Australasian Groundwater & Environmental Consultants

Report on

Vali Gas Field Underground Water Impact Report

Prepared for
Erias Group

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Vali Gas Field Underground Water Impact Report

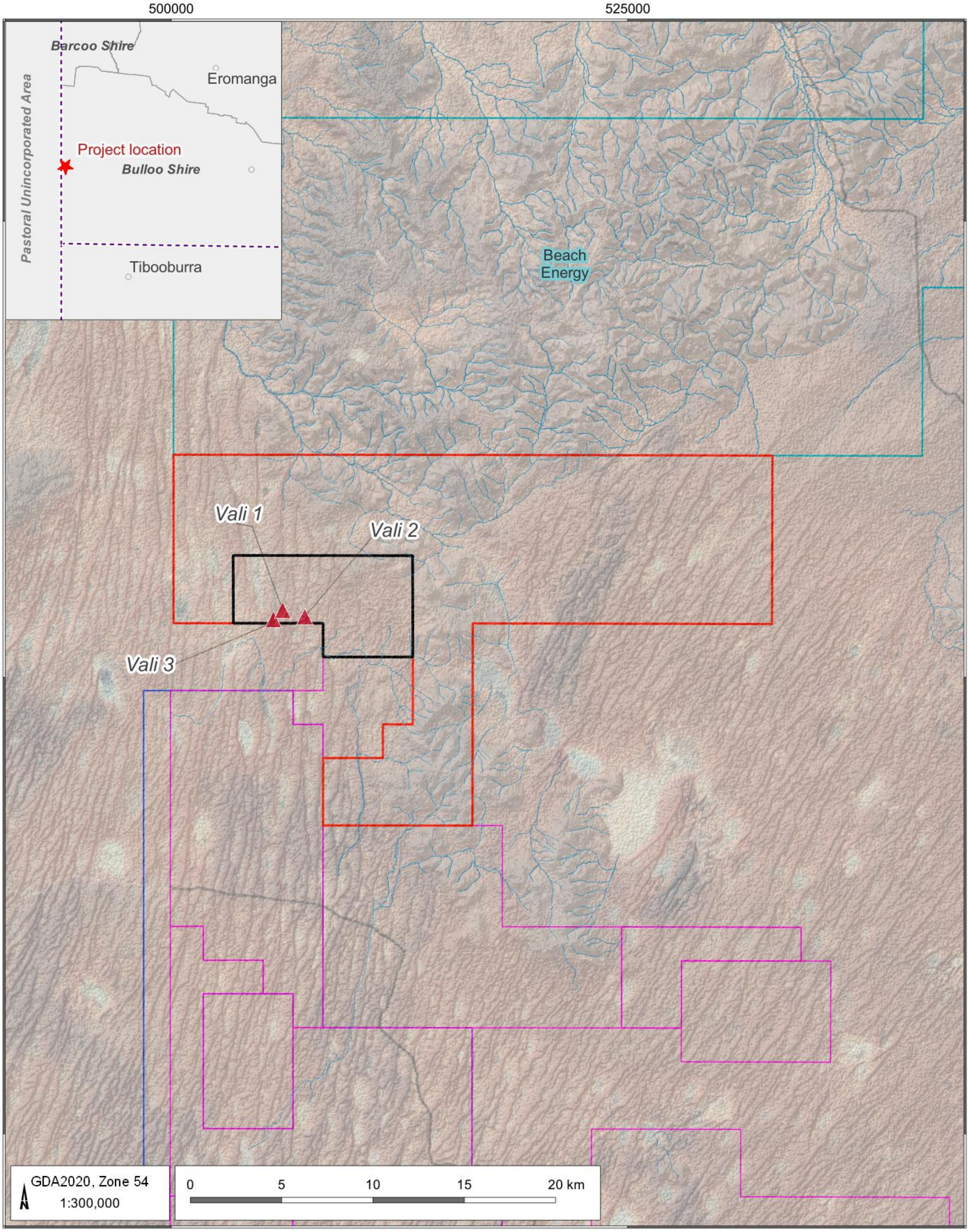
1 Introduction

ERIAS Group (ERIAS) is supporting Vintage Energy (Vintage) in converting Authority to Prospect (ATP) 2021 to a Petroleum Lease (PL) for the Vali Gas Project (the Project). The Water Act 2000 places a number of requirements on petroleum tenure holders including a requirement to assess and manage the impacts of underground water extraction associated with the extraction of coal seam gas (CSG), and/or other petroleum or mineral resources. Since December 2010, the Water Act 2000 has been amended to include (among other requirements) provisions for the preparation, consultation and submission of an Underground Water Impact Report (UWIR) summarising the results of these assessments. ERIAS has engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to prepare the UWIR for the Project.

1.1 Project area

The Project is currently operating within the ATP2021 in the Shire of Bulloo in Queensland. There are three production wells, Vali-1, Vali-2 and Vali-3, located on separate pads, between 700 and 1,700 metres apart and covering an area of approximately 1.2 km^2. The Vali gas field is limited to the three production wells; no additional drilling is planned. Figure 1.1 shows the extent of this Project area and the associated PL area (PL1125).

The broader Project includes a second gas field named Odin located across Queensland and South Australia. The production well Odin 1 is approximately six kilometres west of Vali-3, in South Australia. Odin gas field Project is excluded from this UWIR.



LEGEND

- Place names
- Vali production wells
- Watercourse
- Roads
- State Borders
- Authority to Prospect (ATP 2021)
- Authority to Prospect (ATPs)
- Petroleum Lease 1125
- Santos Petroleum Leases
- Santos Exploration Permits for Petroleum
- Local government region

Vali Gas Field Underground Water Impact Report (VGF5000.001)

Project location

AGE

DATE 02/05/2024

FIGURE No: 1.1

Source: 1 second SRTM Derived DEM-S - © Commonwealth of Australia (Geoscience Australia) 2011.; GEODATA TOPO 250K Series 3 - © Commonwealth of Australia (Geoscience Australia) 2006.;
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1.2 Legislation and guidelines

The primary legislative requirements related to the extraction of groundwater from deep aquifers and management of produced water for Vali Gas Field activities are summarised below.

1.2.1 Petroleum and Gas (Production and Safety) Act 2004 (QLD)

Under the Petroleum and Gas (Production and Safety) Act 2004 (Qld), the petroleum tenure holder may take or interfere with underground water in the area of the tenure if this happens during the course of, or results from, the carrying out of another authorised activity for the tenure. The Act also requires tenure holders to comply with underground water obligations specified in the Water Act 2000 (Qld).

1.2.2 Water Act 2000 (QLD)

Management of underground water impacts as a result of the exercise of underground water rights by petroleum tenure holders for petroleum or CSG projects is detailed in Chapter 3 of the Water Act 2000. The Act provides a framework that requires the petroleum tenure holder to prepare an Underground Water Impact Report (UWIR) which establishes obligations for monitoring and managing impacts on aquifers and springs. More specifically it also provides for trigger levels for establishing the significance of impact on an aquifer in the event of a decline in water levels. These trigger thresholds are:

- a 5 m decline in water levels within a consolidated aquifer;
- a 2 m decline in water levels within an unconsolidated aquifer; and
- a 0.2 m decline in water levels associated with active springs.

Areas where the expected decline in groundwater levels exceeds the relevant trigger level, within the next three years are defined as Immediately Affected Areas (or IAA). Areas where the expected declines in groundwater level exceed the trigger threshold in the longer term (i.e. sometime after three years) are defined as Long-term Affected Areas (or LTAA).

1.2.3 Underground Water Impact Report (UWIR)

The overall purpose of an Underground Water Impact Report (UWIR) is to provide a summary of the predicted groundwater impacts of a Project and set out how these expected impacts are to be monitored and managed. The relevant guideline (Queensland government, 2021) recommends specific methods for making predictions about the impacts of underground water extractions and for the preparation of UWIRs.

A UWIR must contain the following information:

- Part A: Information about underground water extractions resulting from operators exercising their underground water rights.
- Part B: Information about aquifers affected, or likely to be affected either in the short or longer term to assist with management of impacts of the exercise of water rights by tenure holders.
- Part C: Maps showing the area of affected aquifer(s) where underground water levels are expected to decline by more than the relevant trigger thresholds.
- Part D: A water monitoring strategy.
- Part E: A spring impact management strategy.

1.2.4 Environmental Protection Act 1994 (QLD)

The Environmental Protection Act 1994 and the related Environmental Protection (Water) Policy (EPP Water) provides a framework to protect and/or enhance the suitability of Queensland waters for various beneficial uses.

Surface waters are managed under the Cooper Creek water plan which is a component of the Lake Eyre Basin. The Lake Eyre Basin extends across Queensland, South Australia, New South Wales and the Northern Territory and the governments are signatories of the Lake Eyre Basin Intergovernmental Agreement (IGA).

Groundwater resources in the Project area are managed under the Great Artesian Basin and Other Regional Aquifer (GABORA) Water Plan (Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017). The Water Plan is divided into groundwater units listed in Schedule 2 of the Water Plan and the geological formations are listed in Schedule 3 of the Water Plan. Although the geological formations of the Eromanga Basin are listed in Schedule 3 of the Water Plan, the groundwater resources from the Cooper Basin are not mentioned in the Water Plan. Therefore, there are no environmental values and water quality objectives listed in Schedule 1 of the Water Plan for the groundwater resources extracted from Vali Gas production wells.

1.3 Report structure

The structure of this UWIR is in accordance with requirements of the Environmental Protection Act 1994 (section 126A and 227AA) and Water Act 2000 (section 376) and with associated Queensland Government guidelines (Queensland Government, 2021), and includes the following sections:

- Part A: Information about underground water extractions resulting from the exercise of underground water rights (Section 2).
- Part B: Information about aquifers affected, or likely to be affected; underground water flow description (Section 3).
- Part C: Predicted changes to water levels in the affected aquifer(s) (Section 4).
- Part D: An assessment of the impacts on environmental values from the exercise of underground water rights (Section 5).
- Part E: A water monitoring strategy (Section 6).
- Part F: A spring impact management strategy (Section 7).

2 Underground water extraction (Part A)

2.1 Quantity of water already extracted

There are three production wells located within ATP2021. Production testing started in Q1 2023 from the Patchawarra and Toolachee Formations which form part of the Cooper Basin. Information on the stratigraphic units screened in each of these three wells is provided in Table 2.1. The Vali-1 well was completed in 2020 and Vali-2 and Vali-3 were completed in 2021. Vali-1 is the main testing production well with 135 days of production from late February to July 2023.

Table 2.1 Production wells, production dates and stratigraphy

Bore name	Start of production	Stratigraphic unit(s)	Comments
Vali-1	21 February 2023	Patchawarra Formation	135 days of testing production
Vali-2	March 2023	Toolachee and Patchawarra Formations	16 days of testing production. Well flowing from Patchawarra only from 4 May 2023
Vali-3	March 2023	Toolachee Formation	11 days of testing production

In total 3,493 kL of water was extracted from the three wells between 21 February 2021 and 13 December 2023. The most productive period was between February and July 2023 with the net flow of water returned to the wells for hydraulic stimulation purposes is shown in Table 2.2.

Table 2.2 Monthly water extraction 2023

Months	Water extraction* (kL)				
	Vali-1 (Patchawarra)	Vali-2^ (Patchawarra)	Vali-2 (Toolachee)	Vali-3 (Toolachee)	Total
February 2023	161.30	0.00	0.00	0.00	161.30
March 2023	379.67	0.00	96.82	211.69	688.18
April 2023	275.99	0.00	99.36	193.79	569.15
May 2023	198.39	530.38	12.08	0.00	740.85
June 2023	231.65	541.98	0.00	0.00	773.62
July 2023	263.99	62.00	0.00	0.00	325.99
Total	**1510.99**	**1134.35**	**208.26**	**405.48**	**3259.09**

Notes: *cumulated water extraction to facility and to flare/vent/blowdown.
^Well flowing from Patchawarra only from 4th May 2023.

2.2 Quantity of water to be extracted in the next three years

Expected total water extraction from the three wells for the next three years is summarised in Table 2.3. Groundwater extraction from the three wells is expected to be for a duration of 20 years with a total of 11,600kL per year.

Table 2.3 Total predicted water extraction volumes

Financial Year	Date	Total water extraction (kL)	Total water extraction (m^3/d)	Average per well (m^3/d)
2023/2024	1 July to 30 June	6,900	19	6.3
2024/2025	1 July to 30 June	11,600	32	10.6
2025/2026	1 July to 30 June	11,600	32	10.6
2026/2027	1 July to 30 June	11,600	32	10.6
2027/2028	1 July to 30 June	11,600	32	10.6

3 Existing environment and aquifer information (Part B)

3.1 Climate

The Scientific Information for Landowners (SILO) database provides interpolated rainfall and evaporation data from available climate stations for a selected location. The monthly patched point SILO rainfall data for the Project site (longitude 141.13, latitude -28.01) were obtained from the Long Paddock website on 9 January 2024 (Queensland Government, 2024). Interpolated climatic information was obtained for the period January 2000 and December 2023.

According to the Köppen major classification system (BOM, 2005) the Project area experiences a desert climate. Figure 3.1 summarises observed monthly average temperature ranges and precipitation between 2000 and 2023. As shown monthly precipitation is limited, typically less than 10 mm/month in winter rising slightly in the summer to up to 26 mm on average in January. Average annual rainfall over the period analysed was 174 mm. Average maximum temperature in January is 39ºC falling to 20ºC on average in July.

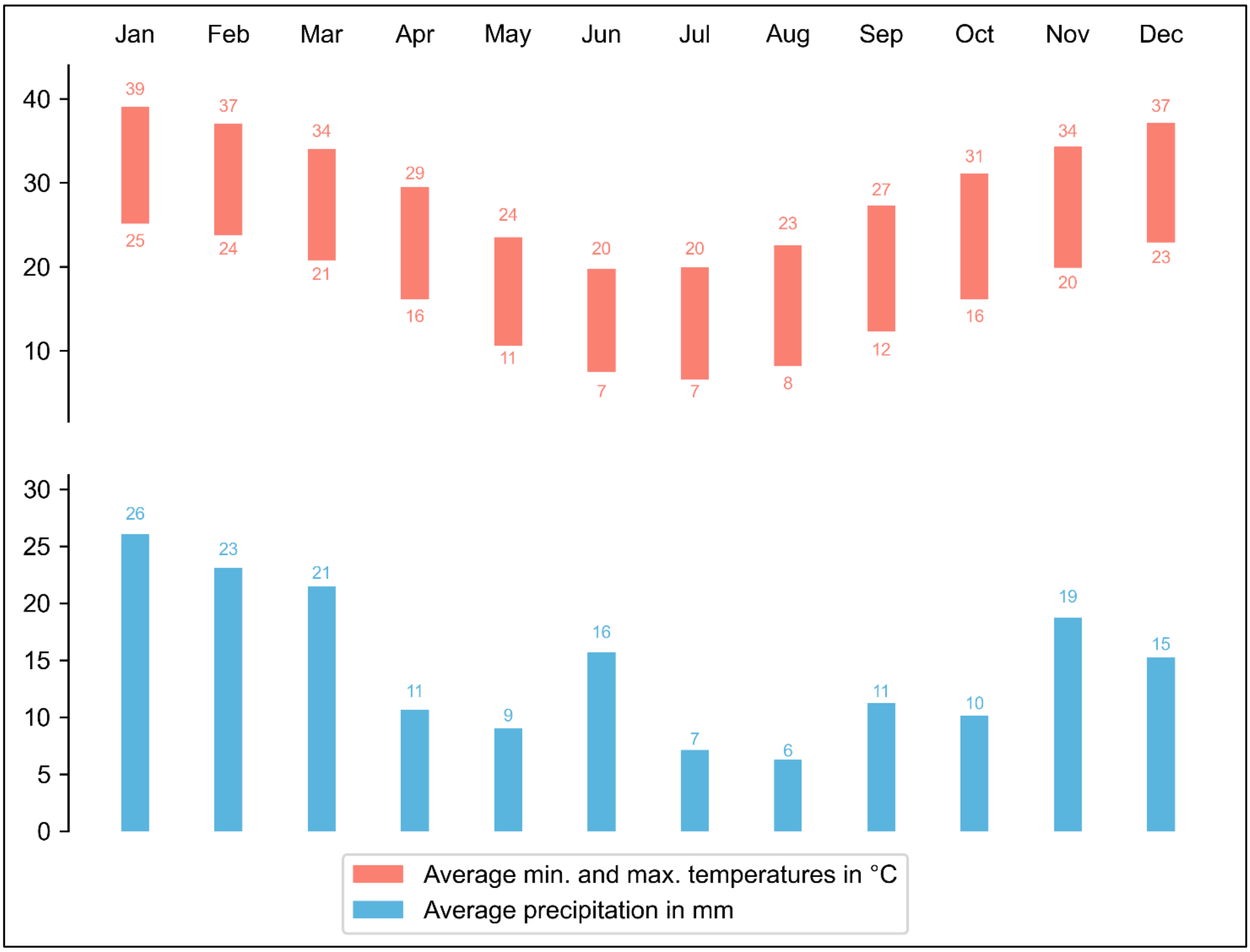


Figure 3.1 Average temperatures and precipitations between 2000 and 2023

The monthly Cumulative Rainfall Departure (CRD) was calculated for the period January 2000 to January 2024 and shows the area has experienced distinct cycles of above and below-average rainfall (Figure 3.2). The CRD method (Weber and Stewart, 2004) represents a summation of the monthly departure of rainfall from the long-term average monthly rainfall. A rising trend in the CRD plot therefore indicates periods of above-average rainfall, whilst a negative slope indicates periods of below-average rainfall.

The first part of the graph shows the millennium drought until 2010, then a wet period between 2010 and 2012. Between 2013 and 2020 rainfall totals were below average for the most part, with relatively short periods of above average rainfall. Since 2020 rainfall has been close to average.

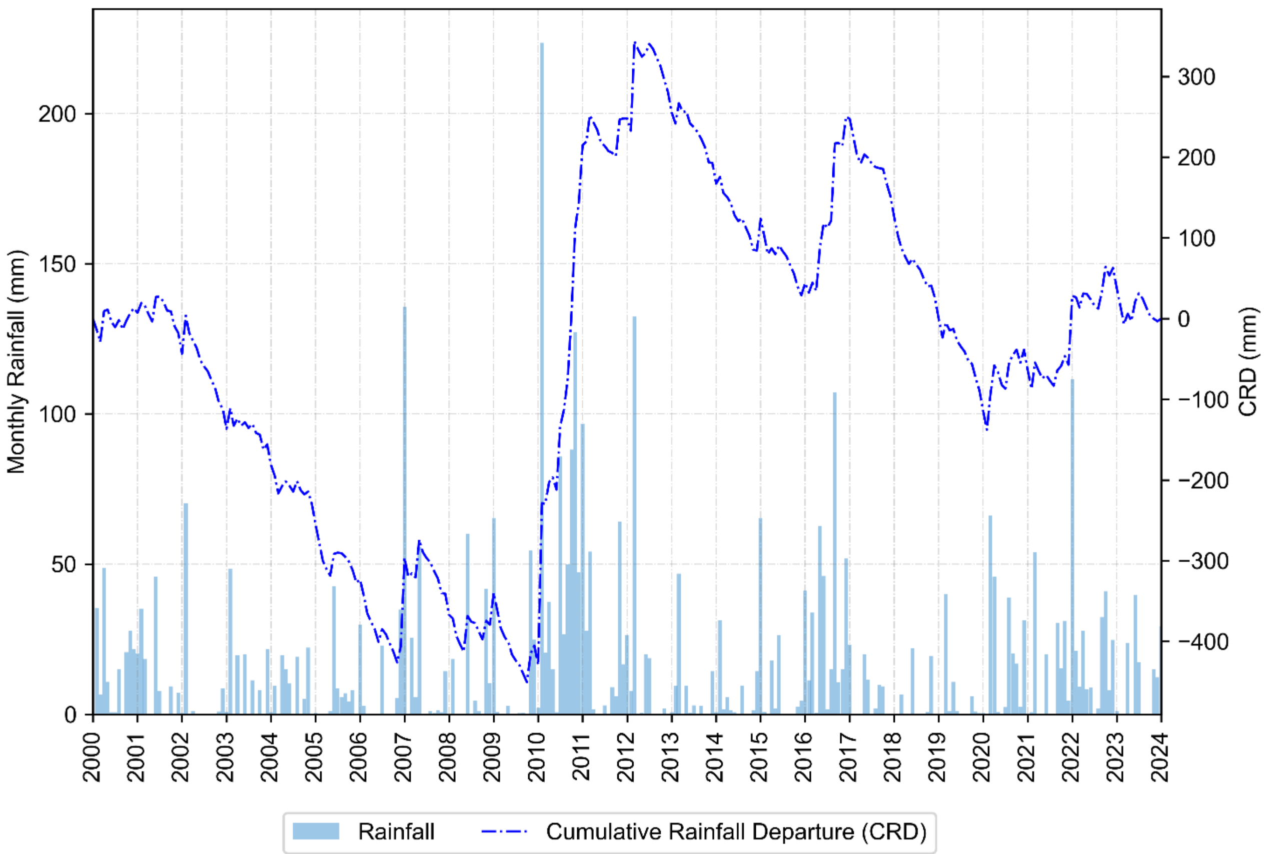


Figure 3.2 Monthly SILO rainfall and CRD (2000-2024)

3.2 Topography and drainage

Figure 3.3 shows the topography and drainage of the Project area.

3.2.1 Topography

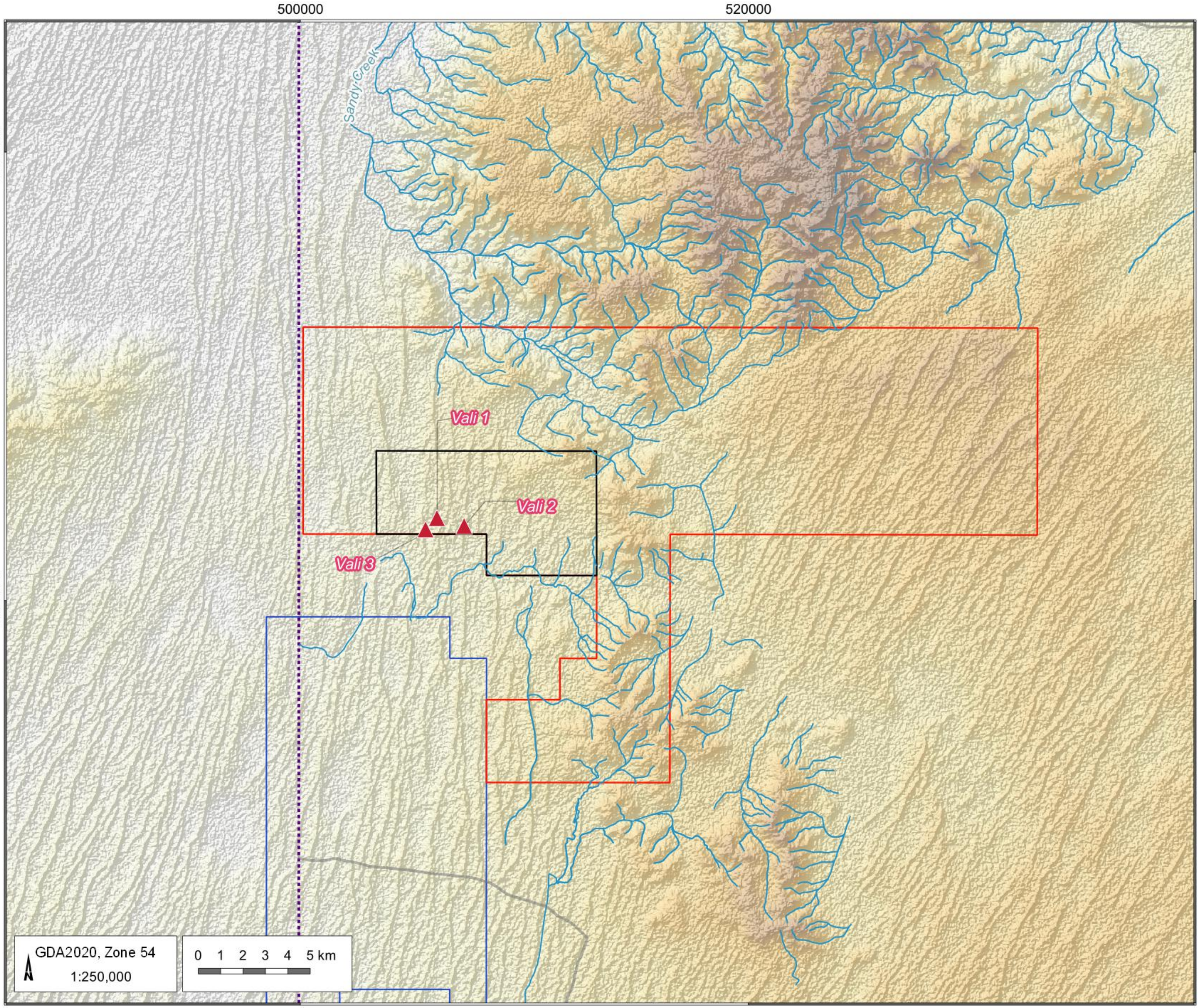
The Vali gas field site is located between the Simpson, Strzelecki and Sturt Stony deserts. The terrain in the area is dominated by undulating dune fields. It also comprises flat gibber plains, sand plains and flood plains.

Ground elevation at the Vali-1 well site is between 102 and 105 metres Australian Height Datum (mAHD). It is adjacent to a clay depression and a dune. Ground elevation at the Vali-2 pad is approximately 107 mAHD and 103 mAHD at the Vali-3 well pad.

3.2.2 Drainage

The site is located in a sub-basin of the Cooper Creek. Local drainage lines flow towards Lake Eyre, which is located approximately 370 km to the west of the Project area.

There are no springs from the Queensland Springs Database mapped within or near the Project area. The nearest mapped spring is approximately 300 km to the east of the Project area. The closest Great Artesian Basin springs in South Australia are approximately 100 km south west of the Project area.



LEGEND

- Vali wells
- Watercourse
- Roads
- State border
- Authority to Prospect (ATP 2021)
- Petroleum Lease 1125
- Santos Exploration Permits for Petroleum

Elevation (mAHD)

- 75
- 100
- 120
- 140
- 160
- 180
- 200

Vali Gas Field Underground Water Impact Report (VGF5000.001)

Topography and drainage

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20/06/2024

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FIGURE No:
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3.3 Geology

A review of the geological and hydrogeological features that occur beneath ATP2021 are described below and have been used to develop the hydrogeological conceptualisation of the groundwater regime beneath the Project area and surrounds. This understanding forms the basis for the analytical groundwater flow model. As mentioned previously the targets for gas production at PL1125 comprise the Toolachee and the Patchawarra Formations within the Cooper Basin. There are no regional faults mapped in the Project area.

Figure 3.4 summarises the stratigraphy of the project area.

3.3.1 Surface deposits

Figure 3.5 shows the surface geology at the Vali Gas field which is dominated by Quaternary sands. The older Tertiary age Glendower Formation outcrops to the east of the PL1125 and the Winton Formation (Cretaceous) outcrops to the northeast of ATP2021. The Glendower Formation is a fluvial deposit comprising sandstone, siltstone, conglomerate and mudstone. The Winton formation comprises interbedded, fine to coarse sandstone, siltstone, shale and coal seams deposited in fluvio-lacustrine environments. The total average thickness of the surface deposits (Quaternary, Tertiary and Cretaceous) is 850 metres.

3.3.2 Eromanga Basin

The Winton Formation is underlain by a series of sedimentary deposits with comprise the Eromanga Basin which represents the largest sub-basin within the Great Artesian Basin (GAB). The total sedimentary thickness of the Eromanga Basin at the site is approximately 1,050 metres. It comprises several stacked formations. The Hutton Sandstone is one of the major sandstone formations of the GAB and is present at the base of the Eromanga Basin in the Project area with a thickness averaging 105 metres. The base of the Eromanga Basin is approximately 2,000 metres below ground level (mbgl) at the Project area. A major unconformity at the base of the Eromanga Basin separates it from the underlying Cooper Basin.

3.3.3 Cooper Basin

The Eromanga Basin unconformably overlies the Cooper Basin. The Cooper Basin is a non-marine sedimentary pile and can be subdivided into three major geological groups:

- Triassic Nappamerri Group: which comprises the Tinchoo Formation (interbedded siltstone and sandstone, minor coal seams and intraclast conglomerate) and the Arraburry Formation (mudstone, siltstone and fine-grained sandstone). The total thickness of the Nappamerri Group is approximately 350 metres in the Project area.
- Permian Gilgealpa Group: which includes the two target formations for the Vali gas field (i.e. the Toolachee and the Patchawarra Formations).
  - The Toolachee Formation comprises interbedded fine to coarse-grained sandstone, siltstone and carbonaceous shale. It is approximately 160 metres thick in the Project area (between 2,400 and 2,550 metres below ground level) and unconformably overlies the mudstones and siltstones of the Daralingie Formation.
  - The Daralingie Formation, The Roseneath Shale, Epsilon Formation and Murteree Shale overlie the Patchawarra Formation. The cumulative thickness of these deposits in the Project area is around 350 metres which predominantly comprises interbedded mudstone, siltstone and shale.
  - The Patchawarra Formation predominantly comprises interbedded sandstone, siltstone, shale and coal. It is approximately 310 metres thick at the three existing production wells. Depths are approximately between 2,800 and 3,110 metres below ground level.
  - The underlying Tirrawarra Sandstone predominantly comprises fine to coarse-grained sandstone interbedded with conglomerate and minor carbonaceous siltstone, shale and coal.
- Late Carboniferous Group: which includes the Merrimelia Formation, it is of glacial origin.

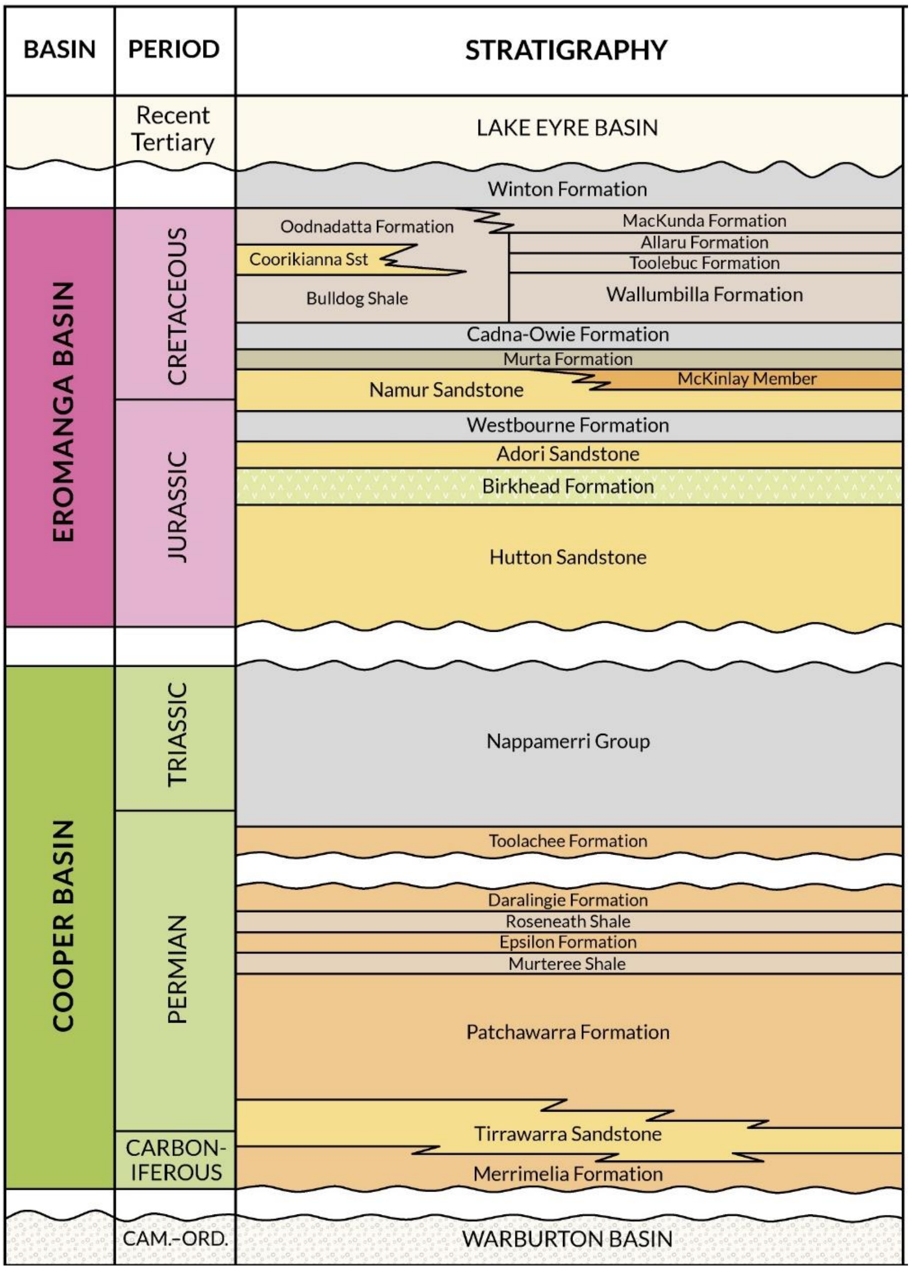
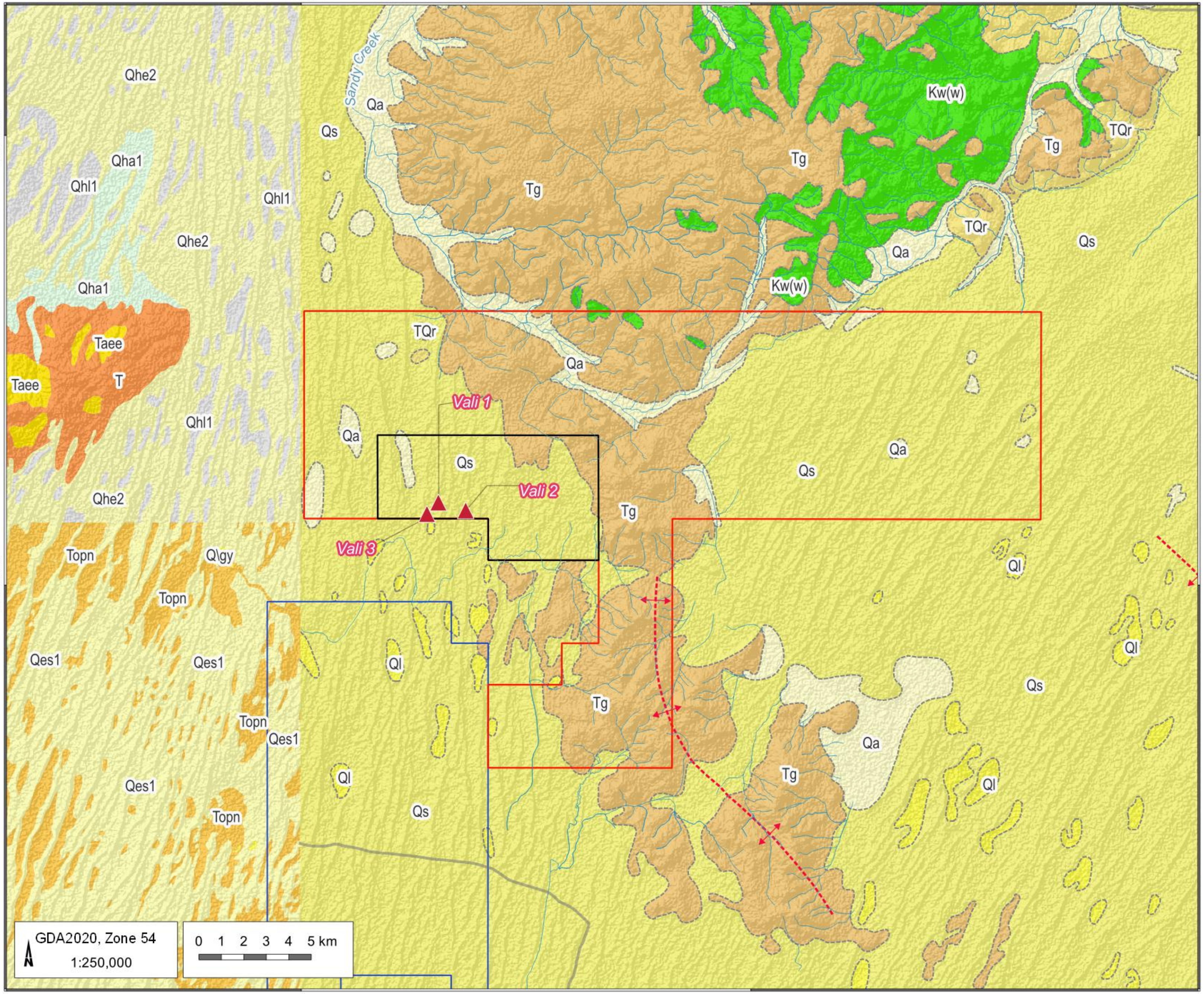


Figure 3.4 Stratigraphy of the Eromanga and Cooper basins



Vali Gas Field Underground Water Impact Report (VGF5000.001)

Surface geology

DATE
20/06/2024

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FIGURE No:
3.5

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3.4 Hydrogeology

As would be expected significant groundwater resources are generally only consistently intersected in those stratigraphic units which are sandstone dominated. Other units which are dominated by siltstone, mudstone and shale formations tend to act as aquitards. The main aquifers for water extraction include the following:

- Shallow Quaternary and Tertiary sediments.
- The Winton Formation.
- The Great Artesian Basin (GAB) aquifers of the Eromanga Basin which include: Mackunda Formation, Wallumbilla Formation, Cadna-Owie Formation, Hooray and Hutton Sandstones.
- Other Cooper Basin aquifers including: Toolachee Formation, Epsilon Formation, Patchawarra Formation and Tirrawarra Sandstone.

The Winton and Mackunda aquifers are the primary targets for groundwater extraction in the project area because they are relatively shallow and consequently easier and cheaper to drill into. Groundwater from Cadna-Owie, Hooray systems and other Eromanga Basin aquifers are rarely targeted for extraction locally due to drilling depths exceeding 1,000 metres. Petroleum exploration bores that intersect these deeper aquifers are sometimes repurposed for water supply purposes, however as discussed in Section 5.1, the deepest existing water supply bore within 15 km of the Project Area is less than 300 m deep. The aquifers of the Cooper Basin are present at ever greater depth (base of the Toolachee is approximately 2,550 mbgl and base of the Patchawarra is 3,110 mbgl) and only accessed for gas production.

It is considered unlikely that the impact of water extraction in the Cooper Basin could extend far beyond the top of the Cooper Basin into the overlying Eromanga Basin due to the geological discontinuity between the two basins and the thickness and the anticipated low permeability of the Tinchoo Formation, which sits immediately below the base of the Eromanga Basin. Based on this assertion, the aquifers which could be impacted by the three Vali project production wells include:

- Hutton Sandstone: typically, comprises fine to coarse-grained quartzose porous sandstones interbedded with minor finer-grained siltstones. It lies unconformably over the Cooper Basin. Thickness is approximately 105 metres (between 1,900 and 2,000 mbgl). Estimated hydraulic conductivities are between 9.8×10^{-3} and 3.5×10^{-1} m/d (Santos, 2019) and storativity is estimated at 1×10^{-4}.
- Toolachee Formation: typically comprises porous sandstones interbedded with finer-grained siltstones, mudstones and shales with thin coal seams and some conglomerates. It unconformably overlies older formations across the whole Cooper Basin. Thickness is around 160 metres (between 2,380 and 2,540 mbgl in Vali-1). Estimated hydraulic conductivities are between 2×10^{-3} and 4.3×10^{-3} m/d (Santos, 2019) and storativity is 5.5×10^{-5}.
- Epsilon Formation: predominantly siltstone with minor coal and sandstones. The thickness averages 50 metres. There are no hydraulic properties estimated in the surrounding existing UWIR.
- Patchawarra Formation: consisting of variable porous sandstone interbedded with siltstone, mudstone and shale with thin coal seams. The thickness is 310 m at the project area (between 2,805 and 3,115 mbgl at Vali-1). Estimated hydraulic conductivities are between 3.3×10^{-4} and 3.5×10^{-3} m/d (Santos, 2019) and storativity is 1.1×10^{-4}.
- The Tirrawarra Sandstone: consisting of fine to coarse-grained and pebbly sandstone interbedded with conglomerate, minor carbonaceous siltstone, shale and coal. The Tirrawarra Sandstone is on approximately 80 metres. No estimated hydraulic conductivities were provided in other UWIR reports.

3.5 Groundwater quality

Single groundwater results are available for four locations within the project area: two mixed samples from Vali-1, Vali-2 and Vali-3 production bores (taken from two different locations within the gas/water collection network) and samples from two landowner bores (the Watties and Christmas bores) collected during baseline assessment data collation activities. Table 3.1 summaries the formations screen in each bore as well as sampling dates.

Table 3.1 Water sample information

Sample name	Date	Lithology
Top Pond (mixed sample from Vali-1, 2 and 3)	22/09/2023	Toolachee and Patchawarra Formations
Overflow Pond (mixed sample from Vali-1, 2 and 3)	22/09/2023	Toolachee and Patchawarra Formations
Watties Bore	05/04/2022	Glendower or Winton Formations
Christmas Bore	05/04/2022	Glendower or Winton Formations

Salinity can be described by total dissolved solid (TDS) concentrations or electrical conductivity (EC[1]). TDS concentrations are commonly classified on a scale ranging from fresh to extremely saline. The Queensland Government released science notes (Queensland Government, 2018) about salinity limits for water to provide an overview of the typical salinity characteristics of water (Table 3.2).

Table 3.2 Guide to typical salinity limits for waters (Queensland Government, science notes L137)

Type	EC (µS/cm)	TDS (mg/l)
Distilled water	1	0.67
Rainfall	30	20
Freshwater	0 to 1500	0 to 1000
Great Artesian Basin Water	700 to 1000	470 to 670
Brackish water	1500 to 15000	1000 to 10050
Upper limit recommended for drinking	1600	1070
Seawater	55000	36850
Tolerances of livestock to salinity in drinking water (at these values, animals may have an initial reluctance to drink, but stock should adapt without loss of production)		
• Beef cattle	5970 to 7460	4000 to 5000
• Dairy cattle	3730 to 5970	2500 to 4000
• Sheep	7460 to 14925	5000 to 10000
• Horses	5970 to 8955	4000 to 6000
• Poultry	2985 to 4475	2000 to 3000
General limits for irrigation		
• Salt sensitive crops	650	435
• Moderately salt sensitive crops	1300	870
• Salt tolerant crops	5200	3485
• Generally, too saline for crops	8100	5430

[1] Electrical conductivity is a measure of the saltiness of the water and is measured on a scale from 0 to 50,000 µS/cm. Electrical conductivity is measured in micro siemens per centimetre (µS/cm).

The samples taken from the Watties and Christmas bores suggest that groundwater is brackish with electrical conductivity ranging between 2,220 and 7,560 µS/cm (i.e. towards the upper end of the limits for stock watering and irrigation uses (Table 3.2). Given the depth of the Toolachee and Patchawarra units in the Project area, data for the gas production bores points are highly saline conditions with EC ranging between 10,000 and 19,000 µS/cm and well above the upper limits for drinking, stock watering or irrigation (Table 3.2).

A piper plot (Figure 3.6) and a Durov diagram (Figure 3.7) were generated for the four water samples collected. As shown in Figure 3.6, all boreholes can be classified as a sodium-chloride water type. As would be expected, given the higher salinity values discussed above water drawn from the production bores is characterised by substantially higher chloride concentrations (between 3,300 and 7,200 mg/L) than the groundwater drawn from the local water supply bores (between 810 and 1,800 mg/L).

The pH is close to neutral for three samples, ranging between 6.8 and 7.5 (Figure 3.7). On the other hand, water sampled from the overflow pond is basic with a pH of 8.5. This may be related to chemical changes occurring within the pond.

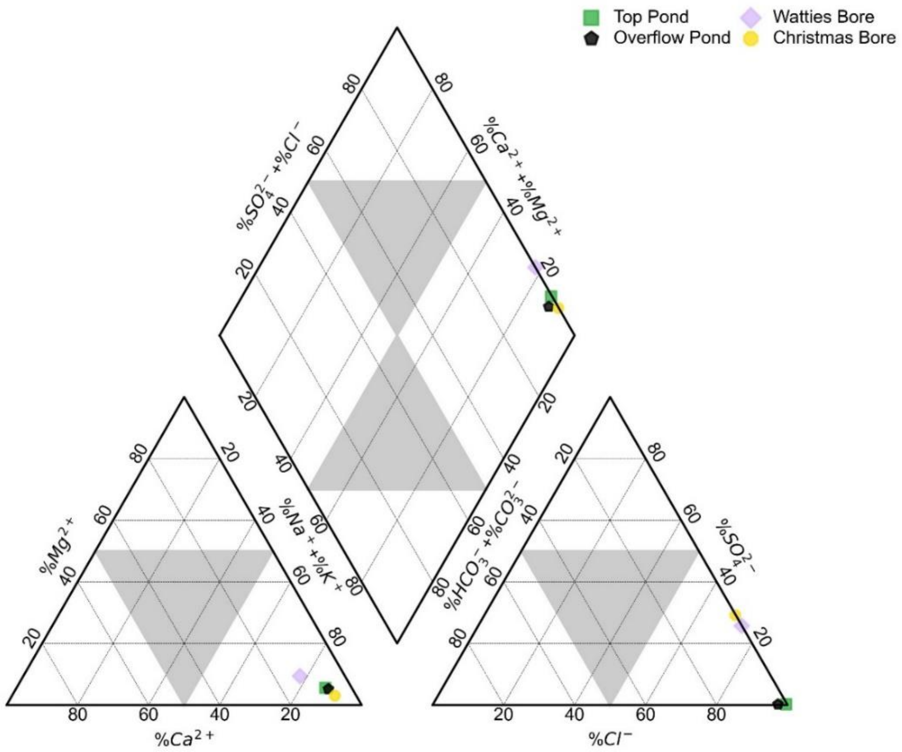


Figure 3.6 Piper plot

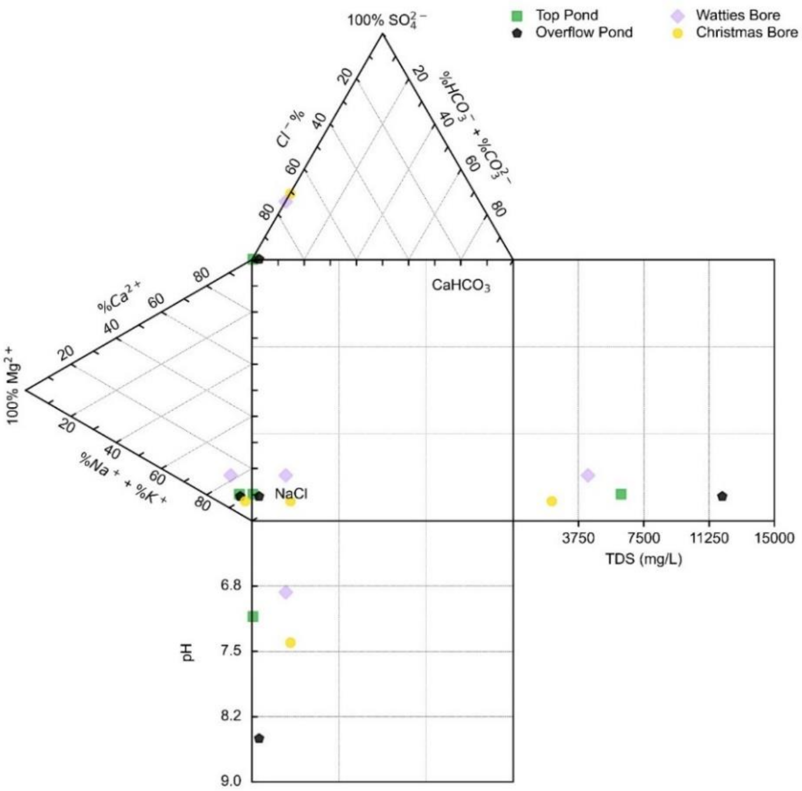


Figure 3.7 Durov diagram

3.6 Hydrogeological conceptual model

Figure 3.8 presents a hydrogeological conceptual model of Vali gas field based on the data available. Other local water supply bores in the Project area extend to less than 300 metres below ground level and are therefore thought to be extracting from the Winton or Glendower Formations. The Eromanga Basin unconformably overlies the Cooper Basin where the three production bores, Vali-1, Vali-2 and Vali-3 are extracting water from between 2,380 and 3,110 m below ground level (i.e. more than 2,080 m below local groundwater extractions). Vali-1 is screened within the deepest formation, the Patchawarra Formation. The production well Vali-3 is screened within the Toolachee Formation and the Vali-2 extracts gas from both the Toolachee and Patchawarra Formations. Adopted hydraulic conductivity and storativity values are based predominantly on values available for adjacent lease areas (Santos 2019; Beach Energy, 2020) which are shown in Figure 3.8. Sections 3.6.1 and 3.6.2 below describe the estimated water levels and potential groundwater flow and recharge mechanisms within the Cooper Basin.

3.6.1 Underground water flow and aquifer interactions

As would be expected given the depth of the target formations in the Project area, information on groundwater levels and flow directions in the Toolachee and Patchawarra formations and the Cooper Basin in general are somewhat limited. Groundwater movement even within coarse sandstone units present at such depths is likely to be limited by its reduced capacity to transmit water as permeability tends to decrease with increasing depth. Similarly, groundwater recharge through the overlying 2,400 m thick sedimentary pile which includes significant thicknesses of aquitard material is likely to be negligible. Hence consistent with the water quality data described above (Section 3.5) Toolachee and Patchawarra formations are saline and likely to be relatively old, when compared to waters from the overlying GAB aquifers in the Eromanga Basin. The implication here is that the recharge of the Cooper Basin aquifers may be considered minimal to none (Keppel at al., 2016). In general groundwater flow, if it occurs at all given the expected low permeability, generally follows the sedimentary bedding, towards lower-lying areas.

Evidence gathered from DST testing during drilling showed “over-pressuring” in the Toolachee, Daralingie and Patchawarra Formations (i.e. pressures which increase with depth and are above the hydrostatic pressure line), which suggests the existence of highly effective seals (i.e. aquitards) within the Nappamerri Group (Lech et al., 2020). Movement of groundwater into and out of the Cooper Basin formations via the overlying Eromanga Basin aquifers is therefore only likely to occur where a connected pathway through the Nappamerri group exists or is subsequently established. Hypothesized pathways include locations where the unit abuts basement highs which could, in combination with localised faulting, create preferential pathways for vertical fluid migration.

3.6.2 Underground water level trend analysis

There is limited groundwater level information in the Cooper Basin within the Vali gas field. Short post-production and production shut-in pressure tests were provided for two production wells, Vali-1 and Vali-2, in August 2023. The estimated water levels at Vali-1 from the pressure tests vary between 190 and 1,500 metres (not stabilised) below ground level. The shut-in pressure test at Vali-2 was not stabilised and the pressure measured was equivalent to 1,140 metres below ground level at the time of the test. It is likely there is a depressurisation in the production wells above 1,500 metres of water depletion however it is unlikely the depressurisation extends to the overlaying Eromanga Basin. The Winton Formation is likely locally depressurised from the water users' bores.

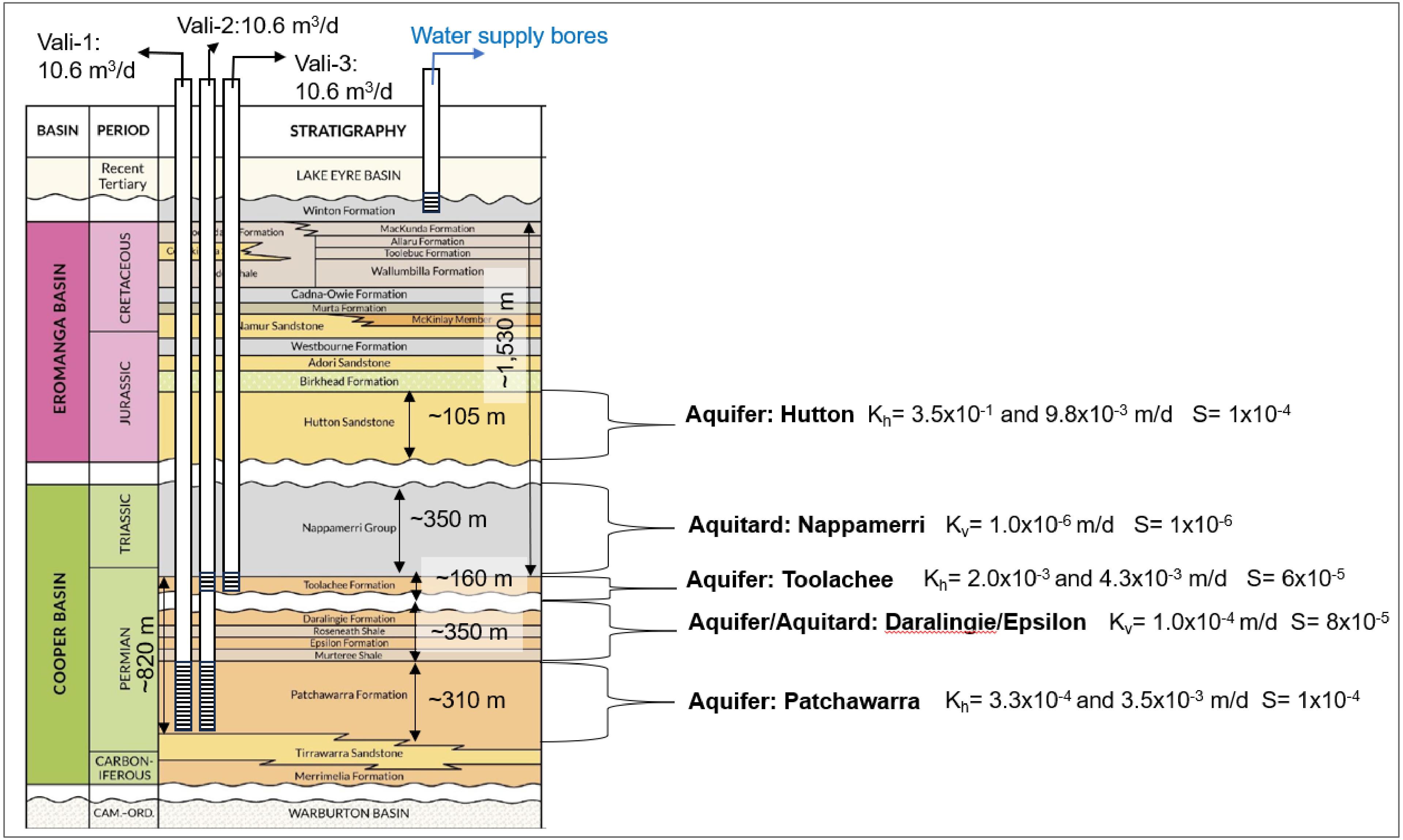


Figure 3.8 Hydrogeological conceptual model

4 Predictions of groundwater impacts (Part C)

For the purposes of this UWIR, the affected area in the Cooper Basin and the Hutton Sandstone is considered to be the area where observed or predicted groundwater level drawdown, caused by the removal of water to allow efficient gas extraction, exceeds five metres (Section 1.2.2). The drawdown threshold for potential impact on springs and groundwater dependent ecosystems (GDEs) is 0.2 m.

4.1 Model approach

A relatively simple analytical modelling approach has been adopted for the study on the basis that the risk to existing water users and GDEs are expected to be relatively low, since:

- The proposed development is limited to continued extraction from three existing wells located on a small 1.2 km2 PL area (PL1125).
- The volume of water extracted from the wells is relatively minor, 11.6 ML per year over the next 20 years (Section 2), an extraction rate which is likely to be similar to other existing stock & domestic extractions in the area.
- There is a significant (1,530 m) vertical separation of the target formations (the Toolachee and Patchawarra formations) from potential receptors (existing water supply bores screened into the Winton Formation and terrestrial GDEs potentially partially sourced by near surface aquifer units).
- The existence of a number of regional scale aquitards in the zone between the target formations and potential receptors, including in particular the Nappamerri Group which is known to form a highly effective seal at the top of the Cooper Basin in the area (Lech et al., 2020).
- There are no mapped major faults which might form vertical impact propagation pathways or mound springs which might provide evidence of actual pathways, within 100 km of the Project area.

Due to the existence of a geological discontinuity between the Eromanga and the Cooper Basins and the thickness of the Nappamerri Group aquitard above the Toolachee Formation, it is considered unlikely that the impact of water extraction in the Cooper Basin will propagate into the overlying Eromanga Basin. Nevertheless, the Hutton Sandstone has been simulated to quantify potential drawdown at the base of the Eromanga Basin from the Vali gas field

Predictive modelling was undertaken using the MLU software (version 2.25.78). This is a relatively sophisticated quasi 3D analytical modelling tool which unlike other analytical tools allows simulation of multiple aquifer systems and intervening aquitards and can easily be set up to provide predictions in each aquifer based on ongoing extraction from a number of extraction wells.

The primary objective of the predictive modelling was to provide estimates of the decline in water level in response to the ongoing removal of water from the Toolachee and Patchawarra formations over a three-year period (i.e. identify the IAA area) and in the long-term (i.e. the LTAA area). Given the relative positions of the target formation and the receptors this primarily involved assessing the degree to which extraction impacts propagate vertically through the overlying material.

4.1.1 Model construction

For analytical modelling purposes as summarised in Table 4.1 the conceptual model shown in Figure 3.8 was simplified slightly such that material present between the two target formations (the Toolachee and the Patchawarra Formations) which includes the Epsilon Formation aquifer and surrounding aquitards was simulated using a single layer. As shown each of the three remaining aquifers (i.e. the Hutton Sandstone and the Toolachee and the Patchawarra Formations) were simulated using dedicated layers and consistent with the conceptual model were modelled as being separated by significant thicknesses of intervening aquitard material.

Adopted hydraulic parameters used for modelling purposes are also provided in Table 4.1 and were sourced from existing UWIR surrounding the Project area.

Table 4.1 Initial scenario - hydrogeological parameters

Layer	Thickness (m)	K (m/d)	S	Lithology	Aquifer
1	105	$3.5x10^{-1}$	$1.0x10^{-4}$	Hutton Sandstone	Aquifer
2	350	*$1.0x10^{-6}$	$1.0x10^{-6}$	Nappamerri Group	Aquitard
3	160	$2.0x10^{-3}$	$5.5x10^{-5}$	Toolachee Formation	Aquifer
4	350	*$2.0x10^{-4}$	$8.0x10^{-5}$	Daralingie Formation/Roseneath Shale/Epsilon Formation/Murteree Shale	Aquifer/Aquitard
5	310	$3.3x10^{-4}$	$1.1x10^{-4}$	Patchawarra Formation	Aquifer

Note: *Vertical hydraulic conductivity.

Modelled water extraction rates and layer attributions for each of the simulated extraction wells are summarised in Table 4.2.

Table 4.2 Production wells

Well name	Easting	Northing	Modelling layer	Pumping rate (m3/d)	IAA	LTAA
Vali 1	506107.8	6903682.8	5	10.6	3 years	20 years
Vali 2	507322.8	6903329.1	3,5	10.6	3 years	20 years
Vali 3	505599.3	6903174.4	3	10.6	3 years	20 years

Note: Coordinates system: GDA 2020.

4.1.2 Assumptions and limitations

The assumptions and limitations of the analytical modelling include:

- Predictive production rates provided by Vintage were equally divided between the Vali-1, Vali-2 and Vali-3 bores while the current production rates are mainly from Vali-1.
- Estimated aquifer parameters (hydraulic conductivity and storativity) are based on literature review or based on UWIRs for adjacent production leases (Santos, 2019; Beach Energy 2020). No hydrogeological parameter measurements were available for the Vali gas field.
- Project life of Vali gas field is estimated at 20 years.
- Like other similar tools MLU neglects the effects of the storage term within aquitard units and hence does not predict any lag between stresses applied to the target formations (Toolachee and Patchawarra formations). As such the predicted impacts are expected to be conservative especially with regard to the timing of any impacts in the Hutton Sandstone. In practice, impacts would likely take hundreds if not thousands of years to migrate through the underlying 350 m thick aquitard and would therefore be significantly delayed.

4.2 Model results

Figure 4.1 and Figure 4.2 present the predicted drawdown for the initial scenario in the production wells Vali-1, Vali-2 and, Vali-3 in the Cooper Basin and the Hutton Sandstone. Table 4.3 presents the maximum drawdown, the IAA and LTAA, with five-metre drawdown contours.

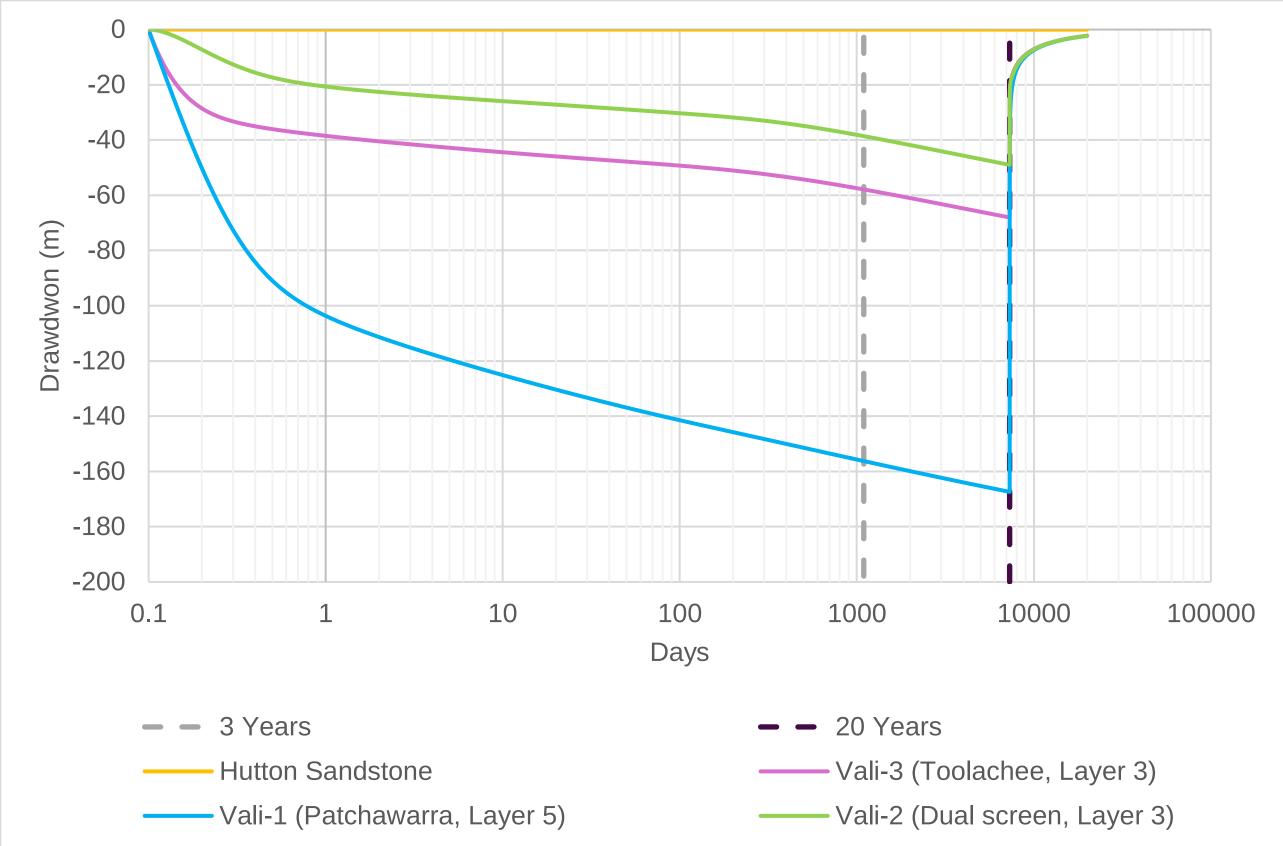


Figure 4.1 Predicted drawdown – initial scenario

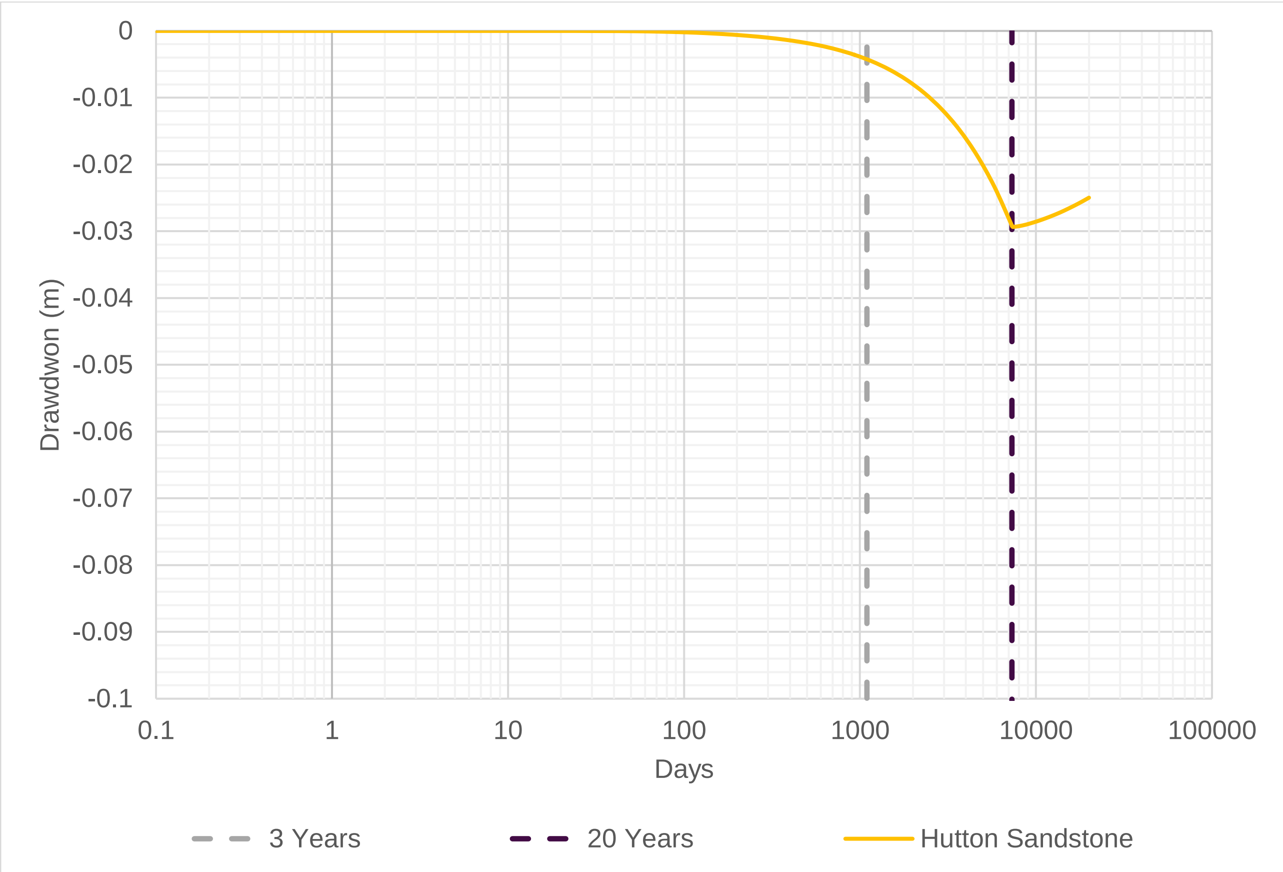


Figure 4.2 Predicted drawdown – initial scenario - Hutton Sandstone

Table 4.3 Predicted maximum drawdown – initial scenario

Aquifer	IAA (year 3)		LTAA*	
	Drawdown (m)	5 m Drawdown Extent radius (km)	Maximum Drawdown (m) – year 20	5 m Drawdown extent radius (km)
Hutton	0.005	NA	0.03	NA
Toolachee (Vali-2 and Vali-3)	58	1.65	68	4 (year 22)
Patchawarra (Vali-1 and Vali-2)	156	1.65	167	4 (year 22)

4.2.1 Immediately affected area (IAA)

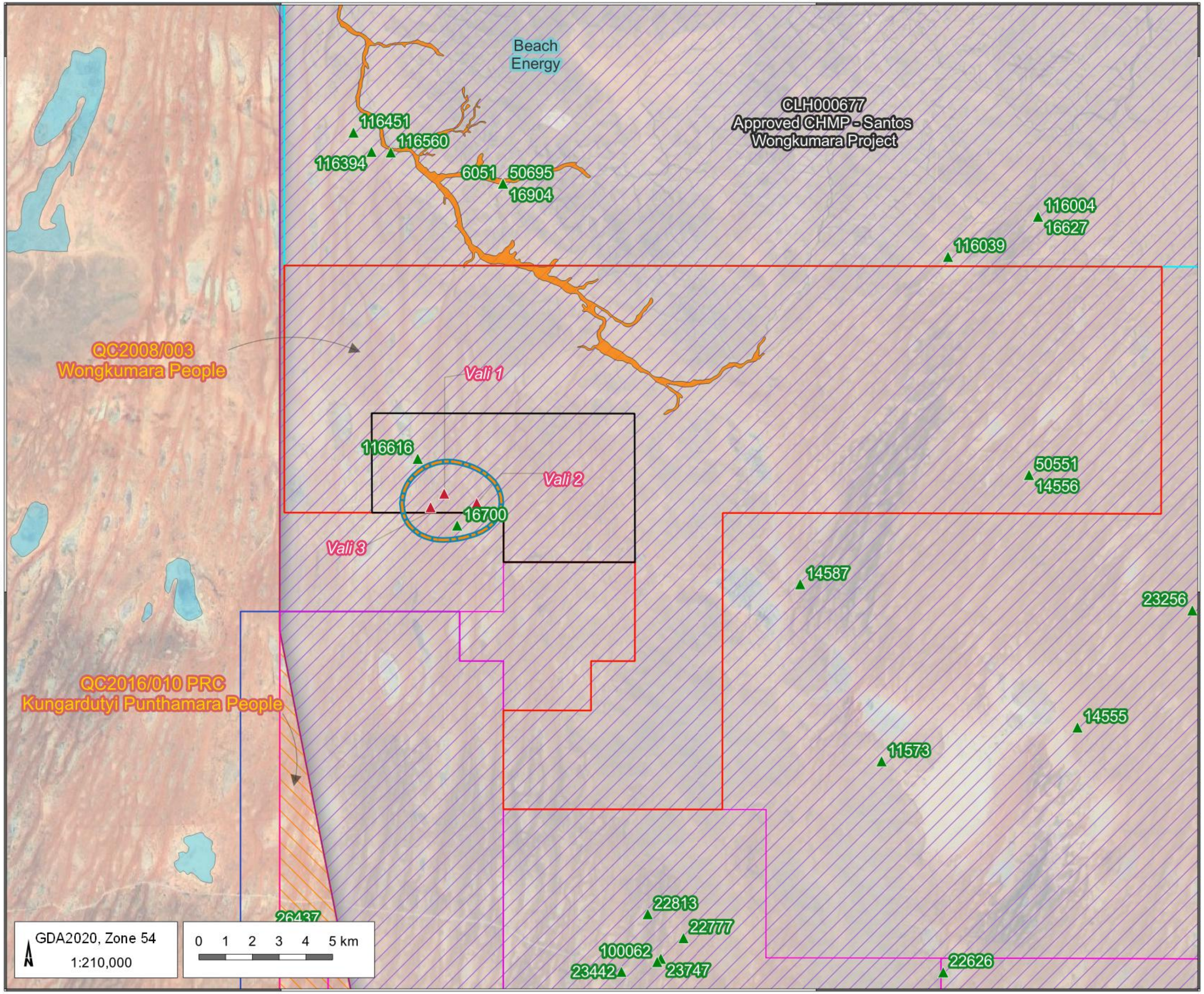
The predicted IAA area, i.e. the area where more than 5 m of drawdown is predicted during the 2023 to 2026 UWIR reporting period for the Toolachee and the Patchawarra formations (Layers 3 and 5) is presented in Figure 4.3. The maximum drawdown predicted in the Hutton Sandstone during this period (Figure 4.2) is 5 millimetres and hence there is no IAA for this aquifer. No drawdown impacts are therefore predicted on any units overlying the Hutton Sandstone. The maximum predicted drawdown is 156 m at Vali-1 within the Patchawarra Formation.

As shown in Figure 4.3 and Table 4.3 the predicted IAA for the Toolachee and the Patchawarra formations are very similar (since the Vali-2 bore is screened in both formations and hence provides a location connection between the two units) and extend around 1.7 km from the production wells Vali-1, Vali-2 and Vali-3.

4.2.2 Long-term affected area (LTAA)

The predicted LTAA area, i.e. the area where more than 5 m of drawdown is predicted at any time in the future for the Toolachee and the Patchawarra formations (Layers 3 and 5) is presented in Figure 4.4. Maximum predicted drawdown in the Hutton Sandstone at the end of the production period (Figure 4.2) is 0.03 m and hence there is no LTAA for this aquifer. No drawdown impacts are therefore predicted on any units overlying the Hutton Sandstone. The maximum predicted drawdown is 167 m in Vali-1 within the Patchawarra Formation.

As shown in Figure 4.4 and Figure 4.3 the predicted LTAA for the Toolachee and the Patchawarra formations are very similar (since the Vali-2 bore is screened in both formations and hence provides a location connection between the two units) and extend around 4 km from the production wells Vali-1, Vali-2 and Vali-3.



LEGEND

- Place names
- Vali wells
- Registered bores
- State Borders
- 5m drawdown contour (m) - Toolachee
- 5m drawdown contour (m)- Patchawarra
- Authority to Prospect (ATP 2021)
- Authority to Prospect (ATPs)
- Petroleum Lease 1125
- Santos Petroleum Leases
- Santos Exploration Permits for Petroleum
- Santos Cooper Basin
- Cultural Heritage Management Plan boundary

Cultural Heritage Party boundaries

- Kungardutyi Punthamara People
- Wongkumara People

Aquatic GDEs

- Low potential GDE - from national assessment

Terrestrial GDEs

- Moderate potential GDE - from regional studies

Vali Gas Field Underground Water Impact Report (VGF5000.001)

IAA - Predicted groundwater impact drawdown – Toolachee and Patchawarra

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FIGURE No:
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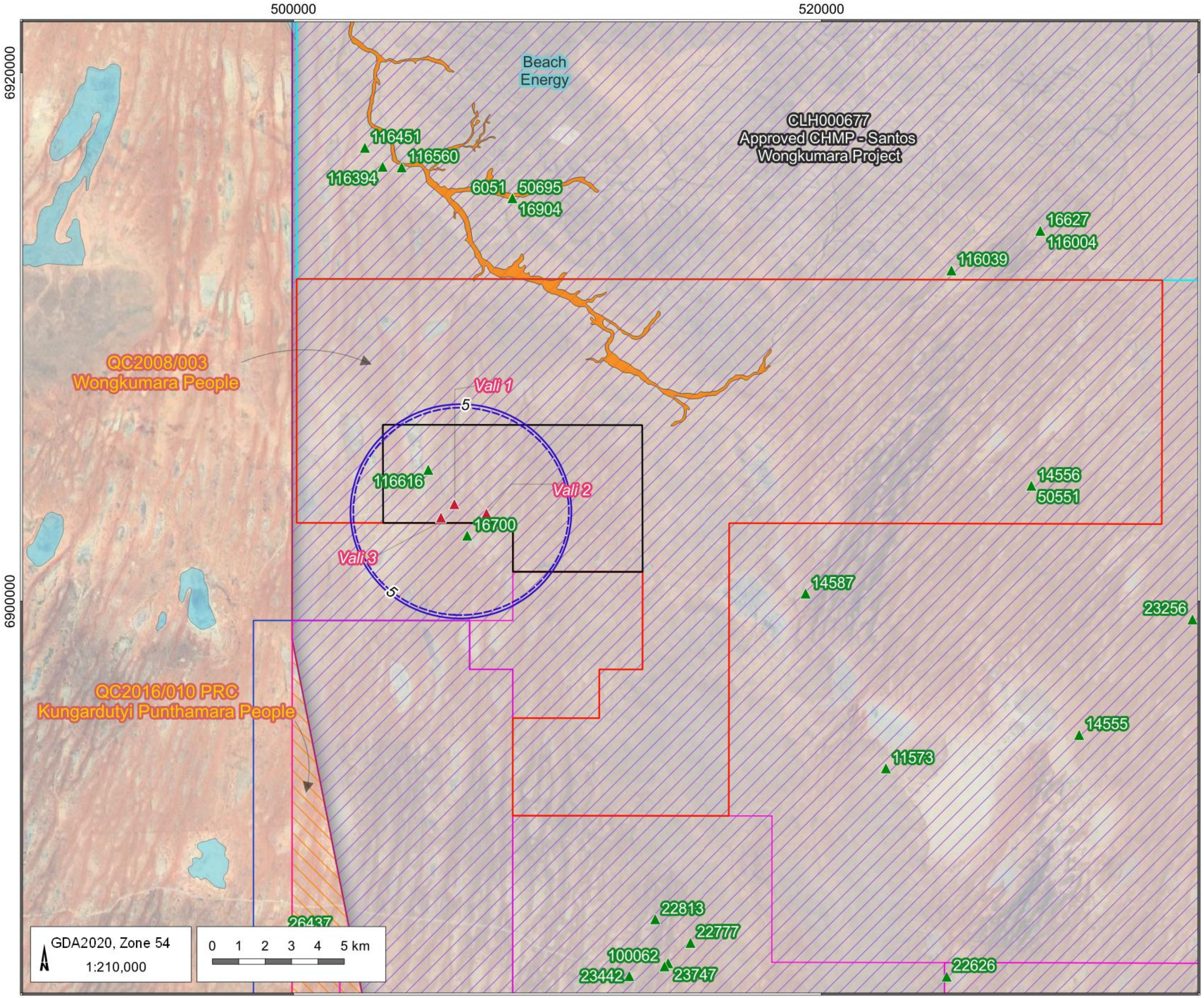

LEGEND

- Place names
- Vali wells
- Registered bores
- State Borders
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- 5m drawdown contour (m)- Patchawarra
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Vali Gas Field Underground Water Impact Report (VGF5000.001)

LTAA - Predicted groundwater impact drawdown – Toolachee and Patchawarra formations

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20/06/2024

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FIGURE No:
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4.2.3 Sensitivity

Nine scenarios were run for sensitivity analysis with hydraulic conductivities and storativity of one order of magnitude higher and lower than the initial scenario (scenario 5). Table 4.4 and Table 4.5 present the hydraulic parameters for the nine scenarios.

Figure 4.5, Figure 4.6, Figure 4.7 andFigure 4.8 present the predicted drawdown in each production well and the Hutton Sandstone for the nine sensitivity scenarios. The maximum predicted drawdown in the Hutton Sandstone is 4.24 m (Scenario 10) after 20 years of production. The maximum predicted drawdown after three years is 565.42 m and 1,630 m at the end of life of the project in the well Vali-1 (Scenario 9).

Figure 4.9 and Figure 4.10 present the IAA and LTAA. The groundwater depletion in scenarios 1 and 2 are lower than five metres in any of the analytical model layers therefore there are no IAA and LTAA identified for those sensitivity scenarios. Groundwater drawdown exceeding five meters is predicted after 20 years from scenario 3. Scenarios 4, 6, 7, 8, 9 and 10 show a predicted drawdown exceeding 5 metres within 3 years and at the end of life of the project. The largest predicted IAA in the Patchawarra and Toolachee is approximately 5 km radius and 10 km radius for the LTAA (scenario 6).

There is no groundwater drawdown greater than five metres predicted in the Eromanga Basin (Hutton Sandstone) in any sensitivity scenarios. There are no impacted registered water bores screened in the Cooper Basin and no environmental receptors identified within the IAA and LTAA.

Existing petroleum wells Kappa 1, Kappa 3, Kappa 4 and Chef 1 from Santos's Petroleum Lease are within the LTAA of sensitivity scenarios 6 and 9, within a radius of eight kilometres.

Table 4.4 Sensitivity scenarios 1 to 4

Scenarios #	1		2		3		4	
Layer	**K (m/d)**	**S**	**K (m/d)**	**S**	**K (m/d)**	**S**	**K (m/d)**	**S**
1	3.5×10^{-1}	**1.0×10^{-3}**	3.5×10^{-1}	1.0×10^{-4}	3.5×10^{-1}	**1.0×10^{-5}**	3.5×10^{-1}	**1.0×10^{-3}**
2	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}
3	**2.0×10^{-2}**	**6.0×10^{-4}**	**2.0×10^{-2}**	6.0×10^{-5}	**2.0×10^{-2}**	**5.5×10^{-6}**	2.0×10^{-3}	**6.0×10^{-4}**
4	2×10^{-4}	**8.0×10^{-4}**	2.0×10^{-4}	8.0×10^{-5}	2.0×10^{-4}	**8.0×10^{-6}**	2.0×10^{-4}	**8.0×10^{-4}**
5	**3.3×10^{-3}**	**1.0×10^{-3}**	**3.3×10^{-3}**	1.0×10^{-4}	**3.3×10^{-3}**	**1.1×10^{-5}**	3.3×10^{-4}	**1.0×10^{-3}**

Table 4.5 Sensitivity scenarios 6 to 10

Scenarios #	6		7		8		9		10	
Layer	**K (m/d)**	**S**	**K (m/d)**	**S**	**K (m/d)**	**S**	**K (m/d)**	**S**	**K (m/d)**	**S**
1	3.5×10^{-1}	**1.0×10^{-5}**	**3.5×10^{-2}**	**1.0×10^{-3}**	**3.5×10^{-2}**	1.0×10^{-4}	**3.5×10^{-2}**	**1.0×10^{-5}**	**3.5×10^{-2}**	**1.0×10^{-5}**
2	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	**1.0×10^{-5}**	1.0×10^{-6}
3	2.0×10^{-3}	**5.5×10^{-6}**	**2.0×10^{-4}**	**5.5×10^{-4}**	**2.0×10^{-4}**	5.5×10^{-5}	**2.0×10^{-4}**	**5.5×10^{-6}**	**2.0×10^{-4}**	**5.5×10^{-6}**
4	2.0×10^{-4}	**8.0×10^{-6}**	**2.0×10^{-5}**	**8.0×10^{-4}**	**2.0×10^{-5}**	8.0×10^{-5}	**2.0×10^{-5}**	**8.0×10^{-6}**	**2.0×10^{-5}**	**8.0×10^{-6}**
5	3.3×10^{-4}	**1.1×10^{-5}**	**3.3×10^{-5}**	**1.1×10^{-3}**	**3.3×10^{-5}**	1.1×10^{-4}	**3.3×10^{-5}**	**1.1×10^{-5}**	**3.3×10^{-5}**	**1.1×10^{-5}**

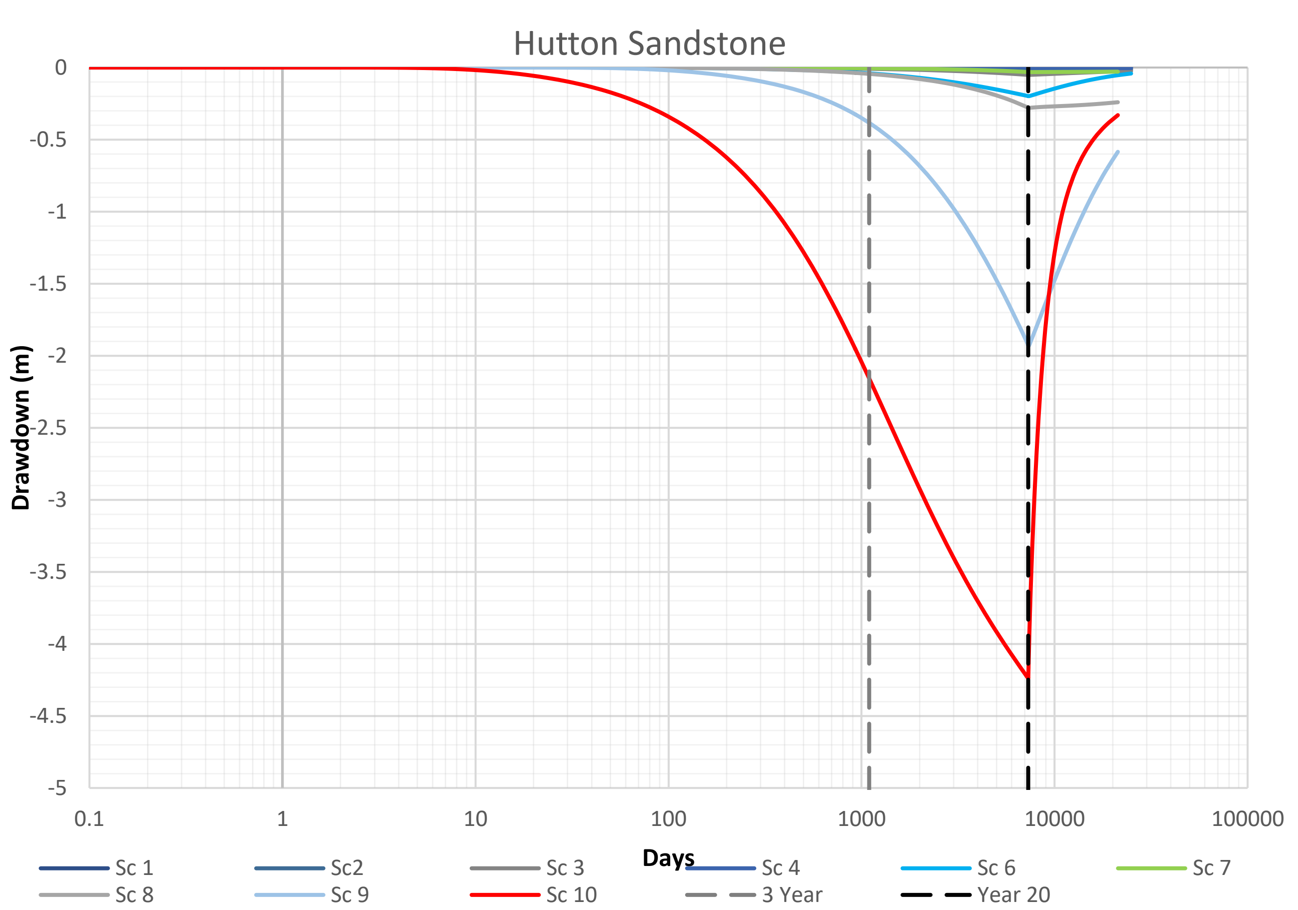


Figure 4.5 Sensitivity analysis – predicted drawdown – Hutton Sandstone

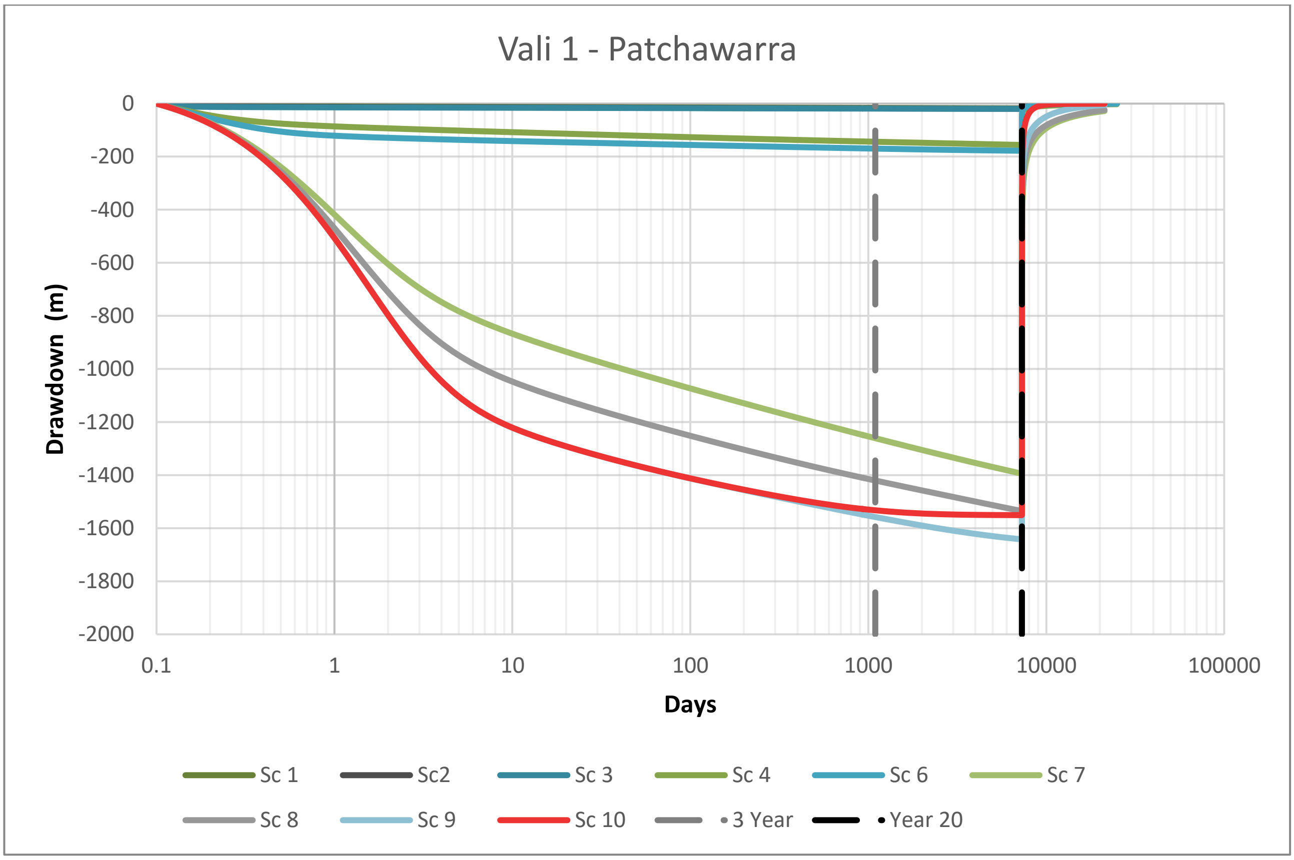


Figure 4.6 Sensitivity analysis – predicted drawdown – Vali-1

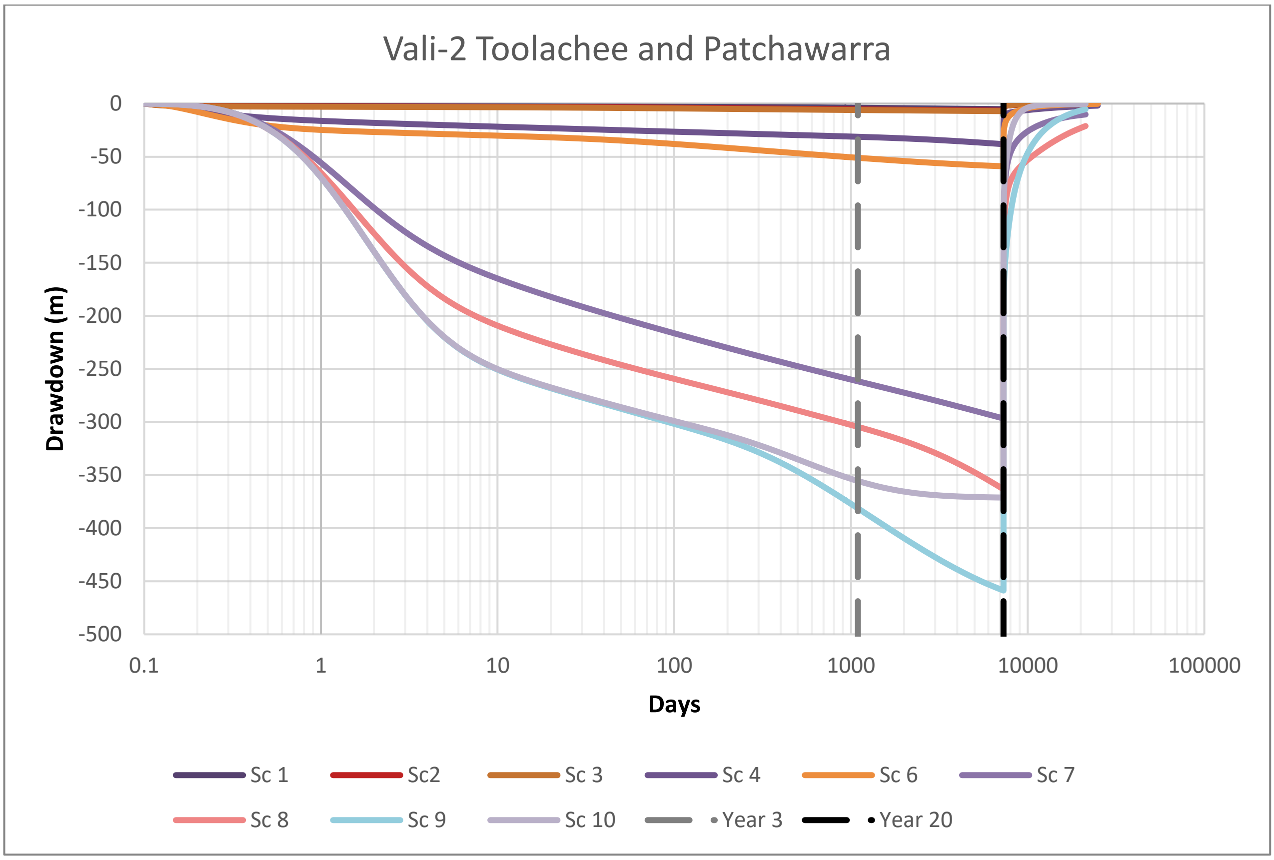


Figure 4.7 Sensitivity analysis – predicted drawdown – Vali-2

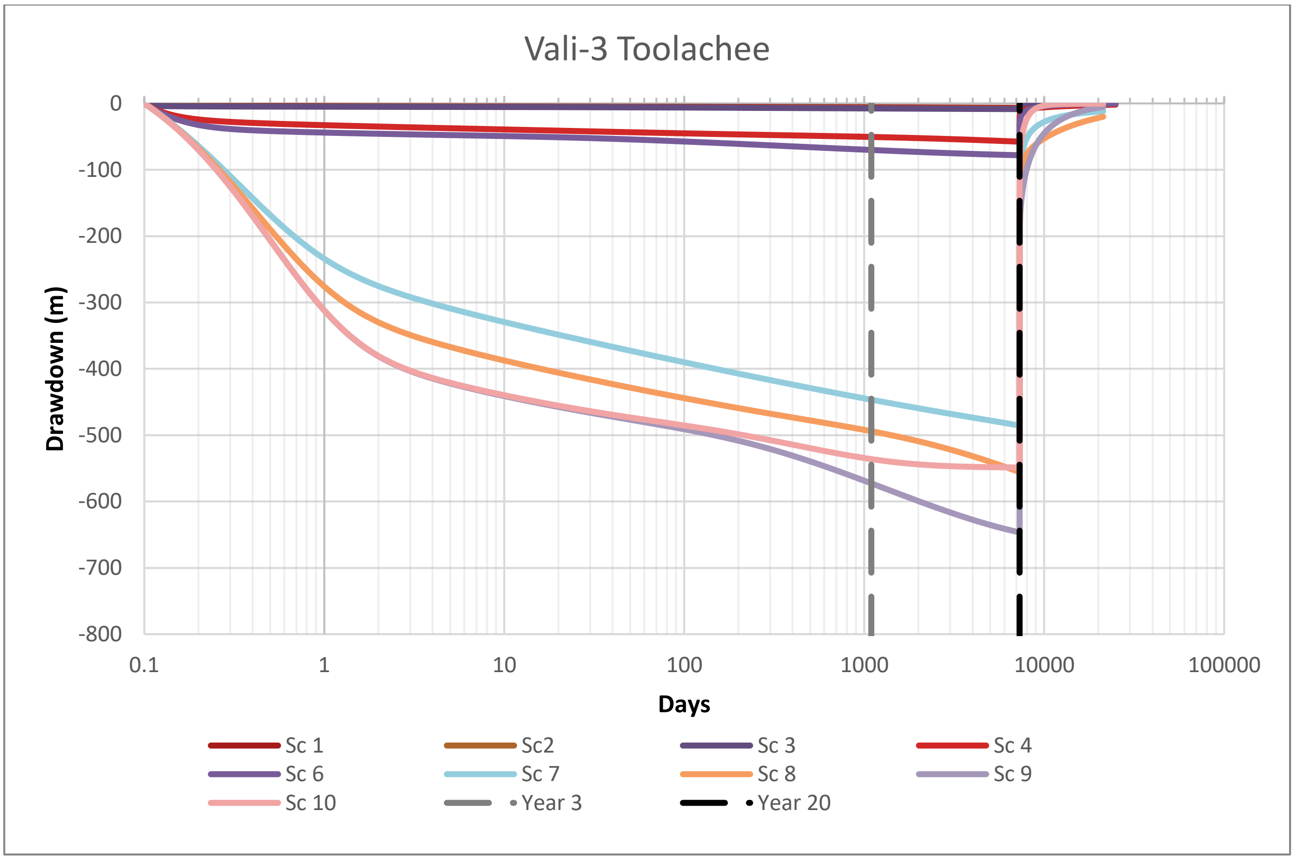
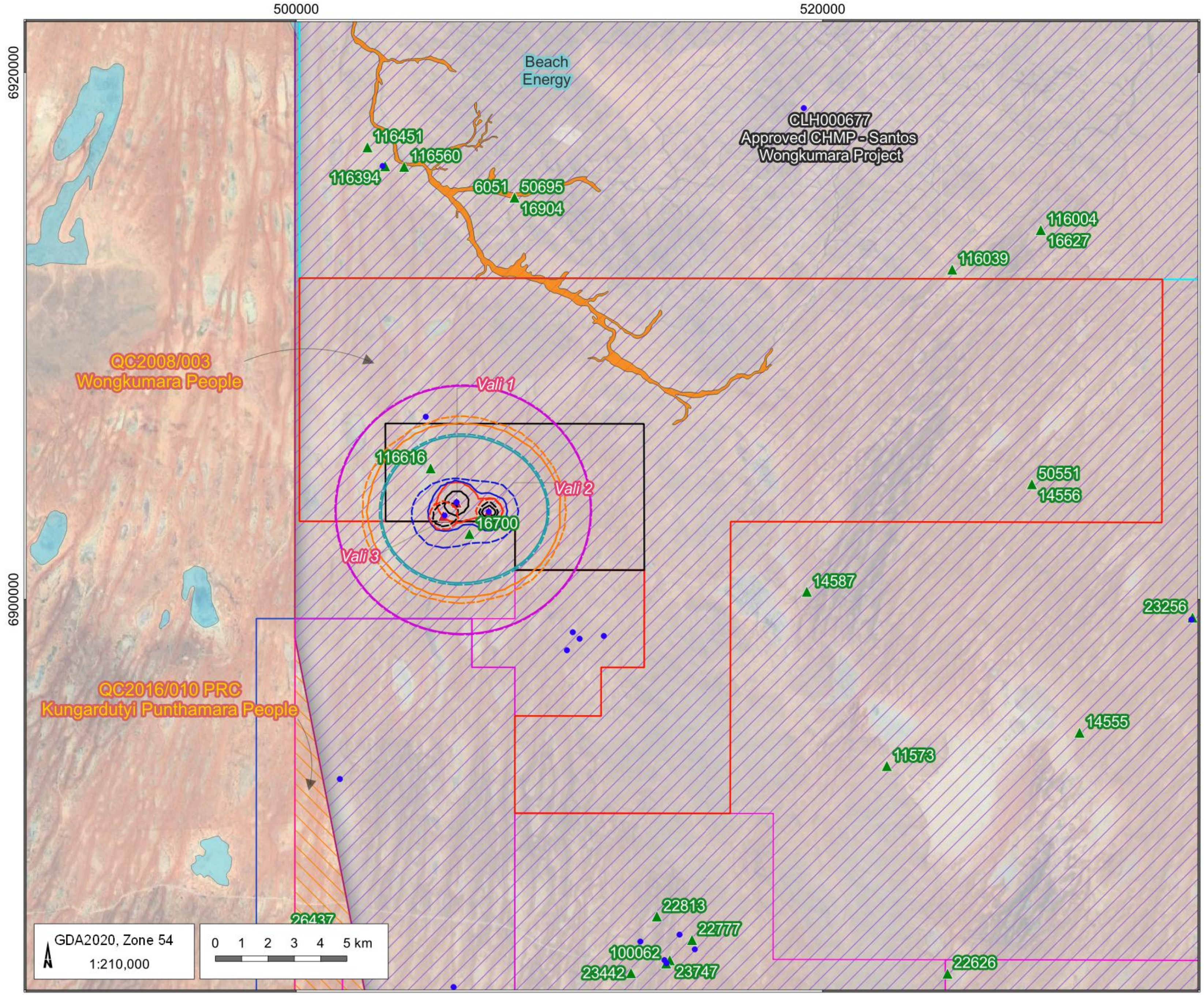


Figure 4.8 Sensitivity analysis – predicted drawdown – Vali-3



LEGEND

- Place names
- Vali wells
- Registered bores
- Petroleum wells
- Authority to Prospect (ATP 2021)
- Petroleum Lease 1125
- Cultural Heritage Management Plan boundary

Cultural Heritage Party boundaries

- Kungardutyi Punthamara People
- Wongkumara People

Aquatic GDEs

- Low potential GDE - from national assessment

Terrestrial GDEs

- Moderate potential GDE - from regional studies

5m drawdown contours (Toolachee)

- Sc. 4 Base K High S
- Sc. 6 Base K Low S
- Sc. 7 Low K High S
- Sc. 8 Low K Base S
- Sc. 9 Low K Low S
- Sc. 10

5m drawdown contours (Patchawarra)

- Sc. 4 Base K High S
- Sc. 6 Base K Low S
- Sc. 7 Low K High S
- Sc. 8 Low K Base S
- Sc. 9 Low K Low S
- Sc. 10

Vali Gas Field Underground Water Impact Report (VGF5000.001)

IAA – sensitivity analysis - Toolachee and Patchawarra

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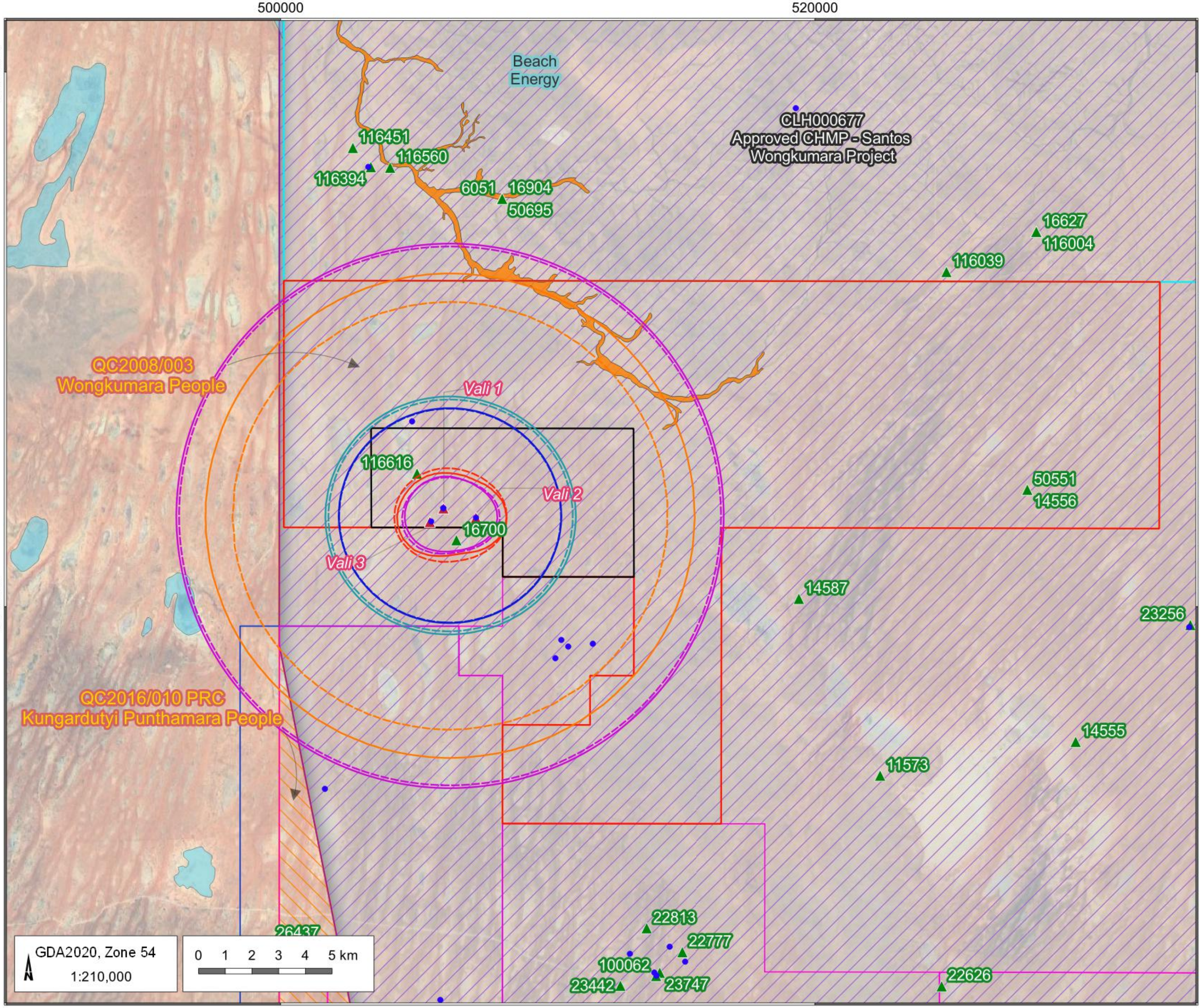

LEGEND

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- Wongkumara People

Aquatic GDEs

- Low potential GDE - from national assessment

Terrestrial GDEs

- Moderate potential GDE - from regional studies

5m drawdown contours (Toolachee)

- Sc. 4 Base K High *S*
- Sc. 6 Base K Low *S*
- Sc. 7 Low K High *S*
- Sc. 8 Low K Base *S*
- Sc. 9 Low K Low *S*
- Sc. 10

5m drawdown contours (Patchawarra)

- Sc. 4 Base K High *S*
- Sc. 6 Base K Low *S*
- Sc. 7 Low K High *S*
- Sc. 8 Low K Base *S*
- Sc. 9 Low K Low *S*
- Sc. 10

Vali Gas Field Underground Water Impact Report (VGF5000.001)

LTAA – sensitivity analysis - Toolachee and Patchawarra

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FIGURE No:
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5 Impact on environmental values (Part D)

According to the Water Act 2000 Guideline (Queensland Government, 2021), by default the environmental values may include (Section 1.2.4):

- aquaculture uses and human consumption of aquatic food;
- irrigation, farm supply/use, stock water uses;
- drinking water uses;
- aquatic ecosystems;
- recreational uses;
- industrial uses; and
- cultural and spiritual values.

Figure 5.1 presents the environmental values and existing registered groundwater bores identified within 15 km radius of the Vali gas field.

5.1 Irrigation, farm supply/use and drinking water

There are eight existing registered water bores within fifteen kilometres of Vali production wells. Further details relating to each of these existing bores is provided in Table 5.1. As shown, the majority of the bores are screened into the Winton Formation at depths of up to 294 m below ground and at least 1,600 m above the top of the Hutton Sandstone and hence based on the model results presented above (Section 4.2) are not expected to experience any Project related drawdown. Therefore, there are no expected changes in water quality in the registered bores listed in Table 5.1 resulting from the decline of groundwater levels.

Table 5.1 Queensland registered water bores within 15 km radius

RN	Bore name	Easting*	Northing*	Ground elevation (mAHD)	Year drilled	Formation	Top Screen (mbgl)	Bottom Screen (mbgl)	Bore depth (mbgl)
14556	Watties bore	527944	6904365	80.5	1960	Glendower Formation or Winton Formation	NA	81.1	NA
16700	Christmas Yard bore	506583	6902489	96.3	1966	Winton formation	125	154.2	NA
50551	Watties No 2	527944	6904365	NA	1980	Winton formation	NA	81.1	NA
116616	Kudnari	505108	6904981	NA	2023	Winton formation	145.9	148.2	150.2
116394	NA	503380	6916450	NA	2013	-	NA	76	77
116560	Anakin Bore	504101	6916428	NA	2013	Winton formation?	260	272	294
50695	NA	508297	6915261	122	1990	Winton formation	NA	NA	125
14587	Roundhill Bore	519404	6900298	76.5	1961	Winton formation	NA	168.6	168.6

Notes: Coordinate system GDA 2020.
NA: Not Available.

5.2 Groundwater dependent ecosystems (incl. springs)

5.2.1 Springs

There are no springs mapped within 15 km of the Project area. The nearest known GAB springs are located around 100 km to the southwest in South Australia. In Queensland, the nearest springs are 300 km to the east of the area, outside the Cooper Basin. No information is currently available on the source aquifer for these springs in Queensland.

5.2.2 Groundwater Dependent Ecosystems (GDE)

No GDE are present within the PL1125. As shown in Figure 5.1 a moderate potential terrestrial GDE has been identified by the Bureau of Meteorology (BOM) along the ephemeral Sandy Creek to the north of the Project area. Hence any groundwater support to this area will be provided by aquifers at or close to the ground surface. Therefore, potentially significant drawdown impacts of more than 0.2 m drawdown are not expected to extend beyond the top of the Cooper Basin at more than 2,000 m below ground. No qualitative and quantitative impacts of this or any other terrestrial GDEs present in the area are predicted.

5.3 Aquatic ecosystem

Several lacustrine and palustrine intermittent wetlands are present within the project area, with claypans adjacent to the well sites observed on aerial photographs. Low potential aquatic GDE associated with lacustrine wetland are mapped in South Australia, to the west of the project area (Aquatic GDEs). The closest aquatic GDE is more than 10 km from the Vali gas field. As no groundwater level impacts are expected above the top of the Cooper Basin which is around 2000 m below ground, no impacts on quality, water levels and flows are anticipated on any surficial aquatic ecosystems.

5.4 Aquaculture

There is no known use of groundwater for aquaculture purposes within 15 km radius of the Project area.

5.5 Recreational waters

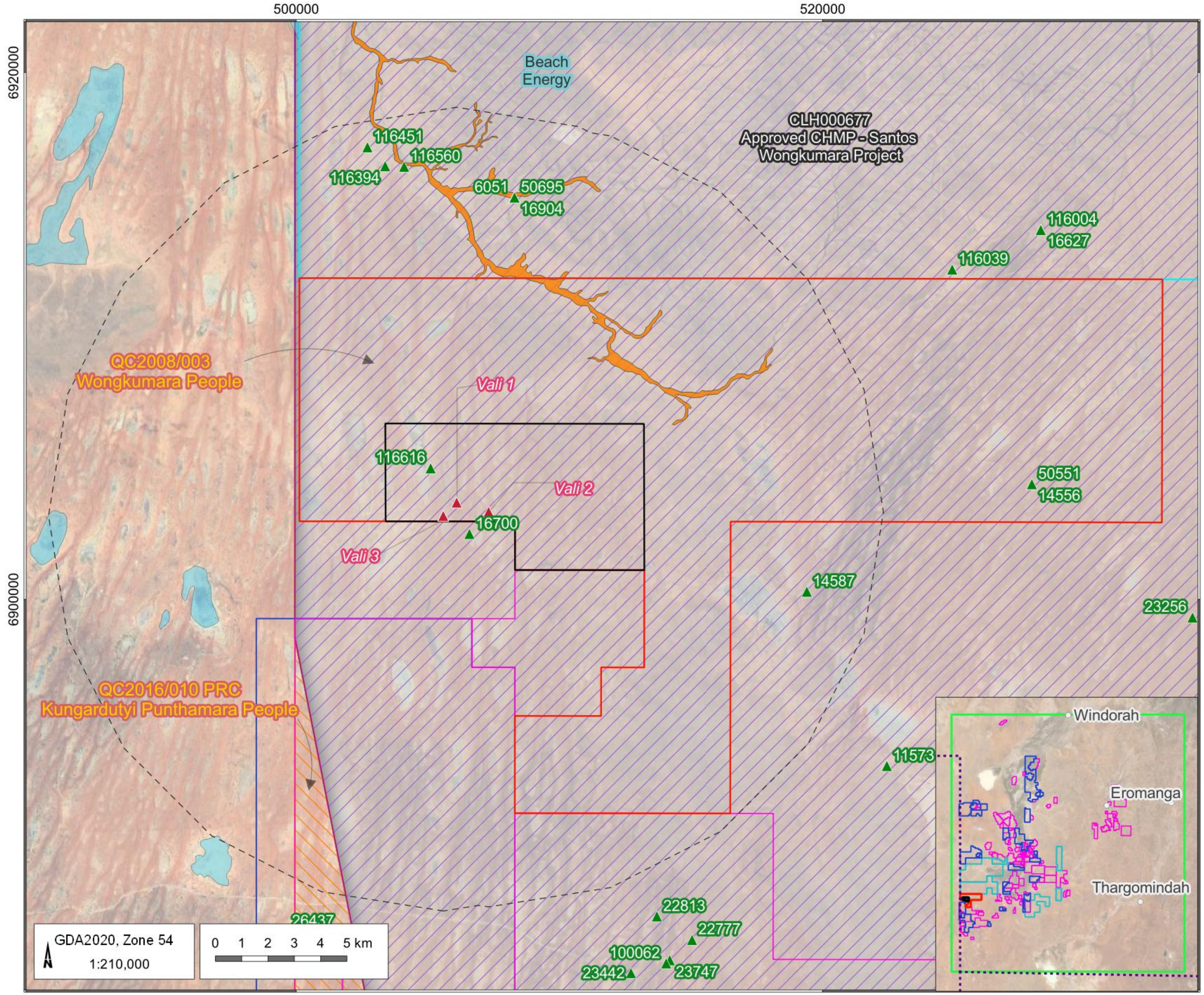
There are no known primary or secondary recreational waters within 15 km radius of the Project area.

5.6 Industrial

Figure 1.1 shows the petroleum leases and exploration leases adjacent to Vali Gas Project. Santos Petroleum leases are directly adjacent to the south of the Project area. However, no existing Santo's production bores are within 15 km radius of the Project area (Figure 4.10). No qualitative and quantitative impacts are anticipated on industrial users.

5.7 Cultural and spiritual values

The three production wells are within the cultural heritage area of the Wongkumara People. In the absence of any known mound springs or other similar features within 300 km of the Project area and no predicted impact on groundwater levels above the top Cooper Basin, no qualitative and quantitative impacts are anticipated on any water dependent cultural or spiritual features.



LEGEND

- Place names
- Vali wells
- Registered bores
- State Borders
- Authority to Prospect (ATP 2021)
- Authority to Prospect (ATPs)
- Petroleum Lease 1125
- Santos Petroleum Leases
- Santos Exploration Permits for Petroleum
- Santos Cooper Basin
- Cultural Heritage Management Plan boundary
- Vli wells 15km radius

Cultural Heritage Party boundaries

- Kungardutyi Punthamara People
- Wongkumara People

Aquatic GDEs

- Low potential GDE - from national assessment

Terrestrial GDEs

- Moderate potential GDE - from regional studies

Vali Gas Field Underground Water Impact Report (VGF5000.001)

Environmental values

DATE
20/06/2024

AGE

FIGURE No:
5.1

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6 Water monitoring strategy (Part E)

6.1 Objectives

Under section 376(f) of the Water Act, responsible tenure holders are required to develop an appropriate underground water monitoring strategy to keep track of the quantity of water produced or taken because of the exercise of relevant underground water rights. Responsible tenure holders are also required to monitor any changes in underground water levels and the underground water quality.

The monitoring rationale should include (but not be restricted to):

- an assessment of changes in water levels and water quality because of the exercise of relevant underground water rights;
- supplementation of existing monitoring programs to fill any critical gaps in data; and
- an explanation about how it will improve the understanding about the impacts of underground water extractions on aquifers.

6.2 Monitoring strategy

Whilst no impacts on environmental values in either the IAA or LTAA (Part D) are expected, groundwater monitoring is proposed to confirm these predictions. In addition to the monitoring of the three gas production wells (Vali-1, Vali-2 and Vali-3), monitoring of the two nearby registered bores (RN 16700 and RN 116616) is proposed to confirm the absence of any project impacts at these existing bores.

As the water supply bore RN16700 (Christmas Yard Bore) is outside of PL1125, an agreement between the landowner and Vintage will be necessary prior to including this bore in the monitoring program. Registered bore RN116616 (Kudnari bore) is located within PL1125 and is occasionally used for water supply by Vintage.

A monitoring program is recommended to record the following parameters for both the production wells and the two water supply bores:

- Total extraction volumes of the targeted gas reservoir (Toolachee and Patchawarra Formations) and the water supply aquifer (Winton Formation).
- Pressure of the targeted gas reservoir and water levels in the Winton Formation; and
- Water quality of the gas reservoir and in the Winton Formation.

Monitoring parameters and frequency are presented in Table 6.1 for the three production wells and Table 6.2 for the two registered bores.

The tenure holder will maintain the current monthly monitoring of the water production rates from each gas production well. The quality of combined water drawn from the production wells will be monitored biannually from the separator to identify any changes in groundwater chemistry which might be indicative of water being drawn from different sources. In addition, a minimum of one shut-in test will be recorded annually to estimate the reservoir pressure in the Toolachee and Patchawarra Formations to assess the change in reservoir pressure during the project.

The monitoring of groundwater levels, groundwater quality and total extraction volumes will be undertaken biannually at Kudnari bore (RN 116616). Following an agreement with the landowner, the Christmas Yard Bore (RN 16700) might also be included in the monitoring program with proposed groundwater quality, total extraction volume and groundwater level[2] monitored biannually.

[2] Pending on the access – submerged pump might prohibit the installation of a data logger or taking manual water level measurements.

Table 6.1 Production wells - groundwater monitoring parameters and frequency

Well name	PL	Easting[1]	Northing[1]	Water level	Volume extracted	Water quality	
				Frequency*	Frequency	Parameters	Frequency
Vali-1	1125	506107.8	6903682.8	Annually	Monthly	pH, EC, TRH, cations and anions	Biannual
Vali-2	1125	507322.8	6903329.1	Annually	Monthly	pH, EC, TRH, cations and anions	Biannual
Vali-3	1125	505599.3	6903174.4	Annually	Monthly	pH, EC, TRH, cations and anions	Biannual

Notes: [1] Coordinate system GDA2020.
* One pressure test annually for one bore.

Table 6.2 Registered bores - groundwater monitoring parameters and frequency

RN	Well name	PL	Easting[1]	Northing[1]	Water level	Volume extracted	Water quality	
					Frequency	Frequency	Parameters	Frequency
RN116616	Kudnari	1125	505108	6904981	Biannual	Biannual	pH, EC, TRH, cations and anions	Biannual
[2]RN16700	*Christmas Yard bore*	-	*506583*	*6902489*	*Biannual**	*Biannual*	*pH, EC, TRH, cations and anions*	*Biannual*

Notes: [1] Coordinate system GDA2020.
[2] Proposed: awaiting agreement between Vintage and the landowner to be included in the monitoring program.

6.3 Reporting

Monitoring data will be provided to the Office of Groundwater Impact Assessment (OGIA) where possible biannually or at least once a year (Guideline Water Act 200, 2021).

7 Spring impact management strategy (Part F)

As discussed in Section 5.2.1 the nearest mapped GAB spring is more than 100 km away from the Project area, in South Australia. The nearest springs in Queensland are 300 km east outside the Cooper Basin boundaries. No impact from the Vali gas field was predicted beyond the Cooper Basin. As such a spring monitoring program is not required for this UWIR.

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