assessed to be stable. Woleebee Creek was described as having a low width to depth ratio indicating lower potential energy for erosion and bank scouring although some evidence of minor erosion was present on the banks despite vegetation being present. Debris was present in the channel but assessed to be fallen limbs from trees growing in the channel and on the banks. The banks and channel were described as comprising silty clay.

The 2022 aquatic ecology survey of Woleebee Creek identified creek bank heights of 2.5 m in the upper reaches in the southern area of PL 209, to 7 m in the north of PL 445 just south of the confluence with Wandoan Creek. In all instances, the creek beds are described as predominantly comprising alluvial sand. Site TAQ4, a survey location on ATP 2059, identified 4 m creek banks consisting of mainly sand, with shallow ponds of less than 1 m deep.

Figure 6.5 Banks Gently Sloping Towards the River and Evidence of Pooling in Woleebee Creek at Aquatic Ecology Sampling Location LAQ9 in PL 445 (A), Woleebee Creek at Aquatic Ecology Sampling Location TAQ4 on ATP 2059 (B). See Figure 6.10 for Locations

6.4 Flood Regime

Floodplain mapping is presented in Figure 6.6. This presents the Queensland Floodplain Assessment Overlay (QFAO), which estimates areas potentially at threat of inundation by flooding.

Flood modelling maps are available through Queensland Globe (State of Queensland 2021d). Flood modelling mapping for a 1% annual exceedance probability (AEP) or 1 in 100-year flood are available. For a 1 in 100-year flood event, flooding may occur in all main channels and tributaries. In upper tributaries, flood depths for a 1 in 100-year flood event are generally less than 0.5 m, with flood depth between 1 to 2 m mapped within Woleebee Creek and Wandoan Creek.

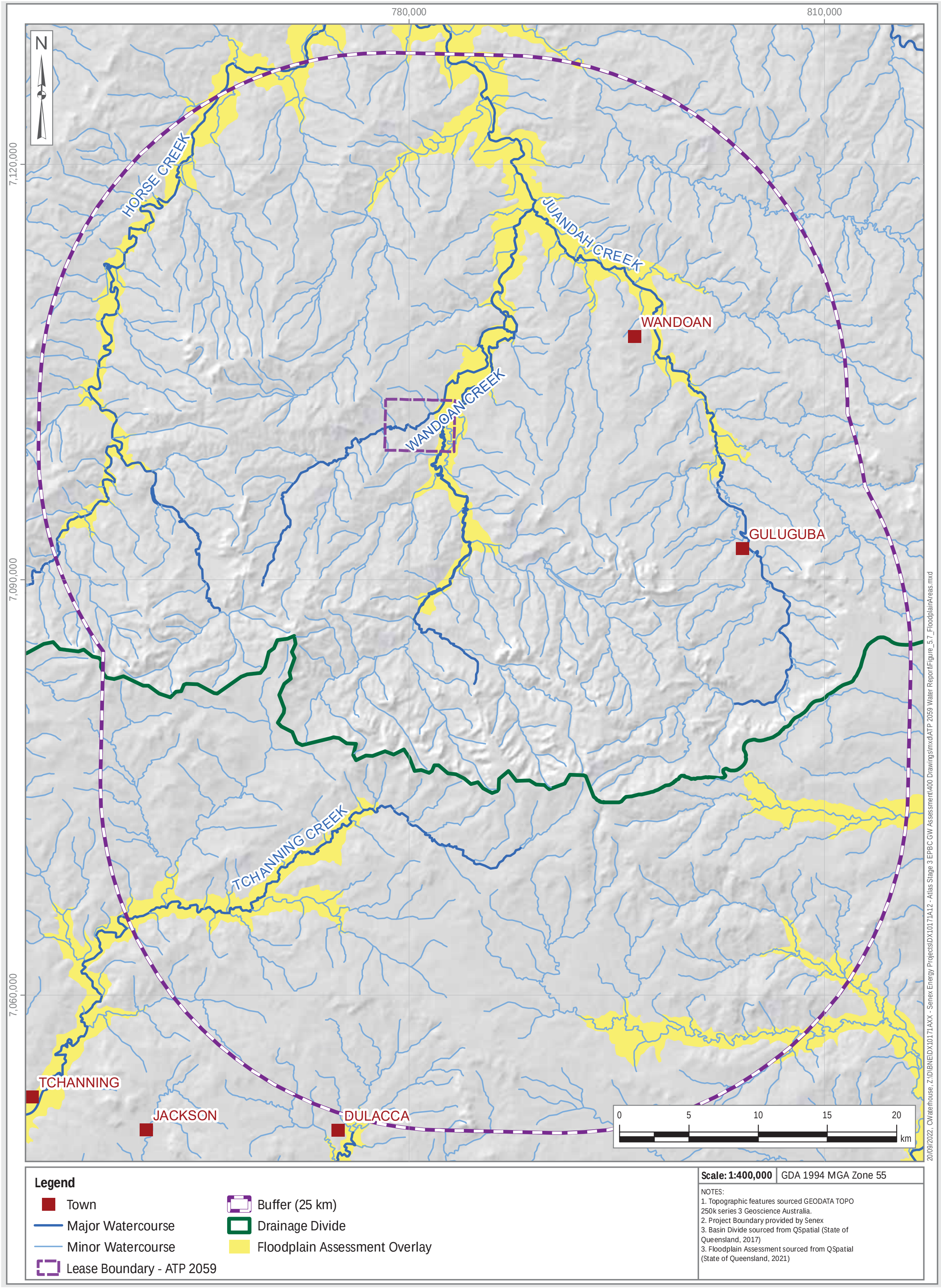

Figure 6.6 Extent of Floodplain Areas

6.5 Surface Water Flow

6.5.1 Watercourse Classification

Hydrologic flow can be classified into three regimes: permanent, semi-permanent and ephemeral based on Kennard et al. (2010):

- Permanent: Stream discharge persists during both high rainfall (typically summer wet season) and low rainfall (typically winter dry season) periods. During drought years, some cease to flow periods may occur, however non-flowing, connected pools will persist throughout the waterway channel.
- Semi-Permanent: A watercourse that contains water for more than 70% of the time on average. These watercourses experience high discharges during heavy rainfall periods (i.e., summer wet season), however are typically reduced to a series of disconnected, non-flowing series of pools during the dry season.
- Ephemeral: These watercourses will typically only experience surface water flow during or immediately after heavy or sustained rainfall events (i.e., summer wet season). Following periods of flow surface water will persist in the form of non-flowing, disconnected pools separated by dry / exposed stream bed. Surface water (flowing or non-flowing) is only present for a small part of the hydrological cycle.

The watercourses across the Project area are characteristically ephemeral and typically flow only during significant runoff events. This is likely a consequence of the catchments being in the upper most reaches with limited runoff area.

6.5.2 Flow and Discharge

Field verification has been undertaken for sections of Woleebee Creek and Wandoan Creek for the Atlas Project on PL 1037 (KCB 2018b). During this field verification program, no surface water flow was observed in any of the watercourses surveyed (Woleebee Creek and Wandoan Creek), although ponds were observed. This was also observed in the aquatic ecology assessment undertaken in March 2022 (Freshwater Ecology 2022a). This is consistent with the ephemeral nature of these watercourses.

There are no Queensland Government surface water flow gauges within the Project area, however one flow gauge (130344A – Juandah Creek at Windamere) is located ~16 km north of the Project area within Juandah Creek (Figure 6.1), downstream of the confluence between Woleebee Creek and Juandah Creek.

Gauge data were available from October 1974 to June 2022. The highest average daily flows occur between November and February each year with the lowest flows in June to August. Figure 6.7 shows the cumulative exceedance probability for the average daily recorded flow and indicates that flows are present ~40% of the gauged period, and the discharge is greater than 500 ML/d for ~5% of the gauged period. This data highlights the ephemeral nature of Juandah Creek and that it is likely to flow only during and after significant runoff events.

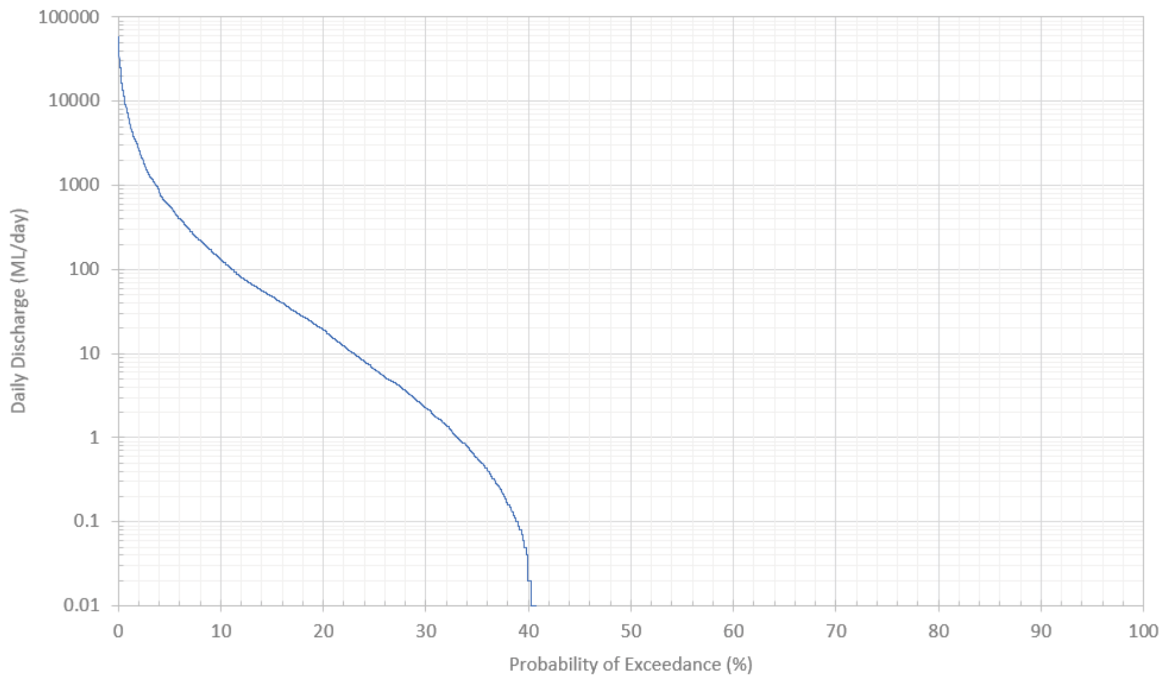

Figure 6.7 Cumulative Exceedance Probability for Recorded Daily Discharge at Juandah Creek (130344A – Juandah Creek at Windamere)

6.6 Surface Water Quality

Available surface water quality data has also been sourced from the Queensland Government for the gauge at Juandah Creek (at Windermere). Data are available between 1985 and 2022 and summarised in Table 6.1.

Table 6.1 Summary of Water Quality Measured at Juandah Creek at Windermere (130344A)

Parameter	Count	Min	Max	Mean	Standard Deviation
Conductivity @ 25°C (field)	23	108	865	307	220
Turbidity (NTU) (field)	13	11	2000	379	543
Colour True (Hazen units)	15	5	86	32	22
pH (pH units) FLD	16	6.8	8.2	7.6	0.4
Total Alkalinity as $CaCO_3$ (mg/L)	22	36	264	100	72
Total Diss. Solids (mg/L)	22	77	588	192	138
Calcium as Ca soluble (mg/L)	22	5	53	17	15
Chloride as Cl (mg/L)	22	8	165	33	38
Magnesium as Mg soluble (mg/L)	22	1	13	4	3
Potassium as K (mg/L)	22	3	10	6	2
Sodium as Na (mg/L)	22	13	148	42	35
Sulfate as SO_4 (mg/L)	22	2	22	7	5
Aluminium as Al soluble (mg/L)	12	0.0	4.2	0.4	1.2
Boron as B (mg/L)	17	0.00	0.20	0.06	0.05
Copper as Cu soluble (mg/L)	14	0.00	0.05	0.03	0.02
Fluoride as F (mg/L)	21	0.05	0.20	0.12	0.05
Iron as Fe soluble (mg/L)	21	0.00	11.50	1.22	2.65

Parameter	Count	Min	Max	Mean	Standard Deviation
Manganese as Mn soluble (mg/L)	16	0.00	0.07	0.02	0.02
Silica as SiO_2 soluble (mg/L)	21	12	44	21	7
Zinc as Zn soluble (mg/L)	14	0.00	0.08	0.02	0.02

Based on the available water quality data from the Department of Regional Development, Manufacturing and Water (RDMW) gauge downstream of the Project, Piper and Durov diagrams have been prepared. These are presented in Figure 6.8 and Figure 6.9.

The surface water from both the RDMW gauge, and pools at Wandoan Creek are characterised as a sodium-bicarbonate water type, with some sodium enrichment. The electrical conductivity, as shown on the Durov plot (Figure 6.9), ranges between ~110 µS/cm and 865 µS/cm, with a median value of 307 µS/cm.

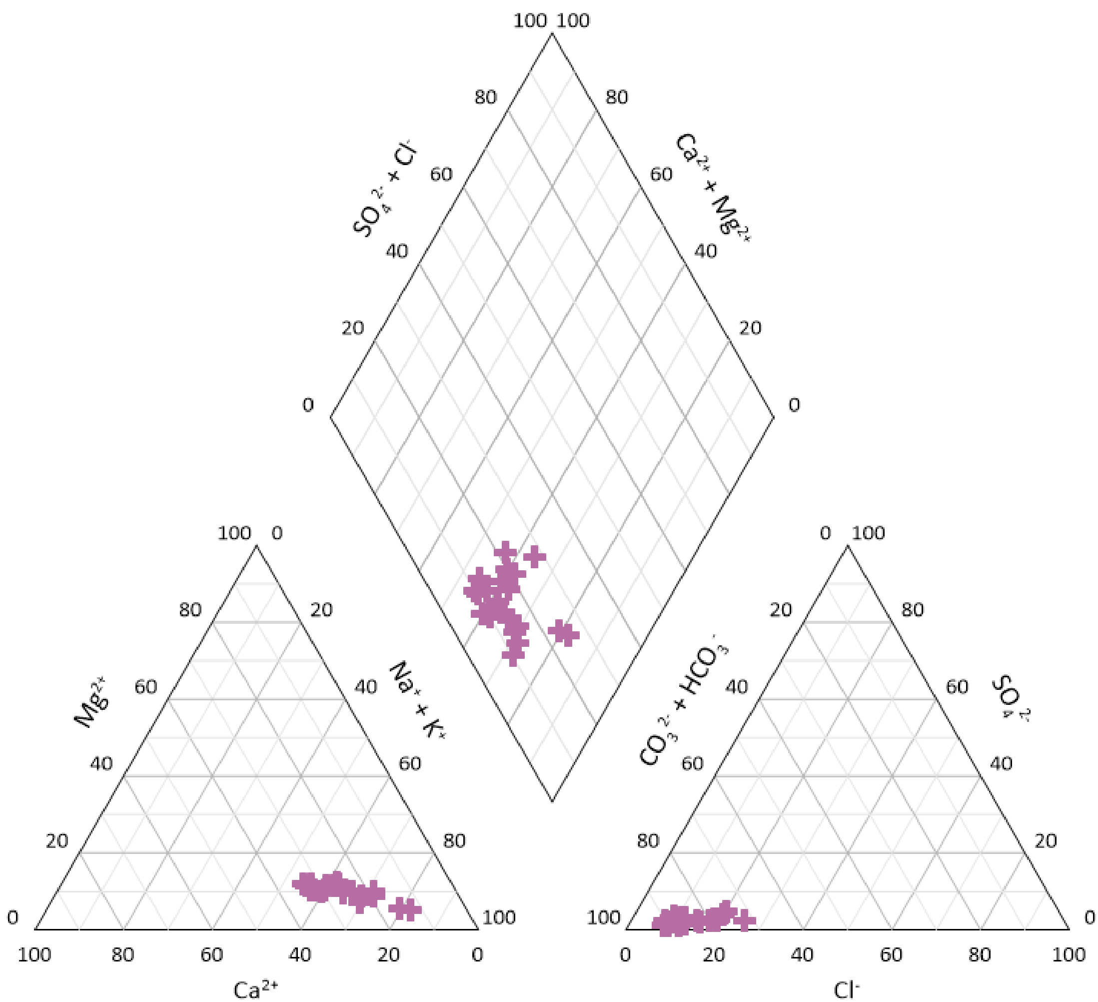

Figure 6.8 Piper Diagram for Surface Water Samples from Juandah Creek (130344A – Juandah Creek at Windamere)

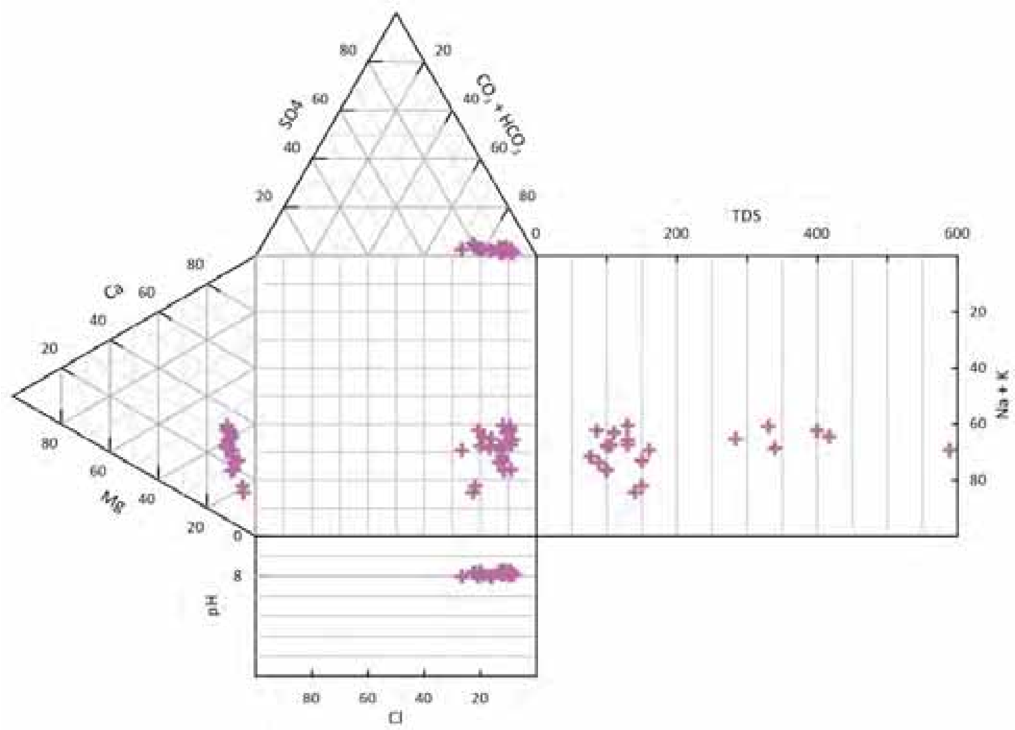

Figure 6.9 **Durov Diagram for Surface Water Samples from Juandah Creek (130344A – Juandah Creek at Windamere)**

6.7 Current Surface Water Stressors

The Dawson River sub-basin is heavily influenced by anthropogenic pressures including land use, riparian management, water infrastructure and point source pollution; and is also highly modified as a result of agricultural and grazing practices.

Since circa 1850, the primary land use in the Dawson River sub-basin has been sheep and cattle grazing. The State of River report (Telfer 1995) lists indicators of the physical conditions of the Dawson River and its tributaries. The “Southern Tributaries” catchment identified by Telfer (1995) is of most relevance to this report as the upper reaches are located within ATP 2059.

The condition of land immediately adjacent to reaches within the State of River study (Telfer 1995) is typically rated as being in poor to moderate condition (89% of reaches). Subjective assessments of disturbance reflect these ratings with 9% moderately disturbed, 43% highly disturbed, 31% very highly disturbed, and 15% extremely disturbed. Major factors contributing to disturbance were identified as grazing (94% of sites), roads (37%), bridges or culverts (20%), ford and ramp structures (13%) and forestry (4%) (Telfer 1995).

6.8 Existing Surface Water Users

Under the Fitzroy Basin ROP (State of Queensland 2015), creeks within the Project area are within the Dawson Valley Water Management Area. Within this management area Woleebee, Horse and Juandah Creeks are a tributary of the Dawson N Zone, along the AMTD reach 356.5 to 428.0 (km); and, is described as ‘Upstream limit of Glebe Weir and Eurombah Creek Junction’.

There are no resource operations licence holders in the Dawson N Zone of the Dawson Valley Water Management Area (State of Queensland 2021a). No other surface water users have been identified within the vicinity of the Project.

6.9 Aquatic Ecology

An aquatic ecology assessment was undertaken by ERM for the Project in 2022 (ERM 2022b) and Freshwater Ecology (Freshwater Ecology 2022a). This included surveys of Woleebee and Wandoan Creeks. Aquatic ecology surveys were also undertaken by Hydrobiology on PL 1037 in 2018 along reaches of Woleebee Creek to the west of ATP 2059 (KCB 2018d).

As detailed in previous sections, the Project area lies within the southern tributaries of the Upper Dawson. This is part of the 'Central Freshwater Biogeographic Province', based on its broad patterns in the natural distribution of aquatic faunal communities, being broadly similar to other coastal flowing catchments in the central part of Queensland (DES 2018b).

As detailed in Section 4.1.2.5, an aquatic ecology field survey was undertaken within the Project area. Details of the identified habitats, aquatic species and assessment of baseline aquatic values are provided in the following section.

6.9.1 Habitat Description

Waterways across the Project area are ephemeral, with most waterways anecdotally drying completely during dry periods and few waterways retaining refugial pools. Twenty-three of the 32 sites inspected across ATP 2059, PL 445 and PL 209, during the field survey held water in March 2022 while all other sites were dry.

At the time of sampling most waterways had already ceased surface flows with disconnected pools noted along the watercourses, although subsurface flow was apparent at sites along most creeks with sandy substrates. Disconnected pools are often separated by open grassland and poorly defined channels. The riparian vegetation density along the sites varied from moderate to non-existent, with most sites having a relatively low coverage of riparian vegetation.

In-stream habitat, using habitat bioassessment, was mostly found to be in 'fair' condition across all sites sampled (17 of the 24 sites assessed across ATP 2059, PL 445 and PL 209). The remaining seven sites were determined to be in 'poor' condition.

The location of the surveyed sites is shown on Figure 6.10, site profiles for selected sites are provided in Table 6.2.

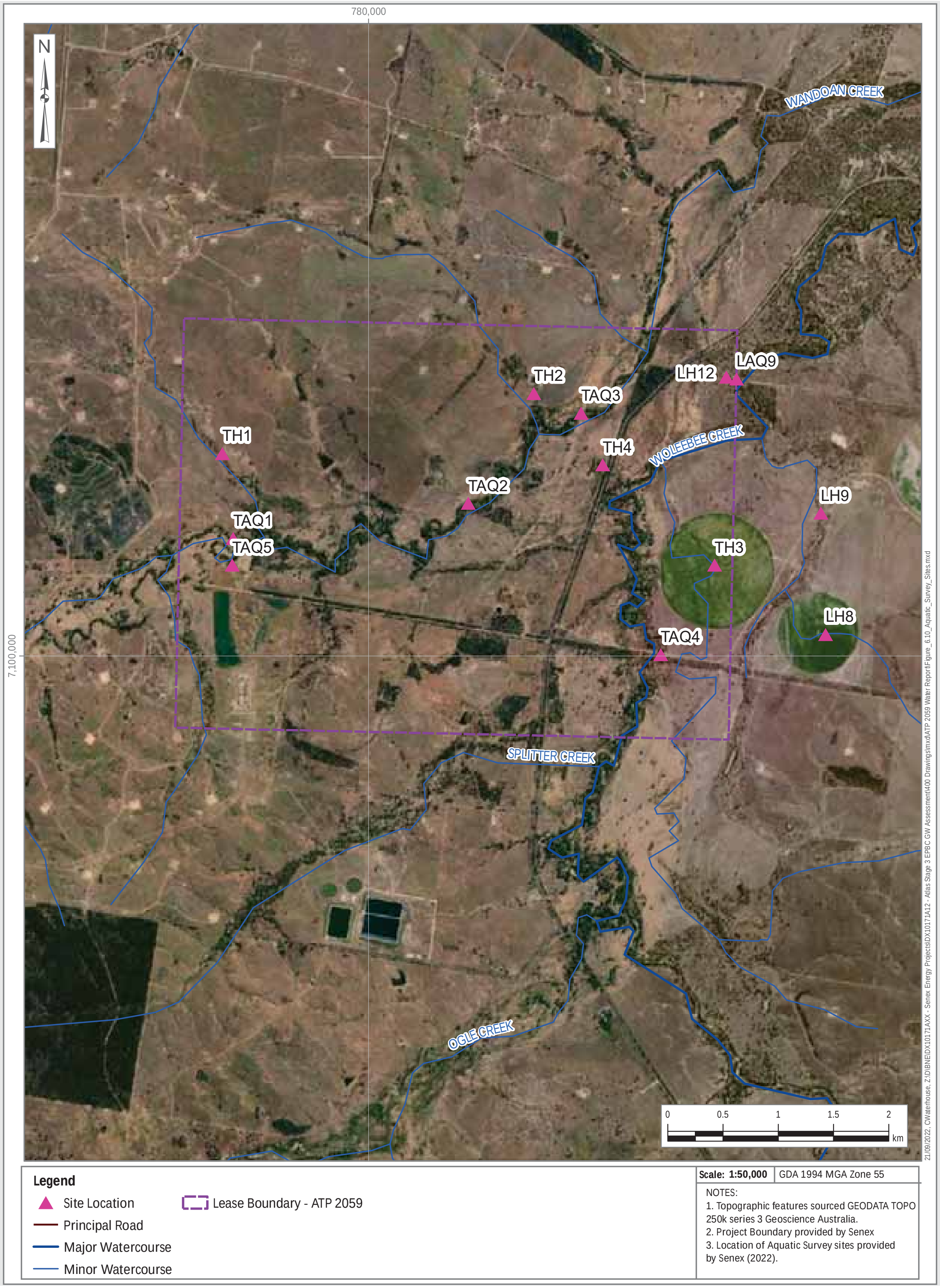

Figure 6.10 Location of Aquatic Survey Sites

Table 6.2 Habitat Description and Photographs for Selected Aquatic Ecology Sites Surveyed in March 2022 (Freshwater Ecology 2022a)

Site	Feature	Site Photo	
Woleebee Creek			
LAQ9	**Location:** Main channel of Woleebee Creek on PL 445. **Waterbody**: Likely to retain subsurface (hyporheic flows) for some time after the cessation of heavy rainfall. **Wetland type:** Riverine **Stream order:** 5 **Macrocrustaceans:** Palaemonidae (freshwater prawns) and Paratacidae. **Turtles:** An eastern long-necked turtle was captured. **Habitat bioassessment score**: Fair condition		
Wandoan Creek			
TAQ1	**Location:** water body in Wandoan Creek on ATP 2059 **Waterbody**: Subsurface flows expressing in some reaches. Uncertain whether these were hyporheic or groundwater expressions. Shallow and highly ephemeral. **Wetland type:** Riverine **Stream order:** 4 **Macrocrustaceans:** Palaemonidae (freshwater prawns) and Paratacidae (freshwater crayfish) **Amphibians:** Green-stripe frog recorded. **Habitat bioassessment score**: Poor/fair condition		

6.9.2 Aquatic Invertebrates

The field survey identified the following in terms of aquatic invertebrates:

- A total of 53 macroinvertebrate taxa (mainly family level) were collected from the four sites that held water across the Project area. In addition to the macroinvertebrates recorded, three groups of microcrustacea (Cladocera, Copepoda, Ostracoda) were recorded. Overall, there is a low abundance of aquatic macroinvertebrates across the Project area. The low abundances are likely to be due to the largely ephemeral nature of the waterways. Taxa diversity across all samples ranged from 6 to 28 (with a mean of 16.4 taxa across all samples) and was typically higher in edge samples than bed samples. These results are also typical for ephemeral streams in central Queensland.
- Macrocrustaceans were collected during both macroinvertebrate and fish sampling. Three families of macrocrustacean were detected across the Atlas Stage 3 Project area: Atyidae (glass shrimp), Palaemonidae (freshwater prawns) and Paratacidae (freshwater crayfish). The Palaemonidae species was Macrobrachium australiense, a common and widespread species across eastern Australia. Freshwater prawns are opportunistic scavengers that forage on detritus, algae, invertebrates and small fish and are very hardy.

6.9.3 Fish Community

The field survey identified the following in terms of fish community:

- 2,192 fish individuals from eight species were recorded from the fourteen sites that were sampled, five of which are relatively widespread.
- Eight of the species of fish recorded were native species, with the only introduced species (tilapia – *Oreochromis mossambicus*) recorded as juveniles at a single site. Tilapia is a restricted noxious fish under the Biosecurity Act 2014.
- The most abundant species was spangled perch (*Leiopotherapon unicolor)* which accounted for nearly half of all fish recorded was found at all sites sampled for fish. Other widespread species recorded were Agassiz's glassfish (*Ambassis Agassizi*), Midgely's carp gudgeon (*Hypseleotris bucephalus)*, eastern rainbowfish (*Melanotaenia splendida*) and bony bream (*Nematalosa erebi*) which were recorded at 79%, 79%, 71% and 50% of sites sampled respectively. Single specimens of eel-tailed catfish (*Tandanus tandanus*) and sleepy cod (*Oxyeleotris lineolata*) were recorded in the March 2022 sampling.
- All the native fish species recorded are relatively common and widespread across their distributions.

6.9.4 Aquatic Fauna

A single specimen of eastern long-necked turtle (*Chelodina longicollis*) was captured at site LAQ9 on Woleebee Creek on PL 445 just east of ATP 2059. This species is capable of moving long distances overland between waterholes, particularly after heavy rainfall. Given the disconnected nature of these habitats, any turtle use of these areas is likely to be transitory, particularly given turtles prefer deeper pool habitats connected by riffle areas.

No platypus (*Ornithorhynchus anatinus*) was recorded in the March 2022 surveys. Considering the generally poor habitat suitability and the distance from existing records it is considered unlikely that platypus would occur across the Project area.

Only three species of frog were recorded in the March 2022 sampling. The green-stripe frog (*Cyclorana albugutta*) was recorded at sites (LAQ5, LAQ11, TAQ1, TAQ2, TAQ3, TAQ4 and TAQ5). The specimen at site TAQ4 was observed being consumed by a keelback snake (*Tropidonophis mairii).* The broad-palmed rocket frog (*Litoria latopalmata*) was recorded only at site TAQ1. Cane toads (*Rhinella marina*) were recorded at sites LAQ11 and TAQ1

6.9.5 Aquatic Values

An overall aquatic value rating of Low, Moderate or High, was assigned to watercourse of Strahler stream order three or greater within the Project area based on the summation of all available information from the desktop assessment and field survey. The criteria used to define each category are provided in Table 6.3. These aquatic value ratings are also discussed below in the context of geographic significance, that is, in terms of State, regional, catchment and local significance.

Table 6.3 Criteria Used for Assigning Overall Aquatic Values Rating

Aquatic values rating	Criteria
High value	aquatic endangered, vulnerable and near threatened (EVNT) species are confirmed or likely to occur (i.e., recording/sighting recorded within 5 km of the proposed alignment) and suitable habitat available), and flow and/or permanent water present (e.g., refugia), and/or in-stream habitat conditions in near natural or good condition (an Excellent or Good habitat bioassessment score)
Moderate value	aquatic EVNT species could possibly occur (i.e., marginal habitat), and Priority* species are confirmed or likely to occur (i.e., suitable habitat available), and/or high diversity of non-conservation significant native aquatic fauna and or flora, and/or presence of permanent or persistent refugial waterholes, and/or in-stream habitat conditions in moderate to good condition (a Good or Fair habitat bioassessment score)
Low value	aquatic EVNT and Priority species are unlikely to occur and drainage feature without refugial waterholes, and/or presence of non-conservation significant native aquatic fauna and or flora, and/or may have some in-stream aquatic habitat value (a Fair or Good habitat bioassessment score)

*Priority species for conservation identified in the Back on Track (BOT) actions for Biodiversity in the Fitzroy NRM Region (DERM 2010) and those identified in the Expert Panel Report for the ACA of the Riverine and non-Riverine wetlands of the GBR catchments (Inglis and Howell 2009; Rollason and Howell 2011).

Watercourses transecting the Project area were rated as Moderate value, at a local level, primarily due to the presence of permanent or persistent pools. These provide critical dry season refugia for the aquatic life that use them, to sustain them until the rains, which is significant on a local tributary scale. These ecosystems are protected as Aquatic Ecosystems Environmental Values under *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (State of Queensland 2019b), which fulfils the *Environmental Protection Act 1994*. On a catchment scale, aquatic value of these watercourses would be Low, as the more permanent main channel of the Dawson and its larger tributaries support much more diverse aquatic communities.

All sites surveyed were scored as low or fair habitat, had presence (but low diversity) of non-conservation significant native aquatic fauna and flora.

Following the field surveys an assessment on the likelihood of occurrence for aquatic Endangered, Vulnerable and Near Threatened (EVNT) species was undertaken, suitable habitat was not identified. All EVNT species identified in an initial desktop assessment were considered unlikely to occur within the Project area.

7 HYDROGEOLOGICAL SETTING

7.1 Regional Geology

The Project area is located within the Surat Basin, a basin of Jurassic-Cretaceous age, which is underlain by the Permo-Triassic Bowen Basin. Cenozoic-age formations are present overlying the Surat Basin formations. The regional geological map of the Project area and surrounds is shown in Figure 7.1.

Cenozoic-age formations cover much of the Surat Basin and generally comprise unconsolidated alluvial sediments, which have been deposited along pre-existing watercourses (OGIA 2016b).

The Surat Basin underlies approximately 180,000 km^2 of southeast Queensland; and is connected to the Eromanga Basin to the west, the Clarence-Moreton Basin to the east, and the Mulgildie Basin to the northeast. The Surat Basin is bounded to the northeast by the Auburn Arch and to the southeast by the Texas Block. The northern margin of the basin has been exposed and extensively eroded. Basin sediments generally dip southwest (OGIA 2016b).

The maximum thickness of the Surat Basin is ~2,500 m, which occurs in the Mimosa Syncline west of the Project area. Generally, sediment deposition was continuous and widespread within the basin. Deposition in the basin commenced with a period of passive thermal subsidence over much of eastern Australia. During the Early Jurassic, deposition was mostly fluvio-lacustrine, while by the Middle Jurassic coal swamp environments predominated over much of the basin, except in the north where fluvial sedimentation continued (Geoscience Australia 2017; OGIA 2021g).

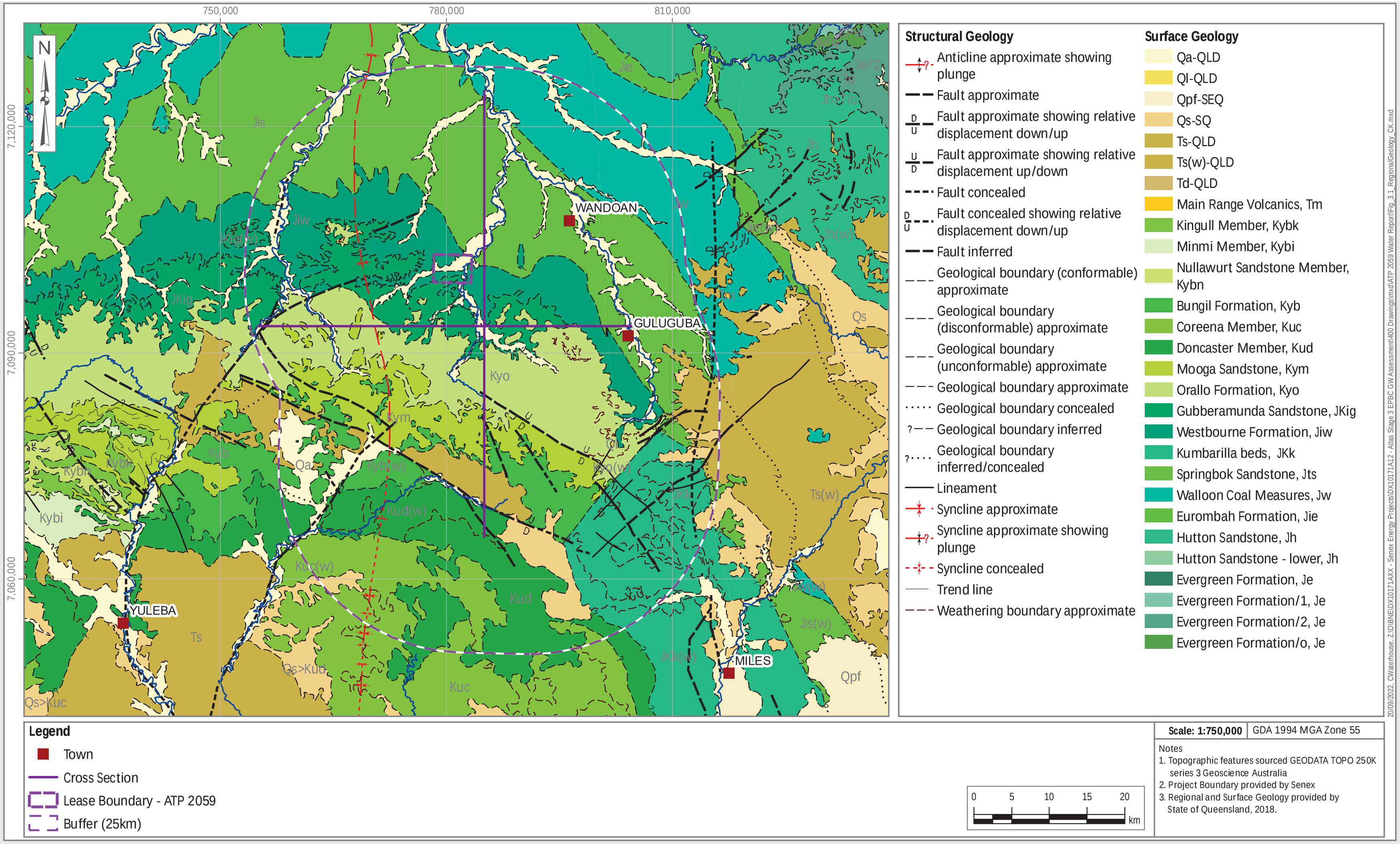

Figure 7.1 **Regional Geological Map**

7.2 Regional Hydrostratigraphy

The Surat Basin forms part of the Great Artesian Basin (GAB), which comprises several aquifers and confining aquitards. Aquifers of the Surat Basin are a significant source of water used for stock, public water, and domestic supply.

The hydrostratigraphy of the Surat and Bowen Basin is presented in Figure 7.2, taken from the 2021 UWIR (OGIA 2021g). A summary of each of the hydrostratigraphic units within the Surat Basin, and of relevance to the Project, is provided below (from oldest to youngest).

The Precipice Sandstone *Aquifer*

The Precipice Sandstone is the basal unit of the Surat Basin overlying the Moolayember Formation and sedimentary sequences of the Bowen Basin. Lower and upper subunits are recognised. This is often separated by a siltstone or shale unit. The layers with the coarsest grain sizes were deposited by transverse bars in a braided stream system and the finer grain sized sediments were deposited in a lower energy fluviatile meandering system (Martin 1981). The lower subunit, also known as the Precipice Braided Stream Facies (or Precipice BSF), consists of white, fine to very coarse-grained, in part pebbly, thin to very thickly bedded, porous, quartz rich sandstone with a white clay matrix (Exon 1976).

Evergreen Formation *Aquitard*

The Evergreen Formation conformably overlies the Precipice Sandstone and separates the Precipice Sandstone from the Hutton Sandstone. The Evergreen Formation is considered an aquitard and generally consists of mudstones laminated with fine-grained sandstone, siltstone and shale (Green 1997).

Hutton Sandstone *Aquifer*

The Hutton Sandstone was deposited in a non-marine environment by meandering streams on a broad floodplain (Exon 1976) and consists mainly of sandstone with interbedded siltstone, shale, minor mudstone, and coal. The sandstone is white to light grey, fine to medium-grained, well sorted, generally quartz rich, partly porous with some pebble bands, shale, and siltstone clasts in the lower part. Siltstones and shales are light to dark grey, micaceous, carbonaceous and commonly interlaminated with very fine-grained sandstone (Green 1997). It is highly heterogeneous, with sand bodies limited in vertical and lateral extent.

Durabilla (Eurombah) Formation *Aquitard*

The Durabilla Formation, often referred to as the Eurombah Formation, conformably overlies the Hutton Sandstone. The depositional environment for this unit was fluvial with periods of rapid sedimentation. It is often difficult to differentiate the Durabilla Formation from the WCM. It is more restricted in extent than either the Hutton Sandstone or the WCM (Green 1997). The Durabilla Formation is considered an aquitard, consisting of siltstone, mudstone and fine to medium-grained poorly sorted sandstone, with almost no coal and consequently, little permeability (OGIA 2016c).

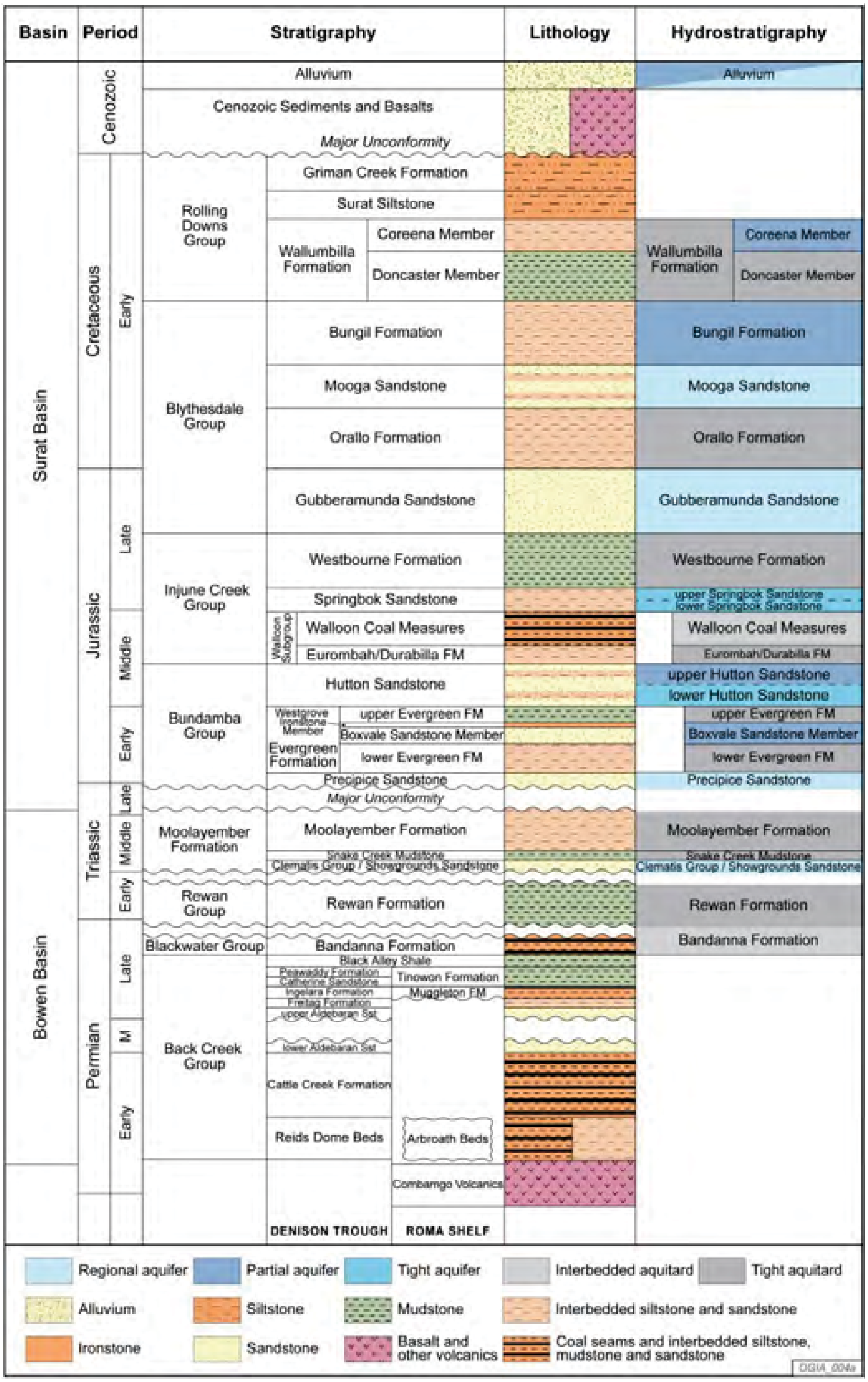

Figure 7.2 Regional Hydrostratigraphy (OGIA 2021g)

Walloon Coal Measures *Productive Coal Seam*

The Walloon Coal Measures (WCM) is the target formation for the appraisal program. This formation conformably overlies the Durabilla Formation. It was deposited in a low energy meander-belt river system, with the coal layers deposited mainly in an overbank environment (Exon 1976). The WCM consists of very fine to medium-grained argillaceous sandstone, siltstone, mudstone, and coal with minor calcareous sandstone, impure limestone, and ironstone (Swarbrick 1973). Typically, the coal layers are positioned in the upper half to three-quarters of the coal measures, with mudstones, siltstones and lithic sandstones dominant in the lower part. At a regional scale the WCM is considered as a leaky aquitard (OGIA 2016b). The stratigraphy of the WCM is presented in Figure 7.3.

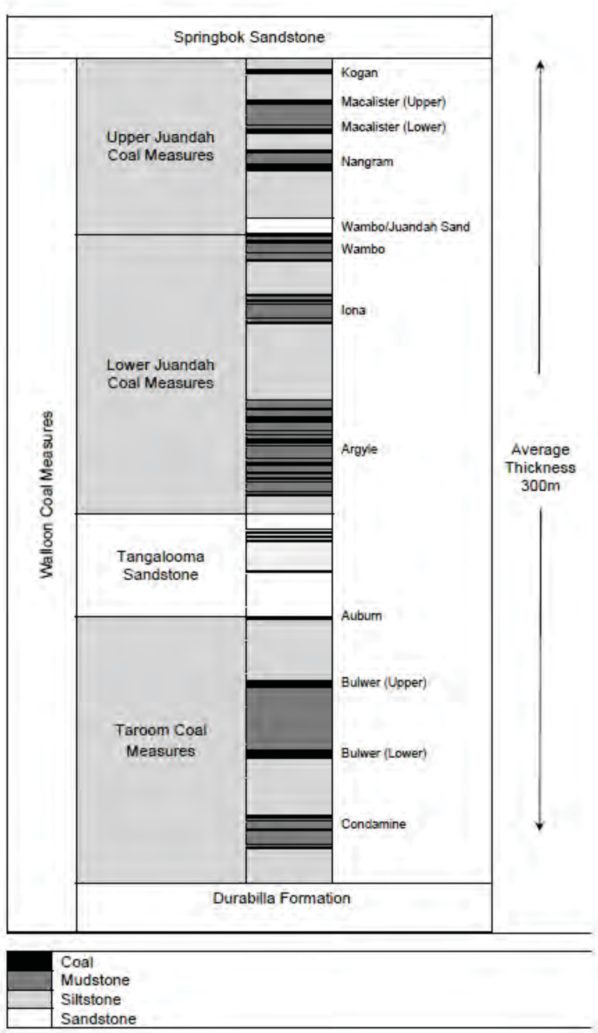

Figure 7.3 Stratigraphy of the Walloon Coal Measures (OGIA 2016c)

Springbok Sandstone *Aquifer*

The Springbok Sandstone overlies the WCM. It was deposited by streams and includes overbank and swamp deposits in the upper part of the unit which indicates streams becoming less energetic with time (Exon 1976). The Springbok Sandstone consists mostly of feldspathic sandstones, commonly with calcareous cement (Green 1997). At the basin scale, the sandstones range from very fine to coarse-grained, although some very coarse-grained, poorly sorted pebbly beds also occur. Minor interbedded siltstones, mudstones, and thin coal seams are also present, primarily in the upper part of the unit. Within the GAB, the Springbok Sandstone is considered a usable water source, however it is highly variable in hydraulic properties and yield across the basin. The Springbok Sandstone also has a very high content of mudstone and siltstone at many locations with very low permeability (OGIA 2016c).

Westbourne Formation *Aquitard*

The Westbourne Formation conformably overlies the Springbok Sandstone. Deposited in an environment with characteristics consistent with a low energy, lacustrine deltaic plain (Green 1997), the Westbourne Formation comprises predominately siltstone layers with thick interbeds of fine to medium-grained sandstone and minor mudstone. Small coal fragments, lenses and lamina are common throughout the formation. Within the GAB sequence, the Westbourne Formation is considered an aquitard.

Gubberamunda Sandstone *Aquifer*

Regionally, the Gubberamunda Sandstone conformably overlies the Westbourne Formation, but locally is disconformable, particularly around the margins of the basin (Green 1997). It was deposited by braided and meandering stream systems draining surrounding highlands (Exon 1976). Consistent with a fluvial depositional environment, repeated packages of siltstone and fine to coarse sandstone were deposited. Deposits of carbonaceous shale along with minor coal fragments are typically present. Within the GAB, the Gubberamunda Sandstone is considered a usable aquifer.

Orallo Formation *Minor Discontinuous Aquifer*

The Orallo Formation conformably overlies the Gubberamunda Sandstone. It was deposited in a relatively low energy fluvial environment with local ponding (Green 1997). The Orallo Formation consists of fine to coarse-grained sandstone interbedded with clay, siltstone, silty mudstone, bentonite clay, and coal. The Orallo Formation is considered a minor discontinuous aquifer.

Mooga Sandstone *Aquifer*

The Mooga Sandstone generally conformably overlies the Orallo Formation, with local disconformities (Exon 1976). Deposits tend towards fine to medium grain size sand, although siltstones, mudstones and shale are present (Exon 1976). Three subunits are recognised. The upper Mooga Sandstone and lower Mooga Sandstone are considered aquifers. The middle Mooga Sandstone consists of siltstones, mudstones, and shale and is considered an aquitard.

Bungil Formation *Aquifer*

The Bungil Formation conformably overlies the Mooga Sandstone. This unit is comprised of interbedded fine-grained lithic sandstones, siltstones and mudstones with minor quartzose sandstone present. The Bungil Formation is considered an aquifer.

7.3 Local Hydrogeology

7.3.1 Surat Basin Units

The Project is situated in an area where the Westbourne and Gubberamunda Formations outcrop. Two cross-sections, oriented North-South and West-East, through the Project area, are shown on Figure 7.4. The cross-sections have been prepared using the OGIA Surat CMA Geological Model (OGIA 2021g) and indicate that the WCM occurs at ~220 to 300 m below ground level; and, is ~400 m thick.

Table 7.1 presents the mean thickness within the Project area for each of the underlying hydrostratigraphic units. Isopachs for the key hydrostratigraphic units are presented in Figure 7.5, with the top of the unit elevations shown in Figure 7.9.

Table 7.1 Mean Aquifer / Aquitard Thicknesses within the Project Area (After OGIA 2021g)

Hydrostratigraphic Unit	Aquifer / Aquitard	Mean Thickness (m)
Orallo Formation	Minor Discontinuous Aquifer	26
Gubberamunda Sandstone	Aquifer	43
Westbourne Formation	Aquitard	41
Springbok Sandstone	Aquifer	104
Walloon Coal Measures	Productive Coal Seams	413
Durabilla Formation	Aquitard	87
Hutton Sandstone	Aquifer	236
Evergreen Formation	Aquitard	203
Precipice Sandstone	Aquifer	73

There are no mapped major geological structures (e.g., faults) within the vicinity of the Project. The nearest major fault is the Burunga Fault which is located approximately 29 km to the east of ATP 2059, 17 km east of Wandoan.

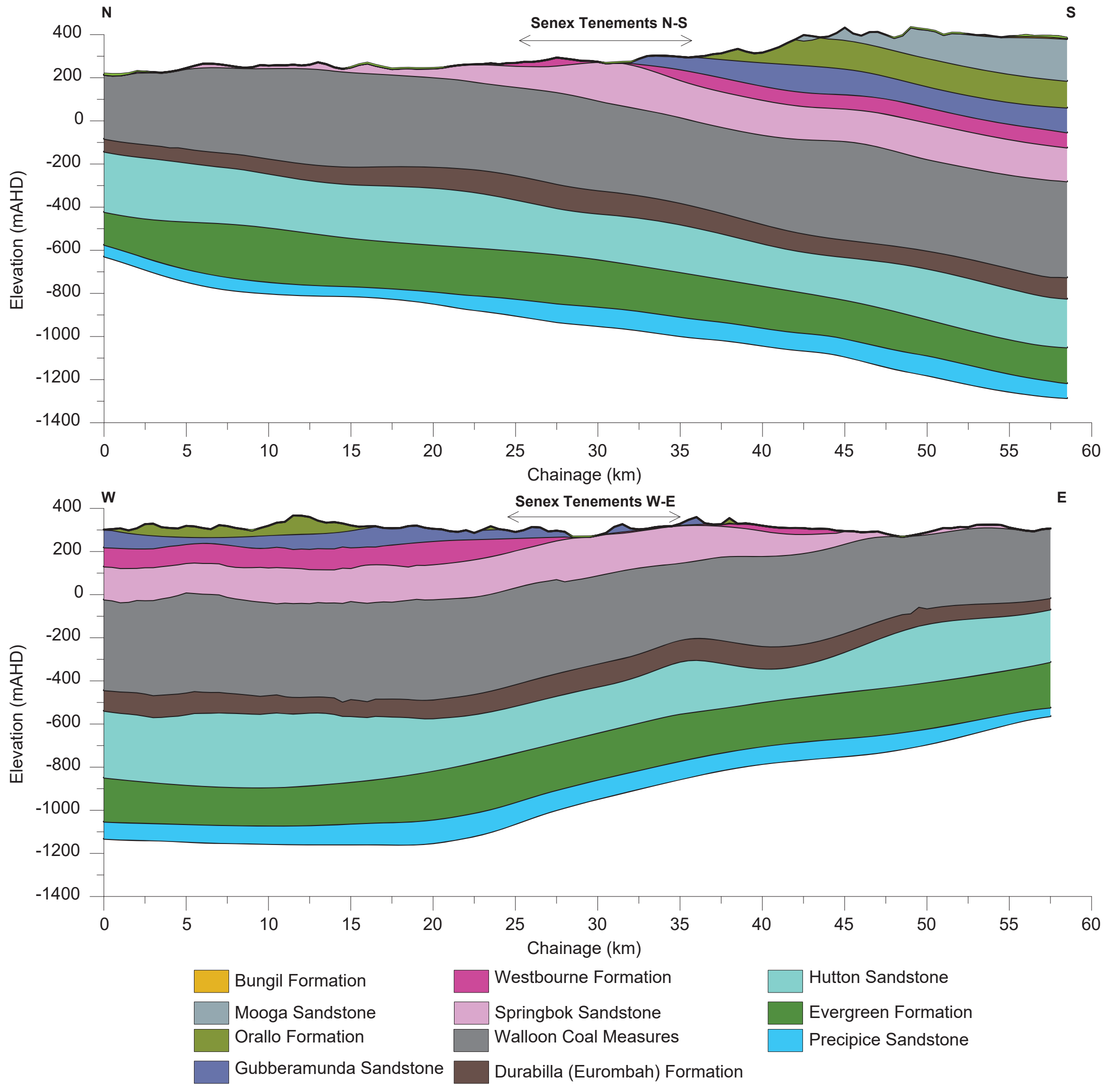

Figure 7.4 Geological Cross-Sections Surat CMA Geological Model (OGIA 2021g)

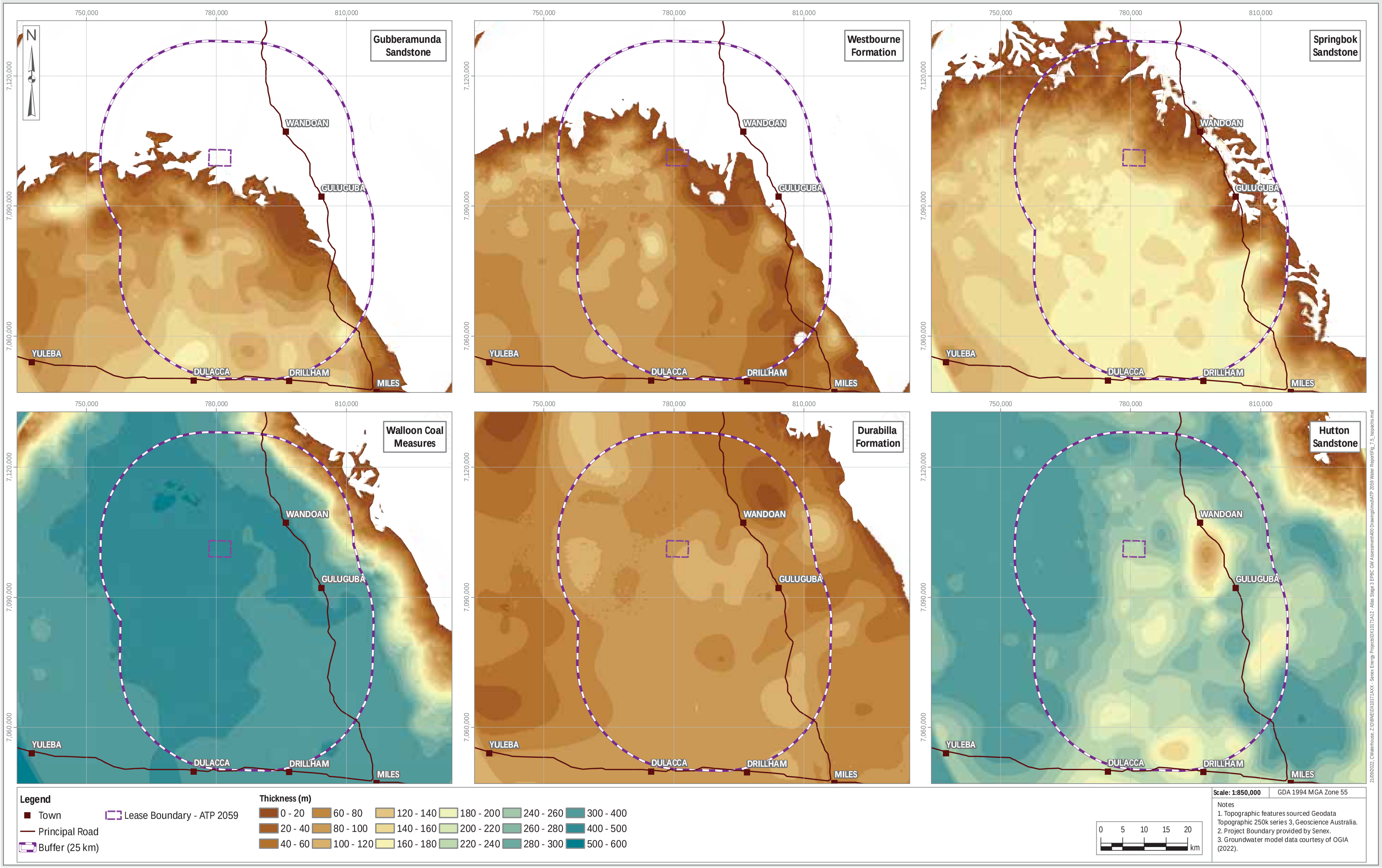

Figure 7.5 Formation Isopachs for Relevant Surat Basin Units (OGIA 2021g)

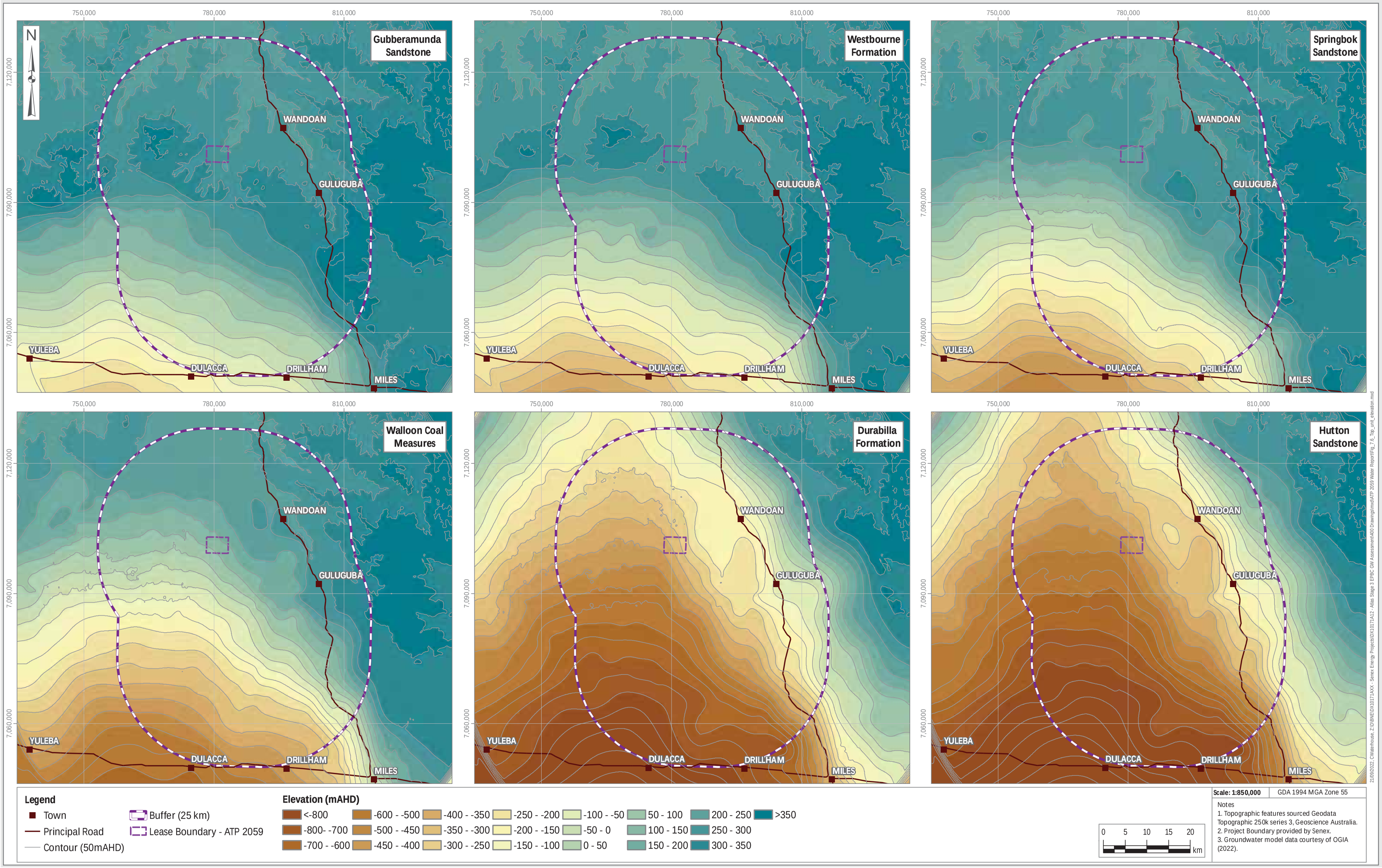

Figure 7.6 **Top of Unit Elevation for Relevant Surat Basin Units (OGIA 2021g)**

7.3.2 Alluvium

Quaternary-age alluvium is mapped within the Project area and is associated with Wandoan, and Woleebee Creeks. The lateral extent of the alluvium increases in the northeast of ATP 2059 towards the confluence of Wandoan Creek and Woleebee Creek. For Wandoan Creek, due to its location within the sub-catchment, topographic elevation and ephemeral nature, the alluvium is expected to be relatively thin and poorly developed, although sand banks up to 5 m high have been observed. Alluvium associated with Woleebee Creek is deeper and assumed to be well-developed. There are two registered bores installed in the alluvium of Woleebee Creek in the east of ATP 2059 (RN 123247 and RN123246) with alluvium up to 18 m deep.

Observations of the alluvium in Woleebee and Wandoan Creek were made in the field verification for Project Atlas (KCB 2018d), close to and within the Project area and summarised below.

Wandoan Creek Alluvium

- The bedrock geology beneath Wandoan Creek in ATP 2059 is the Westbourne Formation.
- The Gubberamunda Sandstone outcrops further upstream, outside of the Project area to the west. Other Gubberamunda outcrops are present to the north and south of the creek in the Project Atlas tenements.
- The creek bed generally consists of silt / silty sand. The creek bed is generally sandier upstream where the creek is closer to the Gubberamunda Sandstone outcrop and becomes silty and clayey downstream consistent with the underlying geology (Westbourne Formation).
- One small rock outcrop was identified along Wandoan Creek on PL 1037 to the west of ATP 2059. This is described as a fine-grained sandstone, which is friable and considered to be a lithological unit of the Westbourne Formation. This unit had been moulded by surface water flow within the creek (Figure 7.7).
- Alluvial sand was encountered to a distance of approximately 400 m from the creek bed, just south of Weldon’s Road, which passes north of Wandoan Creek. This is consistent with the geological mapping.

Figure 7.7 Bedrock and superficial geology encountered at Wandoan Creek A) Outcrop of fine-grained sandstone; B) Sandy creek bed in the upstream sections of the creek

Woleebee Creek Alluvium

- In the upper reaches of the Woleebee Creek (in PL 1037), the creek bed is sandy. The sand is coarse-grained and considered to be associated with the Gubberamunda Sandstone (which outcrops upstream). Further downstream where the creek is underlain by the Westbourne Formation, the creek bed becomes more silty and clayey (Figure 7.8).
- A rock outcrop was identified in the upper reaches of the creek on PL 1037 (Figure 7.8). The base of the outcrop consisted of mudstones considered to be part of the Westbourne Formation, which is overlain by an 'ironstone' and is interpreted to have been formed by the chemical precipitation of iron and manganese. Overlaying the ironstone is a fine gravel conglomerate which in turn is overlain with coarse-grained sandstone with cross-bedding. The coarse-grained sandstone is typical of the Gubberamunda Sandstone. The outcrop is considered to show the conformity between the Gubberamunda Sandstone and the underlying Westbourne Formation.
- Other rock outcrops were observed downstream. These consisted of mudstones and fine-grained sandstone associated with the Westbourne Formation. These rocks were weak and friable.
- The change in bedrock geology could have resulted in the change in the meandering nature of the creek. The presence of the harder coarse-grained sandstone of the Gubberamunda Sandstone may have resulted in a straighter creek channel upstream, with the weak and friable mudstones of the Westbourne Formation resulting in a meandering form downstream.

Figure 7.8 Bedrock and superficial geology encountered at Woleebee Creek A) Outcrop of fine-grained sandstone and mudstone (Westbourne Formation); B) Typical sandy creek bed

7.4 Aquifer / Aquitard Hydraulic Properties

A number of hydraulic tests, to determine hydraulic parameters, have been conducted across the Surat Basin on formations overlying and underlying the WCM.

Hydraulic Conductivity

OGIA (2019b) present the measured range of hydraulic conductivities estimated from core, drill stem tests (DSTs) and pumping tests within the Surat CMA on Figure 7.9. The data was compiled from a range of sources including the Queensland Groundwater Database (GWDB), Queensland Petroleum Exploration Database (QPED), GAB Water Resource Assessment (Smerdon et al. 2012) and public domain sourced investigations undertaken by other CSG proponents including QGC, APLNG and Arrow Energy.

Ranges of horizontal permeability values from these tests, together with model calibrated values indicate that the Gubberamunda and Precipice Sandstones are the most permeable consolidated formations in the Surat CMA (Figure 7.9) (OGIA 2019b).

Limited site-specific hydraulic parameter values are available for the alluvium within the Project area. A hydraulic conductivity of between 0.2 and 1.4 m/d has been reported for the alluvium associated with Horse Creek (AGE 2012), which is located in an adjacent catchment approximately 20 km northwest of the Project.

Storage

Estimates of storage parameters are presented in documentation for the neighbouring QGC tenures (Golder Associates 2009b). The storage coefficient is reported to range between 5×10^{-3} and 5×10^{-4} for all consolidated hydrostratigraphic units.

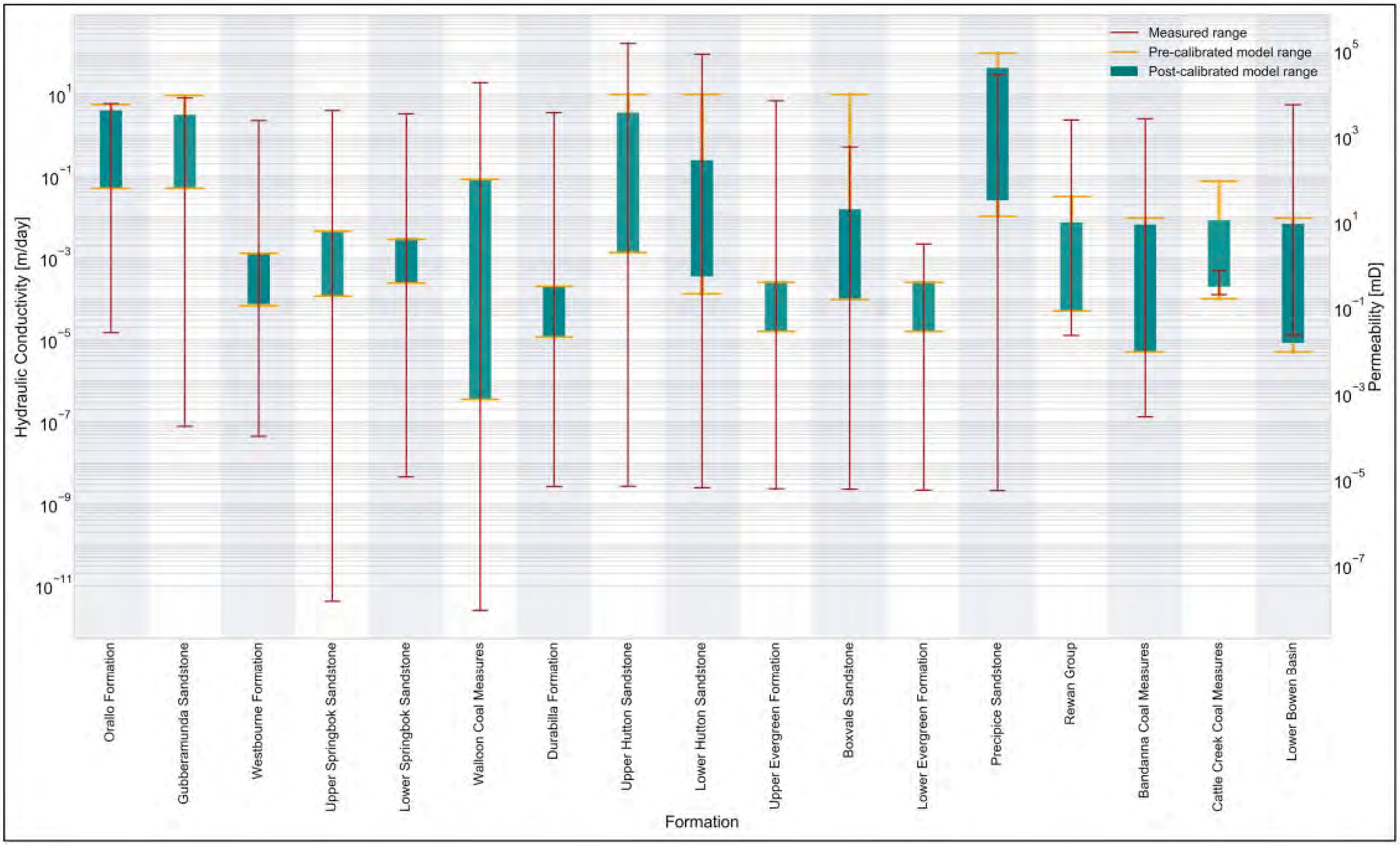

Figure 7.9 Hydraulic Conductivity Values for Surat Basin Units (after OGIA 2019b)

7.5 Inter-Aquifer Connectivity

The Surat Basin comprises layers of aquifers and aquitards of varying hydraulic properties. The formations predominantly comprise fluvial sedimentary deposits that have formed stratifications of sand, silt and clay within and across hydrostratigraphic formations (OGIA 2016b). Groundwater flow within the Surat Basin hydrostratigraphic units is predominantly horizontal, as vertical flow is restricted by the spatial extent and continuity of aquitards, and by lower permeability horizons within the aquifers (OGIA 2016b).

Across the Project extent, there is potential for interaction between the WCM and aquifers above and below, specifically the overlying Springbok Sandstone and underlying Hutton Sandstone (separated from the WCM by the Durabilla Formation). The Durabilla Formation is mapped across the entire Project area, with a mean thickness of 87 m (Figure 7.10), which provides a significant vertical barrier between the WCM and underlying Hutton Sandstone. An upper WCM aquitard has been mapped by OGIA (the Walloon Coal Measures non-productive zone, OGIA 2021g) as being up to 25 m thick across the Project area, separating the WCM coal seams from the overlying Springbok Sandstone.

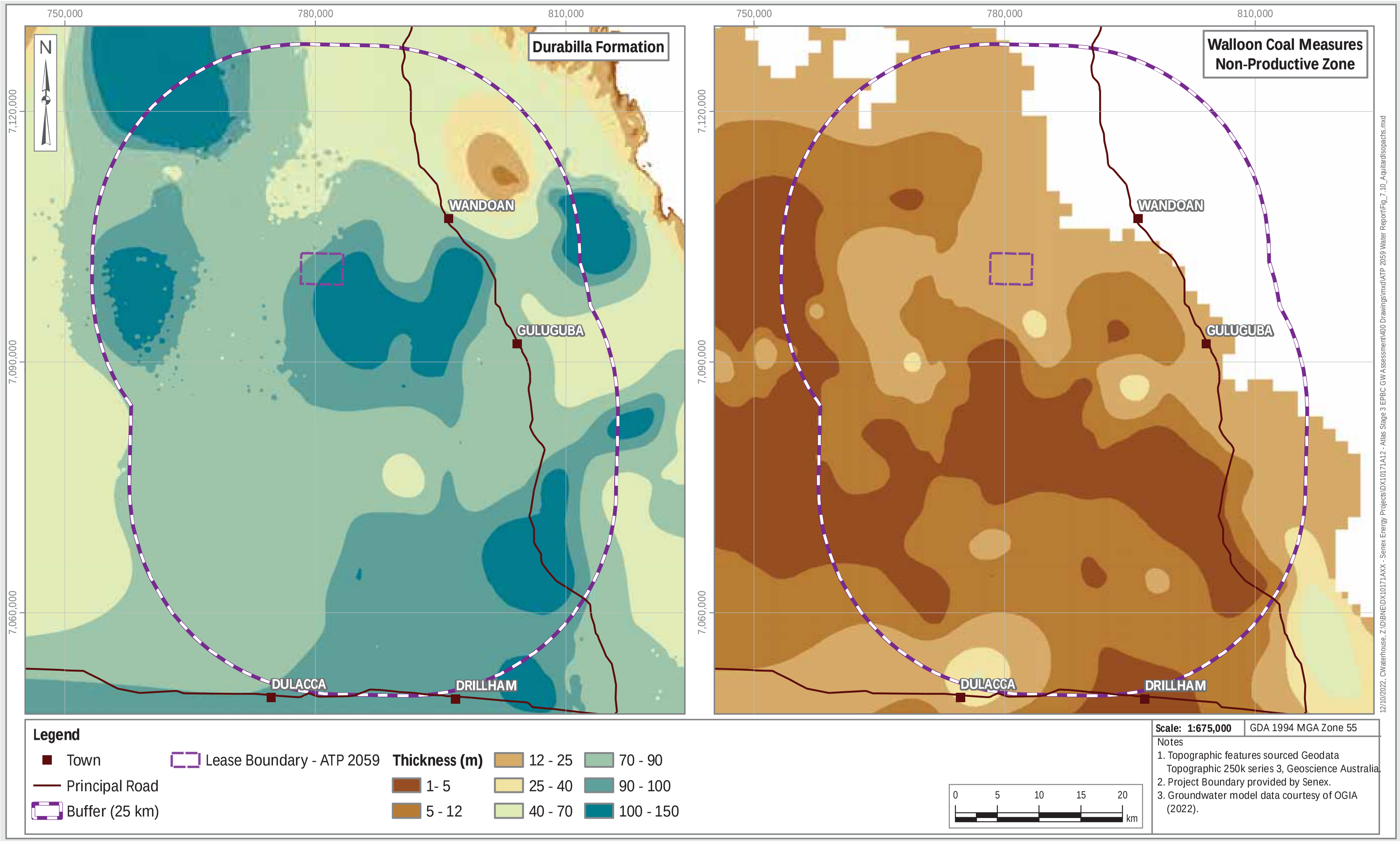

Figure 7.10 Aquitard Isopachs (OGIA 2017a; 2021g)

7.6 Groundwater Recharge

Groundwater recharge processes within the Surat Basin are summarised in the *Hydrogeological Conceptualisation Report for the Surat Cumulative Management Area* (OGIA 2016b) and based on Kellett et al. (2003), and *Regional flow systems and potentiometry in Queensland's Surat and Southern Bowen Basins* (OGIA 2021d). Key processes of recharge include localised recharge, preferential pathway flow and diffuse recharge:

- Localised recharge occurs beneath drainage features including rivers, creeks and alluvial and Tertiary groundwater systems where there is sufficient saturation and hydraulic head to allow water to infiltrate into aquifers. Areas of localised recharge are considered limited in extent in the GAB (Kellett et al. 2003).
- Preferential pathway flow arises from changes in permeability within aquifers and in overlying regolith, providing conduits for water to infiltrate. Zones of higher permeability may include fissures, faults, joints, tree roots and high-permeability beds within individual formations and along bedding planes (Kellett et al. 2003; Sucklow et al. 2016). This mechanism is considered the dominant recharge process in the GAB (Kellett et al. 2003).
- Diffuse discharge is the process by which rainfall infiltrates directly though outcropping aquifers. This is expected to occur within all outcrop areas and therefore this process applies to the largest spatial extent (Kellett et al. 2003).

Within the vicinity of the Project area, groundwater recharge is likely to occur as a result of localised recharge occurring beneath watercourses and alluvial systems where sufficient saturation and hydraulic head allows water to infiltrate into surficial aquifers. Recharge will also occur as diffuse recharge with rainfall infiltrating directly through outcropping aquifers, such as the Gubberamunda Sandstone which outcrops in the south of ATP 2059.

Recharge estimates were made by OGIA (OGIA 2019a):

- Orallo Formation (outcrops to the south) – 2.4 mm/year.
- Gubberamunda Sandstone (outcrops in the Project area) – 3.4 mm/year.
- Westbourne Formation (outcrops in the Project area) – 1.6 mm/year.
- Springbok Sandstone (outcrops to the northeast) – 1.3 mm/year.

7.7 Groundwater Levels and Flow

7.7.1 Regional Groundwater Flow

Basin scale groundwater flow within the Surat Basin is typically north to south from northern outcrop areas. There is also a preference of groundwater to flow towards the north (towards Taroom) on the northern side of the Great Dividing Range with groundwater discharging into the Dawson River catchment (OGIA 2016c; 2021d). South of the Range, groundwater flow is generally southward, broadly consistent with the dip of the formation (OGIA 2021d).

Groundwater movement is slow in the GAB with flow velocities estimated at 1 to 5 m/yr (Habermehl 1980). Generally, groundwater flow and movement occurs as sub-horizontal flow, with limited vertical leakage across formations, where pressure differences may exist (OGIA 2016c). Local groundwater flow conditions may be different from regional flow conditions with potential steeper gradients and increased velocities in response to hydraulic stresses such as groundwater abstraction.

7.7.2 Groundwater Elevation and Monitoring Bores

There are 79 active monitoring bores at 56 sites within the 25 km buffer (State of Queensland 2021c) (Figure 7.11 and Table 7.2). The majority of these monitoring bores are installed as part of the UWIR and other programs, such as the CSG Online or CSG Net programs, which are coordinated by the Queensland Government. In addition, there are ten seepage monitoring bores installed by Senex in the Westbourne Formation, for monitoring of potential seepage from established development infrastructure for Project Atlas (within PL 1037) as required by the EA for that project (EA0001207).

Individual maps of monitoring bore locations, for each formation, are provided in the following sections. It should be noted that some of the monitoring bore data is not currently available through the GWDB, which may be a function of recent installation, or the frequency of data entry into the GWDB. Aquifer attributions for the monitoring bores have been determined by OGIA as part of their 2021 Surat CMA numerical groundwater model update (OGIA 2022).

Table 7.2 Groundwater Monitoring Bores Within 25 km Buffer

Formation	No. of Monitoring Bores
Wallumbilla Formation	1
Mooga Sandstone	3
Gubberamunda Sandstone	11
Westbourne Formation	10
Upper Springbok Sandstone	7
Lower Springbok Sandstone	2
Upper Juandah Coal Measures	9
Lower Juandah Coal Measures	11
Taroom Coal Measures	7
Durabilla Formation	2
Lower Evergreen Formation	1
Upper Hutton Sandstone	8
Lower Hutton Sandstone	3
Precipice Sandstone	4
Total	**79**

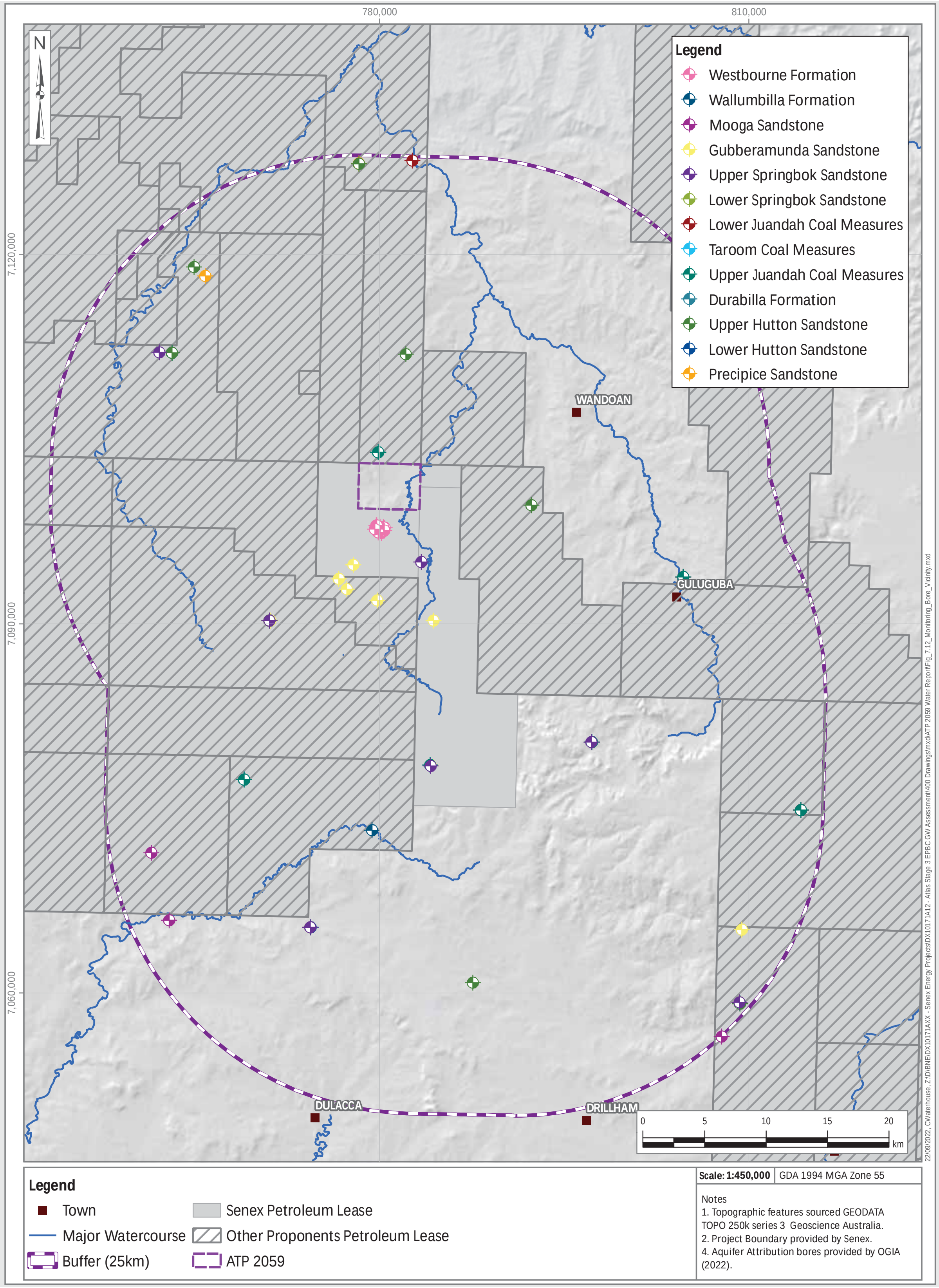

Figure 7.11 Location of Monitoring Bores within the Vicinity of the Project

Gubberamunda Sandstone Monitoring Bores

There are eleven Gubberamunda Sandstone monitoring bores within the 25 km buffer zone surrounding the Project area. Bore locations are shown on Figure 7.12, and a groundwater elevation hydrograph is presented for the bores on Figure 7.13.

Observations from available data include:

- Groundwater elevations range between ~269 and ~314 mAHD, with highest elevations corresponding to highest ground elevations in the southeast. RN43482 exhibits the lowest groundwater elevation, located immediately to the west of PL 445 within ATP 2059.
- Groundwater levels in most bores are either stable (particularly shallow bores) or exhibit slightly declining trends. RN160522 (located due west of PL 445) has seen a steep decline from 2012, followed by an increase to 2016 after which levels stabilised. This observation is supported by rainfall CRD (Figure 5.2), indicating some degree of climatic influence at that location. RN123553 has seen periodic water level increases and decreases of +/- 12 m since 2016 and may be influenced by pumping. RN13030808 located in PL 209 remains stable since pre-2010 with an elevation of ~282 mAHD.
- Inferred groundwater flow within the Gubberamunda Sandstone is northwest and south from a high point at RN160704. This observation corresponds with expected groundwater flow directions on either side of the river basin divide at the southern extent of PL 209.

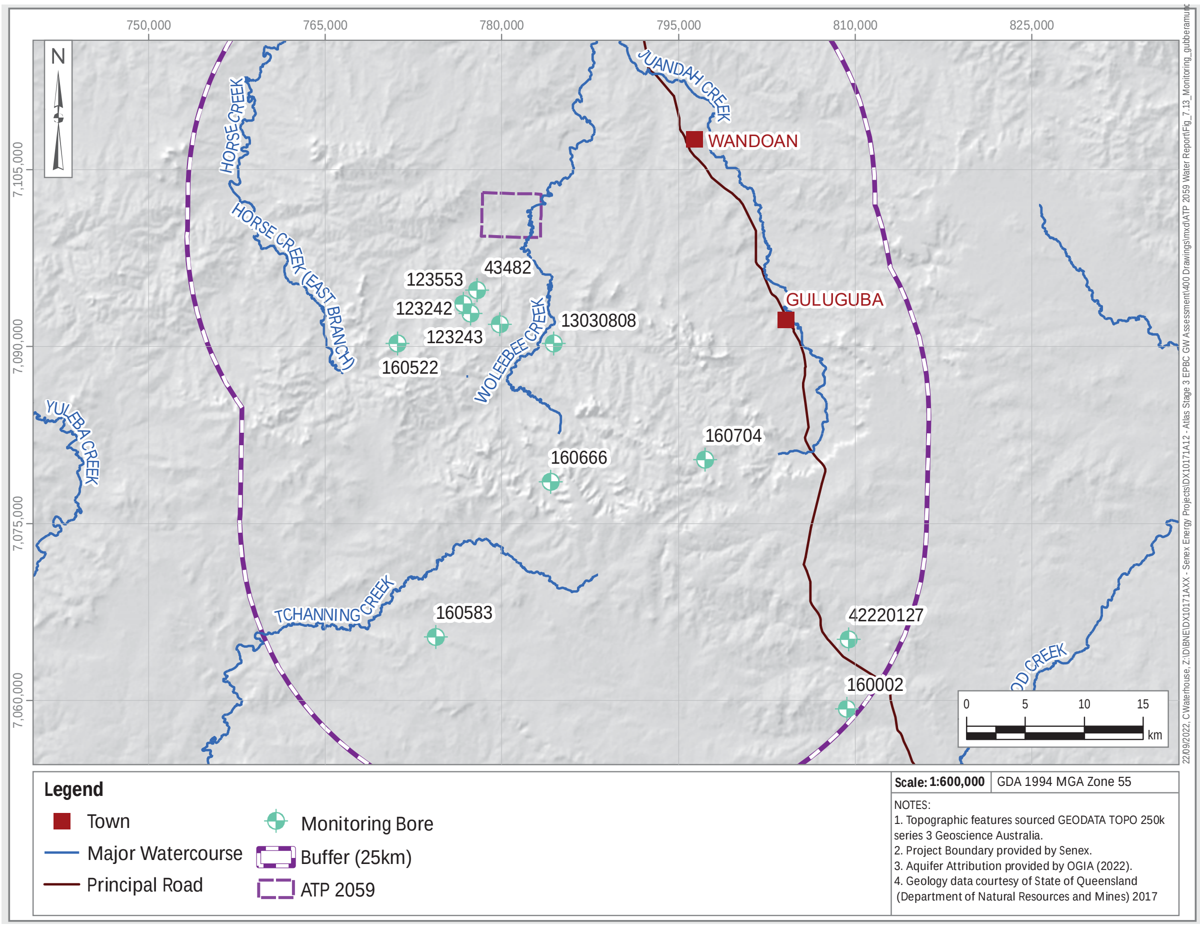

Figure 7.12 Location of Gubberamunda Sandstone Monitoring Bores

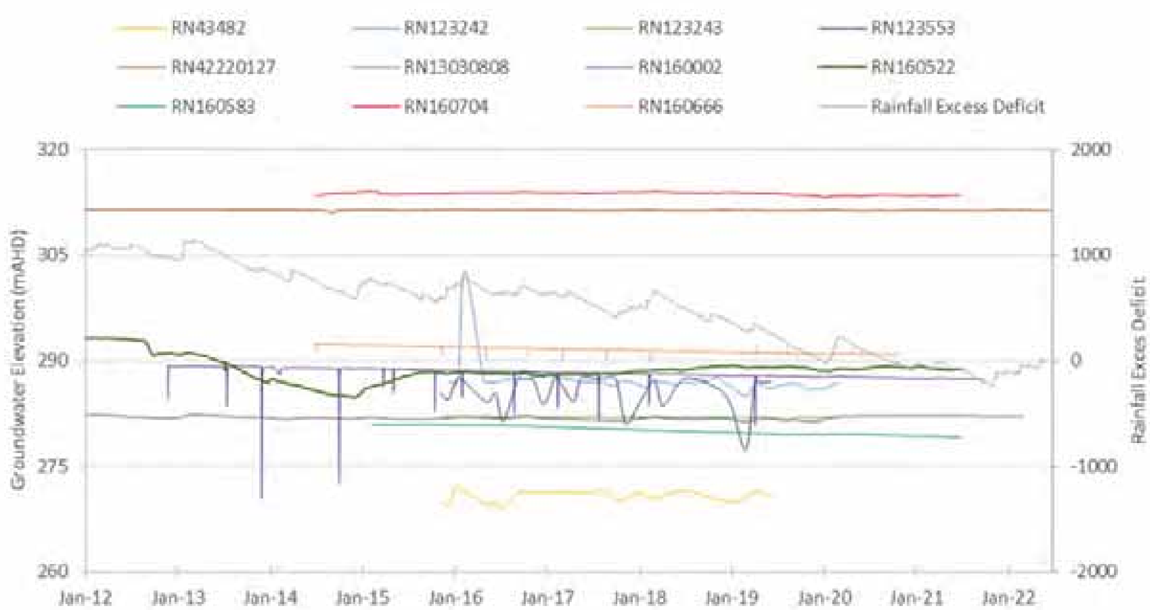

Figure 7.13 Groundwater Elevation Hydrograph – Gubberamunda Sandstone

Westbourne Formation Monitoring Bores

There are ten monitoring bores on the Project Atlas tenure screened within the Westbourne Formation, with the locations shown on Figure 7.14. These bores were installed by Senex for seepage monitoring of Project Atlas produced water dams.

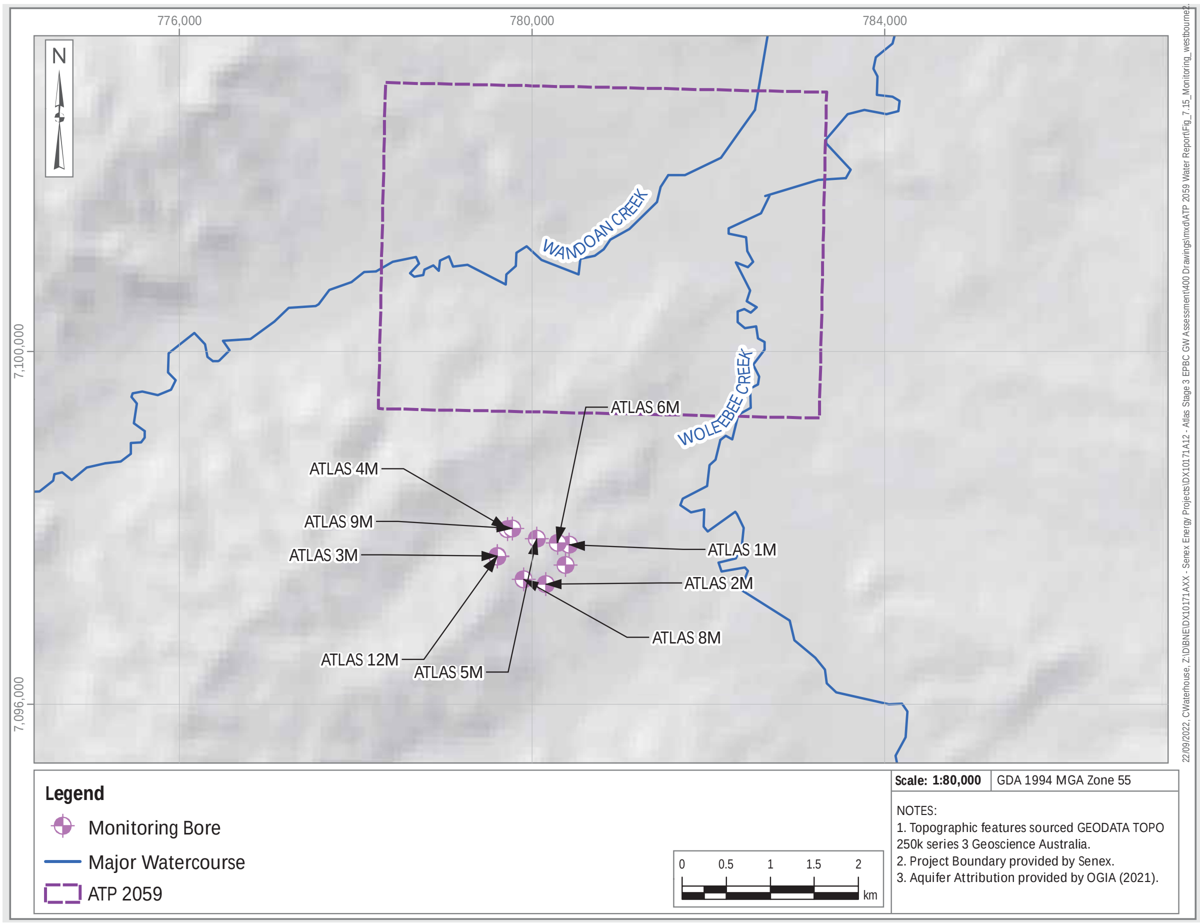

Figure 7.14 Location of Westbourne Formation Monitoring Bores

Figure 7.15 presents the groundwater elevation for seven of the ten bores screened within the Westbourne Formation. These bores have been monitored from June 2020 and were installed by Senex. Of the ten bores, only six are monitored consistently with four being consistently dry (Atlas 6M, 7M, 8M and 12M). The hydrographs identify that groundwater elevations range between ~257 mAHD and 264 mAHD. Groundwater levels in these bores have remained relatively stable across the monitoring period, with a rise of approximately 3 m observed in monitoring bore Atlas 2M.

Groundwater within the Westbourne Formation at the Atlas produced water dams occurs in a shallow and deeper confined groundwater system. In the deeper Westbourne Formation, flow direction is towards the east-southeast with a low horizontal hydraulic gradient across the site (Senex 2022).

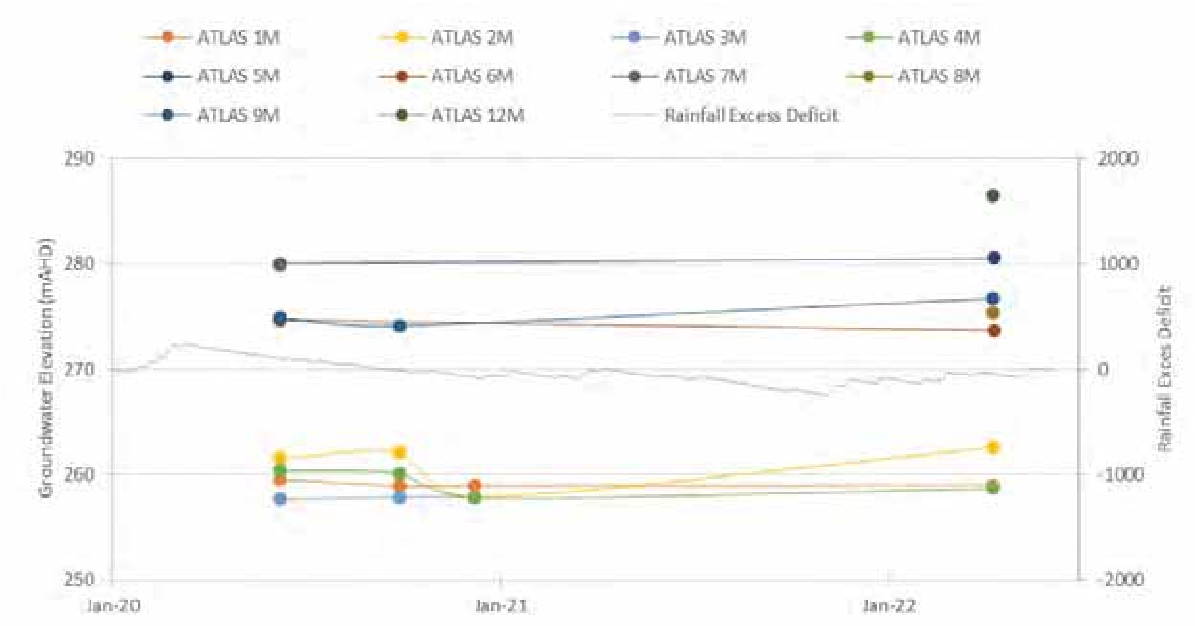

Figure 7.15 Groundwater Elevation Hydrograph – Westbourne Formation

Upper Springbok Sandstone Monitoring Bores

There are seven Upper Springbok Sandstone monitoring bores within the 25 km buffer zone. Bore locations are shown on Figure 7.16, and a groundwater elevation hydrograph is presented for the bores on Figure 7.17.

Observations from available data include:

- Groundwater elevations range between ~250 and ~335 mAHD, with highest elevations corresponding to highest ground elevations in the south (RN160193). RN180018 exhibits the lowest groundwater elevation, located at the northwest extent of the 25 km buffer, adjacent to the east branch of Horse Creek.
- RN160694 and RN160812 exhibit periodic pumping and recovery trends associated with landholder pumping which is common in Springbok Sandstone bores. Slow and frequently incomplete recovery trends indicate homogeneity and low permeability within the Springbok Sandstone (OGIA 2021g).
- Groundwater levels in most bores have remained stable since 2016. RN160431 (located ~12 km due west of PL 209) has seen a steep decline from 2012 until 2019 when levels stabilised. Overall decline was ~36 m over 10 years. A moderate concentration of groundwater use has been noted in this area and is considered to be contributing locally to drawdown (OGIA 2021d).
- Inferred groundwater flow within the Upper Springbok Sandstone is northwest from a high point at RN160193, this aligns with observations from OGIA (OGIA 2021d).

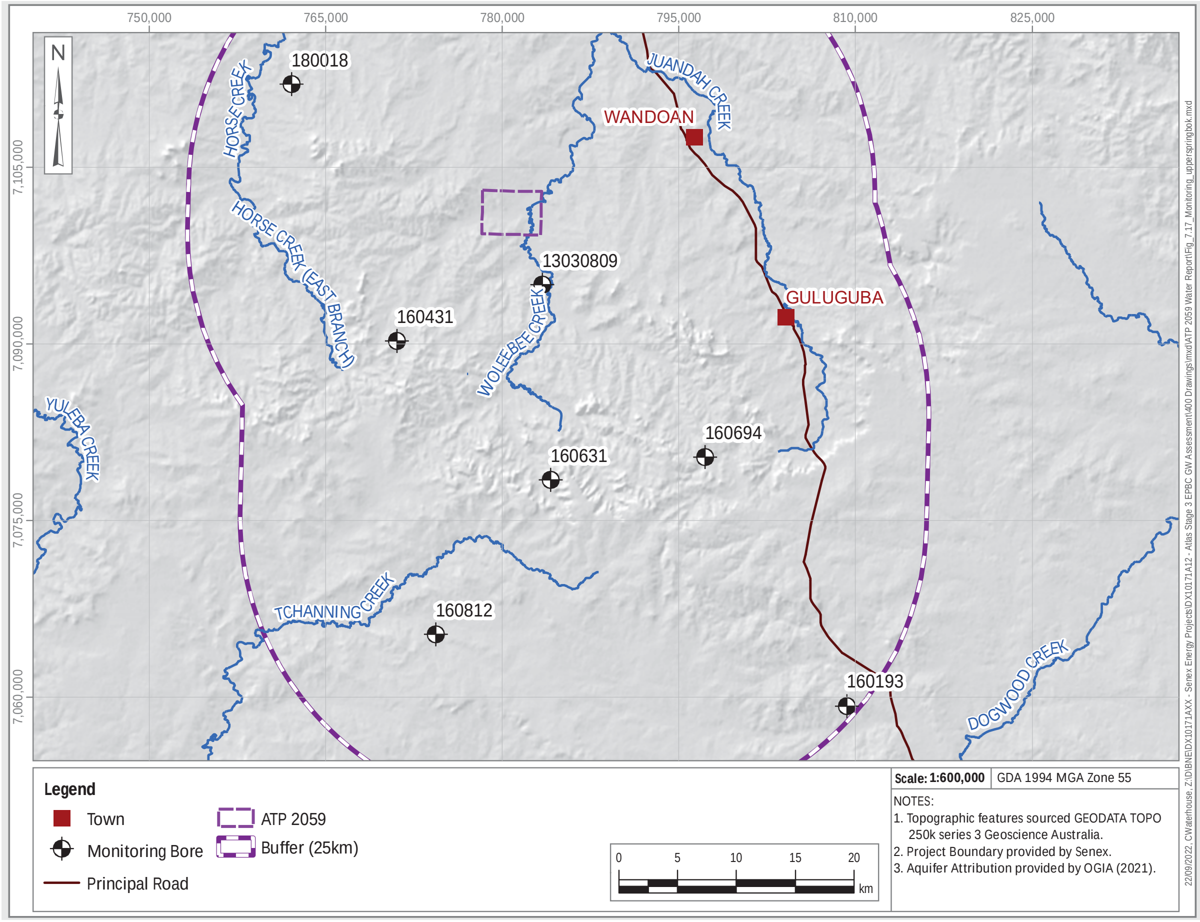

Figure 7.16 Location of Upper Springbok Sandstone Monitoring Bores

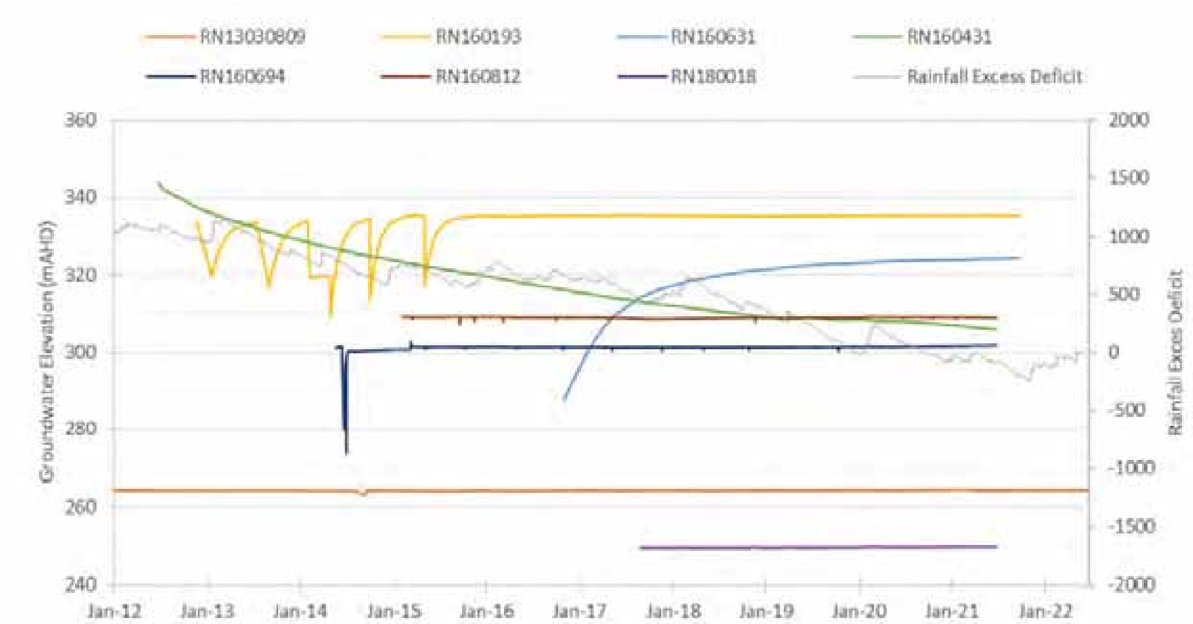

Figure 7.17 Groundwater Elevation Hydrograph – Upper Springbok Sandstone

Lower Springbok Sandstone Monitoring Bores

There are two Lower Springbok Sandstone monitoring bores, at two locations, with groundwater elevation data available in the vicinity of the Project area. The location of these bores is shown in Figure 7.18.

There are two Lower Springbok Sandstone monitoring bores within the 25 km buffer zone, a groundwater elevation hydrograph is presented for those bores on Figure 7.19.

Observations from available data include:

- Groundwater elevations range between ~269 and ~277 mAHD. Groundwater levels in in RN 160853 have remained stable, however RN 160430 may be influenced by pumping in the Upper Sandstone (OGIA 2021d).

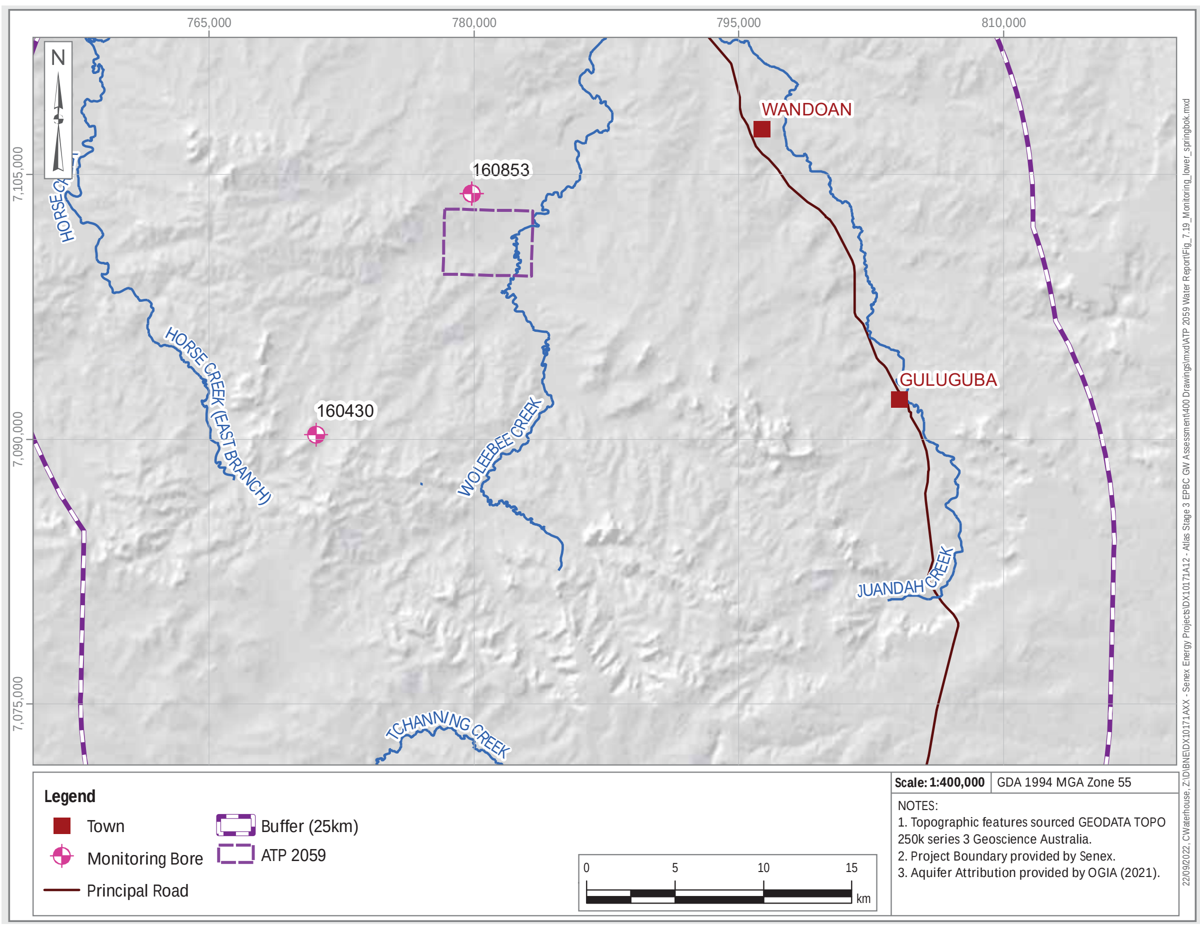

Figure 7.18 Location of Lower Springbok Sandstone Monitoring Bores

Figure 7.19 Groundwater Elevation Hydrograph – Lower Springbok Sandstone

Walloon Coal Measures Monitoring

There are 27 WCM monitoring bores within the vicinity of the Project area. The majority of these locations include multi-unit monitoring bores across the different coal seams of the WCM, at ten locations:

- Nine in the Upper Juandah Coal Measures;
- Eleven in the Lower Juandah Coal Measures; and
- Seven in the Taroom Coal Measures.

These locations are shown on Figure 7.20.

Monitoring records are presented in Figure 7.21, Figure 7.22 and Figure 7.23. These monitoring locations are likely operated by neighbouring CSG tenure holders and show a variety of responses which are likely due to depressurisation or testing which has commenced in these areas. Groundwater elevations within the WCM range between ~340 mAHD and 70 mAHD.

Groundwater flow in the WCM is generally south to north towards Taroom, however CSG development areas result in localised variations to this regional flow direction (OGIA 2021d). The observed drawdown in the CSG areas is steep, with little drawdown observed outside of the operating fields. This is likely to reflect the discontinuous nature of the coal seams in these gas fields and low effective horizontal permeabilities (OGIA 2021d). This explains the variety of responses in the groundwater elevations.

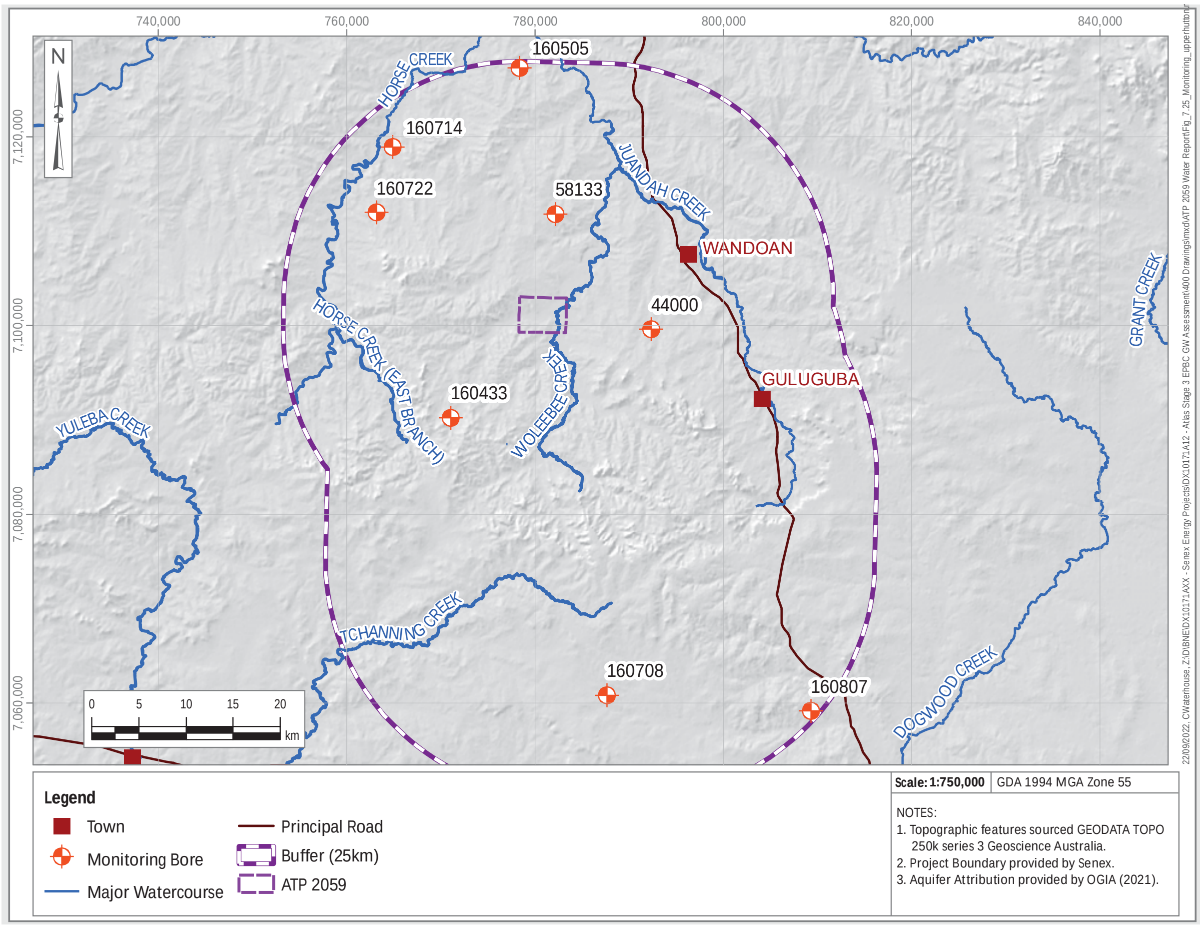

Figure 7.20 Location of WCM Monitoring Bores

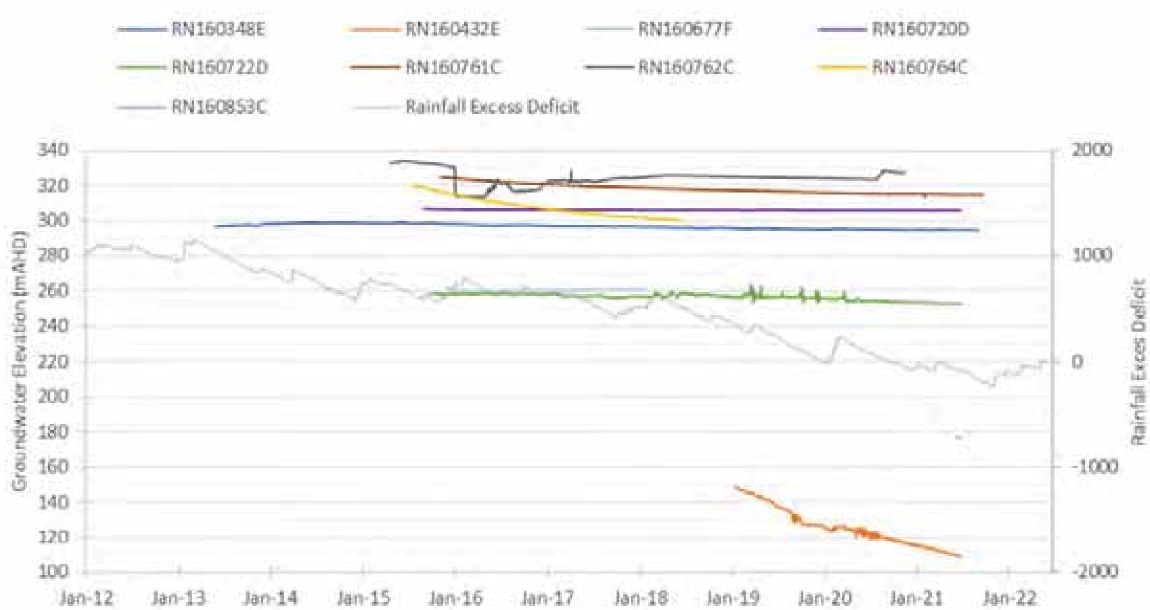

Figure 7.21 Groundwater Elevation Hydrograph for WCM – Upper Juandah Coal Measures

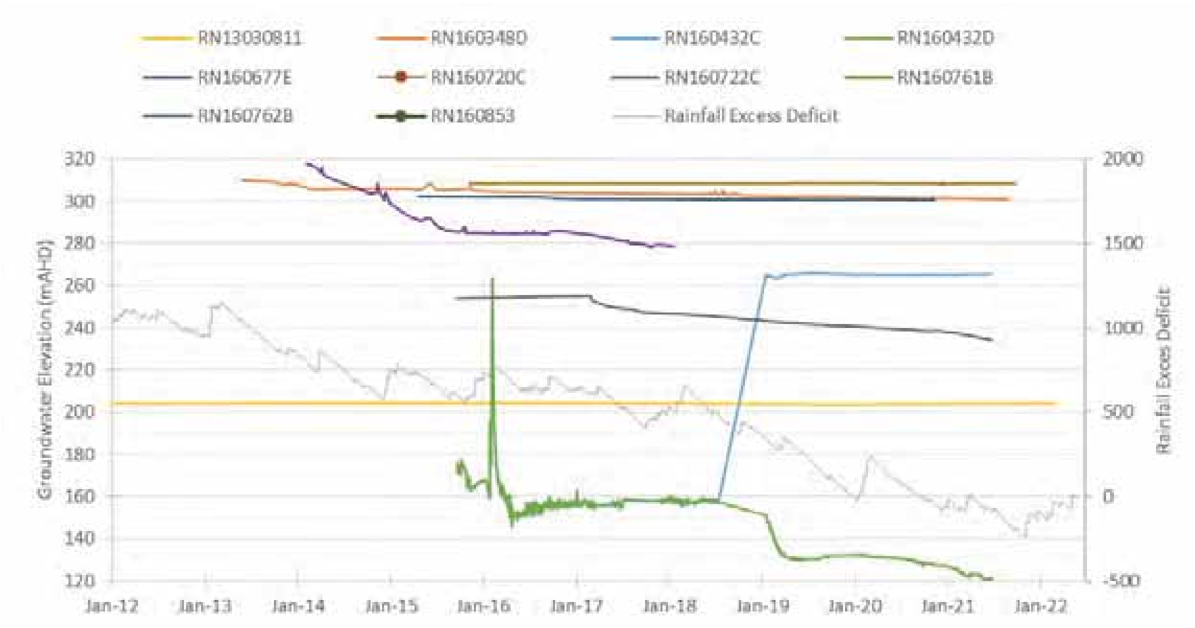

Figure 7.22 Groundwater Elevation Hydrograph for WCM – Lower Juandah Coal Measures

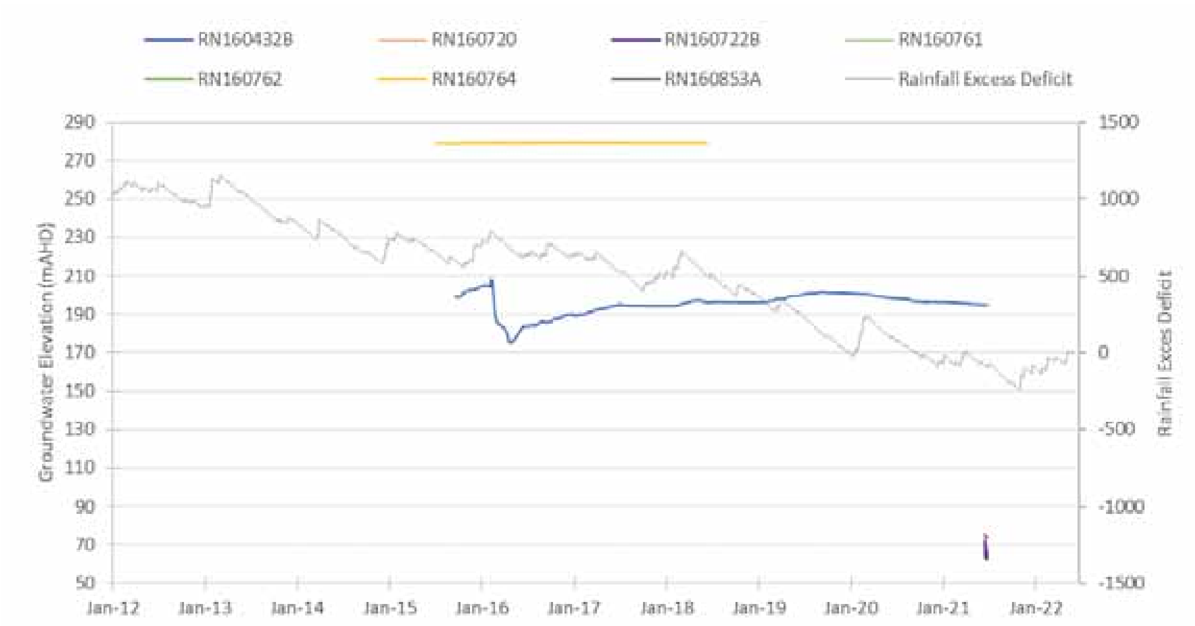

Figure 7.23 Groundwater Elevation Hydrograph for WCM – Taroom Coal Measures

Upper Hutton Sandstone Monitoring Bores

Temporal groundwater elevations for the Hutton Sandstone are available for eight sites within the vicinity of the Project area. The location of these sites is shown on Figure 7.24 with the groundwater elevation hydrograph presented on Figure 7.25.

The range of groundwater elevation from these monitoring bores is between ~235 mAHD and 287 mAHD. Generally, most groundwater level records present relatively static groundwater levels with the exception of RN 160807 and RN 160505 which show a gradual decline. The monitoring record for RN 58133, located north of the Project, indicates a response to local pumping. RN 160722 and RN 44000 may also be responding to local water use.

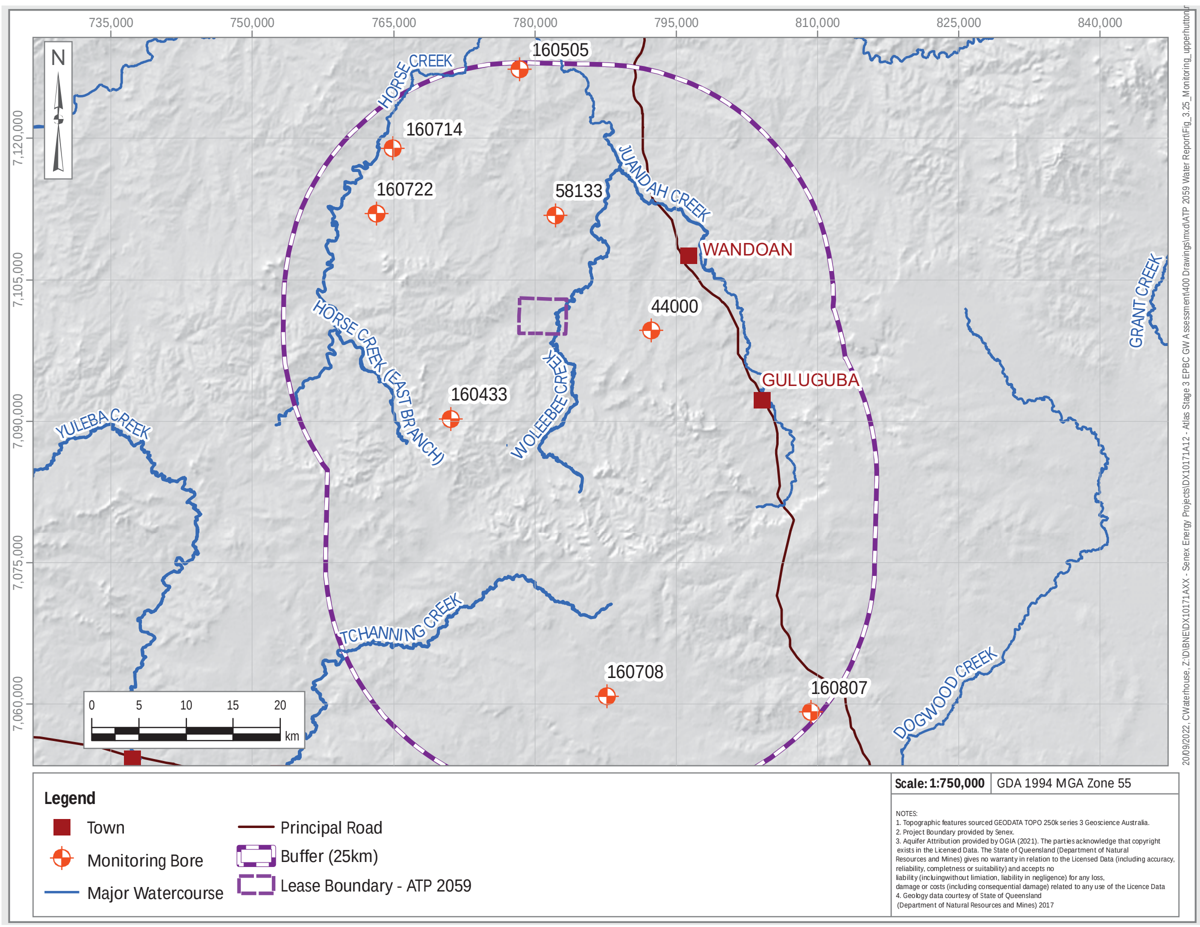

Figure 7.24 Location of Upper Hutton Sandstone Monitoring Bores

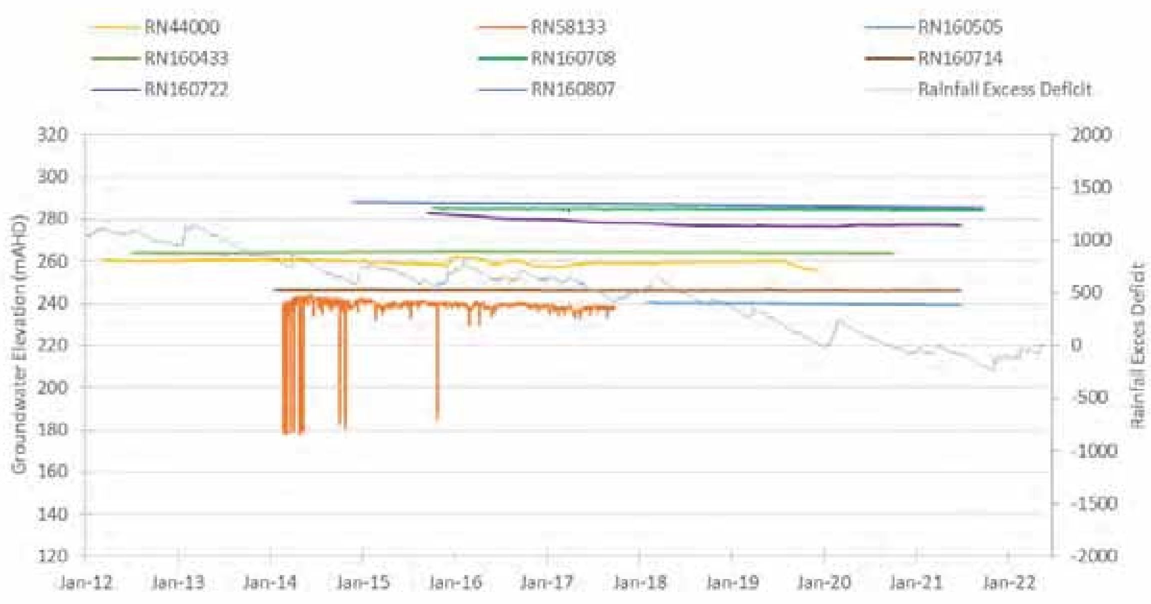

Figure 7.25 Groundwater Elevation Hydrograph – Upper Hutton Sandstone

Lower Hutton Sandstone Monitoring Bores

There are three Lower Hutton Sandstone monitoring bores within the Project 25 km buffer zone (Figure 7.26). Groundwater hydrographs for these bores are presented in Figure 7.27.

Observations from available data include:

- Groundwater elevations range between ~277 and ~285 mAHD.
- Groundwater elevations are generally stable in RN160813. RN160348 experienced a decrease of ~1.5 m in 2016 where the water level remained stable for approximately two years, then increased to previous levels. This pattern repeated in 2019 to 2020. This may be due to issues with the pressure transducer at this bore. The bore exhibits an overall slightly declining trend of 1.2 m over ~7 years, RN160677 exhibits a similar trend.
- Inferred groundwater flow within the Lower Hutton Sandstone is north towards Taroom (recognising limited data) which aligns with OGIA's potentiometric map for the Hutton Sandstone (OGIA 2021d).

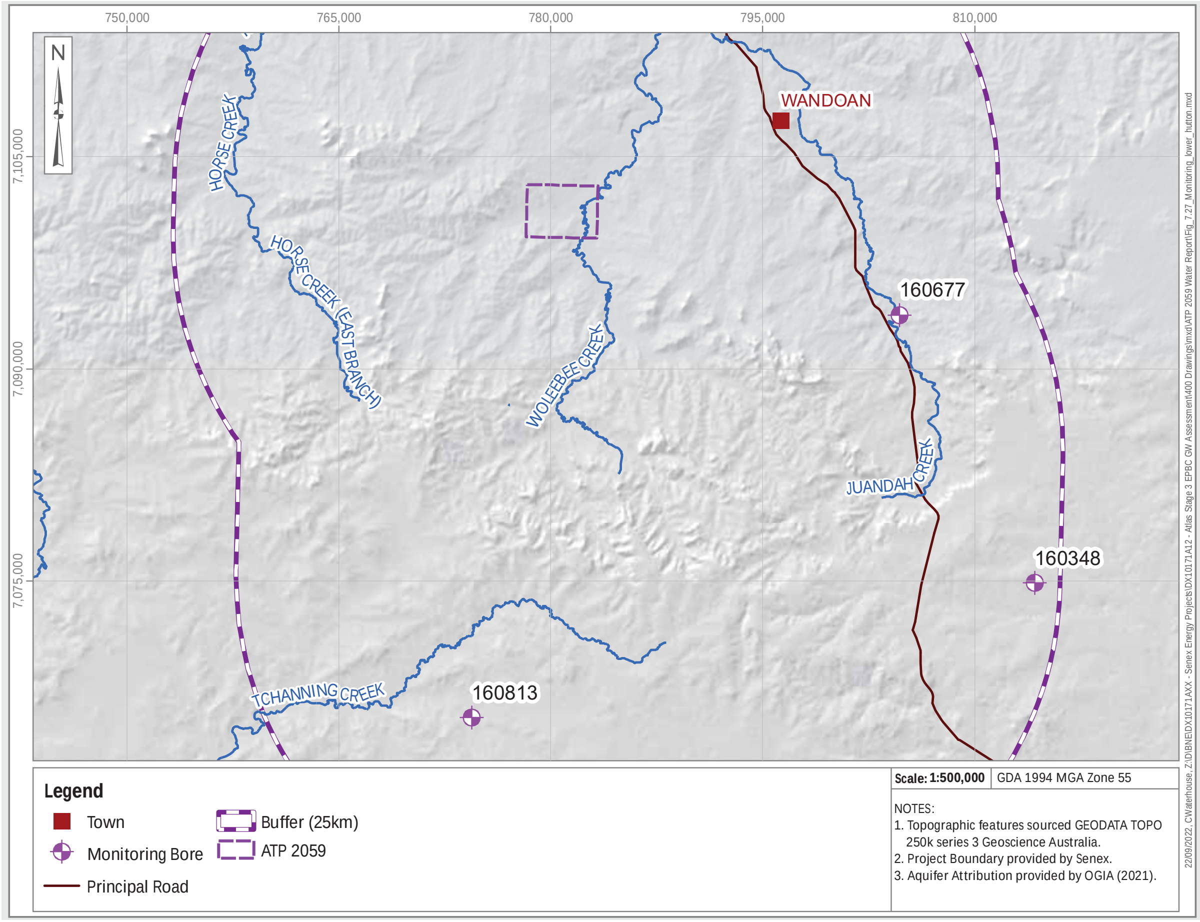

Figure 7.26 Location of Lower Hutton Sandstone Monitoring Bores

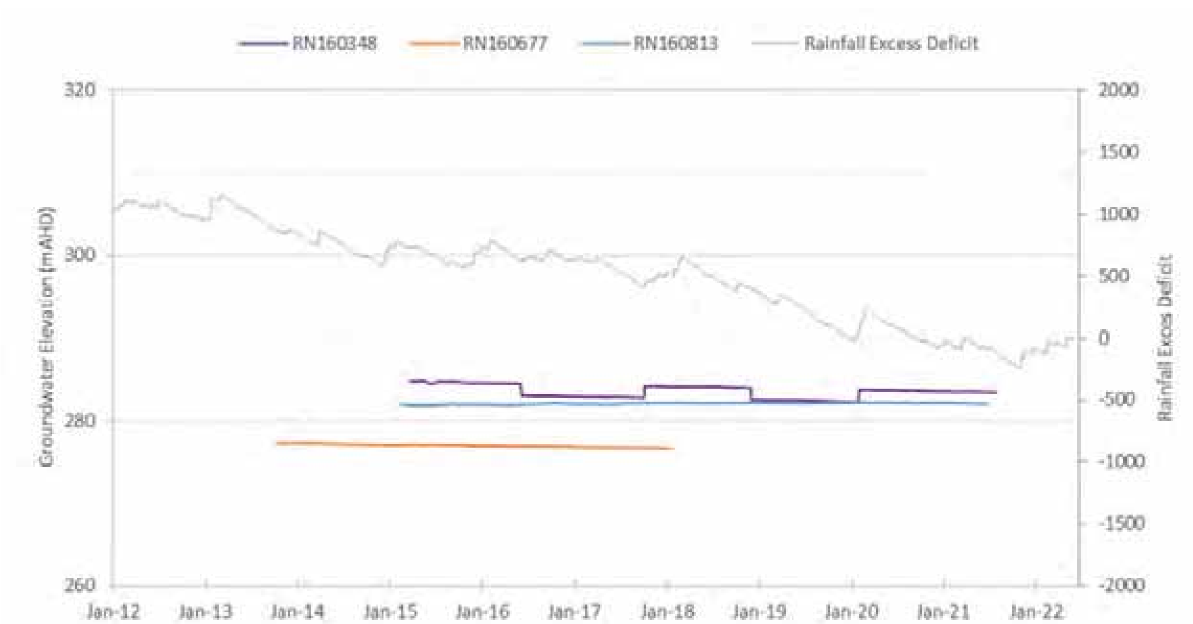

Figure 7.27 Groundwater Elevation Hydrograph – Lower Hutton Sandstone

Evergreen Formation Monitoring Bores

There is one bore monitoring the Evergreen Formation within the vicinity of the Project area, with their locations shown in Figure 7.28. Hydrographs for selected monitoring bores are presented in Figure 7.29.

RN160686 is a multi-level site and includes monitoring of the Evergreen Formation (Pipe B) and Precipice Sandstone (Pipe D) and is located approximately 18 km east of the Project.

The groundwater hydrograph for the Evergreen Formation bore is presented in Figure 7.29 and indicates that the groundwater elevation is ~282 mAHD. The groundwater level in this bore has remained stable within a minimum and maximum range of approximately 2 m.

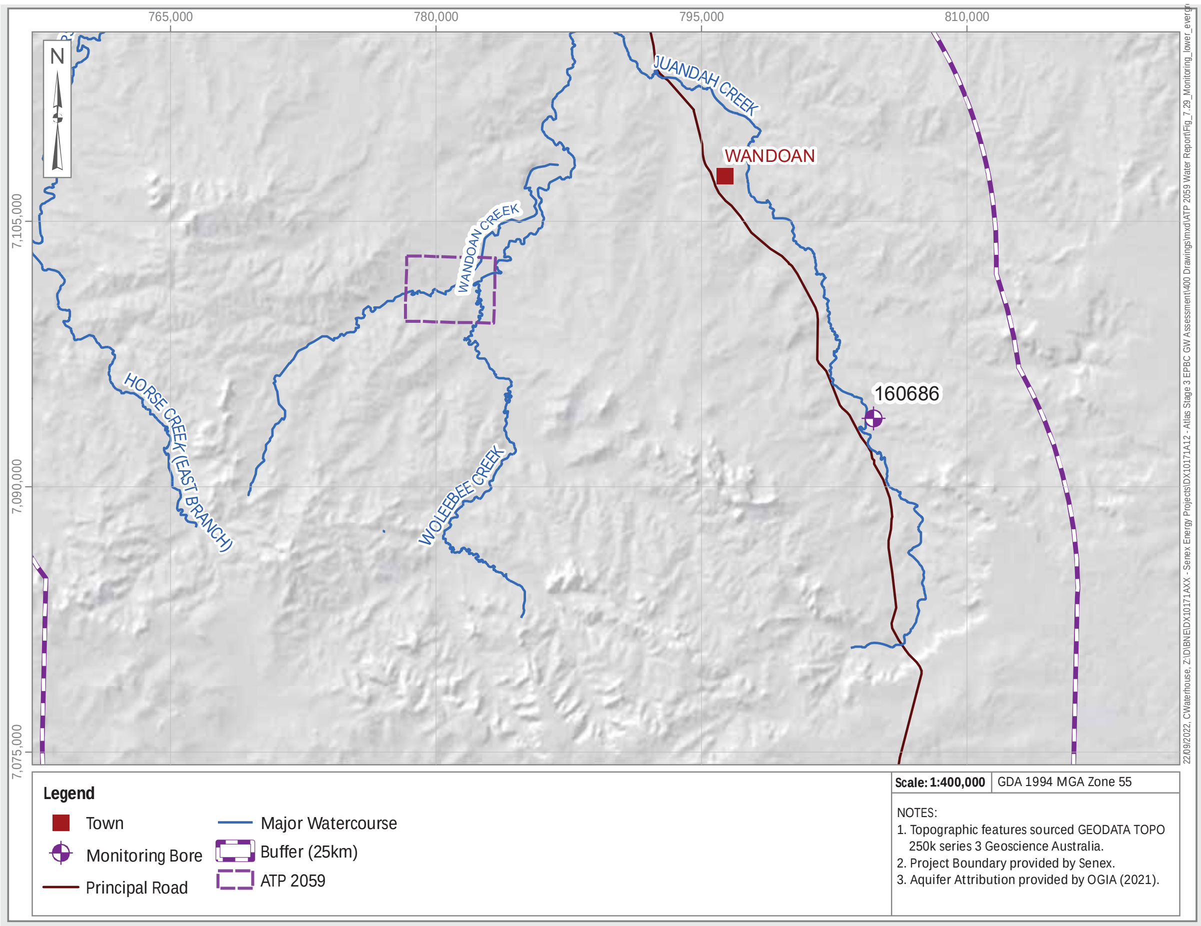

Figure 7.28 Location of Evergreen Formation Monitoring Bore

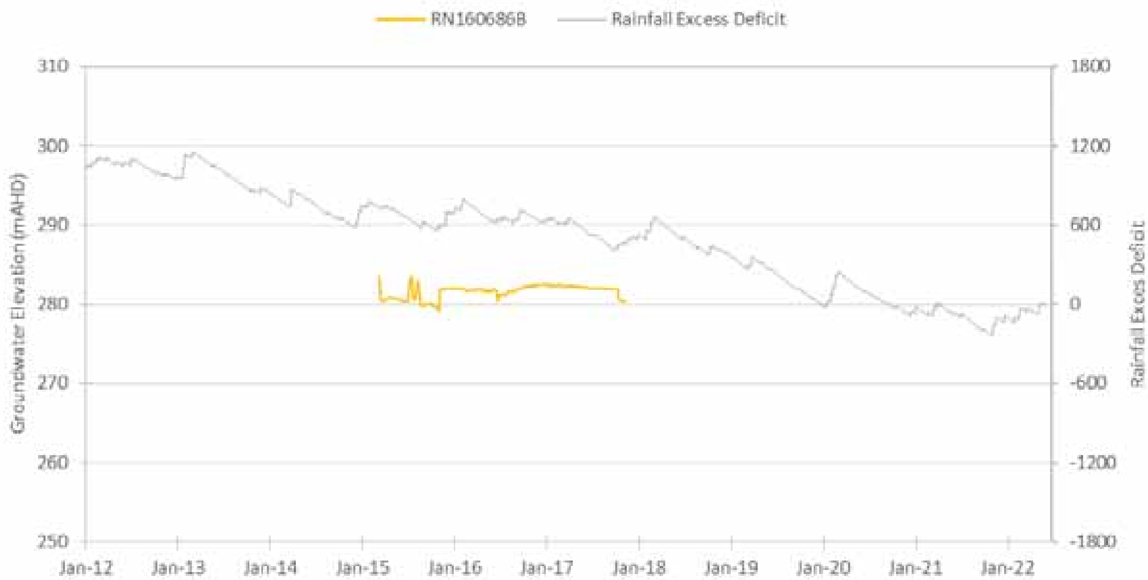

Figure 7.29 Groundwater Elevation Hydrograph – Evergreen Formation

Precipice Sandstone Monitoring Bores

There are four bores monitoring the Precipice Sandstone within the vicinity of the Project area, with their locations shown in Figure 7.30. Hydrographs for selected monitoring bores are presented in Figure 7.31.

The hydrographs indicates that the groundwater elevation in the Precipice Sandstone at RN160441 has been rising since mid-2015 and is likely a function of an aquifer injection scheme occurring ~80 km to the west of the Project at Reedy Creek (OGIA 2021d).

RN 160863 is located ~20 km to the northwest of the Project and monitors the Precipice Sandstone at depth (top of Precipice Sandstone ~1,100 mbgl). The groundwater level in this bore has been rising which is likely due to the Reedy Creek and Spring Gully aquifer reinjection schemes, with trials having commenced in December 2012.

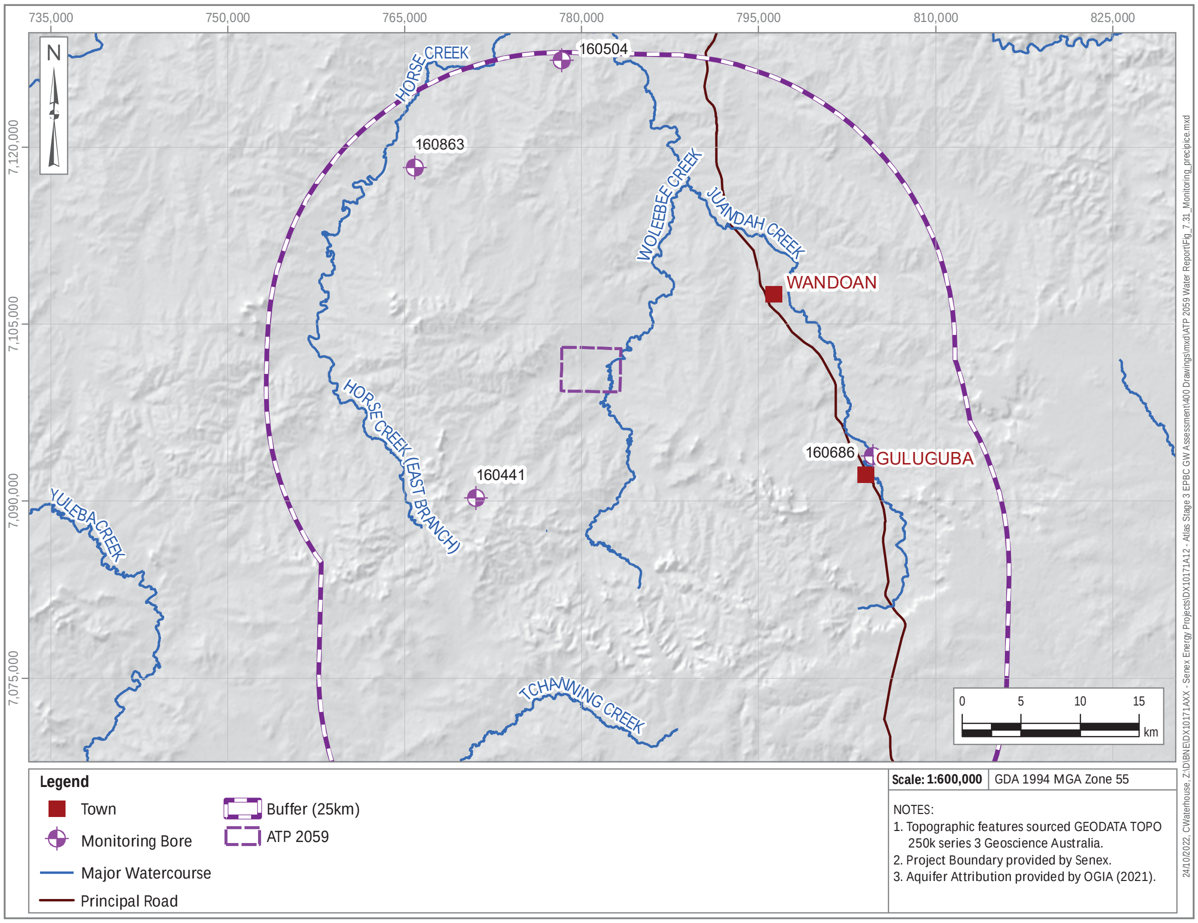

Figure 7.30 Location of Precipice Sandstone Monitoring Bores

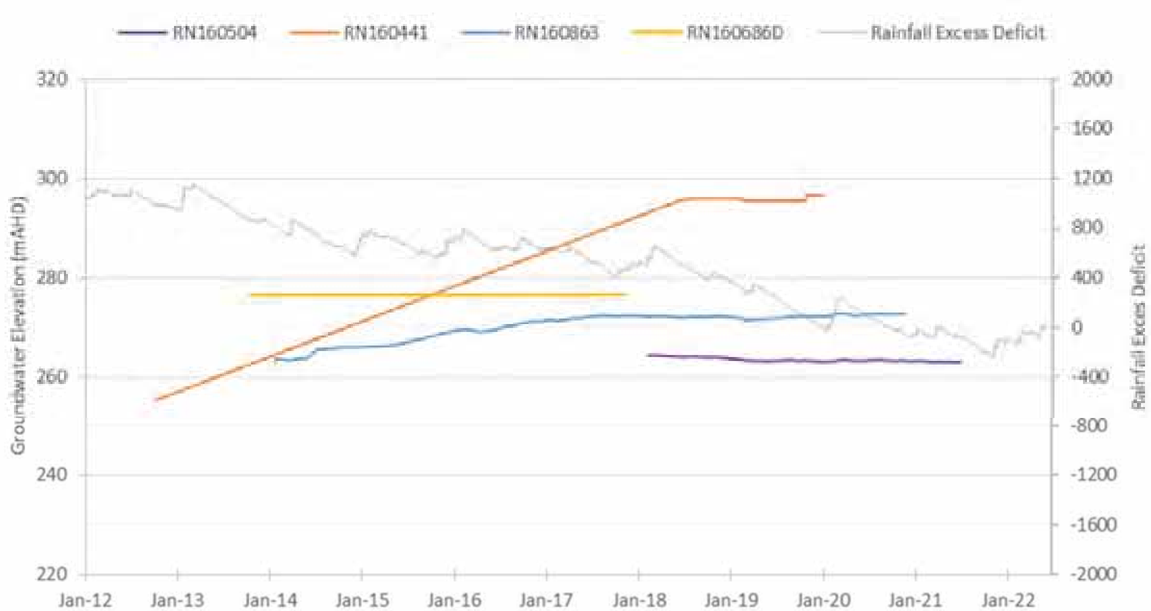

Figure 7.31 Groundwater Elevation Hydrograph –Precipice Sandstone

7.8 Groundwater Chemistry

Groundwater chemistry within the Surat Basin has been considered using information provided in the UWIR. Table 7.3 presents a summary of the regional groundwater chemistry associated with each hydrostratigraphic unit occurring within the Project area from OGIA (2016b). Generally, the total dissolved solids (TDS), used as an indicator of salinity, is a broad range across the basin.

Table 7.3 Summary of Regional Groundwater Chemistry for Each Hydrostratigraphic Unit (OGIA 2016a)

Hydrostratigraphic Unit	OGIA (2016b) Description
Orallo Formation	Fresh to saline conditions with TDS ranging from 75 to 20,000 mg/L, mean of 1,700 mg/L.
Gubberamunda Sandstone	Fresh to brackish water. Mean TDS of 450 mg/L with a range of between 70 and 7,500 mg/L. Mean TDS ranges between 480 to 1,160 mg/L, depending on location category.
Westbourne Formation	Characterised by fresh to saline groundwater (TDS mean of 1,500 mg/L), ranging from 150 to 19,000 mg/L.
Springbok Sandstone	Fresh to brackish water quality, with a mean TDS of 1,000 mg/L (ranging between 200 and 7,000 mg/L).
WCM	Fresh to saline groundwater, TDS ranges from 30 to 18,000 mg/L, with a mean TDS of around 3,000 mg/L.
Hutton Sandstone	TDS ranges from 70 to 16,000 mg/L, with a mean TDS of around 1,600 mg/L, low salinity calcium and magnesium bicarbonate type water in the recharge areas, to a relatively high-salinity sodium-chloride type water in discharge areas.
Evergreen Formation	Low salinity (TDS) and concentrations of sodium and chloride, TDS ranges from 80 to 670 mg/L, with a mean TDS of around 260 mg/L.
Precipice Sandstone	Precipice Sandstone has the freshest groundwater in the Surat CMA, salinity ranges from 50 to 850 mg/L with a mean salinity (TDS) of 193 mg/L.

Further groundwater chemistry data has been sourced from the GWDB for bores within a 25 km buffer of the Project. Figure 7.32 presents a Durov and piper diagram for each relevant hydrostratigraphic unit from the GWDB records. The following observations can be made:

- All of the samples (regardless of formation) show either a sodium-chloride signature or a sodium-bicarbonate signature water type.
- The groundwater samples from the alluvial bores have a different signature to the Surat Basin units, with a stronger sodium-bicarbonate signature.

Fresher groundwater is observed in the samples from the alluvium, Gubberamunda Sandstone and Hutton Sandstone, with higher EC in samples measured from the WCM and Springbok Sandstone.

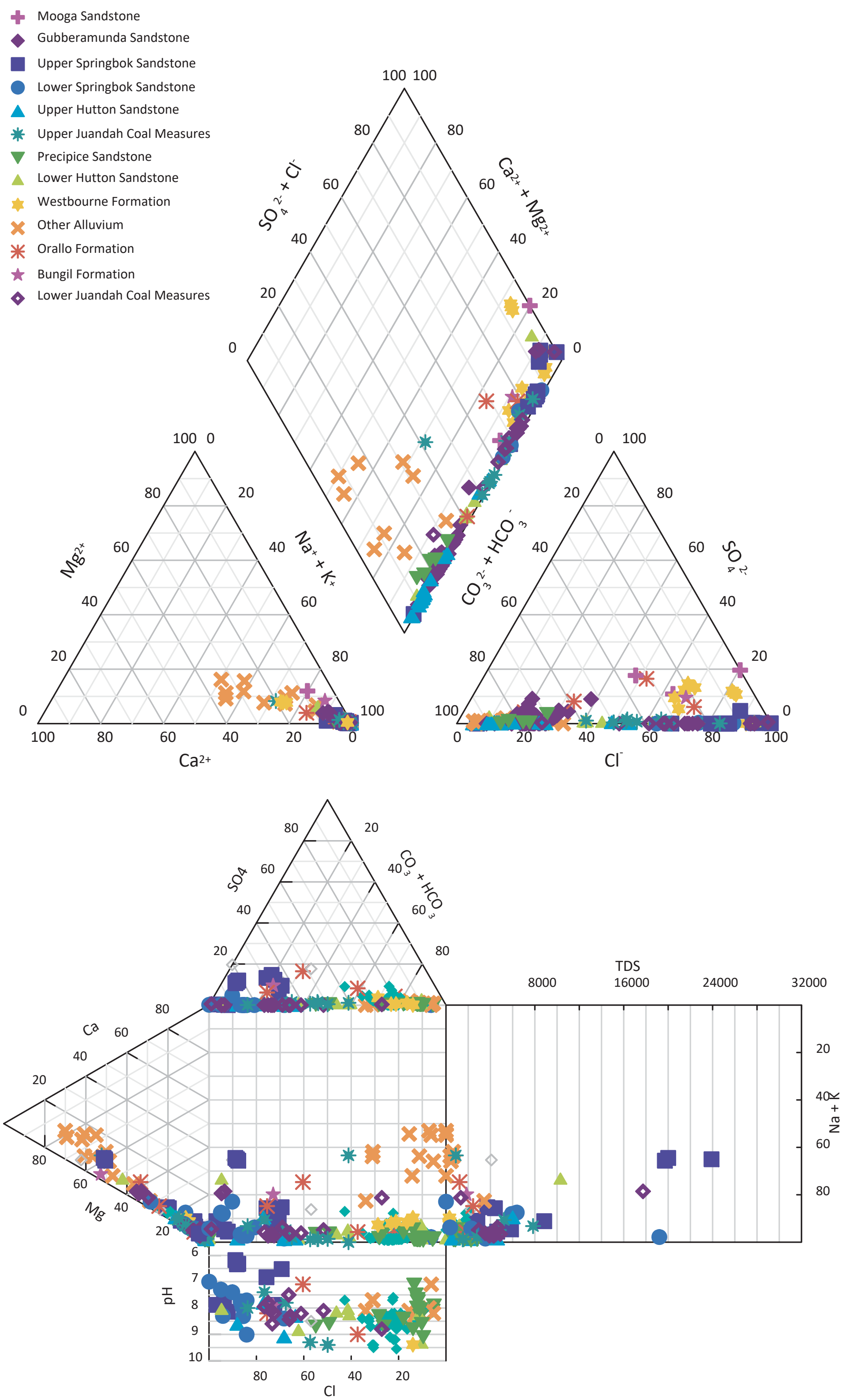

Figure 7.32 Piper and Durov Diagram from GWDB Chemistry Records from Bores within a 25 km Buffer of the Project Area

7.9 Groundwater-Surface Water Interaction

Groundwater-surface water interaction within the Project area may occur from two key processes:

- Discharge of groundwater to watercourses as baseflow; and
- Recharge to aquifers as leakage from watercourses.

Recharge to groundwater systems from watercourses may occur across the Project area, however as discussed in Section 7.6, there must be sufficient saturation and hydraulic head to allow water to infiltrate into aquifers.

A discussion on baseflow fed reaches of watercourses, or watercourse springs, and the groundwater-surface water interaction is discussed further in Section 7.10.1.

7.10 Springs and Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are defined as 'Natural ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services' (Richardson et al. 2011).

There are three categories of GDEs:

- **Aquatic GDEs**, which are ecological communities dependent on the surface expression of groundwater, including springs other than EPBC-listed springs, river baseflow systems (watercourse springs), riparian ecosystems and wetlands;
- **Terrestrial GDEs,** which are surface ecosystems dependent on the subsurface presence of water (i.e., terrestrial vegetation accessing the water table below ground), including ecosystems that are intermittently and permanently dependent on groundwater; and
- **Subterranean GDEs**, which are subterranean ecosystems dependent on the permanent presence of subsurface water. For the purposes of this document, this includes vertebrates and invertebrates only (i.e., excludes unicellular and simple multicellular organisms).

Potential surface expression GDEs and subsurface GDEs are mapped by DES (State of Queensland 2018a) as potentially being present in the vicinity of the Project (Figure 7.35). These generally correspond with the location of the mapped alluvium associated with Woleebee Creek within the Project area and Wandoan Creek, Horse Creek and Juandah Creek further afield but within the 25 km buffer.

There are no spring vents or complexes within the vicinity of the Project.

7.10.1 Potential Aquatic GDEs

Baseflow fed reaches of watercourses, or watercourse springs, are sections of a watercourse where groundwater from an aquifer enters the stream through the streambed (OGIA 2021g). A report published by OGIA in 2017 re-maps potential gaining streams (or baseflow fed reaches, watercourse springs) within the Surat CMA (OGIA 2017b). This report identified sections of Woleebee Creek as a potentially gaining stream. OGIA have re-mapped watercourse springs within the Surat CMA for the 2021 UWIR report (OGIA 2021g), these are shown on Figure 7.32with the details of the springs summarised in Table 7.4.

There is one watercourse spring within the ATP 2059 area associated with Wandoan and Woleebee Creeks. These watercourse springs are identified as being associated with the alluvium. This is noted as a spring of interest but not currently affected or listed as a mitigation site (OGIA 2021g).

Table 7.4 UWIR Watercourse Spring Details

Site Number	Name	Source Aquifer
W279	Woleebee Creek	Alluvium

Reaches of Woleebee Creek within PL 1037 were assessed during the field verification program in 2018 (KCB 2018c). The following observations were made regarding Woleebee Creek as a gaining stream:

- The assessment was conducted during the dry season and no flow was observed within the areas surveyed.
- Pools of water were encountered in the lower reaches of Woleebee Creek (within the PL), which were rainfall derived surface water based on turbid appearance and field water quality (547 µS/cm). The lab TDS of 324 mg/L is much lower than the underlying Westbourne Formation TDS (see Table 7.3 in Section 7.8).
- Based on the difference between the field water quality measured at Woleebee Creek pools, field observations and groundwater elevation monitoring data from the alluvium and Gubberamunda Sandstone, it is considered unlikely that Woleebee Creek is a baseflow fed reach (i.e., it is a losing stream).

The verification program considered it unlikely that Woleebee Creek is a baseflow fed reach. This aligns with the assessment undertaken by CDM Smith for QGC relating to tenements to the south, which concluded the ephemeral creeks feeding Juandah Creek are not 'gaining' from alluvial groundwater (CDM Smith 2021).

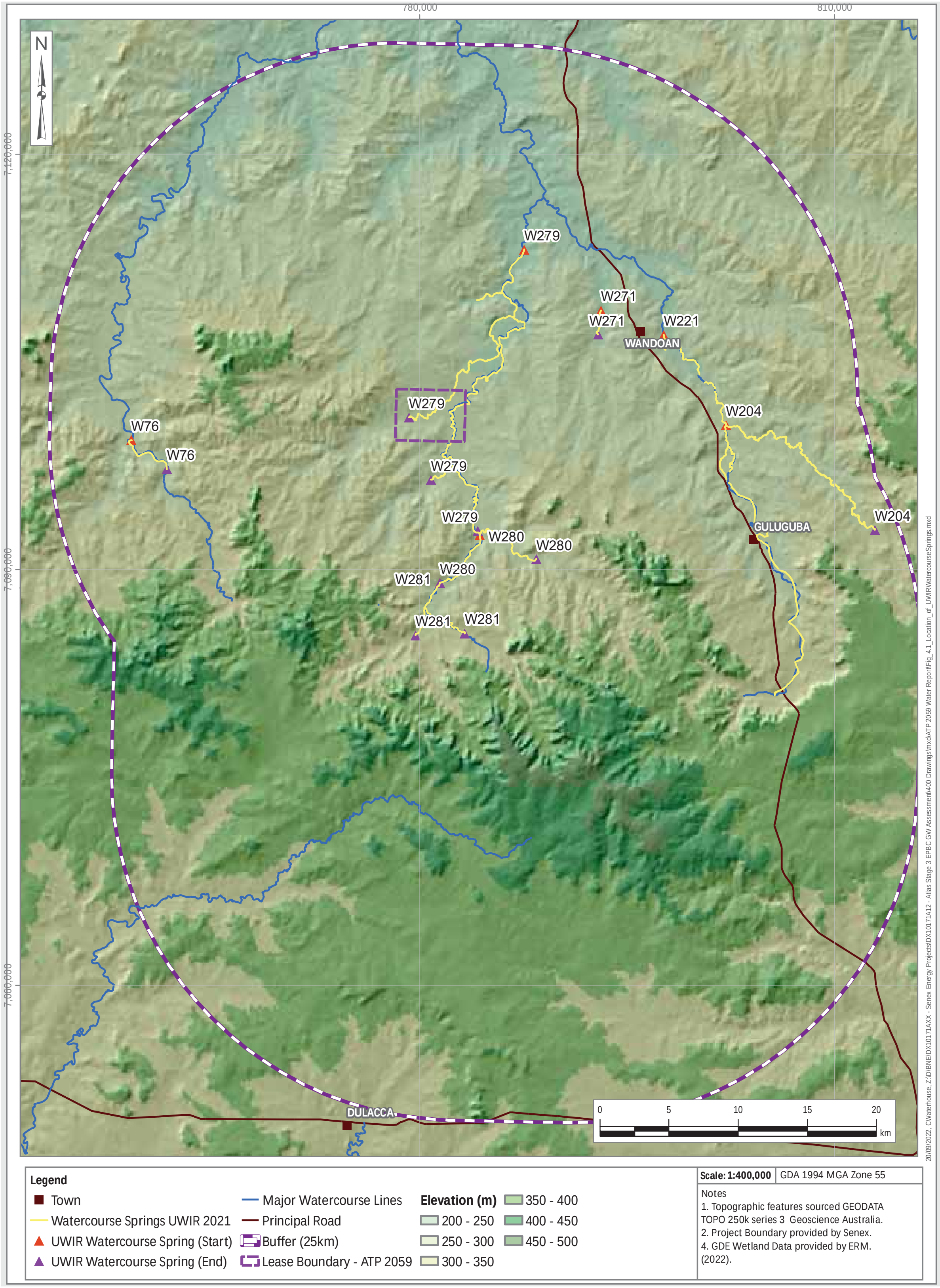

Figure 7.33 Location of Watercourse Springs (OGIA 2021g)

A review of water qualities from the various sources across the Project area has been undertaken, while a piper diagram representing the proportional distribution of the major ionic constituents of these water qualities is presented in Figure 7.34:

- Surface water samples collected locally in Wandoan Creek and from Juandah Creek to the northeast (at the Juandah Creek RDMW gauge);
- Groundwater samples collected locally in PL 209, PL 445, PL 1037 and ATP 2059 (note only two alluvium water quality samples are available locally and these bores are also screened across the Westbourne Formation); and
- Alluvium water quality samples taken within the 25 km buffer of the Project area.

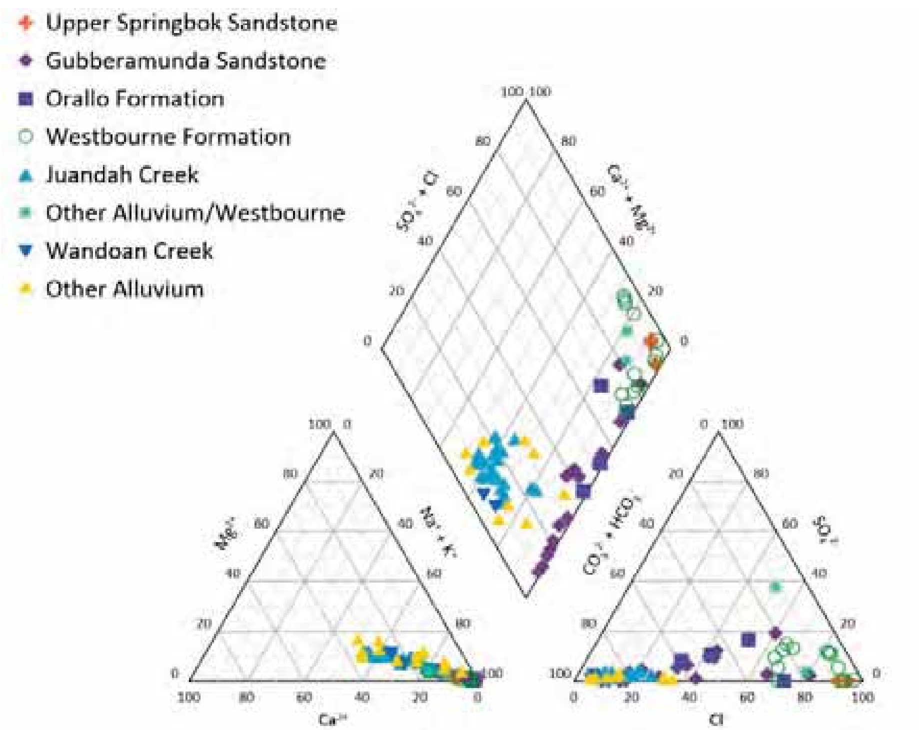

Figure 7.34 Piper Diagram showing Surface Water and Groundwater Samples from Alluvium Bores

Figure 7.34 shows the difference between the water quality of the alluvium and the underlying GAB units. The water quality of the alluvium (in yellow) is very similar to the surface water qualities of Wandoan and Juandah Creeks. The water qualities of the Westbourne Formation and Springbok Sandstone are distinct from the water quality of the alluvium, indicating a lack of connection between the units (i.e., the underlying Westbourne Formation and Springbok Sandstone do not discharge into the alluvium). The underlying GAB units generally have a higher salinity than the alluvium (discussed further in Section 7.8 above).

The comparable water qualities of the surface water and alluvium indicates that the alluvium is recharged/replenished by the surface water systems during flow events following prolonged rainfall event/s.

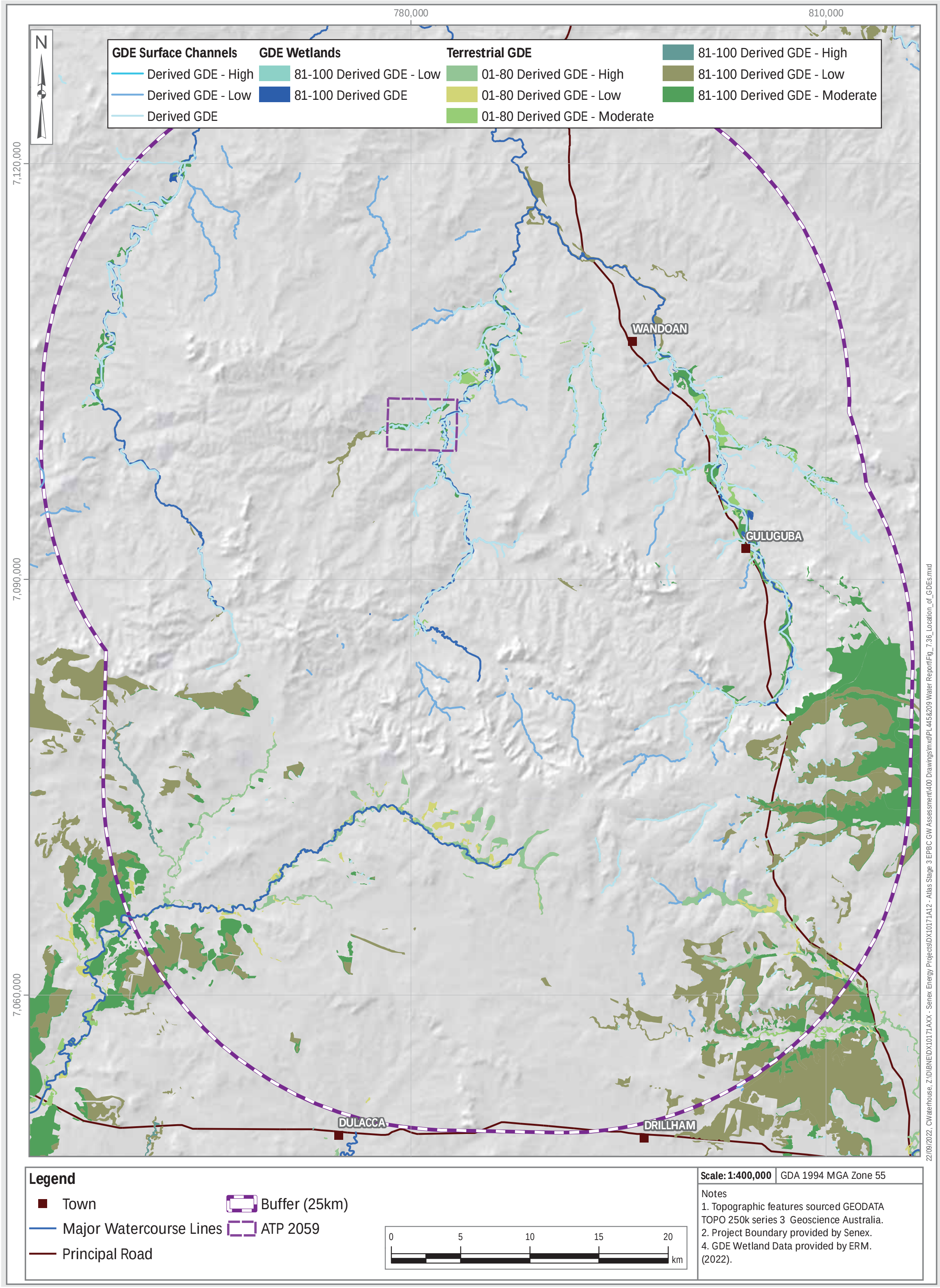

Figure 7.35 Location Mapped Potential GDEs

7.10.2 Potential Terrestrial GDEs

The DES dataset identifies potential terrestrial GDEs within the Project area (State of Queensland 2018d). These GDEs are present in the vicinity of Wandoan and Woleebee Creeks. An assessment of those GDEs was performed by ERM (ERM 2022a). A summary of the findings is provided in this section and in Appendix VI.

The assessment was conducted in two stages. Firstly, a desktop analysis was performed to identify potential terrestrial GDEs based on available GDE mapping. A field survey was then performed to verify the potential Terrestrial GDEs identified during the desktop assessment and collect data to assess their condition and identify other potential ecological values.

Within the Project area, the majority of terrestrial and aquatic GDEs are associated with watercourses and adjacent alluvial plains. This includes the named creeks Woleebee Creek, Wandoan Creek, Conloi Creek and Hellhole Creek, as well as several unnamed creeks and hydrological features.

Using terminology developed as part of the DES GDE mapping, the following potential terrestrial and aquatic GDE types have been identified from the desktop assessment as occurring within the Project area:

1. Riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent flow.
2. Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow.

These potential GDE types correspond with RE types that occur on alluvial landscapes, associated with watercourses and the adjacent floodplain areas. Based on the DES GDE mapping rule sets, these vegetation communities rely on alluvial aquifers that form from gravel, sand, silt and/or clay deposited by fluvial processes in river channels or on floodplains. These deposits store and transmit water to varying degrees through inter-granular voids and pore spaces (ERM 2022a).

RE Verification

The Project area comprises mosaics of remnant and regrowth REs of varying patch size and ecological condition. RE 11.3.25 (Forest Red Gum Eucalyptus tereticornis or River Red Gum Eucalyptus camaldulensis woodland fringing drainage lines) is the most widely abundant vegetation community identified that the potential to be a GDE, however interconnected patches of other REs are present. Historic land clearing is known to have occurred throughout the Project area that has impacted the condition of terrestrial GDEs, particularly along creek lines and water courses. Grazing pressure is also likely to influence the ecological condition of RE patches and their value for maintaining biodiversity levels.

The locations of the field verified RE areas are presented in Figure 7.36.

ATP 2059 is dominated by RE 11.3.25 (Forest Red Gum *Eucalyptus tereticornis* woodland fringing drainage lines), however areas of RE 11.3.2 (Popular Box *Eucalyptus populnea* woodland on alluvial plains), 11.3.27 (Freshwater wetlands: Coolabah *Eucalyptus coolabah* and/or Forest Red Gum open woodland to woodland fringing swamps) and 11.3.17 (Poplar Box woodland with *Brigalow Acacia harpophylla* and/or Belah *Casuarina cristata* on alluvial plains) are also present in smaller more fragmented patches within a wider landscape of modified pastures, cropping and grazing land (ERM 2022a).

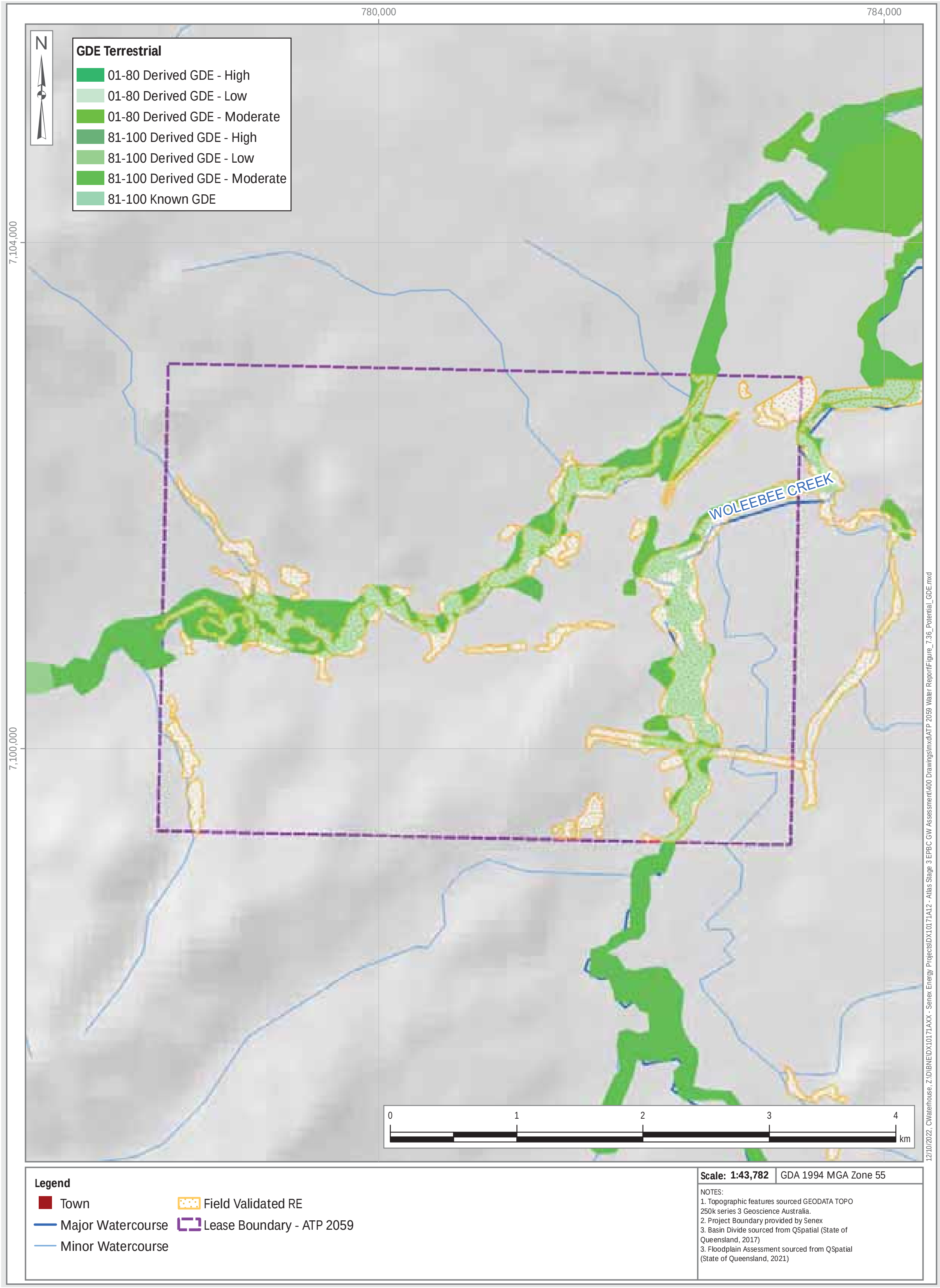

Figure 7.36 Mapped Potential GDEs in the Project Area and Field Verified REs

Groundwater Dependence

The dominant ecosystem, RE 11.3.25, is known to include both ephemeral and permanent wetlands so aquatic vegetation present will vary depending on the presence of permanent, open water. However, these areas were not recorded/mapped within the Project area. The ecology survey identified flora and fauna that do not depend on the permanent presence of water. These communities have built resilience due to the ephemeral nature of these creek systems, which follow an episodic wetting and drying cycle.

Although the presence of tree species that inhabit wetter environments indicate some potential for groundwater use, the leaf water potential and isotope data, from studies undertaken by QGC directly north of the Project area on similar RE's along creek tributaries to Juandah Creek, demonstrated that trees are sourcing water largely from soil moisture stores which fluctuate with rainfall (CDM Smith 2021). This is considered to be a function of the dimorphic rooting systems which access water at multiple depths. In this study, depth profiles of soil moisture showed that most trees were accessing water at relatively shallow depths (and several meters above the water table) where soil moisture is high.

A review of available literature on tree rooting depth for those dominant species present in each of the ground-truthed REs has been completed to understand how dependent these species may be on groundwater (Table 7.5) (ERM 2022a). The average rooting depth for species of Eucalyptus present at the Project area is known, based on literature reviews, to range from 9 m to 22.6 m, depending on the species and the interactions between geomorphology and plant physiological traits. Eucalypts (including Forest Red Gums) have two rooting systems (known as a dimorphic rooting system), with the ability to access deep groundwater during periods of time where shallower soil moisture is limited, they have shown physiological responses allowing them to adapt to water stress (CDM Smith 2021).

Groundwater dependence of identified vegetation was inferred using established risk assessment guidelines (Serov, Kuginis, and Williams 2012). This assessment is outlined in Table 7.6. The results indicate that the potential terrestrial GDEs located along the creek systems may be groundwater dependent as they occur within an alluvial system (associated with creeks) and the ecosystem is associated with streamlines. This alluvial system, as discussed in Section 7.9, is replenished during prolonged wet periods when the ephemeral creek system is flowing, and is disconnected from the Gubberamunda Sandstone, Westbourne Formation and Upper Springbok Sandstone, which is of a higher salinity.

Table 7.5 Potential GDEs, Vegetation Description and Tree Rooting Depth (ERM 2022a)

Regional Ecosystem Code and Names	GDE Type	Dominant Flora Species	Field Verified Condition	Groundwater Dependence and Rooting Depth	Representative Site Photographs (ERM 2022a)
11.3.2 *Eucalyptus populnea* woodland on alluvial plains	Treed regional ecosystems on alluvial overlying sandstone ranges with fresh, intermittent flow.	Poplar Box *Eucalyptus populnea*	Majority of this RE and potential GDE is in a remnant condition. Occurs on alluvial plains adjacent to riparian vegetation.	12.6 - 22.6 m for Poplar Box	
11.3.25 *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent flow.	Forest Red Gum	Largely confined to fringing riparian vegetation along watercourse and is the most common RE and GDE type within the Project area. Varying condition, ranging from advanced regrowth to remnant.	At least 9m and assumed to reach groundwater reservoirs (Forest Red Gum) 12.1 - 22.6 m *(E. camaldulensis)*	

Regional Ecosystem Code and Names	GDE Type	Dominant Flora Species	Field Verified Condition	Groundwater Dependence and Rooting Depth	Representative Site Photographs (ERM 2022a)
11.3.27 Freshwater Wetlands	Riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent flow	Variable freshwater vegetation ranging from open water to fringing sedgelands and eucalypt woodlands. Forest Red Gum	Occurs largely in closed depressions or oxbows adjacent to watercourses or on adjacent alluvial plains.	*Eucalyptus camaldulensis*- 12.1-22.6 m Forest Red Gum- at least 9m *Eucalyptus coolabah* possibly at least 7-8 m	
11.3.17 *Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plain	Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow	Poplar Box Brigalow *Acacia harpophylla* Belah *Casuarina cristata*	Identified as majority remnant vegetation and occurs on adjacent alluvial floodplains, usually connected to the adjacent riparian zone.	Poplar Box - 12.6-22.6m (Kath, et al., 2014) Brigalow - Unknown Belah - Unknown	

Regional Ecosystem Code and Names	GDE Type	Dominant Flora Species	Field Verified Condition	Groundwater Dependence and Rooting Depth	Representative Site Photographs (ERM 2022a)
11.3.19 *Callitris glaucophylla, Corymbia* spp. and/or *Eucalyptus melanophloia* woodland on Cainozoic alluvial plains	Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow	White Cypress Pine *Callitris glaucophylla*; *Corymbia spp*. And/or Silver-leaved Ironbark Eucalyptus melanophloia	Occurs on alluvial floodplains adjacent to riparian zone	Up to 6m (*Callitris glaucophylla*) (Eberbach, 2003) Silver-leaved Ironbark - Unknown but likely potential to be similar to Forest Red Gum	

Table 7.6 Groundwater Dependence Assessment for Potential Terrestrial GDEs Associated in the Project Area

Groundwater Dependence	Wandoan Creek and Woleebee Creek
General	
Is the ecosystem identical or like another that is known to be groundwater dependent?	There is potential for the identified RE's to access groundwater but this has not been confirmed. The relative reliance on groundwater could not be identified for some of these dominant species, it is likely that the Eucalyptus species present are resilient to changes in groundwater availability due to their dimorphic root structure. For other dominant flora species, such as Brigalow and Belah, at least an indirect reliance on groundwater availability through water discharge should be assumed.
Does the community contain species known to require permanent saturation such as within aquifers, karsts, or mound springs or some wetlands?	No
Is the distribution of the ecosystem consistently associated with known areas of groundwater discharge; e.g., springs, mound springs or groundwater seeps in terrestrial and/or near shore marine environments?	No. Standing water is present but not considered to be groundwater (due to water quality and turbidity) and it is unlikely that groundwater would express as baseflow or watercourse springs along these creeks.
Is the distribution of the ecosystem typically confined to locations where groundwater is known or expected to be shallow? For example, topographically low areas, major breaks of topographic slope; i.e., cliffs or escarpments, alluvial and coastal sand beds aquifers, gaining streams?	Yes. The vegetation is located within the area of sandy alluvium associated with the watercourse. However, these creeks are not considered to be gaining streams, and therefore, not connection to the regional groundwater system of the bedrock.
Terrestrial GDEs	
Is the water table level near or at the surface or within the root zone of the surrounding vegetation? If roots can reach a source of fresh water, is it generally true that this water will be absorbed by the roots and transpired by the canopy.	Yes. There are two registered bores accessing the alluvium on Woleebee Creek in ATP 2059. Measurements at these bores record groundwater at ~7.5 mbgl (April 2022). Average root depth for species of Eucalyptus present is known, based on literature reviews, to range from 9m to 22.6m, depending on the species and the interactions between geomorphology and plant physiological traits (ERM 2022a)
Is the vegetation community composed of species known to require permanent saturation (wet rainforest or wet sclerophyll forests) or high soil moisture levels (dry rainforest)?	No.
Does the vegetation in a particular community occur along stream lines?	Yes. Field verified RE's are associated with water courses and the adjacent alluvial plains.
Is the vegetation community known to function as a refuge for more mobile fauna during times of drought?	No. Wandoan Creek is ephemeral and therefore would not likely have permanent water during the dry season or periods of limited rain.

7.10.3 GDE Subterranean Fauna

Stygofauna are known to occur in alluvial, limestone, fractured rock, calcrete aquifers and coal seams in Australia. Stygofauna are subterranean aquatic animals that live in groundwater. Communities are often dominated by crustacean invertebrates, also containing oligochaetes, insects, other invertebrate groups and occasionally fish. Where stygofauna are abundant, for example in alluvial aquifers, they are likely to contribute to improvement of water quality through processes such as biochemical filtration (Hancock, Boulton, and Humphreys 2005).

The prospective habitat for subterranean fauna is dependent on the presence of underground voids of suitable size and connectivity, to satisfy biological requirements. Subterranean faunae were previously believed to be restricted to alluvial or karst landscapes (limestone or calcrete dominated systems) which provided optimal habitat conditions. In more recent years, subterranean faunae have been found to occur in various types of non-karstic geological units and aquifer systems that exhibit suitable voids for colonisation, including alluvial, fractured rock, calcrete aquifers and coal seams, in addition to limestone (Hose et al. 2015; EPA 2016a).

The extent of subterranean habitat present is dependent on the interconnection of subsurface crevices, fractures, and voids, within suitable geological units and aquifer systems, in addition to connectivity to recharge areas and sources of particulate organic matter for food.

Stygofauna have previously been recorded in the Wandoan area, where sampling of groundwater from Horse Creek alluvium to the west of the Project, and WCM near Wandoan (close to the WCM outcrop) recorded several stygofauna taxa (Xstrata 2008; Hose et al. 2015; State of Queensland 2016). Stygofauna are rarely found more than 100 m below the surface and are usually most abundant within the top 30 m from below ground surface (Hose et al. 2015). Stygofauna are found across a range of water quality conditions (from fresh to saline), but most common in fresh and brackish water (electrical conductivity less than 5000 µS/cm) (Hose et al. 2015).

Sampling for subterranean fauna was undertaken at twelve existing landholder bores within the Project area (Appendix V). The sampling was generally undertaken in accordance with available technical sampling guidelines (DES 2018c; EPA 2016b). Sampling was undertaken by Freshwater Ecology (Freshwater Ecology 2022b). Only two specimens of one potential stygofauna (from a single bore) were recorded in the twelve samples collected. Given the location of the bore, it is likely that these two specimens are stygofauna but they could not be formally identified. No stygofauna (stygobites or stygophiles) were recovered from the other eleven bores sampled, although large numbers of stygoxenes[5] (both whole and heavily decomposed) were recorded from most bores.

Stygofauna sampling was undertaken on neighbouring PL 1037 at four existing landholder bores. The sampling was undertaken in accordance with available technical sampling guidelines (DES 2018c; EPA 2016b). Sampling was undertaken by Hydrobiology (KCB 2018d) in accordance with DSITI (2015). The following major taxonomic groups, a representative subset of specimens collected were identified to the genus level: amphipoda, copepoda, isopoda, ostracoda, remipedia, spelaeogriphacea, syncarida and thermosbaenacea. For the following taxonomic groups, a representative subset of specimens collected were, at a minimum, identified to the

[5] Animals found accidentally in groundwater.

order or family level: acarina, coleopteran, decapoda, mollusca, nematode, oligochaete, rotifer, polychaeta and turbellaria.

Stygofauna were recorded at two bores, the first of which is estimated to be screened across both the Westbourne Formation and Gubberamunda Sandstone (Table 7.7). A review of the GWDB bore card and drilling log, and the groundwater chemistry results suggest that the majority of the water inflow is likely to be from the Gubberamunda Sandstone. The Gubberamunda Sandstone is inferred to be present between 19 and 25 mbGL within this bore. The stygofauna found include two Cyprididae species (Cyprinopsinae sp.) and three nematode species (Nematoda sp.).

The second bore is screened within the Upper Springbok Sandstone with depth to water recorded as 18.37 m below ground. Despite the higher EC (20,948 µS/cm), Stygofauna were found to occur in this bore.

In the context of the WCM within the Project area, it is unlikely that stygofauna will be present within the target coal seams. Although there is reported occurrence within coal seams of the Surat Basin, near Wandoan; these were in shallow bores (Xstrata 2008). In the Project, all CSG production will occur from the coal seams greater than 250 mbgl, which is deeper than any known occurrence of stygofauna in the Surat Basin.

Table 7.7 Summary of Stygofauna Sampling Results (KCB 2018d)

Bore	Aquifer Attribution	Bore Depth (mbgl)	EC (µs/cm)	Stygofauna Present
Bore 1	Gubberamunda Sandstone / Westbourne Formation	67.4	3,724	Yes
Bore 4	Upper Springbok Sandstone	25.0	20,948	Yes

Aquifer attribution from OGIA (2017e) and Senex baseline assessment (KCB 2018d)

There are no threatened stygofauna species listed in Queensland under the EPBC Act.

7.11 Existing Groundwater Users

7.11.1 Registered Groundwater Bores

Within a 25 km buffer of the Project area, there are 810 groundwater bores present with aquifer attributions provided by OGIA (OGIA 2022). Of these 810, 79 bores are not recorded in the registered groundwater bores database (GWDB)(State of Queensland 2022a).

Of these 810 bores, 590 are existing bores, including water supply or monitoring bores, with the remainder being either abandoned or decommissioned. A summary of registered bores is presented in Table 7.8 along with their type and status, as derived from the GWDB.

Table 7.8 GWDB Registered Bore Details, 25 km Buffer (State of Queensland 2022a; OGIA 2022)

Type		Abandoned and Destroyed (AD)	Abandoned but Usable (AU)	Existing (EX)	Proposed (PR)	Unknown	Total
Artesian	Condition Unknown (AB)	-	-	6	-		
	Ceased to Flow (AC)	3	-	5	-		
	Controlled Flow (AF)	5	-	14	-		
Sub-Artesian (SF)		116	5	565	12		
Unknown		-	-	-	-	79	
	Total	**124**	**5**	**590**	**12**	**79**	**810**

AB: artesian condition unknown; AF: bores that are under artesian pressure and capped to control free flow; AC: bores that have been artesian in the past but have now become sub-artesian due to a reduction in artesian pressure; AB: likely artesian bores, however their current pressure condition is unknown; SF: bores which do not flow under any condition and where active pumping is required to abstract water.

7.11.2 Bore Baseline Assessment

Under the *Water Act 2000*, petroleum tenure holders are required to undertake baseline assessment of water bores prior to commencement of production. A baseline assessment program within ATP 2059 was undertaken in 2022. Assessments were undertaken in accordance with the 'Baseline Assessment Guideline' (State of Queensland 2021f). The assessment was undertaken to obtain information such as:

- Bore status, type and purpose;
- Information related to the construction of the bore, including depth installed, screen interval and source aquifer;
- Groundwater level and quality and field gas measurement; and
- Bore equipment including pump depth, pumping frequency and flow rate.

A bore baseline assessment has been undertaken in ATP 2059. Of the two bores identified for Baseline Assessment, both have been assessed to date. These bores were identified as not operational (Streamline Hydro 2022).

7.11.3 Groundwater Use and Purpose

Of the 669 existing or unknown status bores in Table 7.8 (OGIA 2022):

- 410 bores have been identified as being used for water supply purposes (WS);
- 32 are potential water supply bores (PWS);
- 219 are not a water supply bore, some are monitoring bores or not currently used for water supply (NWS); and
- Eight are recent drills and the purpose is unknown.

The locations of these existing bores are shown on Figure 7.37.

Groundwater abstraction for stock and domestic (S&D) use is the dominant water use purpose within the vicinity of the Project. There are five bores noted as town water supply and ten for intensive stock use. The location of the bores with their purpose indicated is shown on Figure 7.38.

A summary of aquifer attribution is presented in Table 7.9 (OGIA 2022). OGIA have designated all bores with a primary source aquifer, which has been used to populate the table.

Table 7.9 Summary of Aquifer Attribution, 25 km Buffer of PL 209 and PL 445 (OGIA 2022)

Formation	Number of Bores (EX, AU or Unknown)*
Other alluvium	41
Cenozoic Sediments	8
Wallumbilla Formation	5
Bungil Formation	27
Mooga Sandstone	50
Orallo Formation	61
Gubberamunda Sandstone	145
Westbourne Formation	33
Upper Springbok Sandstone	30
Lower Springbok Sandstone	15
Upper Juandah Coal Measures	100
Lower Juandah Coal Measures	48
Taroom Coal Measures	20
Durabilla Formation	5
Upper Hutton Sandstone	37
Lower Hutton Sandstone	10
Upper Evergreen Formation	1
Lower Evergreen Formation	1
Precipice Sandstone	34
Moolayember Formation	2
Rewan Group	1
Total	**674**

*Includes abandoned but usable (AU), existing (EX) and status unknown bores are included.

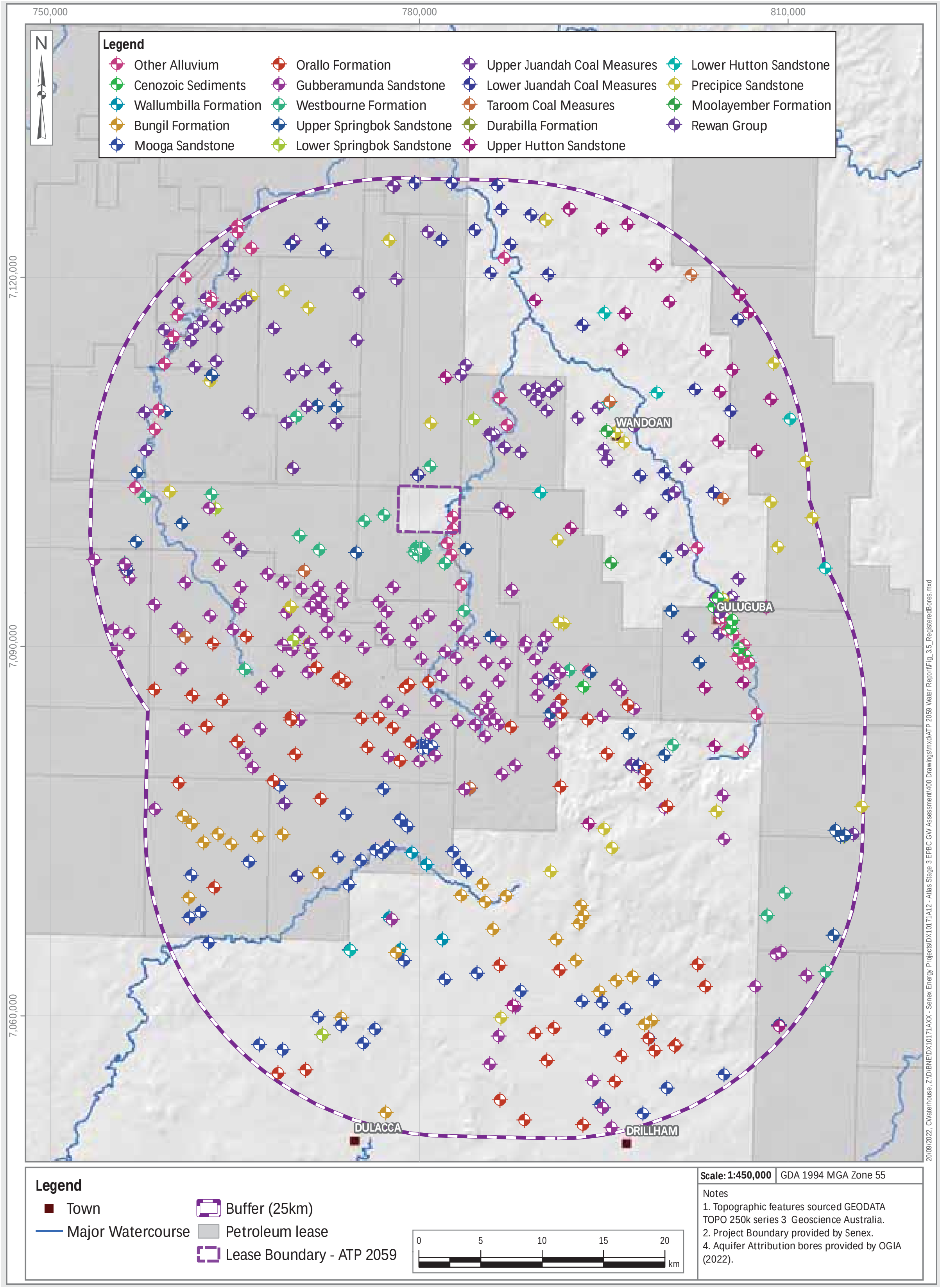

Figure 7.37 Location of Registered Bores within the Vicinity of the Project Area

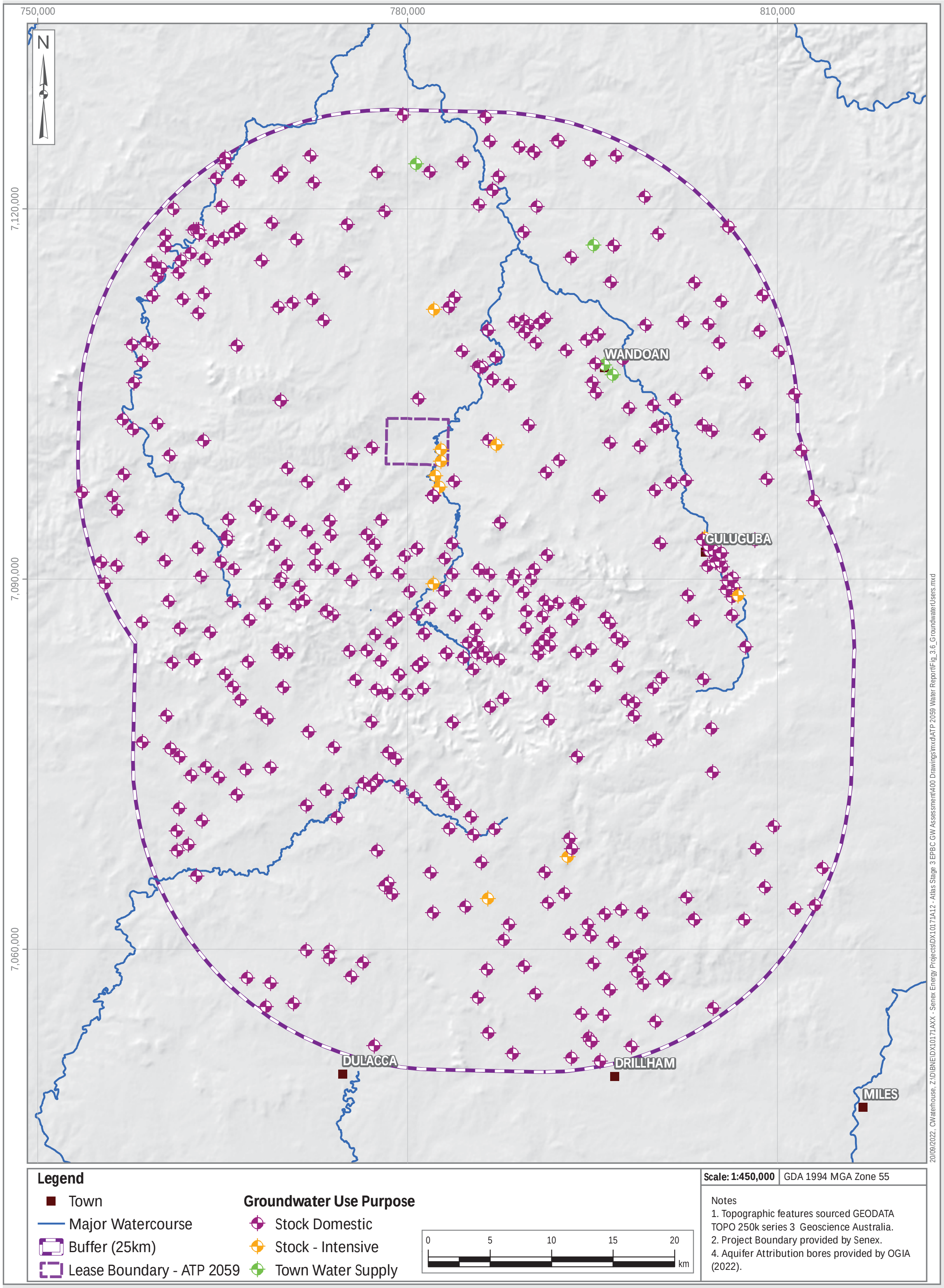

Figure 7.38 Location of Groundwater Users and Purpose of Use

7.12 Hydrogeological Conceptual Model Summary

The hydrological and hydrogeological systems at ATP 2059 can be summarised as follows:

- The target for CSG production is the WCM, which occurs at ~220 to 300 m below ground level; and is ~400 m thick.
- The surface geology within ATP 2059 comprises outcrops of the Gubberamunda Sandstone and Westbourne Formation of the Surat Basin. The Upper Springbok Sandstone outcrops within the north eastern extent of ATP 2059. Quaternary-age alluvium is present along the Woleebee and Conloi Creek systems.
- The WCM outcrop to the north and northeast of the Project area, while the Orallo Formation outcrop to the southeast.
- The WCM is separated from overlying and underlying aquifers by aquitard layers of the Upper WCM aquitard and Durabilla Formation.
- The watercourses within the Project area, Wandoan and Woleebee Creeks, are characteristically ephemeral and typically flow only during significant rainfall events. Pooled water may remain after significant rainfall events, which provides a habitat for a limited number of aquatic species. Shallow pools were identified in the watercourses but were generally turbid with water quality results indicating that these pools are fresh and surface water sourced. The identified aquatic ecosystems are generally of low to fair habitat and had presence (but low diversity) of non-conservation significant native aquatic fauna and flora.
- Baseflow contributions from the alluvium and Surat Basin units to the watercourses are considered unlikely. This has been concluded through previous site verification along these creek systems in PL 1037 from site observations and water quality analyses (fresh water quality but high turbidity). It is likely that the groundwater system in the alluvium is replenished by surface water during prolonged wet periods when the ephemeral creek system is flowing.
- The alluvial systems present within the Project area are generally associated with Wandoan and Woleebee Creeks. Alluvial bank heights of up to 8 m have been observed along Woleebee Creek within PL 445 and alluvial depths of up to 18 m confirmed in registered bores within ATP 2059.

  The water quality of the alluvium indicates that it is recharged and replenished by surface water during prolonged wet periods during periods of creek flow. The water quality is distinct from groundwater in the underlying Westbourne Formation or Springbok Sandstone, which is generally more saline (Section 7.9).
- Terrestrial GDEs have been identified and are generally associated with Wandoan and Woleebee Creek systems. These potential GDEs are considered to be sourcing water from shallow soil systems and the underlying alluvium present along the creek systems (Section 7.10.1).
- These potential terrestrial GDEs are considered to be resilient and adapt well to stress, with the larger eucalypts (including Forest Red Gums) having a dimorphic root system and are well adapted to the drying and wetting ephemeral environment associated with the

creek systems (Section 7.10.1). Groundwater use within the Project area is limited to the shallowest units of the Gubberamunda Sandstone, Westbourne Formation and Springbok Sandstone, with bores used for stock and domestic purposes. Further afield, groundwater is also accessed from the deeper units for both stock and domestic purposes, and town water supply (Section 7.11).

A hydrogeological conceptualisation of the system is presented in Figure 7.39.

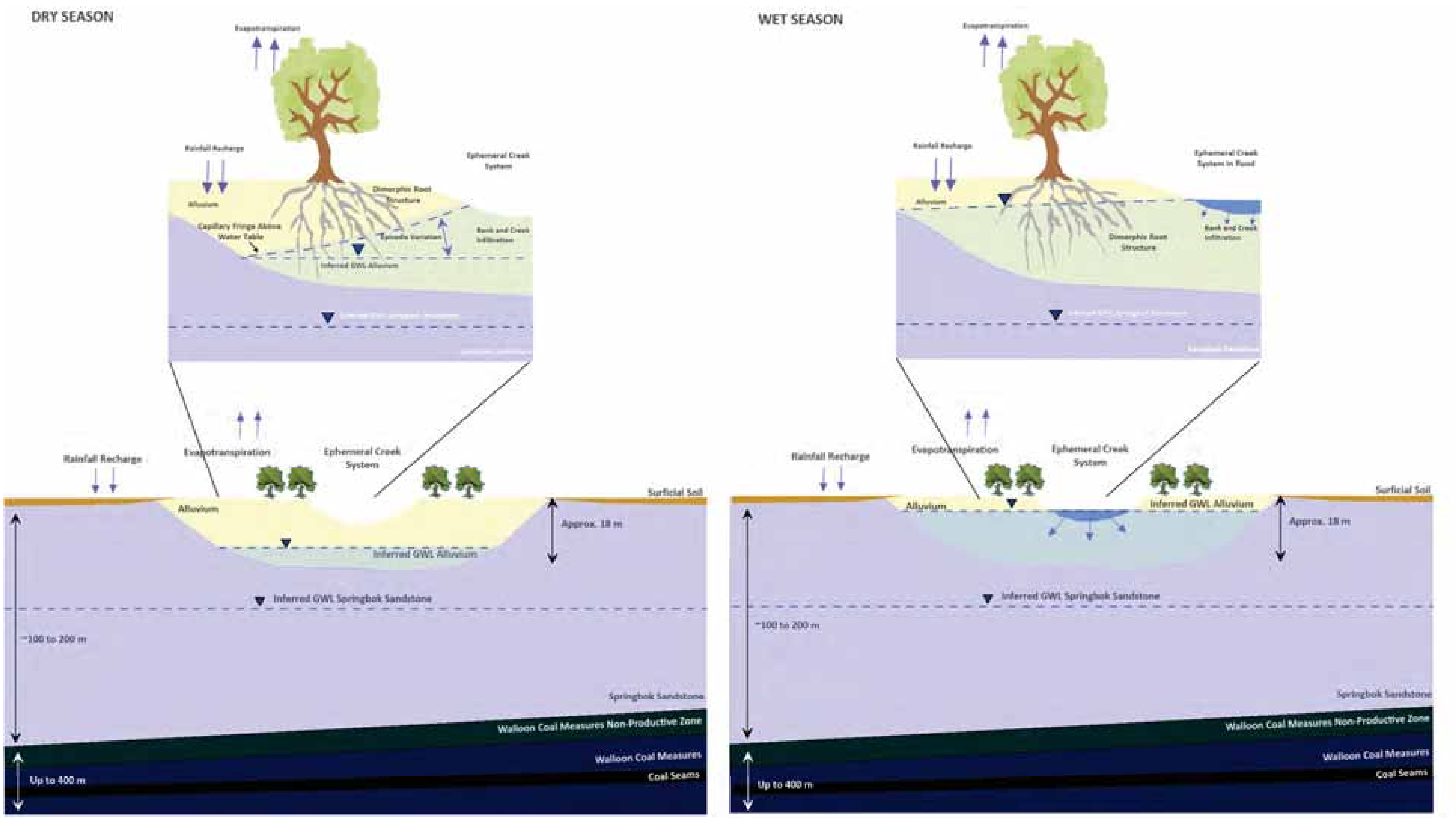

Figure 7.39 Hydrogeological Conceptual Model (Not to Scale)

8 NUMERICAL GROUNDWATER MODELLING

8.1 Overview

As part of the Surat CMA UWIR (OGIA 2021g) OGIA developed a regional numerical groundwater flow model to predict cumulative groundwater pressure impacts due to activities from multiple petroleum and gas tenure holders. The model was first developed and utilised as part of the 2012 UWIR (QWC 2012). An updated UWIR and updated numerical groundwater model was published by OGIA in September, 2016 (OGIA 2016c), July, 2019 (OGIA 2019b) and most recently May 2022 (OGIA 2021g).

The primary purpose of the model is to predict regional water pressure or water level changes in aquifers within the Surat CMA in response to the extraction of gas and associated water from targeted coal seams. In particular, the OGIA numerical groundwater model is used to assess potential impacts to springs and landholder groundwater bores and develop strategies for management of those impacts.

The Surat CMA UWIR is updated periodically (approximately every three years), therefore, the OGIA numerical groundwater model for the Surat CMA is also updated periodically to support the UWIR. Key updates to the model include recalibration of the model based on monitoring data provided by proponents operating within the CMA and the incorporation of newly approved CSG developments within the CMA. Therefore, each update to the OGIA model results in the additional incorporation of site data and an update of the predicted cumulative drawdown impacts across the CMA.

The model domain includes the extent of the Surat CMA, with hydrostratigraphic units from the Surat Basin as well as interconnected basins (Bowen Basin and Clarence-Moreton Basin). The model domain is shown in Figure 8.1. The model consists of 35 layers, of which seven layers represent the Walloon Coal Measures, as shown in Figure 8.2.

A summary of key aspects of the model is presented in Table 8.1, with further detail provided in the following sections. A key update to the 2021 OGIA model is the incorporation of coal mines within the Surat Basin.

Table 8.1 Summary of the OGIA Regional Groundwater Flow Model (OGIA 2021c)

Model Component	Description
Modelling Platform	MODFLOW-USG
Model Domain	Model covers the entire Surat CMA (Figure 8.1), including all coal seam formations and potentially connected aquifers in the Surat, southern Bowen and Clarence-Moreton Basins.
Model Layers	Model consists of 35 layers (Figure 8.2).
Grid Spacing	Model grid spacing is 1.5 km x 1.5 km
Parameterisation	Initial parameters for use in the Surat CMA model were developed using an innovative workflow, developed by OGIA, centred around a suite of detailed numerical permeameters. This workflow was initially developed for use in the 2016 regional groundwater flow model and has been further enhanced for the current model. This approach extracts full value from the large geological and hydraulic parameter dataset available for the CMA. Outputs from this process include formation scale horizontal and vertical permeabilities that are then used as inputs to the regional groundwater flow model for further calibration against water level and other observed data.
Water Production Simulation	Simulated using the MODFLOW-USG ‘drain’ boundary condition. Multiple MODFLOW-USG drains are assigned to each well; these descend over time as pressures in the CSG well are reduced.

Model Component	Description
Calibration	Calibration of the groundwater flow model in three stages: 'pre-development' (1947) to replicate conditions that existed prior to the commencement of any groundwater extraction; pre-CSG extraction conditions commensurate with 1995; and a transient simulation to replicate the period from January 1995 to December 2020, during which CSG extraction commenced initially from the Bandanna Formation and then from the Walloon Coal Measures.

The key changes to the 2021 regional groundwater model include:

- The introduction of an additional layer in the WCM to better represent the geological subdivision of this formation and improve representation of flow between units of the WCM.
- Representation of coal mines where overlapping impacts with CSG development are likely to occur, this included the Wandoan Coal Project located directly north of the Project area.

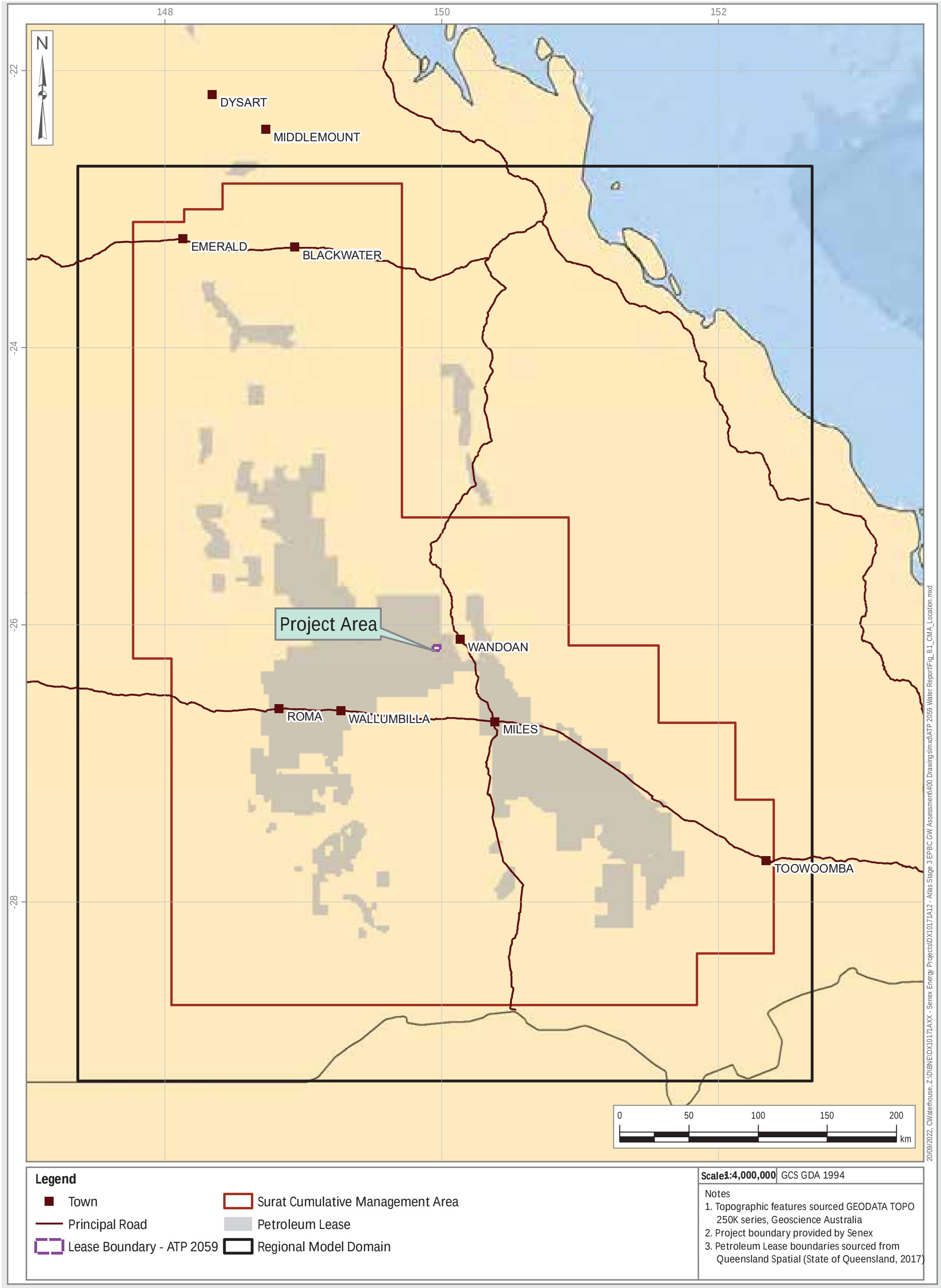

Figure 8.1 Location of the Surat CMA Regional Flow Model Extent and the Project

Model layer	Formation	Basin
1	All Alluvium and Basalt (including Main Range Volcanics)	Cenozoic
2	Upper Cretaceous (Griman Creek Formation & Surat Siltstone) and the Condamine-Walloon transition zone	Surat & Clarence-Moreton basins
3	Wallumbilla Formation	
4	Bungil Formation	
5	Mooga Sandstone	
6	Orallo Formation	
7	Gubberamunda Sandstone	
8	Westbourne Formation	
9	Upper Springbok Sandstone	
10	Lower Springbok Sandstone	
11	Walloon Coal Measures non-productive zone	
12	Upper Juandah Coal Measures - Layer 1	
13	Upper Juandah Coal Measures - Layer 2	
14	Lower Juandah Coal Measures - Layer 1	
15	Lower Juandah Coal Measures - Layer 2	
16	Lower Juandah Coal Measures - Layer 3	
17	Taroom Coal Measures	
18	Durabilla Formation	
19	Upper Hutton Sandstone	
20	Lower Hutton Sandstone	
21	Upper Evergreen Formation	
22	Boxvale Sandstone	
23	Lower Evergreen Formation	
24	Precipice Sandstone	
25	Moolayember Formation	Bowen Basin
26	Clematis Group	
27	Rewan Group	
28	Bandanna Formation non-productive zone	
29	Upper Bandanna Formation	
30	Lower Bandanna Formation	
31	Lower Bowen 1	
32	Cattle Creek Formation non-productive zone	
33	Upper Cattle Creek Formation	
34	Lower Cattle Creek Formation	
35	Lower Bowen 2	

Regional aquifer | Partial aquifer | Tight aquifer | Interbedded aquitard | Tight aquitard

OGIA_017

Figure 8.2 Model Layers and Corresponding Hydrostratigraphic Units Represented in the OGIA Regional Groundwater Flow Model (OGIA 2021c)

8.2 Model Parameters, Boundary Conditions and Calibration

The information provided in the following sections has been summarised from the *Groundwater Modelling Report for the Surat Cumulative Management Area* (OGIA 2016c), *Underground Water Impact Report for the Surat CMA* (OGIA 2021g), and *Modelling of cumulative groundwater impacts in the Surat CMA: approach and methods* (OGIA 2021c).

8.2.1 Model Parameters

OGIA improved their approach to assigning initial numerical groundwater model parameters as part of the update to the regional model for the 2016 UWIR (OGIA 2016c) and have continued to further enhance the model for the 2021 UWIR (OGIA 2021g).

The approach included three steps, as described in OGIA (2019c):

- 'Initial values of hydraulic conductivity for each of six lithology types' (clean sand, dirty sand, siltstone, mudstone, carbonaceous shale and coal) from geophysical logs are derived from expert knowledge, literature and analysis of geophysical logs.
- These initial values are then input to a stochastic permeability model and calibrated (or 'conditioned') through comparison with around 13,000 hydraulic test results at three different scales (i.e., pump tests, core test and geophysical measurement).
- Once calibrated, these values are then used to populate numerical permeameters – detailed 21 x 21 km numerical models of each stratigraphic unit, generated using lithological data for about 6,000 CSG wells and covering the full extent of the twelve stratigraphic units modelled. In total, more than 138,000 model runs were carried out during this part of the process.'

8.2.2 Groundwater Abstraction – Boundary Conditions

Optimal flow conditions for gas production are typically achieved when water pressures within the production well are equivalent to 25 to 80 m of water head (OGIA 2019c). To simulate water production, OGIA have used the MODFLOW-USG 'drain' boundary condition, with multiple drains assigned to each production well descending over time as pressures in the CSG production well reduce. The simulation using the drain boundary condition, is based on the sequencing of development and production well spacing provided by tenure holders across the model domain. Water is removed from the model to achieve the optimal head conditions (25 to 80 m), rather than removing a volume predicted using a modelling tool (e.g., estimated abstraction volume in Section 3).

Groundwater abstraction for non-petroleum and gas purposes, such as stock and domestic, are simulated using the MODFLOW-USG 'well' boundary condition.

8.2.3 Model Calibration

Calibration of the 2021 model was achieved using a three-stage simulation (OGIA 2021c). The first was a pre-development (1947) simulation was to replicate conditions that existed prior to the commencement of any groundwater extraction, for petroleum, gas or other purposes. The second simulation was to replicate pre-petroleum and gas extraction conditions in 1995 to provide starting or initial conditions for the third and final stage. The third stage was a transient simulation to replicate the period from January 1995 to December 2020, during which petroleum and gas production commenced initially from the Bandanna Formation and then from the Walloon Coal Measures.

The calibration was undertaken using the automated calibration software PEST, with a range of qualitative and quantitative measures used to assess each calibration iteration, consistent with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012).

8.3 Senex Model Scenarios

At the request of Senex, OGIA has simulated an appraisal scenario using the 2021 groundwater model based on production plans provided by Senex. Outputs from this model were used as part of this assessment. The original 2021 UWIR model included the approved APLNG 'Woleebee' gas field in PL 445 and PL 209, therefore, this gas field was removed for the modelled scenarios.

These outputs have been provided for use and processed as part of this assessment. All processing and analysis of model outputs was undertaken by KCB based on raw model outputs provided by OGIA.

The modelled scenarios completed by OGIA comprise:

- Cumulative CSG Development without the Project:

  Cumulative drawdown associated with all CSG and coal mining activities but excluding the Project (ATP 2059, PL 209, and PL 445) and the APLNG Woleebee gas field.
- Project Development scenarios (2023 until 2045):

  Drawdown associated with 31 wells on ATP 2059 and 120 wells on PL 445 and PL 209 (total of 151 wells) (Project only).

Total cumulative drawdown of the Project, plus all other CSG and coal mining projects, is calculated by adding the individual drawdown predicted by the Project only, to the cumulative scenario without the project, resulting in a cumulative drawdown scenario for the project development scenario.

The predicted drawdown presented in Sections 8.5 and 8.6 relates to the presence of CSG wells in ATP 2059 and neighbouring PL 209 and PL 445, as the activities on the three PLs were modelled by OGIA together as the full Atlas Stage 3 Project.

8.4 Assumptions and Limitations

Assumptions and limitations of the regional groundwater model are provided in OGIA (2016d). Key assumptions and limitations of the model associated with its use for this assessment are provided in the following:

- Since the model is required to cover the full extent of the Surat CMA and all aquifers potentially impacted by petroleum and gas water extraction within it, groundwater numerical model cell sizes are relatively large in lateral extent (1.5 km × 1.5 km). One outcome of the large cell size is that shallow, unconfined groundwater systems, and the interaction of these systems with deeper systems, can be simulated only approximately.

- Model cell sizes are large in vertical extent. Other than the WCM, most stratigraphic layers in the Surat and Bowen Basins are represented by only one or two model layers. Vertical head gradients within these layers, and geological details which lead to variations of these gradients, are only an approximation for the entire stratigraphic thickness (i.e., heterogeneity of the stratigraphic unit is not fully captured in the numerical model although considerable efforts were made to generate upscaled parameters and test that the model could replicate impact predictions made using highly detailed models with minimal upscaling).
- Desaturation of coal measures leading to desorption of gas, and hence the resulting dual phase flow, is simulated using a van Genuchten function in which water saturation is a function of pressure alone. This is a simplification of more complex processes that include desorption of gas, and then flow of gas together with water towards extraction centres. Buoyant up-dip movement of gas is also not represented.
- The effect of local faulting and abandoned and poorly constructed wells on vertical propagation of drawdown to stratigraphic units adjacent to the WCM units is not currently considered. However, major regional fault systems and are represented in both the model structure and parameterisation and hence their effects on impact propagation are considered. However, major regional fault systems and are represented in both the model structure and parameterisation and hence their effects on impact propagation are considered.
- Limited site-specific hydraulic parameter data is available and therefore the values utilised in the model in the vicinity of the Project have been inferred and calibrated through reference to data outside of the Project area, which may increase / decrease the effects of CSG production, and associated groundwater abstraction, within the Project area.
- CSG production is represented by drain boundary conditions with elevations set for optimal gas production. As a result, the produced volume of water from the drain cells may not necessarily represent actual CSG water production due to localised variability in aquifer hydraulic parameters. The model, however, been calibrated to historic actual production data and is able to replicate production in most current fields to a high degree of accuracy.

8.5 Project Only Scenario Results

Numerical model outputs provided by OGIA, for the scenarios detailed in the previous section, have been used by KCB to assess the extent and magnitude of drawdown related to CSG production from the Project.

Appendix II includes the predicted drawdown for the individual model layers, which represent the modelled hydrostratigraphic units (detailed in Figure 8.2). The figures in Appendix II present the drawdown during field development and post-development. Summary figures are presented in Figure 8.3 and Figure 8.4 showing the maximum Project only predicted drawdown (for the model duration). Observations include:

- Drawdown greater than 0.2 m (spring trigger threshold) is predicted in model layer 8 (Westbourne Formation) to model layer 18 (Durabilla Formation).
- Drawdown greater than 5 m (consolidated bore trigger threshold) is predicted in model layers 10 to 18 (Lower Springbok Sandstone to Durabilla Formation).
- The highest drawdown is predicted in model layer 17, which represents the Taroom Coal Measures.
- Drawdown within the Upper Juandah Coal Measures Layer 2 (model layer 13) has the widest drawdown extent: 13.1 km beyond the Project area extent.

As indicated, Appendix II presents the predicted drawdown during field development and post-development. The post-development timesteps presented are for 2060 (~10-years since end of CSG production), 2100 (50-years since end of CSG production) and 2300 (250-years since end of CSG production. These figures show groundwater level recovery within the WCM, and in the later timesteps, the propagation of drawdown in the overlying / underlying layers.

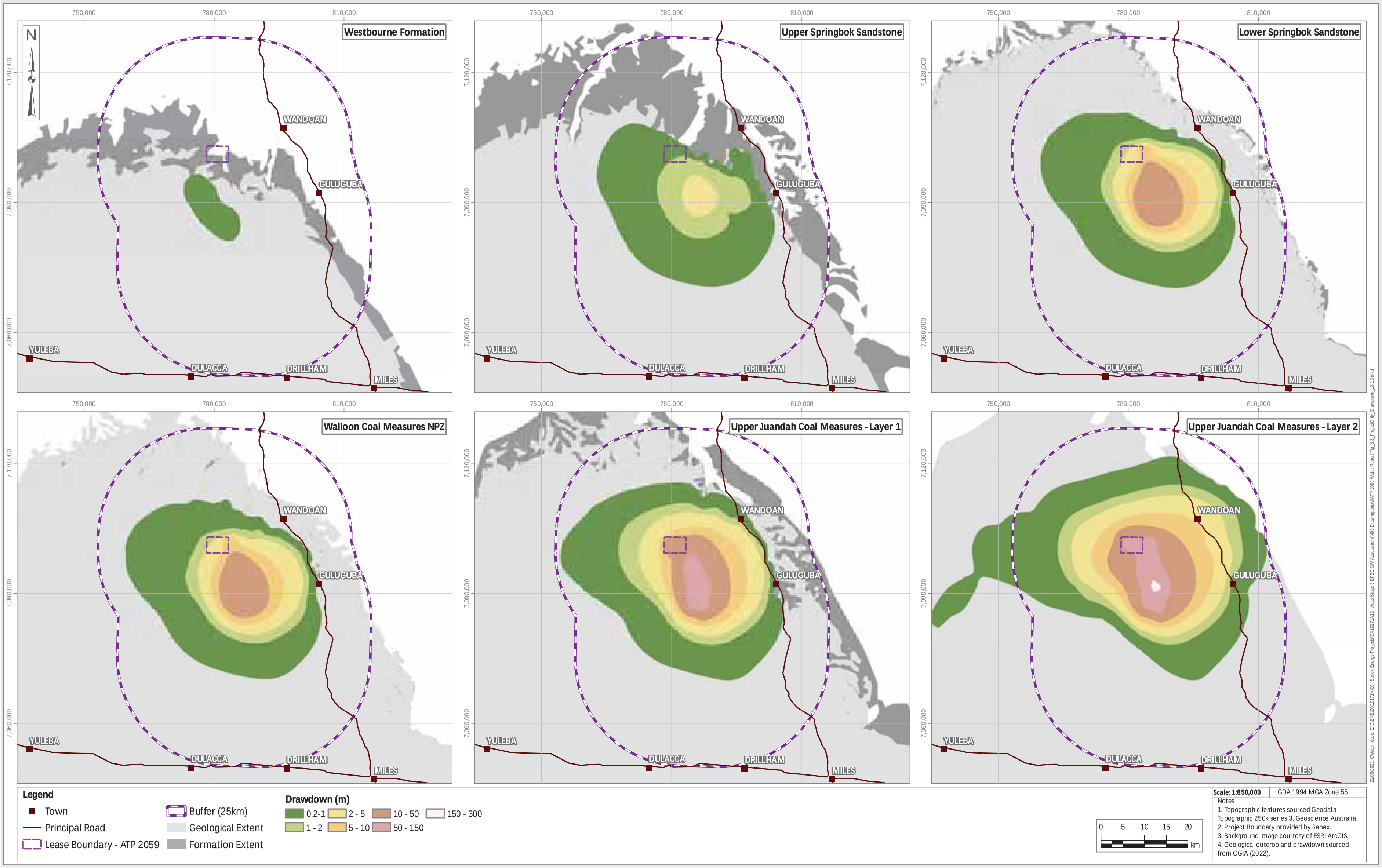

Figure 8.3 Extent of 'Project Only' Maximum Predicted Drawdown for Model Layers 8 (Westbourne Formation) to 13 (Upper Juandah Coal Measures – Layer 2)

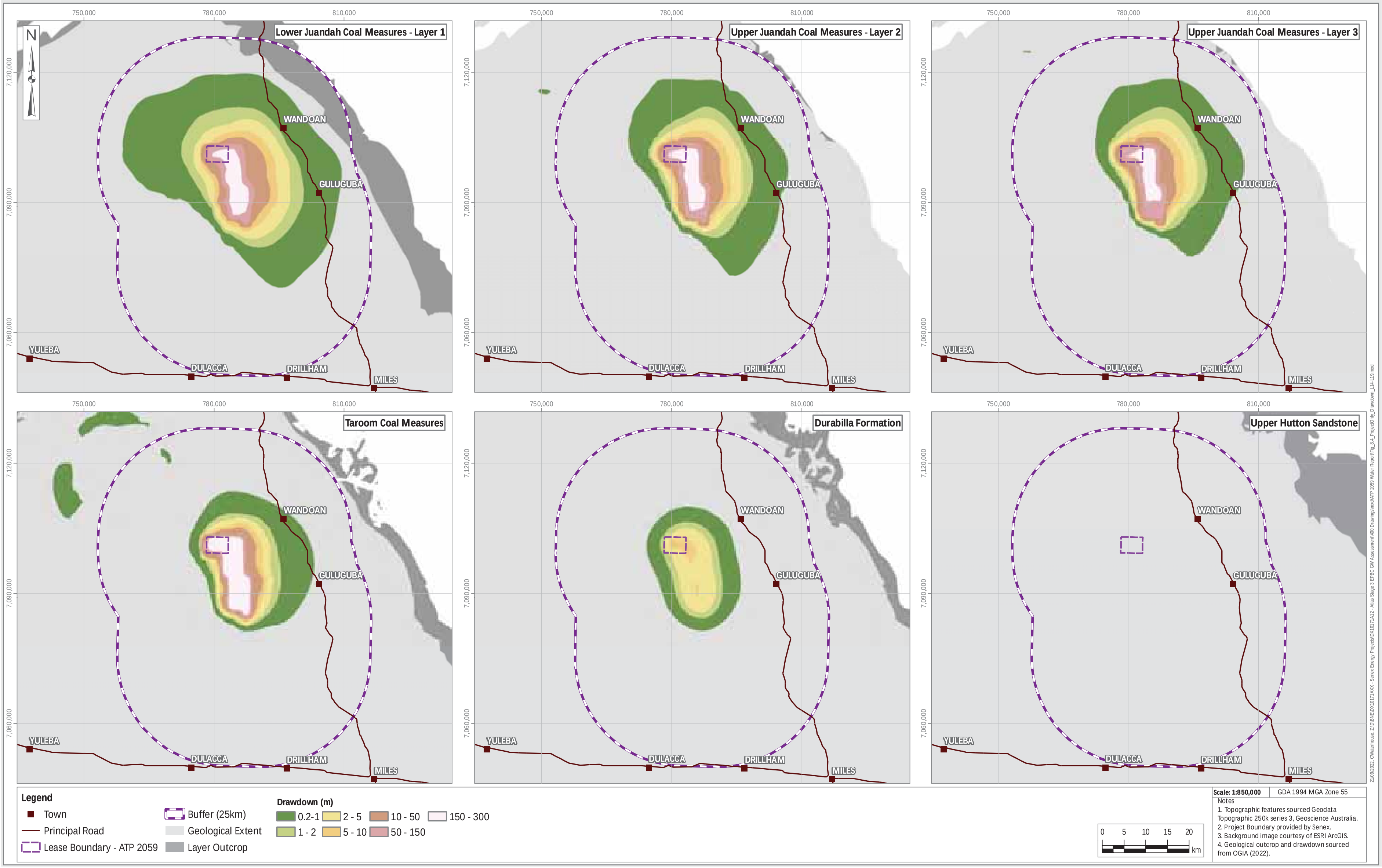

Figure 8.4 Extent of 'Project Only' Maximum Predicted Drawdown Model Layers 14 (Lower Juandah Coal Measures – Layer 1) to 19 (Upper Hutton Sandstone)

8.6 Cumulative Scenario Results

As detailed in Section 2.2.2, the Project is located within the Surat CMA, which was declared under the *Water Act 2000*, as a result of concentrated development by multiple tenure holders.

The Project area is located adjacent to other active and proposed CSG developments. As groundwater is removed via CSG production wells to depressurise the coal seams, there will be a degree of interaction between the individual tenure holders. There is also the potential for planned future mining operations in the area to increase the cumulative impacts.

OGIA, established under the *Water Act 2000*, is responsible for predicting regional impacts on water pressures in the hydrostratigraphic units of the Surat CMA and identifying potentially impacted groundwater bores and springs as presented in the UWIR, which is updated and published every three years.

Drawdown results for the cumulative scenario, focused on the Project area, are presented in Appendix III for individual modelled hydrostratigraphic units. Summary figures for the cumulative scenario are presented in Figure 8.5 and Figure 8.6. These figures show the maximum predicted cumulative drawdown for the model duration.

The cumulative drawdown results indicate drawdown within the vicinity of the Project area for the Westbourne Formation, Springbok Sandstone, WCM and Hutton Sandstone. The majority of the drawdown occurs towards the west of the Project, associated with neighbouring CSG developments. Drawdown also occurs to the southeast, where other CSG proponents are also operating.

The post-development timesteps for cumulative drawdown for the various hydrostratigraphic units are presented in Appendix III. These timesteps include 2060 (10-years since end of CSG production), 2100 (50-years since end of CSG production) and 2300 (250-years since end of CSG production). Similar to the Project only, the figures show groundwater level recovery within the WCM; and, in the later timesteps, the propagation of drawdown in the overlying / underlying layers.

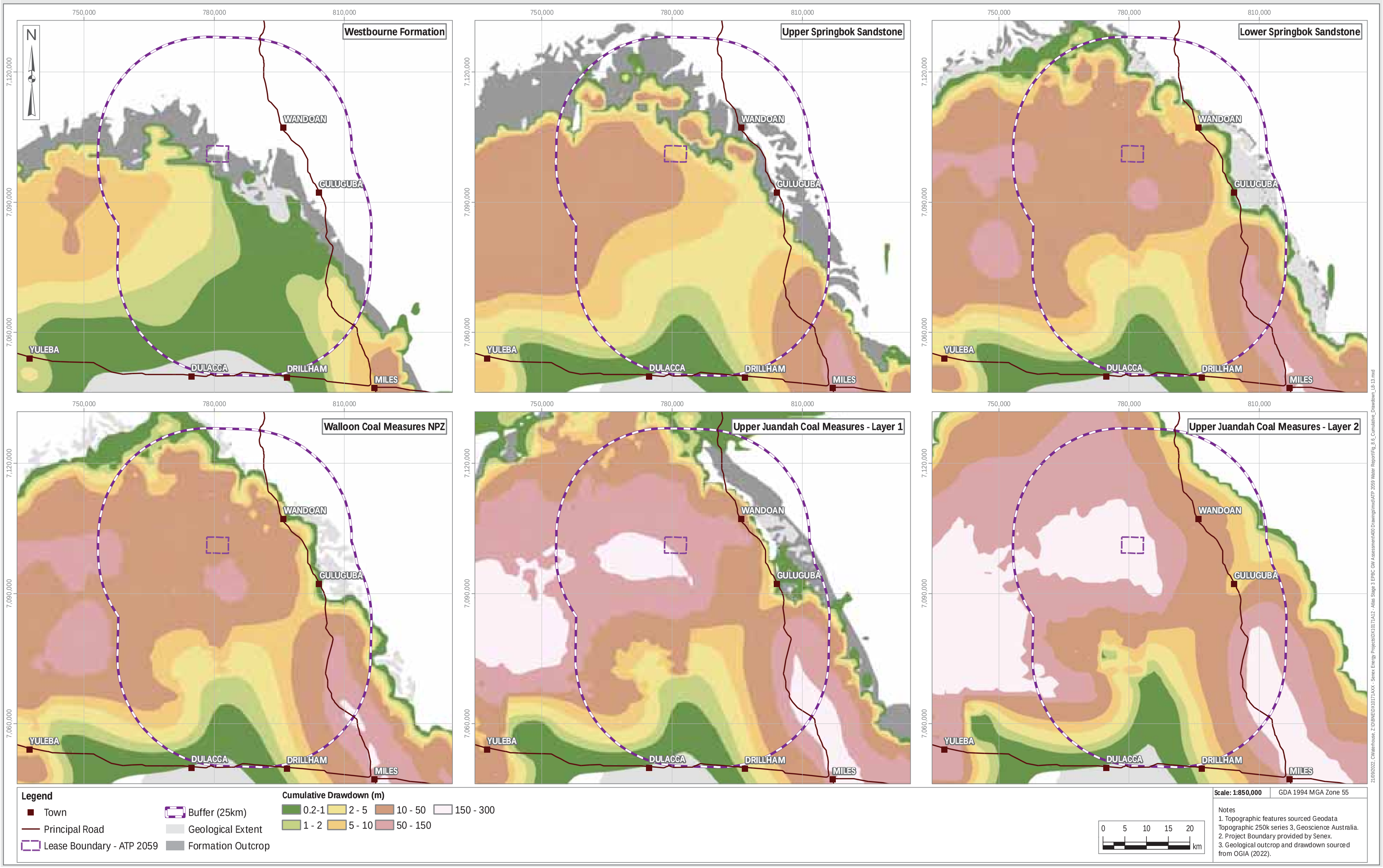

Figure 8.5 Extent of 'Cumulative' Maximum Predicted Drawdown for Model Layers 8 - 13 Westbourne Formation to Upper Juandah Coal Measures – Layer 2

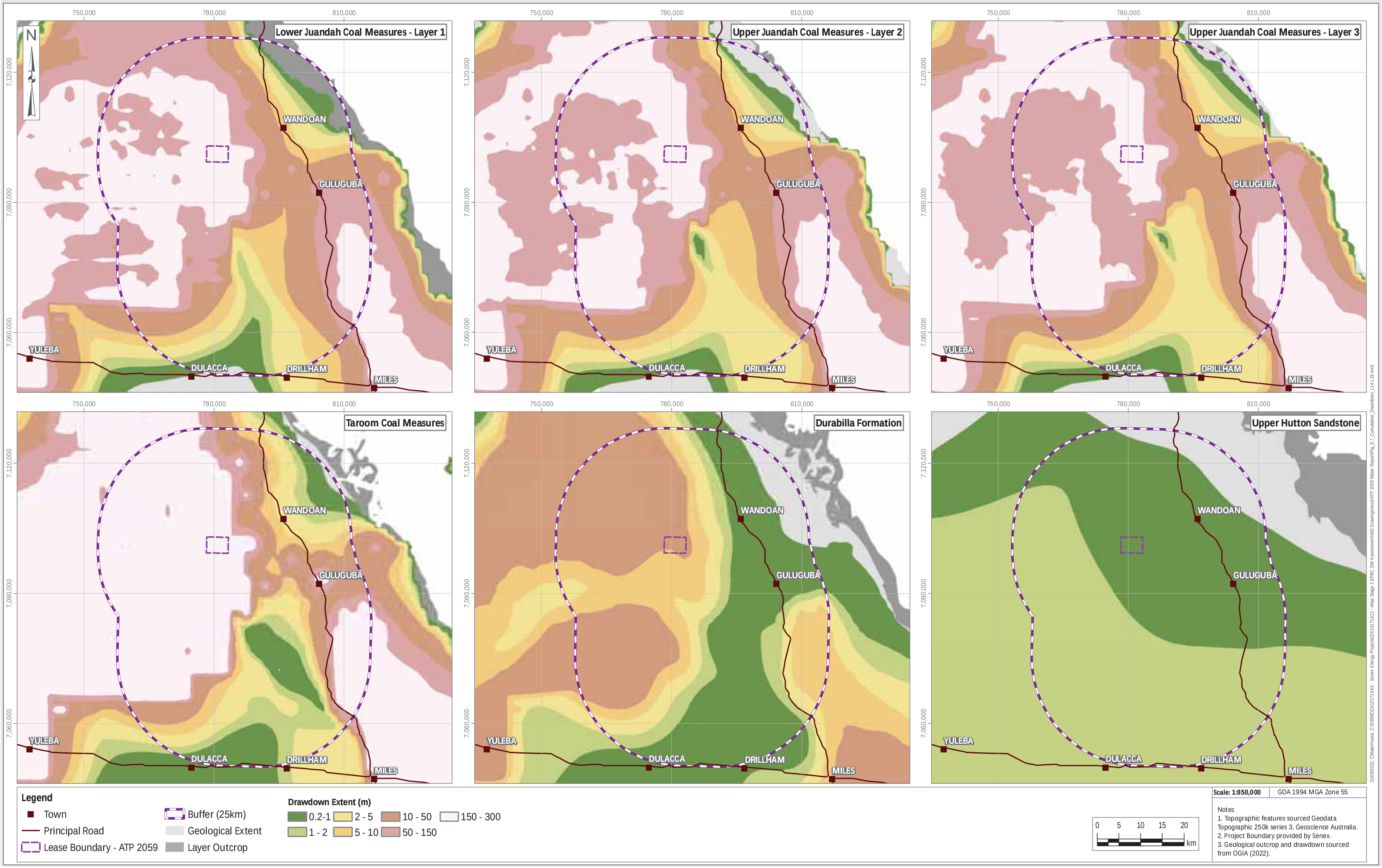

Figure 8.6 Extent of 'Cumulative' Maximum Predicted Drawdown for Model Layers 14 to 19 – Lower Juandah Coal Measures – Layer 1 to Upper Hutton Sandstone

9 IMPACT ASSESSMENT

This section presents the potential project impacts from the drawdown associated with the 31 wells on ATP 2059 and 120 wells on PL 445 and PL 209 (total of 151 wells). The activities on the three PLs were modelled by OGIA together as the full Atlas Stage 3 Project. The results are therefore present an overly conservative assessment of impact from the activities on ATP 2059.

9.1 Potential Project Impacts

9.1.1 Groundwater

CSG water production occurs as part of the CSG extraction process. Groundwater is removed via CSG wells during the process of depressurisation of the coal seams, which then liberates gas flow. This depressurisation and gas flow sustains a groundwater flow from each well to maintain the target gas producing operational pressure.

Senex intend to exercise their underground water rights under the *Petroleum and Gas (Production and Safety) Act 2004* (State of Queensland 2020c) to produce CSG. Several other authorised petroleum lease holders are also exercising their underground water rights in the vicinity of Project Atlas.

Potential impacts resulting from CSG water production include:

- Decline in groundwater level / pressure at water bores, reducing water availability and potentially impacting groundwater EVs.
- Reduction in groundwater head resulting in a reduction of groundwater discharge at spring complexes, potentially causing degradation of GDEs.
- Reduction of baseflow to watercourses, potentially resulting in degradation of GDEs and reduced water availability to potential users downstream.

These impacts have been quantitatively assessed in the following sections using modelling outputs from the UWIR 2021 numerical groundwater model.

Other potential impacts associated with groundwater are mitigated and managed by adopting the appropriate monitoring, management, and mitigation strategies. These potential impacts may include:

- Introduction of a connection between hydrostratigraphic units which were previously isolated units though drilling and construction of CSG production wells, resulting in the potential for alteration of flow regimes and quality.
- Drilling fluids used during the drilling process, which can impact groundwater quality.
- Seepage from CSG produced water storage impacting groundwater levels and quality, through seepage.
- Localised incidental CSG activities impacting shallow groundwater systems, such as fuel spills or improper storage of chemicals.
- Beneficial use activities impacting shallow groundwater systems through over-irrigation, or the lack of adherence to relevant beneficial use quality guidelines.

Monitoring, management and mitigation practices associated with the above activities are discussed further in Section 10.

9.1.2 Surface Water

Impacts to surface water and associated aquatic systems from the Project are anticipated to be minimal. The Project does <u>not</u> include any:

- Planned discharge to / abstraction from the surface water systems; or
- Surface water diversions.

Potential impacts likely to result from Project activities are summarised below. These impacts are associated with the general construction and day to day operations of CSG surface facilities rather than CSG production; and comprise:

- Localised transport of suspended sediment to waters during construction or site works, resulting in the potential to alter flow regimes and quality;
- Localised release of hydrotest water, effluent or trench water to land (these fluids are not intended for release to the surface water system so has limited potential for any impact to surface water quality);
- Alteration of a watercourse character or changes to riparian buffers due to construction works;
- Unplanned releases from water storage facilities have the potential to impact surface water and associated ecosystems; and
- Fuel and chemicals will be used as part of the project, with the potential for unplanned release that could impact surface water quality.

These impacts are managed and mitigated by adopting and implementing the appropriate monitoring, management, and mitigation strategies. Further discussion of these potential impacts is included in the following sections.

9.2 Impacts to Third-Party Surface Water Users

There are no surface water users identified within the vicinity or immediately downstream of the Project, therefore, no impacts to third-party surface water users are predicted as a result of the Project development.

9.3 Impacts to Third-Party Groundwater Users

Potential long-term impacts to groundwater bores have been assessed against the *Water Act 2000* bore trigger threshold of 2 m for an unconsolidated aquifer (e.g., alluvium) and 5 m for a consolidated aquifer (e.g., Surat Basin units) using the outputs and drawdown predictions from the UWIR numerical model. The maximum predicted drawdown was used for this assessment, irrespective of the timing of predicted drawdown. Assumptions / limitations of this assessment include:

- Many groundwater bores within the vicinity of the Project were constructed to intersect multiple formations. OGIA have assigned each bore a dominant source aquifer, this dominant aquifer was used to assess potential drawdown at each bore. Appendix IX provides the attributed formation (or formations) as discussed in Section 7.11.3 and the formation used as part of the impact assessment.

- Forty-four bores were assigned as 'screened within alluvium'. Where the OGIA model does not simulate alluvium at a bore location, predicted drawdown in the unit directly underlying the alluvium was considered for the impact assessment and assessed against the *Water Act 2000* bore trigger threshold of 2 m for an unconsolidated aquifer. Appendix IV details the unit assigned to those bores for impact assessment purposes.

9.3.1 Project Only Impacts to Third-Party Groundwater Users

A summary of the impacts to groundwater bores from the Project only simulation is presented in Table 9.1, with individual bore results presented in Appendix IV. Table 9.1 indicates the number of bores assessed for each formation; the number of bores which are predicted to have any drawdown; the number of bores which exceed the groundwater bore trigger threshold of 5 m drawdown for consolidated aquifers; and the maximum drawdown modelled for all the bores attributed to that formation.

Table 9.1 Project Only – Summary of Impact Assessment Results for Groundwater Bores

Formation	Number of Bores	Number of Bores with Drawdown	Number of Bores Predicted to Exceed Trigger Thresholds	Maximum Drawdown Predicted Across the Bores (m)
Bungil Formation	29	0	0	0.00
Mooga Sandstone	59	0	0	0.00
Orallo Formation	74	0	0	0.00
Gubberamunda Sandstone	148	62	0	0.01
Westbourne Formation	38	13	0	0.11
Upper Springbok Sandstone	45	35	0	2.33
Lower Springbok Sandstone	15	14	0	1.11
Walloon Coal Measures	228	220	23	123.34
Durabilla Formation	5	2	0	0.02
Hutton Sandstone	47	3	0	0.01
Evergreen Formation	2	0	0	0.00
Precipice Sandstone	37	0	0	0.00

The results indicate:

- Predicted drawdown (of any magnitude) is observed in bores attributed to most hydrostratigraphic units, however, only bores in the WCM are predicted to experience a drawdown greater than 5 m.
- There are 23 bores in the WCM which have a predicted drawdown greater than 5 m. These bores are screened in the Upper Juandah Coal Measures (21 bores) and the Taroom Coal Measures (two bores). Fifteen of these bores are predicted to experience drawdown of less than 10 m, six between 10 and 20 m drawdown, and only two with a drawdown of more than 20 m. The maximum predicted drawdown in any one bore is 123.32 m (screened in the Upper Juandah Coal Measures).
- Of these 23 bores, 12 are noted by OGIA as water supply bores, ten bores are noted as 'not water supply', and one as 'potential water supply'. The location of these bores, where the

water level is predicted to drawdown greater than the trigger threshold, is presented in Figure 9.1.

- The groundwater bores triggered in the Project only scenario, are already triggered by adjacent developments (e.g., without any contribution from the Project).

As discussed in Section 7.11.3, five bores in the vicinity of the Project are used for town water supply which target the Precipice Sandstone, the Lower Hutton Sandstone and the WCM. These bores are located near Wandoan and to the north of the Project area, approximately 14 km away. The results of the impact assessment indicate that there is less than 0.1 m drawdown as a result of the Project at these town water supply bores.

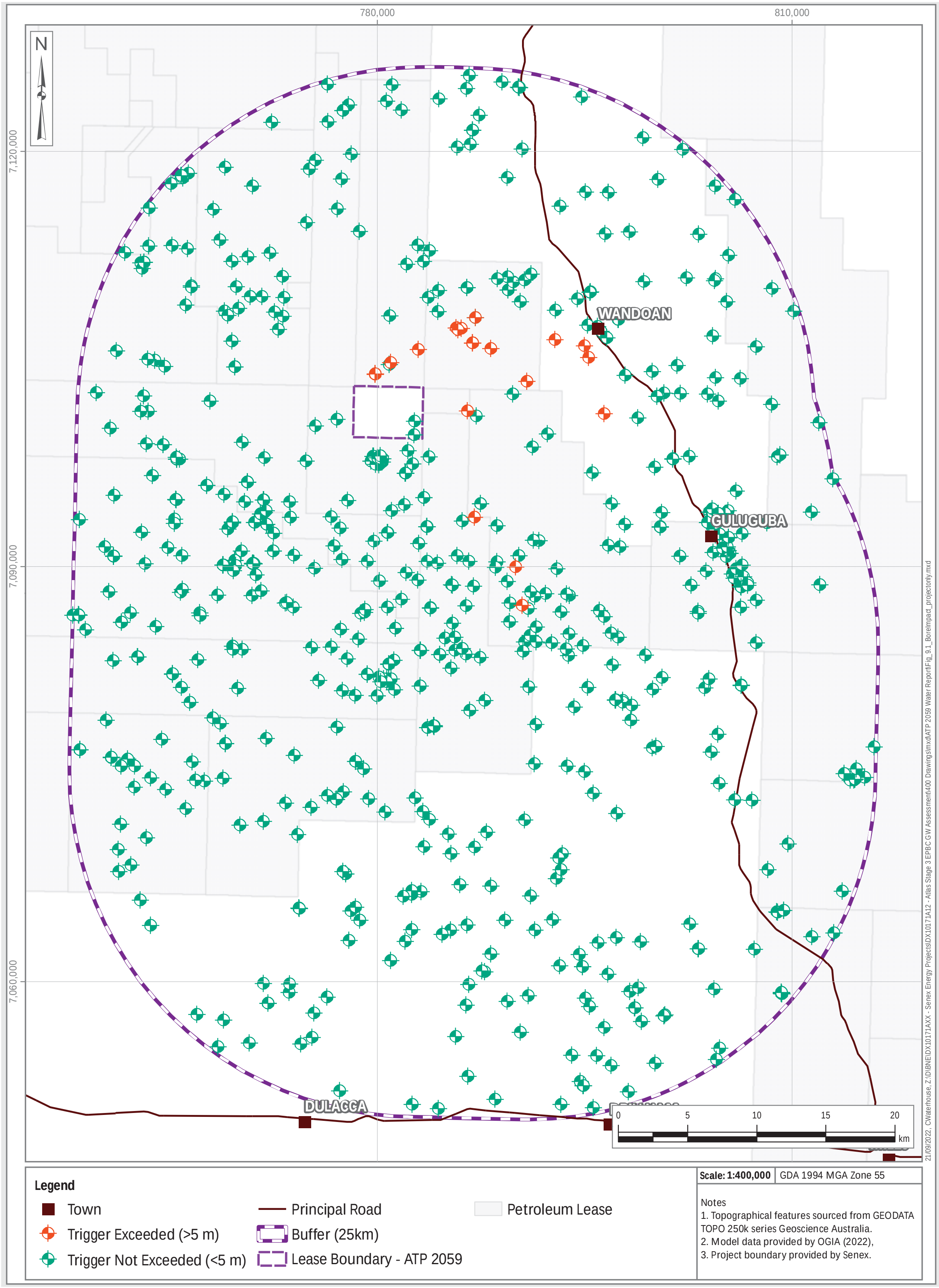

Figure 9.1 Summary of Impacts to Groundwater Bores – Project Only

9.3.2 Cumulative Impact to Third-Party Groundwater Users

The cumulative impact assessment was undertaken using the same approach adopted for the Project only impacts (e.g., *Water Act 2000* trigger thresholds).

A summary of the cumulative impact results for groundwater bores is presented in Table 9.2, with results for individual bores presented in Appendix IV. The results indicate the following:

- Within the 25 km buffer from the Project, 248 bores are triggered (i.e., >5 m drawdown) in the cumulative scenario.
- There are five additional bores triggered as part of the cumulative scenario (i.e., the contribution of the Project development results in five additional bores being triggered in the cumulative scenario, these bores would not have been triggered without the presence of the Project). Two of these bores are attributed to the Upper Springbok Sandstone and three are attributed to the Upper Juandah Coal Measures. The locations of these bores are presented on Figure 9.2.
- Of the five additional bores, none are located on tenement and are all located off-site to the east. One of these bores is noted as “Abandoned and destroyed”, two are noted as “Monitoring bores (and not water supply bores)”, and two are noted as “Existing bores”. Of the existing bores, a bore baseline assessment confirmed one of these bores is blocked and has not been used since 1996 (Arrow 2013). The maximum Project only contribution to drawdown on the only existing, usable bore is 26%.
- Of the 248 bores, the Project only contribution to drawdown of more than 1% occurs at 99 bores, and more than 10% at 36 bores. The maximum contribution from the Project is 81%, this bore is located on PL 209 which has been confirmed as not existing through the 2022 Baseline Assessment (KCB 2022).

Table 9.2 Cumulative Scenario – Summary of the Impact Assessment Results for Groundwater Bores

Formation	Number of Bores within 25 km	Project Only – Number of Bores Triggered	Cumulative – Number of Bores Triggered
Bungil Formation	29	0	0
Mooga Sandstone	59	0	0
Orallo Formation	74	0	0
Gubberamunda Sandstone	148	0	0
Westbourne Formation	38	0	3
Upper Springbok Sandstone	45	0	22
Lower Springbok Sandstone	15	0	14
Walloon Coal Measures	228	23	205
Durabilla Formation	5	0	4
Hutton Sandstone	47	0	0
Evergreen Formation	2	0	0
Precipice Sandstone	37	0	0

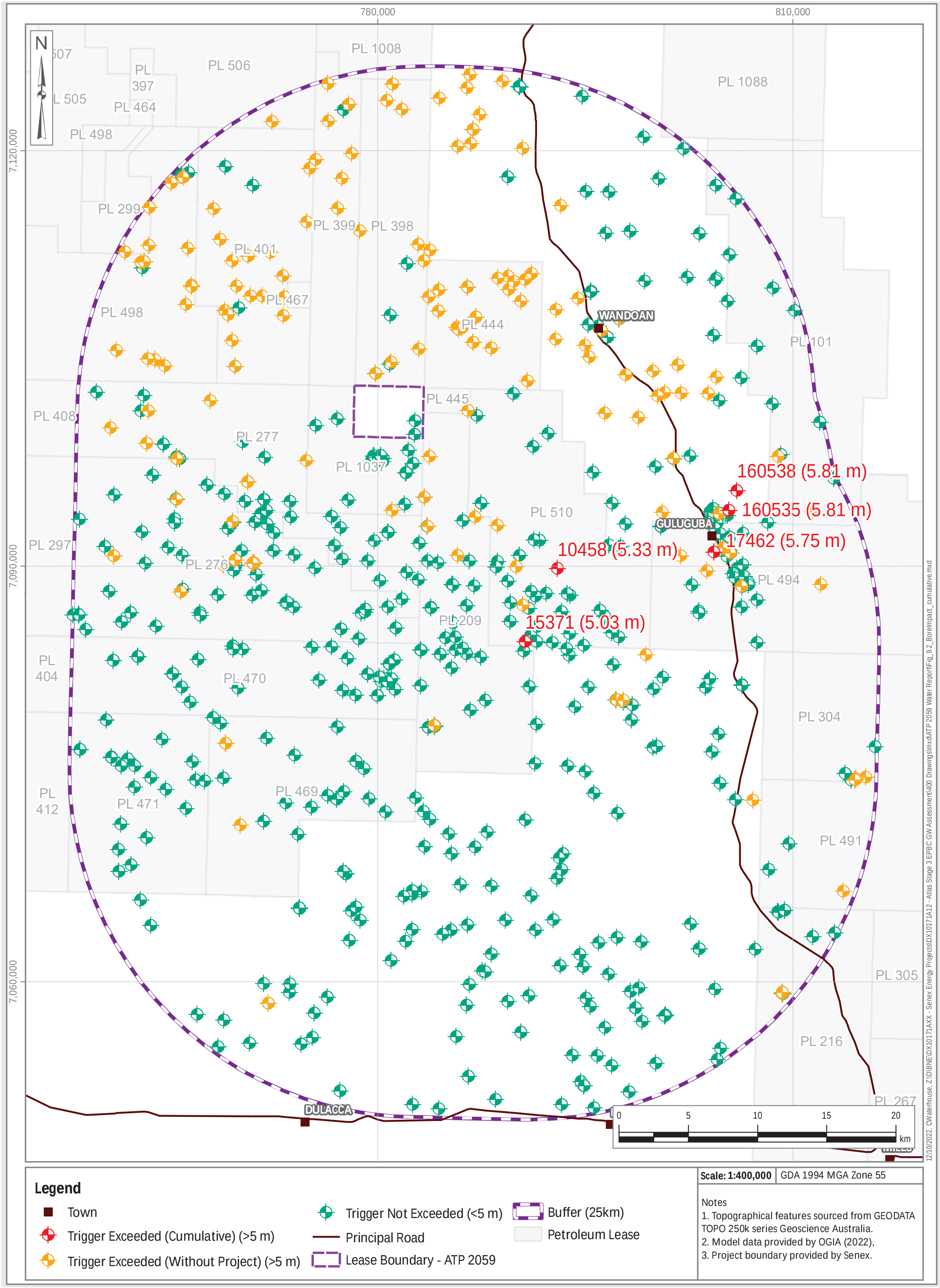

Figure 9.2 Summary of Impacts to Groundwater Bores – Cumulative

9.4 Impacts to Groundwater Dependent Ecosystems

Outcropping geological formations in the Project area have the potential for connection to aquatic and terrestrial GDEs, either directly, or through connections to overlying alluvial deposits. The areas of interest for assessment of impacts to GDEs are the outcrop areas of:

- Upper Springbok Sandstone – this unit outcrops under PL 445 and to the north / northeast of PL 445 and PL 209 to the east of ATP 2059.
- Westbourne Formation – this unit outcrops within ATP 2059.
- Gubberamunda Sandstone – this outcrops under the southern extent of ATP 2059.

Areas of interest were identified by the 0.2 m drawdown extent for each outcrop formation. Potential drawdown greater than 0.2 m in these outcropping geological units have been compared to locations of potential GDEs and springs from the Queensland GDE mapping (State of Queensland 2018a) and field verification by ERM ecologists for GDEs located within the Project area.

In summary:

- Project only drawdown of more than 0.2 m is not predicted for the Gubberamunda Sandstone for the Project only scenario, and cumulatively the Project does not contribute to any further potential GDE areas exceeding the 0.2m trigger. Potential GDEs on the Gubberamunda Sandstone are not considered further in the GDE assessment.
- Project only drawdown in the Westbourne Formation is predicted to be less than 0.2 m on any Westbourne Formation outcrops. The Project does contribute cumulatively to additional drawdown in the outcrop area of the Westbourne Formation. This occurs in a small area of the Westbourne Formation outcrop in PL 1037 (Atlas) and neighbouring tenement PL 277 to the west (QGC).
- The groundwater in the Upper Springbok Sandstone outcrop area is predicted to have a drawdown greater than 0.2 m due to the Project development (Project only simulation), resulting in this formation being the main formation of interest for this GDE impact assessment.

9.4.1 Impacts to Aquatic GDEs Areas

There are three potential aquatic GDEs areas of interest within or close to the Project area. These aquatic GDEs are defined by the Queensland GDE mapping as being sourced from Quaternary alluvial aquifers overlying sandstone ranges with fresh, intermittent groundwater connectivity; there is moderate confidence in their presence (State of Queensland 2018a). The locations and summary of predicted drawdown is presented in Figure 9.3 and Table 9.3.

The one mapped aquatic GDE located within the Project area of ATP 2059 (No. 1; Table 9.3 and Figure 9.3) is located on the Westbourne Formation outcrop and is interpreted to be sourcing water from the Westbourne Formation which is not predicted to experience drawdown greater than 0.2 m (for any scenario). The alluvium overlying the Westbourne Formation is also not predicted to drawdown greater than 0.2 m. GDE No. 2, located on neighbouring PL 209 is also located on the alluvium and Westbourne Formation and is not predicted to experience drawdown greater than 0.2 m.

The aquatic GDE located to the north of PL 445 (No. 3), is located on the Springbok Sandstone outcrop (Site 3 in Table 9.3 and Figure 9.3). The alluvium overlying the Springbok Sandstone is not predicted to experience drawdown due to the development of the Project. Drawdown in the Upper Springbok Sandstone, of up to 19.7 m, is predicted at this location due to surrounding development activities (i.e., without the development of the Project). This drawdown is due to the proposed development of the Wandoan Coal Project. The GDE is located directly adjacent to a planned area of disturbance. **The predicted drawdown from the presence of the Project only, at the location of aquatic GDEs of interest, is predicted to be less than the 0.2 m trigger.**

The proposed development of the Project is predicted to contributes less than 1% of the cumulative drawdown at the location of this GDE, with the model predicting the same drawdown both with and without the Project due to the close proximity of the Wandoan Coal Project.

Table 9.3 Predicted Drawdown at Potential Aquatic GDEs Areas of Interest

No.	GDE Rule ID	Location	Source Aquifer[1]	Project Development Scenario Only Drawdown (m)	Cumulative with Project (m)	Proportion Contribution of the Project %
1	SURAT_RS_01A	ATP 2059	Alluvium	0.00	0.08	-
			Westbourne Formation	0.00	0.00	-
2	SURAT_RS_01A	PL 209	Alluvium	0.00	0.09	-
			Westbourne	0.00	0.00	-
3	SURAT_RS_01A	1.8 km north of PL 445	Alluvium	0.00	0.08	-
			Upper Springbok	0.12	19.71	0.6

1. Source aquifer as defined the Queensland GDE mapping and GDE Rule ID dataset.

It is also unlikely that these potential aquatic GDE areas are sourced from the deeper GAB units of the Westbourne Formation and Upper Springbok Sandstone given the evidence from the field verification provided in Section 7.10.1 and 7.10.2.

Reaches of Woleebee Creek within PL 1037 were assessed during field verification in 2018 (KCB 2018c) directly adjacent to ATP 2059. Field verification was undertaken as part of this assessment (KCB 2018a). The 2018 field verification identified that there is unlikely to be significant baseflow provided to this creek, however it is likely that during some periods, groundwater levels in the alluvium will rise up into the sandy base of the creek. The field verification also concluded that based on the difference between the alluvial groundwater and surface water major ionic chemistry signatures, and groundwater chemistry signatures from the Surat Basin units, groundwater within the alluvium is not considered to be sourced from the underlying Surat Basin unit (Westbourne Formation) at the locations assessed.

As described in Section 6.9 these ephemeral creeks of low diversity and of non-conservation significant aquatic fauna and flora, lack suitable habitat for EVNT aquatic species.

Impacts to aquatic ecosystems are expected to be minimal and will be managed through implementation of the appropriate management, mitigation and monitoring practices associated with construction and operation. These are detailed in Section 10. Based on the characteristics of the Aquatic GDEs present (as described in Section 6.9) a change of less than 0.2 m is unlikely to affect those species that are present or the ecological function of these ecosystems.

Impacts to threatened EPBC-listed aquatic species are considered unlikely.

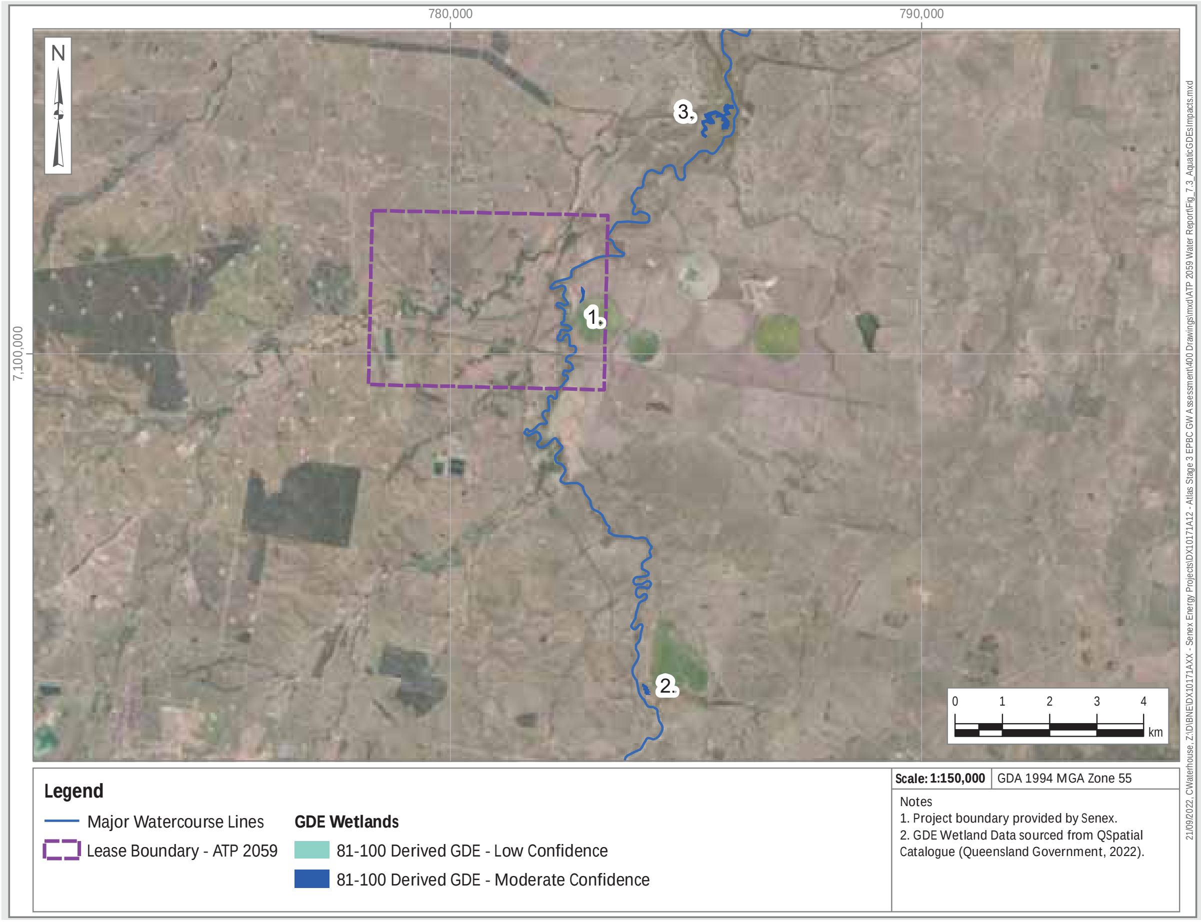

Figure 9.3 Aquatic GDEs of Interest within the Vicinity of the Project

9.4.2 Impacts to Watercourse Springs

OGIA has identified the potential for watercourse springs on tenement along Woleebee Creek, these are:

- W279 – alluvium.
- W280 – alluvium/Gubberamunda Formation.
- W281 – alluvium/Orallo Formation.

These springs have been assessed against the *Water Act 2000* spring trigger threshold of 0.2 m using the outputs and drawdown predictions from the UWIR numerical model. The Project only scenario does not result in drawdown at these locations in the potential source aquifers, the predicted cumulative drawdown is also <0.2 m.

Reaches of Woleebee Creek within PL 1037 were assessed during field verification in 2018 (KCB 2018c) directly adjacent to ATP 2059. Field verification was undertaken as part of this assessment (KCB 2018a). The 2018 field verification identified that there is unlikely to be significant baseflow provided to this creek, however it is likely that during some periods, groundwater levels in the alluvium will rise up into the sandy base of the creek. The field verification also concluded that based on the difference between the alluvial groundwater and surface water major ionic chemistry signatures, and groundwater chemistry signatures from the Surat Basin units, groundwater within the alluvium is not considered to be sourced from the underlying Surat Basin unit (Westbourne Formation) at the locations assessed.

There is no drawdown predicted at these locations and therefore the spring trigger threshold is not predicted to be exceeded.

9.4.3 Impacts to Terrestrial GDEs

Westbourne Formation

There is only one potential terrestrial GDE mapped on the Westbourne Formation outcrop within the predicted 0.2 m cumulative drawdown extent. There are no terrestrial GDEs mapped in the predicted 0.2 m Project only drawdown extent of the Westbourne Formation outcrop. **The Project alone does not result in drawdown greater than the 0.2 m trigger at GDE areas on the Westbourne Formation outcrop.** This area is shown on Figure 9.4 and predicted drawdown summarised in Table 9.4.

This terrestrial GDE is located on PL 277 (QGC) approximately 2.7 km west of ATP 2059 and is described as a 'treed regional ecosystem with alluvia on fresh, intermittent flow'. It has an assigned GDE rule of Surat_RS_01C, and there is low confidence of its dependence on groundwater (State of Queensland 2018a). The dominant regional ecosystem (RE) is identified as 11.3.25, which is *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines. The average rooting depth for species of Eucalyptus present at the Project area is known, based on literature reviews, to range from 9 m to 22.6 m, depending on the species and the interactions between geomorphology and plant physiological traits. The groundwater source for this GDE is described as 'Quaternary alluvial aquifers with a fresh, intermittent groundwater connectivity regime' and 'shallow alluvial, local, unconfined, and unconsolidated'.

Predicted drawdown in the alluvium, the source aquifer, at this location is less than the 0.2 m drawdown trigger. The cumulative drawdown in the Westbourne Formation is greater than 0.2 m, with a predicted drawdown of 2.6 m. The Project contribution to this cumulative drawdown is ~6%.

Table 9.4 Terrestrial GDEs within the Predicted 0.2 m Drawdown Extent on the Westbourne Formation Outcrop

Location	GDE Rule ID	Source aquifer	Project Development Scenario Only Drawdown (m)	Cumulative with Project (m)	Proportional Contribution of the Project %	Area Of Potentially Affected GDE (km^2)
2.7 km west of ATP 2059 in PL 277	Surat_RS_01C	Alluvium	0.00	0.09	-	-
		Westbourne	0.19	3.68	5.16	0.09
			0.16	2.60	6.15	0.27

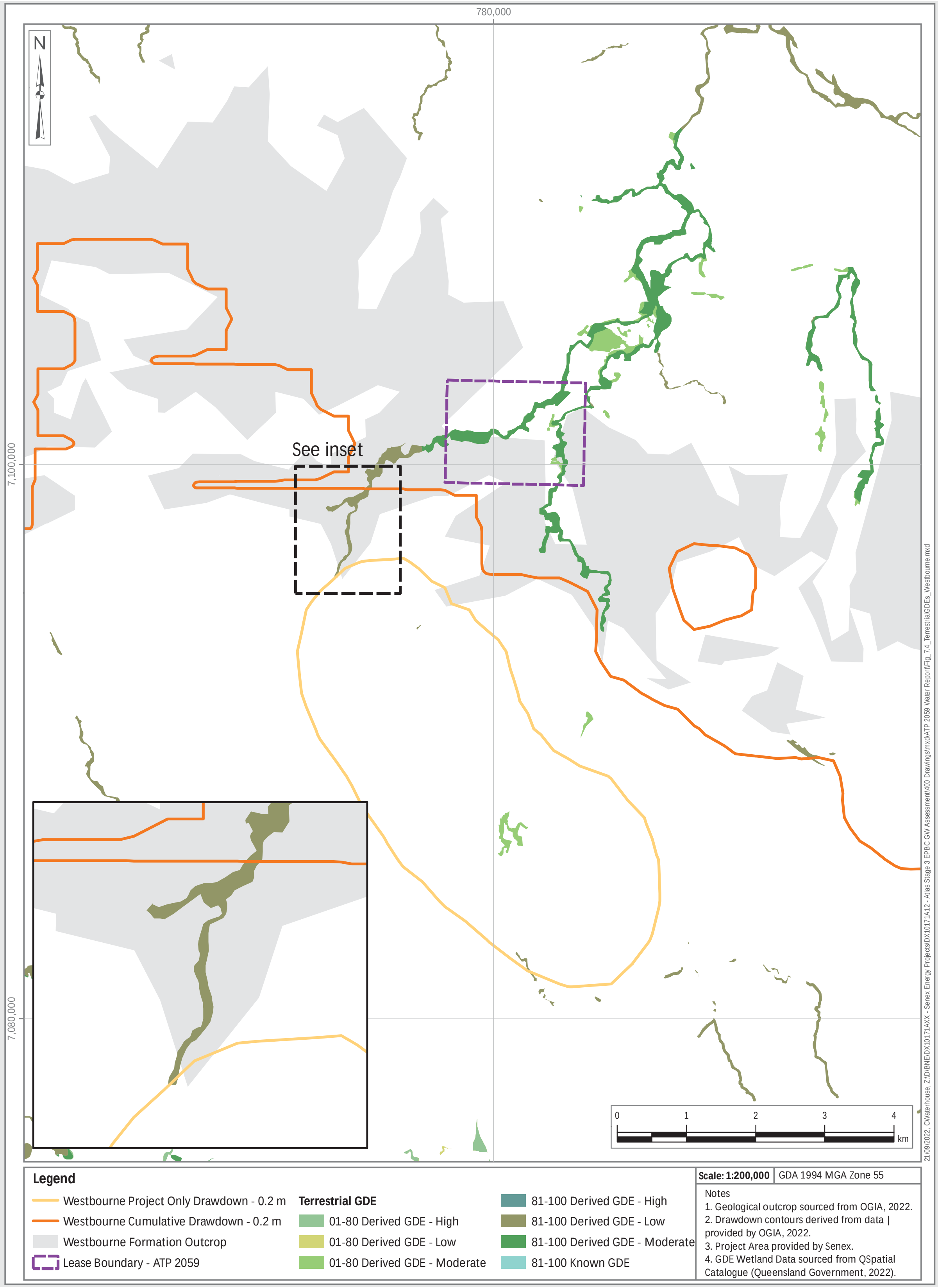

Figure 9.4 Mapped Potential Terrestrial GDEs and Predicted Drawdown Area – 0.2 m Contours Westbourne Formation

Springbok Sandstone

There are four potential terrestrial GDEs located on the Springbok Sandstone outcrop within the 0.2 m Springbok Sandstone Project only drawdown extent. These areas are shown on Figure 9.5, with the predicted drawdown summarised in Table 9.5. One of these potential GDEs (No. 1) is located on Senex tenement PL 445.

These GDEs are described as:

- Surat_RS_01A: Quaternary alluvial aquifers overlying sandstone ranges with fresh, intermittent groundwater connectivity regime (moderate confidence in GDE status).
- Surat_RS_03A: permeable consolidated sedimentary rock aquifers with fresh, intermittent groundwater connectivity regime (low confidence in GDE status).

Project only drawdown is not predicted in the alluvium at these mapped GDE locations.

These four potential GDEs are cumulatively triggered by surrounding project activities (without the presence of the Project). The Project contributes to the cumulative drawdown at these GDEs (see Table 9.5), with the highest contribution being at GDE No. 4 which is located ~12 km east of ATP2059. GDE No. 2 and 3 are located directly on, or close to, proposed areas of disturbance associated with the proposed Wandoan Coal Mine, with the Project contributing less than 6% of the predicted drawdown. The approved Wandoan Coal Project is planned to excavate both alluvium and Springbok Sandstone with pit depths of 24 to 60 m. The Springbok Sandstone will likely need to be dewatered by the Wandoan Coal Project for pit excavation.

These potential terrestrial GDEs are all located along ephemeral creek systems. As discussed in Section 7.10.1, the likely source of water for these three GDEs is the alluvium. Bore logs from nearby registered bores confirm the presence of alluvium at each of these locations, with the alluvium identified as having a depth of up to 18 m in ATP 2059, in the vicinity of GDE No. 1. The water quality of the alluvium indicates that groundwater in this aquifer is replenished by surface water during prolonged periods of rainfall (Section 7.9), when the ephemeral creeks are flowing. The distinction between the alluvium water quality and underlying Westbourne Formation and Springbok Sandstone water quality (which is of higher salinity) indicates that these units are disconnected. These potential terrestrial GDEs are considered to be resilient and adapt well to stress, with the larger eucalypts (including Forest Red Gums) having a dimorphic root system and are well adapted to the drying and wetting ephemeral setting associated with the creek systems (Section 7.10.1).

Based on the available characteristics of the GDE physiographic setting, it is interpreted that these potential GDEs:

1. may be intermittently supported by groundwater in the alluvium (as discussed in Section 7.10.1), which is not predicted to experience drawdown;
1. the alluvium source aquifer is not considered to be connected to the Upper Springbok Sandstone (as discussed in Section 7.9) which is predicted to experience drawdown; and,
2. are being triggered cumulatively by neighbouring activities without the presence of the Project (by the Wandoan Coal Project and other CSG activities).

Based on the above, it is concluded that the contributing drawdown impacts from the Project to potential terrestrial GDEs are not considered significant.

Table 9.5 Terrestrial GDEs within the Predicted 0.2 m Drawdown Extent on the Upper Springbok Sandstone Outcrop

No.	Location	GDE Rule ID	Source aquifer	Project Development Scenario Only Drawdown (m)	Cumulative with Project (m)	Proportional Contribution of the Project %	Area Of Potentially Affected GDE (km^2)	RE
1	Within PL 445 at the boundary of ATP 2059 and PL 445	Surat_RS_01A	Alluvium	0.00	0.08	-	-	11.3.25 (Forest Red Gum *Eucalyptus tereticornis* woodland fringing drainage lines) however areas of RE 11.3.2 (Poplar Box *Eucalyptus populnea* woodland on alluvial plains), RE 11.3.27 (Freshwater wetlands: Coolabah *Eucalyptus coolabah* and/or Forest Red Gum) open woodland to woodland fringing swamps) and RE 11.3.17 (Poplar Box woodland with Brigalow *Acacia harpophylla* and/or *Belah Casuarina cristata* on alluvial plains) are also present
		Surat_RS_03A	Upper Springbok Sandstone	0.90	4.57	19.69	0.07	
2	10.3 km E of ATP 2059	Surat_RS_01A	Alluvium	0.00	0.08	-	-	RE 11.3.25 *Eucalyptus tereticornis* or *E. camaldulensis* woodland
		Surat_RS_03A	Upper Springbok Sandstone	0.28	5.12	5.47	0.17	
				0.48	8.42	5.70	0.05	
3	13.7 km east of ATP 2059	Surat_RS_03A	Upper Springbok Sandstone	0.45	36.74	1.22	0.001	11.9.5/11.9.10
				0.32	29.3	1.09	0.01	
4	~15 km southeast of ATP 2059	Surat_RS_01A	Alluvium	0.00	0.07	-	-	RE 11.3.25 *Eucalyptus tereticornis* or *E. camaldulensis* woodland
		Surat_RS_03A	Upper Springbok Sandstone	0.51	2.24	22.76	0.02	

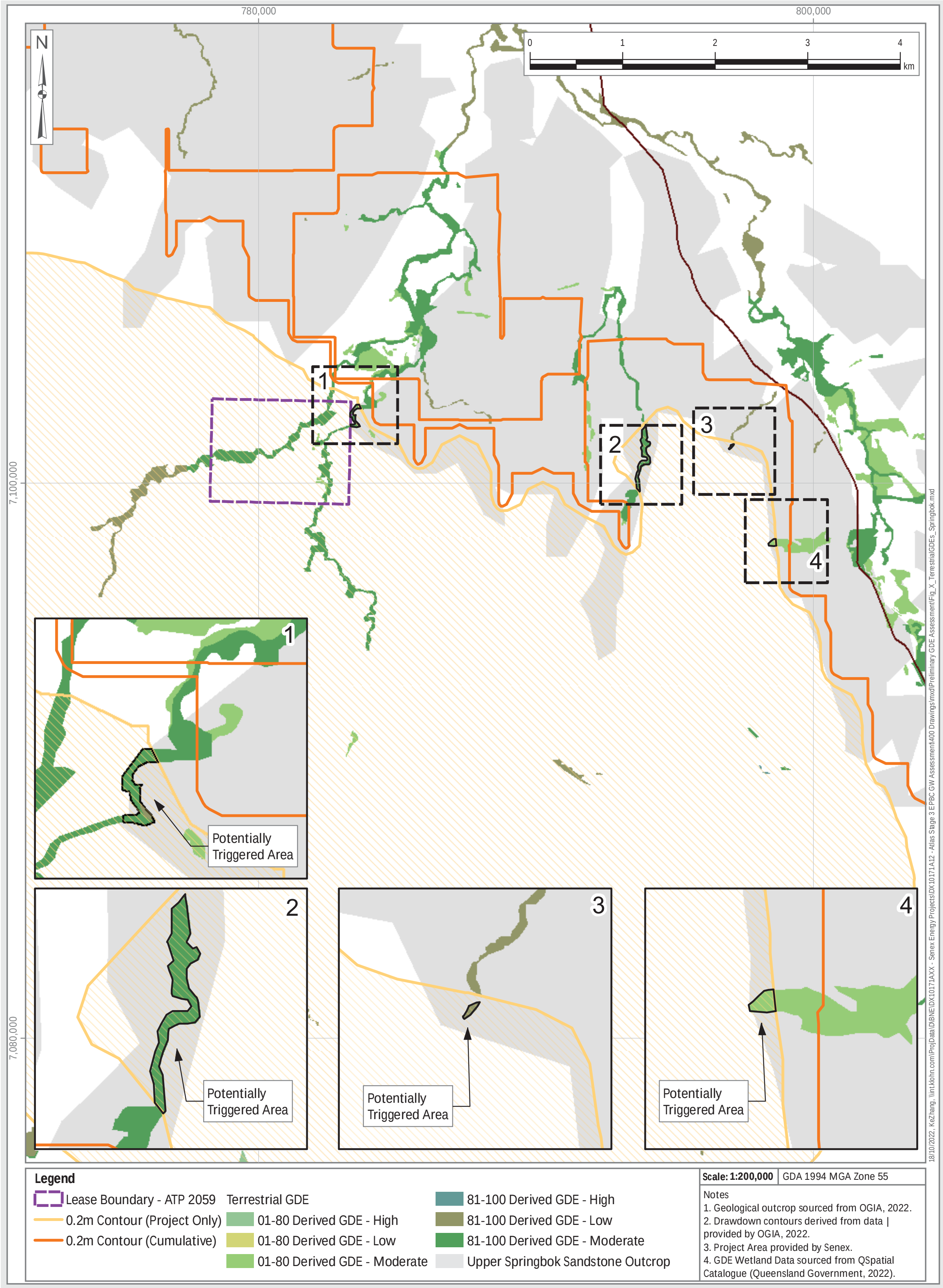

Figure 9.5 Mapped Potential Terrestrial GDEs and Predicted Drawdown Area – 0.2 m Contours Upper Springbok Sandstone Formation

9.4.4 Impacts to Subterranean Fauna

Impacts to potential stygofauna habitats are limited to the unconfined outcrop areas. Stygofauna have been identified in PL 1037 in the Gubberamunda Sandstone/Westbourne Formations and Upper Springbok Sandstone (KCB 2018d). The potential impact is summarised as follows:

- For ecological systems potentially reliant on groundwater within the shallow aquifers, the cumulative scenario does not predict any drawdown within the Gubberamunda Sandstone from the Project.
- For ecological systems potentially reliant on groundwater in the Westbourne Formation outcrop, the Project only drawdown in the Westbourne is predicted to be less than 0.2 m. The results of the numerical modelling indicate that there is negligible (at most a 2%) reduction in saturated thickness in the outcrop areas of the Westbourne Formation to the west and east of the Project area.
- Drawdown is predicted in the Upper Springbok Sandstone within outcrop areas to the north and northeast of the Project area. These areas are cumulatively triggered without the presence of the Project with the Project contributing up to 0.9m of drawdown within PL 445, this equates to a proportional drawdown contribution of the Project of ~20%. Given the overall thickness of the Springbok Sandstone of ~100 m, the reduction in saturated thickness from the Project only is negligible.

No discernible impacts to subterranean fauna as a result of the Project development are predicted.

10 MITIGATION, MANAGEMENT AND MONITORING

This section provides further detail on Senex's proposed mitigation, management and monitoring practices for the Project.

10.1 CSG Production Wells and General Project Activities

Measures to minimise impacts to groundwater quality and avoid introducing connectivity between formations during the construction of CSG production wells, include the following:

- CSG production wells will be designed, constructed and decommissioned in accordance with the "Code of Practice for the construction and abandonment of petroleum wells, and associated bores in Queensland Version 1" (State of Queensland 2019a). This code outlines mandatory requirements and good practice to reduce the risk of environmental harm. CSG production wells will be designed to:
  - Prevent any interconnection between target hydrocarbon bearing formations and aquifers;
  - Ensure that gas is contained within the well and associated pipework and equipment without leakage;
  - Ensure zonal isolation between different aquifers is achieved; and
  - Not introduce substances that may cause environmental harm.

A chemical risk assessment has been undertaken for the Project to consider drilling fluids used in CSG production well drilling. Drilling fluids and additives used during drilling activities will be water based, appropriate for the well design and local geological conditions, and will be used in accordance with the mandatory requirements and good practice guidelines outlined in the code of practice (State of Queensland 2019a), as well as the Safety Data Sheets (SDS) provided with each fluid/additive. With relation to drilling fluids, the mandatory requirements include:

- Drilling fluids must be selected and managed to ensure all manufactured products used during well procedures on CSG wells are in accordance with the manufacturer's recommendations and relevant SDS.
- The name, type and quantity of each chemical used on each well throughout the life of the well must be recorded.

Good industry practice for CSG drilling includes:

- Drilling fluid should be a carefully monitored and controlled mixture designed to:
  - Achieve best drilling results and ensure efficient removal of formation cuttings.
  - Control formation pressures.
  - Minimise damage to formations.
- Petroleum tenure holders should ensure that the drilling fluid selected is appropriate for the well design to manage any locally experienced drilling problems and the geological conditions likely to be encountered.
- The use of biodegradable substances in the drilling fluid is preferred.

- The source of water for all well procedures (drilling, completion, workover and abandonment) should be recorded for future well monitoring purposes.
- Products should be chosen, stored, and used at concentrations that minimise the risk of causing environmental harm.
- Personnel, including contractors, should be aware of the environmental impact and emergency spill procedures for the products and substances in use on site.
- Petroleum tenure holders should use established, effective drilling practices to achieve a stable, uniform and, as far as possible, in-gauge hole.

Drilling fluids will be disposed of in accordance with EA conditions outlined in Schedule B (waste). Additionally, hydraulic fracture stimulation will not be undertaken as part of the Project.Further details on the management practices associated with chemical and fuel storage are provided in Section 10.6.2.

10.2 CSG Water Production

10.2.1 CSG Production Well Monitoring

As per the requirements outlined in the *Petroleum and Gas (Production and Safety) Act 2004* (State of Queensland 2020b), the volume of CSG water produced will be monitored and recorded and provided to the relevant authority as required.

10.2.2 Groundwater Monitoring

Groundwater monitoring will serve as a key mechanism for the early identification of the changes in groundwater levels as a result of CSG water production, within the WCM and other formations where groundwater receptors exist.

The groundwater monitoring requirements for CSG tenure holders within the Surat CMA are provided as part of the UWIR WMS (OGIA 2021g), which establishes baseline trends, identifies any changes within or near CSG development areas or locations of interest and informs future improvement of groundwater modelling. Due to the relatively small scale of the Project, and location in relation to existing tenure holders, and monitoring infrastructure (required by the UWIR WMS), Senex are not currently required by OGIA to install any groundwater monitoring facilities within the Project. Senex will comply with any updates to the WMS that may be required in any future updates of the UWIR. The location of existing monitoring within the vicinity of the Project is shown in Figure 7.11.

Senex is currently obligated to maintain and monitor two WMS monitoring points (a Springbok Sandstone and a multi zone WCM), located within the adjacent PL209 (Table 10.1).

Table 10.1 Groundwater Monitoring on Senex Tenements

RN	Owner	Source Aquifer	Location	Monitoring Status
160631	RDMW/Senex	Upper Springbok	PL 209	Senex WMS obligation (formerly APLNG monitoring)
160764	RDMW/Senex	Upper Juandah Coal Measures Lower Juandah Coal Measures Taroom Coal Measures	PL 209	Senex WMS obligation (formerly APLNG monitoring)

Note: RDMW – Department of Regional Development, Manufacturing and Water

10.2.3 Groundwater Bore Baseline Assessments

Senex were required by DES to undertake baseline assessments for two bores within the ATP 2059 (Section 7.11.2). To date baseline assessments have been completed for both bores, with neither bore identified as operational.

Senex will comply with any updates to the bores required for baseline assessment as part of the WMS that may be required in any future updates of the UWIR. Any future baseline assessments will be conducted in accordance with the DES 'Baseline Assessment Guideline' (DES 2022a).

10.2.4 Surface Water Monitoring

There are no planned discharges to surface water from the proposed Project infrastructure (e.g., water storage facilities). Should this change, monitoring will be undertaken prior to installation of infrastructure to confirm baseline conditions of the surface water system and to confirm potential impacts associated with discharge from the Project infrastructure.

Any releases from the various facilities during operation will be unplanned or a result of extreme climatic conditions. Details of the event-based monitoring program associated with beneficial use releases from the Project infrastructure is provided in Section 10.4.3.

Further discussion of mitigation and management associated with surface water systems is provided in Section 10.6.

10.3 Bore Impact Management Measures

The *Water Act 2000* outlines requirements for make good obligations of a resource tenure holder for a bore located in immediately affected areas. Tenure holders must carry out a bore assessment and enter into a make good agreement with the bore owner if the bores are located within an immediately affected area. The UWIR assigns bores to tenure holders located within immediately affected areas. There is currently one bore assigned to Senex within an immediately affected area in PL 445 (formerly assigned to Origin APLNG; RN 58910 in the Upper Juandah Coal Measures).

The results of the impact assessment to bores indicate that there would be five additional bores that may potentially experience water level decline greater than 5 m as a result of the cumulative scenario (i.e., the contribution of the Project development results in five additional bores being triggered in the cumulative scenario). Two of these bores are attributed to the Upper Springbok Sandstone and three are attributed to the Upper Juandah Coal Measures. These bores are not located on Senex tenements and of the five, only one appears to be existing and in a 'usable' condition.

Senex will comply with any updates to the make good agreements required in future updates of the UWIR and undertake bore assessments as required as a result of make good obligations. Any required bore assessments will be undertaken in accordance with the DES 'Bore Assessment Guideline' (DES 2022b).

Senex has developed their CSG Water Management Strategy, outlined in the CSG Water Management Plan (ATP 2059: SENEX-ATLS-EN-PLN-013; PL 445 and PL 209: SENEX-ATLS-EN-PLN-014) , and described in the following section, to maximise beneficial use of CSG water. To minimise impacts to landowner bores, Senex proposes to establish Landowner Water Supply Agreements (WSAs).

10.4 CSG Water Management

CSG water management will be undertaken in accordance with the Senex CSG Water Management Plan (SENEX-ATLS-EN-PLN-006), which has been developed to meet the requirements of the CSG Water Management Policy (State of Queensland 2012).

10.4.1 CSG Water and Treated CSG Water Quality Monitoring

Untreated CSG water quality will be monitored on a quarterly frequency or based on licensing requirements for the intended use (e.g., stock watering or irrigation). The water quality data from **untreated** CSG water will be used to:

- Inform the water treatment facility design and operation; and
- Monitor the water quality for suitability for the designated beneficial use and in accordance with water quality objectives in the *End of Waste Code Associated Water (including coal seam gas water)* (DES 2019a), and the *End of Waste Code Irrigation of Associated Water (including coal seam gas water)* (DES 2019b), and conditions provided in the 'Streamlined Model Conditions for Petroleum Activities' (DES 2016b) that are aligned with the beneficial reuse of produced water.

Water quality data from **treated** CSG water will be monitored regularly and used to:

- Confirm that the water quality is suitable for the designated use or water supply arrangement and in accordance with water quality objectives in the End of Waste (EOW) codes (as noted above); and
- Confirm the water treatment facility is effectively treating the CSG water.

10.4.2 Water Storage Pond Monitoring

CSG produced water and brine will be stored in existing storage facilities on PL 1037. These facilities have the potential to impact the shallow groundwater quality should over-topping or a breach of the facility liner occur. CSG water storage ponds will be constructed in accordance with the *'Manual for Assessing Consequence Categories and Hydraulic Performance of Structures'* (DES 2016a) and relevant EA conditions. Water storage facilities will be monitored to ensure the operating water levels are maintained within the specifications of the dam design.

Senex have established a seepage monitoring program for the CSG water storage pond on PL 1037, in which ten shallow seepage monitoring bores monitor the underlying Westbourne Formation (see Section 7.7.2). and one private landholder bore as required by the EA requirements for PL 1037. This is in compliance with Senexs' existing obligations to the State.

Should additional water storage ponds be constructed, Senex may consider installing additional monitoring bores, or utilise existing water bores within the Project area. Where new monitoring bores are required, they will be drilled and installed in accordance with the Minimum Construction Requirements for Water Bores in Australia (NUDLC 2020) and monitored in accordance with relevant Queensland regulations.

Any monitoring program will be designed and implemented to monitor for pond seepage in accordance with the relevant EA conditions, and the requirements outlined in the *'Streamlined Model Conditions for Petroleum Activities'* (DES 2016b). Shallow groundwater monitoring will also be conducted in conjunction with monitoring of the water quality within the water storage pond. The monitoring program will be designed to:

- Be undertaken by a suitably qualified person, and in accordance with 'Groundwater Sampling and Analysis – A Field Guide' (Sundaram et al. 2009);
- Be undertaken on a quarterly basis;
- Submit all water quality samples for analysis at a laboratory with NATA accreditation;
- Identify water quality associated with the water stored within the dam;
- Identify the background groundwater quality in the vicinity of the dam as a reference site;
- Provide information to develop trigger levels and detection limits associated with dam seepage; and
- Be documented and updated should new containment facilities be constructed.

10.4.3 Beneficial Use Activities

To minimise impacts to shallow groundwater quality, as a result of beneficial use activities such as irrigation, water quality will be monitored to confirm compliance with water quality objectives in the *End of Waste Code Associated Water (including coal seam gas water)* (DES 2019a), and the *End of Waste Code Irrigation of Associated Water (including coal seam gas water)* (DES 2019b), and conditions provided in the 'Streamlined Model Conditions for Petroleum Activities' (DES 2016b) that are aligned with the general beneficial use approval.

10.5 Infrastructure Location Planning

To avoid, minimise and manage potential impacts to GDEs and watercourses across the Project area, and to support well field layout for all surface infrastructure, including wells and gathering pipelines, Senex will implement a 'Environmental Protocol for Field Development and Constraints Analysis' (SENEX-QLDS-EN-PRC-019) (the Constraints Protocol). The Constraints Protocol aims to ensure that infrastructure siting:

- Considers biodiversity values and environmental constraints, such as sensitive receptors, when selecting preferential locations; and aligning with planning principles to avoid, minimise, mitigate and then manage potential environmental impacts; and
- Identifies any additional external environmental approvals required and that those are secured prior to the commencement of construction activities.

With respect to environmental values, the protocol addresses avoiding or minimising and managing potential impacts to:

- Biodiversity values contributing to ESAs, MNES and MSES;
- Habitat for wildlife, including threatened MSES and MNES threatened communities, flora and fauna; and
- Wetlands, watercourses, springs and GDEs.

The Constraints Protocol also recognises that, in addition to environmental constraints, landholder, engineering and cultural heritage constraints must be considered during infrastructure siting.

The process involves a desktop constraints analysis, site surveys, post-survey environmental constraints analysis and preparing a report that includes a list of site-specific environmental conditions and associated constraints maps. These are included in the final Access to Work (ATW) documentation, issued upon sign-off by the Project Manager to relevant staff and contractors prior to commencing construction.

The final location of production wells will also be determined in consultation with relevant landholders to ensure that the location does not disrupt land use.

10.6 Environmental Management Practices

Senex have developed a Project Atlas Environmental Management Plan (SENEX-ATLS-EN-PLN-001) that describes how Senex will manage potential environmental impacts associated with conducting gas production activities and to ensure compliance with EA conditions, industry guidelines and regulatory requirements. The relevant environmental controls relating to minimising the impact to groundwater and surface water are described below.

10.6.1 Watercourses and Riparian Ecosystems

Watercourses and riparian ecosystems, depending on their location, may be intersected by Right-of-way's (RoWs) for the gathering system, where they cannot be avoided. Impacts to these features have been considered as part of the Project impact assessment. Potential impacts that may result from these crossings during construction and operation include generation of suspended sediment in the watercourse, altered geomorphic watercourse characteristics (e.g. changes to bed and bank profile), changes to riparian buffers (vegetation clearing), construction in bed and/or banks of waterways, and habitat fragmentation. A number of mitigation and management measures are planned to limit the impact to waterways and riparian ecosystems. These include:

- **Site Selection** – During field planning for site selection, watercourse crossings are avoided where possible because of environmental impacts (including impacts such as fragmentation and disruption of flows), and their associated additional construction requirements, including erosion and sediment control and monitoring. Where possible, existing watercourse crossings will be utilised to minimise land disturbance and impacts to riparian vegetation and associated habitat.
- **Construction Planning** – Overall, construction activities will not interfere or block natural drainage. Stormwater will be allowed to pass through the sites in a controlled manner and at non-erosive flow velocities. Watercourse crossing points will be adequately stabilised to prevent erosion and the RoW construction period when working in waterways will be minimised.
- **Erosion and Sediment Control** – works on site will not commence until any relevant Contractor erosion and sediment control procedures have been approved and installed as required. Erosion and sediment control structures will be inspected periodically and after rain events and maintenance carried out where required.

- **Rehabilitation** – The scale of the initial disturbance for construction is planned to be 18 m wide for RoWs. This width will be reduced during the operating phase to a nominal area that will be rehabilitated directly over the pipeline to maintain pipeline integrity, and a 6 m access track will be maintained to access wells and infrastructure. Within the life of the well field, RoWs through watercourses may be rehabilitated sooner than the gas field life, depending on their location and the well's operational life.

To minimise the impacts of water quality in surface watercourses and wetlands during construction and operation, the following measures will be implemented:

- Petroleum activities within any wetland area or watercourse must be carried out in accordance with an approved Authority To Work (ATW). Watercourse crossings will be limited to those strictly necessary for construction or operation of infrastructure and only at locations approved in the ATW.
- Any waterway barrier works (works that pose a barrier to water flow) must only be undertaken where authorised under an ATW and only at the location specified.
- Where required, watercourse crossing points will be adequately stabilised to prevent erosion.
- 'No-go' areas will be GPS located and clearly marked.
- Construction activities will be managed to minimise interference with overland flow paths.
- Clean stormwater will be diverted around disturbed land wherever practicable.
- For linear infrastructure – construction or maintenance activities in wetlands or a watercourse will be required to be carried out under the authorisation of an ATW and under the supervision of a Senex environment representative to ensure conditions of the EA are achieved.

In addition, the following monitoring and reporting will be undertaken:

- Watercourse crossings to be monitored for erosion and sedimentation during construction, regularly during dry conditions, and daily inspections during rainfall of >50 mm in one day or >100 mm over four days or as soon as watercourse access is re-established after flooding.
- During periods of flow, surface waters downstream of construction areas near a watercourse or wetland area will be monitored for water quality as per the Project Atlas Environmental Management Plan (SENEX-ATLAS-EN-PLN-001).
- Records of all erosion and sediment control and water quality checks will be maintained by Senex staff and provided to the Senex Environment Manager.
- Construction or maintenance works on linear infrastructure in wetlands or watercourses will be monitored by a Senex representative to ensure compliance with the EA conditions.

10.6.2 Chemical and Fuel Storage

To minimise the impacts of a chemical or fuel spill to surface or groundwater the following measures will be implemented:

- All fuel, oil and chemicals are to be stored, transported and handled in accordance appropriate standards including AS 3780:2008 – The storage and handling of corrosive substances, AS 1940:2004 – The storage and handling of flammable and combustible liquids, AS 3833:2007 – Storage and handling of mixed classes of dangerous goods in packaged and intermediate bulk containers.
- Storage areas will be sealed, bunded, and adequately ventilated.
- Storage and refuelling areas will be preferentially located away from watercourses, sensitive areas and any source of ignition as determined by the Senex Site Supervisor.
- Containment bunds and/or sumps will be drained periodically of accumulated rainwater to prevent overflow and subsequent pollution of the surrounding land and watercourses.

In addition, the following monitoring and reporting will be undertaken:

- All chemical, oil and fuel storage areas are to be inspected regularly for temporary storage, and for permanent storage areas during the operating phase by the Contractor Site Supervisor and/or the Senex Site Supervisor.
- All spills are to be contained immediately and managed through the Senex Spill Response procedure (see Project Atlas Environmental Management Plan).
- Emergency events will be managed in accordance with the contingency procedures in the Emergency Response Plan.
- Incident details will be recorded immediately and notified through the Senex Incident reporting systems, reported and investigated.

10.6.3 Soil and Erosion Management

Senex have developed an ‘Erosion and Sediment Control Procedure’ (SENEX-QLDS-EN-PRC-003; Senex 2018c), which outlines measures to ensure Senex meets its regulatory obligations relating to managing disturbed land that has potential to release soil directly or indirectly to land or water on, or adjacent to, Senex work sites. The procedure provides guidance to implement erosion and sediment controls during civil earthworks for activities in Queensland, where there is significantly disturbed land. The objective of the procedure is to set out methods to manage soil erosion and control sediment generated close to the source, thereby minimising the potential for onsite activities adversely impacting the surrounding environment.

To minimise soil erosion, mass movement and gully erosion, the following measures will be implemented:

- Ensure stormwater passes through the site in a controlled manner and at non-erosive flow velocities. Divert clean water from the work site where practical.
- Minimise the duration that disturbed soils are exposed to the erosive forces of wind rain and flowing water.
- Minimise work-related soil erosion and sediment runoff.
- Minimise negative impacts to land or properties adjacent to the activities (including roads).

- Inspect worksites periodically as required, before expected rainfall events, and after rain events and undertake maintenance where required as per the Erosion and Sediment Control Plan.

In addition, the following monitoring and reporting will be undertaken:

- Regular inspections to monitor for potential erosion and sedimentation during construction works will be undertaken. These inspections will occur regularly during dry conditions, and daily inspections during rainfall of >50 mm in one day or >100 mm over 4 days or as soon as site access is re-established.
- Watercourse crossings will be monitored for erosion and sedimentation during construction regularly during dry conditions, and during rainfall of >50 mm in one day or >100 mm over 4 days or as soon as watercourse access is re-established after flooding.
- Records of all erosion and sediment control and water quality monitoring will be maintained by the Senex staff.

10.6.4 Emergency and Incident Response: Spills

In the event of an environmental incident:

- Personnel who observe an environmental incident including a spill are required to immediately notify the Contractor Site Supervisor who will then notify the Senex Site Supervisor.
- In the event of a chemical, oil or fuel spill, the spill will be contained and cleaned up as outlined in the Senex Spill Response Plan.
- Contractors are required to have in place procedures for spill response which are in accordance with the Senex Spill Response Plan and will include details requirements for:
  - Minimising release;
  - Containing spilled material;
  - Raising the alarm and response;
  - Locations of spill kits; and
  - Management of contaminated material if necessary.
- Any spills will be assessed by the Senex Site Supervisor supported by the Senex Environment Manager as required to determine appropriate remediation options such as the removal of contaminated material.
- Incident reports are required to contain information required by the Safety Management Plan and Incident Reporting and Investigation Procedure.
- Emergency Response drills will be performed to ensure readiness and identify opportunities for improvement.

Senex requires that all incidents including spills are reported and fully investigated in accordance with their specific level of potential risk.

10.7 Reporting

Senex will undertake all reporting as per the requirements under the State legislation, including to OGIA as part of the UWIR requirements and in accordance with the Project's EA conditions.

11 CLOSING

We would like to thank you for the opportunity to work on this assignment. Should you have any questions, please do not hesitate to contact the undersigned.

KCB AUSTRALIA PTY LTD.

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APPENDIX I

OGIA Model Parameters

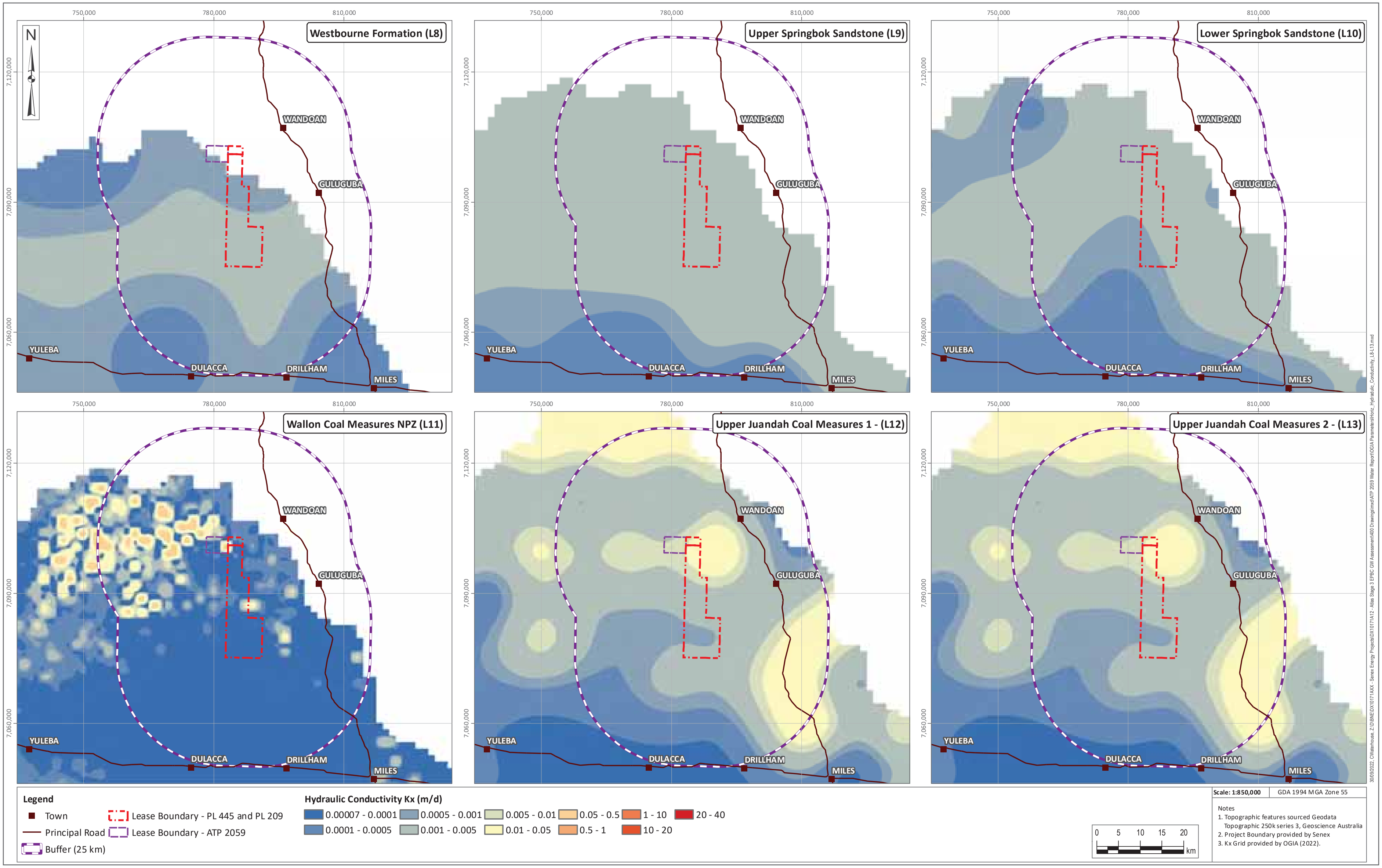

Figure I-1 Horizontal Hydraulic Conductivity (L8 – Westbourne Formation to L 13 – Upper Juandah Coal Measures – Layer 2)

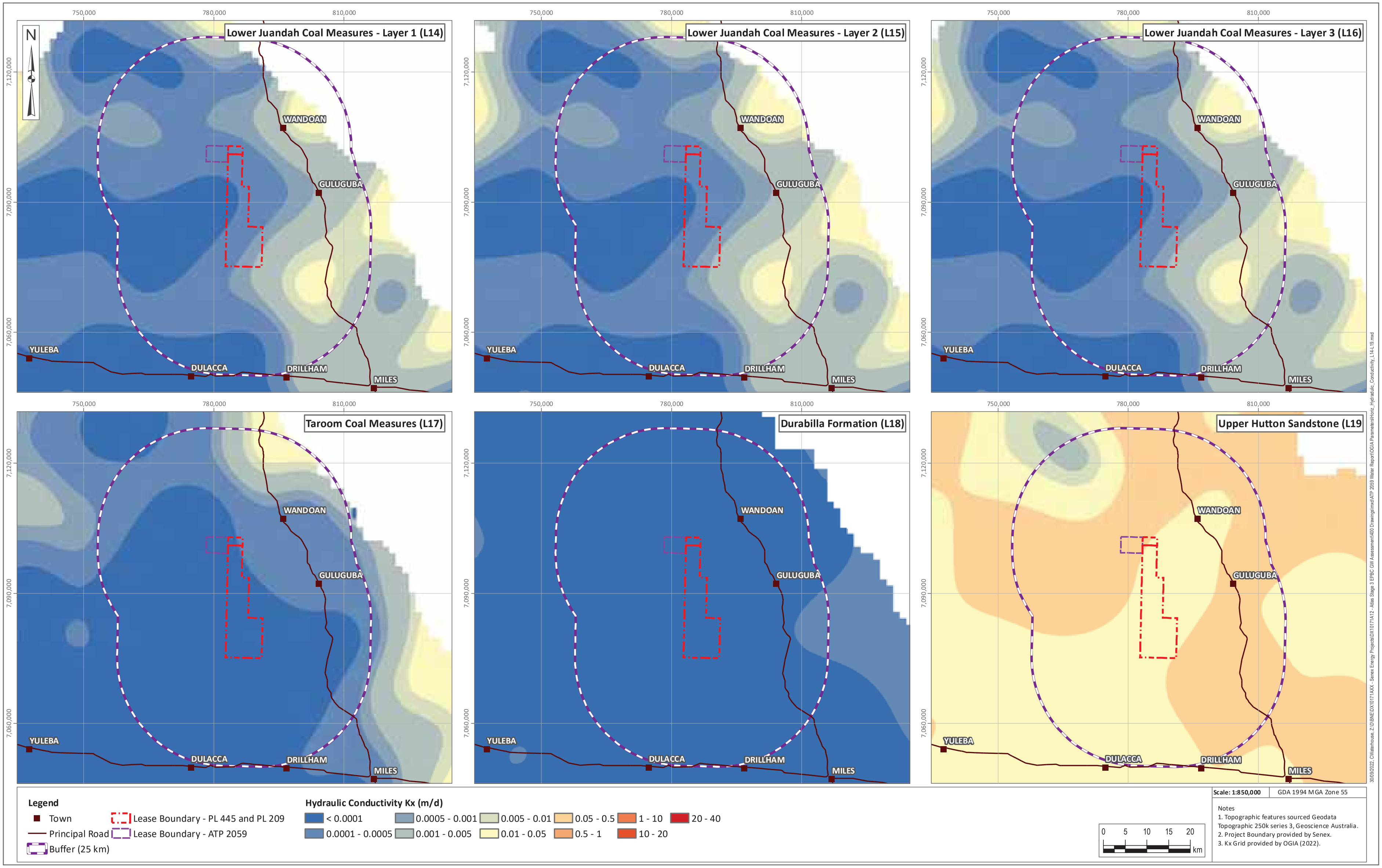

Figure I-2 Horizontal Hydraulic Conductivity (L14 Lower Juandah Coal Measures Layer 1 to L 19 Upper Hutton Sandstone)

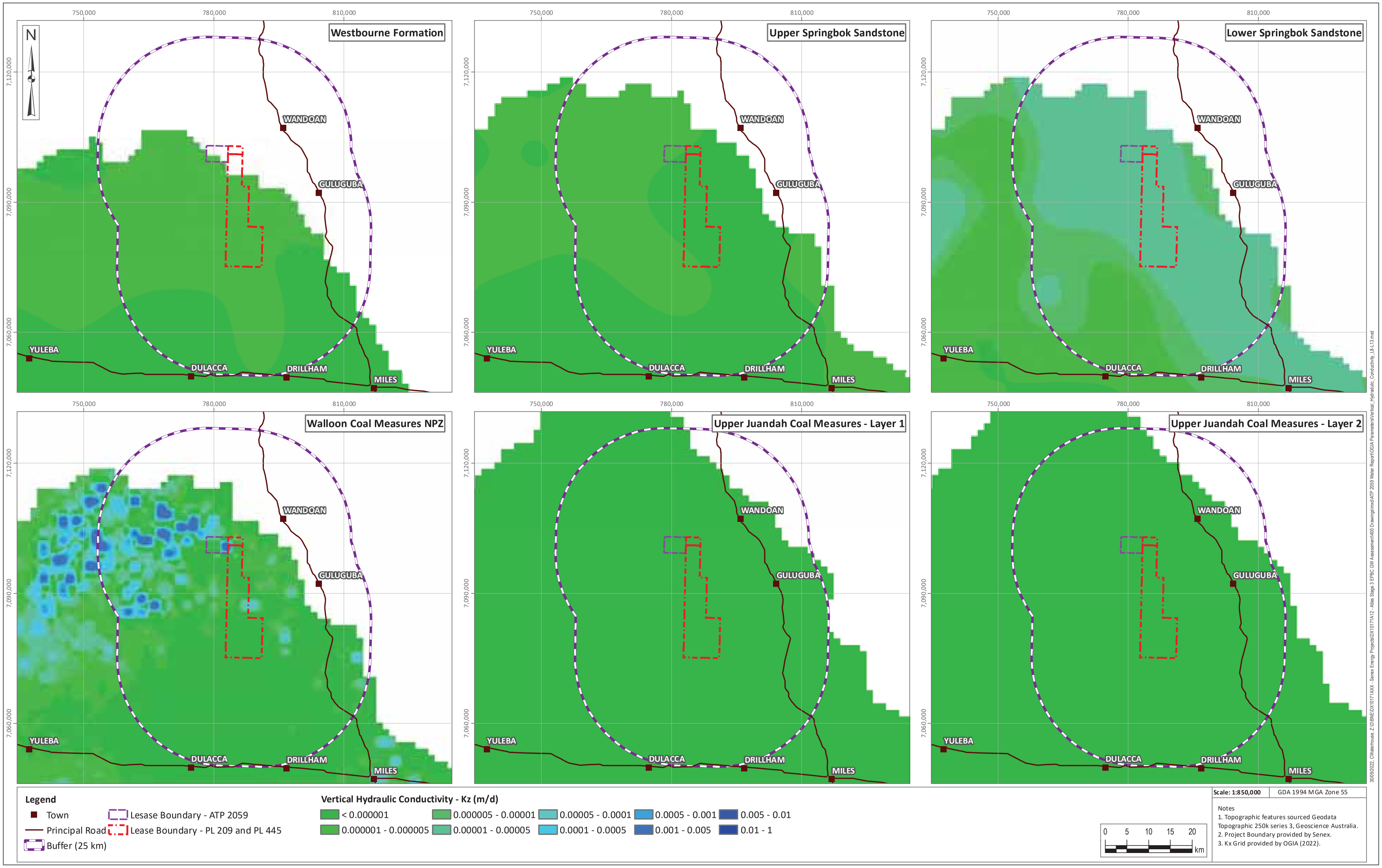

Figure I-3 Vertical Hydraulic Conductivity (L8 – Westbourne Formation to L 13 – Upper Juandah Coal Measures – Layer 2)

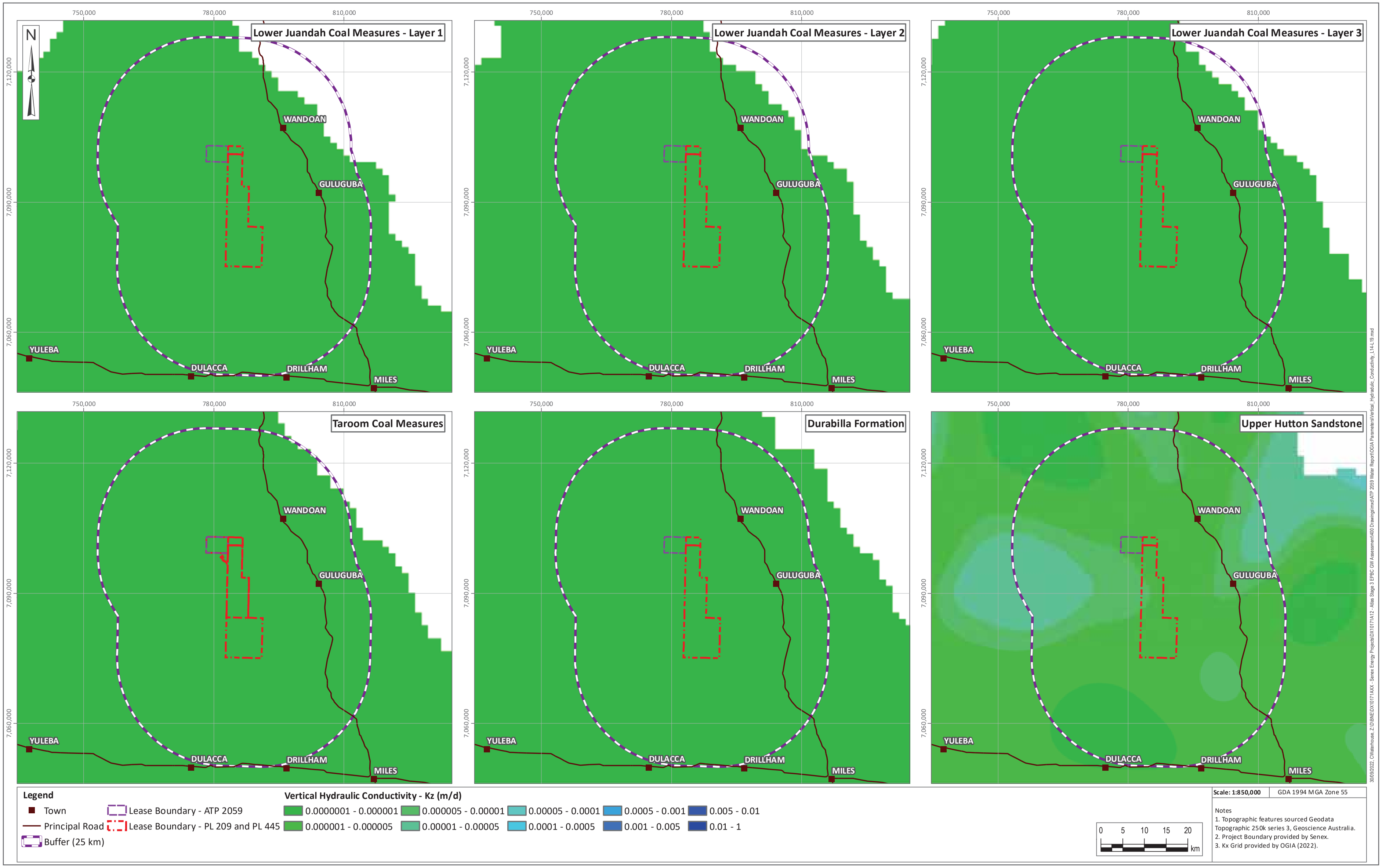

Figure I-4 Vertical Hydraulic Conductivity (L14 Lower Juandah Coal Measures Layer 1 to L 19 Upper Hutton Sandstone)

APPENDIX II

Predicted Drawdown Extent – Project Only

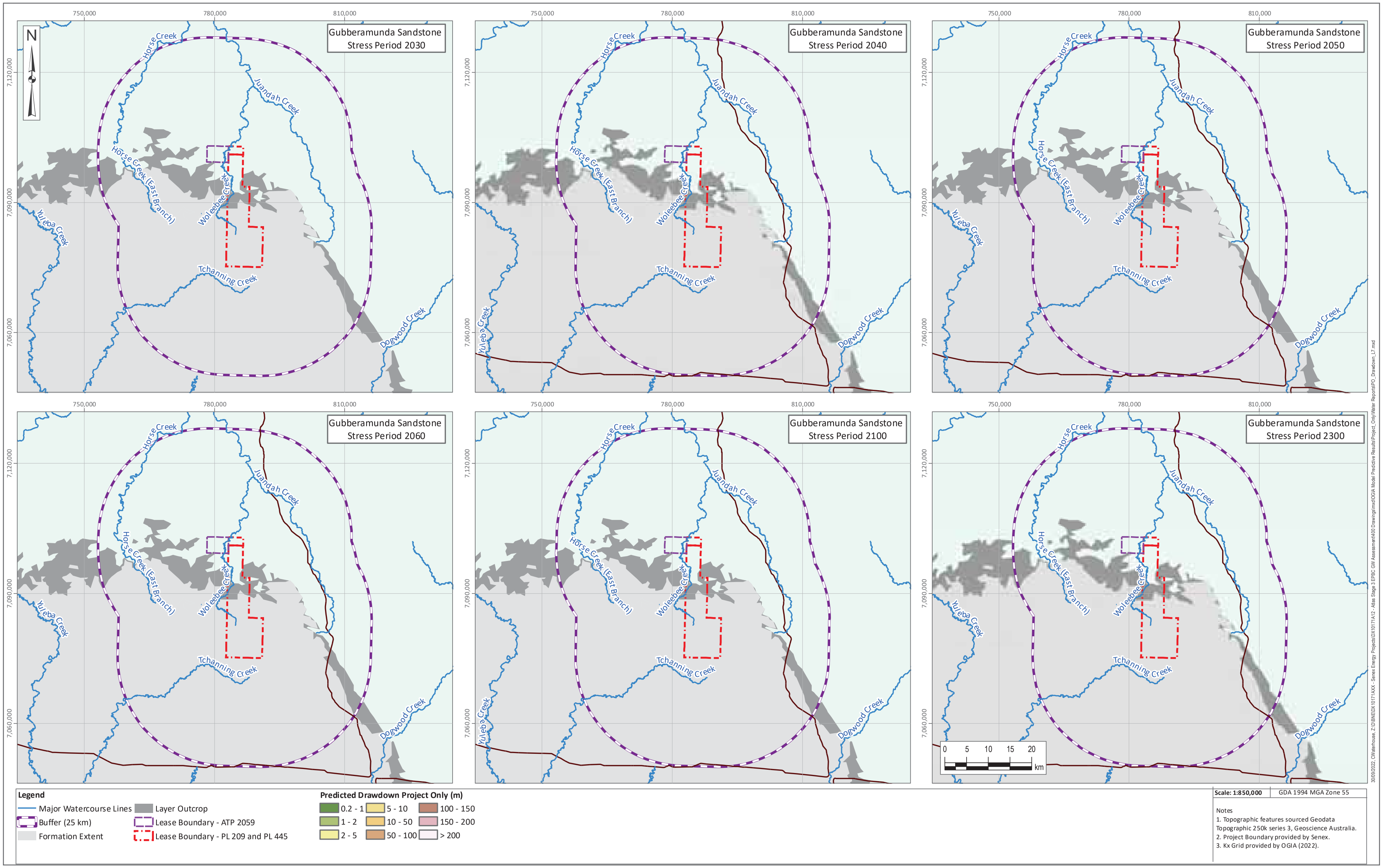

Figure II-1 Project Only Drawdown – Layer 7 – Gubberamunda Sandstone

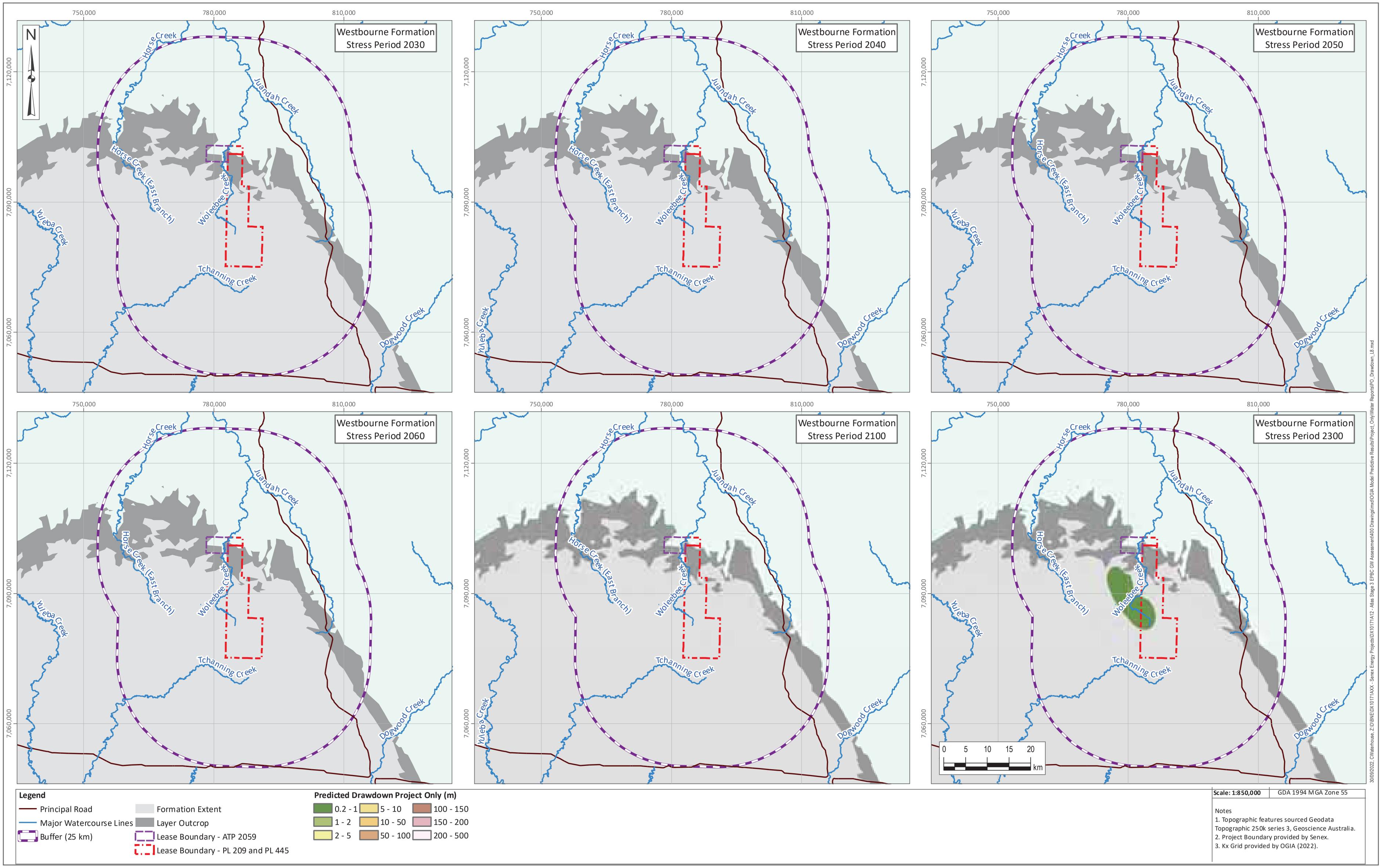

Figure II-2 Project Only Drawdown – Layer 8 – Westbourne Formation

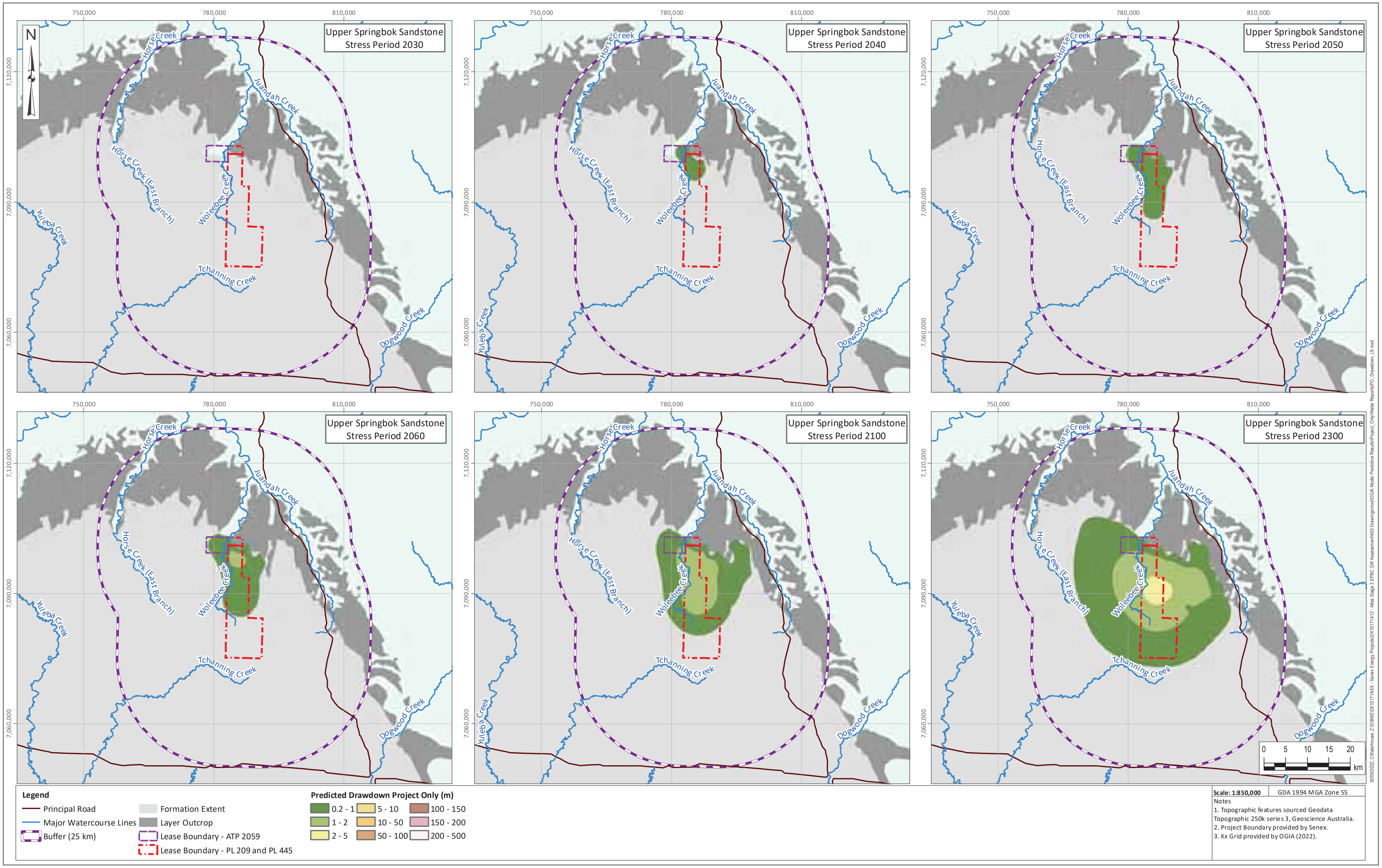

Figure II-3 Project Only Drawdown – Layer 9 – Upper Springbok Sandstone

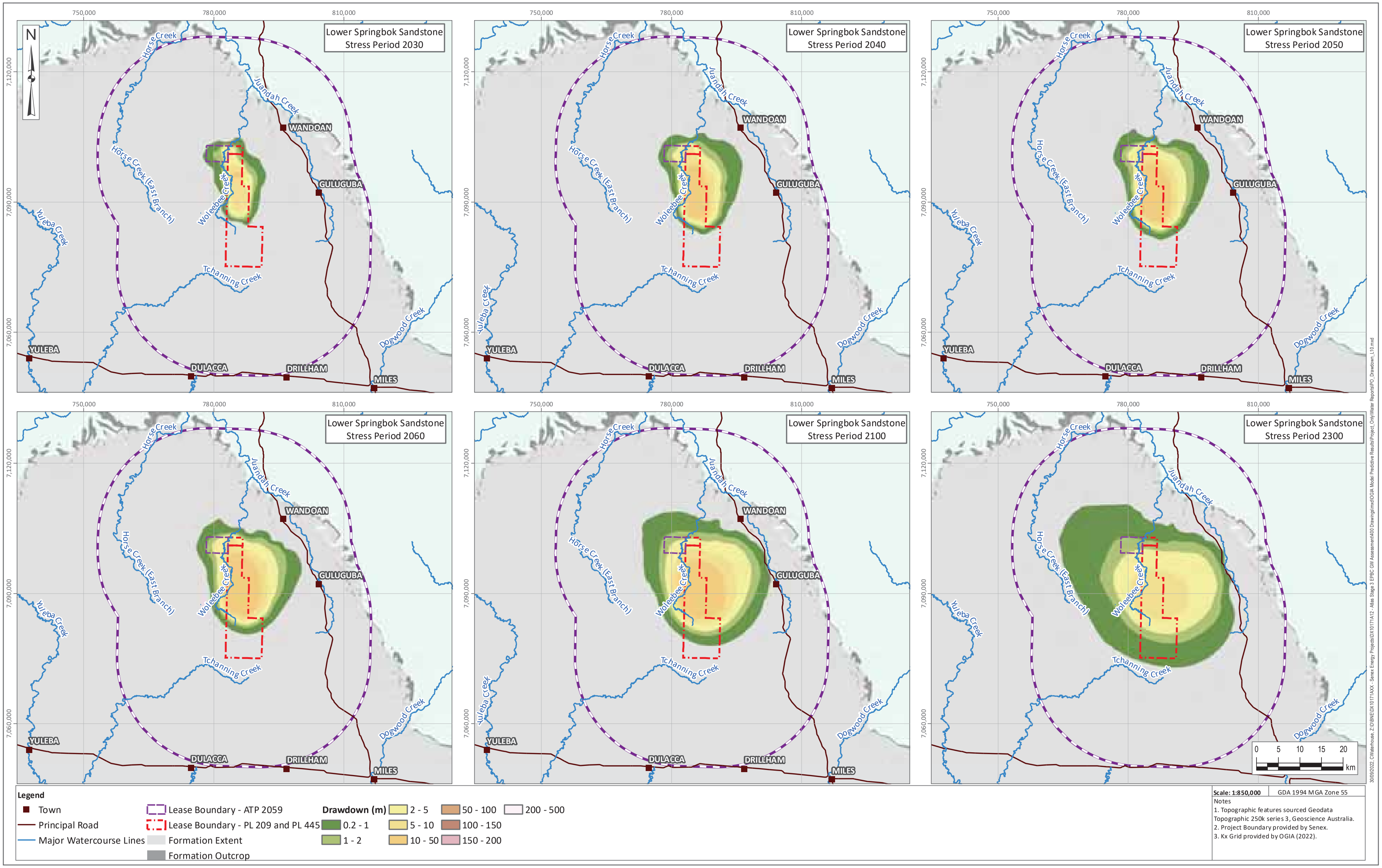

Figure II-4 Project Only Drawdown – Layer 10 – Lower Springbok Sandstone

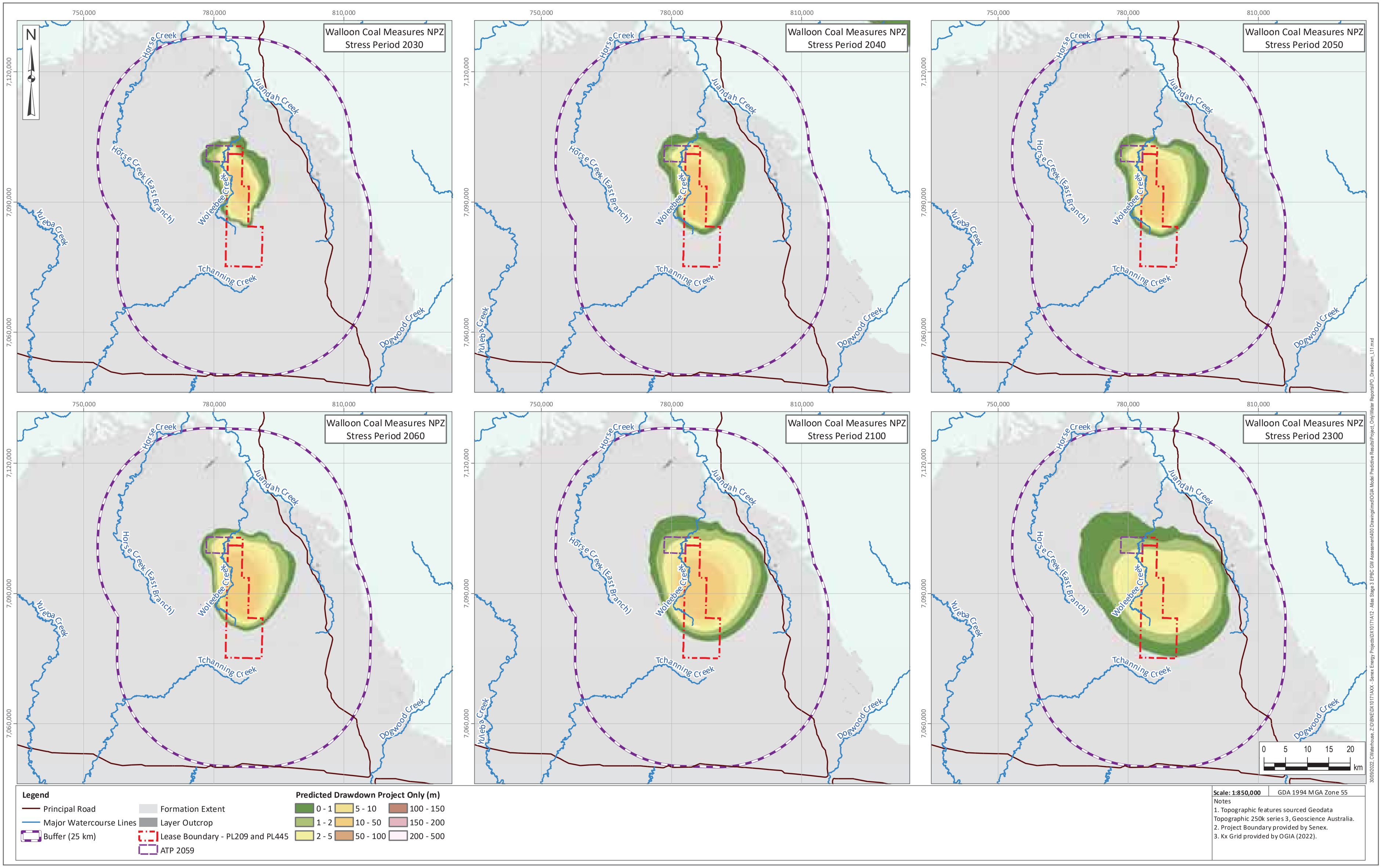

Figure II-5 Project Only Drawdown – Layer 11 – Walloon Coal Measures Non-Productive Zone

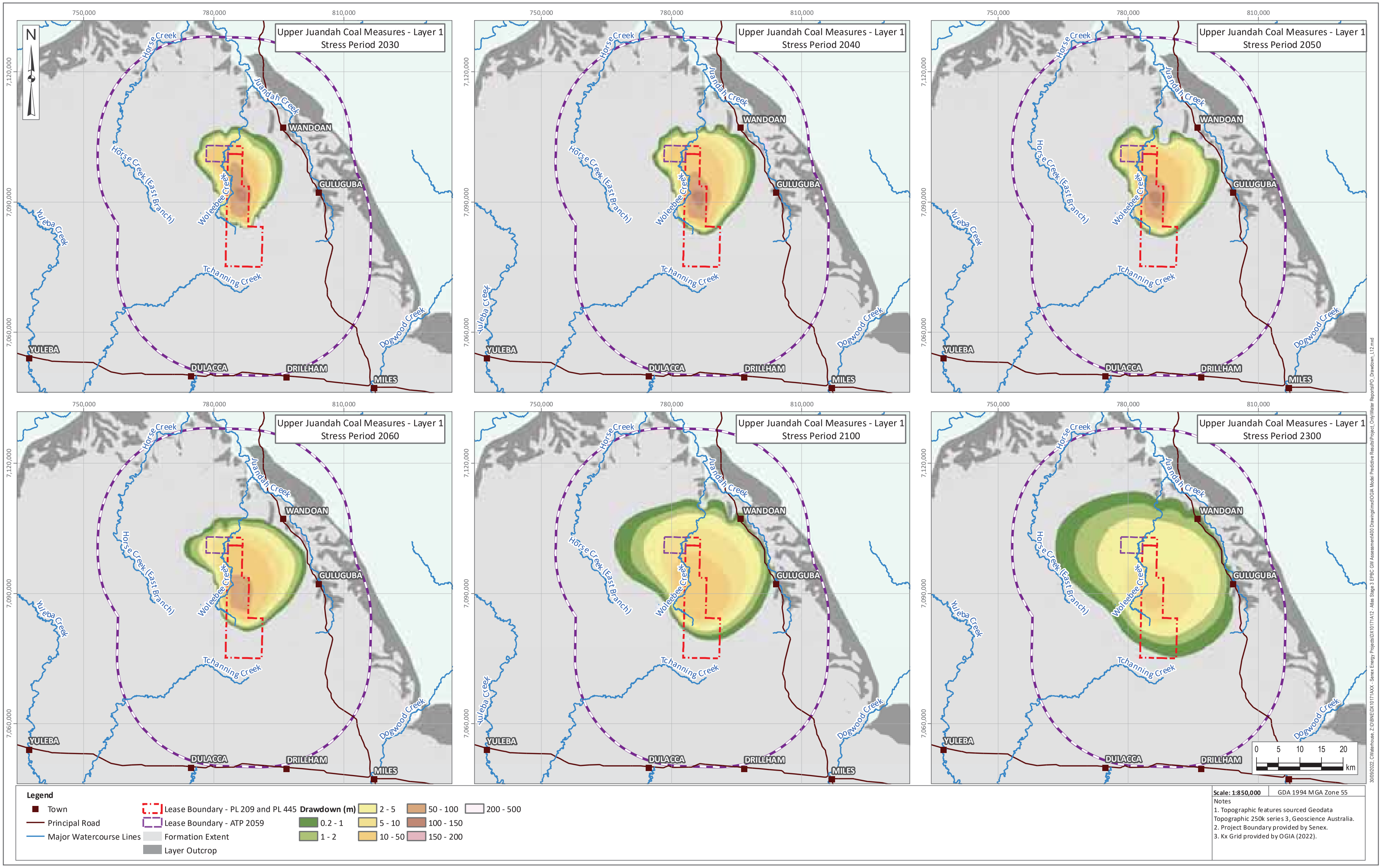

Figure II-6 Project Only Drawdown – Layer 12 – Upper Juandah Coal Measures Layer 1

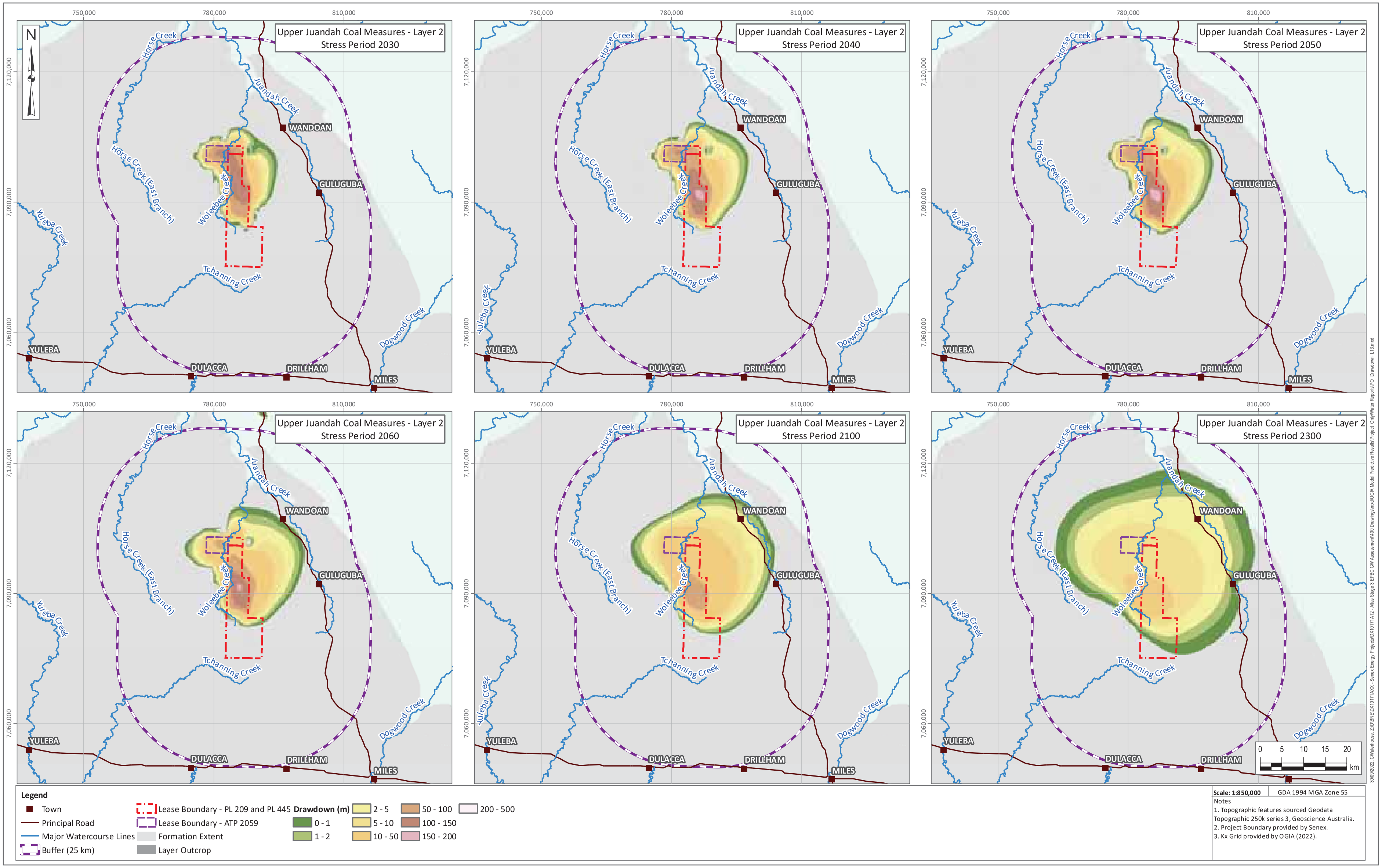

Figure II-7 Project Only Drawdown – Layer 13 – Upper Juandah Coal Measures Layer 2

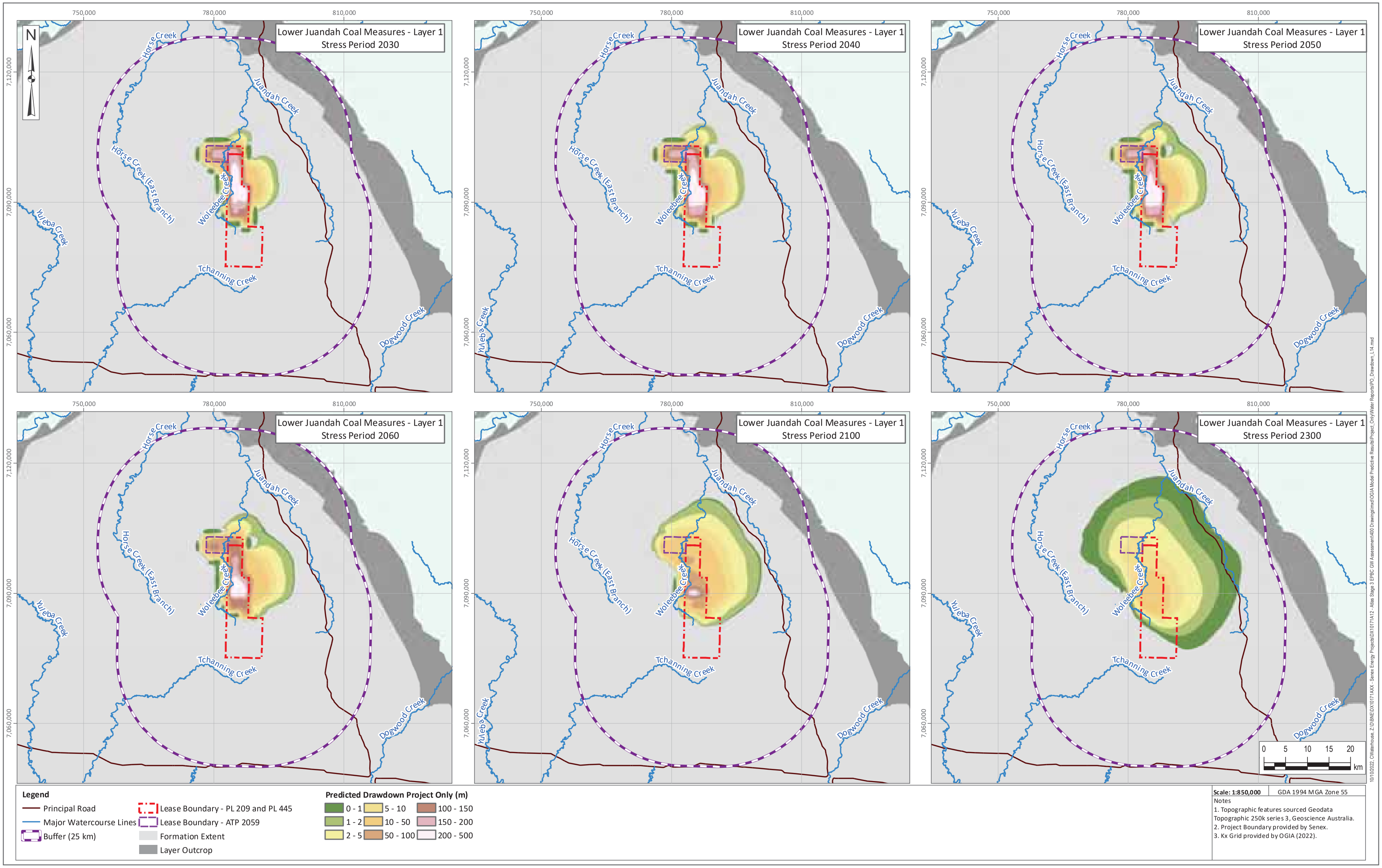

Figure II-8 Project Only Drawdown – Layer 14 – Lower Juandah Coal Layer 1

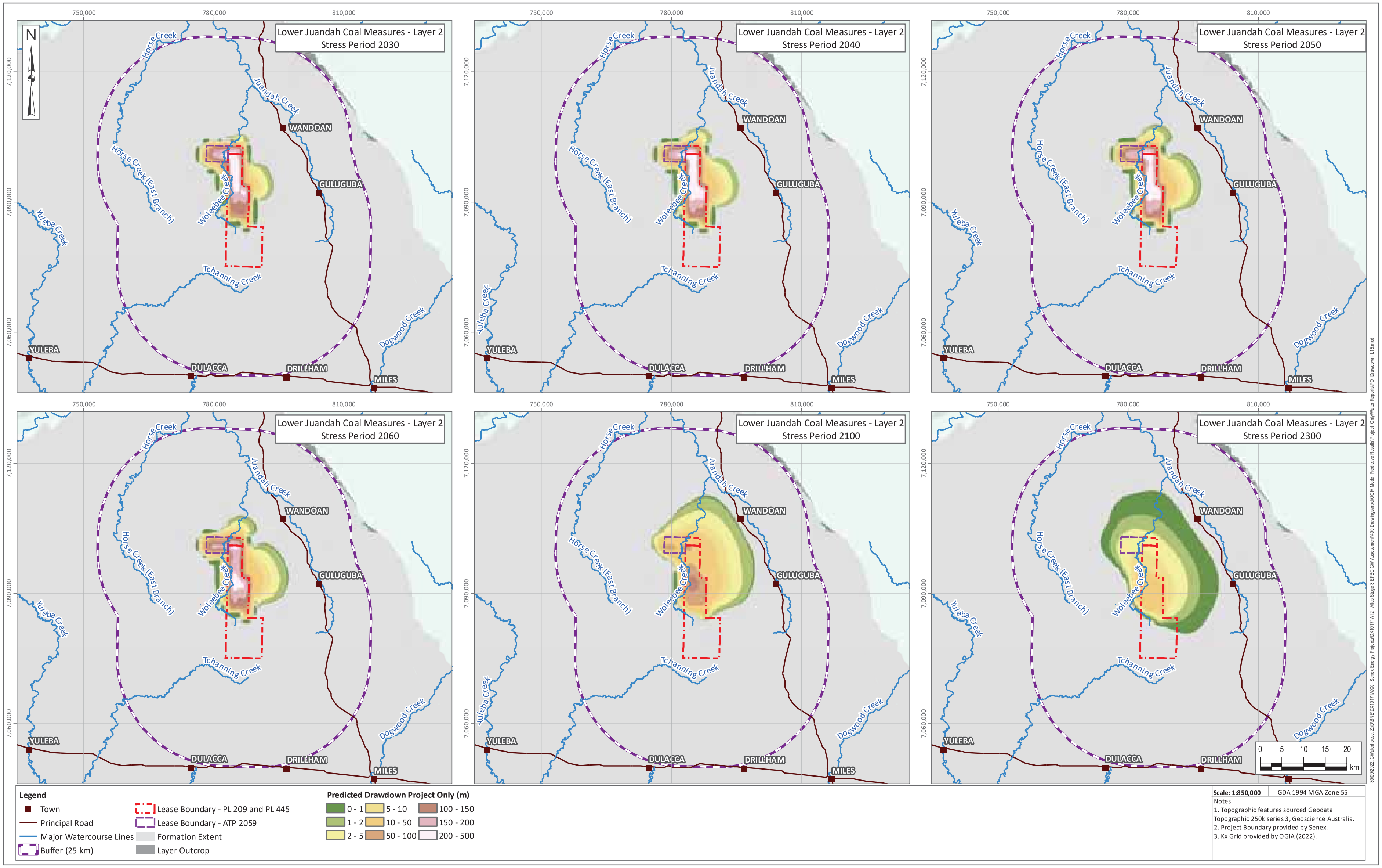

Figure II-9 Project Only Drawdown – Layer 15 – Lower Juandah Coal Layer 2

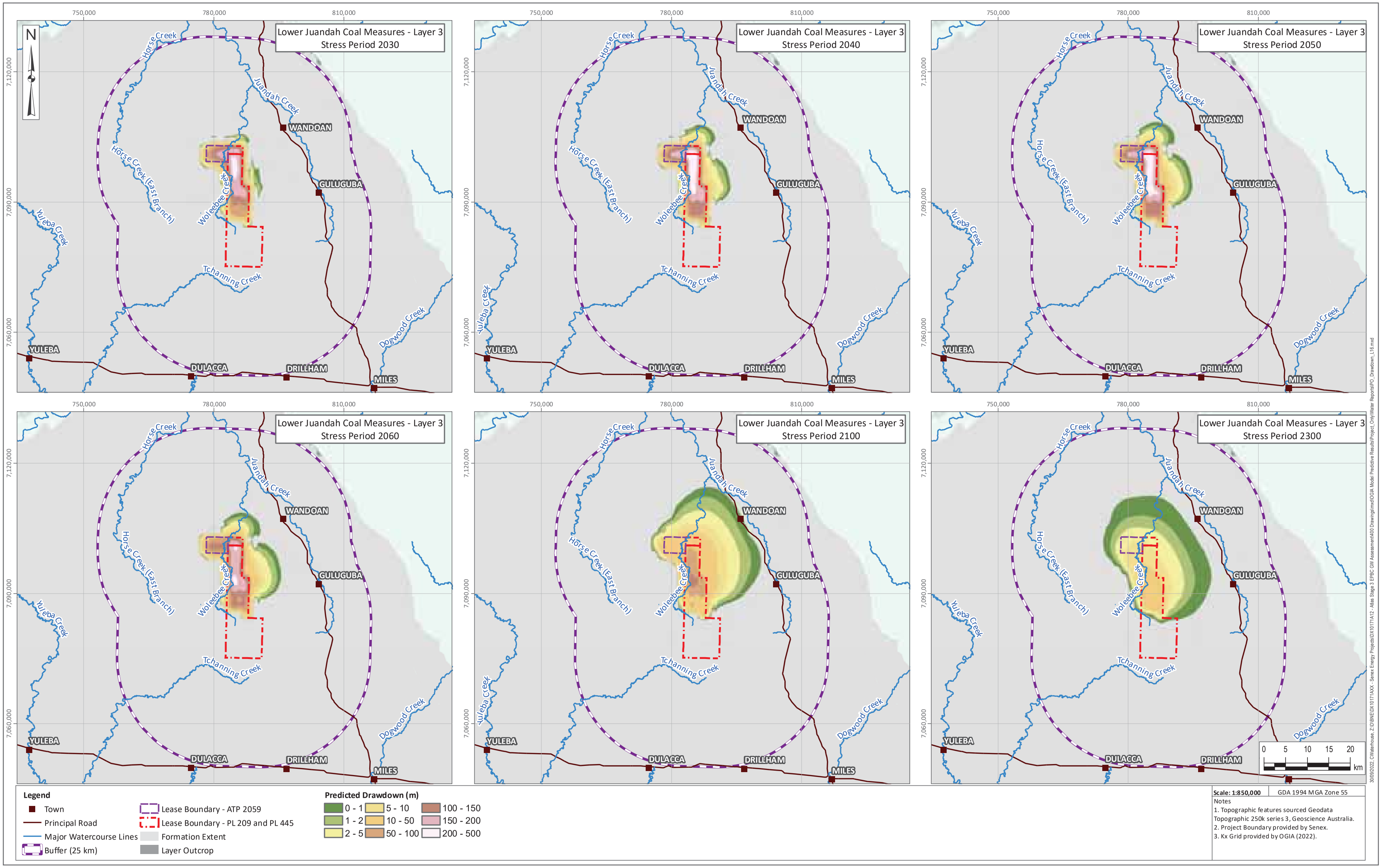

Figure II-10 Project Only Drawdown - Layer 16 – Lower Juandah Coal Layer 3

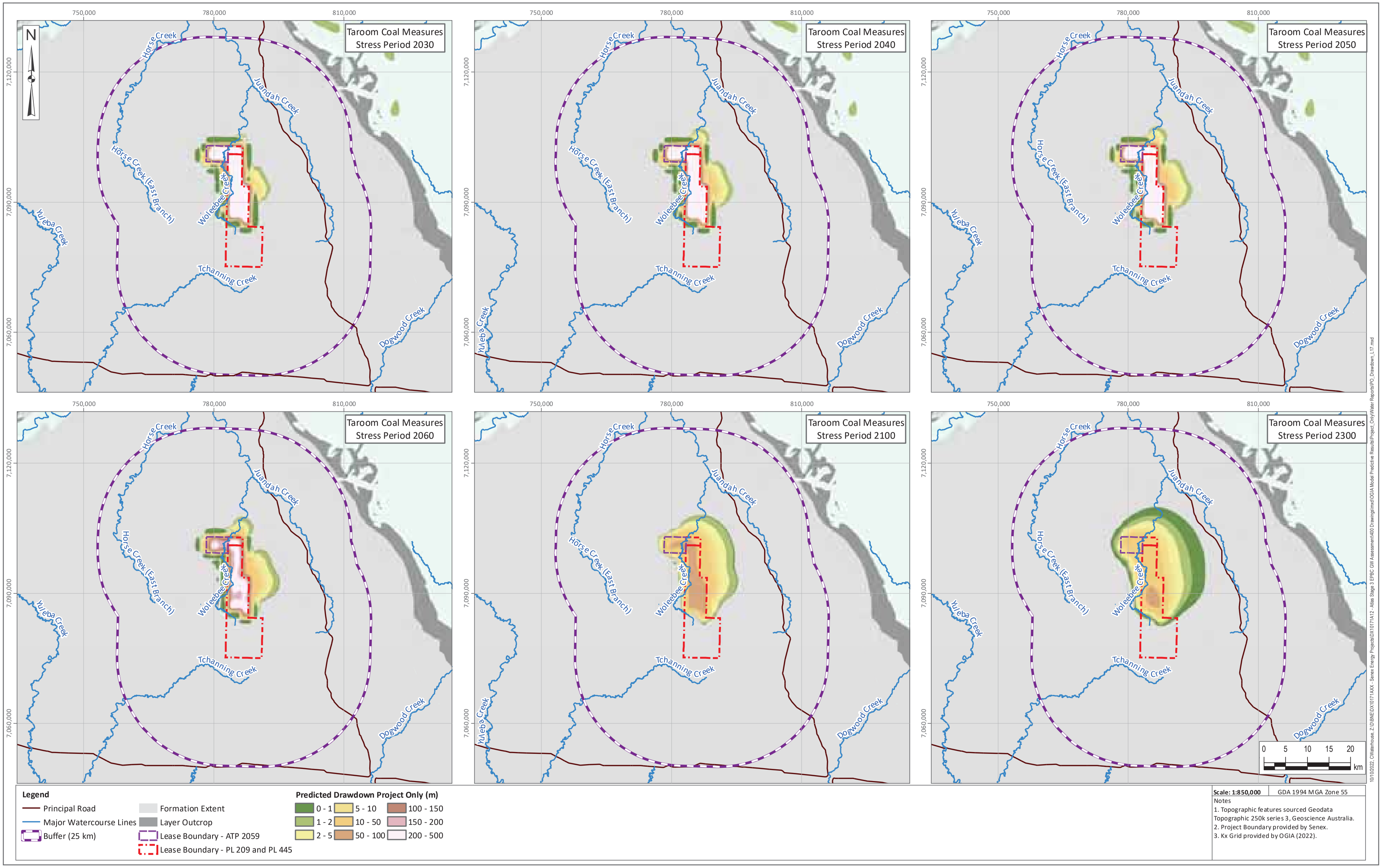

Figure II-11 Project Only Drawdown - Layer 17 – Taroom Coal Measures

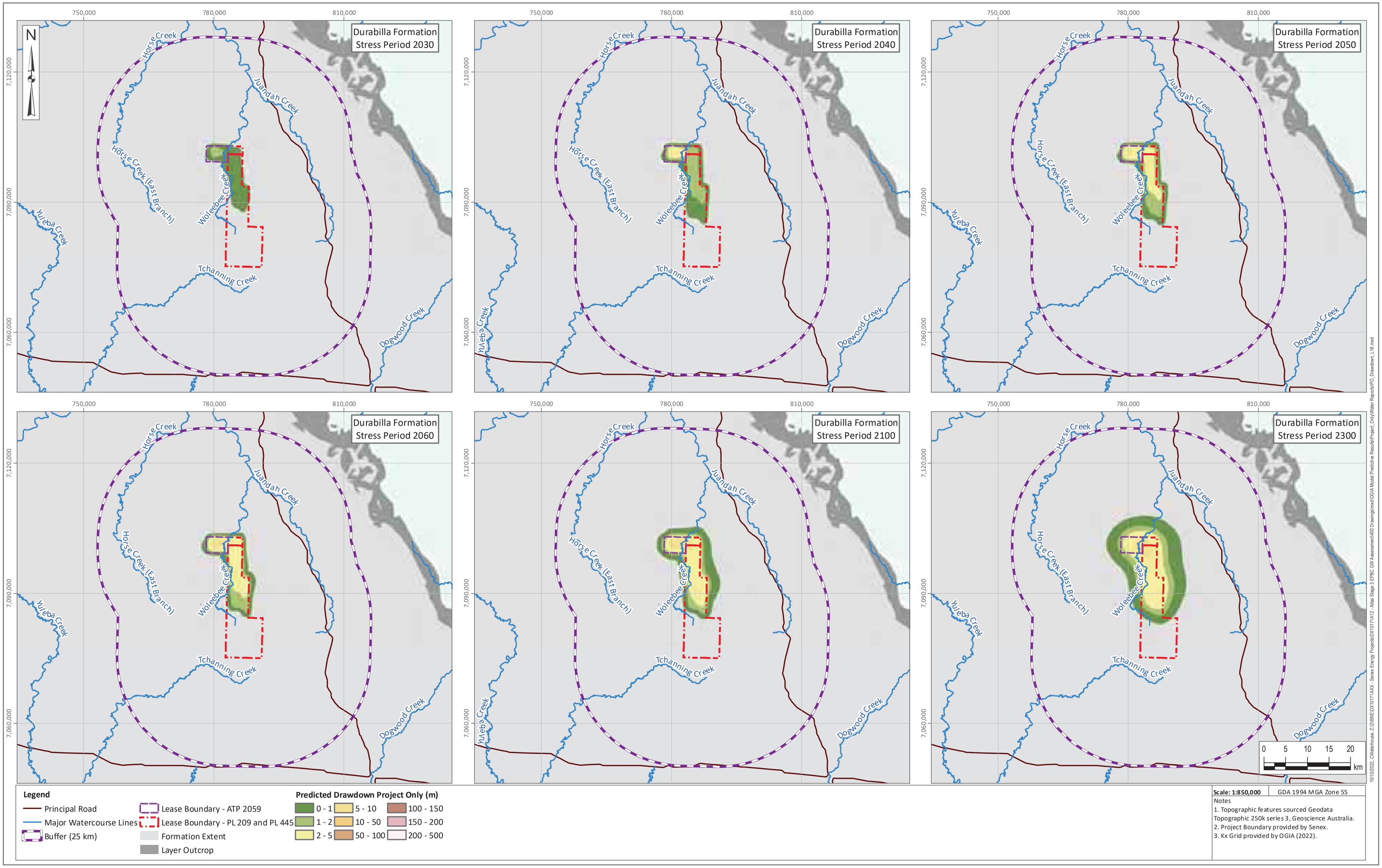

Figure II-12 Project Only Drawdown - Layer 18 – Durabilla Formation

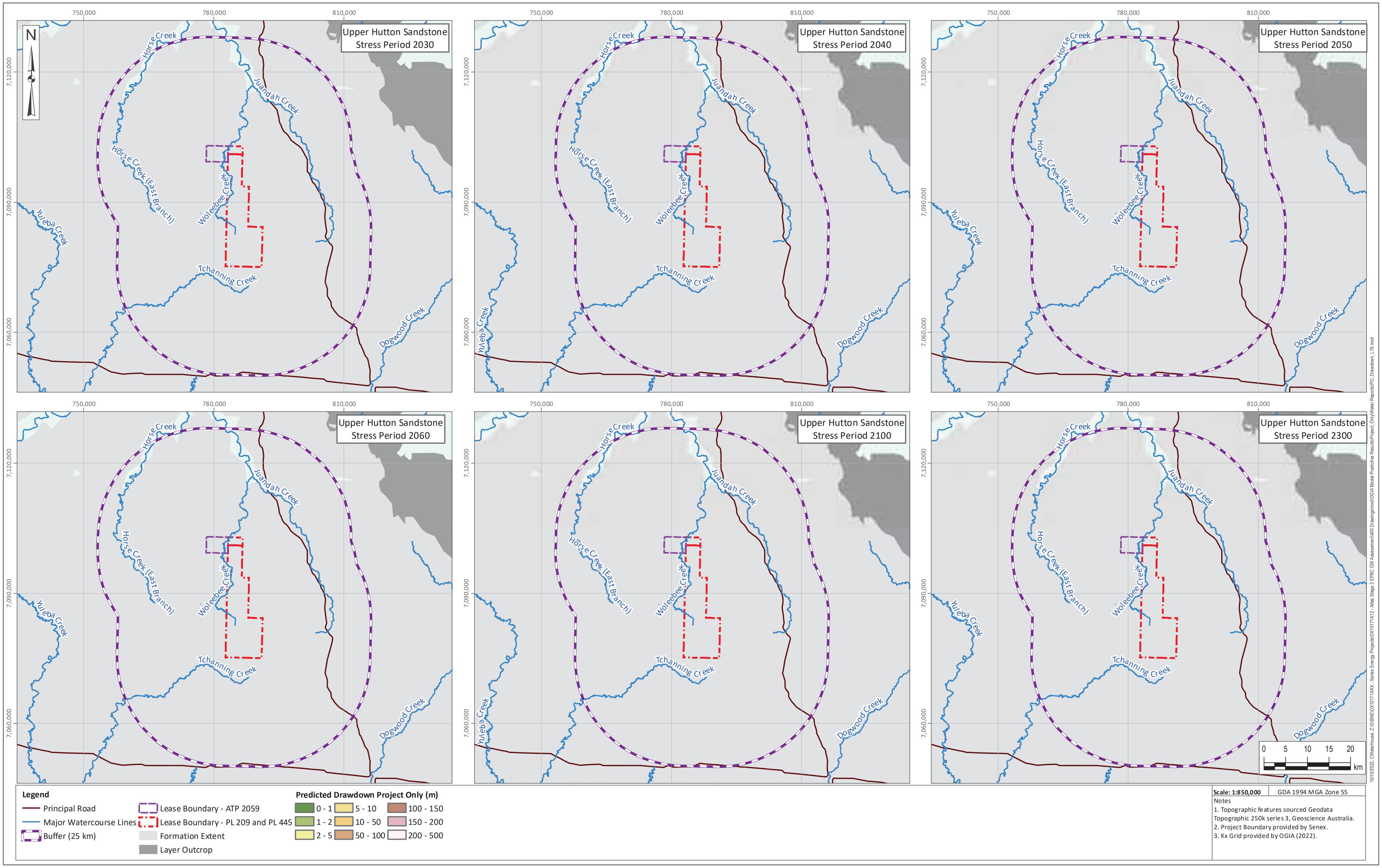

Figure II-13 Project Only Drawdown - Layer 19 – Upper Hutton Sandstone

APPENDIX III

Predicted Drawdown Extent - Cumulative

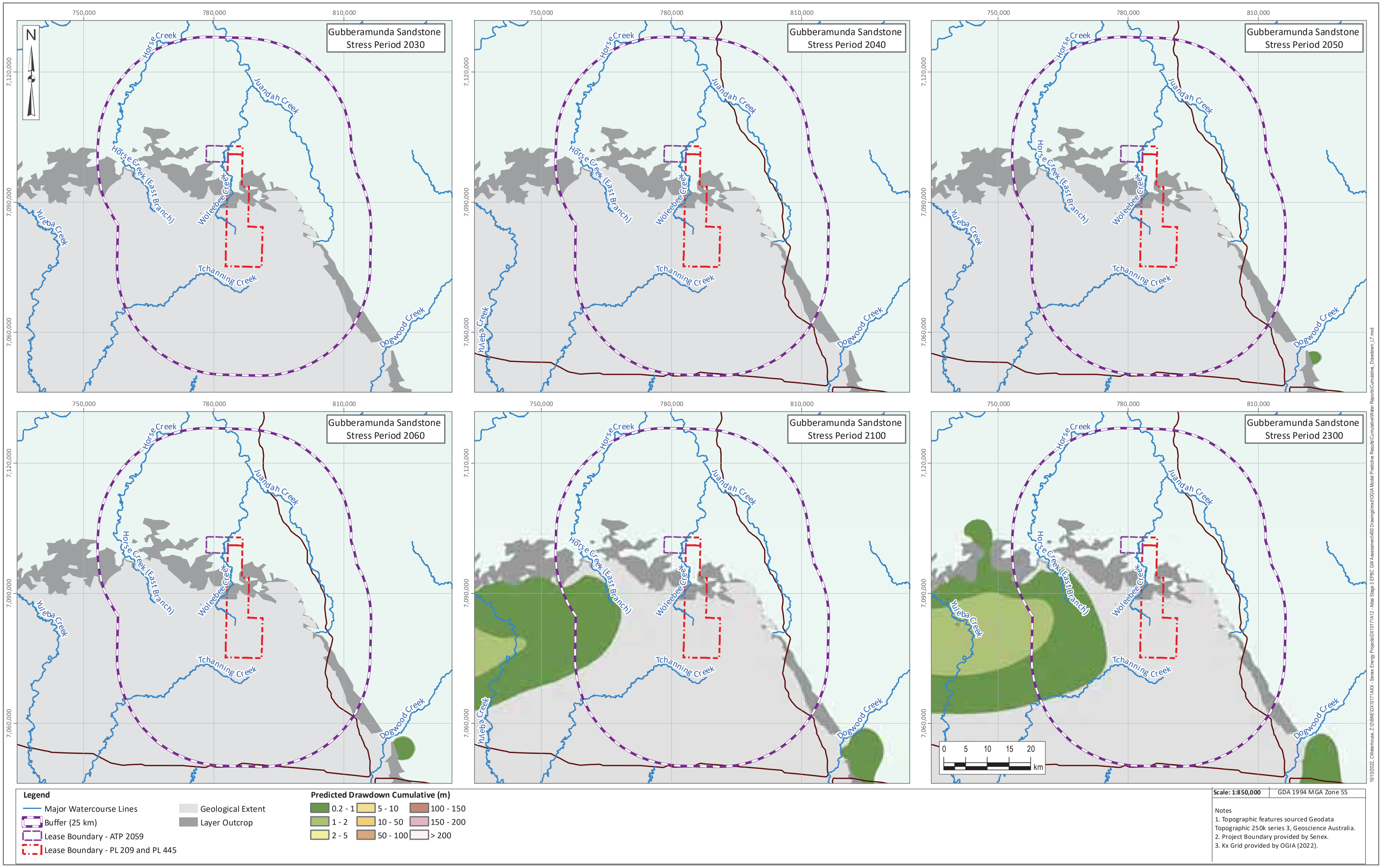

Figure III-1 Cumulative Drawdown – Layer 7 – Gubberamunda Sandstone

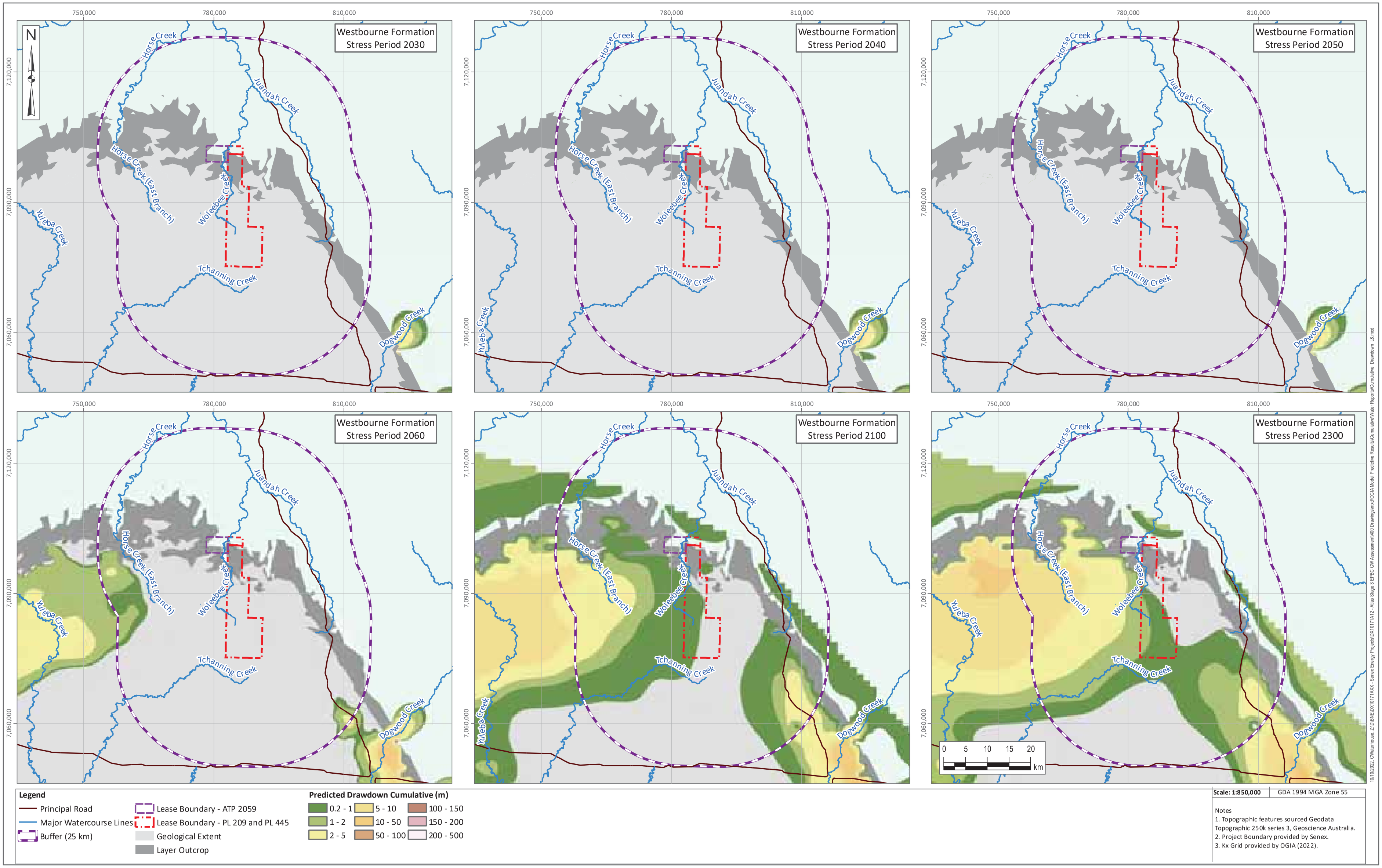

Figure III-2 Cumulative Drawdown – Layer 8 – Westbourne Formation

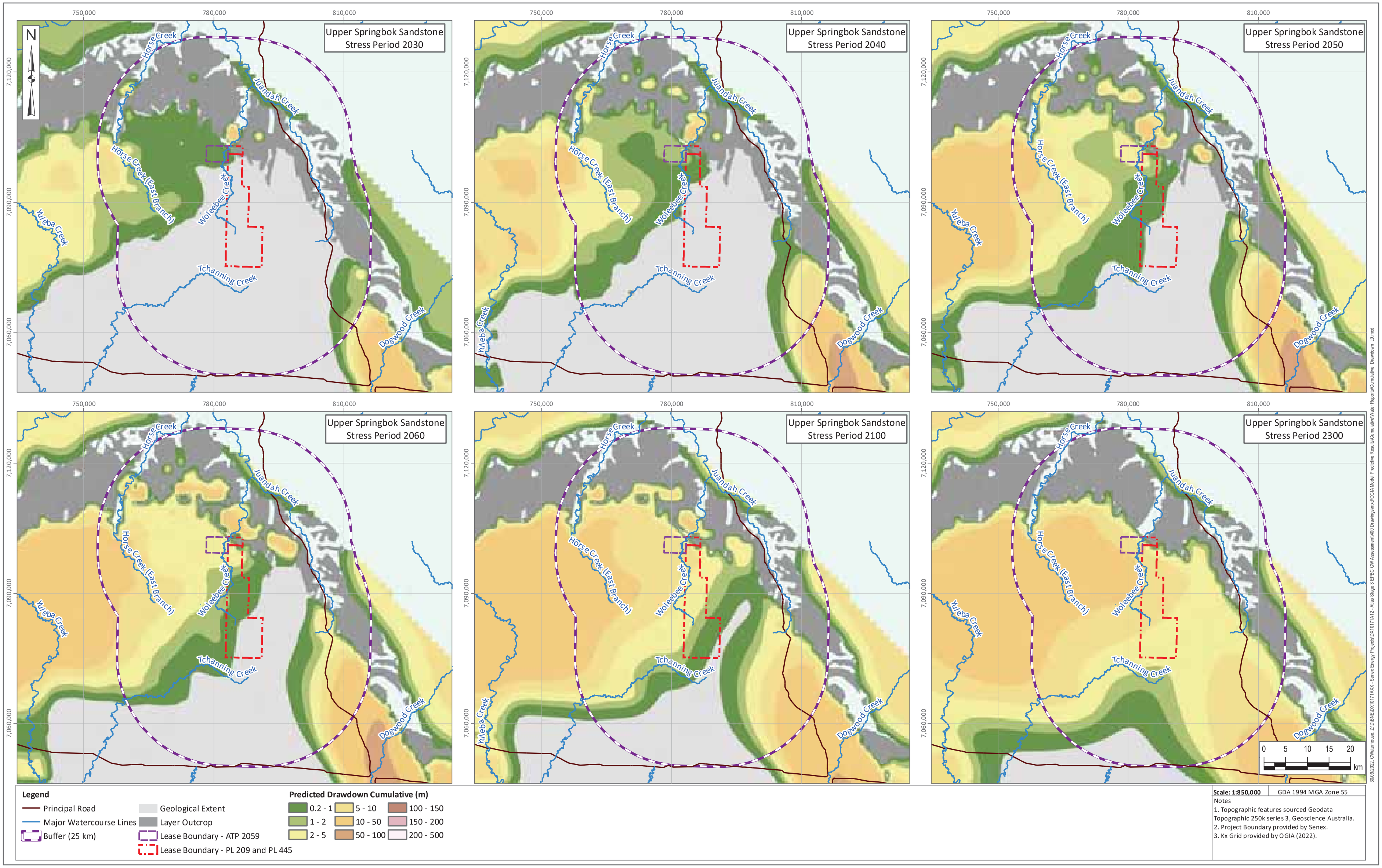

Figure III-3 Cumulative Drawdown – Layer 9 – Upper Springbok Sandstone

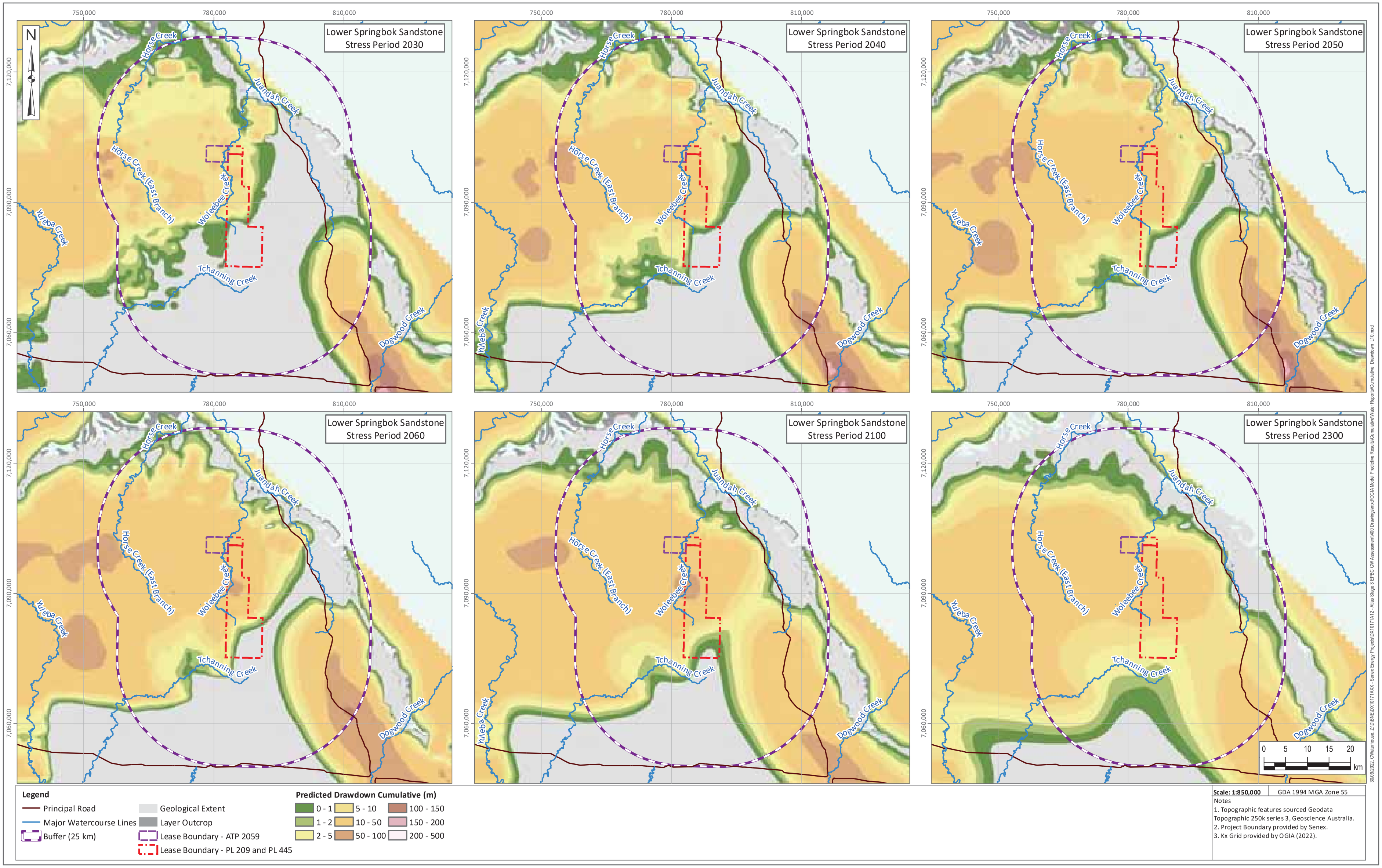

Figure III-4 **Cumulative Drawdown – Layer 10 – Lower Springbok Sandstone**

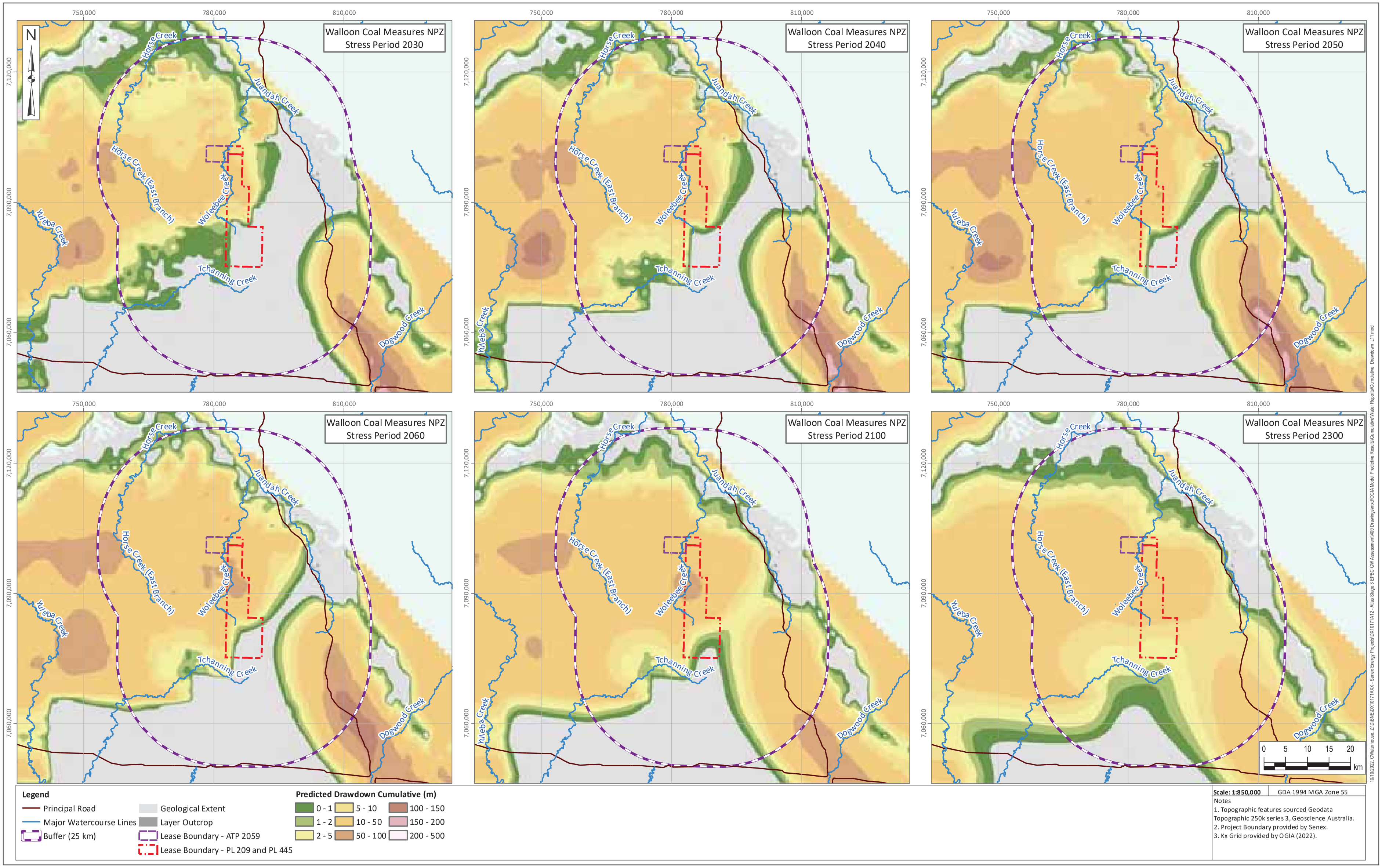

Figure III-5 Cumulative Drawdown – Layer 11 – Walloon Coal Measures Non-Productive Zone

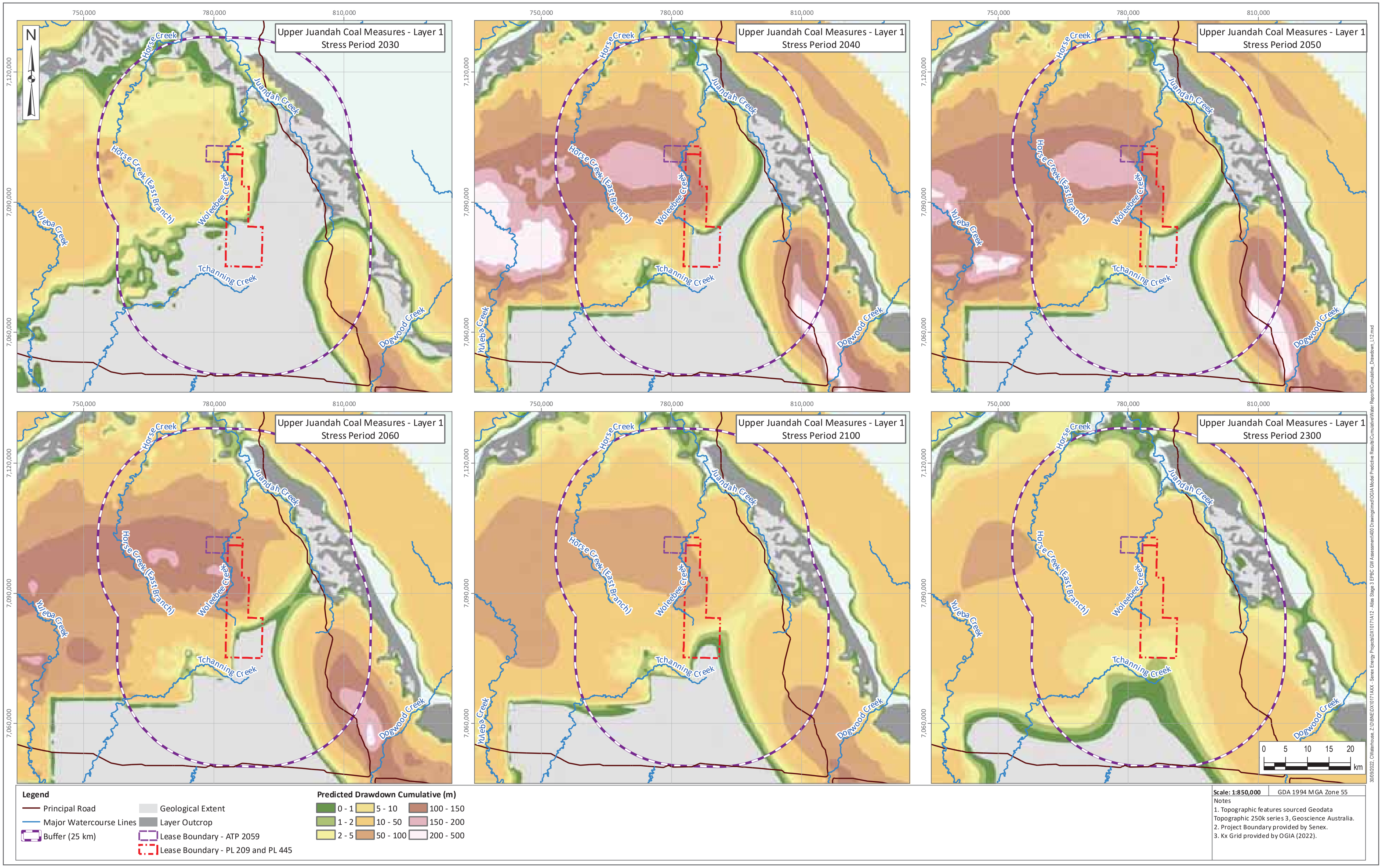

Figure III-6 Cumulative Drawdown – Layer 12 – Upper Juandah Coal Measures Layer 1

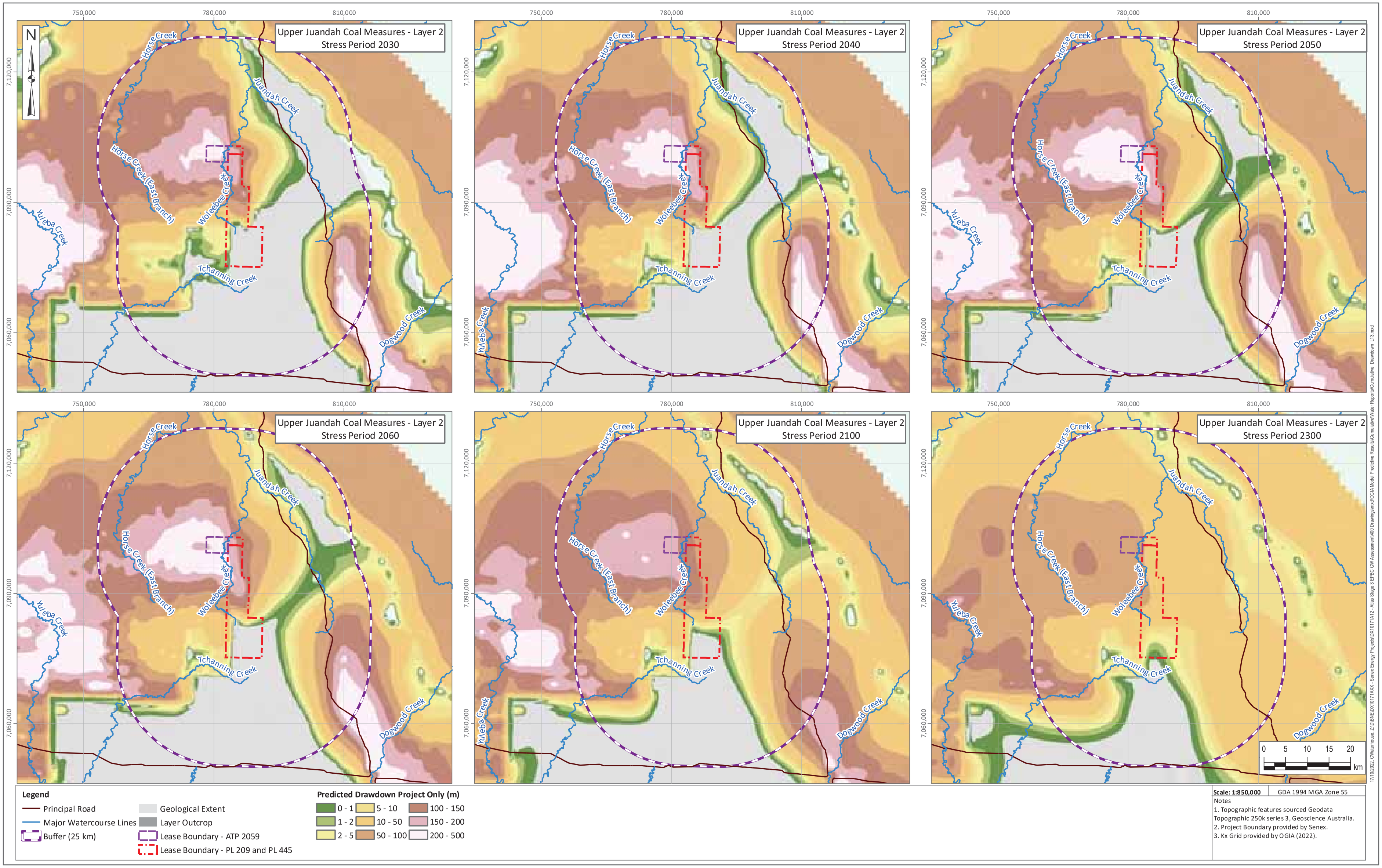

Figure III-7 Cumulative Drawdown – Layer 13 – Upper Juandah Coal Measures Layer 2

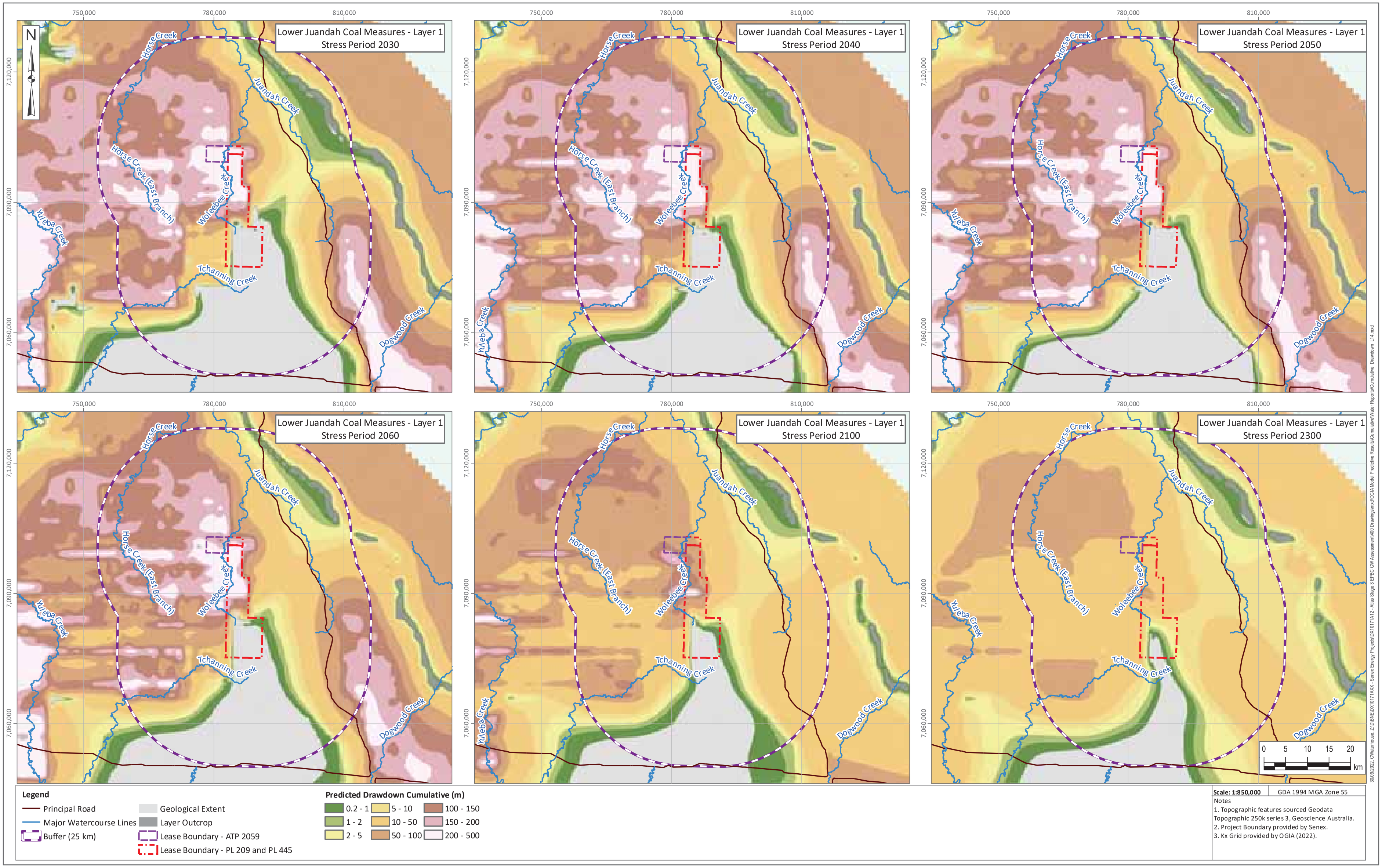

Figure III-8 Cumulative Drawdown – Layer 14 – Lower Juandah Coal Layer 1

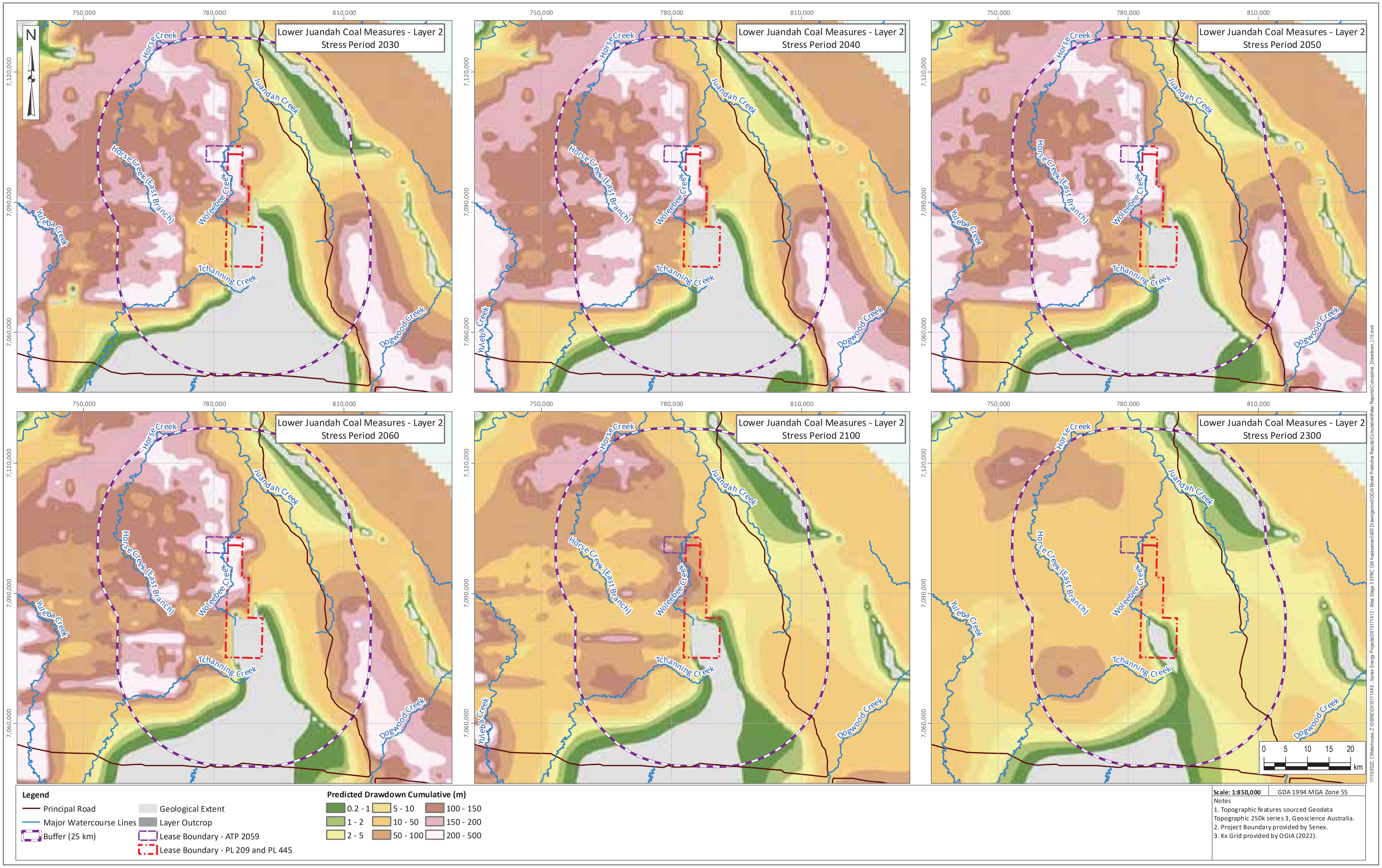

Figure III-9 Cumulative Drawdown – Layer 15 – Lower Juandah Coal Layer 2

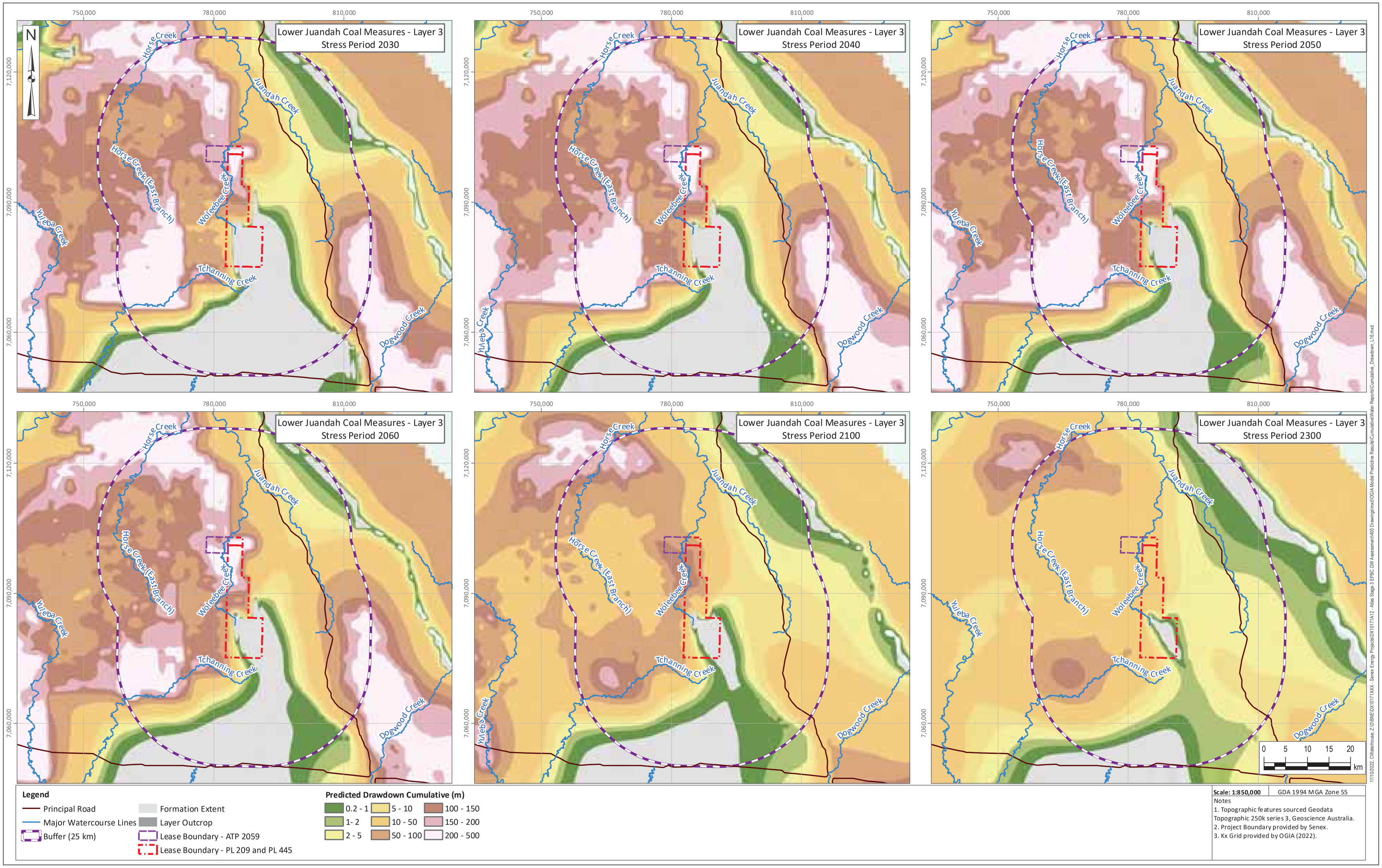

Figure III-10 Cumulative Drawdown - Layer 16 – Lower Juandah Coal Layer 3

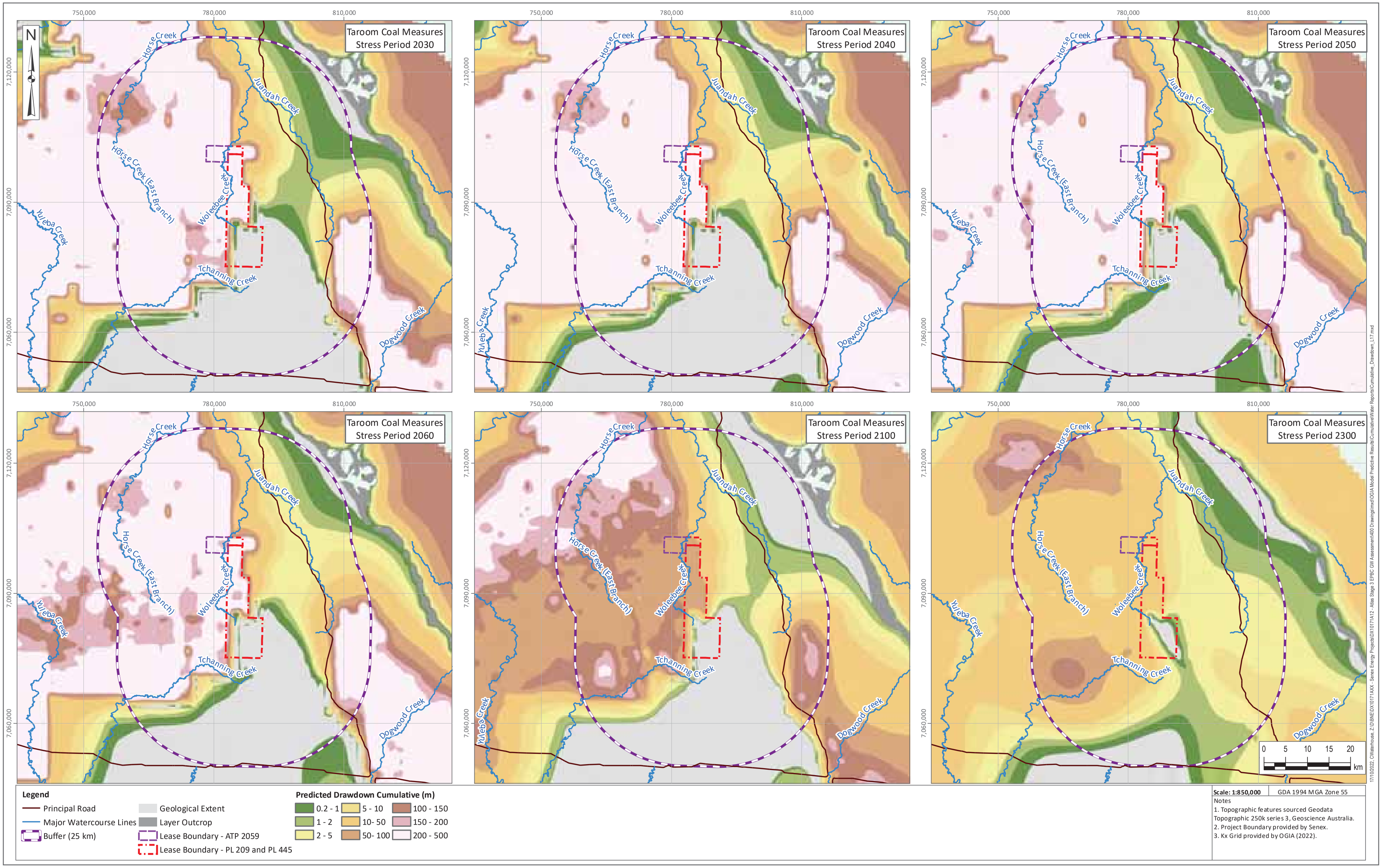

Figure III-11 Cumulative Drawdown - Layer 17 – Taroom Coal Measures

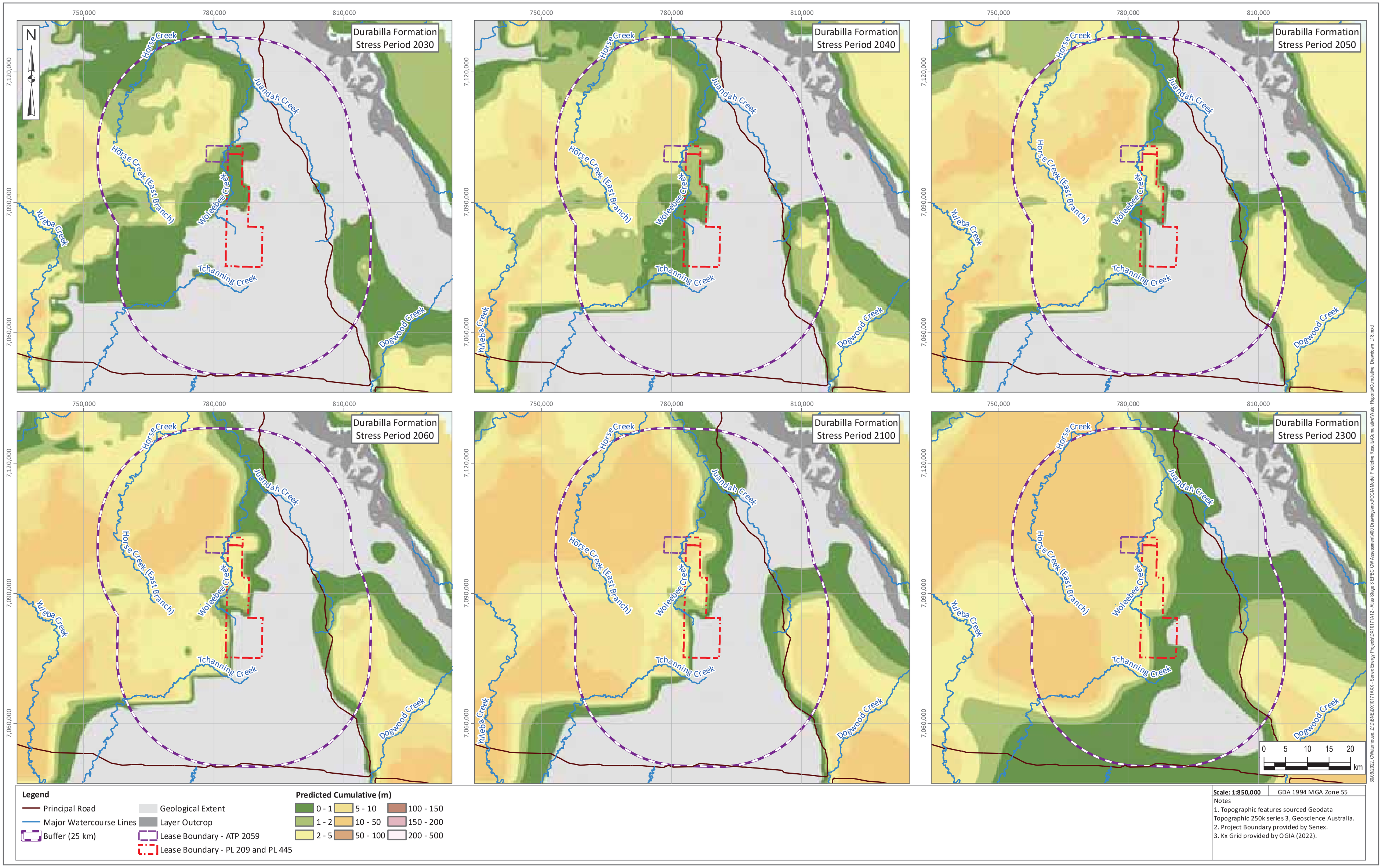

Figure III-12 Cumulative Drawdown - Layer 18 – Durabilla Formation

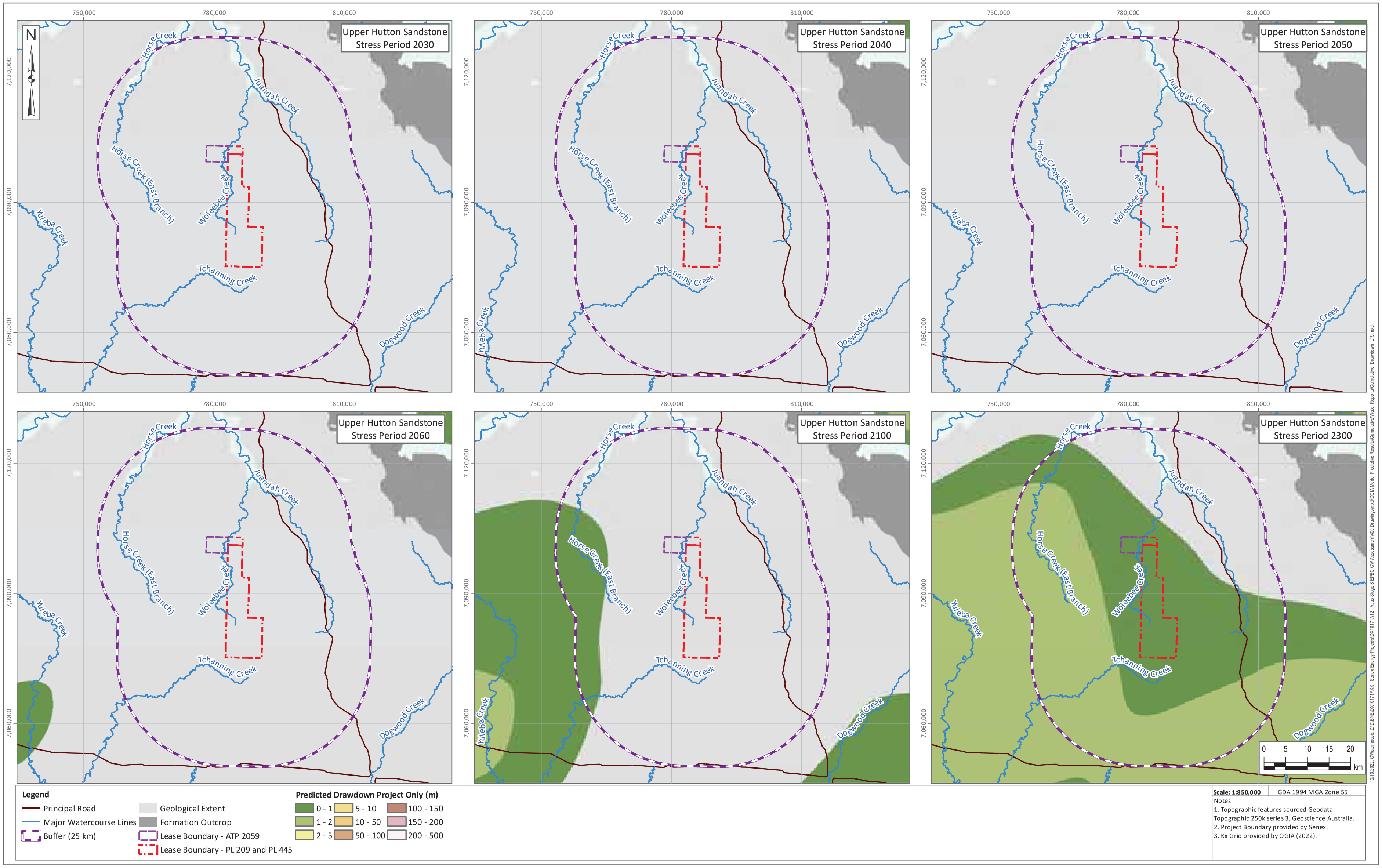

Figure III-13 Cumulative Drawdown - Layer 19 – Upper Hutton Sandstone

APPENDIX IV

Groundwater Bore Impact Assessment Results

Appendix IV
Groundwater Bore Impact Assessment

Table 1 Bores Exceeding the Trigger Threshold as a results of the Project (Total 23 Bores)

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exceeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-1	Upper Juandah Coal Measures	Max. drawdown from L12/L13	123.34	✓	152.81	✓	81%
ATLS3-2	Upper Juandah Coal Measures	Max. drawdown from L12/L13	36.04	✓	50.81	✓	71%
ATLS3-3	Upper Juandah Coal Measures	Max. drawdown from L12/L13	19.82	✓	125.60	✓	16%
ATLS3-4	Upper Juandah Coal Measures	Max. drawdown from L12/L13	18.42	✓	233.16	✓	8%
ATLS3-5	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	14.01	✓	200.50	✓	7%
ATLS3-6	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	14.01	✓	200.50	✓	7%
ATLS3-7	Upper Juandah Coal Measures	Max. drawdown from L12/L13	11.56	✓	174.97	✓	7%
ATLS3-8	Taroom Coal Measures	L17 Taroom Coal Measures	10.38	✓	396.11	✓	3%
ATLS3-9	Upper Juandah Coal Measures	Max. drawdown from L12/L13	9.06	✓	67.68	✓	13%
ATLS3-10	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	8.92	✓	14.52	✓	61%
ATLS3-11	Upper Juandah Coal Measures	Max. drawdown from L12/L13	7.72	✓	84.76	✓	9%
ATLS3-12	Upper Juandah Coal Measures	Max. drawdown from L12/L13	7.72	✓	84.76	✓	9%
ATLS3-13	Upper Juandah Coal Measures	Max. drawdown from L12/L13	7.72	✓	84.76	✓	9%
ATLS3-14	Upper Juandah Coal Measures	Max. drawdown from L12/L13	7.47	✓	83.79	✓	9%
ATLS3-15	Upper Juandah Coal Measures	Max. drawdown from L12/L13	7.47	✓	83.79	✓	9%
ATLS3-16	Upper Juandah Coal Measures	Max. drawdown from L12/L13	7.47	✓	83.79	✓	9%
ATLS3-17	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	6.95	✓	63.91	✓	11%
ATLS3-18	Upper Juandah Coal Measures	Max. drawdown from L12/L13	6.05	✓	56.62	✓	11%
ATLS3-19	Upper Juandah Coal Measures	Max. drawdown from L12/L13	6.05	✓	56.62	✓	11%
ATLS3-20	Upper Juandah Coal Measures	Max. drawdown from L12/L13	5.74	✓	52.48	✓	11%
ATLS3-21	Upper Juandah Coal Measures	Max. drawdown from L12/L13	5.47	✓	55.05	✓	10%
ATLS3-22	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	5.46	✓	222.84	✓	2%
ATLS3-23	Upper Juandah Coal Measures	Max. drawdown from L12/L13	5.18	✓	45.76	✓	11%

Table 2 Bores Exceeding the Trigger Threshold within the Cumulative Scenario, with Contribution from the Project (Total 216 bores)

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exceeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-24	Upper Juandah Coal Measures	Max. drawdown from L12/L13	4.71	×	42.42	✓	11%
ATLS3-25	Upper Juandah Coal Measures	Max. drawdown from L12/L13	4.58	×	32.19	✓	14%
ATLS3-26	Upper Juandah Coal Measures	Max. drawdown from L12/L13	4.30	×	23.49	✓	18%
ATLS3-27	Upper Juandah Coal Measures	Max. drawdown from L12/L13	4.11	×	204.03	✓	2%
ATLS3-28	Upper Juandah Coal Measures	Max. drawdown from L12/L13	4.00	×	19.15	✓	21%
ATLS3-29	Upper Juandah Coal Measures	Max. drawdown from L12/L13	3.95	×	38.42	✓	10%
ATLS3-30	Upper Juandah Coal Measures	Max. drawdown from L12/L13	3.95	×	38.42	✓	10%
ATLS3-31	Upper Juandah Coal Measures	Max. drawdown from L12/L13	3.92	×	38.30	✓	10%
ATLS3-32	Upper Juandah Coal Measures	Max. drawdown from L12/L13	3.88	×	44.92	✓	9%
ATLS3-33	Upper Juandah Coal Measures	Max. drawdown from L12/L13	3.56	×	15.36	✓	23%
ATLS3-34	Upper Juandah Coal Measures	Max. drawdown from L12/L13	3.36	×	27.63	✓	12%
ATLS3-35	Upper Juandah Coal Measures	Max. drawdown from L12/L13	3.27	×	22.24	✓	15%
ATLS3-36	Upper Juandah Coal Measures	Max. drawdown from L12/L13	2.90	×	224.72	✓	1%
ATLS3-37	Upper Juandah Coal Measures	Max. drawdown from L12/L13	2.87	×	34.25	✓	8%
ATLS3-38	Upper Juandah Coal Measures	Max. drawdown from L12/L13	2.87	×	34.25	✓	8%
ATLS3-39	Upper Juandah Coal Measures	Max. drawdown from L12/L13	2.84	×	38.26	✓	7%
ATLS3-40	Upper Juandah Coal Measures	Max. drawdown from L12/L13	2.84	×	38.26	✓	7%
ATLS3-41	Upper Juandah Coal Measures	Max. drawdown from L12/L13	2.82	×	32.73	✓	9%
ATLS3-42	Upper Juandah Coal Measures	Max. drawdown from L12/L13	2.40	×	13.58	✓	18%
ATLS3-43	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	2.33	×	8.32	✓	28%
ATLS3-44	Upper Juandah Coal Measures	Max. drawdown from L12/L13	2.29	×	212.81	✓	1%
ATLS3-45	Upper Juandah Coal Measures	Max. drawdown from L12/L13	2.22	×	178.28	✓	1%
ATLS3-46	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	2.19	×	9.27	✓	24%
ATLS3-47	Upper Juandah Coal Measures	Max. drawdown from L12/L13	2.18	×	11.87	✓	18%
ATLS3-48	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	2.12	×	7.02	✓	30%
ATLS3-49	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	1.97	×	10.05	✓	20%
ATLS3-50	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.95	×	9.70	✓	20%
ATLS3-51	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	1.80	×	8.23	✓	22%
ATLS3-52	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	1.78	×	10.95	✓	16%
ATLS3-53	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.72	×	224.35	✓	1%
ATLS3-54	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.72	×	224.35	✓	1%
ATLS3-55	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.68	×	10.05	✓	17%
ATLS3-56	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.61	×	60.25	✓	3%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exceeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-57	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	1.59	×	5.33	✓	30%
ATLS3-58	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	1.51	×	92.37	✓	2%
ATLS3-59	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.46	×	117.89	✓	1%
ATLS3-60	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.46	×	117.89	✓	1%
ATLS3-61	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.39	×	134.54	✓	1%
ATLS3-62	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.39	×	134.54	✓	1%
ATLS3-63	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.38	×	133.40	✓	1%
ATLS3-64	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	1.30	×	5.03	✓	26%
ATLS3-66	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.16	×	145.63	✓	1%
ATLS3-68	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.12	×	128.45	✓	1%
ATLS3-69	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.12	×	128.45	✓	1%
ATLS3-70	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.12	×	128.45	✓	1%
ATLS3-71	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	1.11	×	23.12	✓	5%
ATLS3-75	Upper Juandah Coal Measures	Max. drawdown from L12/L13	1.03	×	136.64	✓	1%
ATLS3-76	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.99	×	125.49	✓	1%
ATLS3-78	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.93	×	149.67	✓	1%
ATLS3-79	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.88	×	5.75	✓	15%
ATLS3-80	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.88	×	5.81	✓	15%
ATLS3-81	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.88	×	5.81	✓	15%
ATLS3-82	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.85	×	7.96	✓	11%
ATLS3-83	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.81	×	160.40	✓	1%
ATLS3-84	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.81	×	160.40	✓	1%
ATLS3-86	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.77	×	12.81	✓	6%
ATLS3-87	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.74	×	17.83	✓	4%
ATLS3-88	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.68	×	142.07	✓	0%
ATLS3-89	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.68	×	142.07	✓	0%
ATLS3-90	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.68	×	15.12	✓	4%
ATLS3-91	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.66	×	26.75	✓	2%
ATLS3-96	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.60	×	156.18	✓	0%
ATLS3-97	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.58	×	214.71	✓	0%
ATLS3-99	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.57	×	6.72	✓	8%
ATLS3-101	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.56	×	115.56	✓	0%
ATLS3-102	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.52	×	12.22	✓	4%
ATLS3-103	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.52	×	12.22	✓	4%
ATLS3-104	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.52	×	60.28	✓	1%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exceeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-105	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.51	×	222.33	✓	0%
ATLS3-106	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.51	×	222.33	✓	0%
ATLS3-107	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.51	×	106.69	✓	0%
ATLS3-112	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.48	×	7.84	✓	6%
ATLS3-113	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.48	×	6.62	✓	7%
ATLS3-114	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.47	×	14.77	✓	3%
ATLS3-115	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.45	×	111.37	✓	0%
ATLS3-116	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.44	×	13.35	✓	3%
ATLS3-117	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.44	×	13.35	✓	3%
ATLS3-118	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.43	×	150.20	✓	0%
ATLS3-119	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.42	×	126.70	✓	0%
ATLS3-120	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.42	×	38.08	✓	1%
ATLS3-121	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.42	×	38.08	✓	1%
ATLS3-122	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.42	×	38.08	✓	1%
ATLS3-123	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.42	×	38.08	✓	1%
ATLS3-126	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.40	×	67.59	✓	1%
ATLS3-127	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.38	×	138.52	✓	0%
ATLS3-128	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.38	×	95.72	✓	0%
ATLS3-129	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.38	×	25.15	✓	1%
ATLS3-130	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.35	×	147.80	✓	0%
ATLS3-131	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.35	×	147.70	✓	0%
ATLS3-132	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.34	×	162.33	✓	0%
ATLS3-133	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.34	×	130.95	✓	0%
ATLS3-134	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.34	×	131.99	✓	0%
ATLS3-135	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.34	×	131.99	✓	0%
ATLS3-136	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.34	×	126.47	✓	0%
ATLS3-137	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.34	×	135.52	✓	0%
ATLS3-138	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.33	×	8.52	✓	4%
ATLS3-139	Walloon Coal Measures NPZ	L11 Walloon Coal Measures NPZ	0.32	×	31.55	✓	1%
ATLS3-140	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.31	×	126.12	✓	0%
ATLS3-141	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.31	×	126.12	✓	0%
ATLS3-142	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.31	×	8.70	✓	4%
ATLS3-143	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.29	×	115.99	✓	0%
ATLS3-144	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.29	×	7.15	✓	4%
ATLS3-146	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.27	×	30.16	✓	1%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exceeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-148	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.27	×	6.40	✓	4%
ATLS3-149	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.27	×	133.02	✓	0%
ATLS3-150	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.27	×	133.02	✓	0%
ATLS3-151	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.25	×	24.73	✓	1%
ATLS3-152	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.25	×	33.56	✓	1%
ATLS3-153	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.23	×	12.31	✓	2%
ATLS3-154	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.22	×	118.79	✓	0%
ATLS3-155	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.22	×	131.88	✓	0%
ATLS3-156	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.22	×	25.69	✓	1%
ATLS3-158	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.20	×	102.87	✓	0%
ATLS3-159	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.20	×	18.82	✓	1%
ATLS3-160	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.18	×	11.66	✓	2%
ATLS3-161	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.18	×	318.62	✓	0%
ATLS3-162	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.18	×	318.62	✓	0%
ATLS3-163	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.18	×	111.39	✓	0%
ATLS3-164	Walloon Coal Measures NPZ	L11 Walloon Coal Measures NPZ	0.18	×	21.42	✓	1%
ATLS3-165	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.18	×	81.61	✓	0%
ATLS3-166	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.17	×	42.34	✓	0%
ATLS3-167	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.17	×	157.32	✓	0%
ATLS3-168	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.16	×	81.76	✓	0%
ATLS3-169	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.16	×	81.76	✓	0%
ATLS3-171	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.16	×	103.28	✓	0%
ATLS3-172	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.15	×	11.31	✓	1%
ATLS3-173	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.15	×	318.60	✓	0%
ATLS3-174	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.15	×	318.60	✓	0%
ATLS3-175	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.15	×	318.60	✓	0%
ATLS3-176	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.15	×	26.31	✓	1%
ATLS3-177	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.15	×	111.49	✓	0%
ATLS3-178	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.15	×	122.69	✓	0%
ATLS3-179	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.15	×	122.69	✓	0%
ATLS3-180	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.14	×	105.51	✓	0%
ATLS3-182	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.14	×	99.94	✓	0%
ATLS3-183	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.14	×	99.94	✓	0%
ATLS3-184	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.14	×	83.19	✓	0%
ATLS3-186	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.13	×	90.75	✓	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exceeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-187	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.13	×	90.75	✓	0%
ATLS3-188	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.13	×	90.75	✓	0%
ATLS3-189	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.13	×	19.78	✓	1%
ATLS3-190	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.13	×	18.85	✓	1%
ATLS3-191	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.13	×	79.01	✓	0%
ATLS3-192	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.12	×	93.56	✓	0%
ATLS3-193	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.12	×	6.33	✓	2%
ATLS3-194	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.12	×	71.92	✓	0%
ATLS3-195	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.12	×	100.11	✓	0%
ATLS3-196	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.12	×	83.83	✓	0%
ATLS3-197	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.11	×	5.21	✓	2%
ATLS3-199	Taroom Coal Measures	L17 Taroom Coal Measures	0.11	×	271.10	✓	0%
ATLS3-200	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.11	×	273.34	✓	0%
ATLS3-202	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.10	×	134.03	✓	0%
ATLS3-203	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.10	×	95.42	✓	0%
ATLS3-204	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.10	×	25.24	✓	0%
ATLS3-206	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.10	×	79.26	✓	0%
ATLS3-207	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.10	×	79.26	✓	0%
ATLS3-208	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.10	×	76.71	✓	0%
ATLS3-209	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.10	×	28.89	✓	0%
ATLS3-808	Springbok Sandstone	Max. drawdown from L9 and L10	0.10	×	55.73	✓	0%
ATLS3-211	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.10	×	95.03	✓	0%
ATLS3-212	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.10	×	95.03	✓	0%
ATLS3-213	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.09	×	138.17	✓	0%
ATLS3-214	Westbourne Formation	L8 Westbourne Formation	0.09	×	5.65	✓	2%
ATLS3-215	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.09	×	75.15	✓	0%
ATLS3-216	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.09	×	116.44	✓	0%
ATLS3-217	Westbourne Formation	L8 Westbourne Formation	0.09	×	6.27	✓	1%
ATLS3-219	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.08	×	7.35	✓	1%
ATLS3-221	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.08	×	38.40	✓	0%
ATLS3-222	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.08	×	82.38	✓	0%
ATLS3-223	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.08	×	76.13	✓	0%
ATLS3-224	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.08	×	76.13	✓	0%
ATLS3-225	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.08	×	18.49	✓	0%
ATLS3-226	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.08	×	41.99	✓	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exceeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-227	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.07	✗	73.47	✓	0%
ATLS3-228	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.07	✗	73.47	✓	0%
ATLS3-229	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.07	✗	74.50	✓	0%
ATLS3-230	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.07	✗	69.24	✓	0%
ATLS3-231	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.07	✗	233.96	✓	0%
ATLS3-233	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.07	✗	68.44	✓	0%
ATLS3-234	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.07	✗	34.91	✓	0%
ATLS3-236	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.07	✗	36.11	✓	0%
ATLS3-237	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.07	✗	243.75	✓	0%
ATLS3-238	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.06	✗	72.66	✓	0%
ATLS3-239	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.06	✗	21.86	✓	0%
ATLS3-241	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.06	✗	225.48	✓	0%
ATLS3-242	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.05	✗	76.16	✓	0%
ATLS3-243	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.05	✗	25.63	✓	0%
ATLS3-246	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.05	✗	51.28	✓	0%
ATLS3-247	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.05	✗	51.28	✓	0%
ATLS3-250	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.04	✗	9.26	✓	0%
ATLS3-252	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.04	✗	297.18	✓	0%
ATLS3-254	Taroom Coal Measures	L17 Taroom Coal Measures	0.04	✗	189.55	✓	0%
ATLS3-255	Westbourne Formation	L8 Westbourne Formation	0.04	✗	9.68	✓	0%
ATLS3-256	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.03	✗	191.60	✓	0%
ATLS3-257	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.03	✗	191.60	✓	0%
ATLS3-258	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.03	✗	14.29	✓	0%
ATLS3-259	Taroom Coal Measures	L17 Taroom Coal Measures	0.03	✗	332.36	✓	0%
ATLS3-260	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.03	✗	16.17	✓	0%
ATLS3-261	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.03	✗	7.41	✓	0%
ATLS3-262	Taroom Coal Measures	L17 Taroom Coal Measures	0.03	✗	132.49	✓	0%
ATLS3-264	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.02	✗	205.30	✓	0%
ATLS3-265	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.02	✗	205.30	✓	0%
ATLS3-266	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.02	✗	68.25	✓	0%
ATLS3-267	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.02	✗	43.62	✓	0%
ATLS3-270	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.02	✗	24.55	✓	0%
ATLS3-273	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.02	✗	10.05	✓	0%
ATLS3-274	Taroom Coal Measures	L17 Taroom Coal Measures	0.01	✗	102.42	✓	0%
ATLS3-275	Taroom Coal Measures	L17 Taroom Coal Measures	0.01	✗	102.42	✓	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exceeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-276	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.01	×	12.85	✓	0%
ATLS3-279	Taroom Coal Measures	L17 Taroom Coal Measures	0.01	×	466.12	✓	0%
ATLS3-299	Taroom Coal Measures	L17 Taroom Coal Measures	0.01	×	286.82	✓	0%
ATLS3-300	Taroom Coal Measures	L17 Taroom Coal Measures	0.01	×	286.82	✓	0%
ATLS3-323	Taroom Coal Measures	L17 Taroom Coal Measures	0.01	×	532.60	✓	0%
ATLS3-329	Durabilla Formation	L18 Durabilla	0.01	×	8.60	✓	0%
ATLS3-349	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.01	×	6.08	✓	0%
ATLS3-350	Taroom Coal Measures	L17 Taroom Coal Measures	0.01	×	597.95	✓	0%

Table 3 Bores Exceeding the Trigger Threshold within the Cumulative Scenario with No Project Contribution (Total Nine Bores)

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exceeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-351	Taroom Coal Measures	L17 Taroom Coal Measures	0.00	×	494.09	✓	0%
ATLS3-366	Durabilla Formation	L18 Durabilla	0.00	×	7.86	✓	0%
ATLS3-439	Taroom Coal Measures	L17 Taroom Coal Measures	0.00	×	12.57	✓	0%
ATLS3-445	Durabilla Formation	L18 Durabilla	0.00	×	9.31	✓	0%
ATLS3-446	Durabilla Formation	L18 Durabilla	0.00	×	9.31	✓	0%
ATLS3-587	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.00	×	9.73	✓	0%
ATLS3-673	Taroom Coal Measures	L17 Taroom Coal Measures	0.00	×	6.85	✓	0%
ATLS3-742	Upper Springbok Sandstone	L10 Upper Springbok Sandstone	0.00	×	31.65	✓	0%
ATLS3-755	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.00	×	263.81	✓	0%

Table 4 Summary of Bores which do not Exceed the Trigger Threshold Both in Project and Cumulative Scenario (Total 562 bores)

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-65	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	1.29	×	4.69	X	0%
ATLS3-67	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	1.12	×	4.19	X	0%
ATLS3-72	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	1.10	×	4.18	X	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-73	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	1.05	×	4.24	×	0%
ATLS3-74	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	1.04	×	3.90	×	0%
ATLS3-77	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.96	×	3.48	×	0%
ATLS3-85	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.79	×	4.80	×	0%
ATLS3-92	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.60	×	3.29	×	0%
ATLS3-93	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.60	×	3.29	×	0%
ATLS3-94	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.60	×	3.29	×	0%
ATLS3-95	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.60	×	3.29	×	0%
ATLS3-98	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.57	×	3.87	×	0%
ATLS3-100	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.56	×	3.85	×	0%
ATLS3-108	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.48	×	4.22	×	0%
ATLS3-109	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.48	×	4.22	×	0%
ATLS3-110	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.48	×	4.22	×	0%
ATLS3-111	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.48	×	4.22	×	0%
ATLS3-124	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.41	×	3.83	×	0%
ATLS3-125	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.41	×	3.85	×	0%
ATLS3-145	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.29	×	1.72	×	0%
ATLS3-147	Upper Juandah Coal Measures	Max. drawdown from L12/L13	0.27	×	3.56	×	0%
ATLS3-157	Taroom Coal Measures	L17 Taroom Coal Measures	0.21	×	4.33	×	0%
ATLS3-170	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.16	×	4.65	×	0%
ATLS3-181	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.14	×	1.94	×	0%
ATLS3-185	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.14	×	2.48	×	0%
ATLS3-198	Westbourne Formation	L8 Westbourne Formation	0.11	×	2.78	×	0%
ATLS3-201	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.10	×	2.21	×	0%
ATLS3-205	Taroom Coal Measures	L17 Taroom Coal Measures	0.10	×	4.08	×	0%
ATLS3-210	Hutton	Max. drawdown L19/20	0.00	×	0.32	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-218	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.08	×	1.78	×	0%
ATLS3-220	Westbourne Formation	L8 Westbourne Formation	0.08	×	4.74	×	0%
ATLS3-232	Westbourne Formation	L8 Westbourne Formation	0.07	×	0.24	×	0%
ATLS3-235	Westbourne Formation	L8 Westbourne Formation	0.07	×	0.54	×	0%
ATLS3-240	Taroom Coal Measures	L17 Taroom Coal Measures	0.06	×	3.51	×	0%
ATLS3-244	Westbourne Formation	L8 Westbourne Formation	0.05	×	3.11	×	0%
ATLS3-245	Westbourne Formation	L8 Westbourne Formation	0.05	×	0.55	×	0%
ATLS3-248	Taroom Coal Measures	L17 Taroom Coal Measures	0.05	×	1.52	×	0%
ATLS3-249	Taroom Coal Measures	L17 Taroom Coal Measures	0.05	×	1.52	×	0%
ATLS3-251	Taroom Coal Measures	L17 Taroom Coal Measures	0.04	×	2.30	×	0%
ATLS3-253	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.04	×	2.79	×	0%
ATLS3-263	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.03	×	0.47	×	0%
ATLS3-268	Westbourne Formation	L8 Westbourne Formation	0.02	×	3.26	×	0%
ATLS3-269	Durabilla Formation	L18 Durabilla Formation	0.02	×	0.72	×	0%
ATLS3-271	Westbourne Formation	L8 Westbourne Formation	0.02	×	2.70	×	0%
ATLS3-272	Westbourne Formation	L8 Westbourne Formation	0.02	×	3.36	×	0%
ATLS3-277	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.14	×	0%
ATLS3-278	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.14	×	0%
ATLS3-280	Westbourne Formation	L8 Westbourne Formation	0.01	×	3.34	×	0%
ATLS3-281	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.60	×	0%
ATLS3-282	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.43	×	0%
ATLS3-283	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.69	×	0%
ATLS3-284	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.55	×	0%
ATLS3-285	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.55	×	0%
ATLS3-286	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.82	×	0%
ATLS3-287	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.66	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-288	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.01	×	0.86	×	0%
ATLS3-289	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.17	×	0%
ATLS3-290	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.10	×	0%
ATLS3-291	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.10	×	0%
ATLS3-292	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.15	×	0%
ATLS3-293	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.36	×	0%
ATLS3-294	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.13	×	0%
ATLS3-295	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.01	×	0.74	×	0%
ATLS3-296	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.11	×	0%
ATLS3-297	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.24	×	0%
ATLS3-298	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.33	×	0%
ATLS3-301	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.13	×	0%
ATLS3-302	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.08	×	0%
ATLS3-303	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.36	×	0%
ATLS3-304	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.36	×	0%
ATLS3-305	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.36	×	0%
ATLS3-306	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	1.18	×	0%
ATLS3-307	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.11	×	0%
ATLS3-308	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.11	×	0%
ATLS3-309	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.11	×	0%
ATLS3-310	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.01	×	0.70	×	0%
ATLS3-311	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.54	×	0%
ATLS3-312	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.13	×	0%
ATLS3-313	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.99	×	0%
ATLS3-314	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.28	×	0%
ATLS3-315	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.63	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-316	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.07	×	0%
ATLS3-317	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.14	×	0%
ATLS3-318	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.86	×	0%
ATLS3-319	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.46	×	0%
ATLS3-320	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.46	×	0%
ATLS3-321	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.07	×	0%
ATLS3-322	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.07	×	0%
ATLS3-324	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.22	×	0%
ATLS3-325	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.02	×	0%
ATLS3-326	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.06	×	0%
ATLS3-327	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.06	×	0%
ATLS3-328	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.06	×	0%
ATLS3-330	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.06	×	0%
ATLS3-331	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.06	×	0%
ATLS3-332	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.06	×	0%
ATLS3-333	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.06	×	0%
ATLS3-334	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.05	×	0%
ATLS3-335	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.10	×	0%
ATLS3-336	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.15	×	0%
ATLS3-337	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.72	×	0%
ATLS3-338	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.05	×	0%
ATLS3-339	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.36	×	0%
ATLS3-340	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.36	×	0%
ATLS3-341	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.24	×	0%
ATLS3-342	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.17	×	0%
ATLS3-343	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.17	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-344	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.17	×	0%
ATLS3-345	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.07	×	0%
ATLS3-346	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.07	×	0%
ATLS3-347	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.01	×	0.17	×	0%
ATLS3-348	Taroom Coal Measures	L17 Taroom Coal Measures	0.01	×	4.76	×	0%
ATLS3-352	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.20	×	0%
ATLS3-353	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	1.11	×	0%
ATLS3-354	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.03	×	0%
ATLS3-355	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.07	×	0%
ATLS3-356	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.07	×	0%
ATLS3-357	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.04	×	0%
ATLS3-358	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.99	×	0%
ATLS3-359	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.23	×	0%
ATLS3-360	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.12	×	0%
ATLS3-361	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.18	×	0%
ATLS3-362	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.18	×	0%
ATLS3-363	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.04	×	0%
ATLS3-364	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.55	×	0%
ATLS3-365	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.27	×	0%
ATLS3-367	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.04	×	0%
ATLS3-368	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.14	×	0%
ATLS3-369	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.14	×	0%
ATLS3-370	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.14	×	0%
ATLS3-371	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.14	×	0%
ATLS3-372	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.14	×	0%
ATLS3-373	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.03	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-374	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.04	×	0%
ATLS3-375	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.04	×	0%
ATLS3-376	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.18	×	0%
ATLS3-377	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.15	×	0%
ATLS3-378	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.21	×	0%
ATLS3-379	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.21	×	0%
ATLS3-380	Orallo Formation	L6 Orallo Formation	0.00	×	0.06	×	0%
ATLS3-381	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.11	×	0%
ATLS3-382	Orallo Formation	L6 Orallo Formation	0.00	×	0.11	×	0%
ATLS3-383	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.09	×	0%
ATLS3-384	Orallo Formation	L6 Orallo Formation	0.00	×	0.05	×	0%
ATLS3-385	Orallo Formation	L6 Orallo Formation	0.00	×	0.09	×	0%
ATLS3-386	Lower Springbok Sandstone	L10 Lower Springbok Sandstone	0.00	×	3.25	×	0%
ATLS3-387	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.03	×	0%
ATLS3-388	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.18	×	0%
ATLS3-389	Orallo Formation	L6 Orallo Formation	0.00	×	0.11	×	0%
ATLS3-390	Orallo Formation	L6 Orallo Formation	0.00	×	0.03	×	0%
ATLS3-391	Lower Hutton Sandstone	L20 Lower Hutton Sandstone	0.00	×	0.60	×	0%
ATLS3-392	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.11	×	0%
ATLS3-393	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.11	×	0%
ATLS3-394	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.11	×	0%
ATLS3-395	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.02	×	0%
ATLS3-396	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	1.08	×	0%
ATLS3-397	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	1.09	×	0%
ATLS3-398	Orallo Formation	L6 Orallo Formation	0.00	×	0.06	×	0%
ATLS3-399	Orallo Formation	L6 Orallo Formation	0.00	×	0.11	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-400	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.05	×	0%
ATLS3-401	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.02	×	0%
ATLS3-402	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.02	×	0%
ATLS3-403	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.09	×	0%
ATLS3-404	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.13	×	0%
ATLS3-405	Orallo Formation	L6 Orallo Formation	0.00	×	0.04	×	0%
ATLS3-406	Orallo Formation	L6 Orallo Formation	0.00	×	0.03	×	0%
ATLS3-407	Orallo Formation	L6 Orallo Formation	0.00	×	0.03	×	0%
ATLS3-408	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.19	×	0%
ATLS3-409	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.24	×	0%
ATLS3-410	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.05	×	0%
ATLS3-411	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.07	×	0%
ATLS3-412	Orallo Formation	L6 Orallo Formation	0.00	×	0.05	×	0%
ATLS3-413	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.46	×	0%
ATLS3-414	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.38	×	0%
ATLS3-415	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.78	×	0%
ATLS3-416	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.51	×	0%
ATLS3-417	Orallo Formation	L6 Orallo Formation	0.00	×	0.09	×	0%
ATLS3-418	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.93	×	0%
ATLS3-419	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.96	×	0%
ATLS3-420	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.03	×	0%
ATLS3-421	Orallo Formation	L6 Orallo Formation	0.00	×	0.04	×	0%
ATLS3-422	Orallo Formation	L6 Orallo Formation	0.00	×	0.14	×	0%
ATLS3-423	Taroom Coal Measures	L17 Taroom Coal Measures	0.00	×	0.49	×	0%
ATLS3-424	Orallo Formation	L6 Orallo Formation	0.00	×	0.04	×	0%
ATLS3-425	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.03	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-426	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.03	×	0%
ATLS3-427	Orallo Formation	L6 Orallo Formation	0.00	×	0.20	×	0%
ATLS3-428	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.74	×	0%
ATLS3-429	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.75	×	0%
ATLS3-430	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.13	×	0%
ATLS3-431	Orallo Formation	L6 Orallo Formation	0.00	×	0.17	×	0%
ATLS3-432	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	1.24	×	0%
ATLS3-433	Lower Hutton Sandstone	L20 Lower Hutton Sandstone	0.00	×	1.17	×	0%
ATLS3-434	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.56	×	0%
ATLS3-435	Lower Hutton Sandstone	L20 Lower Hutton Sandstone	0.00	×	0.43	×	0%
ATLS3-436	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.04	×	0%
ATLS3-437	Orallo Formation	L6 Orallo Formation	0.00	×	0.02	×	0%
ATLS3-438	Orallo Formation	L6 Orallo Formation	0.00	×	0.10	×	0%
ATLS3-440	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.07	×	0%
ATLS3-441	Orallo Formation	L6 Orallo Formation	0.00	×	0.14	×	0%
ATLS3-442	Orallo Formation	L6 Orallo Formation	0.00	×	0.14	×	0%
ATLS3-443	Orallo Formation	L6 Orallo Formation	0.00	×	0.23	×	0%
ATLS3-444	Orallo Formation	L6 Orallo Formation	0.00	×	0.05	×	0%
ATLS3-447	Orallo Formation	L6 Orallo Formation	0.00	×	0.09	×	0%
ATLS3-448	Orallo Formation	L6 Orallo Formation	0.00	×	0.25	×	0%
ATLS3-449	Lower Hutton Sandstone	L20 Lower Hutton Sandstone	0.00	×	0.41	×	0%
ATLS3-450	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.52	×	0%
ATLS3-451	Orallo Formation	L6 Orallo Formation	0.00	×	0.14	×	0%
ATLS3-452	Orallo Formation	L6 Orallo Formation	0.00	×	0.23	×	0%
ATLS3-453	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.25	×	0%
ATLS3-454	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.26	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-455	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.01	×	0%
ATLS3-456	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.07	×	0%
ATLS3-457	Lower Hutton Sandstone	L20 Lower Hutton Sandstone	0.00	×	0.55	×	0%
ATLS3-458	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.74	×	0%
ATLS3-459	Orallo Formation	L6 Orallo Formation	0.00	×	0.08	×	0%
ATLS3-460	Orallo Formation	L6 Orallo Formation	0.00	×	0.28	×	0%
ATLS3-461	Orallo Formation	L6 Orallo Formation	0.00	×	0.21	×	0%
ATLS3-462	Orallo Formation	L6 Orallo Formation	0.00	×	0.05	×	0%
ATLS3-463	Orallo Formation	L6 Orallo Formation	0.00	×	0.04	×	0%
ATLS3-464	Orallo Formation	L6 Orallo Formation	0.00	×	0.08	×	0%
ATLS3-465	Orallo Formation	L6 Orallo Formation	0.00	×	0.08	×	0%
ATLS3-466	Orallo Formation	L6 Orallo Formation	0.00	×	0.08	×	0%
ATLS3-467	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.06	×	0%
ATLS3-468	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.04	×	0%
ATLS3-469	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.04	×	0%
ATLS3-470	Orallo Formation	L6 Orallo Formation	0.00	×	0.23	×	0%
ATLS3-471	Orallo Formation	L6 Orallo Formation	0.00	×	0.23	×	0%
ATLS3-472	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	1.36	×	0%
ATLS3-473	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.15	×	0%
ATLS3-474	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.03	×	0%
ATLS3-475	Orallo Formation	L6 Orallo Formation	0.00	×	0.09	×	0%
ATLS3-476	Taroom Coal Measures	L17 Taroom Coal Measures	0.00	×	2.34	×	0%
ATLS3-477	Lower Hutton Sandstone	L20 Lower Hutton Sandstone	0.00	×	0.35	×	0%
ATLS3-478	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.01	×	0%
ATLS3-479	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.07	×	0%
ATLS3-480	Bungil Formation	L4 Bungil Formation	0.00	×	0.05	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-481	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.21	×	0%
ATLS3-482	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.21	×	0%
ATLS3-483	Orallo Formation	L6 Orallo Formation	0.00	×	0.20	×	0%
ATLS3-484	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.07	×	0%
ATLS3-485	Orallo Formation	L6 Orallo Formation	0.00	×	0.28	×	0%
ATLS3-486	Orallo Formation	L6 Orallo Formation	0.00	×	0.27	×	0%
ATLS3-487	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.01	×	0%
ATLS3-488	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.01	×	0%
ATLS3-489	Bungil Formation	L4 Bungil Formation	0.00	×	0.08	×	0%
ATLS3-490	Orallo Formation	L6 Orallo Formation	0.00	×	0.21	×	0%
ATLS3-491	Orallo Formation	L6 Orallo Formation	0.00	×	0.06	×	0%
ATLS3-492	Lower Hutton Sandstone	L20 Lower Hutton Sandstone	0.00	×	0.90	×	0%
ATLS3-493	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.44	×	0%
ATLS3-494	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.44	×	0%
ATLS3-495	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.11	×	0%
ATLS3-496	Lower Hutton Sandstone	L20 Lower Hutton Sandstone	0.00	×	0.46	×	0%
ATLS3-497	Bungil Formation	L4 Bungil Formation	0.00	×	0.05	×	0%
ATLS3-498	Lower Hutton Sandstone	L20 Lower Hutton Sandstone	0.00	×	0.28	×	0%
ATLS3-499	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.26	×	0%
ATLS3-500	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.07	×	0%
ATLS3-501	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.07	×	0%
ATLS3-502	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.07	×	0%
ATLS3-503	Orallo Formation	L6 Orallo Formation	0.00	×	0.09	×	0%
ATLS3-504	Orallo Formation	L6 Orallo Formation	0.00	×	0.07	×	0%
ATLS3-505	Orallo Formation	L6 Orallo Formation	0.00	×	0.24	×	0%
ATLS3-506	Orallo Formation	L6 Orallo Formation	0.00	×	0.24	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-507	Orallo Formation	L6 Orallo Formation	0.00	×	0.24	×	0%
ATLS3-508	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.00	×	0%
ATLS3-509	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.06	×	0%
ATLS3-510	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.08	×	0%
ATLS3-511	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.08	×	0%
ATLS3-512	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.08	×	0%
ATLS3-513	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.14	×	0%
ATLS3-514	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.07	×	0%
ATLS3-515	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.09	×	0%
ATLS3-516	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.08	×	0%
ATLS3-517	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.19	×	0%
ATLS3-518	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.18	×	0%
ATLS3-519	Lower Hutton Sandstone	L20 Lower Hutton Sandstone	0.00	×	0.34	×	0%
ATLS3-520	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.02	×	0%
ATLS3-521	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.02	×	0%
ATLS3-522	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.09	×	0%
ATLS3-523	Orallo Formation	L6 Orallo Formation	0.00	×	0.05	×	0%
ATLS3-524	Bungil Formation	L4 Bungil Formation	0.00	×	0.06	×	0%
ATLS3-525	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.09	×	0%
ATLS3-526	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.09	×	0%
ATLS3-527	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.09	×	0%
ATLS3-528	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.09	×	0%
ATLS3-529	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.07	×	0%
ATLS3-530	Orallo Formation	L6 Orallo Formation	0.00	×	0.09	×	0%
ATLS3-531	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.25	×	0%
ATLS3-532	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.07	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-533	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.07	×	0%
ATLS3-534	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.17	×	0%
ATLS3-535	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.10	×	0%
ATLS3-536	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.16	×	0%
ATLS3-537	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.19	×	0%
ATLS3-538	Orallo Formation	L6 Orallo Formation	0.00	×	0.06	×	0%
ATLS3-539	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.17	×	0%
ATLS3-540	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.17	×	0%
ATLS3-541	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.16	×	0%
ATLS3-542	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.05	×	0%
ATLS3-543	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.10	×	0%
ATLS3-544	Orallo Formation	L6 Orallo Formation	0.00	×	0.07	×	0%
ATLS3-545	Orallo Formation	L6 Orallo Formation	0.00	×	0.08	×	0%
ATLS3-546	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.09	×	0%
ATLS3-547	Bungil Formation	L4 Bungil Formation	0.00	×	0.05	×	0%
ATLS3-548	Bungil Formation	L4 Bungil Formation	0.00	×	0.05	×	0%
ATLS3-549	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.19	×	0%
ATLS3-550	Orallo Formation	L6 Orallo Formation	0.00	×	0.06	×	0%
ATLS3-551	Bungil Formation	L4 Bungil Formation	0.00	×	0.05	×	0%
ATLS3-552	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.16	×	0%
ATLS3-553	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.14	×	0%
ATLS3-554	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.09	×	0%
ATLS3-555	Orallo Formation	L6 Orallo Formation	0.00	×	0.11	×	0%
ATLS3-556	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.08	×	0%
ATLS3-557	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.10	×	0%
ATLS3-558	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.09	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-559	Orallo Formation	L6 Orallo Formation	0.00	×	0.02	×	0%
ATLS3-560	Bungil Formation	L4 Bungil Formation	0.00	×	0.11	×	0%
ATLS3-561	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.10	×	0%
ATLS3-562	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.16	×	0%
ATLS3-563	Orallo Formation	L6 Orallo Formation	0.00	×	0.11	×	0%
ATLS3-564	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.06	×	0%
ATLS3-565	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.04	×	0%
ATLS3-566	Orallo Formation	L6 Orallo Formation	0.00	×	0.03	×	0%
ATLS3-567	Bungil Formation	L4 Bungil Formation	0.00	×	0.11	×	0%
ATLS3-568	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.10	×	0%
ATLS3-569	Orallo Formation	L6 Orallo Formation	0.00	×	0.05	×	0%
ATLS3-570	Orallo Formation	L6 Orallo Formation	0.00	×	0.05	×	0%
ATLS3-571	Orallo Formation	L6 Orallo Formation	0.00	×	0.05	×	0%
ATLS3-572	Orallo Formation	L6 Orallo Formation	0.00	×	0.04	×	0%
ATLS3-573	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.11	×	0%
ATLS3-574	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.08	×	0%
ATLS3-575	Wallumbilla Formation	L3 - Wallumbilla Formation	0.00	×	0.06	×	0%
ATLS3-576	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.17	×	0%
ATLS3-577	Orallo Formation	L6 Orallo Formation	0.00	×	0.02	×	0%
ATLS3-578	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.03	×	0%
ATLS3-579	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.11	×	0%
ATLS3-580	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.11	×	0%
ATLS3-581	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.11	×	0%
ATLS3-582	Bungil Formation	L4 Bungil Formation	0.00	×	0.11	×	0%
ATLS3-583	Orallo Formation	L6 Orallo Formation	0.00	×	0.09	×	0%
ATLS3-584	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.10	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-585	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.10	×	0%
ATLS3-586	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.11	×	0%
ATLS3-588	Orallo Formation	L6 Orallo Formation	0.00	×	0.03	×	0%
ATLS3-589	Orallo Formation	L6 Orallo Formation	0.00	×	0.03	×	0%
ATLS3-590	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.01	×	0%
ATLS3-591	Bungil Formation	L4 Bungil Formation	0.00	×	0.04	×	0%
ATLS3-592	Bungil Formation	L4 Bungil Formation	0.00	×	0.12	×	0%
ATLS3-593	Bungil Formation	L4 Bungil Formation	0.00	×	0.12	×	0%
ATLS3-594	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.16	×	0%
ATLS3-595	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.10	×	0%
ATLS3-596	Bungil Formation	L4 Bungil Formation	0.00	×	0.10	×	0%
ATLS3-597	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.11	×	0%
ATLS3-598	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.75	×	0%
ATLS3-599	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.01	×	0%
ATLS3-600	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.11	×	0%
ATLS3-601	Bungil Formation	L4 Bungil Formation	0.00	×	0.12	×	0%
ATLS3-602	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.10	×	0%
ATLS3-603	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.03	×	0%
ATLS3-604	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.03	×	0%
ATLS3-605	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.02	×	0%
ATLS3-606	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.11	×	0%
ATLS3-607	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.10	×	0%
ATLS3-608	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.11	×	0%
ATLS3-609	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.11	×	0%
ATLS3-610	Bungil Formation	L4 Bungil Formation	0.00	×	0.12	×	0%
ATLS3-611	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.12	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-612	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.12	×	0%
ATLS3-613	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.09	×	0%
ATLS3-614	Upper Hutton Sandstone	L19 Upper Hutton Sandstone	0.00	×	0.09	×	0%
ATLS3-615	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.69	×	0%
ATLS3-616	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.70	×	0%
ATLS3-617	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.03	×	0%
ATLS3-618	Bungil Formation	L4 Bungil Formation	0.00	×	0.13	×	0%
ATLS3-619	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.69	×	0%
ATLS3-620	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.67	×	0%
ATLS3-621	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.67	×	0%
ATLS3-622	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.66	×	0%
ATLS3-623	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.66	×	0%
ATLS3-624	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.65	×	0%
ATLS3-625	Bungil Formation	L4 Bungil Formation	0.00	×	0.10	×	0%
ATLS3-626	Orallo Formation	L6 Orallo Formation	0.00	×	0.03	×	0%
ATLS3-627	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.62	×	0%
ATLS3-628	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.62	×	0%
ATLS3-629	Other Alluvium	L1 - Alluvium	0.00	×	0.10	×	0%
ATLS3-630	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.04	×	0%
ATLS3-631	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.04	×	0%
ATLS3-632	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.61	×	0%
ATLS3-633	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.61	×	0%
ATLS3-634	Bungil Formation	L4 Bungil Formation	0.00	×	0.03	×	0%
ATLS3-635	Cenozoic Sediments	L1 - alluvium	0.00	×	0.11	×	0%
ATLS3-636	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.61	×	0%
ATLS3-637	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.60	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-638	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.61	×	0%
ATLS3-639	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.60	×	0%
ATLS3-640	Other Alluvium	L1 - Alluvium	0.00	×	0.11	×	0%
ATLS3-641	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.59	×	0%
ATLS3-642	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.60	×	0%
ATLS3-643	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.15	×	0%
ATLS3-644	Bungil Formation	L4 Bungil Formation	0.00	×	0.05	×	0%
ATLS3-645	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.60	×	0%
ATLS3-646	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.60	×	0%
ATLS3-647	Other Alluvium	L1 - Alluvium	0.00	×	0.09	×	0%
ATLS3-648	Other Alluvium	L1 - Alluvium	0.00	×	0.09	×	0%
ATLS3-649	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.59	×	0%
ATLS3-650	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.59	×	0%
ATLS3-651	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.58	×	0%
ATLS3-652	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.58	×	0%
ATLS3-653	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.08	×	0%
ATLS3-654	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.57	×	0%
ATLS3-655	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.03	×	0%
ATLS3-656	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.58	×	0%
ATLS3-657	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.13	×	0%
ATLS3-658	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.13	×	0%
ATLS3-659	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.13	×	0%
ATLS3-660	Other Alluvium	L1 - Alluvium	0.00	×	0.09	×	0%
ATLS3-661	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.56	×	0%
ATLS3-662	Other Alluvium	L1 - Alluvium	0.00	×	0.08	×	0%
ATLS3-663	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.55	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-664	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.54	×	0%
ATLS3-665	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.53	×	0%
ATLS3-666	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.53	×	0%
ATLS3-667	Bungil Formation	L4 Bungil Formation	0.00	×	0.05	×	0%
ATLS3-668	Upper Evergreen Formation	L21 Upper Evergreen Formation	0.00	×	0.13	×	0%
ATLS3-669	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.53	×	0%
ATLS3-670	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.53	×	0%
ATLS3-671	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.54	×	0%
ATLS3-672	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.54	×	0%
ATLS3-674	Precipice Sandstone	L24 Precipice Sandstone	0.00	×	0.51	×	0%
ATLS3-675	Bungil Formation	L4 Bungil Formation	0.00	×	0.02	×	0%
ATLS3-676	Bungil Formation	L4 Bungil Formation	0.00	×	0.02	×	0%
ATLS3-677	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.03	×	0%
ATLS3-678	Other Alluvium	L1 - Alluvium	0.00	×	0.08	×	0%
ATLS3-679	Other Alluvium	L1 - Alluvium	0.00	×	0.08	×	0%
ATLS3-680	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-681	Cenozoic Sediments	L1 - alluvium	0.00	×	0.07	×	0%
ATLS3-682	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-683	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-684	Cenozoic Sediments	L1 - alluvium	0.00	×	0.08	×	0%
ATLS3-685	Other Alluvium	L1 - Alluvium	0.00	×	0.08	×	0%
ATLS3-686	Cenozoic Sediments	L1 - alluvium	0.00	×	0.08	×	0%
ATLS3-687	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-688	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-689	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-690	Cenozoic Sediments	L1 - alluvium	0.00	×	0.07	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-691	Cenozoic Sediments	L1 - alluvium	0.00	×	0.07	×	0%
ATLS3-692	Cenozoic Sediments	L1 - alluvium	0.00	×	0.07	×	0%
ATLS3-693	Cenozoic Sediments	L1 - alluvium	0.00	×	0.07	×	0%
ATLS3-694	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-695	Bungil Formation	L4 Bungil Formation	0.00	×	0.05	×	0%
ATLS3-696	Cenozoic Sediments	L1 - alluvium	0.00	×	0.07	×	0%
ATLS3-697	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-698	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-699	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-700	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-701	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-702	Cenozoic Sediments	L1 - alluvium	0.00	×	0.07	×	0%
ATLS3-703	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-704	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-705	Cenozoic Sediments	L1 - alluvium	0.00	×	0.07	×	0%
ATLS3-706	Cenozoic Sediments	L1 - alluvium	0.00	×	0.07	×	0%
ATLS3-707	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-708	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-709	Cenozoic Sediments	L1 - alluvium	0.00	×	0.06	×	0%
ATLS3-710	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.01	×	0%
ATLS3-711	Bungil Formation	L4 Bungil Formation	0.00	×	0.01	×	0%
ATLS3-712	Bungil Formation	L4 Bungil Formation	0.00	×	0.01	×	0%
ATLS3-713	Other Alluvium	L1 - Alluvium	0.00	×	0.06	×	0%
ATLS3-714	Other Alluvium	L1 - Alluvium	0.00	×	0.06	×	0%
ATLS3-715	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.00	×	0%
ATLS3-716	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.00	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-717	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.00	×	0%
ATLS3-718	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.00	×	0%
ATLS3-719	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.02	×	0%
ATLS3-720	Orallo Formation	L6 Orallo Formation	0.00	×	0.01	×	0%
ATLS3-721	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-722	Lower Juandah Coal Measures	Max. drawdown from L14 to L16	0.00	×	0.00	×	0%
ATLS3-723	Bungil Formation	L4 Bungil Formation	0.00	×	0.00	×	0%
ATLS3-724	Other Alluvium	L1 - Alluvium	0.00	×	0.12	×	0%
ATLS3-725	Other Alluvium	L1 - Alluvium	0.00	×	0.08	×	0%
ATLS3-726	Other Alluvium	L1 - Alluvium	0.00	×	0.08	×	0%
ATLS3-727	Other Alluvium	L1 - Alluvium	0.00	×	0.08	×	0%
ATLS3-728	Other Alluvium	L1 - Alluvium	0.00	×	0.08	×	0%
ATLS3-729	Other Alluvium	L1 - Alluvium	0.00	×	0.08	×	0%
ATLS3-730	Other Alluvium	L1 - Alluvium	0.00	×	0.11	×	0%
ATLS3-731	Other Alluvium	L1 - Alluvium	0.00	×	0.13	×	0%
ATLS3-732	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.00	×	0.00	×	0%
ATLS3-733	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.00	×	0.00	×	0%
ATLS3-734	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.00	×	0.00	×	0%
ATLS3-735	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-736	Moolayember Formation	L25 Moolayember Formation	0.00	×	0.14	×	0%
ATLS3-737	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-738	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.00	×	0%
ATLS3-739	Orallo Formation	L6 Orallo Formation	0.00	×	0.00	×	0%
ATLS3-740	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.00	×	0%
ATLS3-741	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.00	×	0.00	×	0%
ATLS3-743	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-744	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-745	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-746	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-747	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-748	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-749	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-750	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-751	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-752	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-753	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-754	Rewan Group	L27 Rewan Group	0.00	×	1.54	×	0%
ATLS3-756	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-757	Orallo Formation	L6 Orallo Formation	0.00	×	0.00	×	0%
ATLS3-758	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.00	×	0.00	×	0%
ATLS3-759	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.00	×	0.00	×	0%
ATLS3-760	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-761	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.00	×	0%
ATLS3-762	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.00	×	0%
ATLS3-763	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.00	×	0%
ATLS3-764	Lower Evergreen Formation	L23 Lower Evergreen Formation	0.00	×	0.04	×	0%
ATLS3-765	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-766	Moolayember Formation	L25 Moolayember Formation	0.00	×	0.16	×	0%
ATLS3-767	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.01	×	0%
ATLS3-773	Other Alluvium	L1 - Alluvium	0.00	×	0.11	×	0%
ATLS3-774	Other Alluvium	L1 - Alluvium	0.00	×	0.10	×	0%
ATLS3-775	Other Alluvium	L1 - Alluvium	0.00	×	0.09	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-776	Other Alluvium	L1 - Alluvium	0.00	×	0.08	×	0%
ATLS3-777	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-778	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-779	Other Alluvium	L1 - Alluvium	0.00	×	0.07	×	0%
ATLS3-780	Other Alluvium	L1 - Alluvium	0.00	×	0.06	×	0%
ATLS3-781	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.01	×	0%
ATLS3-782	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.00	×	0.01	×	0%
ATLS3-783	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.00	×	0.00	×	0%
ATLS3-784	Wallumbilla Formation	L3 - Wallumbilla Formation	0.00	×	0.00	×	0%
ATLS3-785	Upper Springbok Sandstone	L9 - Upper Springbok Sandstone	0.00	×	0.00	×	0%
ATLS3-786	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.00	×	0%
ATLS3-787	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.00	×	0%
ATLS3-788	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.00	×	0%
ATLS3-789	Gubberamunda Sandstone	L7 Gubberamunda Sandstone	0.00	×	0.00	×	0%
ATLS3-790	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-791	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-792	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-793	Orallo Formation	L6 Orallo Formation	0.00	×	0.00	×	0%
ATLS3-794	Orallo Formation	L6 Orallo Formation	0.00	×	0.00	×	0%
ATLS3-795	Mooga Sandstone	L5 Mooga Sandstone	0.00	×	0.00	×	0%
ATLS3-796	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-797	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-798	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-799	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-800	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-801	Wallumbilla Formation	L3 - Wallumbilla Formation	0.00	×	0.00	×	0%

Senex ID	Aquifer Attribution	Impact Assessment Formation	Project Only Drawdown (m)	Trigger Exceeded - Project	Cumulative Drawdown (m)	Trigger Exeeded - Cumulative	Contribution of Project to Cumulative %
ATLS3-802	Bungil Formation	L4 Bungil Formation	0.00	×	0.00	×	0%
ATLS3-803	Wallumbilla Formation	L3 - Wallumbilla Formation	0.00	×	0.00	×	0%
ATLS3-804	Wallumbilla Formation	L3 - Wallumbilla Formation	0.00	×	0.00	×	0%
ATLS3-805	Bungil Formation	L4 Bungil Formation	0.00	×	0.00	×	0%
ATLS3-806	Wallumbilla Formation	L3 - Wallumbilla Formation	0.00	×	0.00	×	0%
ATLS3-807	Wallumbilla Formation	L3 - Wallumbilla Formation	0.00	×	0.00	×	0%
ATLS3-809	Orallo Formation	L6 Orallo Formation	0.00	×	0.00	×	0%
ATLS3-810	Westbourne Formation	L8 Westbourne Formation	0.00	×	0.00	×	0%
ATLS3-768	Metamorphic/igneous/old basement rocks	Layer 1 - basalt	0.00	×	0.08	×	0%
ATLS3-769	Metamorphic/igneous/old basement rocks	Layer 1 - basalt	0.00	×	0.07	×	0%
ATLS3-770	Metamorphic/igneous/old basement rocks	Layer 1 - basalt	0.00	×	0.07	×	0%
ATLS3-771	Metamorphic/igneous/old basement rocks	Layer 1 - basalt	0.00	×	0.08	×	0%
ATLS3-772	Metamorphic/igneous/old basement rocks	Layer 1 - basalt	0.00	×	0.12	×	0%

APPENDIX V

Stygofauna Assessment

Senex - Atlas Stage 3 Gas Project
Stygofauna Pilot Survey

Prepared for ERM
August 2022

Document Control Summary

Document Revisions

Project Title		Senex - Atlas Stage 3 Gas Project – Stygofauna Pilot Survey			
Project Manager		Dr Timothy Howell			
Document Title		FE22007_Atlas3StygoJun2022_V1			
Electronic File Name	**Status**	**Prepared by**	**Reviewed by**	**Authorised by**	**Date**
FE22007_Atlas3StygoJun2022_V1	Draft	TDH	GLB	TDH	23/8/2022
FE22007_Atlas3StygoJun2022_FINAL	Final	TDH	HQT	TDH	11/10/2022

Document Distribution

Electronic File Name	Status	Issued to	Format	Issued by
FE22007_Atlas3StygoJun2022_V1	Draft	Matt Davis	MS word	TDH
FE22007_Atlas3StygoJun2022_FINAL	Final	Matt Davis	MS word	TDH

Table of Contents

1. Introduction

Senex's proposed Atlas Stage 3 project is located in the Surat Basin, 20 kilometres south-west of the town of Wandoan in Queensland. ERM was engaged by Senex manage ecological surveys and associated approval inputs for the Atlas Stage 3 project. Freshwater Ecology Consulting was engaged by ERM to undertake the stygofauna sampling component of the surveys.

KCB were engaged by Senex to undertake bore baseline assessment work for the Atlas Stage 3 project and their representatives helped facilitate the stygofauna sampling undertaken by Freshwater Ecology and described in this report.

2. General Terminology

In Australia, Groundwater Dependent Ecosystems (GDE's) are defined as 'ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services' (Richardson *et al*. 2011). Not all GDE's draw on groundwater directly and not all GDE's are solely reliant on groundwater.

Six types of Groundwater Dependent Ecosystems have been identified in Australia:

- Terrestrial vegetation that relies on the availability of shallow groundwater.
- Wetlands such as paperbark swamp forests and mound springs.
- River baseflow systems where groundwater discharge provides a significant baseflow component to the river.
- Aquifer and cave ecosystems where life exists independent of sunlight (this GDE contains stygofauna and is the focus of the current survey).
- Terrestrial fauna species, both native and introduced, that rely on groundwater as a source of drinking water.
- Estuarine and near-shore marine systems, such as coastal mangroves, salt marshes and sea-grass beds, which rely on the submarine discharge of groundwater.

Until recently (mid 1990's), aquifers were considered to be devoid of life, however, research in Australia and overseas has highlighted the fact that groundwater systems provide a critical habitat for a diverse range of aquatic fauna called stygofauna (Hose *et al*. 2015, Glanville *et al*. 2016). The term stygofauna encompasses;

- Stygobionts (stygobites) which are defined as being organisms that are obligate groundwater inhabitants for their entire life cycle (Sket 2008),
- Stygophiles which are defined as surface-dwelling species that complete some or all of their life cycle in groundwater (Sket 2008), and
- Stygoxenes which are defined as animals found accidentally in groundwater (Sket 2008).

Typically, it is the stygobionts and stygophiles that are referred to collectively as stygofauna (Hose *et al*. 2015) and these definitions will be adopted for this Atlas 3 Project survey.

3. What are Stygofauna?

Stygofauna are aquatic subterranean animals that are totally groundwater dependent and found throughout Australian aquifers. Groundwater ecology surveys and studies over the past 30 years in Australia have identified a diverse range of organisms inhabiting groundwater systems, however, whilst the groundwater ecosystem is diverse and unique, this ecosystem is probably the least studied globally. Tomlinson *et al.* (2008) noted that stygofauna are valued as a biodiversity resource, as indicators of groundwater ecosystem health and potential providers of ecosystem services including, nutrient cycling and storage (e.g. carbon, nitrogen, phosphorus), organic matter cycling and redistribution, water treatment (e.g. filtering water to remove toxins), water regulation (e.g. increasing the size of interstitial pore spaces to maintain hydraulic flow pathways and infiltration rates), and mineral weathering and formation.

Stygofauna are morphologically and physiologically different from even closely related surface-dwelling species having independently evolved common morphological traits such as lacking eyes, having hardened body parts, lacking body pigments and having worm-like body shapes and enhanced sensory appendages as an adaption to the groundwater environment (Humphreys 2006). Individuals from 9 of the 17 major stygofauna taxonomic groups identified by Botosaneanu (1986) have been recorded in the groundwater ecosystems of Queensland with undescribed families identified across a further 3 taxonomic groups (Nematoda, Rotifera, and Turbellaria). Groundwater fauna from the 5 remaining taxonomic groups yet to be identified in Queensland groundwater ecosystems include Decapoda, Polychaeta, Remipedia, Spelaeogriphacea, and Thermosbaenacea (Glanville *et al*. 2016). Many of Queensland's stygofauna communities are unstudied or understudied hampering both global and local comparisons. Despite this, Europe, North America and other areas of Australia (e.g. Western Australia) provide the most appropriate baseline for comparison given the higher survey effort employed in these regions (Deharveng *et al.* 2009, Halse *et al.* 2014). While research has identified that eastern Queensland supports moderately rich stygofauna communities (Hancock & Boulton 2008, Cook *et al.* 2012, Halse *et al.* 2014), analysis highlights that this estimate is too low due to the low sampling effort and limited sampling coverage that largely excludes arid regions and low taxonomic resolution (Glanville *et al*. 2016).

Many stygofauna communities around the world are dominated by amphipods, copepods, and isopods (Deharveng *et al.* 2009, Halse *et al.* 2014). Queensland stygofauna communities comprise copepods and isopods in proportions comparable with world averages (Eberhard *et al.* 2009) and copepod proportions comparable to experiences in eastern Australia and the Pilbara (Eberhard *et al.* 2009, Halse *et al.* 2014). However, Queensland stygofauna communities differ due to the dominance of oligochaetes (Eberhard *et al.* 2009), syncarids (Eberhard *et al.* 2009) and beetles (Eberhard *et al.* 2009). Dissimilar to many other stygofauna communities around the world, stygofauna communities in Queensland have a low proportion of molluscs (Eberhard *et al.* 2009). This compositional feature more closely reflects that of other Australian stygofauna communities (Hancock & Boulton 2008), including the Pilbara (Eberhard *et al.* 2009, Halse *et al.* 2014), than global experiences. These comparisons are limited by low sampling effort in many regions, however, the composition of Queensland stygofauna communities is clearly differentiated from that of most of the world (Glanville *et al*. 2016).

Stygofauna are adapted to groundwater environments and conditions of constant temperature, no sunlight, low nutrient and oxygen content, stable water quality and sediments that provide a limited and narrow pore space (Hose *et al.* 2015). Stygofauna have low metabolic rates and low reproductive rates relative to surface species which enables them to survive in the low energy, low oxygen groundwater environment. Groundwater ecosystems typically have few stygobiont species at any one locality and consequently low diversity. However, the isolation of aquifers and limited dispersal abilities of groundwater organisms has created a fauna dominated by short-range endemic species (Harvey 2002). As stygofauna are adapted to a stable physical and chemical subterranean environment, and as species often exhibit narrow geographic ranges, even slight alterations to the groundwater environment (i.e. flow, flux, pressure, level, quality and the transport of nutrients and organic matter) can result in significant changes to the composition and distribution of stygofauna communities and even the potential loss of species. The major pressures on groundwater systems in Queensland, as elsewhere, are from anthropogenic activities (i.e. agriculture, industry and domestic water supply) that modify aspects of the groundwater environment and impact on groundwater quantity (water levels and pressures), groundwater quality (salinity, chemistry, contamination) and groundwater interactions between surface and sub-surface systems. The pressures on groundwater ecosystems are also cumulative (Danielopol *et al.* 2003).

3.1 Ecological Requirements of Stygofauna

Twenty years ago it was believed that stygofauna only existed within a very narrow physico-chemical parameter range. More recent surveys and studies have shown that this is not the case and that stygofauna may be found across a more diverse physico-chemical range of groundwater systems than was previously commonly assumed. Only recently has the true biological diversity of aquifers begun to emerge, both in Australia and globally.

In 2016, Glanville *et al.*, reviewed a state-wide database which included 755 stygofauna samples from 582 sites in Queensland and the current knowledge on stygofauna biodiversity and biogeography. This study correlated stygofauna recordings against environmental data and reported the following important outcomes:

- Groundwater with a wide range of physico-chemical properties have been recorded as supporting groundwater ecosystems in Queensland.
- Stygofauna have been recorded living in groundwater ranging in depth from 0.1 to 63.2 metres below ground level; electrical conductivity ranging from 11.5 to 54,800 µS/cm; groundwater temperatures ranging from 17.0 to 30.7^{o}C, and groundwater pH ranging from 3.5 to 10.3.
- Stygofauna taxon richness shows a general negative trend with increasing depth to groundwater or electrical conductivity (a default measurement for salinity).
- Taxon richness is highest in neutral to slightly alkaline pH groundwater systems and in water temperatures between 18 and 27^{o}C.
- Taxon richness was shown to decrease sharply with increasing groundwater acidity and alkalinity.

It was acknowledged that the stygofauna preferences identified from the Queensland database may partially reflect the limited sampling effort that has occurred across physico-chemically diverse groundwater systems and that the data was predominantly from sites sampled only once.

Hose *et al.* (2015) also noted a number of key factors determining the presence/absence of stygofauna in aquifers:

- Stygofauna are predominantly found in aquifers with large (1mm or greater) pore spaces which are more common in alluvial, karstic and some fractured rock aquifers. The pore spaces within an aquifer matrix are a critical determinant of whether an aquifer can support large-bodied organisms as stygofauna move within an aquifer by either crawling or swimming. The size of the interstitial spaces also influences the hydraulic conductivity and flow of water which ultimately controls the delivery of carbon and oxygen throughout the ecosystem. Hahn & Fuchs (2009) identified that stygofauna were rare or absent in areas with hydraulic conductivity (K_f) less than 10^{-4}cm/s.
- Stygofauna diversity and abundance typically decreases with depth below ground. Stygofauna are rarely found more than 100 m below ground level and are most abundant less than 20 m below ground (Hancock & Boulton 2008).
- Stygofauna are found across a range of water quality conditions (from fresh to saline), but are most common in fresh and brackish water (i.e. where EC is less than 5,000 µS/cm). 4T (2012) in their review of stygofauna data from Australia reported that stygofauna have been found in hypersaline groundwater (86,900 µS/cm), but are most common at salinities less than 10,000 µS/cm.
- Stygofauna are rarely found in hypoxic groundwater where dissolved oxygen concentrations are less than 0.3 mg/L. 4T (2012) reported that stygofauna have been recorded in groundwater with dissolved oxygen concentrations ranging from 0.2 to 15.3 mg/L.
- Stygofauna are more abundant in areas of surface water-groundwater exchange when compared to deeper areas or those further along the groundwater flow path remote from areas of exchange or recharge with poor hydraulic conductivity. Schmidt *et al.* (2007) noted that hydrological exchange between aquifer and surface water can be more important than other hydrogeological conditions in shaping stygofauna assemblages.

Stygofauna were recorded inhabiting a wide range of lithologies, including unconsolidated sedimentary material (e.g. alluvium, sand); consolidated sedimentary rocks (e.g. sandstone) and fractured rocks (e.g. basalt, granite, volcanics). Whilst sampling data are scarce or absent for many lithologies, the results from Glanville *et al.* (2016) suggest that groundwater systems cannot be eliminated as potential habitat for stygofauna based solely on geology or lithology. Stygofauna were also shown to exist across a diverse physico-chemical range of groundwater systems, and as a result, general assumptions of habitat suitability should not be used to guide sampling activities.

Stygofauna are adapted to a low nutrient (particularly carbon) and oxygen environment. For aquifers to sustain stygofauna there must be a continuous vertical flow of dissolved organic carbon (DOC) from the surface to the aquifer. It is this carbon plus dissolved nutrients that are the basis of the simple food web that sustains bacteria and fungi (biofilms) which stygofauna can feed on (Humphreys 2006). It is largely for this reason that stygofauna diversity and abundance decrease with depth and distance along groundwater flow paths as nutrient supplies decline.

3.2 Stygofauna Diversity

Hose *et al.* (2015) reports that in 2000 there were over 7,800 known stygofaunal species globally, however, large research efforts in Australia and Europe have shown that this number is an underestimation. Guzik *et al.* (2010) reported some 770 stygofauna taxa were known from Western Australia alone, however, this value was estimated to be only 20% of the true number of stygobiont taxa. True richness for the region may be in excess of 4,000 stygobitic species. Based on these values, and the fact that the diversity of stygofauna in the eastern states is largely unexplored, it is likely Australia is globally significant in terms of stygofauna diversity (Hose *et al.* 2015).

Many of Queensland's stygofauna communities are unstudied or understudied, hampering both global and local comparisons. Queensland is known to host at least 24 described families and 23 described genera of stygofauna across 9 of the 17 major stygofaunal taxonomic groups. Undescribed families have also been recorded across a further three major stygofauna taxonomic groups (Glanville *et al.* 2016). The composition of stygofauna in Queensland is broadly consistent with the world average with the notable exception of high richness of oligochaetes and syncarids and low numbers of molluscs. Despite indications that a significant diversity of stygofauna is likely to exist across Queensland groundwater systems, stygofauna biodiversity largely remains undocumented due to limited sampling effort, limited taxonomic resolution and the tendency for stygofauna to exhibit morphological similarities (Glanville *et al.* 2016).

3.3 Potential Impacts on Groundwater and Stygofauna

There are three major changes in groundwater conditions that can directly threaten the integrity of groundwater ecosystems. These stressors are:

- Spatial and temporal changes in water level (i.e. groundwater drawdown);
- Altered groundwater quality; and
- Altered aquifer properties (including aquifer porosity, hydraulic conductivity and depressurisation).

Such changes in the physical and chemical properties of an aquifer, either individually or cumulatively, are likely to affect the occurrence and/or the distribution of stygofauna in an aquifer. Cumulative impacts from multiple stressors need to be considered in combination when assessing impacts on the groundwater environment. Stygofauna exhibit high rates of endemism (short-range endemics) with species often restricted to small geographic areas.

3.4 Knowledge Gaps Regarding Stygofauna

In 2015, Hose *et al.* published a report commissioned by ACARP entitled "Stygofauna in Australian Groundwater Systems: Extent of Knowledge". This report identified a number of emerging issues where knowledge is lacking with regards to risks to aquifer ecosystems from activities that impact groundwater quantity and quality (e.g. mining, water supply, agriculture). In particular, Hose *et al.* (2015) identified a very limited ability to understand and subsequently predict impacts of dewatering/depressurisation of aquifers on stygofauna communities. Additional knowledge-deficient areas were identified as:

- The role of coal seams as stygofauna habitat;
- Water quality tolerance of stygofauna – toxicants and physico-chemical stressors;
- Groundwater foodwebs as a pathway to impact stygofauna;
- Taxonomy and distribution of stygofauna species, and
- Links between hydrological modelling and impacts on stygofauna.

Targeted research and further surveys/studies are required to inform and improve our ability to assess the risk to groundwater ecosystems from operations/industries that impact on groundwater quantity, groundwater quality and groundwater interactions.

4. Sampling Program for Stygofauna

A total of 32 groundwater bores were identified by KCB as being potentially sampleable across and in proximity of the Atlas 3 Project Area. Attempts were made to find each bore and sample them. Several of the bore locations no longer had bores at them, and several others were not able to be sampled (due to either no pumps or existing infrastructure that could not be removed to allow access for stygofauna nets). A total of 12 bores were able to be sampled for stygofauna. The locations of the 12 groundwater bores sampled within the proposed Atlas 3 Project study area are shown in **Figure 1**. The location and history of each bore are presented in **Table 1** and bore hole characteristics presented in **Table 2** below. The bores ranged from full (bore number 14193 was overflowing to 173.1 metres deep), with some bores slotted at particular depths and others open below a certain point. Bore ages varied from 1945 through to 1999. The bores intersected various formations, with one being directly into the alluvium. All operating bores were being used for watering cattle.

Bore inspection and sampling was conducted for this project by Freshwater Ecology from 11th to 16th June 2022.

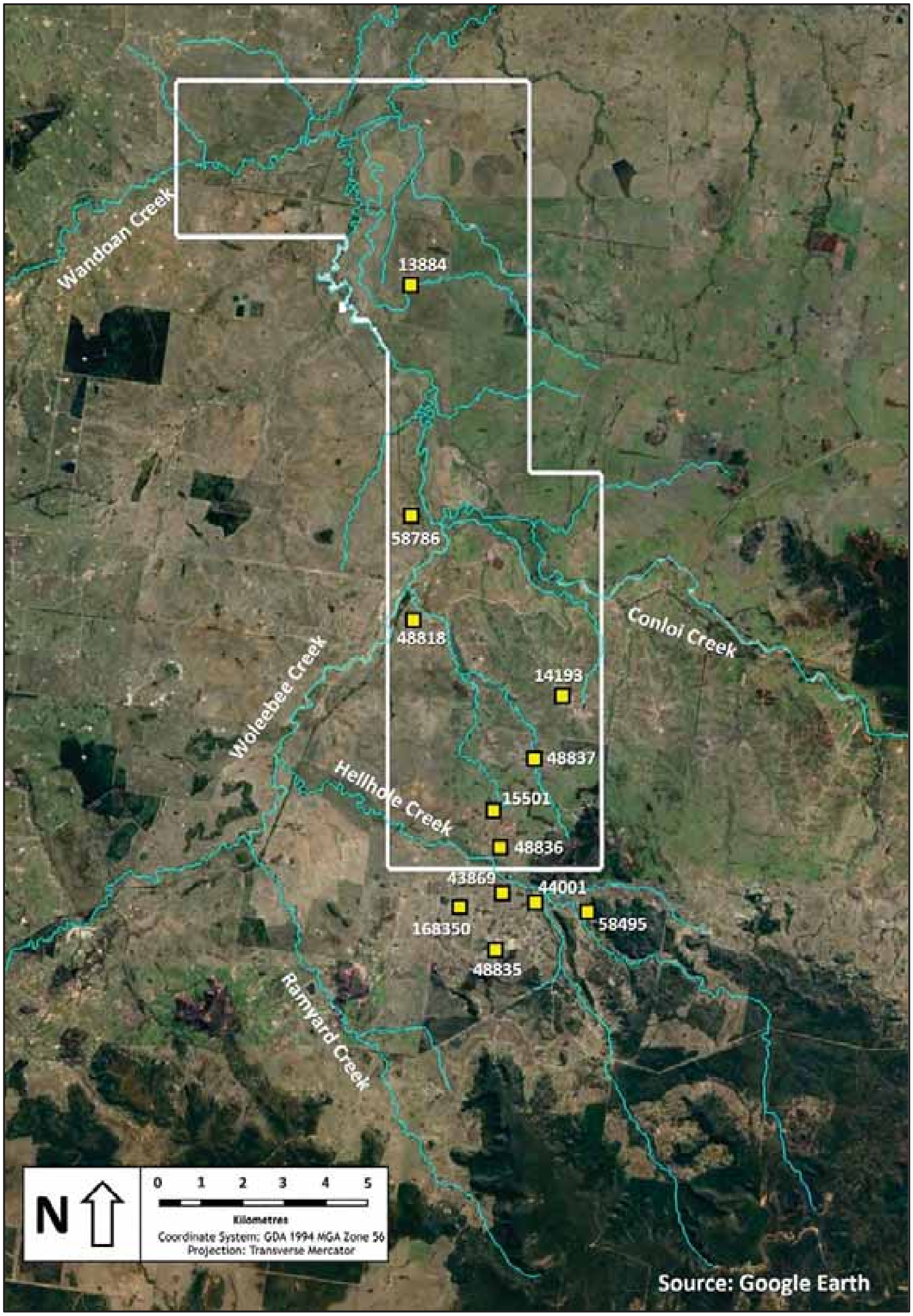

Figure 1: Location of bores sampled for stygofauna

Table 1: **Location of groundwater bores sampled for stygofauna** (N/A – data not available)

Bore Code	Easting (WGS84 55J)	Northing (WGS84 55J)	Strata description	Bore Purpose	Date Drilled	Date Sampled
13844	783791	7098227	Upper Springbok Sandstone	Abandoned	2/06/1958	15/06/2022
58786	783626	7092910	Westbourne formation	Not operative	7/05/1999	11/06/2022
48818	783638	7090412	Gubberamunda Sandstone	Cattle watering	28/03/1974	11/06/2022
14193	786999	7088621	Gubberamunda Sandstone	Cattle watering	1/07/1960	12/06/2022
48837	786446	7087185	Gubberamunda Sandstone	Cattle watering	14/01/1975	13/06/2022
15501	785451	7085947	Gubberamunda Sandstone	Cattle watering	18/12/1962	13/06/2022
48836	785645	7084939	Gubberamunda Sandstone	Cattle watering	31/08/1945	13/06/2022
43869	785702	7084004	Orallo Fm - Gubberamunda Sandstone	Cattle watering	3/08/1973	14/06/2022
44001	786472	7083702	Orallo formation – Gubberamunda Sandstone	Abandoned	10/10/1973	14/06/2022
168350	784545	7083655	Gubberamunda Sandstone	Cattle watering	N/A	14/06/2022
58495	787448	7083477	Orallo formation	Cattle watering	N/A	16/06/2022
48835	785363	7082702	Gubberamunda Sandstone	Cattle watering	14/01/1975	13/06/2022

Table 2: Bore Hole Characteristics (mBGL - metres below ground level; mBTOC - metres below top of casing; EoH – end of hole; SWL – standing water level) (N/A – data not available)

Bore Code	Depth to EoH * (mBGL)	SWL (mBTOC)	Bore Diameter (mm)	Slotted Depth * (m)
13884	173.1	full	152	105.2-110.3
58786	76	33.5	125	72-76
48818	38.1	9.1	125	12.4-38.1
14193	N/A	N/A	125	N/A
48837	47.5	16.2	125	31.7-47.5
15501	106.4	37.2	125	53.9-106.4
48836	91.5	N/A	125	48.8-91.5
43869	109.8	N/A	125	51.6-109.8
44001	112.8	27.6	125	44.8-112.8
168350	N/A	N/A	125	N/A
58495	36	30.1	152	N/A
48835	137.3	N/A	125	101.5-137.2

***values obtained for bore hole logs,**

5. Project Methodology

5.1 Desktop Assessment

A review was undertaken to search for available data and reports on stygofauna within and adjacent to the Atlas 3 Project Area. This included searches for projects in adjacent areas known to have undertaken environmental assessments as well as the Queensland subterranean aquatic fauna database (Queensland Government 2022). There were no available reports found for adjacent projects. As such, it was determined that the most appropriate approach to sampling was to undertake a pilot survey to address the knowledge gaps in the desktop review. A pilot survey typically consists of sampling a minimum of ten bores with bore locations satisfying specific criteria for conducting stygofauna surveys.

5.2 Sampling Team

Field sampling for the Atlas 3 Project was conducted by Dr Timothy Howell from Freshwater Ecology. Dr Howell is a professional aquatic ecologist with experience in stygofauna sample collection and analysis. Tim Howell has more than 20 years' experience as an aquatic ecologist and 12 years' specific experience working on groundwater ecology projects throughout Australia. Freshwater Ecology was supported in the field by Dr Matthew Forbes from KCB.

5.3 Stygofauna Sampling

A total of 12 groundwater bores were sampled for stygofauna in accordance with the methods defined in Queensland Environment Protection (Water) Policy 2009 – Monitoring and Sampling Manual for Biological Assessment (DES 2018) and following established sampling techniques defined elsewhere in Australia and overseas (DSITI 2015, Hancock & Boulton 2008, Dumas & Fontanini 2001, WA EPA Guidance Statements 54 and 54a 2003 & 2007). The field sampling program adopted by Freshwater Ecology met all requirements required for conducting a stygofauna pilot survey.

There are two recommended sampling methods for stygofauna—netting and pumping. Netting is a passive sampling method that collects animals residing within the bore casing. Pumping is an active sampling method that collects groundwater and fauna from within the bore casing and the surrounding aquifer through groundwater recharge. Both methods were used in the current assessment depending on the infrastructure, or lack of, associated with each bore.

Netting was undertaken in three groundwater bores (13884, 58786, 44001) that were 125mm in diameter using a 50mm diameter phreatobiological net (net design and construction conformed with WA EPA Guideline [2003 & 2007] specifications). Nets were made of 50 µm nybolt mesh material and weighted at the bottom with a brass fixture and an attached plastic collecting jar. The net was lowered to the bottom of the bore, bounced three to five times to dislodge any resting animals, and slowly retrieved. At the top of each haul (the aim was always to collect between 4 and

6 hauls with all hauls reaching the bottom of the bore), the collecting jar was rinsed into a 50 µm mesh brass sieve and the net lowered again.

The pumping method was used at the remaining nine groundwater bores which had fixed pumps that were all run off solar panels. Three rows of ten x 9 litre buckets were set out adjacent to the pump. The buckets were filled sequentially once the water from the pump began to flow. To reduce spilling, the buckets were filled to near the top but not full. This ensured that at least 250 litres was collected for each bore. Each bucket was sequentially filtered through the 50 µm mesh brass sieve. As there was little suspended material in the pumped samples for this project, they were collectively washed into a single sample jar for each site.

Once all net hauls were completed or all the buckets from pumping had been filtered through the sieve, the entire sieve contents were then transferred to a labelled sample jar and preserved in methylated spirits (DNA testing of aquatic specimens was not required for this project). A small amount of Rose Bengal, which stains animal tissue pink, was added to each sample to aid in sample processing.

All field equipment was of high quality and fit for purpose, well maintained and operated in accordance with scientific protocols specified above.

5.4 Laboratory Processing of Field Samples

Field samples were logged into a Laboratory Information Management System to record and track sample processing details. Stygofauna sample containers were drained of methylated spirits and stain and washed gently into channelled Sedgwick-Rafter counting trays to create a thin layer of sediment spread across the bottom of the tray. Samples were then sorted under a stereomicroscope with 10x objective lenses and a zoom capability of between 6.3x and 60x. All aquatic animals present were removed (stygofauna and non-stygofauna) and identified to Order/Family level (or lower taxonomic rank if visually possible) in accordance with standard Queensland Government ToR for an EIS and placed in labelled, polyethylene containers filled with 100% AR Grade ethanol for long-term storage.

Sample sorting and initial identification was undertaken by Chris Pietsch from Blue Earth Environmental. Photographs of the sampled specimens considered to be potentially stygofauna were sent to Dr Peter Hancock to determine whether they were likely to be stygofauna and thus require further detailed identification.

5.5 Groundwater Quality Sampling

Groundwater sampling preceded biological sampling to ensure the groundwater contained within the bore was undisturbed. The field meter was calibrated in the laboratory prior to its use in the field, with calibrations regularly cross-checked in the field. All water quality monitoring equipment was of high quality and fit for purpose, well maintained and operated in accordance with the manufacturer’s specifications.

Groundwater quality sampling was conducted differently at bores that were open (i.e. sites that were sampled with the netting method) to those with attached pumping infrastructure (i.e. those sampled by the pumping method). Water was measured for temperature (^{o}C), pH (units), electrical conductivity (µS/cm), dissolved oxygen (mg/L) and turbidity (NTU) using a multi-parameter water quality meter to provide a general estimate of standing groundwater quality.

For open bores, water samples were collected from each bore using a bailer lowered by hand to approximately 2 m to 3 m below the water surface (SWL) prior to stygofauna sampling. Care was taken to slowly and gently pour water from the bailer into a container prior to inserting the WQ probes so as to reduce any artificial aeration that might occur during this process. As this could not be totally eliminated, dissolved oxygen results should be treated with caution.

At sites with existing pumping infrastructure, water quality was measured in the buckets filled from the pump. Water quality was recorded in the 1st, 5th, 10th, 15th, 20th, 25th and 30th buckets for each site. Only the water quality results for the 30th buckets results are reported here as this is likely to be more reflective of the water quality conditions of the groundwater rather than in the bore itself.

6. Results

A review of the Queensland subterranean aquatic fauna database identified 32 bores that had been sampled within a 50 kilometre radius of the Atlas 3 Project Area. Closer examination of the coordinates determined that six of the bores were given a second name (i.e. data from the same bore had been recorded twice), reducing the number of bores previously sampled for stygofauna to 26 (Figure 2).

Examination of the results from the 26 bores determined that only four had recorded true stygobites and a further six bores had identified fauna that was subsequently considered not to be stygobites, and were most likely stygophiles (i.e. species which occasionally utilise groundwater but are not dependent on it). However, as this was not confirmed these styophiles will not be discussed further. All four sites from which stygobites had been recorded were along Horse Creek, approximately 25 kilometres north-west of the northern part of the Atlas 3 Project Area. With the exception of one sample which recorded specimens from the crustacean family Bathynellidae, all specimens were crustaceans from the sub-class Copepoda (of the genus either *Dussartstenocaris* or *Parastenocaris*).

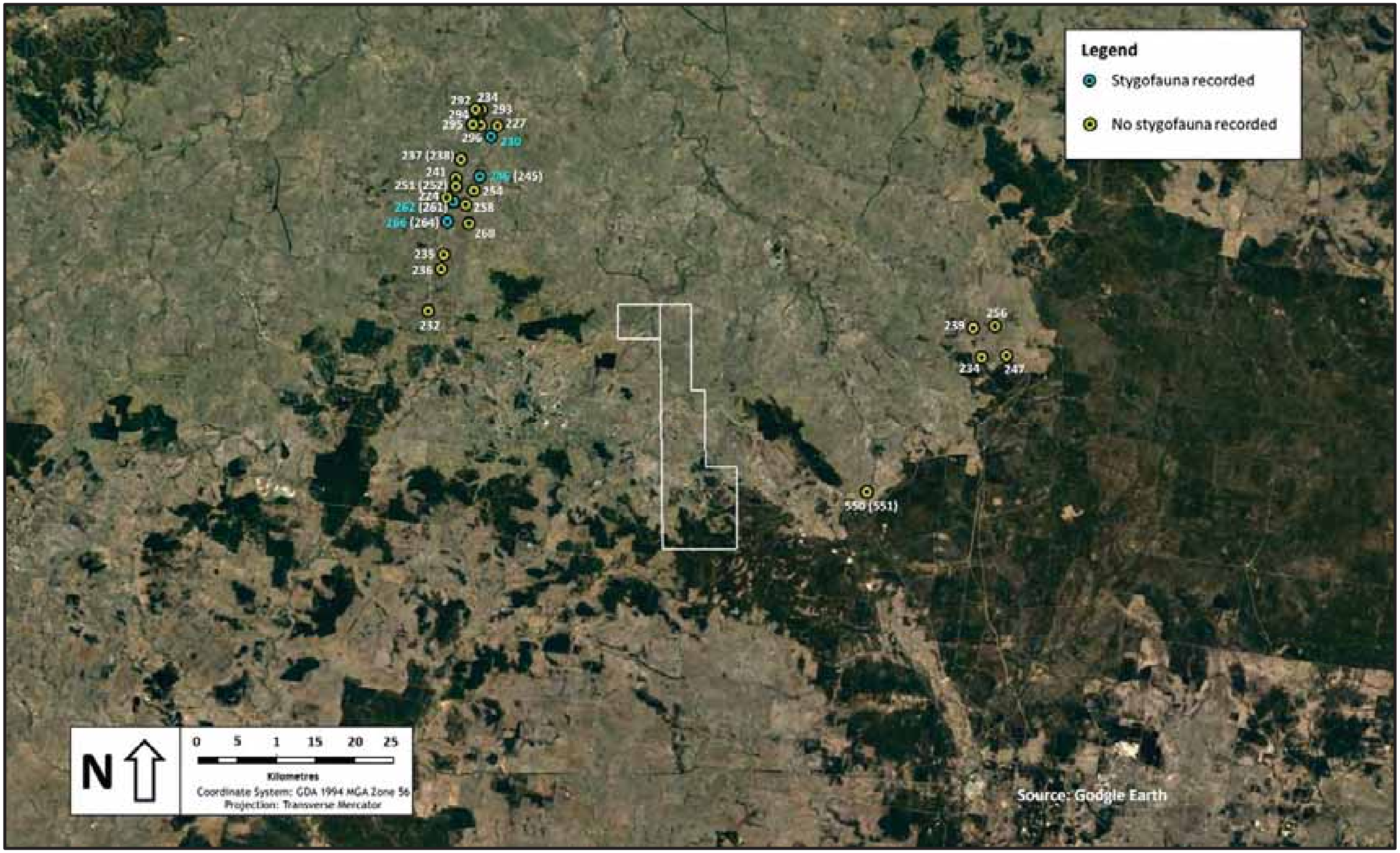

Figure 2: Historical stygofauna sampling within 50 kilometres of the Atlas 3 Project

In-situ groundwater quality monitoring results are presented in **Table 3** below. Except for bore numbers 14193 and 48837 (which were close to neutral), all the bores were slightly to moderately alkaline. The majority of the bores were also slightly saline (i.e. between 785 – 8,500 μS/cm) with only bore number 168351 considered to be very fresh (19.8 μS/cm). The water clarity extracted from the bores was clear to slightly turbid.

Table 3: ***In situ* groundwater quality**

Bore Code	**pH** (units)	**Dissolved Oxygen** (% satn)	**Conductivity** (μS/cm)	**Turbidity** (NTU)	**Temperature** (°C)	**Sample Volume** (L)
13884	8.3	31.1	8,500	82.9	20.1	1
58786	7.3	16.1	4,800	8.4	21.6	1
48818	8.4	16.8	3,200	2.3	22.9	8
14193	7.1	65.2	2,590	2.1	227	8
48837	6.9	16.8	2,370	4.3	22.6	8
15501	7.7	15.0	3,170	5.9	23.1	8
48836	7.4	60.3	5,590	23.7	22.8	8
43869	7.6	22.4	4,000	0.6	24.1	8
44001	8.3	28.9	785	12	23.8	1
168351	8.6	24.1	19.8	1	24.2	8
58495	7.9	28.9	3,020	3.9	24	8
48835	8.2	38.4	1,551	1.1	24.1	8

The quality of stygofauna samples collected across the 12 groundwater bores in June 2022 is summarised in **Table 4** below. Three bores were sampled with the netting method, one which produced a good sample, another which was fair (due to some blockages in the bore) and the third which was poor (only a single haul was possible due to coagulation of the water column following the first haul). The remaining bores were sampled using the pumping method using the existing solar pumping infrastructure on each bore. Eight of the pumping samples were of high quality, with one considered fair due to intermittent flow from cloud shading of the bore during sampling.

Table 4: Summary of stygofauna sampling effort and sample quality

Bore Code	No. hauls / volume of pumped water filtered	Sample Quality
13884	3 hauls	fair, some blockage after 3 hauls from algae at top of bore, bore flowing
58786	1 haul	poor, first haul went down well then subsequent hauls failed to penetrate the water that had been stirred up in the first haul, significant organic matter, H2S smell
48818	250L	good
14193	250L	fair, flow interrupted by shade on solar panel
48837	250L	good
15501	250L	good
48836	250L	good
43869	250L	good
44001	4 hauls	good
168351	250L	good
58495	250L	good, sampling from end of pipe
48835	250L	good

Results from the analysis of the groundwater samples for the presence of stygofauna are presented in **Table 5** below. Two specimens of copepod recorded in bore 48836 (transecting the Gubberamunda Sandstone) represented the only possible stygofauna (stygobiont or stygophile). The identification of this group to the genus level is beyond that which can be achieved by Dr Hancock and would require a microcrustacean specialist. Bore 48836 is located on a hill and largely covered by pumping infrastructure. Therefore, it is unlikely that the specimens collected would have arrived through flooding or have been windswept (in the cyst stage of development). As such, it is likely that these two specimens represent stygofauna.

The most abundant and commonly recorded fauna were formacidae (ants) and collembola (springtails), both of which were considered to be stygoexnes. Formacidae were recorded in half the samples collected and often in high abundance (both whole and in body parts). Formacidae are often recorded in stygofauna sampling as they source water from the bores to support their colonies in dry times. Collembola are typically abundant in soil and the specimens collected exhibited traits consistent with being terrestrial fauna (Dr Hancock pers. comm.). All other fauna recorded were considered stygoxenes (animals which had accidentally fallen into the bores).

Table 5: Analysis of groundwater samples for the presence of stygofauna

Bore Code	Date Sampled	Stygofauna Taxa	Non-Stygofauna Taxa
13884	15/06/2022	0	parts of formacidae
58786	11/06/2022	0	unidentifiable insect parts
48818	11/06/2022	0	7 oligochaeta, unidentifiable insect parts
14193	12/06/2022	0	3 collembolla, 3 acarina, 2 hemiptera, coleoptera larvae, diptera adult
48837	13/06/2022	0	100's formacidae, 100's of parts of ants, 3 collembola
15501	13/06/2022	0	0
48836	13/06/2022	0	100's of formacidae parts, 1 x isopoda, collembolla, acarina, copepoda, coleoptera
43869	14/06/2022	0	ants, coleoptera, 100's of collembolla and acarina
44001	14/06/2022	0	1 araneae, collembola
168351	14/06/2022	0	4 formacidae, coleoptera larvae, diptera adult, 100's of collembola, acarina
58495	16/06/2022	0	3 formacidae, 1 coleoptera, collembola, acarina
48835	13/06/2022	0	15 formacidae, 1 oligochaeta, 1,000's of ant parts, 3 oligochaetes

Table 6: Images of non-stygofauna taxa collected in samples (Photos: Chris Pietsch)

 **14193 – Acarina (mite)**	 **14193 – Collembola (springtails)**
 **14193 – Hemiptera (true bug)**	 **48836 – Isopoda (wood lice)**
 **48836 – Copeoda**	 **44001 – Collembola (springtail) and Araneae (spider)**

7. Conclusion

A stygofauna pilot survey was conducted on the 11th to 16th of June 2022 for the Atlas 3 Project. A total of 12 groundwater bores were sampled using either a netting or pumping method as bore infrastructure dictated.

Stygofauna sampling was conducted by Freshwater Ecology in accordance with the methods defined in Queensland Environment Protection (Water) Policy 2009 – Monitoring and Sampling Manual (DES 2018) and following established (standard) sampling procedures used elsewhere in Australia and overseas (DSITI 2015, Hancock & Boulton 2008, Dumas & Fontanini 2001, WA EPA Guidance Statements 54 and 54a 2003 & 2007). Sampling produced high quality samples from nine groundwater bores.

A desktop review was unable to find publicly available reports on stygofauna sampling within 50 kilometres of the Atlas 3 Project Area. However, an analysis of the Queensland subterranean fauna database identified 28 bores which have been sampled for stygofauna within 50 kilometres of the Project Area, several of which had been sampled on more than one occasion. Of the 28 bores confirmed stygofauna had only been recorded in four. These were all recorded in proximity to Horse Creek, approximately 25 kilometres north-west of the Atlas 3 Project Area.

In-situ groundwater quality was considered high and suitable for the presence of stygofauna. The bores sampled represented a range of locations and aquifers across the Atlas Stage 3 Project Area.

Only two specimens of one potential stygofauna (from a single bore) were recorded in the 12 samples collected. No stygofauna (stygobites or stygophiles) were recovered from the other 11 bores sampled, although large numbers of stygoxenes (both whole and heavily decomposed) were recorded from most bores.

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APPENDIX VI

Terrestrial and Aquatic Groundwater Dependent Ecosystem Mapping and Characterisation

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Technical Note

To	**Steve Fox**
From	**Matt Davis**
Date	**22 October 2022**
Reference	**0639876 Atlas Stage 3 Gas Project**
Subject	**Atlas Stage 3 Gas Project - Potential Groundwater Dependent Ecosystem mapping**

INTRODUCTION AND SCOPE

Senex Energy Pty Ltd (Senex), on behalf of its subsidiaries Senex Assets Pty Ltd and Senex Assets 2 Pty Ltd, proposes to develop, operate, decommission and rehabilitate up to 151 new coal seam gas wells; gas and water gathering systems for the producing wells; access tracks for operational purposes; brine and produced water/irrigation storages; borrow pits; and ancillary supporting facilities on Authority to Prospect (ATP) 2059, Petroleum Lease (PL) 445, the northern portion of PL209 and parts of PL1037 in the central part of the Surat Basin, Queensland. The project is called the Atlas Stage 3 Gas Project (and in this technical note it is referred to as 'the Project'). The gas field will be progressively developed over a period of approx. 5–10 years.

Environmental Resources Management Australia Pty Ltd (ERM) has been engaged by Senex to coordinate terrestrial and aquatic ecology field surveys and assessments, to support the development of the layout and design for the proposed action as part of approval applications required under Queensland State legislation and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* **(EPBC Act).**

To support the ecological and groundwater assessments required as part of the impact assessment and approvals phase of the proposed action, mapping of potential terrestrial and aquatic Groundwater Dependent Ecosystems (GDE) is required. To understand the extent of any potential impacts associated with changes to groundwater hydrology, these GDEs have been field verified within the Project Area and mapped using desktop sources in a 25km buffer area, as shown in Figure 1**. The identification and mapping of potential GDEs will be used by a groundwater modelling specialist to identify locations where changes to groundwater hydrology because of the proposed action may impact on significant ecological features.**

The proposed action is located in the Surat Basin, an area that covers approximately 327,000 km^2 of south-east Queensland and northern New South Wales and forms connecting aquifers with the Great Artesian Basin (Hayes, et al., 2020). Containing a sequence of both Jurassic and Cretaceous sediments, the Surat Basin contains a diverse system of aquifers that provide water discharge throughout south-eastern Queensland.

GDEs are defined as ecosystems that require access to groundwater on a permanent or regular basis in order to meet some or all of their water requirements. GDE's include aquifers, caves, lakes, palustrine wetlands, lacustrine wetlands, rivers and associated riparian vegetation communities. Groundwater plays an important ecological role in some terrestrial and aquatic

ecosystems by supporting vegetation and providing discharge to waterways (Queensland Government, Queensland, 2022).

Dependency on groundwater is likely to fluctuate temporally and spatially depending on regional climatic conditions, geomorphology and topography of the site. In areas that experience seasonal variations in water availability, such as the Surat Basin, vegetation is known to exploit more than one source of water depending on the availability of above ground water (Mensforth, Thorburn, Tyerman, & Walker, 1994).

In addition to supporting vegetation health, subterranean wetlands such as aquifers and caves, as well as alluvial aquifiers, are also noted to support fauna species at various points throughout their life cycle. These include troglofauna, referring to air-breathing fauna that indirectly rely on groundwater, and stygofauna, referring to aquatic fauna relying on groundwater at various stages of their life cycle. The ecology and life histories of groundwater-dependant fauna is poorly understood, however can provide indications of surface water connectivity, water quality, the health of subterranean wetlands and the effectiveness and impacts of management interventions.

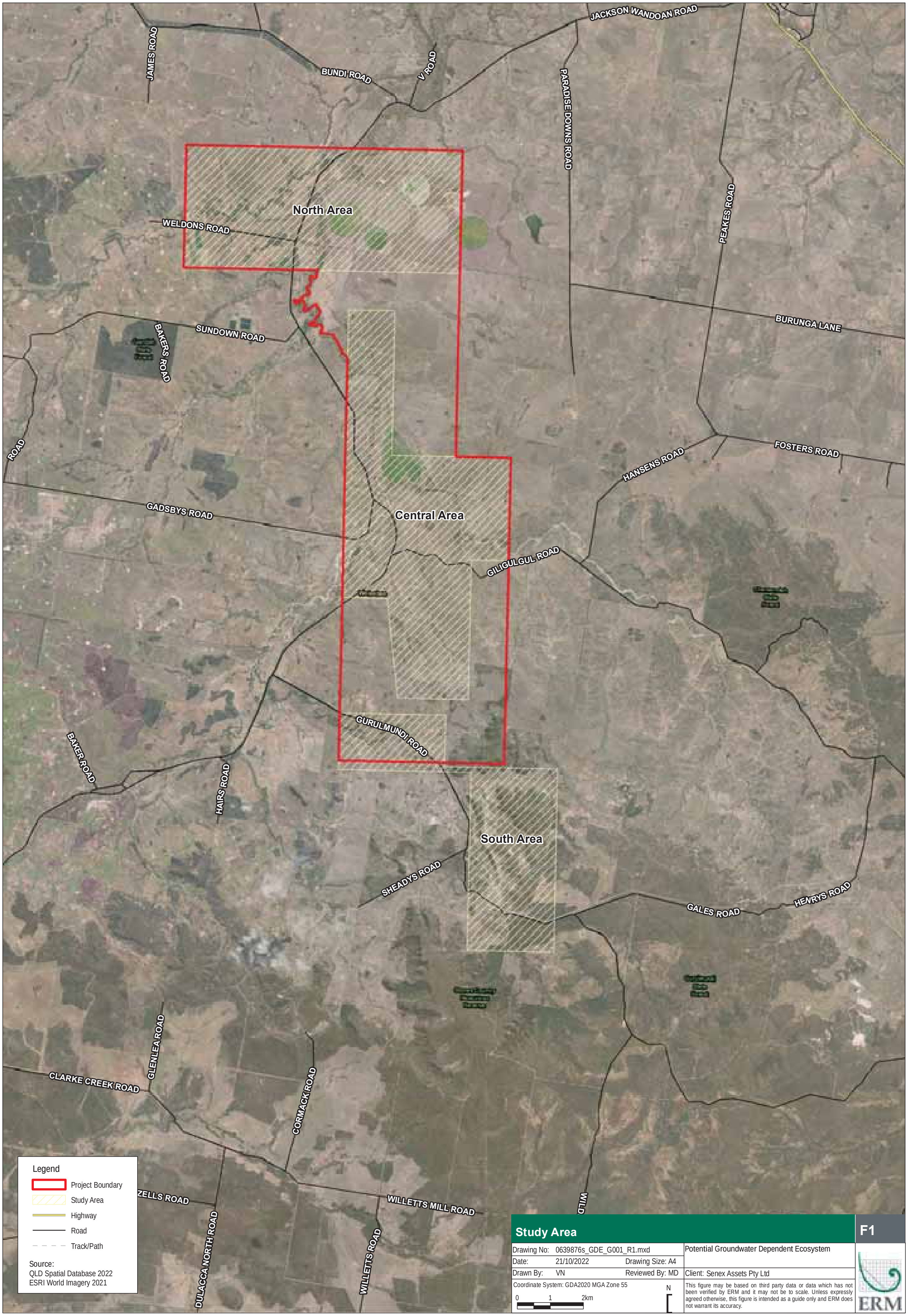
This technical note provides details on the potential GDEs within the Project Area, and accompanies a spatial dataset of field-verified ecological assessments, including:

- Assessment of the likelihood of field-verified vegetation communities being reliant on groundwater, based on their location in the landscape and the vegetation community types;
- Description of the flora species that are characteristic of each terrestrial and aquatic GDE area;
- Description of the general health of the vegetation present within each terrestrial and aquatic GDE area; and
- An estimate of likely deepest rooting depth for each terrestrial GDE area (based on literature review for relevant flora species).

This technical note provides a summary of the results of the GDE mapping for areas within the Atlas Stage 3 Project Area. A desktop assessment has also been completed separately for a landscape assessment area that consists of a buffer of 25km around the Atlas Stage 3 tenements. This landscape assessment area and the Project Area together are referred to as the Study Area in this technical note (Figure 1).

An additional division of the Project Area into northern, central and southern zones has also been developed for the groundwater assessment, as these locations have different surface water and groundwater hydrological conditions.. These three areas and their groundwater and vegetation community characteristic are described further below in this technical note, and include:

1. North: Wandoan and Woleebee Creeks;
2. Central: Woleebee and Conloi Creeks; and
3. South: Hellhole Creek



Study Area F1

Drawing No:	0639876s_GDE_G001_R1.mxd		Potential Groundwater Dependent Ecosystem
Date:	21/10/2022	Drawing Size: A4	
Drawn By:	VN	Reviewed By: MD	Client: Senex Assets Pty Ltd

Coordinate System: GDA2020 MGA Zone 55

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

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METHODOLOGY

Summary of approach

A combination of desktop and field methods were used to develop the potential GDE map included in the shapefile 'PGDE-Atlas3-RevA.shp'. The Queensland Department of Environment and Science (DES) GDE mapping dataset (Version 1.5, April 2017) was reviewed and overlaid with a ground-truthed Regional Ecosystem (RE) mapping dataset collected from fieldwork completed between March and June 2022 by Boobook Ecological Consulting (Boobook). This mapping was also compared with Commonwealth GDE mapping accessed from the Groundwater Dependant Ecosystem Atlas from the Bureau of Meteorology.

Following the mapping process a list of potential GDEs was developed within the Project Area, described by RE and GDE type. The GDE types adopted terminology used in the Queensland GDE mapping rule sets, with the typical vegetation community composition in these areas derived from the RE description, modified from field observations on floristic species.

This process resulted in a field verified potential GDE map, through assessment of the vegetation community type and its location in the landscape. A review of publicly available literature has also been completed to identify potential root depth of the tree species that occur within the identified potential GDEs.

Ground-truthed vegetation survey

Baseline botanical surveys were undertaken by Boobook from March to June 2022, to describe dominant flora and vegetation community structure within the Project Area. Ground-truthing of the REs within the Project Area was undertaken using the quaternary level of data collection as described by Neldner et al. (2022). Field surveys were conducted by Michael Cunningham (Senior Ecologist), Courtney Andrew (Graduate Ecologist) and Rosamund Aisthorpe (Botanist) in the periods 14 – 18th March 2022, 22 – 25th March 2022; 30 April – 5th May 2022), and 9 – 13th June 2022.

Vegetation community assessments were undertaken within 50 m x 20 m plots (0.1 ha) within representative locations in all identified RE and regrowth vegetation types within the Project Area. Faunal habitat values were also assessed within these plots (see below). The locations of vegetation and habitat survey sites are shown in Figure 2. Vegetation community polygons were verified in accordance with Queensland RE description and biodiversity status as per the latest updates of the Regional Ecosystem Description Database (REDD) (DES 2021) and TEC criteria (DAWE 2022b; TSSC 2013, 2019).

RE polygons were assigned to remnant or non-remnant status as defined by the *Vegetation Management Act 1999* (VM Act), with reference to Version 3.2 of the Queensland Government BioCondition Benchmark Database (Queensland Herbarium 2021). Remnant vegetation had obtained a canopy cover more than 50% of the benchmark canopy layer and a height more than 70% of the benchmark height of minimally disturbed vegetation of a given RE (referred to below as the 50/70 rule).

The Project Area features long, narrow linear corridors of vegetation, these features were mapped down to a minimum width of 25 m (equivalent to the 1:25 000 scale in Neldner et al. 2022).

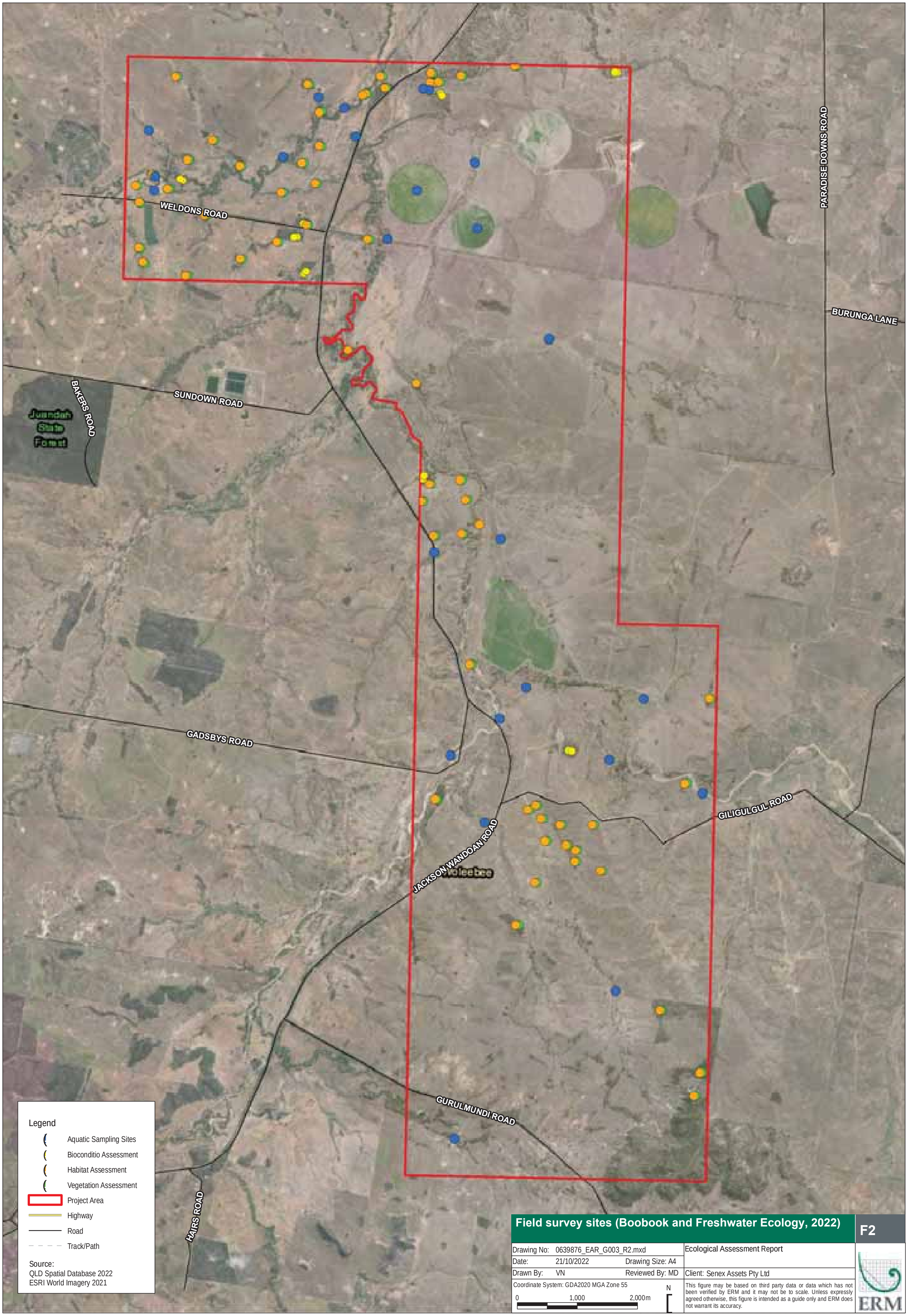
Aquatic ecology surveys and features

Details on the surface water ecology of the Project Area have been informed by field surveys and assessments. The aquatic ecology sampling was undertaken by Freshwater Ecology from the 14 - 21st of March 2022. Thirty-two sites assessed across the Project Area (Figure 2**) and the sampling techniques used were in line with the** *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* **(DES, 2018b). Assessments undertaken included:**

- **Aquatic habitat assessment (all 32 sites);**
- *In situ* **water quality assessment (24 sites);**
- **Macrophytes assessment (30 sites);**
- **Macroinvertebrate assessment (15 sites);**
- **Backpack electrofishing (13 sites);**
- **Fyke netting (large nets) (six sites); and**
- **Visual observation.**

The waterways present within the Project Area are all ephemeral, with most waterways drying completely during dry periods. Very few of these waterways retaining pooling water during dry periods. At the time of the field surveys, the majority of waterways present in the Project Area had already ceased surface water flows with disconnected pools noted along the watercourses. There was some subsurface flow present at sites along most creeks that contained sandy substrates.

The gaps between water pools was often separated by open grasslands and poorly defined channels. Riparian vegetation was present and density of such vegetation varied from moderate to non-existent, with most surveys sites having relatively low vegetation present. The in-stream habitats present were concluded to be mostly of 'fair' condition across the majority of sites that were surveyed (17 of 24), with the remaining seven concluded to be of 'poor' condition.



WELDONS ROAD
PARADISE DOWNS ROAD
BURUNGA LANE
SUNDOWN ROAD
BAKERS ROAD
Juandah State Forest
GADSBYS ROAD
GILIGULGUL ROAD
JACKSON WANDOAN ROAD
Woleebee
GURULMUNDI ROAD
HAIRS ROAD
Legend
Aquatic Sampling Sites
Bioconditio Assessment
Habitat Assessment
Vegetation Assessment
Project Area
Highway
Road
Track/Path
Source:
QLD Spatial Database 2022
ESRI World Imagery 2021
Field survey sites (Boobook and Freshwater Ecology, 2022)
F2
Drawing No: 0639876_EAR_G003_R2.mxd
Date: 21/10/2022
Drawing Size: A4
Drawn By: VN
Reviewed By: MD
Ecological Assessment Report
Client: Senex Assets Pty Ltd
Coordinate System: GDA2020 MGA Zone 55
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FIELD VERIFIED VEGETATION COMMUNITIES AND GROUNDWATER DEPENDENT ECOSYSTEMS

Within the Atlas Stage 3 Project Area, the majority of the terrestrial and aquatic GDEs are associated with watercourses and the adjacent alluvial plains. This includes the named creeks Woleebee Creek, Wandoan Creek, Conloi Creek and Hellhole Creek, as well as several unnamed creeks and hydrological features.

Using the terminology developed as part of the DES GDE mapping, the following potential terrestrial and aquatic GDE types have been identified as occurring within the Atlas 3 Project Area

1. **Riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent flow**

2. **Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow**

Within the Atlas Stage 3 Project Area, these potential GDE types correspond with RE types that occur on alluvial landscapes, associated with watercourses and the adjacent floodplain areas. Based on the DES GDE mapping rule sets, these vegetation communities rely on alluvial aquifers that form from particles such as gravel, sand, silt and/or clay deposited by fluvial processes in river channels or on floodplains. These deposits store and transmit water to varying degrees through inter-granular voids, pore spaces, fractures and other weathered zones of the rock material. Typically groundwater moves laterally and is commonly discharged to the surface along the contact between two rock types.

In addition to the alluvial groundwater processes, the geology of the Surat Basin can produce significant water discharges into surrounding above ground wetlands, particularly in areas with heavy sandstone geology, notably the Precipice Sandstone in the basin's north (Hayes, et al., 2020). The coarser grain size in these rock formations are considerably more permeable than bedrock material in surrounding geological formations and allows hydrological flows to move freely. Aquifer recharge is not uniform and is highly dependent on precipitation levels and flooding regimes. In ephemeral systems, such as those GDE's identified in the Project Area, aquifer recharge will likely occur during alluvial inundation events, i.e. flooding.

Identified GDEs within the Project Area

The GDEs identified within the Project Area have been described in relation to three key areas (Figure 3**), delineated based on general characteristics and condition within the Project Area :**

1. **North: Wandoan and Woleebee Creeks;**
2. **Central: Woleebee and Conloi Creeks; and**
3. **South: Hellhole Creeks**

Field verified vegetation communities extent

All three areas are comprised of mosaics of remnant and regrowth REs of varying patch size and ecological condition. RE 11.3.25 (Forest Red Gum *Eucalyptus tereticornis* **or River Red Gum** *Eucalytpus camaldulensis* **woodland fringing drainage lines) is the most widely abundant vegetation community identified that the potential to be a GDE, however interconnected patches of other REs are present. Historic land clearing is known to have occurred throughout the Project Area that has impacted the condition of terrestrial GDEs, particularly along creek lines and water courses. Grazing pressure is also likely to influence the ecological condition of RE patches and their value for maintaining biodiversity levels.**

North: Wandoan and Woleebee Creeks

The northern section of the Project Area (Figure 3a) is dominated by RE 11.3.25 (Forest Red Gum *Eucalyptus tereticornis* **woodland fringing drainage lines), however areas of RE 11.3.2 (Poplar Box** *Eucalyptus populnea* **woodland on alluvial plains), 11.3.27 (Freshwater wetlands: Coolabah** *Eucalyptus coolabah* **and/or Forest Red Gum) open woodland to woodland fringing swamps) and 11.3.17 (Poplar Box woodland with Brigalow** *Acacia harpophylla* **and/or Belah** *Casuarina cristata* **on alluvial plains) are also present in smaller more fragmented patches within a wider landscape of modified pastures, cropping and grazing land. In addition to exotic pastures, invasive species such as** *Opuntia spp,* **Mother-of-Millions** *Bryophyllum delagoense* **and Harrisia Cactus** *Harrisia martini* **were common throughout this section of the Project Area.**

Dominant canopy tree species recorded during field surveys include *Eucalyptus spp.,* **particularly Poplar Box, and Forest Red Gum. Other characteristic species associated with the RE such as Brigalow, Belah and an understory of False Sandalwood** *Eremophila mitchellii* **have also been confirmed to be present by field surveys and suggest at least some retention of ecological value. Average root depth for species of** *Eucalyptus* **present is known, based on literature reviews, to range from 9m to 22.6m, depending on the species and the interactions between geomorphology and plant physiological traits. Rooting depth of other associated species is poorly understood however assumed to be shallower than these measurements. A combination of remnant and advanced regrowth is present within the northern area with remnant vegetation dominating the REs within the northern areas.**

Riparian zones within the Project Area were largely intact, with Woleebee Creek having the widest remnant, riparian zone in relation to the surrounding vegetation patches. It should be noted that many REs have been identified to be in degraded quality and situated adjacent to endangered vegetation communities. Although the relative reliance on groundwater could not be identified for some of these dominant species, it is likely that the *Eucalyptus* **species present in these riparian zones are likely to be sensitive to changes in ground water availability. For other dominant flora species, such as Brigalow and Belah, at least an indirect reliance on groundwater availability through water discharge should be assumed.**

Central: Woleebee Creeks and Conloi Creeks

The mapped GDEs within the central area (Figure 3b) are also dominated by RE 11.3.25 (Forest Red Gum woodland fringing drainage lines). These patches have been confirmed to largely be remnant communities although some regrowth is also present. Forest Red Gum woodlands fringing water courses are confirmed to be present following field surveys with other *Eucalyptus spp.* **Such as Poplar Box and Silver-leaved Ironbark** *Eucalyptus melanophloia* **also present throughout the area.**

Unlike the northern area, REs that occur in riparian zones and on alluvium in the centre of the Project Area are considerably smaller in size and influenced by increased fragmentation. This will place considerably higher pressures on ecosystem condition with grazing and exotic pasture species likely to negatively impact recruitment, species diversity and structural complexity..

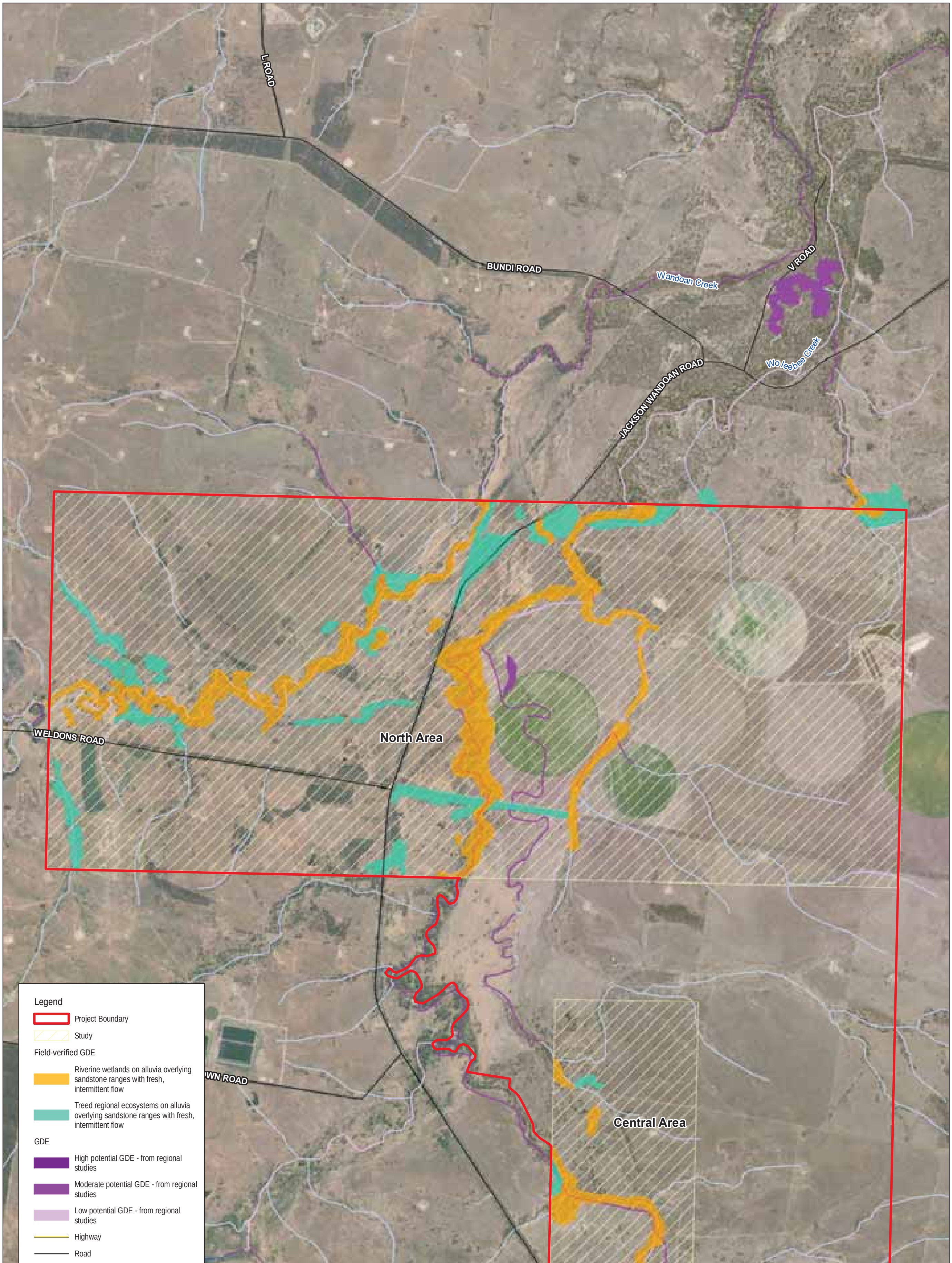
Riparian vegetation offers opportunities for landscape connectivity with Hinchley and Juandah State Forest to the west outside of the Project Area and Gurulmundi State Forest and Stones Country Resources Reserve located in the south of the Project Area. The existing riparian and alluvial vegetation communities in this area supports species dispersal throughout the landscape and provides connectivity between the State Forest areas.

The dominant tree species in this section of the Project Area are again *Eucalyptus spp.,* **with Forest Red Gum, Poplar Box and Silver-leaved Ironbark the most common species. The known rooting depth for these species, as identified from literature reviews, has been identified at between 9m and 22.6m with a reliance on groundwater known for at least Forest Red Gum. High threat invasive species have also been observed that may threaten the long-term ecological condition if propagule pressure is too high.**

Southern: Hellhole Creek

The southern area (Figure 3c) is dominated almost exclusively with RE 11.3.25 (Forest Red Gum woodland fringing drainage lines). A combination of regrowth and remnant vegetation is found in the southern area with the majority of patches confirmed to be remnant. Much like the central area, many patches found in the southern area are highly fragmented and restricted to thin bands of riparian vegetation. This likely increases sensitivity to ecological pressures and inhibits the functional capabilities and recruitment potential of the patch.

Those that remain connected with continuous vegetation were found to contain a higher flora species richness across all community structures and more closely aligned with species assemblages associated with the RE. Dominated by Forest Red Gum and Poplar Box, these patches will be highly reliant on the availability of groundwater, when above groundwater is not present, and sensitive to changes in its availability.



Field-verified GDEs in Project Boundary F3a

Drawing No: 0639876s_GDE_G002_R2.mxd	Potential Groundwater Dependent Ecosystem
Date: 21/10/2022 Drawing Size: A4	
Drawn By: VN Reviewed By: MD	Client: Senex Assets Pty Ltd

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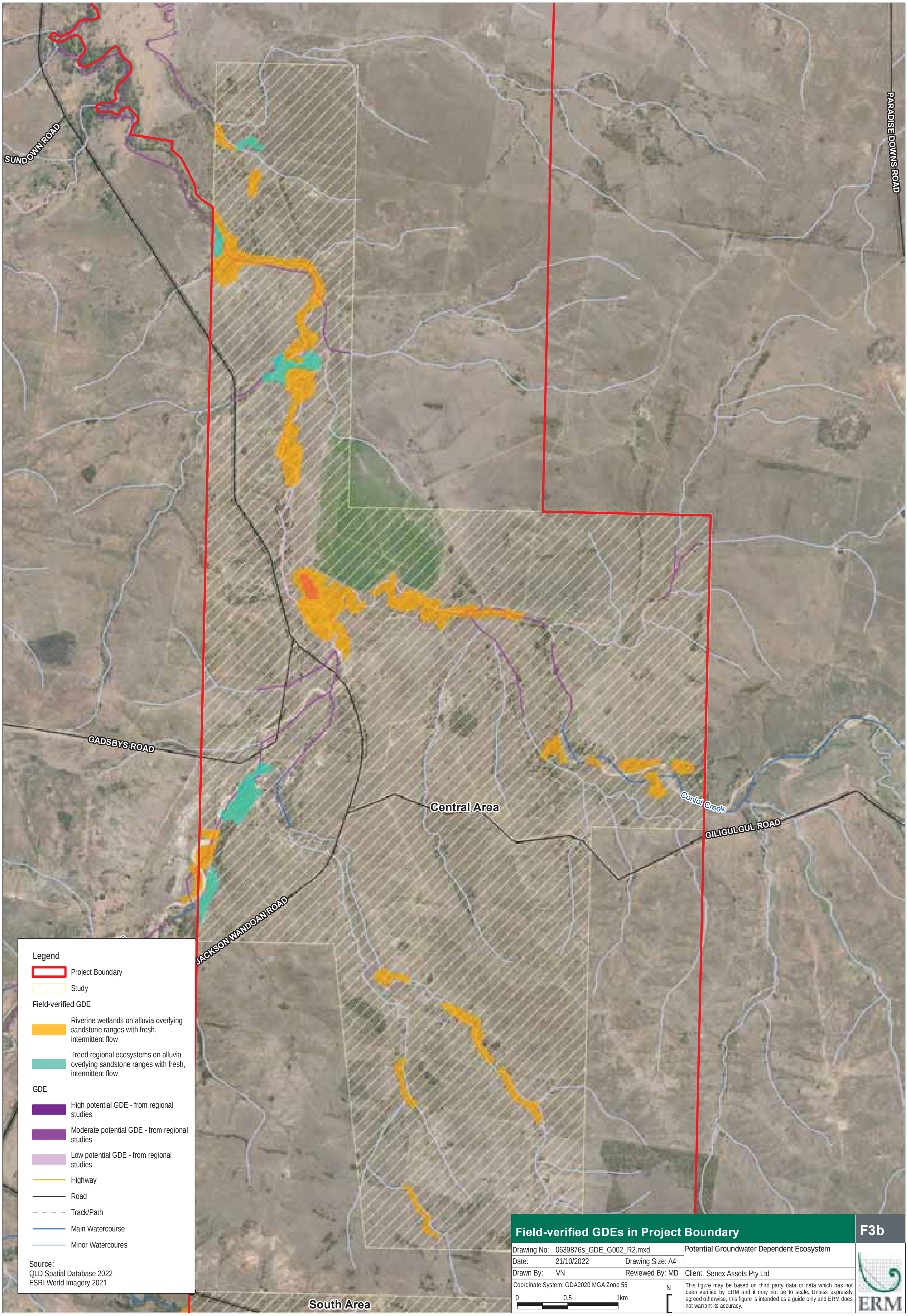
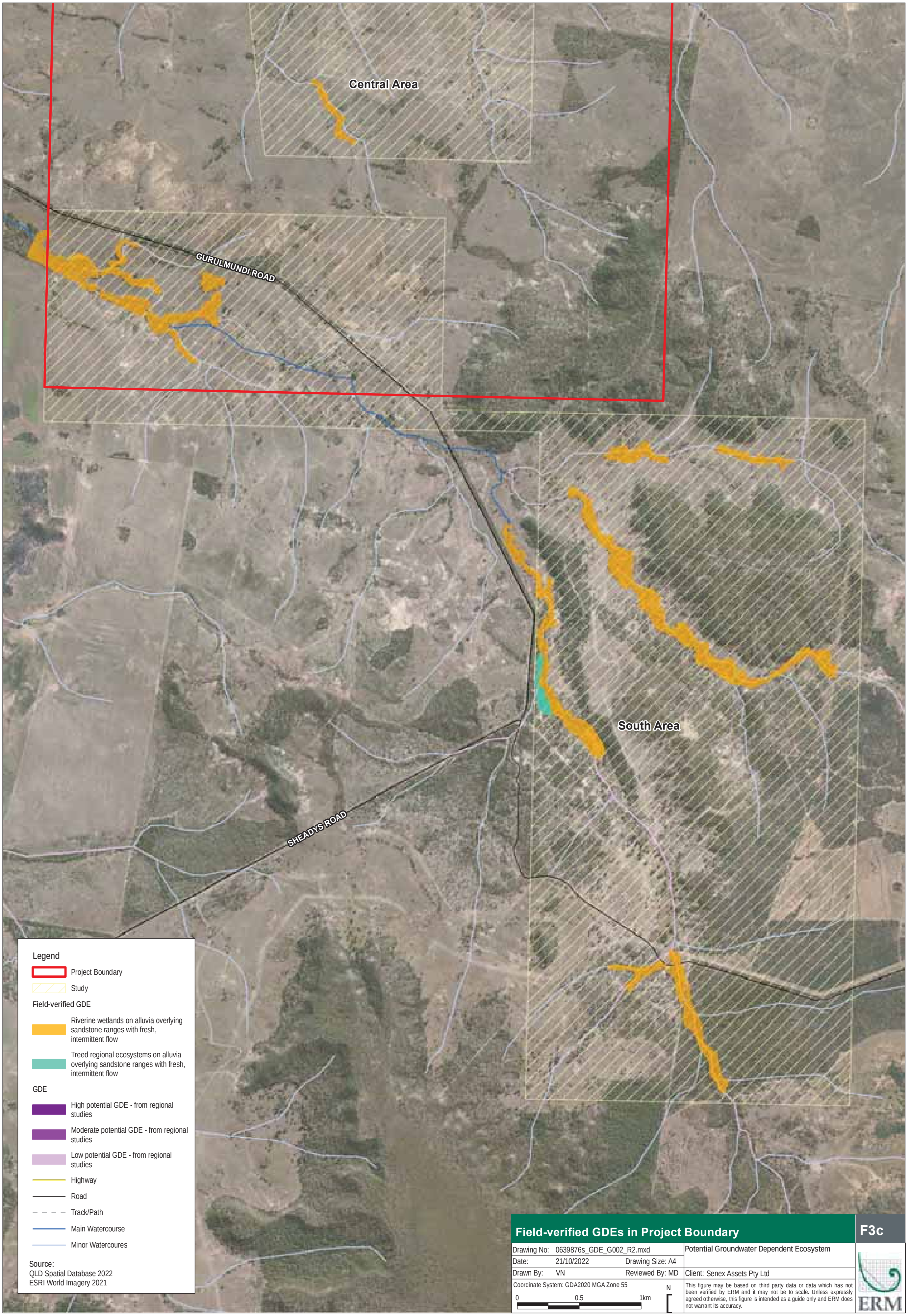


Field-verified GDEs in Project Boundary



Central Area
GURULMUNDI ROAD
South Area
SHEADYS ROAD
Legend
Project Boundary
Study
Field-verified GDE
Riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent flow
Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow
GDE
High potential GDE - from regional studies
Moderate potential GDE - from regional studies
Low potential GDE - from regional studies
Highway
Road
Track/Path
Main Watercourse
Minor Watercoures
Source:
QLD Spatial Database 2022
ESRI World Imagery 2021
Field-verified GDEs in Project Boundary
F3c
Drawing No: 0639876s_GDE_G002_R2.mxd
Date: 21/10/2022
Drawing Size: A4
Drawn By: VN
Reviewed By: MD
Potential Groundwater Dependent Ecosystem
Client: Senex Assets Pty Ltd
Coordinate System: GDA2020 MGA Zone 55
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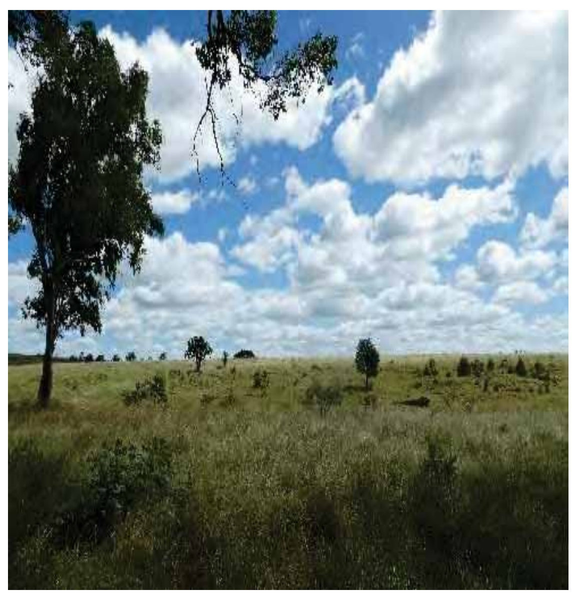
Field verified GDE vegetation communities and condition

RE 11.3.2 *Eucalyptus populnea* woodland on alluvial plains

Regional Ecosystem 11.3.2 is listed as Of Concern under the QLD *Vegetation Management Act 1999* **(Vegetation Management Act 1999, 2019) (VM Act) This vegetation community also meets the definition of the endangered threatened ecological community Poplar Box grassy woodland on alluvial plains, listed under the** *Environment Protection and Biodiversity Conservation Act* **(EPBC Act).**

The RE also provides potential habitat for threatened species including Belson's Panic *Homopholis belsonii***, Koala** *Phascolarctos cinereus* **and Greater Glider (***Petauroides volans***) (Smith & Smith, 2018; Sullivan, Norris, & Baxter, 2003). Poplar Box is the dominant flora species associated with Regional Ecosystem 11.3.2.**

A secondary tree layer may occur in this RE with species such as Doolan *Acacia salicina,* **False Sandalwood and Leichhardt Bean** *Cassia brewsteri.* **Tussock grasses dominate the ground layer with** *Chloris, Enteropogon* **and** *Aristida* **species common. Associated with alluvial plains and dryland ecosystems, Poplar Box and allied flora species are restricted to areas with more reliable water availability. Having been identified to produce an extensive root system and rely on the availability of groundwater reservoirs (Kath, et al., 2014), the health of this regional ecosystem is likely to be influenced by the availability of groundwater in the alluvial strata.**



Photograph 1 Representative photographs of Regional Ecosystem 11.3.2

RE 11.3.17 Eucalyptus populnea woodland with Acacia harpophylla and/or Casuarina cristata on alluvial plain

Regional Ecosystem 11.3.17 is listed as Of Concern under the VM Act and also provides habitat for threatened species such as the Koala, Greater Glider and Belson's Panic (Smith & Smith, 2018).

The dominant flora species include Poplar Box, Brigalow) and Belah*.* **A shrub layer and lower shrub layer are usually present of species such as False Sandalwood***,* **Wilga** *Geijera parviflora* **and Yarran** *Acacia melvillei.*

A ground layer is present dominated by tussock grasses including Red Grass *Bothriochloa decipiens,* **Purple Wire Grass** *Aristida ramosa* **and Curly Windmill Grass** *Enteropogon acicularis.* **While Poplar Box has been identified as utilising groundwater sources, the rooting depth and subsequent groundwater dependence is unknown for both Brigalow and Belah***.* **Suckering from extensive lateral root growth is a common habit in Brigalow***,* **particularly in response to water scarcity, however it is unknown how these structural characteristics influence groundwater usage.**

Other species of *Casuarina* **are known to produce extensive root systems capable of accessing groundwater aquifers. Considering the physiological similarities and size in which Belah is known to reach, it is likely that similar evolutionary traits may be present.**

Photograph 2 Representative photographs of regional ecosystem 11.3.17

RE 11.3.19 Callitris glaucophylla, Corymbia spp. and/or Eucalyptus melanophloia woodland on Cainozoic alluvial plains

Regional Ecosystem 11.3.19 is listed as Least Concern under the VM Act, however it can provide habitat for a number of threatened species such as the flora species *Fimbristylis vagans* **and** *Vittadinia decora.*

White Cypress Pine woodlands are usually codominant with *Eucalypts* **such as Carbeen** *Corymbia tessellaris* **that form well-defined but discontinuous open forest to woodland canopies. Other trees such as Rough-barked Apple** *Angophora melanoxylon* **or Poplar Box may occur as emergent trees. Scattered tall shrubs such as Ironwood** *Acacia excelsa,* **Quinine Bush** *Alstonia constricta* **and White Cypress Pine are often present. A ground layer is sparse to dense in relation to the tree density and consists predominantly of grasses such as Black Spear-grass** *Herteropogon contortus, Erichne helmsii* **and Comet Grass** *Perotis rara.* **Forb diversity is relatively low but may become seasonally prominent. Occurring in deep soils on rises and the alluvial plains of major river systems there is likely to be at least some reliance on groundwater by Silver-leaved Ironbark and** *Corymbia spp.* **based on morphological similarities to closely related species such as River Red Gum. White Cypress Pine is known to have a concentrated root system restricted to surface soils that limits the species capacity to access deep aquifers (Thompson & Eldridge, 2005).**

High soil permeability arising from sandstone geology establishes free draining conditions desired by the species. Intolerances of extended droughts and inundation suggest that this RE type is can be reliant on the availability of water from shallow underground aquifers, alluvium and above ground water.

RE 11.3.25 Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines

Regional Ecosystem 11.3.25 is listed as Least Concern under the VM Act, however it can be associated with high fauna species richness and provides critical habitat for threatened fauna species such as the Koala and Greater Glider (Smith & Smith, 2018; Sullivan, Norris, & Baxter, 2003).

Both River Red Gum and Forest Red Gum provide critical habitat structures to fauna, such as tree hollows, and are important for regulating ecological functions in dryland and wetland systems. Other trees such as River Oak *Casuarina cunninghamiana* **and Black Tea-tree** *Melaleuca bracteata* **may also occur. A tall shrub layer is usually present that includes species such as Doolan***,* **River Myall** *Acacia stenophylla* **and Queensland Ebony** *Lysiphyllum carronii.*

Lower shrubs are sometimes present but rarely form a distinctive layer. The ground layer is open to sparse and dominated by perennial grasses, sedges and forbs. Several vegetation communities make up this RE and species diversity is known to vary between communities. In addition to the two dominant canopy species, others such as *Melaleuca, Corymbia, Casuarina* **species may also be present.**

This RE can include both ephemeral and permanent wetlands and so aquatic vegetation will vary depending on the presence of permanent, open water however none of these areas were recorded and mapped within the Project Area. Both dominant flora species in this RE are known to produce deep root systems (See Table 3-1) and rely on groundwater aquifers for survival. In the case of River Red Gum, high tolerance to saline groundwater is particularly important (Mensforth, Thorburn, Tyerman, & Walker, 1994). *E. camaldulensis* **is commonly found along ephemeral wetlands with variable flooding regimes. The availability of underground aquifers, particularly in alluvial layers are likely to be important for maintaining ecosystem health for areas RE 11.3.25.**

Figure 3-3: **Representative photographs of regional ecosystem 11.3.25**

RE 11.3.27 Freshwater Wetlands

RE 11.3.27 is classified as freshwater palustrine wetlands that occur in a variety of situations including lakes, billabongs, oxbows and depressions on floodplains. It is listed as Least Concern under the VM Act. Vegetation structure and diversity is highly variable throughout the RE with a variety of associated vegetation communities, including open water aquatic species, fringing sedgelands and eucalypt woodlands. Species diversity also varies considerably between communities driven largely by the permanence of water bodies.

Eucalyptus **species are common, and** *Acacia, Melaleuca* **and a range of other species may also be present. Species found in ground layers is variable however** *Cyperus, Chloris* **and** *Phragmites australis* **are common. Woodlands comprised of** *E. camaldulensis* **and/or** *E. tereticornis* **are likely to directly depend on groundwater at least seasonally, especially when situated along ephemeral drainage lines and creeks, or alluvial flood plains.**

Aquatic vegetation in drainage channels in the Project Area are also likely to be indirectly reliant on groundwater systems that provide discharge to above ground wetlands and maintain soil moisture and hydrological flow. Aqautic macrophyte cover, including some floating species and emergent sedges was generally low across the Project Area, reflecting the ephemeral nature of the watercourses.

Vegetation communities dominated by *Eucalyptus* **is likely to provide suitable habitat to threatened species such as the Koala and Greater Glider (Smith & Smith, 2018; Sullivan, Norris, & Baxter, 2003). Habitat structures, such as tree hollows, will also be a critical resources for hollow dependent fauna.**

Photograph 3 Representative photographs of regional ecosystem 11.3.27

Tree rooting depth

A review of available literature on tree rooting depth for those dominant species present in each of the ground-truthed REs has been completed to understand how dependent these species may be on groundwater (Table 3-1).

The depth of root growth is not known for most native trees and estimates that have been presented are based on the literature referenced in Table 3-1. The depth of the root zone will be largely dependent on abiotic environmental conditions such as soil depth, fluctuations in seasonal rainfall and flooding regimes.

Table 0-1 Potential GDEs, vegetation description and tree rooting depth

Regional Ecosystem Code and name	GDE type	Dominant flora species	Field verified condition	Groundwater dependence and rooting depth
11.3.2 *Eucalyptus populnea* **woodland on alluvial plains**	**Treed regional ecosystems on alluvial overlying sandstone ranges with fresh, intermittent flow**	**Poplar Box** *Eucalyptus populnea*	**Majority of this RE and potential GDE is in a remnant condition.** **Occurs on alluvial plains adjacent to riparian vegetation.**	**12.6 - 22.6m (Kath, et al., 2014) for Poplar Box**
11.3.17 *Eucalyptus populnea* **woodland with** *Acacia harpophylla* **and/or** *Casuarina cristata* **on alluvial plain**	**Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow**	**Poplar Box** **Brigalow** *Acacia harpophylla* **Belah** *Casuarina cristata*	**Identified as majority remnant vegetation and occurs on adjacent alluvial floodplains, usually connected to the adjacent riparian zone.**	**Poplar Box** - **12.6-22.6m (Kath, et al., 2014)** **Brigalow - Unknown** **Belah - Unknown**
11.3.19 *Callitris glaucophylla*, *Corymbia spp.* **and/or** *Eucalyptus melanophloia* **woodland on Cainozoic alluvial plains**	**Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow**	**White Cypress Pine** *Callitris glaucophylla*; *Corymbia spp.* **And/or** **Silver-leaved Ironbark** *Eucalypus melanophloia*	**Occurs on alluvial floodplains adjacent to riparian zone**	**Up to 6m (***Callitris glaucophylla***) (Eberbach, 2003)** **Silver-leaved Ironbark - Unknown but likely potential to be similar to Forest Red Gum**
11.3.25 *Eucalyptus tereticornis* **or** *E. camaldulensis* **woodland fringing drainage lines**	**Riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent flow**	**Forest Red Gum**	**Largely confined to fringing riparian vegetation along watercourse and is the most common RE and GDE type within the Project Area.** **Varying condition, ranging from advanced regrowth to remnant.**	**At least 9m and assumed to reach groundwater reservoirs (Forest Red Gum) (Ausecology Pty Ltd, 2018)** **12.1 - 22.6m (***E. camaldulensis***) (Jones, et al., 2020)**

Regional Ecosystem Code and name	GDE type	Dominant flora species	Field verified condition	Groundwater dependence and rooting depth
11.3.27 **Freshwater Wetlands**	**Riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent flow**	**Variable freshwater vegetation ranging from open water to fringing sedgelands and eucalypt woodlands.** **Forest Red Gum**	**Occurs largely in closed depressions or oxbows adjacent to watercourses or on adjacent alluvial plains.**	*Eucalyptus camaldulensis*- **12.1-22.6m (Jones, et al., 2020)** **Forest Red Gum**- **at least 9m (Ausecology Pty Ltd, 2018)** *Eucalyptus coolabah*- **possibly at least 7-8m (Costelloe, 2016)**

MAPPED POTENTIAL GDE WITHIN THE 25KM BUFFER ZONE

Desktop studies have identified a higher diversity of potential terrestrial GDE within the surrounding 25km buffer area with a total of 18 REs mapped as overlapping with the Queensland GDE mapping (Figure 4**). These vegetation communities can be categorised into three broad groups based on functional ecosystem characteristics:**

1. **Deep rooted treed regional ecosystems**
2. **Riverine Wetlands**
3. **Treed regional ecosystems associated with intermittent flow**

These GDE display a scattered distribution throughout the landscape and their presence will likely be influenced strongly by historic land use practices.

Deep rooted treed regional ecosystems

These GDE collectively cover the greatest area throughout the 25km buffer zone. With many being connected to aquifers, some of the deep rooted REs present are likely to be less reliant on riparian zone alluvium with many appearing to persist in the landscape between waterways. Currently these GDE are clustered towards the southern end of the project buffer zone and are prominent around nearby state forests and patches of continuous vegetation not mapped as GDE.

It is likely that these GDE were historically present across the landscape covered by the project boundary but historical impacts associated with grazing and land clearing have likely reduced their distribution throughout the buffer. Like those GDE within the project boundary, these GDE are likely to be dominated by *Eucalyptus spp* **and highly valuable habitat for a range of species. With large patches still present in parts of the landscape, it can be expected that a higher species diversity and variable vegetation structure will have been retained.**

Riverine Wetlands

Those GDE classified as riverine wetlands show a broader collective distribution throughout the project boundaries buffer zone, despite occupying smaller areas. As expected of wetland ecosystems, riverine wetlands are isolated along creek lines and are found throughout the 25km buffer zone. Riverine wetlands are virtually absent from the western side of the project boundary however this may simply be an indication of historic land clearing rather than unsuitable conditions for the GDE.

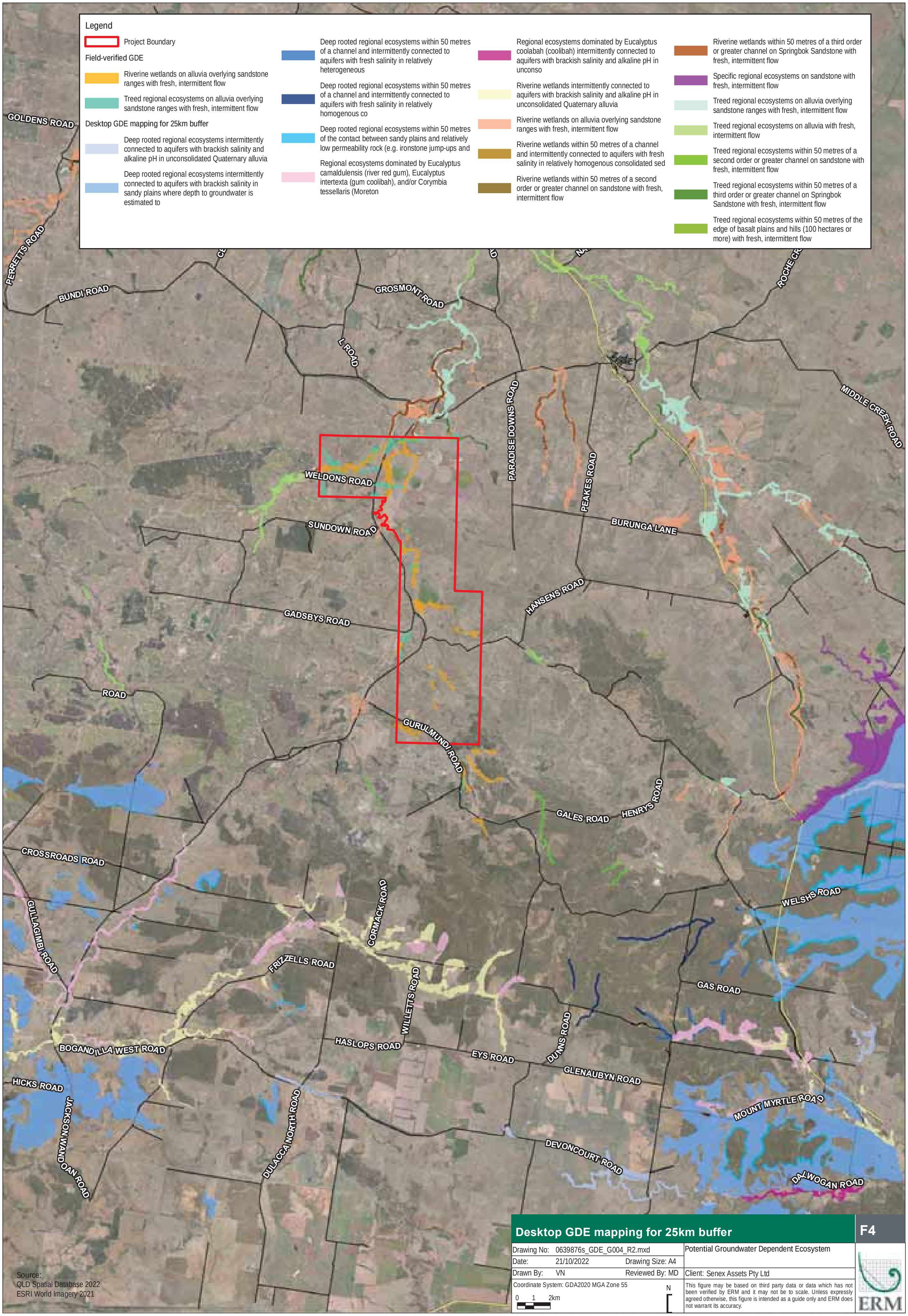
Intact riparian zones show evidence of good ecosystem health with large portions of riverine wetlands forming contiguous patches with relatively good connectivity. Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow in particular appear to be connecting GDE in the north area to the surrounding landscape. With GDE within the project boundary known to potentially provide habitat for threatened species, such as the Koala and Greater Glider, any connectivity through cleared landscapes will likely hold disproportionately large benefits to biodiversity in comparison to patch size. While currently not confirmed with ground-truthing, these riparian zones are likely to be dominated by similar species found in those GDE surveyed within the project boundary. Thus it can be expected that Poplar Box, Rive rRed Gum and Silver-leaved Ironbark will be present in the canopy throughout these GDE.

Some fragmentation is still present within individual GDE, particularly those situated in the northern half of the buffer zone. These fragments are likely connected via creek lines, however the lack of continuous vegetation will likely decrease ecosystem function and, without regrowth or continued recruitment, patches may be at risk to the same disturbance processes known within the project boundary (Grazing, exotic species and limited recruitment potential). Although a largely intact canopy appears to be present, it is unclear to what extent recruitment or expected understory structure is present. With variable structural diversity known from GDE within the project boundary, it can be expected that similar conditions will be present.

Treed regional ecosystems associated with intermittent flow

The remaining GDE present are collectively the most fragmented vegetation communities present throughout the 25km buffer area. Small isolated patches can be found scattered throughout the southern half of the buffer zone. While multiple different GDEs are represented throughout the buffer zone, they are typically small in size with little to no other representative patches present throughout the buffer. The long term persistence of these patches is potentially impacted as a result of fragmentation however flooding regimes may assist populations in dispersal and downstream recruitment. Proximity to continuous vegetation, particularly in state forests, may buffer patches from continued decline. Much like the riverine wetland GDE, the highly fragmented nature of these GDE may not be a reflection of unsuitable conditions but rather a result of historic landscape disturbances associated with land use.

The largest patch of treed GDE can be found directly north of the project boundary and is dominated by treed regional ecosystems on alluvia with fresh intermittent flow. This extensive riparian zone connects two major clusters of GDE types one of which is the diverse vegetation communities found in the north area of the project boundary. Based on the predicted areas produced by state GDE mapping, these GDE appear to provide large areas of riparian zones and are the dominant clusters of dense vegetation in the immediate landscape. Some gaps appear along major water courses in state mapping however it is unclear if this is a reflection of ground-truthed changes in vegetation structure at the local scale or a limitation in the spatial layers sensitivity.



Legend
Project Boundary
Field-verified GDE
Riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent flow
Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow
Desktop GDE mapping for 25km buffer
Deep rooted regional ecosystems intermittently connected to aquifers with brackish salinity and alkaline pH in unconsolidated Quaternary alluvia
Deep rooted regional ecosystems intermittently connected to aquifers with brackish salinity in sandy plains where depth to groundwater is estimated to
Deep rooted regional ecosystems within 50 metres of a channel and intermittently connected to aquifers with fresh salinity in relatively heterogeneous
Deep rooted regional ecosystems within 50 metres of a channel and intermittently connected to aquifers with fresh salinity in relatively homogenous co
Deep rooted regional ecosystems within 50 metres of the contact between sandy plains and relatively low permeability rock (e.g. ironstone jump-ups and
Regional ecosystems dominated by Eucalyptus camaldulensis (river red gum), Eucalyptus intertexta (gum coolibah), and/or Corymbia tessellaris (Moreton
Regional ecosystems dominated by Eucalyptus coolabah (coolibah) intermittently connected to aquifers with brackish salinity and alkaline pH in unconso
Riverine wetlands intermittently connected to aquifers with brackish salinity and alkaline pH in unconsolidated Quaternary alluvia
Riverine wetlands on alluvia overlying sandstone ranges with fresh, intermittent flow
Riverine wetlands within 50 metres of a channel and intermittently connected to aquifers with fresh salinity in relatively homogenous consolidated sed
Riverine wetlands within 50 metres of a second order or greater channel on sandstone with fresh, intermittent flow
Riverine wetlands within 50 metres of a third order or greater channel on Springbok Sandstone with fresh, intermittent flow
Specific regional ecosystems on sandstone with fresh, intermittent flow
Treed regional ecosystems on alluvia overlying sandstone ranges with fresh, intermittent flow
Treed regional ecosystems on alluvia with fresh, intermittent flow
Treed regional ecosystems within 50 metres of a second order or greater channel on sandstone with fresh, intermittent flow
Treed regional ecosystems within 50 metres of a third order or greater channel on Springbok Sandstone with fresh, intermittent flow
Treed regional ecosystems within 50 metres of the edge of basalt plains and hills (100 hectares or more) with fresh, intermittent flow
GOLDENS ROAD
PERRETTS ROAD
BUNDI ROAD
GROSMONT ROAD
L ROAD
ROCHE CR
MIDDLE CREEK ROAD
PARADISE DOWNS ROAD
PEAKES ROAD
WELDONS ROAD
SUNDOWN ROAD
BURUNGA LANE
HANSENS ROAD
GADSBYS ROAD
ROAD
GURULMUNDI ROAD
GALES ROAD
HENRYS ROAD
CROSSROADS ROAD
GULLAGIMBI ROAD
CORMACK ROAD
WELSHS ROAD
FRIZZELLS ROAD
WILLETTS ROAD
GAS ROAD
DUNNS ROAD
BOGANDILLA WEST ROAD
HASLOPS ROAD
EYS ROAD
GLENAUBYN ROAD
HICKS ROAD
JACKSON WANDOAN ROAD
DULACCA NORTH ROAD
MOUNT MYRTLE ROAD
DEVONCOURT ROAD
DALWOGAN ROAD
Source:
QLD Spatial Database 2022
ESRI World Imagery 2021
Desktop GDE mapping for 25km buffer
F4
Drawing No: 0639876s_GDE_G004_R2.mxd
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Client: Senex Assets Pty Ltd
Coordinate System: GDA2020 MGA Zone 55
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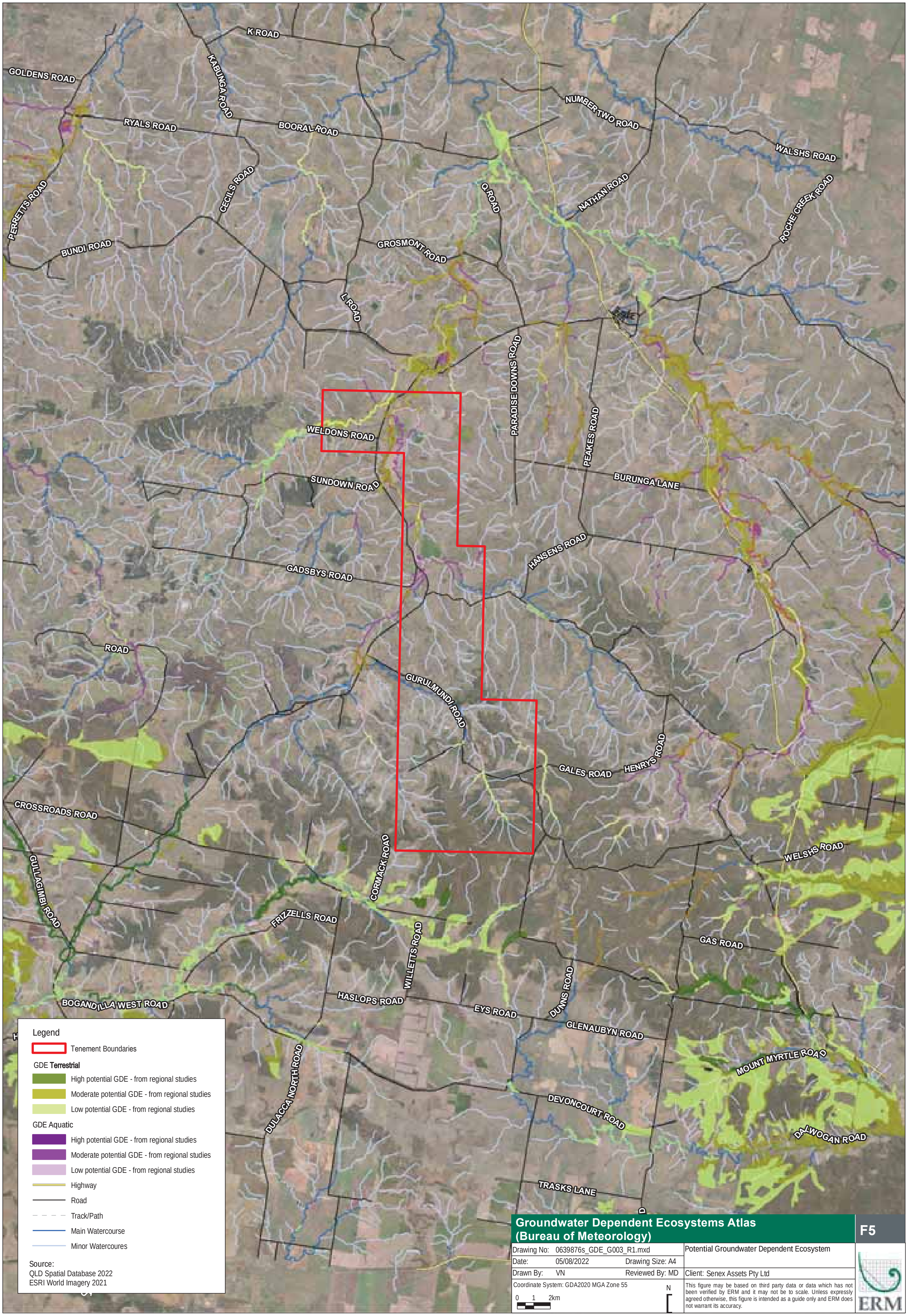
COMMONWEALTH MAPPING OF TERRESTRIAL AND AQUATIC GDE

Commonwealth mapping of aquatic and terrestrial GDE within the 25km buffer from the Atlas Stage 3 Gas Project tenements boundaries, shows that considerable overlapping with Queensland state mapping is present (Figure 5**). GDE remain heavily associated with riparian zones and other waterways outside of protected state forests. Fragmentation is still apparent in Commonwealth mapping and is likely to result from a combination of historic disturbance regimes and natural geomorphological processes.**


K ROAD
GOLDENS ROAD
KABUNGA ROAD
RYALS ROAD
BOORAL ROAD
NUMBER TWO ROAD
WALSHS ROAD
PERRETTS ROAD
CECILS ROAD
Q ROAD
NATHAN ROAD
ROCHE CREEK ROAD
BUNDI ROAD
GROSMONT ROAD
L ROAD
PARADISE DOWNS ROAD
PEAKES ROAD
WELDONS ROAD
SUNDOWN ROAD
BURUNGA LANE
HANSENS ROAD
GADSBYS ROAD
ROAD
GURULMUNDI ROAD
HENRYS ROAD
GALES ROAD
CROSSROADS ROAD
WELSHS ROAD
GULLAGIMBI ROAD
CORMACK ROAD
FRIZZELLS ROAD
WILLETTS ROAD
GAS ROAD
DUNNS ROAD
BOGANDILLA WEST ROAD
HASLOPS ROAD
EYS ROAD
GLENAUBYN ROAD
MOUNT MYRTLE ROAD
DULACCA NORTH ROAD
DEVONCOURT ROAD
TRASKS LANE
Legend
Tenement Boundaries
GDE Terrestrial
High potential GDE - from regional studies
Moderate potential GDE - from regional studies
Low potential GDE - from regional studies
GDE Aquatic
High potential GDE - from regional studies
Moderate potential GDE - from regional studies
Low potential GDE - from regional studies
Highway
Road
Track/Path
Main Watercourse
Minor Watercoures
Source:
QLD Spatial Database 2022
ESRI World Imagery 2021
Groundwater Dependent Ecosystems Atlas
(Bureau of Meteorology)
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Drawing No: 0639876s_GDE_G003_R1.mxd
Date: 05/08/2022
Drawing Size: A4
Drawn By: VN
Reviewed By: MD
Potential Groundwater Dependent Ecosystem
Client: Senex Assets Pty Ltd
Coordinate System: GDA2020 MGA Zone 55
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Appendix F: Terrestrial and Aquatic Ecology Assessment Report – ATP 2059 (ERM, 2023)

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