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Groundwater
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Consultants

Report on

GS64a

Upper Condamine Alluvium
(Central Condamine Alluvium)
Stage 5

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GS64a – Upper Condamine Alluvium (Central Condamine Alluvium)

Stage 5 – Assessment through multiple lines of evidence

The Upper Condamine Alluvium (Central Condamine Alluvium) (GS64a), located in the central part of the Condamine River catchment of southeast Queensland, consists of an unconfined alluvial aquifer system with a losing-disconnected relationship to the Condamine River (Figure 1; Crosbie *et al.*, 2023). The area is underlain by the Surat Basin, which hosts both Coal Seam Gas (CSG) resources and Great Artesian Basin aquifers. Groundwater entitlements are distributed densely across the southern parts of GS64a (on the Condamine Plains south of Dalby) and tend to align with main river reaches and contributing creeks (Figure 1). GS64a spans approximately 4,767 km², with a Sustainable Diversion Limit (SDL) of 46.00 GL/year and a long-term average recharge estimate of 128.00 GL/year (Table 1). Between 2013 and 2023, average annual groundwater extraction was 42.93 GL/year, representing 34% of estimated recharge and 93% of the SDL volume (Figure 2). Groundwater use supports about 6,500 production bores, mainly for irrigation, and stock and domestic use. Take has reduced significantly in recent decades; it was higher than the SDL volume prior to the SDL introduction in 2019 (Figure 2), and it was estimated to be more than 60 GL/year prior to the 1980s. It appears that groundwater pumping supplements surface water supply during years of below-average rainfall (Figure 2). Long-term climate observations show a relatively persistent below-average rainfall signal for the 2011–2024 period but a highly anomalous rainfall year in 2021-22 (Figure 3), which caused moderate flooding in the township of Warwick.

The water table is generally between 15 m and 20 m below the ground surface for most of the SDL resource unit area, though a large area exceeds 20 m in the central irrigation zone of the Condamine Plains (or jurisdiction management Zone 2; Figure 4a). In the upgradient management Zone 1 (South of Pampas), the depth to water is typically less than 15 m. Groundwater flows from southeast to northwest along the main alluvial valley (Figure 4b). Long-term (1974-2024) and short-term (2012-2024) median groundwater levels show spatial agreement and are contained within a well-defined multi-decadal fluctuation zone that ranges from one or two metres thick in Zone 1, to more than 10 m in Zone 2 and Zone 3 (Figure 5). In several areas of GS64a, the recent (short-term) median water level sits below that of the long-term, indicating that current levels remain lower than those of the past. In Zone 2, a drawdown area is evident in the long-term fluctuation zone (Figure 5). Water quality is generally fresh in upgradient areas (salinity below 1,500 mg/L; equivalent to 2239 µS/cm), and brackish in downgradient areas (Figure 6). Long-term water level trends vary broadly (Figure 7), with increasing trends in the north (Zone 4), and decreasing trends in the central area (Zones 2 and 3), and stable trends in the south (Zone 1) (Figure 9). Short term trends have a similar spatial pattern, but with stable trends in the north rather than increasing trends, and fewer declining trends in Zones 2 and 3 (Figure 10). The understanding of temporal salinity trends is limited due to poor data availability (Figure 8).

MDBA (2020) previously reported recharge at 128.00 GL/year based on numerical flow modelling results, incorporating diffuse, floodplain, and in-stream recharge (based on the average recharge for 1999 to 2009 in the calibrated model, and data were extrapolated where the SDL unit extends outside the model domain). This estimate compares favourably to the WAVES modelling estimate for diffuse recharge from the MD-SY2 project (Crosbie et al., 2025) of 172.46 GL/year, and provides the SDL:recharge ratio (SDL/R) of 0.36. Recharge may also occur due to infiltration of irrigation surplus (Dafny, Silburn, 2013). Table 1 shows a storage-to-recharge ratio (S/R) of 401 using this estimate of recharge and the WERP estimate of storage (Rojas et al., 2022), suggesting high buffering capacity and limited vulnerability to short-term climate variability (above the “low responsiveness” threshold¹ defined in Rojas et al., 2022). However, the high extraction-to-SDL (E/SDL) ratio of 0.93 (Table 1) suggests moderate to high pressure on the productive base, particularly as declining water level trends have persisted for many years beyond the reduction in take since the 1980s. Moran and Vink (2010) suggest that reductions of current water levels compared to pre-development conditions in the 1960s range from 3 m to 35 m in the most impacted areas.

The productive base shows moderate signs of stress, with long-term water level declines affecting about 30% of ESLT asset areas of GS64a (Table 2; Figure 11). Statistically significant ($\alpha=0.05$) declines have occurred since 1974 in the central area, mainly Zones 2 and 3, with a magnitude ranging to -0.5 m/y (Figure 9). In contrast, short-term trends (Figure 10) show a greater distribution of bores with no statistically significant trends, and only some persisting declining trends, mainly in Zone 3. The short-term period (2012-2024) is characterised by mainly below-average or close-to-average rainfall, with a single anomalous rainfall year in 2021/22 (Figure 2, Figure 3). Over this time, take has been relatively high, with all years except 2021/22 exceeding 70% of the SDL.

Stage 4 of this BPR technical groundwater review provided a quantitative assessment of resource condition indicators within a 5 km buffer around extraction points (asset area). Long-term groundwater level declines were observed in 29% of the productive base asset area, 28% of the river connectivity asset area, and 27% of the GDE asset area (Table 2). In the short-term, these percentages decreased to 18%, 18% and 15%, respectively (Table 2). Between 34% to 40% of each ESLT asset area (except water quality) showed improving or stable water level conditions in the short-term (Table 2), suggesting partial recovery or stabilisation (Figure 11). Levels of uncertainty, as indicated by areas with insufficient data to inform temporal trends, have increased between the long- and short-term periods (Table 2; Figure 11). This is especially the case for the water quality (salinity) ESLT, where the zones with ‘insufficient data’ to determine temporal trends increased from 79% of the asset area to 96% in the short-term.

The Queensland state-based risk assessment (DNRME, 2019) assigns variable risk ratings across ESLT values. For the productive base, the state risk assessment (DNRME, 2019) highlights a high risk from over-allocation (as BDL > SDL), and noted that take during dry periods exceeds the SDL. Other risks to productive base were low, except for moderate risks to groundwater availability from: increase in take by the resource industry, and increase in take under basic rights (unlicensed take). The risk from licenced take expansion is low because GS64a is a capped system with no unallocated water. Due mainly to historical depletion, groundwater levels are generally too low to contribute baseflow to rivers (Moran and Vink, 2010); leading to a mostly losing or always losing classification for Condamine River and Oakey Creek (Crosbie et al., 2023). Therefore, persisting declining groundwater level trends (Figure 10) are not expected to cause baseflow reduction in GS64a, and this risk to rivers was assessed as low by DNRME (2019). The state (DNRME, 2019) assessed a low risk of impact to groundwater-dependent ecosystems (GDEs) in GS64a if they were terrestrial GDEs or non-riverine wetlands, and a moderate risk to the single spring that is mapped in GS64a. High to medium uncertainty is attached to these risks, as the nature of potential GDE dependence on the alluvial groundwater is not well understood. Water quality risks are assessed as low and were mostly associated with land management processes rather than water management (DNRME, 2019); however, this had a generally high level of uncertainty, promoting the collection of more information on groundwater quality processes.

¹ S/R ratio: High responsiveness: 29 to 111.
Medium responsiveness: 111 to 333.
Low responsiveness: >333.

Future projections from the MD-SY2 project suggest that diffuse recharge in GS64a may increase by 2050 due to more intense rainfall events (Crosbie et al., 2025). In contrast, overbank flood recharge and in-stream recharge are projected to decline by 26.7% and 6% relative to current conditions, respectively (Crosbie et al., 2025), potentially reducing (localised) episodic recharge and groundwater availability during dry periods. These opposing trends introduce uncertainty regarding net future recharge in GS64a. Stage 6 of this BPR technical groundwater review found that the future area of drawdown (Area of Influence, Aol²) is projected to expand under climate change scenarios, with the median future Aol (P50) exceeding the present Aol, indicating likely increases in deteriorating areas (Figure 12). However, the SDL/R ratio is also projected to decrease slightly, indicating overall uncertainty from climate change impacts. The Stage 6 assessment classified the pressure from future climate change on GS64a groundwater resources as moderate (based on long-term and short-term water level evidence).

Overall, short-term groundwater level trends (2012–2024) suggest that a greater extent of improving or stable conditions is present in GS64a than was the case over the long-term (1974–2024), which is marked by historical groundwater level declines. Some areas, most notably Zone 3 near the confluence of the Oakey Creek with the Condamine River, continue to experience persistent declines in water levels, in a setting where groundwater allocations are capped, but are crucial for the agricultural industry. While there is no unallocated water in GS64a, there is good metering information, and water management rules are supported by a numerical flow model. Uncertainty in salinity trends and GDE processes is considerable in GS64a, with 96% of the short-term water quality ESLT asset area now classified as insufficient data to inform temporal trends, and GDE mapping unverified in the field. Current extraction remains close to the SDL and far exceeded it in the past, but take only represents 34% of estimated recharge, and storage estimates indicate a buffered system. The state-based risk assessment highlights the medium to high risk to the productive base from current take or additional demand on groundwater leading to drawdown. Climate projections indicate reduced episodic (localised) recharge from floodplain processes and overall the pressure from climate change is assessed as moderate. Collectively, the analysis suggests that GS64a experiences moderate to high pressure on the productive base, and moderate pressure from future climatic variability, partially offset by the system's buffering capacity and active resource management.

² Area of influence is defined as the area impacted by drawdown caused by groundwater extraction. For the quantitative assessment of Stage 4, this is equivalent to the percentage asset area showing a deteriorating resource condition, which is a statistically significant declining trend in groundwater level.

Productive base (groundwater entitlements) - GS64a

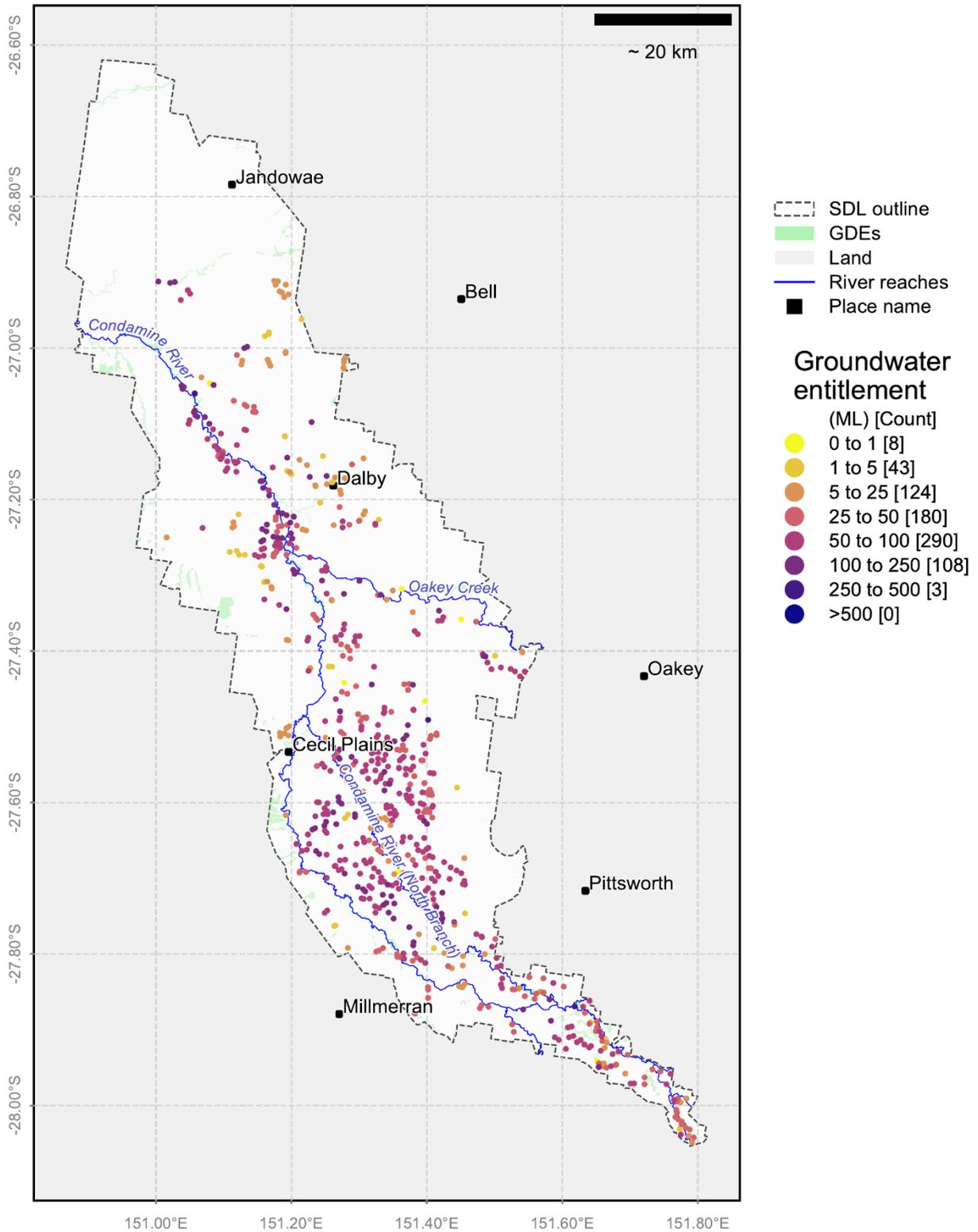


Figure 1 Productive base (groundwater entitlements)

Annual groundwater take and rainfall anomaly for GS64a

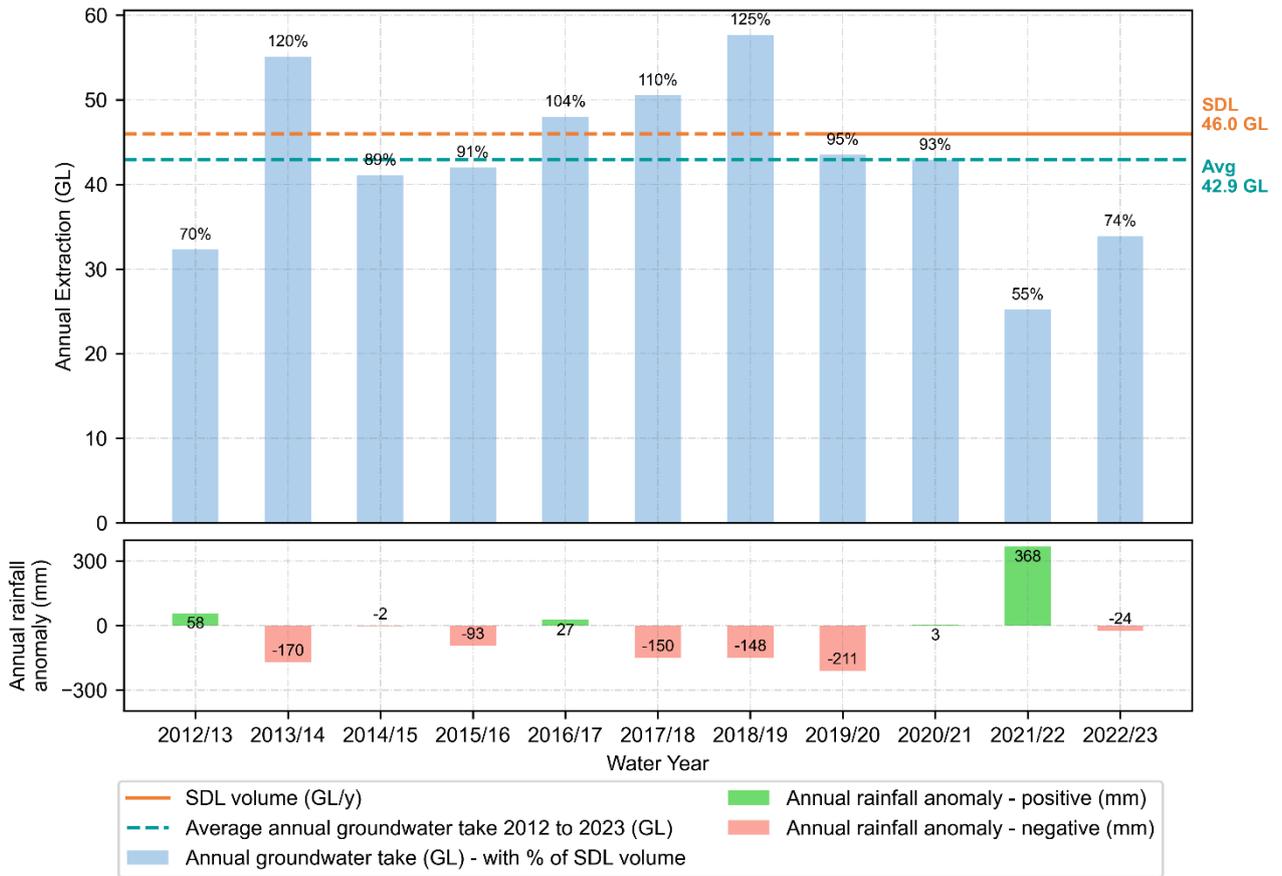


Figure 2 Groundwater take in the SDL since 2012

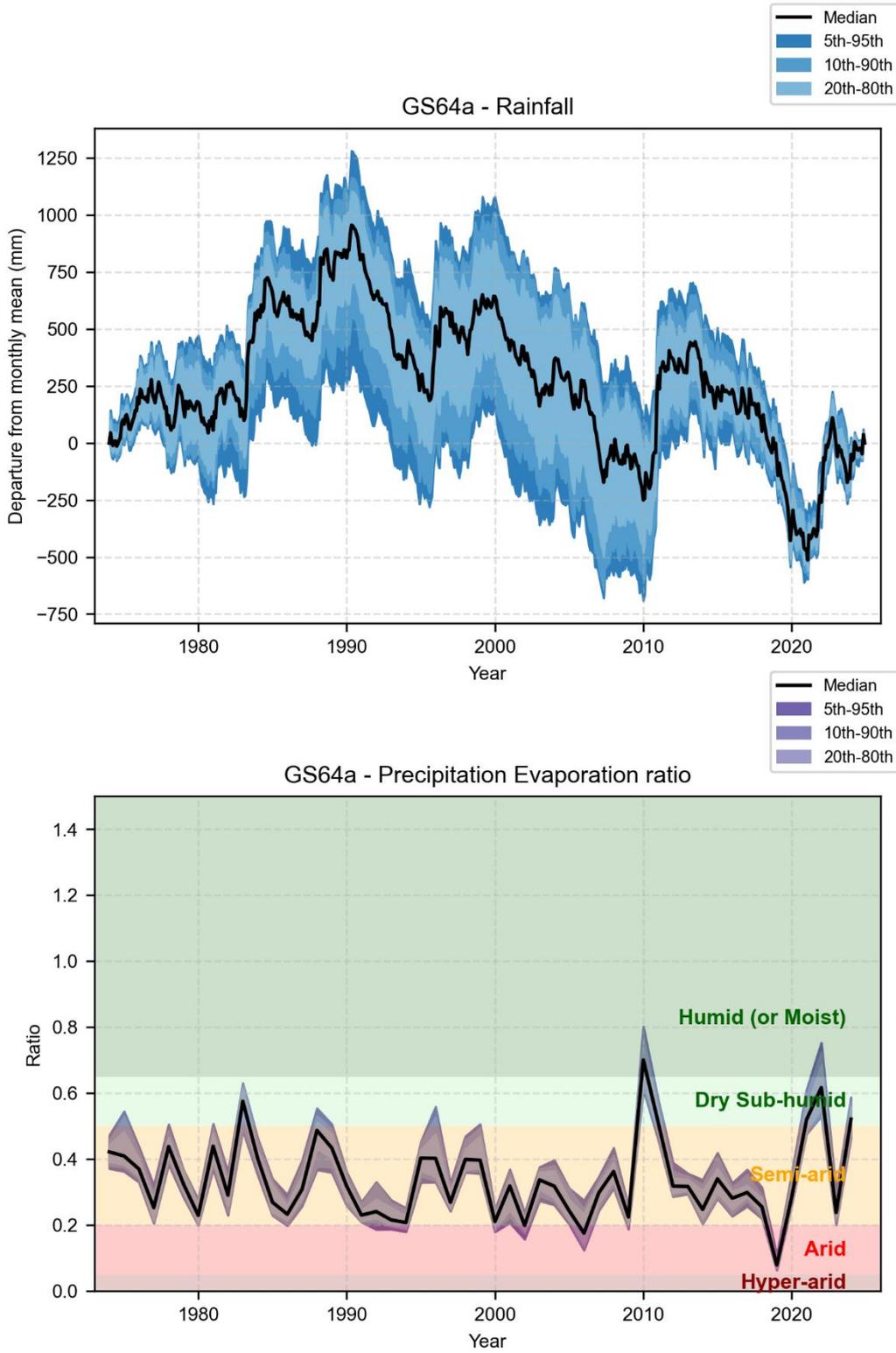
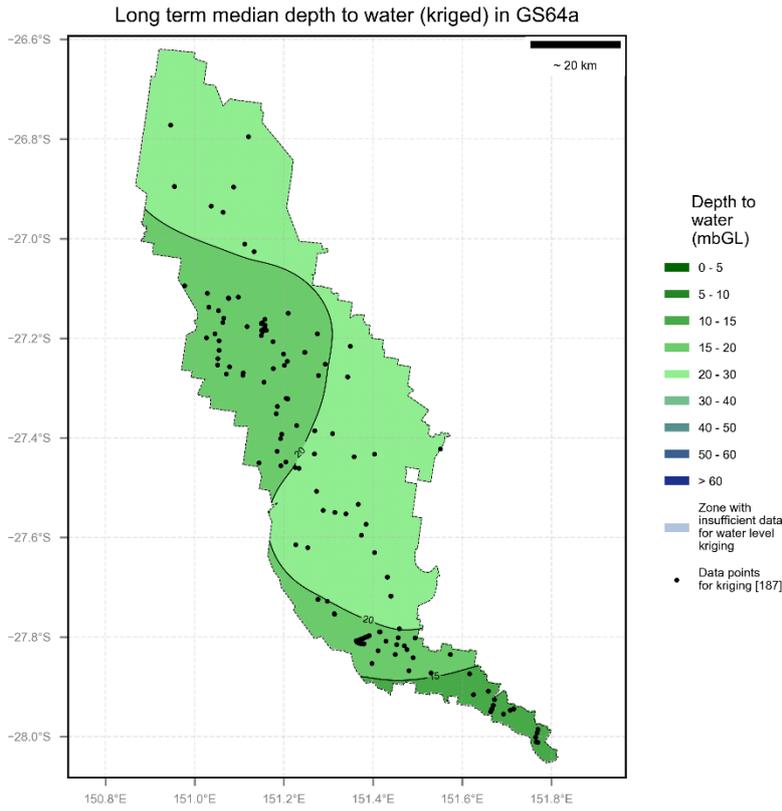
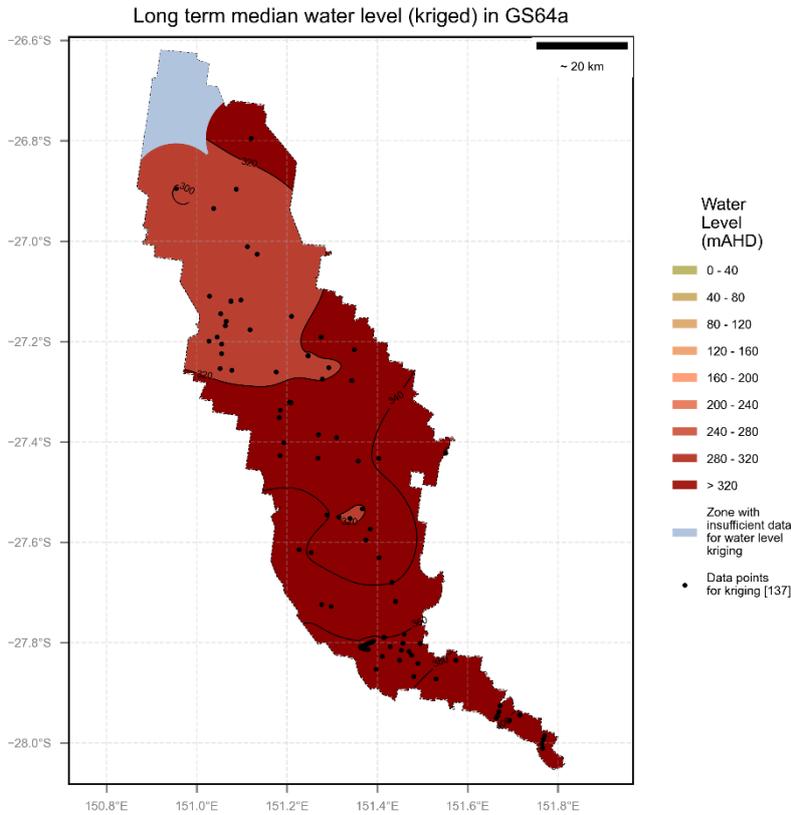


Figure 3 Historical climate trends



Long term - 1974 to 2024; median - 50th percentile water level relative to ground surface

a)

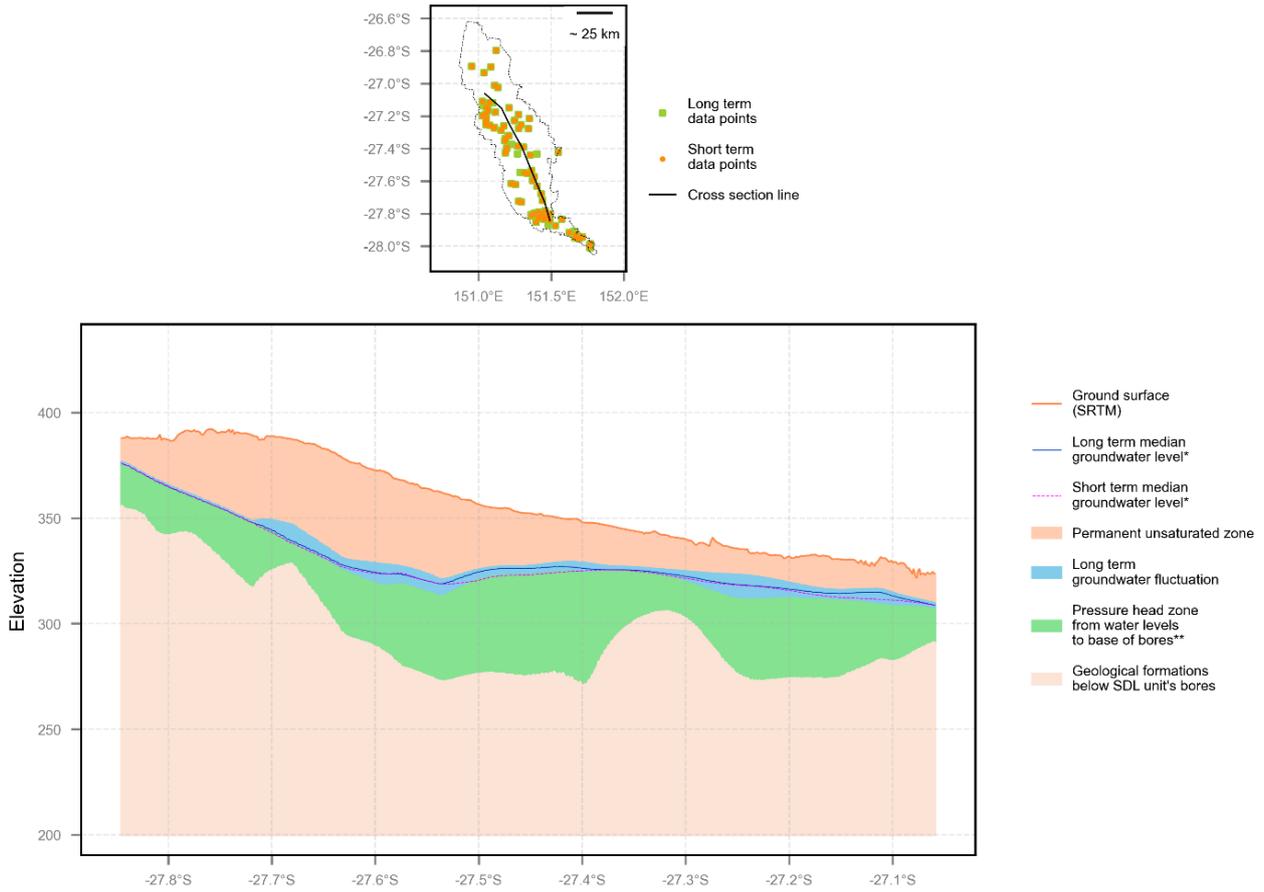


Long term - 1974 to 2024; median - 50th percentile water level relative to Australian Height Datum

b)

Figure 4 Long-term median (a) depth to water and (b) water level elevation

Water level elevation cross section for GS64a



*Long term - 1974 to 2024; Short term - 2012 to 2024; median - 50th percentile

**This cross-section is a scaled representation of bore data specific to the SDL resource unit.

The data are temporally and spatially aggregated, resulting in some smoothing of the representation of water levels and aquifer formations that is different from the detail of reality. The blue zone represents the long term fluctuation in groundwater levels, as indicated by the 5th and 95th percentiles of groundwater levels from 1974 to 2024. The green pressure head zone may be representative of the total available drawdown (TAD), as it shows the water column in bores of the SDL resource unit (measured as the difference between the long-term 5th percentile groundwater level and the base of the bores of the SDL resource unit). This cross-section is for interpretation purposes only and should not be used for planning or compliance purposes.

Figure 5 West to east distribution of water levels in the SDL resource unit

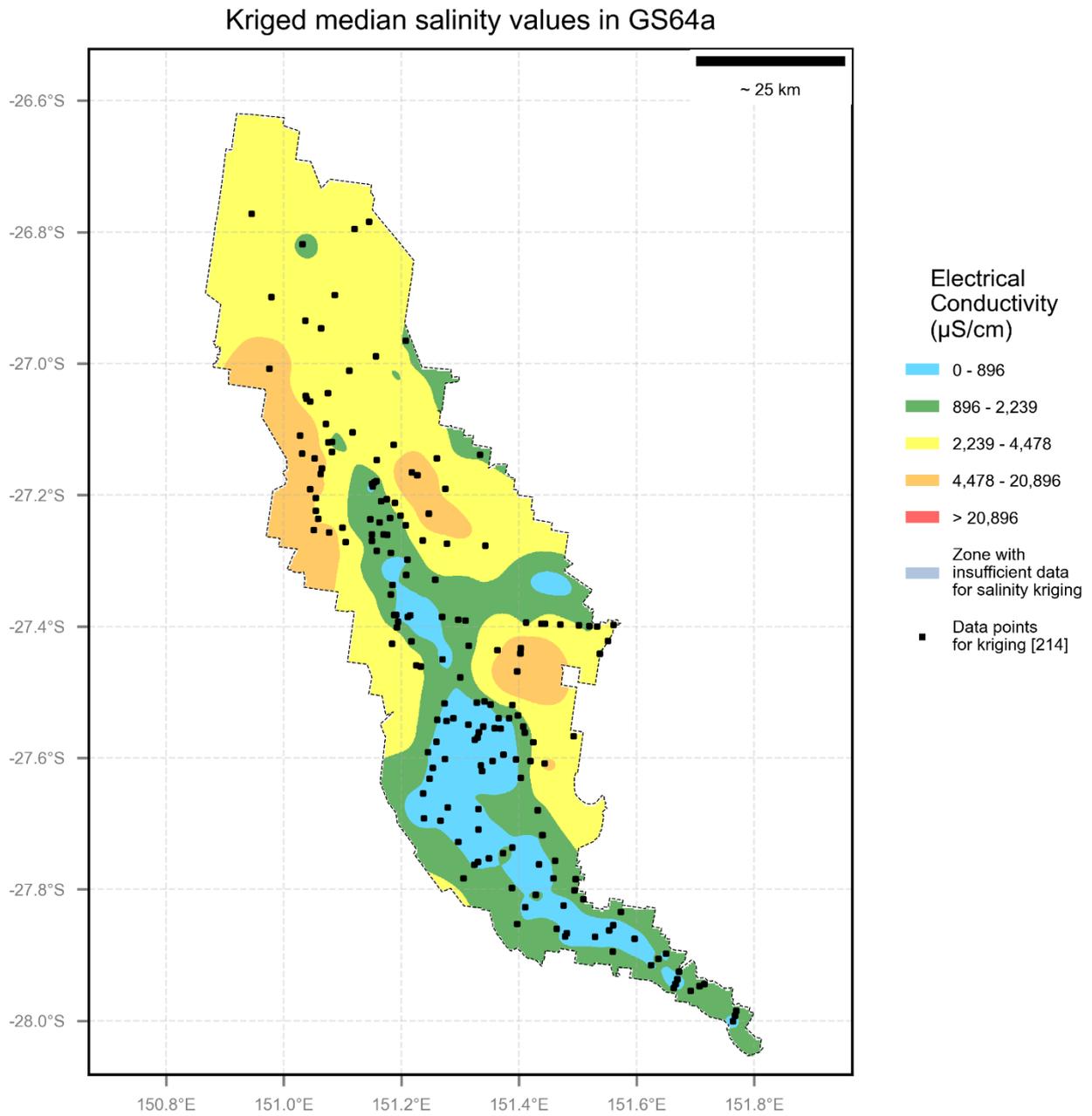


Figure 6 Groundwater salinity distribution

Table 1 Table of groundwater metadata for the SDL resource unit

Parameter	Unit	Long-term (1974 to 2024)	Short-term (2012 to 2024)	SDL resource unit data
SDL volume	GL/y	-	-	46.00
SDL resource unit area	km ²	-	-	4,767
Average annual take (2013 to 2023)	GL/y	-	-	42.93
Number of groundwater entitlement bores	-	-	-	756
SDL resource unit storage estimate*	GL	-	-	51,273
Recharge estimate (SY1)	GL/y	-	-	128.00
Recharge estimate (Stage 2)	GL/y	-	-	128.00
Diffuse recharge estimate (SY2 - WAVES)	GL/y	-	-	172.46
Extraction/SDL (E/SDL) (Stage 2 result)	-	-	-	0.93
SDL/Recharge (SDL/R) (Stage 2 result)	-	-	-	0.36
SDL/Recharge (SDL/R) (SY2 or modelled recharge)	-	-	-	0.36
Storage/Stage 2 Recharge (S/R)	-	-	-	401
Storage/SY2 or modelled Recharge (S/R)	-	-	-	401
Number of bores in the SDL unit	-	5,166	5,166	-
Number of bores for water level trend analysis	-	277	131	-
Number of bores for water level trend with sufficient data	-	167	87	-
Number of bores with decreasing water level trend	-	79	25	-
Number of bores with increasing water level trend	-	12	6	-
Number of bores with no statistically significant water level trend	-	76	56	-
Mean water level trend magnitude	m/y	-0.05	0	-
Minimum water level trend magnitude	m/y	-0.46	-0.46	-
5%ile water level trend magnitude	m/y	-0.27	-0.13	-
10%ile water level trend magnitude	m/y	-0.18	-0.12	-
50%ile water level trend magnitude	m/y	-0.02	-0.01	-
90%ile water level trend magnitude	m/y	0.08	0.12	-
95%ile water level trend magnitude	m/y	0.13	0.14	-
Maximum water level trend magnitude	m/y	0.37	0.37	-
Number of bores for salinity trend analysis	-	224	107	-
Number of bores for salinity trend with sufficient data	-	14	2	-
Number of bores with decreasing salinity trend	-	0	0	-
Number of bores with increasing salinity trend	-	0	0	-
Number of bores with no statistically significant salinity trend	-	14	2	-
Mean salinity trend magnitude	µS/cm/y	35	18	-
Minimum salinity trend magnitude	µS/cm/y	-260	3	-
5%ile salinity trend magnitude	µS/cm/y	-96	4	-
10%ile salinity trend magnitude	µS/cm/y	-7	6	-
50%ile salinity trend magnitude	µS/cm/y	2	18	-
90%ile salinity trend magnitude	µS/cm/y	109	29	-
95%ile salinity trend magnitude	µS/cm/y	264	31	-
Maximum salinity trend magnitude	µS/cm/y	515	32	-

Note: *Groundwater resource storage estimate source: WERP (RQ8b).

Table 2 Table of results from spatial analysis of RCI trends in ESLT asset areas

ESLT Value	Asset area (m2)	Long-term				Short term			
		Proportion of asset area with improving/stable RCI trends	Proportion of asset area with deteriorating RCI trends	Proportion of asset area with uncertain RCI trends	Trend grouping	Proportion of asset area with improving/stable RCI trends	Proportion of asset area with deteriorating RCI trends	Proportion of asset area with uncertain RCI trends	Trend grouping
Productive base	4,251,379,870	35%	29%	36%	Variable trends	40%	18%	42%	Variable trends
GDEs	2,720,362,840	32%	27%	42%	Variable trends	34%	15%	51%	Insufficient data
River connectivity	2,635,057,315	36%	28%	35%	Variable trends	40%	18%	42%	Variable trends
Water quality	3,679,576,424	21%	0%	79%	Insufficient data	4%	0%	96%	Insufficient data

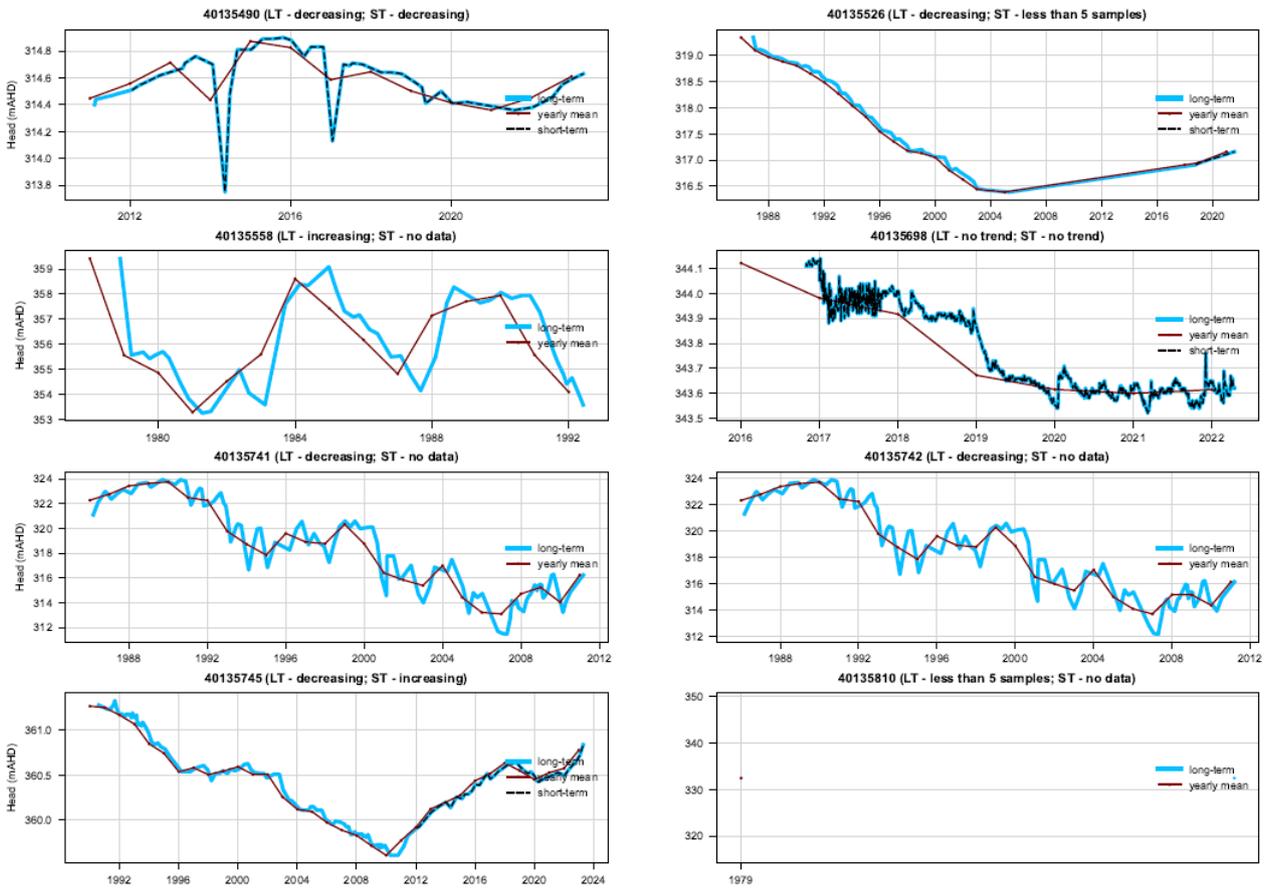


Figure 7 Representative groundwater hydrographs for the SDL resource unit

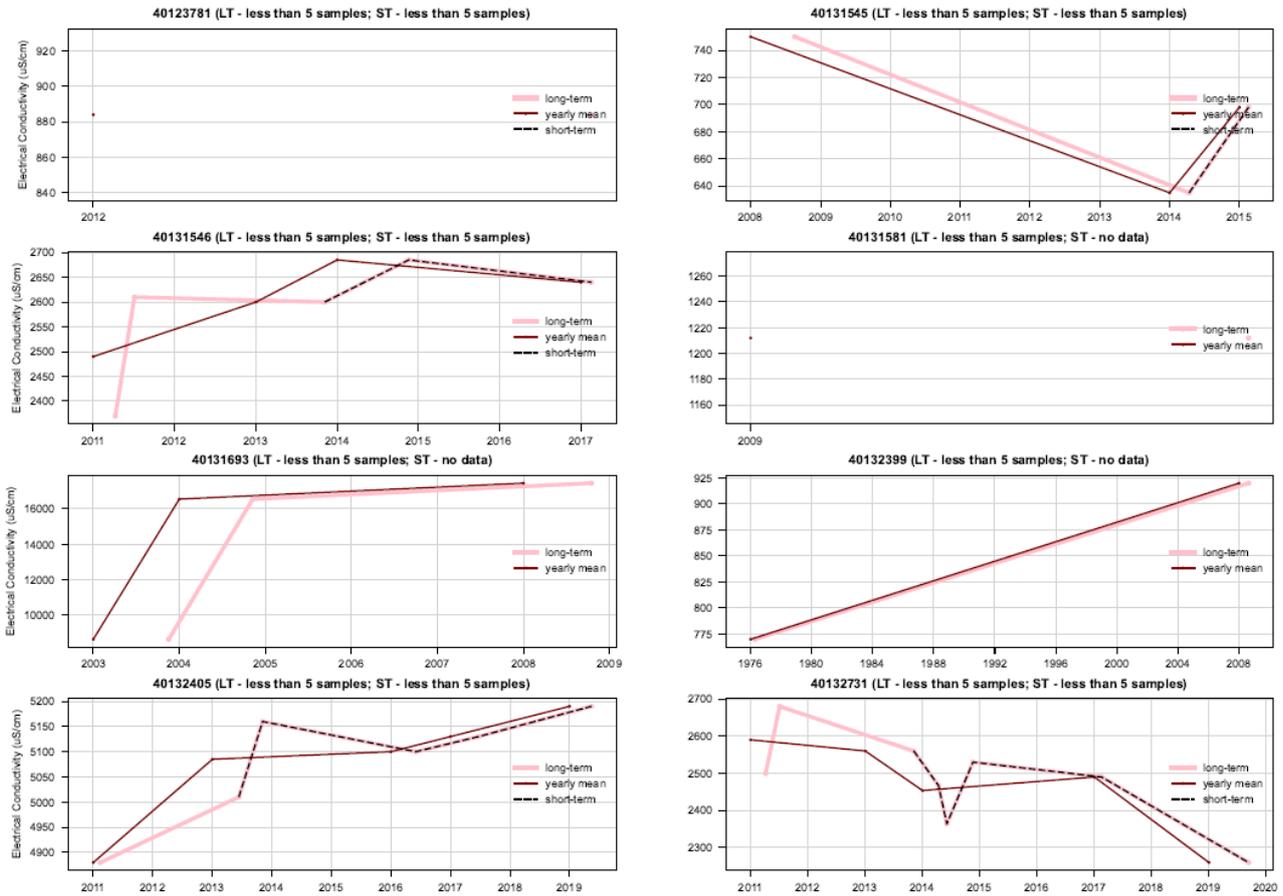
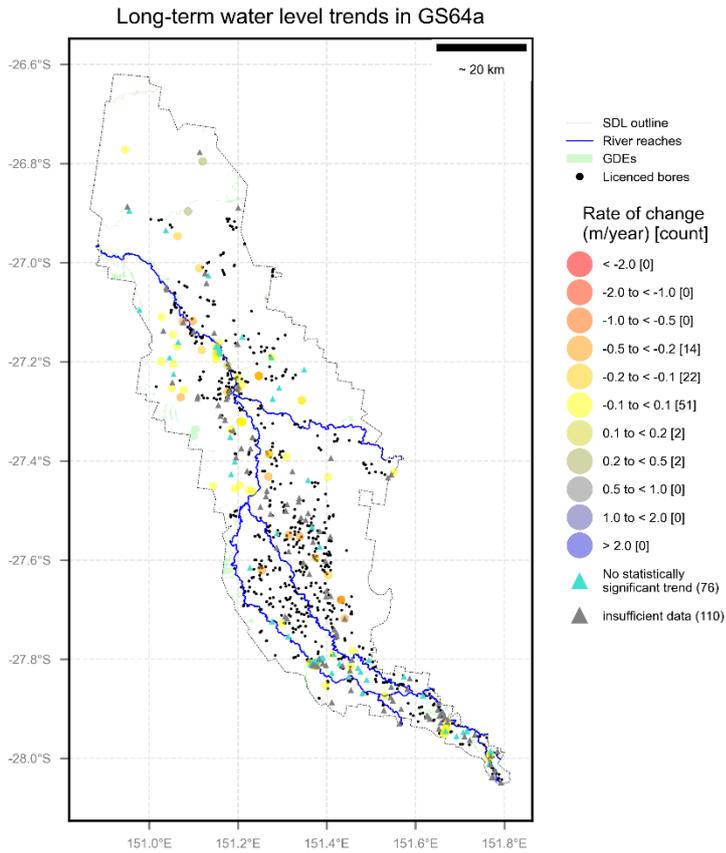
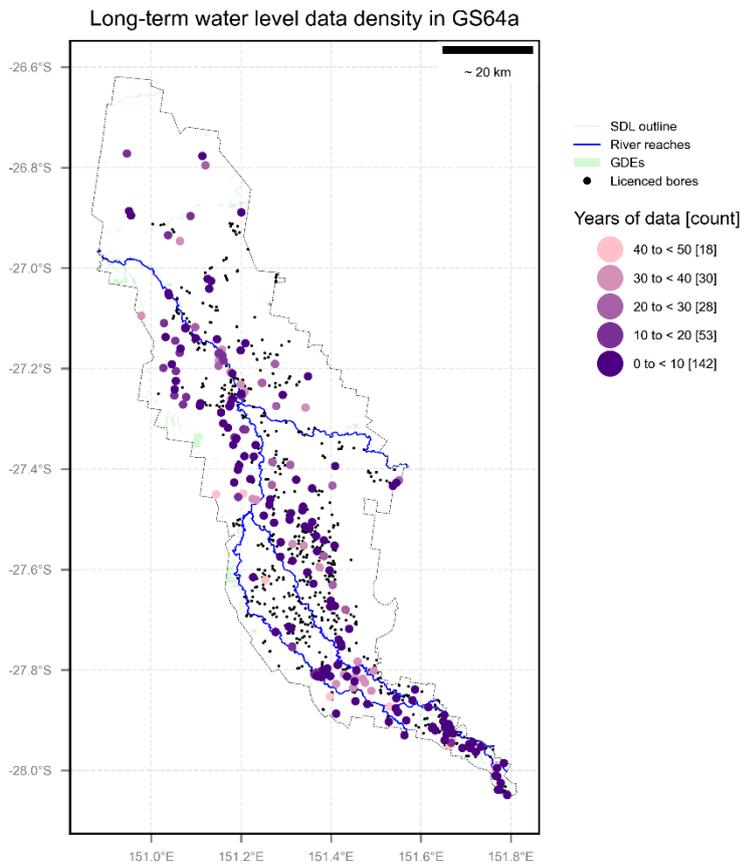


Figure 8 Representative groundwater salinity time series for the SDL resource unit

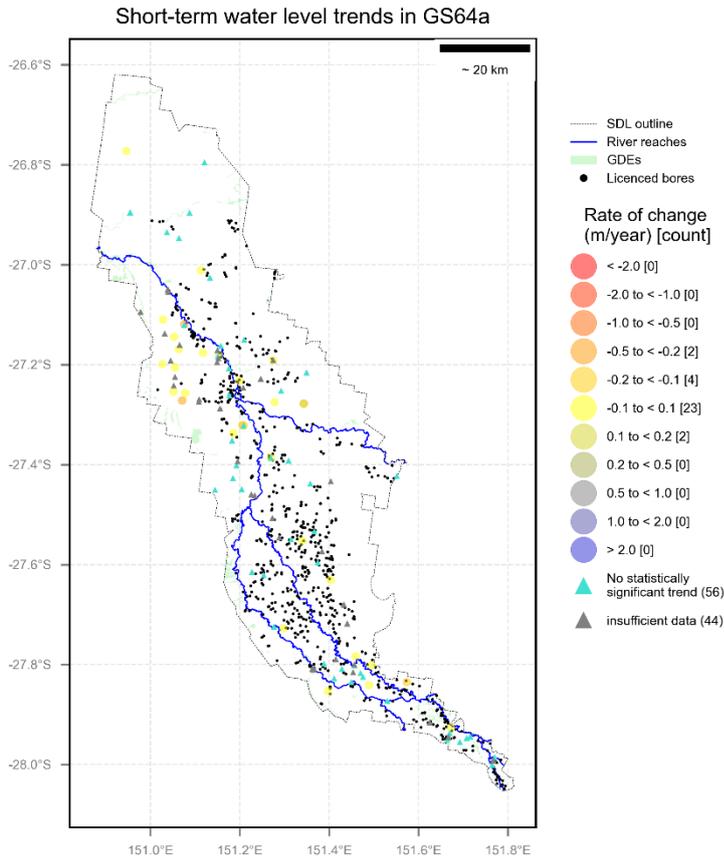


a)

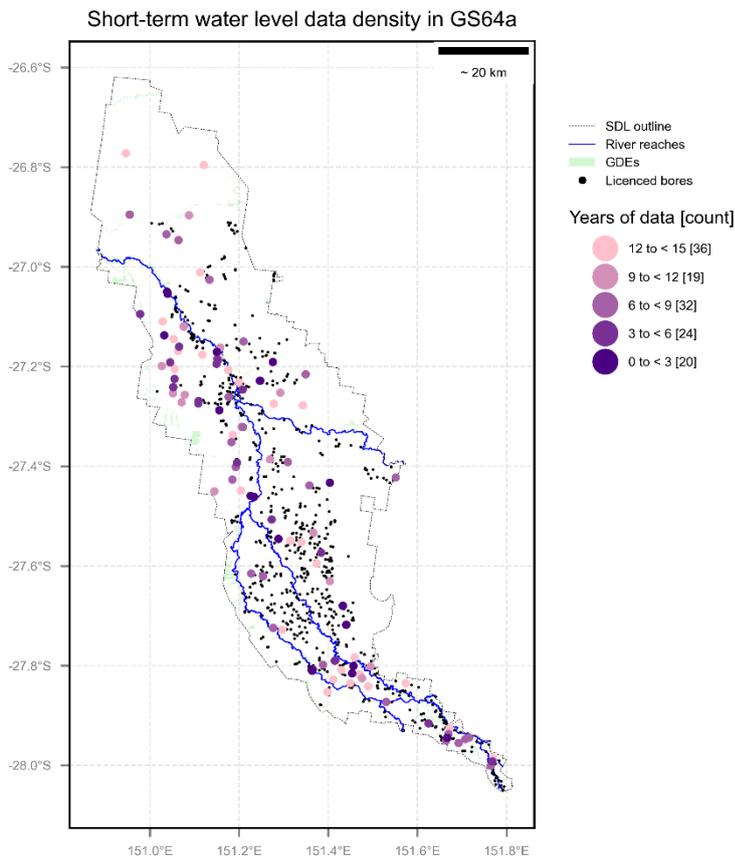


b)

Figure 9 Long-term (1974 to 2024) (a) groundwater level trends and (b) data availability



a)



b)

Figure 10 Short-term (2012 to 2024) (a) groundwater level trends and (b) data availability

Ternary plot for GS64a

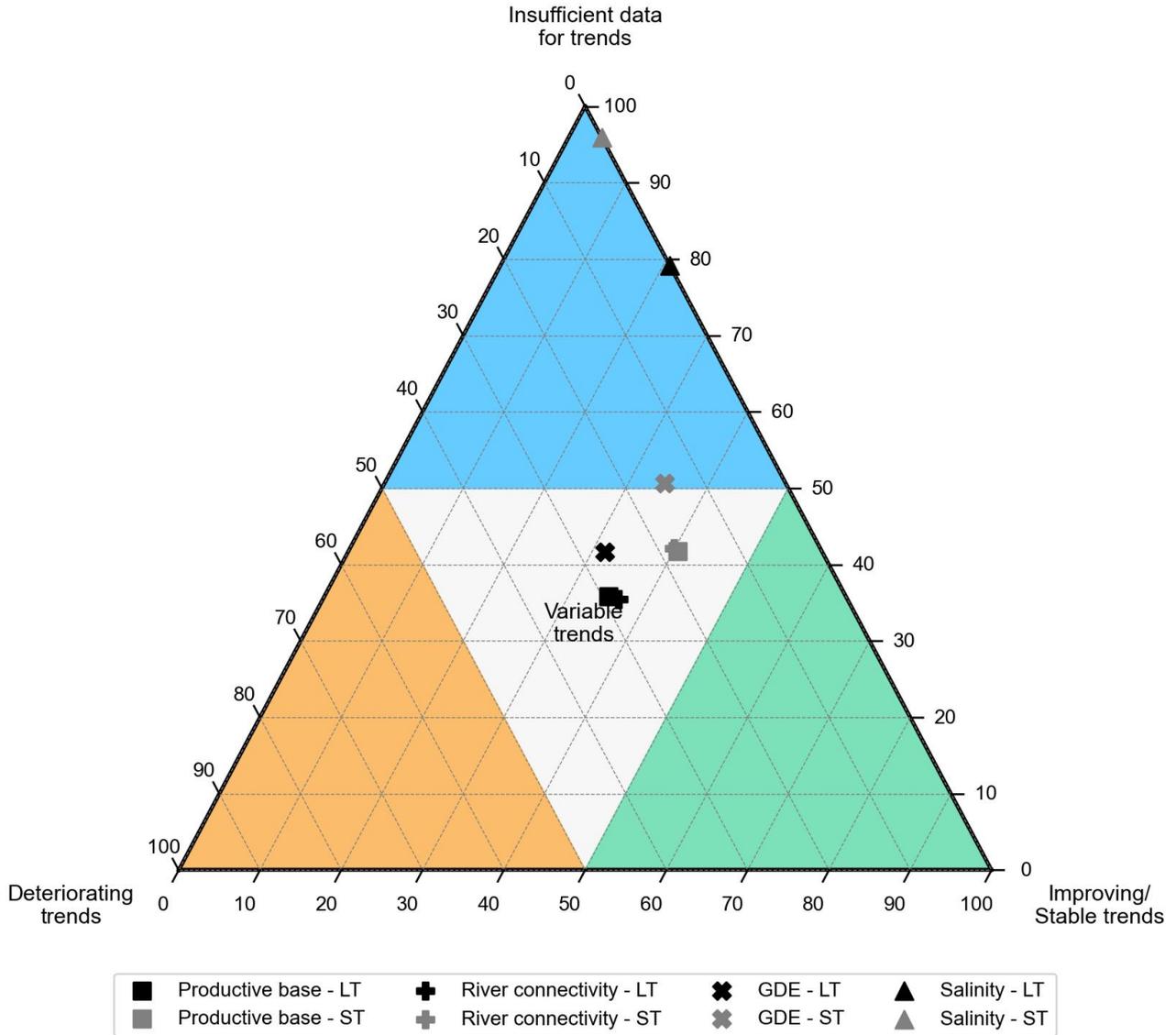


Figure 11 Stage 4 assessment outcome: trends in resource condition indicators for ESLT values

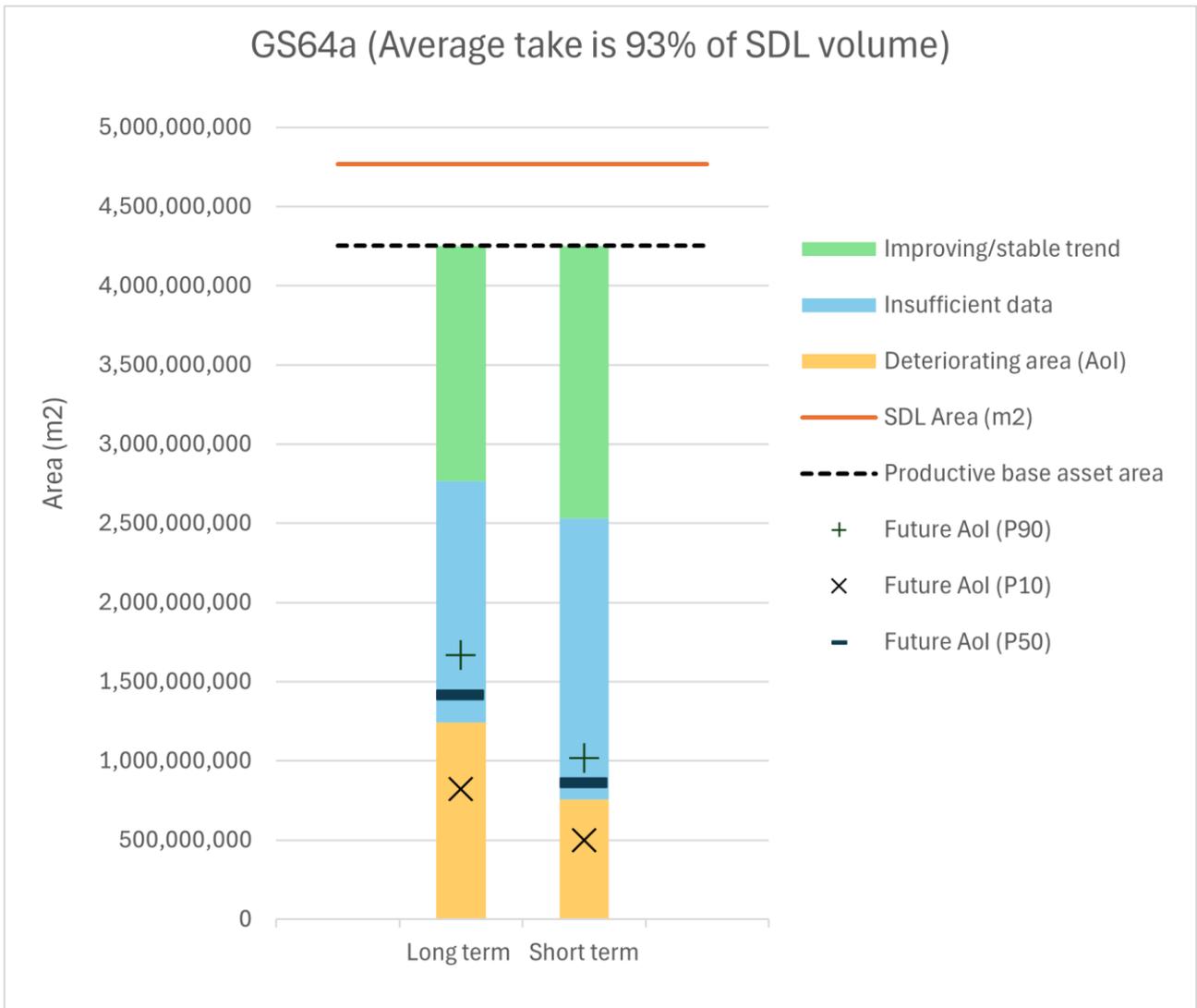


Figure 12 Estimates for change in area of influence (AoI) due to climate change

References

- Crosbie R, Wang B, Kim S, Mateo C, and J Vaze, (2023), Changes in the surface water – Groundwater interactions of the Murray-Darling basin (Australia) over the past half a century. *Journal of Hydrology*, 622, doi:10.1016/j.jhydrol.2023.129683.
- Crosbie R, Doble R, Fu G, Campos Teixeira P, Pickett T, Devanand A, Ticehurst C, Gibbs M, Gunner W, Gonzalez D, Post D. (2025) "Groundwater recharge modelling of the Murray-Darling Basin under historical and future climate conditions". MDB Sustainable Yields 2, Module 3a. CSIRO Report, 2025.
- Dafny E., Silburn D.M., 2013. *The hydrogeology of the Condamine River Alluvial Aquifer (Australia) - critical review*. University of Southern Queensland, Toowoomba, Australia. Available from: <https://research.usq.edu.au/download/1881e0359553c652f9fa55366455ae99d1f439e0fe6eaf7019fc4ad30f1fa3d/3766190/glossy%28v.2.3%29.pdf>."
- DNRME (2019), Condamine and Balonne Risk assessment report 2019, Department of Natural Resources, Mines and Energy, Queensland Government, Brisbane. Available from <https://www.mdba.gov.au/sites/default/files/publications/qld-condamine-balonne-risk-assessment-report-20192.pdf>, accessed on 3 April 2025.
- MDBA (2020) Groundwater report cards For Sustainable Diversion Limit Resource Units under the Murray–Darling Basin Plan. Canberra, Australia. www.mdba.gov.au/sites/default/files/publications/mdba-groundwater-report-cards-november-2020.pdf.
- Moran, C. & Vink, S. 2010, 'Assessment of impacts of the proposed coal seam gas operations on surface and groundwater systems in the Murray-Darling Basin', Centre for Water in the Minerals Industry, Sustainable Minerals Institute, The University of Queensland, Brisbane. Available from <http://secure.environment.gov.au/epbc/notices/assessments/pubs/coal-seam-gas-operations-impacts.pdf>, accessed on 3 April 2025.
- Rojas R., Fu G. and González D. (2022) "Groundwater level trends and aquifer prioritisation in the Murray–Darling Basin". Project RQ8b: Groundwater as an adaptation option to current water resources management. Deliverable T.8b.2 - 31 May 2022. <https://www.mdba.gov.au/sites/default/files/publications/groundwater-level-trends-and-aquifer-prioritisation-in-the-murray-darling-basin.pdf>.