Musgrave and Southern Basins Prescribed Wells Areas
2020–21 water resources assessment

Department for Environment and Water
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DEW Technical Note 2022/18

Government of South Australia
Department for Environment and Water

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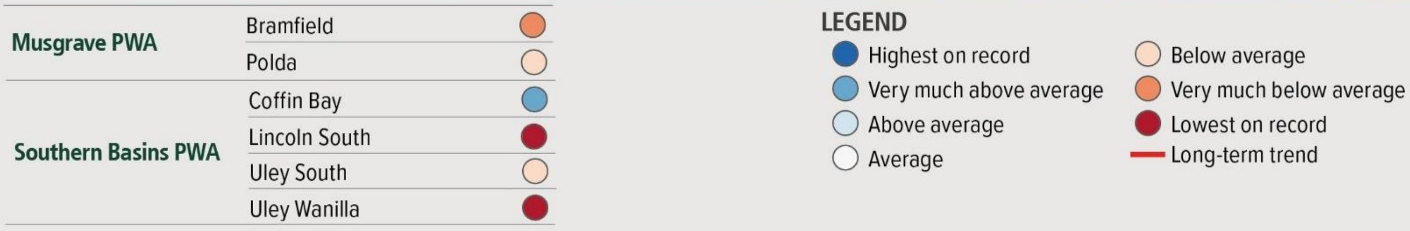
1 Summary



Rainfall

- In the Musgrave Prescribed Wells Area (PWA) in 2021, total annual rainfall at Elliston (BoM station 18069) and Terrah Winds (BoM station 18165) is above the long-term average (1971 to 2021) by 10 to 22%.
- In the Southern Basins PWA in 2021, total annual rainfall at Big Swamp (BoM station 18017) and Westmere (BoM station 18137) is commensurate with the long-term average (1971 to 2021).

Groundwater

- In the Musgrave PWA, most water levels in the Quaternary Limestone aquifer (95%) are classified 'Below average' or lower, compared to their respective historical record.
- In the Southern Basins PWA, most water levels in the Quaternary Limestone aquifer (67%) are classified 'Below average' or lower, compared to their respective historical record.
- In the Uley Wanilla Public Water Supply (PWS) and Lincoln South PWS consumptive pools, water levels in the majority of wells (54% and 57%, respectively) are classified 'Lowest on record'.
- Water levels in all wells in the Coffin Bay consumptive pool and around half of the wells in the Uley South PWS consumptive pool (47%) are classified 'Average' or greater, compared to their respective historical record.
- Across both PWAs, five-year trends show that water levels are declining in 90% of all wells.
- Across both PWAs, ten-year trends show that groundwater salinity is stable (±10% variation) in the majority of wells (73%).

Water use

- Surface-water resources are generally scarce and unreliable in Eyre Peninsula. Consequently, groundwater resources in the Musgrave and Southern Basins PWAs are used for a variety of purposes such as reticulated town water supply, stock and domestic purposes, recreation (e.g., irrigation of golf courses and sports grounds) and industrial uses.
- Licensed extraction in the Musgrave PWA in 2020–21 totals 69 ML, all of which is sourced from the Bramfield consumptive pool.
- Licensed extraction in the Southern Basins PWA in 2020–21 totals 5,449 ML, the majority of which (86%) is sourced from the Uley South PWS consumptive pool. Licensed extraction from larger fresh groundwater resources in 2020–21 includes the Uley Wanilla PWS (65 ML), Lincoln South PWS (536 ML) and Coffin Bay (128 ML) consumptive pools.

1.1 Purpose

The Department for Environment and Water (DEW) has a key responsibility to monitor and report annually on the status of prescribed and other groundwater and surface-water resources. To fulfil this, data on water resources are collected regularly, analysed and reported in a series of annual reports. Three types of reports are provided to suit a range of audiences and their needs for differing levels of information:

- **Technical Notes**: (this document) provide a detailed information and assessment for each resource area, helping to identify the resource condition in further detail.
- **Fact sheets**: provide summary information for each resource area with an Annual Resource Status Overview.
- **State-wide summary**: this summarises information for the main water resources across most regions in a quick-reference format.

This document is the Technical Note for the Musgrave Prescribed Wells Area (PWA) and Southern Basins PWA and collates rainfall, groundwater and water-use data for 2020–21.

1.2 Regional context

The Musgrave PWA (Figure 1.1) and Southern Basins PWA (Figure 1.2) are located within the Eyre Peninsula Landscape region. The PWAs comprise undulating topography which is the remnant of ancient dune systems which were deposited during the Pleistocene era (from around 2.7 million years ago). Thin soils and calcrete are common across both PWAs. Groundwater is the main source of fresh water on the Eyre Peninsula and is used for town water supply, stock and domestic, irrigation, recreational and industrial purposes. There are at least four groundwater systems located in the region: the uppermost unconfined Quaternary Limestone aquifer, an underlying unconfined to confined Tertiary Sands aquifer, a high-salinity Jurassic sedimentary aquifer (that is exclusive to the Musgrave PWA) and a fractured rock aquifer occurring in basement rocks. The Water Allocation Plan (WAP) for the Southern Basins and Musgrave Prescribed Wells Areas (EP NRM Board 2016) was adopted in 2016 and provides for sustainable management of the groundwater resources.

The lowest-salinity groundwater generally resides within the Quaternary Limestone aquifers, which occur widely in both the Musgrave and Southern Basins PWAs. Groundwater resources in the Quaternary limestone are subdivided into discrete basins, which are used to delineate groundwater resources discussed in this Technical Note. These basins, some of which contain considerable volumes of groundwater in storage, comprise geologically controlled fresh groundwater lenses that are separated by areas where the Quaternary limestone is dry or has very low saturated thickness.

The WAP describes six consumptive pools, where the areal extent of each consumptive pool is based on the spatial distribution of the main groundwater basins. In the Musgrave PWA (Figure 1.1), the WAP defines the:

- Bramfield consumptive pool, which extends to the north-east of the township of Elliston
- Polda consumptive pool, located around 50 km inland from Elliston.

In the Southern Basins PWA (Figure 1.2), the WAP defines the:

- Coffin Bay consumptive pool, located immediately inland of the township of Coffin Bay
- Uley South Public Water Supply (PWS) consumptive pool, located around 30 km west of Port Lincoln
- Uley Wanilla PWS consumptive pool, located inland about 15 km east of Coffin Bay
- Lincoln South PWS consumptive pool, located between Port Lincoln and Sleaford Bay.

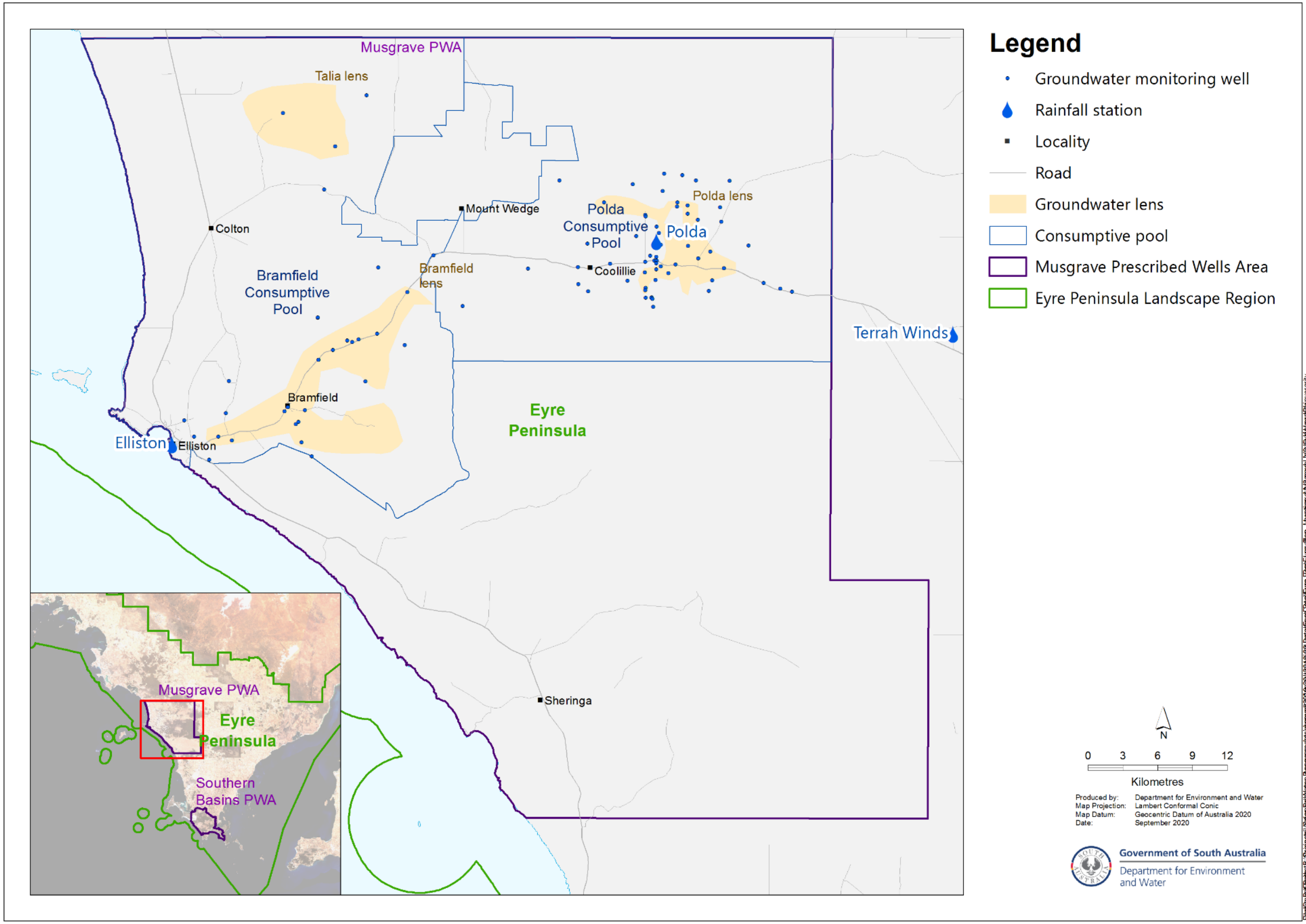


Figure 1.1 Location of Musgrave PWA

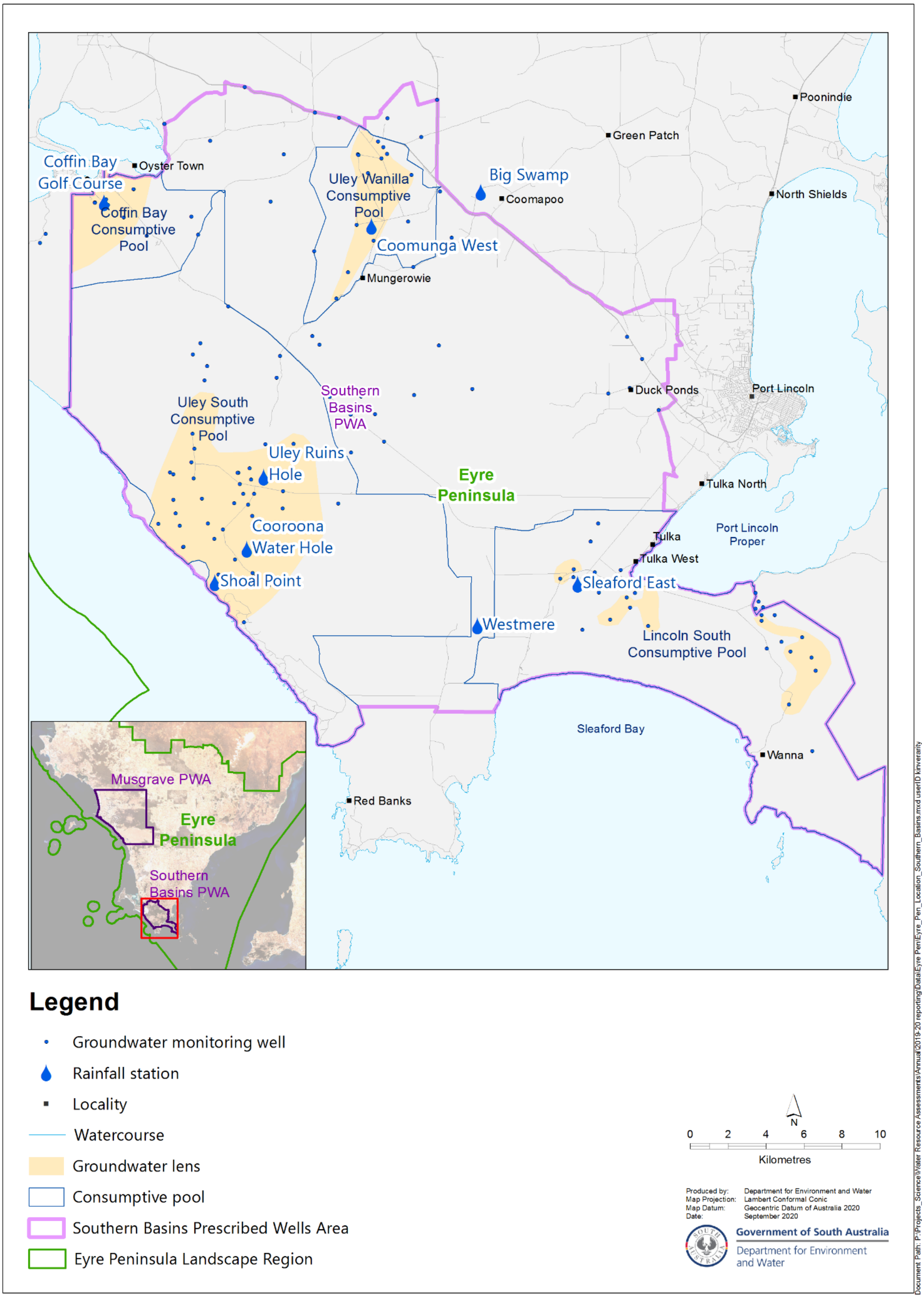


Figure 1.2 Location of Southern Basins PWA

2 Methods and data

This section describes the source of rainfall, groundwater and water-use data presented in this assessment and the methods used to analyse and present these data. The period of data adopted for each parameter is shown in Table 2.1.

Table 2.1 Reporting period description

Parameter	Reporting period	Comment
Rainfall	1 January to 31 December 2021	Groundwater recharge response to incident rainfall is typically rapid in this area; hence, coincident data periods were selected for rainfall and groundwater.
Groundwater	1 January to 31 December 2021	
Water use	1 July 2020 to 30 June 2021	In South Australia, water accounting is reported between 1 July through 30 June of the following year.

2.1 Rainfall

Daily rainfall observations were used from selected DEW and Bureau of Meteorology (BoM) stations in order to calculate monthly and annual totals. Bureau of Meteorology data were obtained from the SILO Patched Point Dataset service provided by the Queensland Government, which provides interpolated values to fill gaps in observations (see figures in Section 3). Annual rainfall totals are calculated for calendar years.

Rainfall maps were compiled using gridded datasets obtained from the Bureau of Meteorology (Figure 3.1). The long-term average annual rainfall map (1986 to 2015) was obtained from Climate Data Online. The map of total rainfall in 2020–21 was compiled from monthly rainfall grids obtained for the months between July 2020 and June 2021 from the Australian Landscape Water Balance website.

2.2 Groundwater

2.2.1 Water level

Water level[1] data were obtained from wells in the monitoring network by both manual and continuous logger measurements. All available water level data are verified and reduced to an annual maximum water level for each well for further analysis. The annual maximum level is used as this represents the unstressed or recovered water level following pumping each year for irrigation, town water supply, stock and domestic and other uses. The amount of pumping can vary from year to year, and the proximity of pumping wells to monitoring wells may affect the reliability of trends and historical comparisons. Therefore, the recovered level is used as it is a more reliable indicator of the status of the groundwater resource. The period of recovery each year was reviewed for each well; in general,

[1] 'Water level' in this report refers to both the watertable elevation, as measured in wells completed in unconfined aquifers, and the potentiometric water level elevation, as measured in wells completed in confined aquifers where the water level or pressure in the monitoring well rises above the top of the aquifer. These are collectively referred to as the 'reduced standing water level' (RSWL).

for unconfined aquifer wells in the Eyre Peninsula, the long-term trend in water level is larger than the seasonal effect, but the return to a maximum level mostly occurs between July and December.

For those wells with suitable long-term records, the annual recovered water levels were then ranked from lowest to highest and given a description based on their decile[2] (Table 2.2). The definition of a suitable long-term record varies depending on the history of monitoring activities in different areas; for the Musgrave and Southern Basins PWAs, any well with 10 years or more of recovered water level data is included, except for the Bramfield consumptive pool in the Musgrave PWA, where only those wells with 30 years or more of recovered water level data were included.

Table 2.2 Percentile/decile descriptions*

Decile	Percentile	Description	Colour
N/A	100	Highest on record	
10	90 to 100	Very much above average	
8 and 9	70 to 90	Above average	
4, 5, 6, and 7	30 to 70	Average	
2 and 3	10 to 30	Below average	
1	0 to 10	Very much below average	
N/A	0	Lowest on record	

* Deciles and descriptions as defined by the Bureau of Meteorology[3]

The number of wells in each description class for the most recent year is then summarised for each aquifer (e.g. Figure 4.1). Hydrographs are shown for a selection of wells to illustrate common or important trends (e.g. Figure 4.3).

Five-year trends are calculated using annual recovered water levels for those wells which have at least five measurements (i.e., at least one measurement a year). The trend line was calculated by linear regression and the well is given a status of 'declining', 'rising', or 'stable', depending on whether the slope of this trend line is below, above, or within a given tolerance threshold. This threshold allows for the demarcation of wells where water levels are changing at very low rates and the water level can therefore be considered stable. The threshold also accommodates for very small measurement errors. The number of rising, declining and stable wells are then summarised for each aquifer (e.g., Figure 4.2). Sedimentary unconfined aquifers with limited areal extent such as those in Eyre Peninsula considered in this report were given tolerance thresholds of 4 mm/y. This is consistent with past practice in the Eyre Peninsula (see DEW (2019) reports in the References).

Thirty-year changes in water level are calculated as the difference between the average water level in a three-year period thirty years ago (i.e., 1991 to 1993) and the average water level in 2021. Twenty-year changes in water level are calculated in a similar way, using a comparison from the average water level in a three-year period twenty years ago (i.e., 2001 to 2003).

2.2.2 Salinity

Water samples are collected from monitoring wells located across the two PWAs by a variety of methods. Samples are collected through a combination of pumping samples from dedicated monitoring wells and by collecting samples from operational SA Water production wells.

Water samples are tested for electrical conductivity (EC) and the salinity (total dissolved solids measured in mg/L, abbreviated as TDS) is calculated. Measurement of the electrical conductivity of a water sample is often subject to small instrument errors.

[2] Decile: a division of a ranked set of data into ten groups with an equal number of values. For example, the first decile contains those values below the 10th percentile.

[3] Bureau of Meteorology Rainfall Map information http://www.bom.gov.au/climate/austmaps/about-rain-maps.shtml

Where more than one water sample has been collected in the course of a year from one well, the annual mean salinity is used for analysis. An example of the results is shown in Figure 4.4.

Ten-year salinity trends are calculated where there are at least seven years of salinity data (i.e. at least one measurement per year). The trend line is calculated by linear regression and the percentage change in salinity is calculated through the following formula:

$$\text{Percentage change in salinity (\%)} = \frac{\text{Slope of linear trend line (mg/L/y)} * 10}{\text{Value of trend line at start of period (mg/L)}} * 100$$

The percentage of change over the trend period is then summarised in categories, depending on the range of change for each resource (e.g., Figure 4.5).

Salinity graphs are shown for a selection of wells to illustrate common or important trends (for example see Figure 4.6).

2.3 Water use

Meter readings are used to estimate licensed extraction for groundwater sources (Section 5).

2.4 Further information

Groundwater data can be viewed and downloaded using the *Groundwater Data* page under the Data Systems tab on WaterConnect. For additional information related to groundwater monitoring well nomenclature, please refer to the Well Details page on WaterConnect.

Other important sources of information on the prescribed resources of the Eyre Peninsula are:

- the most recent summary report on the groundwater resources of the Eyre Peninsula (DEWNR 2010a and b), and annual groundwater level and salinity status reports such as DEW (2019a, b, c, d, e, f and g)
- the Water Allocation Plan for the Southern Basins and Musgrave Prescribed Wells Area (EP NRM Board 2016)
- Stewart et al. (2012), Stewart et al. (2013) and Stewart (2015) assessments of the groundwater resources in the Southern Basins PWA and Musgrave PWA to support the Water Allocation Plan.

3 Rainfall

Annual rainfall across Eyre Peninsula's PWAs is generally higher in the coastal areas than inland. Average annual rainfall varies from approximately 550 mm in the Southern Basins PWA to 350 mm in the northwest of the Musgrave PWA. A network of rainfall stations operated by the BoM and DEW–Landscape South Australia were selected to represent the rainfall distribution in the Musgrave PWA (three stations) and the Southern Basins PWA (seven stations). Long-term rainfall data (1971 to 2021) from stations operated by the BoM are used to calculate long-term averages and changes in rainfall while the DEW–Landscape South Australia sites provided data since 2010 to complement the analyses that are presented herein.

The distribution of total rainfall for 2020–21 was equivalent to the long-term average annual rainfall for 1986 to 2015 (Figure 3.1)[4].

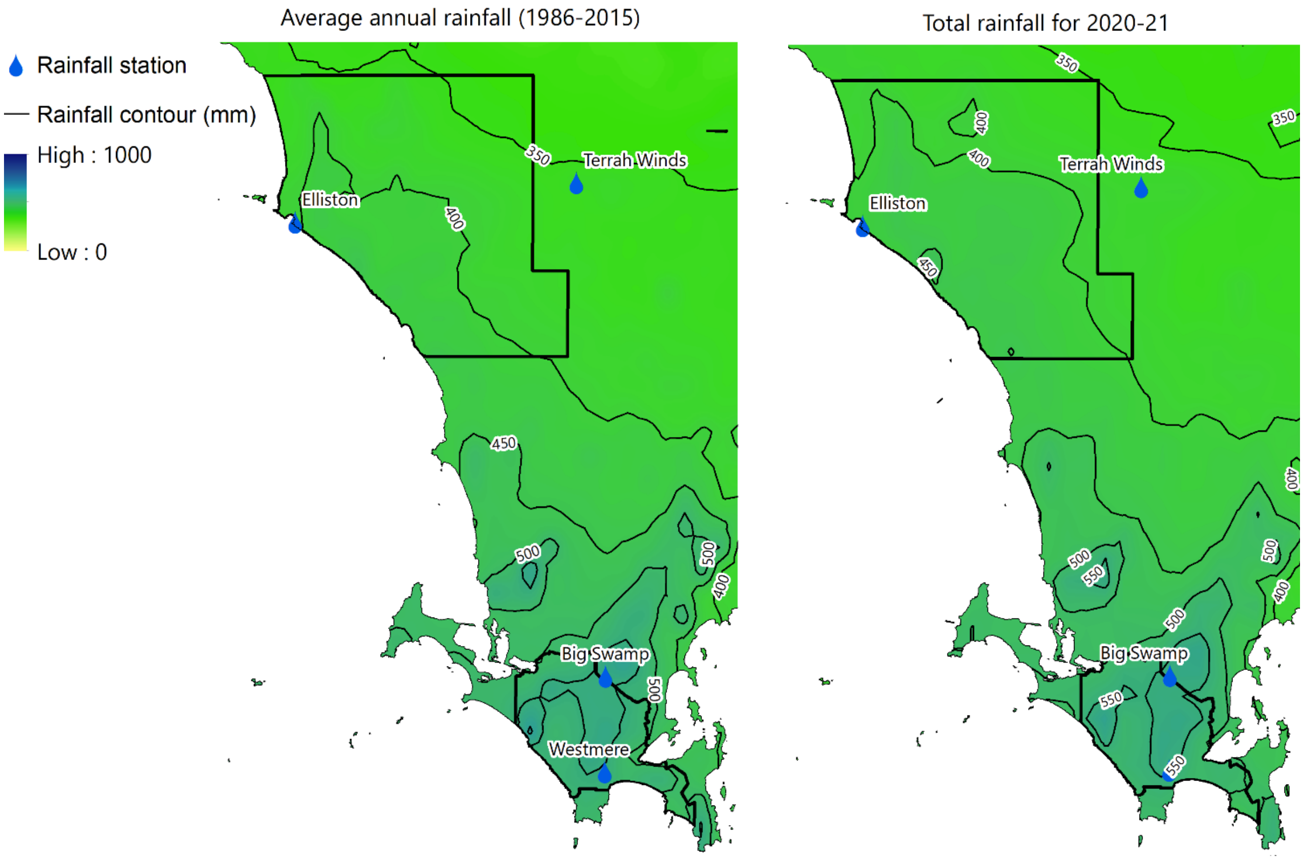


Figure 3.1 Rainfall in the Musgrave PWA and Southern Basins PWA for 2020–21 compared to the standard 30-year climatological average (1986 to 2015)

[4] Some differences may be noticeable between the spatial rainfall maps and the annual rainfall from individual stations. This is due to the use of different data sources and time periods; further detail of sources is provided in Section 2.1.

3.2 Musgrave PWA

The Elliston rainfall station (BoM station 18069; Figure 3.1) is located on the coast in the main township within the PWA at the south-western boundary of the Bramfield consumptive pool. Total annual rainfall recorded at Elliston in 2021 is 517 mm (Figure 3.2), which is 22% (93 mm) higher than the long-term average annual rainfall of 424 mm/y (1971 to 2021). The long-term trend in annual rainfall (1971 to 2021) is declining for this station with three out of the last five years showing below-average total annual rainfall (Figure 3.2).

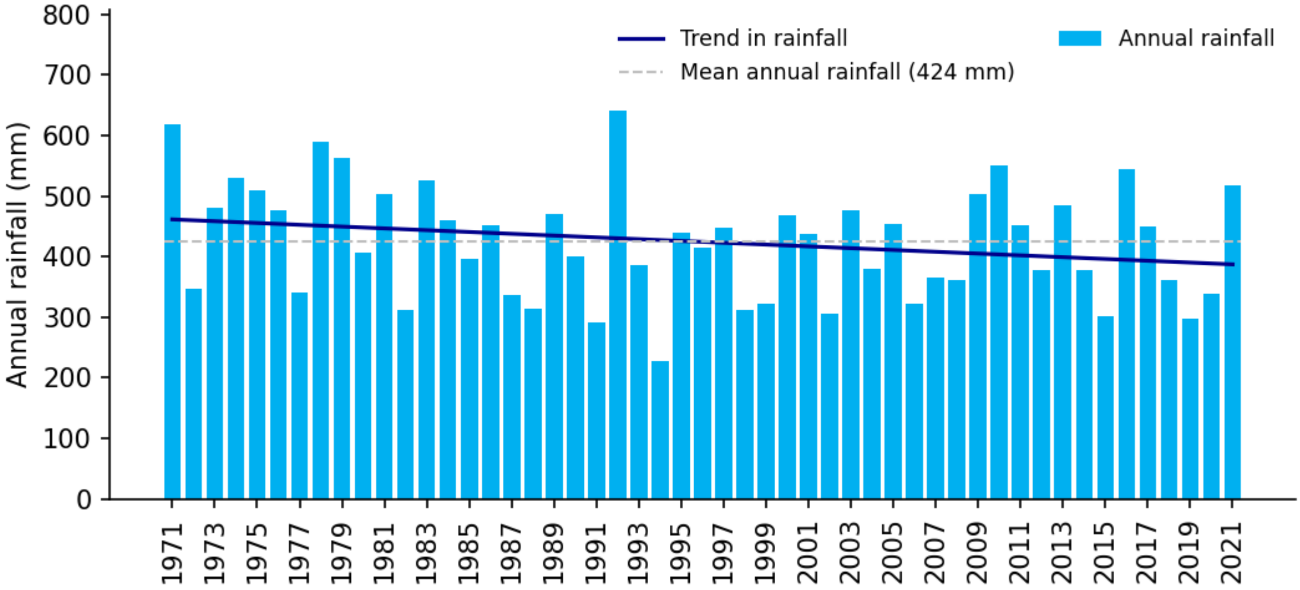


Figure 3.2 Annual rainfall for 1971 to 2021 at the Elliston rainfall station (BoM station 18069)

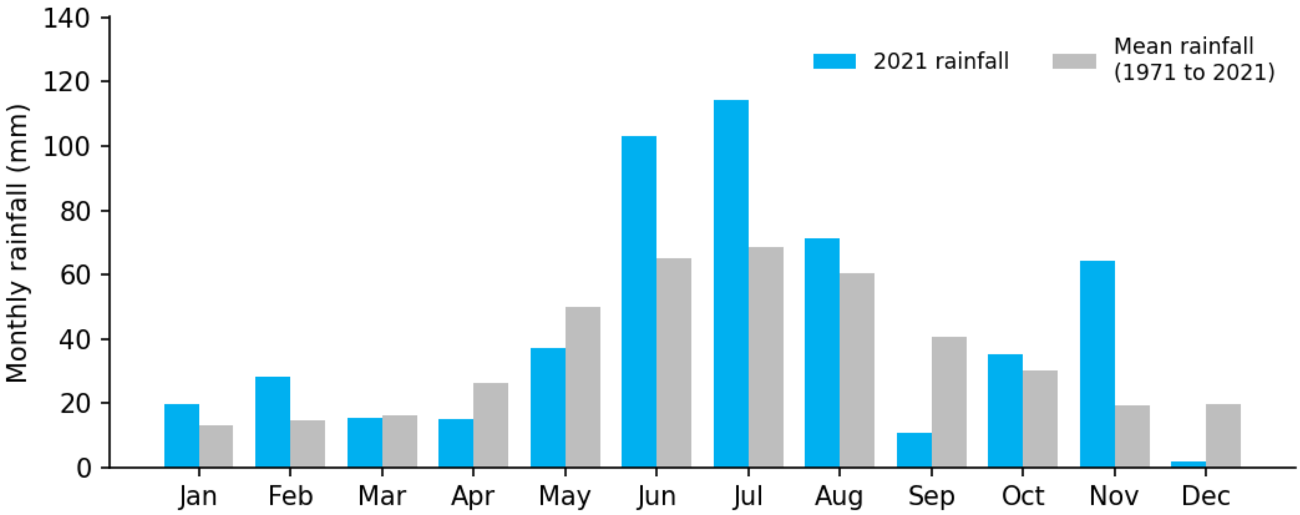


Figure 3.3 Monthly rainfall between January and December 2021 at the Elliston rainfall station (BoM station 18069)

The Terrah Winds rainfall station (BoM station 18165; Figure 3.1) is located 25 km east of the Polda groundwater lens, just outside the eastern boundary of the Musgrave PWA. Total annual rainfall recorded at Terrah Winds in 2021 is 419 mm (Figure 3.4), which is 13% (49 mm) above the long-term average annual rainfall of 370 mm/y (1971 to 2021). The long-term trend in annual rainfall (1970 to 2021) is stable at this station (Figure 3.4).

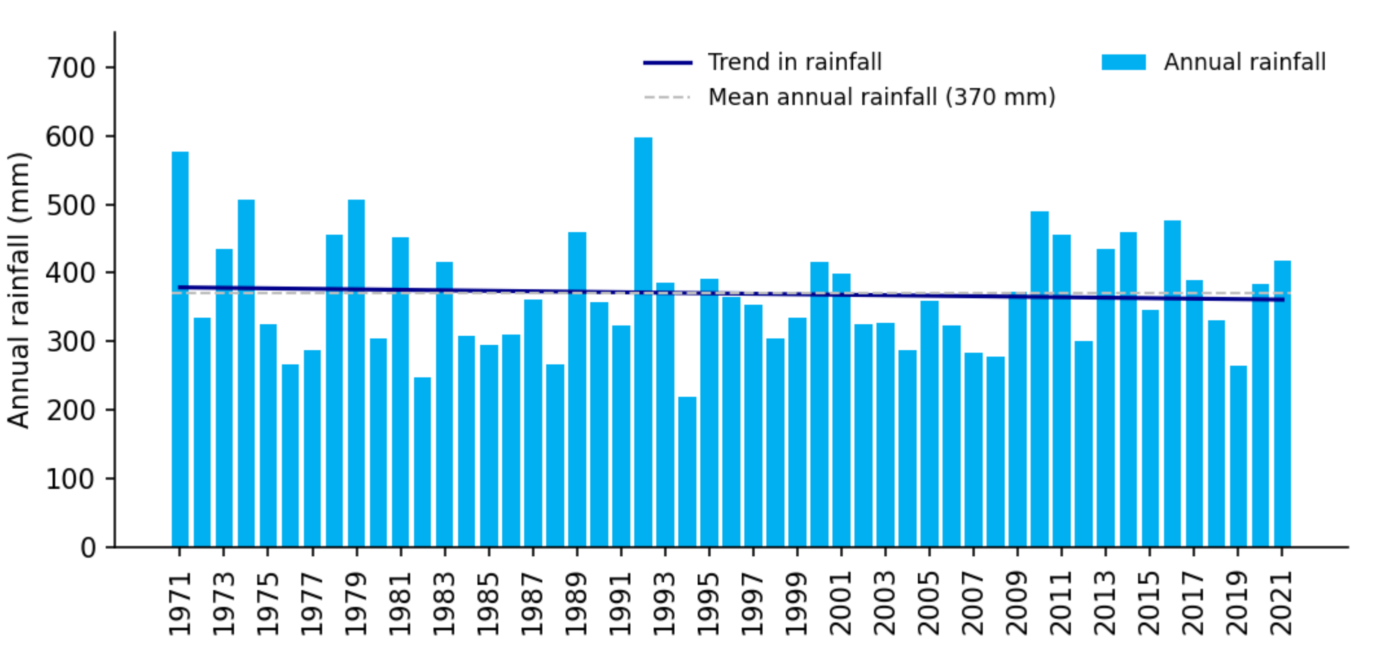


Figure 3.4 Annual rainfall for 1971 to 2021 at the Terrah Winds rainfall station (BoM station 18165)

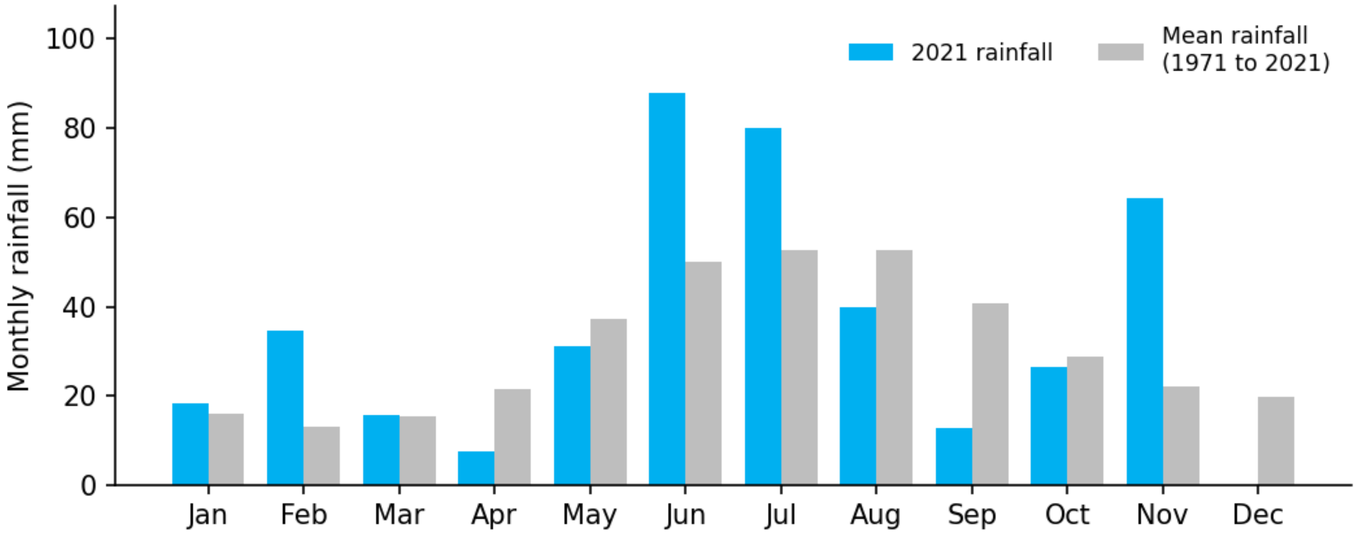


Figure 3.5 Monthly rainfall between January and December 2021 at the Terrah Winds rainfall station (BoM station 18165)

The Polda rainfall station (DEW station A0211001; Figure 1.1Figure 1.2) is located within the Polda consumptive pool in the centre of the Polda lens. Total annual rainfall recorded at the Polda station in 2021 is 397 mm (Figure 3.6), which is 10% (36 mm) higher than the long-term average of 361 mm/y (2010 to 2021). The long-term trend in annual rainfall (2010 to 2021) is declining for this station with four out of the last five years showing below-average annual rainfall (Figure 3.6).

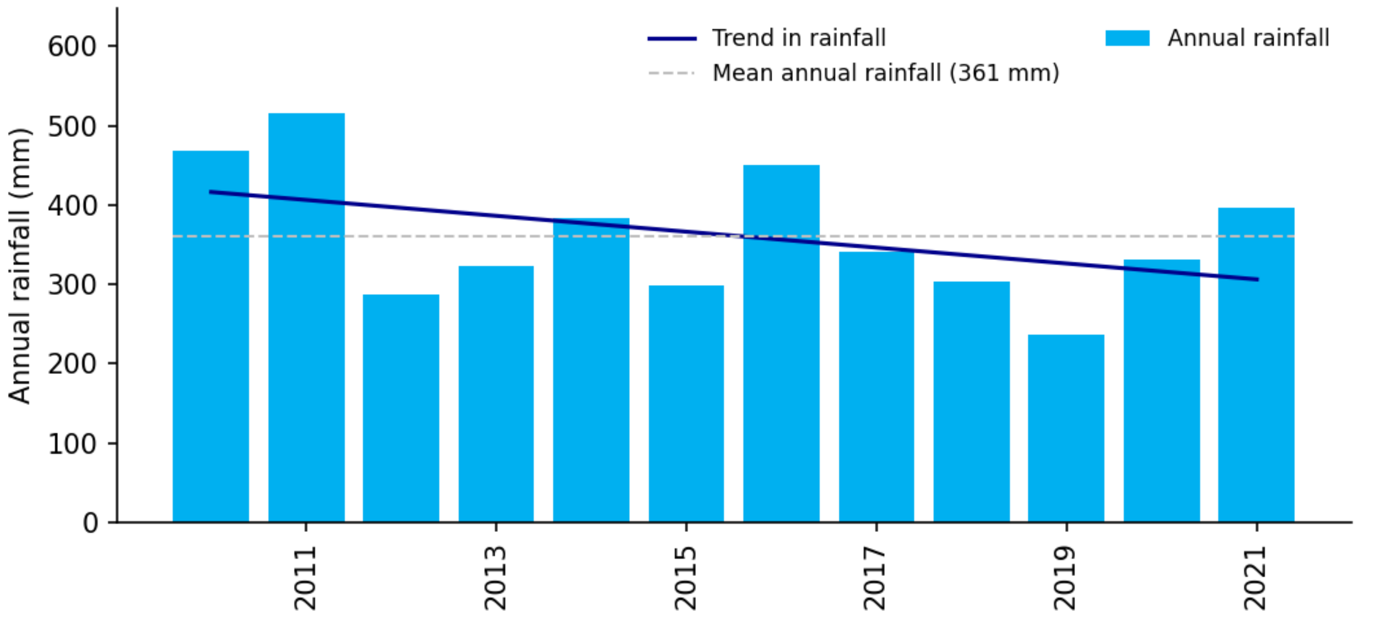


Figure 3.6 Annual rainfall for 2010 to 2021 at the Polda rainfall station (DEW station A0211001)

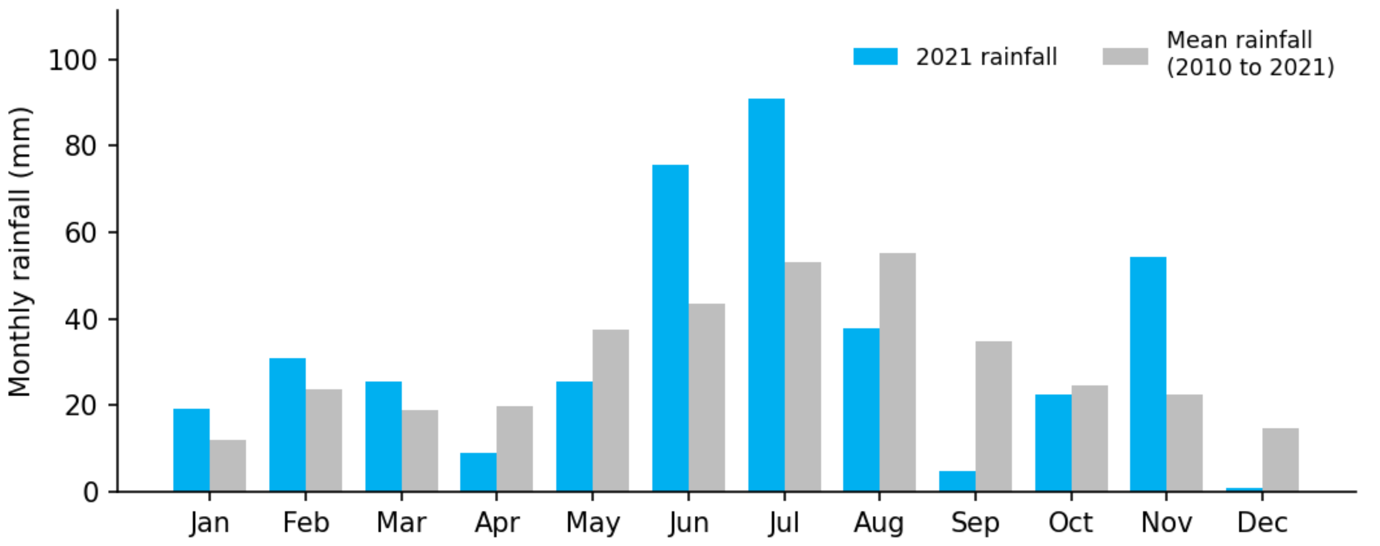


Figure 3.7 Monthly rainfall between January and December 2021 at the Polda rainfall station (DEW station A0211001)

Above-average monthly rainfall is recorded in all the stations during June, July and November 2021 (Figure 3.3, Figure 3.5 and Figure 3.7) with increases ranging from 53% to over 250%. Conversely, below-average rainfall is recorded in all stations during April, September and December 2021 with reductions in monthly rainfall ranging between 43 and 100%. Groundwater levels in the Quaternary Limestone aquifer monitoring well SQR002, which is located near the Polda rainfall station, shows recovery after winter rainfall in 2021 (Figure 3.8).

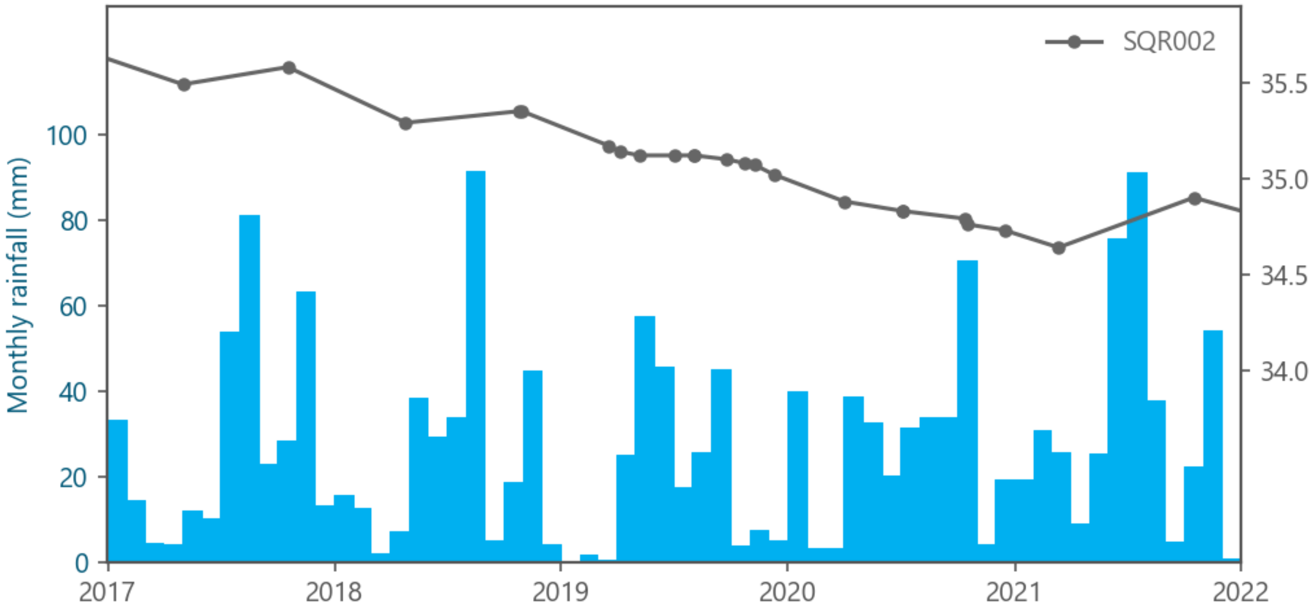


Figure 3.8 **Monthly rainfall between 2017 and 2021 at Polda rainfall station (DEW station A0211001) compared to nearby Quaternary Limestone aquifer levels from SQR002**

3.3 Southern Basins PWA

The Big Swamp rainfall station (BoM station 18017; Figure 1.2) is located halfway between Coffin Bay and Port Lincoln, on the outside northern boundary of the Southern Basins PWA near the Uley Wanilla lens. Total annual rainfall recorded at the Big Swamp in 2021 is 547 mm (Figure 3.9), which is commensurate with the long-term average of 555 mm/y (1971 to 2021). The long-term trend in annual rainfall (1971 to 2021) shows a small decline for this station with three out of the last five years showing below-average annual rainfall (Figure 3.9).

The Westmere rainfall station (BoM station 18137; Figure 1.2) is located in the central part of the Southern Basins PWA towards the southwest of Port Lincoln near Sleaford Bay and on the outside western boundary of the Lincoln South PWS consumptive pool. Total annual rainfall at Westmere in 2021 is 547 mm (Figure 3.11), which is commensurate with the long-term average of 556 mm/y (1971 to 2021). The long-term trend in annual rainfall (1971 to 2021) is declining for this station with three of the past five years showing below-average annual rainfall (Figure 3.11).

Wetter than average conditions are recorded at both stations during February, June, July, October and November 2021 (Figure 3.10 and Figure 3.12) with monthly values ranging between 45% to over 130% more rainfall across the stations. Conversely, drier than average conditions are recorded at both stations during March, April, May, August, September and December 2021 with monthly values ranging between 46% to 100% less rain across the stations.

There are 5 DEW–Landscape South Australia rainfall stations in the Southern Basins PWA (Figure 1.2); three that have been in operation since 2010 and two since 2016.

The stations operating since 2010 are the Coffin Bay Golf Course station, located toward the northwest of the Southern Basins PWA within the Coffin Bay Consumptive pool, the Shoal Point station (DEW station A5121003), located near the coastal cliffs of the Uley South consumptive pool and the Uley Ruins Hole station also located within the Uley South Consumptive Pool (DEW station A5121005). The Coomunga West station (DEW station A5121007), located in the north of the PWA within the Uley Wanilla consumptive pool and the Sleaford East station (DEW station A5121008), located between Westmere station and Tulka on the outside western boundary of the Lincoln South PWS consumptive pool, have been operating since 2016. Annual and monthly charts are presented for the Coffin Bay Golf Course (Figure 3.13 and Figure 3.14) and Shoal Point (Figure 3.15 and Figure 3.16) stations and only the annual averages are reported for the remaining stations.

Total annual rainfall in 2021 is commensurate with the long-term averages for Coffin Bay Golf Course (Figure 3.13) and Shoal Point (Figure 3.15) stations. The remainder of the DEW–Landscape South Australia stations record 24 to 43 mm (5 to 9%) greater than their respective long-term average. The Coffin Bay Golf Course station records 494 mm and the Shoal Point 463 mm in 2021. Total annual rainfall at Uley Ruins Hole, Coomunga West and Sleaford East stations is respectively 478 mm, 556 mm and 505 mm; all three stations are greater than their long-term average.

In 2021, monthly rainfall at the Coffin Bay Golf course station is greater than the long-term average during the months of January, February, June, July, October and November, while the remaining months show below-average monthly rainfall. The monthly rainfall distribution for the Shoal Point station is similar to Coffin Bay golf course station, except in January where rainfall is commensurate with the long-term monthly average (Figure 3.16).

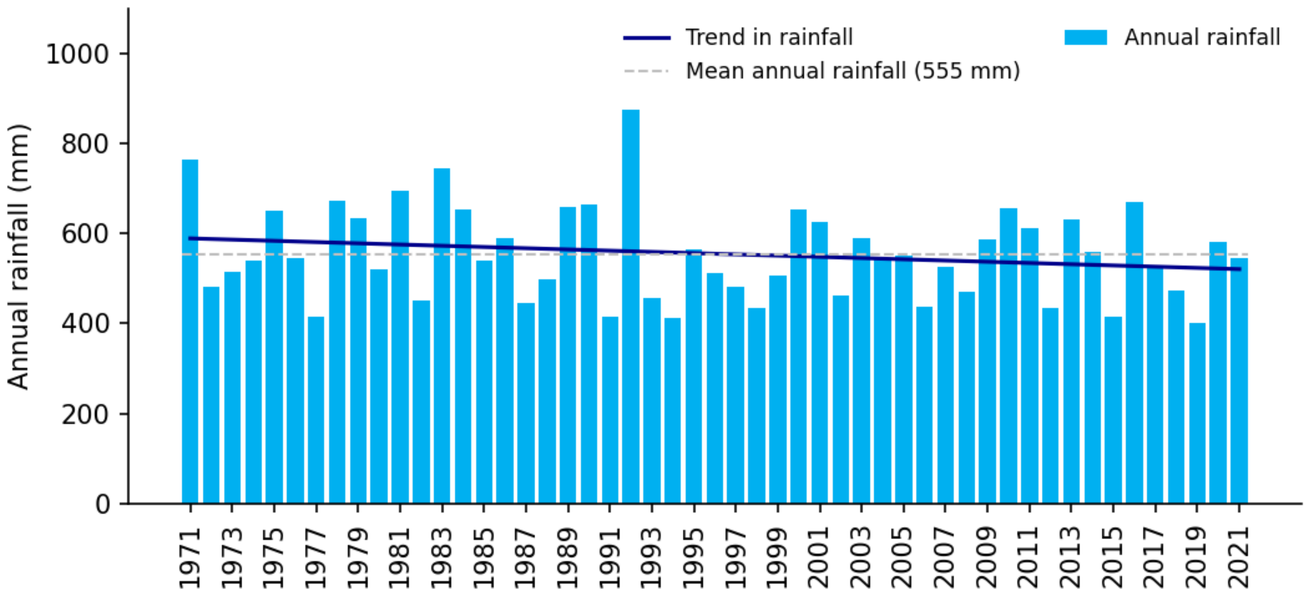


Figure 3.9 Annual rainfall for 1971 to 2021 at the Big Swamp rainfall station (BoM station 18017)

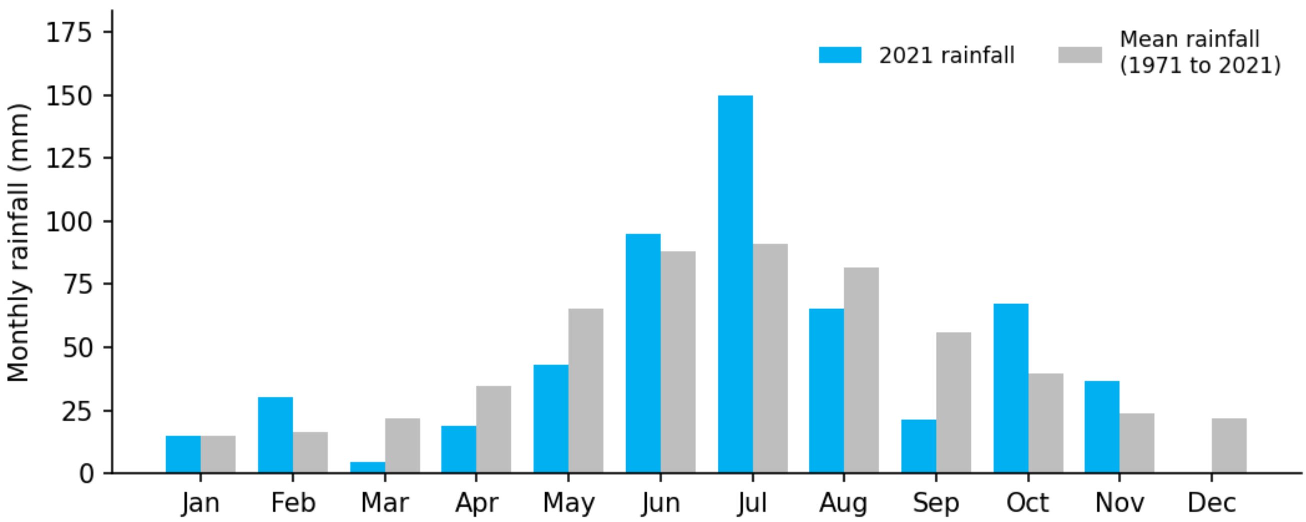


Figure 3.10 Monthly rainfall between January and December 2021 at the Big Swamp rainfall station (BoM station 18017)

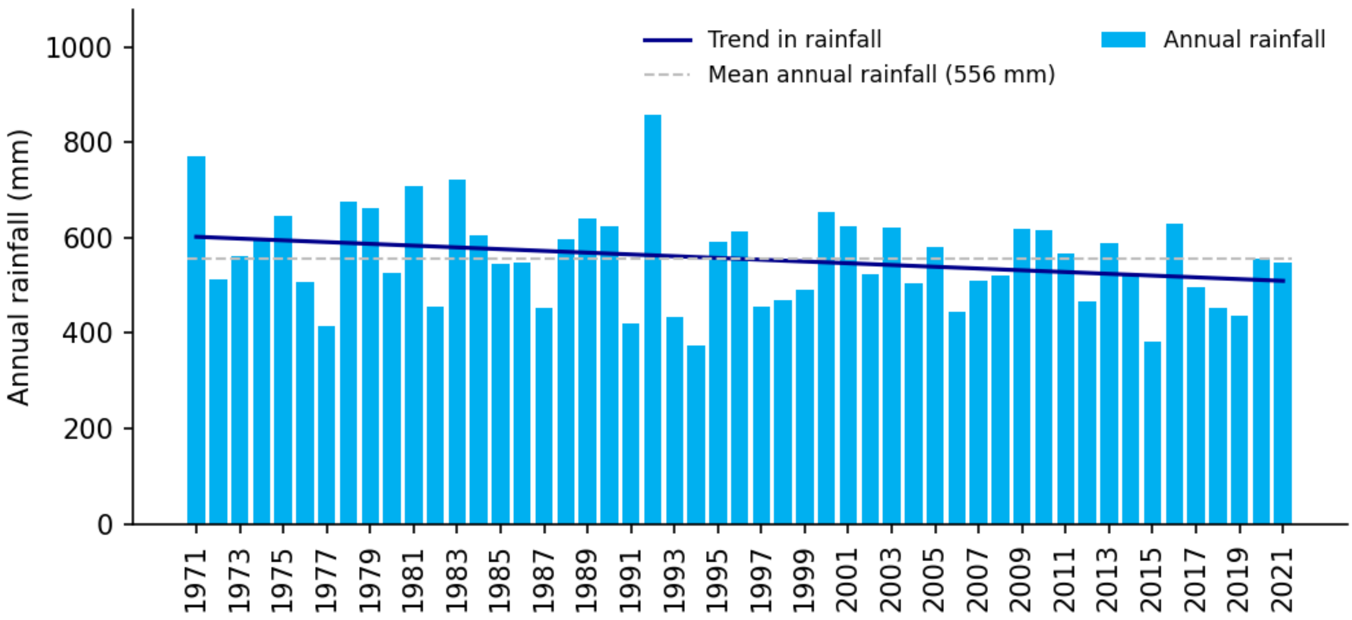


Figure 3.11 Annual rainfall for 1971 to 2021 at the Westmere rainfall station (BoM station 18137)

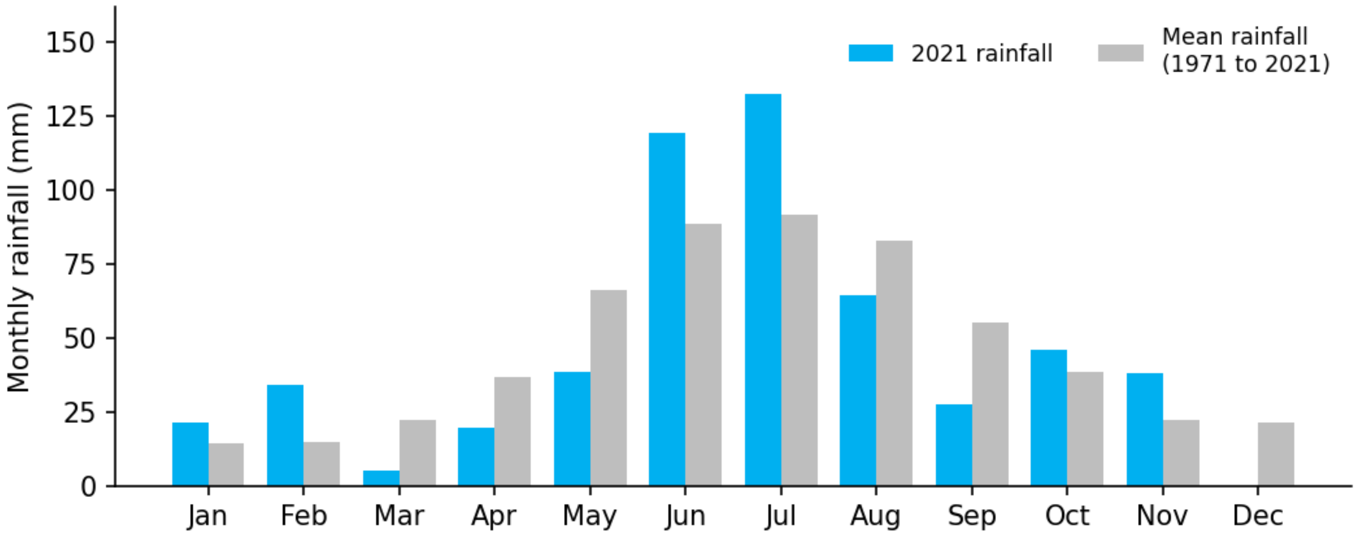


Figure 3.12 Monthly rainfall between January and December 2021 at the Westmere rainfall station (BoM station 18137)

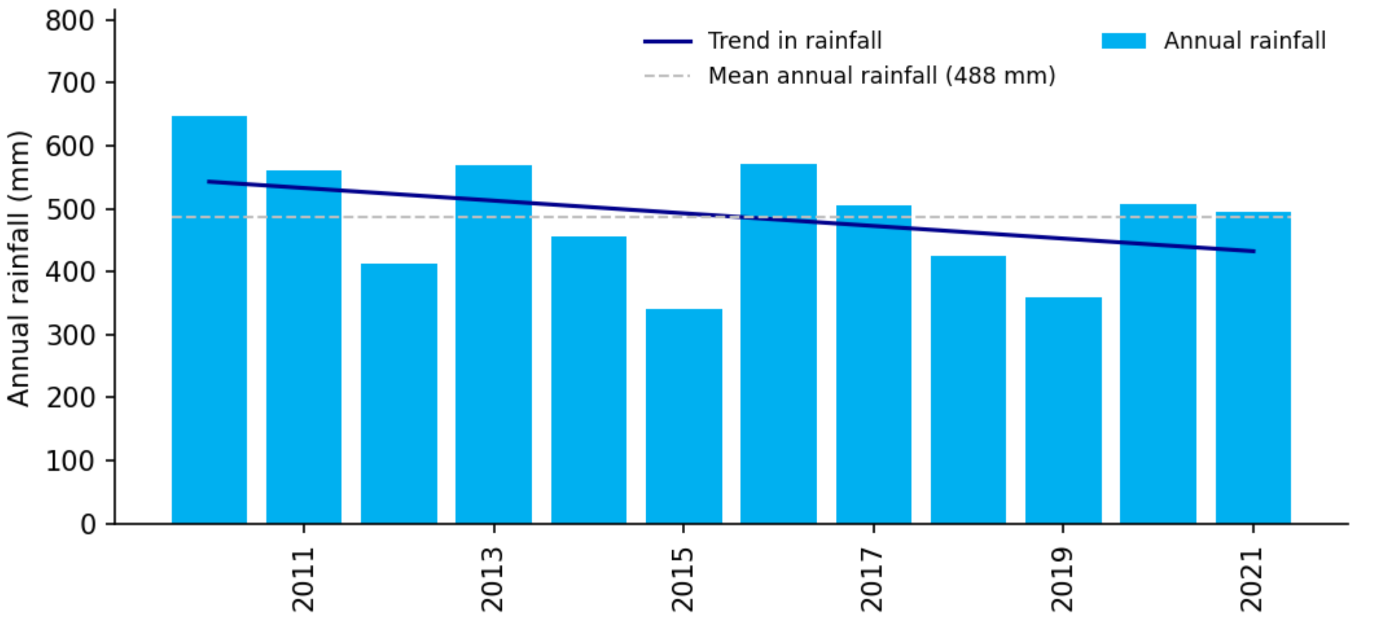


Figure 3.13 Annual rainfall for 2010 to 2021 at the Coffin Bay Golf Course rainfall station (DEW station A5121002)

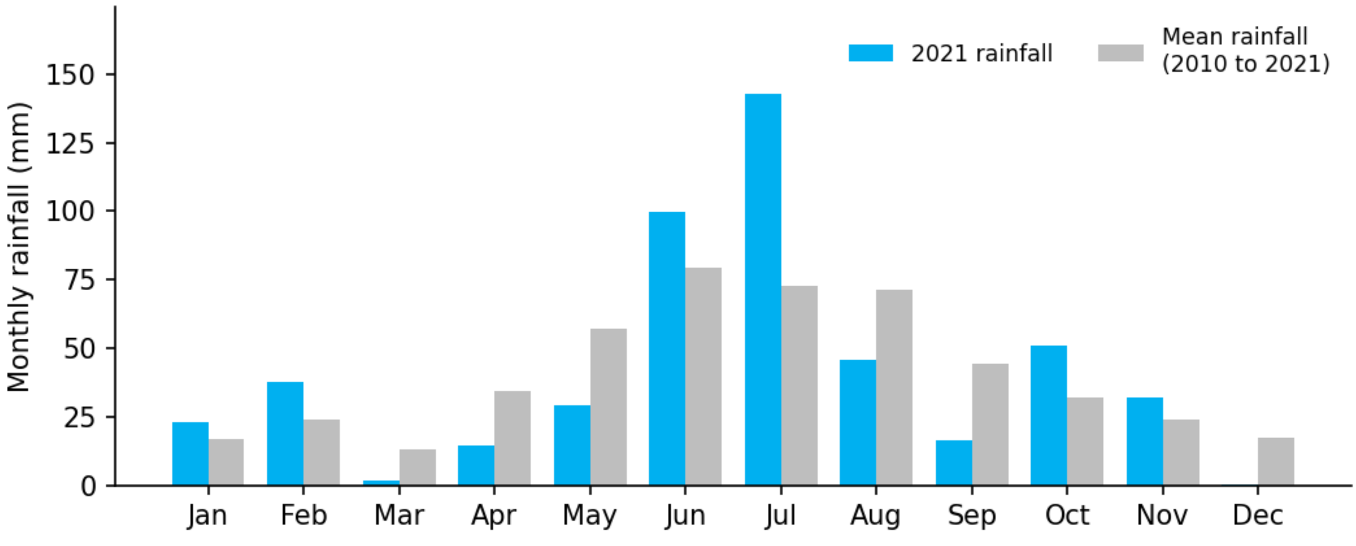


Figure 3.14 Monthly rainfall between January and December 2021 at the Coffin Bay Golf Course rainfall station (DEW station A5121002)

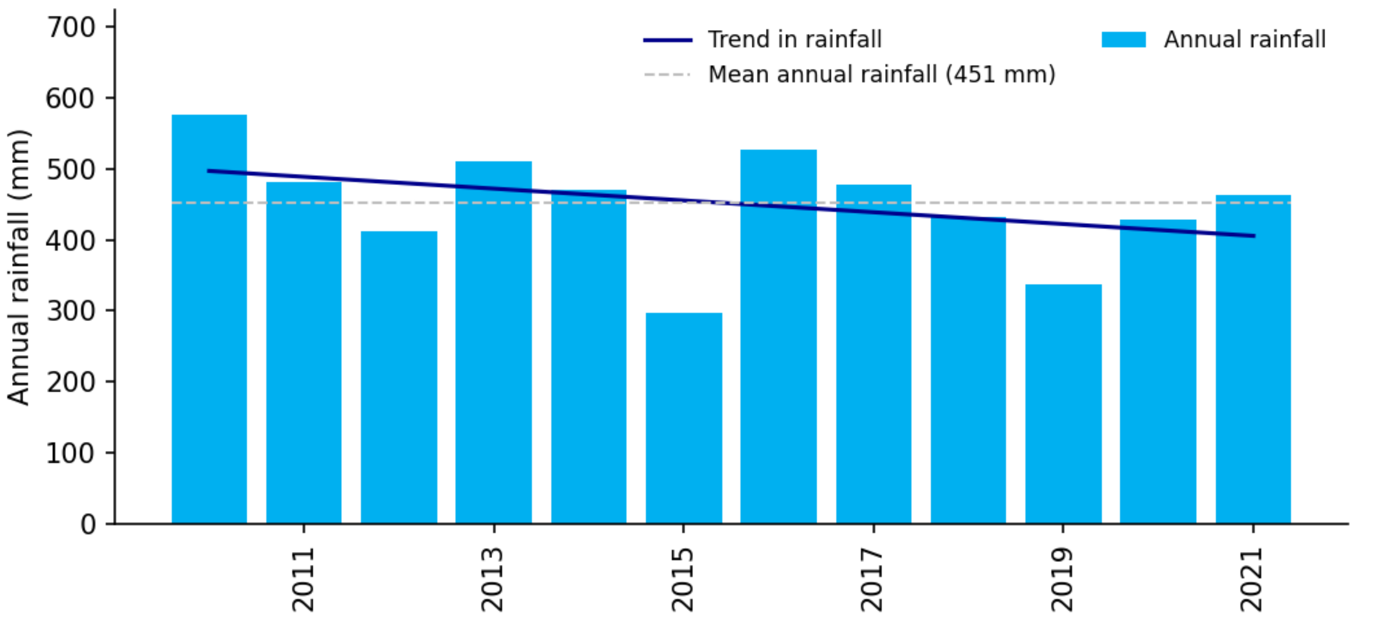


Figure 3.15 Annual rainfall for 2010 to 2021 at the Shoal Point rainfall station (DEW station A5121003)

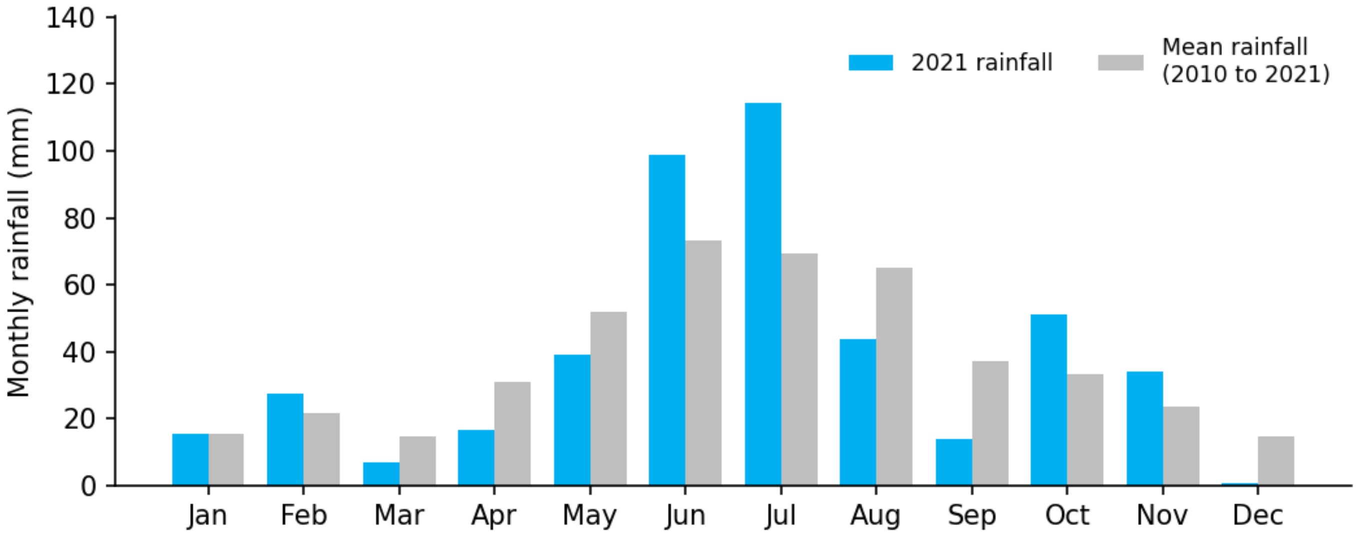


Figure 3.16 Monthly rainfall between January and December 2021 at the Shoal Point rainfall station (DEW station A5121003)

4 Hydrogeology

The Eyre Peninsula is underlain by basement rocks of the Gawler Craton, with limited supplies of fresh groundwater. The only significant sedimentary basin is the Polda Trough, which is located in the Musgrave PWA and has been infilled with Permian, Jurassic and Tertiary sediments during periods of marine transgressions and regressions.

A relatively thin cover of Quaternary and Tertiary sediments occurs across large parts of the western and southern Eyre Peninsula in both the Musgrave and Southern Basins PWAs. Variations in basement topography have led to the development of small basins containing spatially separated fresh groundwater resources in the Quaternary Limestone aquifer. The potable resources in the Quaternary Limestone aquifer are referred to as fresh groundwater lenses and are separated by areas where the saturated thickness of the aquifer is thinner or dry. The Water Allocation Plan defines management zones (i.e., consumptive pools) which extend beyond the physical boundary of the lens(es). There are also underlying Tertiary Sands aquifers and fractured rock aquifers, many of which are low-yielding aquifers and often show higher salinities and consequently, these aquifers are not widely used.

Quaternary Limestone aquifer groundwater levels and salinities in both PWAs are highly responsive to recharge from incident rainfall and trends in groundwater level and salinity are primarily climate driven: below-average rainfall results in a reduction in recharge to the aquifers. Below-average summer rainfall can also result in increasing extractions and when both of these elements are combined, groundwater levels may decline, and salinities may increase. Conversely, above-average rainfall can result in increases in recharge, decreases in extractions and groundwater levels may rise and salinities may stabilise or decrease. Historical rainfall data indicate that trends of above or below-average rainfall can last for up to 25 years and that high-intensity rainfall events can result in rapid groundwater level responses (i.e., recharge).

4.1 Musgrave PWA

In the Musgrave PWA, the Quaternary Limestone aquifer generally comprises a thin veneer of aeolianite sediments of the Bridgewater Formation. These sediments are underlain by thin Tertiary clays and sands of the Uley Formation and Poelpena Formation, which respectively form a thin aquitard and the underlying Tertiary Sands aquifer. Generally, the Tertiary Sands aquifer is of higher salinity than the Quaternary Limestone aquifer and also presents well-development and yield problems due to fine-grained flowing sediments and is not widely used. The thin Tertiary clay aquitard which separates the two aquifers is ubiquitous across the PWA.

The largest Quaternary Limestone fresh groundwater resources in the Musgrave PWA are the Bramfield and Polda lenses, which both have a history of use for town water supply, irrigation and stock and domestic use, with a number of other minor lenses throughout the PWA. However, the primary use across the PWA is for stock and domestic purposes (around 467 ML/y) (Stewart et al. 2012), the vast majority of which is brackish groundwater sourced from the Quaternary Limestone aquifer. The Quaternary Limestone aquifer is also an important water source for groundwater-dependent ecosystems. The main source of recharge to the Quaternary Limestone aquifer is the direct infiltration of incident rainfall, and the direction of groundwater flow is predominantly from the east toward the west and south-west.

4.3 Southern Basins PWA

In the Southern Basins PWA, the Quaternary Limestone aquifer generally comprises aeolianite sediments of the Bridgewater Formation, which is equivalent to the unconfined aquifer in the Musgrave PWA. These sediments are underlain by a layer of Tertiary clays, sands and gravels of the Uley and Wanilla Formations. The Uley Formation acts as a confining layer and aquitard between the Quaternary Limestone and Tertiary Sands aquifers, but it is not present in all locations.

The largest potable groundwater resources in the Southern Basins PWA are freshwater lenses located within the Uley South PWS, Coffin Bay, Uley Wanilla PWS and Lincoln South PWS consumptive pools.

The main source of recharge to the Quaternary Limestone aquifer is the direct infiltration of incident rainfall. Groundwater flows are radial, in directions predominantly towards the coast.

4.4 Musgrave PWA

4.4.1 Bramfield consumptive pool water level

In 2021, winter-recovered water levels in 6 out of 7 (86%) monitoring wells in the Quaternary aquifer of the Bramfield lens in the Musgrave PWA are classified 'Below average' or lower (see Section 2.2.1 for details of the classification; Figure 4.1).

Over the past 30 years, variations in water level in 7 wells range from a decline of 2.79 m to a decline of 0.87 m (median is a decline of 1.8 m).

Five-year trends (2017 to 2021) show declining water levels in the majority of wells (85%), with rates ranging from a decline of 0.39 m/y to no change (median decline of 0.16 m/y; Figure 4.2).

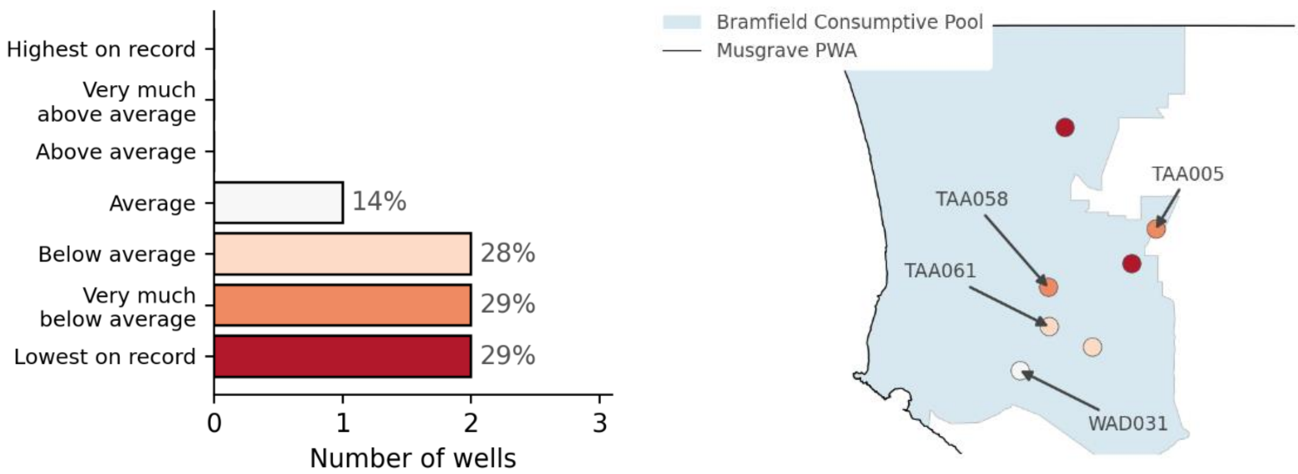


Figure 4.1 2021 winter-recovered water levels for wells in the Quaternary Limestone aquifer in the Bramfield consumptive pool

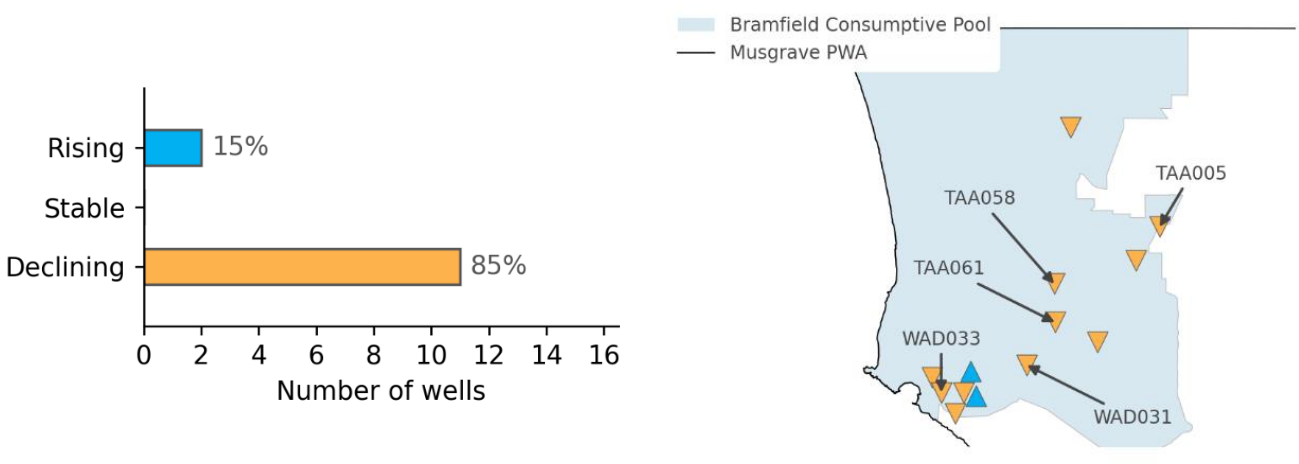


Figure 4.2 2017 to 2021 trend in winter-recovered water levels for wells in the Quaternary Limestone aquifer in the Bramfield consumptive pool

Long-term water level declines have occurred since 1990 in all representative wells in the Quaternary Limestone aquifer in the Bramfield consumptive pool (Figure 4.3). Most wells show their lowest level on record in 2008, during the Millennium Drought (circa 2001 to 2009), following two consecutive years of very low rainfall. TAA005, located on the eastern edge of the Bramfield lens (Figure 4.2) shows its lowest recorded water levels in 1966.

Water levels in all wells showed some recovery following generally above-average rainfall between 2009 to 2013 and 2016 to 2017. However, the extent of water level recovery is greater for those wells nearer the coast e.g., WAD031 and TAA061. More recently, below-average rainfall since 2018 has led to another decline in water levels, and some wells (e.g., TAA058 and TAA005) are approaching water level minima that were measured during the Millennium Drought. The slight rise of water levels in 2021 corresponds with the above-average rainfall in 2021.

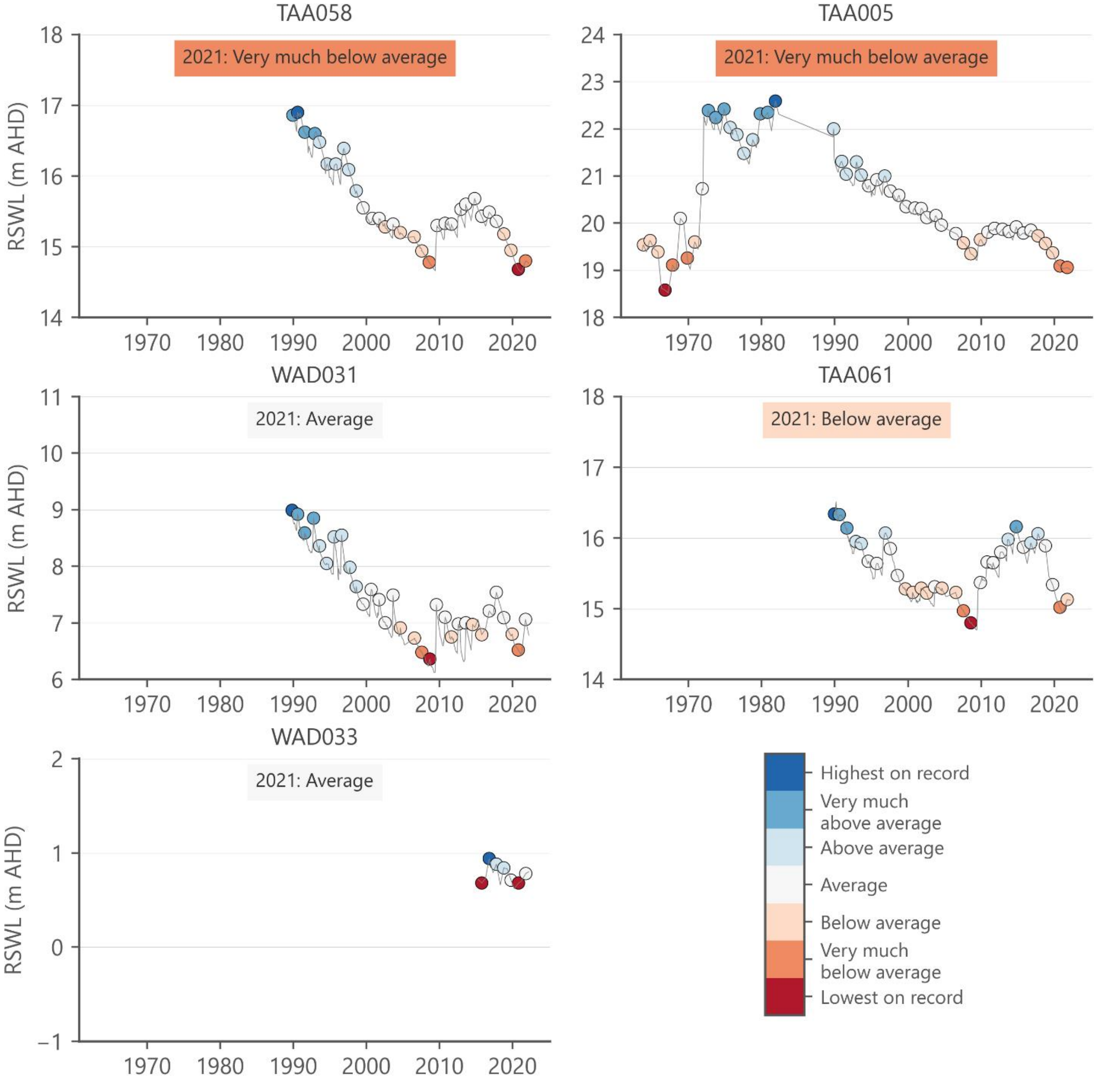


Figure 4.3 Selected hydrographs for wells in the Quaternary Limestone aquifer in the Bramfield consumptive pool

4.4.2 Bramfield consumptive pool salinity

In 2021, sampling results from 8 wells in the Quaternary aquifer of the Bramfield lens in the Musgrave PWA range between 478 mg/L and 1001 mg/L with a median of 550 mg/L (Figure 4.4).

In the ten years to 2021, 3 of 4 wells (75%) show trends of increasing salinity. Ten-year trends show that rates of change in salinity vary from a decrease of 0.6% per year to an increase of 0.5% per year, with a median rate of 0.4% increase per year (Figure 4.5).

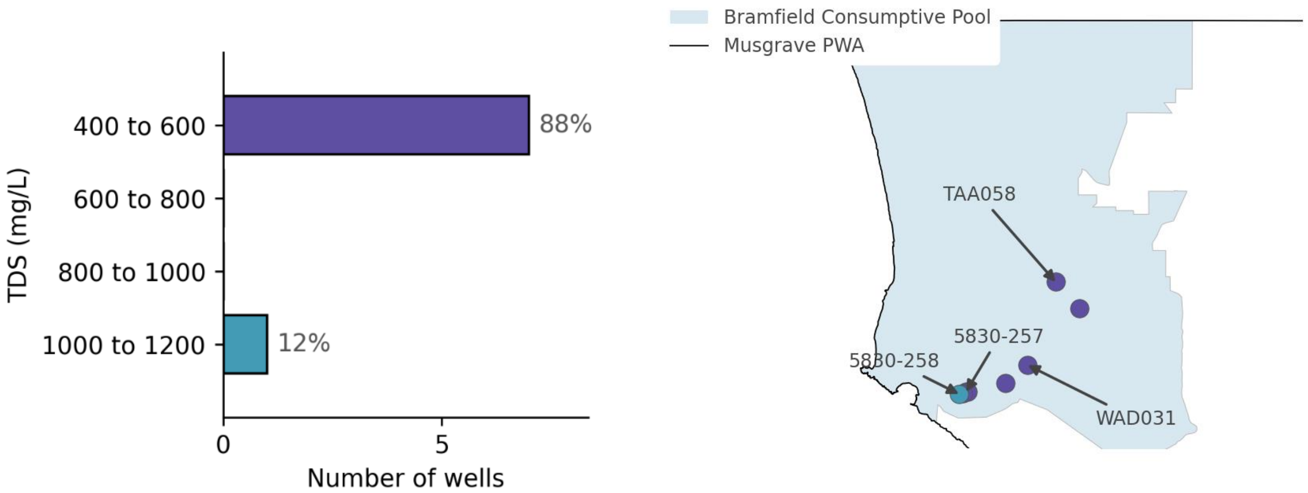


Figure 4.4 2021 salinity observations from wells in the Quaternary Limestone aquifer in the Bramfield consumptive pool

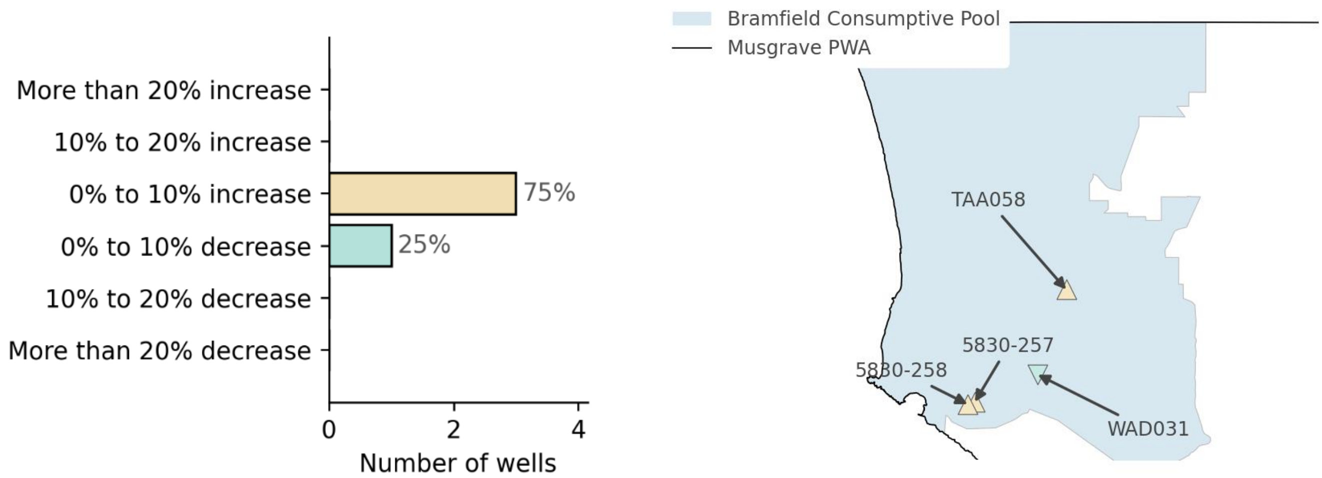


Figure 4.5 Salinity trend in the 10 years to 2021 for wells in the Quaternary Limestone aquifer in the Bramfield consumptive pool

Salinity data for representative wells completed in the Quaternary Limestone aquifer in the Bramfield area (Figure 4.6) show gradual increases in salinity since 2010 (e.g., 5830-257 and 5830-258).

Observation well WAD031 is located in the township of Bramfield while TAA058 is located to the north-east of Bramfield. Both WAD031 and TAA058 show relatively stable groundwater salinity despite declines in water level since 2017 and 2014, respectively (Figure 4.3).

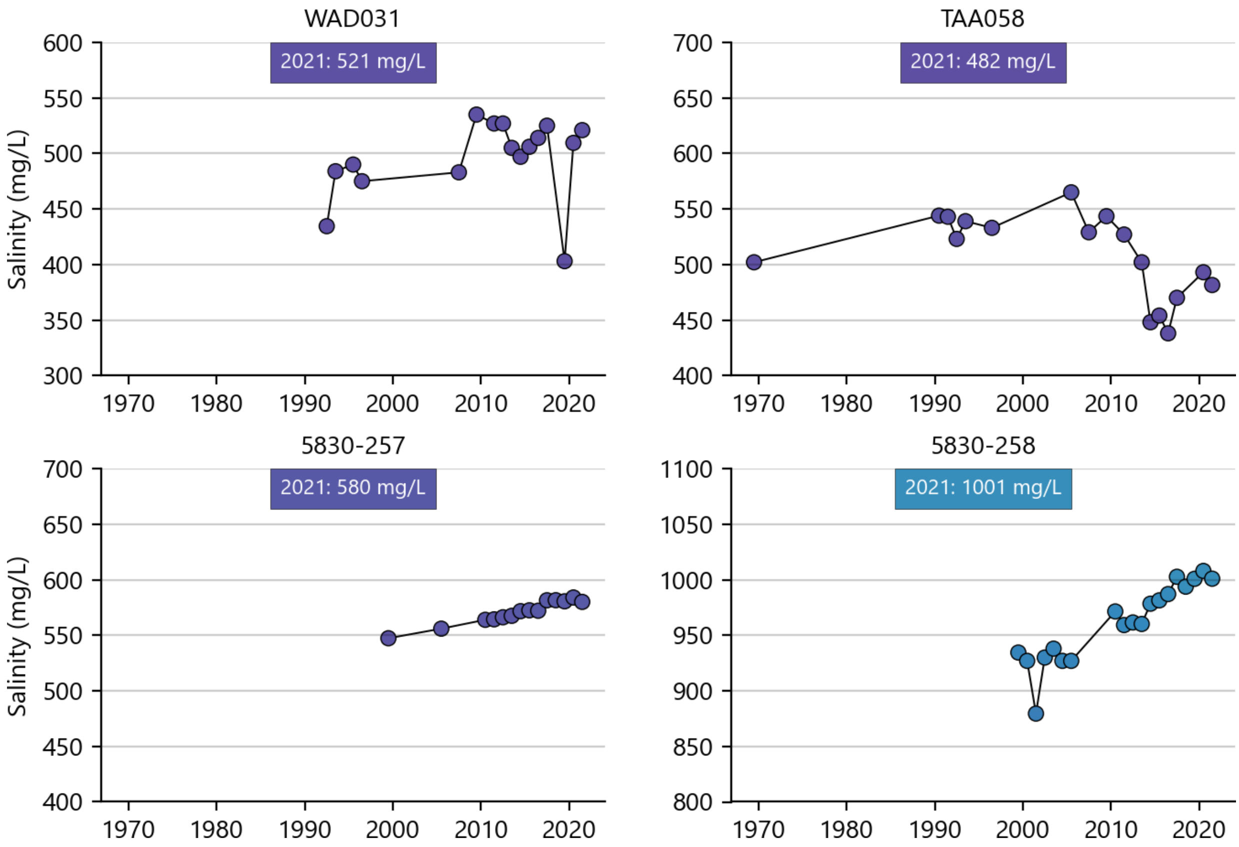


Figure 4.6 Selected salinity graphs for wells in the Quaternary Limestone aquifer in the Bramfield consumptive pool

4.4.3 Polda consumptive pool water level

In 2021, winter-recovered water levels in 32 out of 33 (97%) monitoring wells in the Quaternary aquifer of the Polda lens in the Musgrave PWA are classified as 'Below average' or lower (Figure 4.7).

Over the past 30 years, variations in water level in 33 wells range from a decline of 2.06 m to a decline of 0.68 m (median is a decline of 1.3 m).

Five-year trends show declining water levels in most wells (97%), with rates of decline ranging between 0.24 to 0.01 m/y (median is a decline of 0.18 m/y; Figure 4.8).

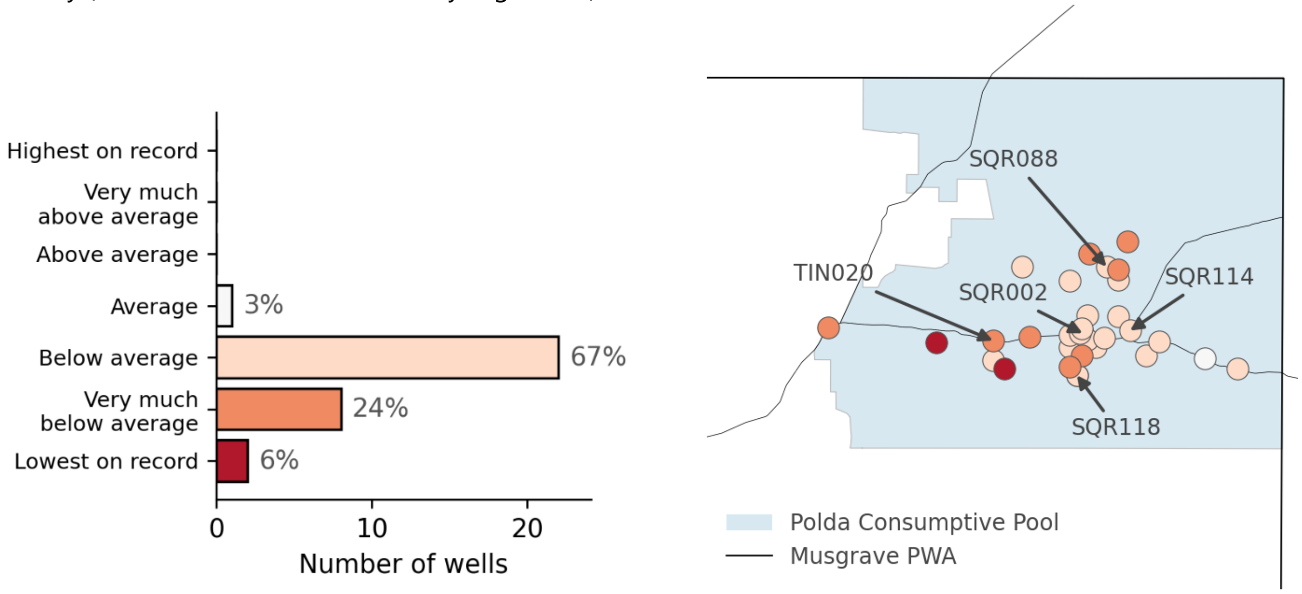


Figure 4.7 **2021 winter-recovered water levels for wells in the Quaternary Limestone aquifer in the Polda consumptive pool**

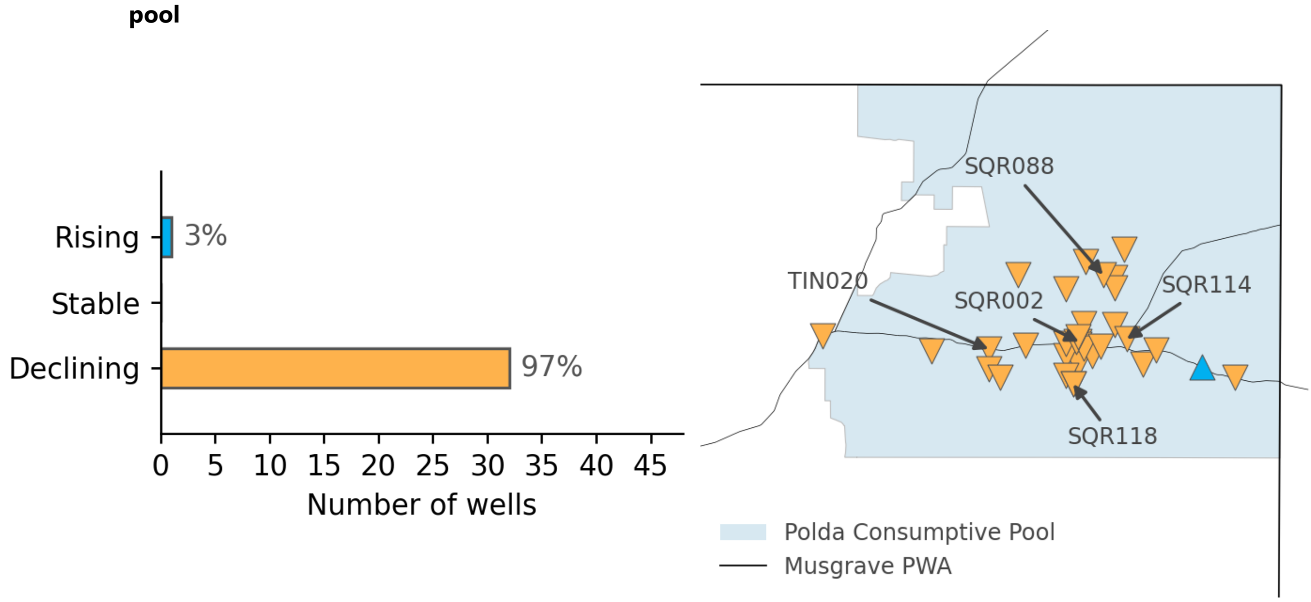


Figure 4.8 **2017 to 2021 trend in winter-recovered water levels for wells in the Quaternary Limestone aquifer in the Polda consumptive pool**

Almost all Quaternary Limestone aquifer wells in the Polda consumptive pool reached their lowest level on record towards the end of the Millennium Drought in 2009 (e.g., see representative wells below, Figure 4.9). Widespread recovery in water levels between 2010 and 2017 corresponds with above-average rainfall in five of seven years (2010 to 2016) at Terrah Winds (BoM Station 18165, Figure 3.4).

Water levels have declined for all wells throughout 2018 to 2020 despite good winter rainfall in 2018. In 2021, most monitoring wells show a rise or stable water levels compared to the levels in 2020.

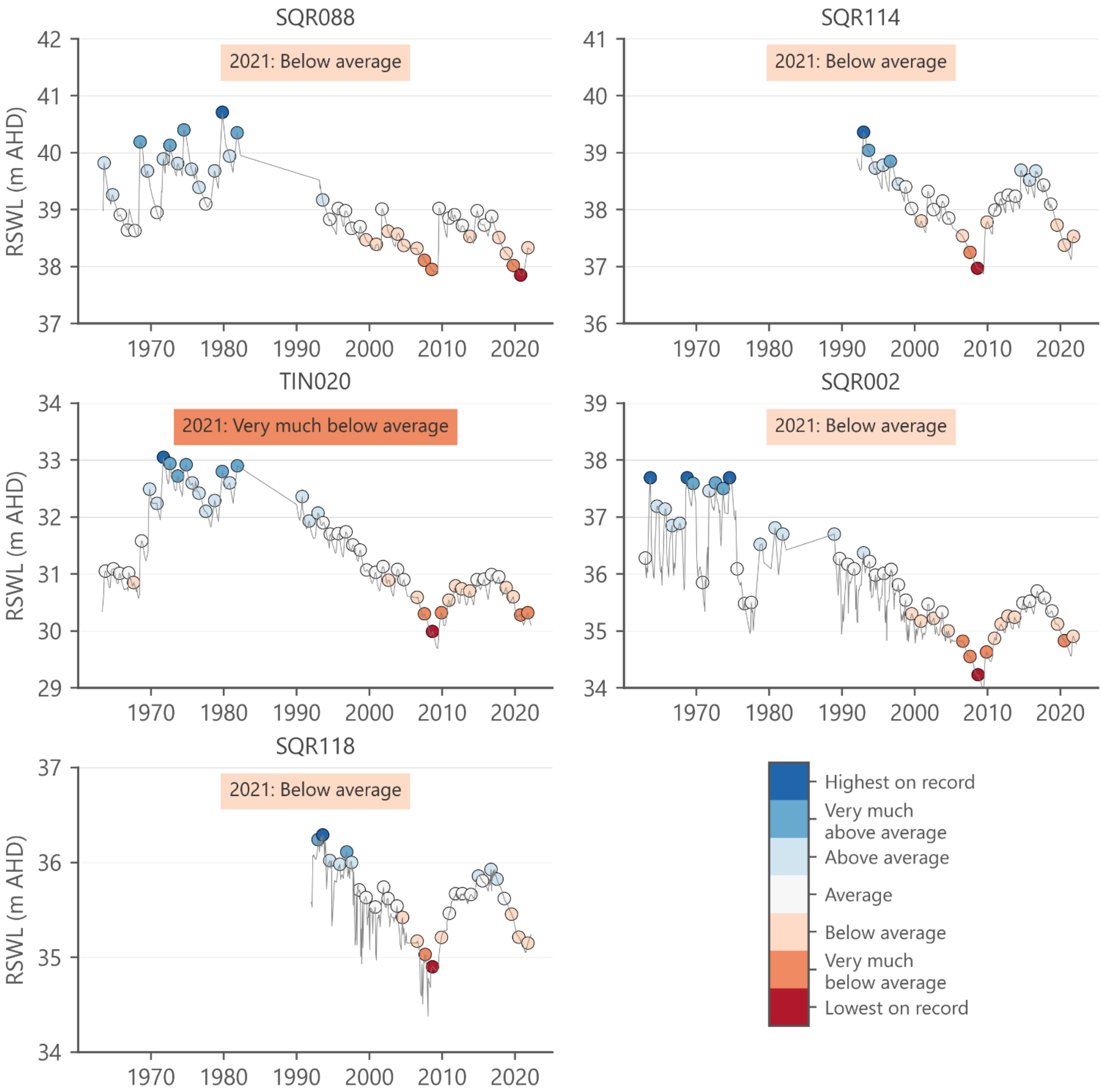


Figure 4.9 Selected hydrographs for wells in the Quaternary Limestone aquifer in the Polda consumptive pool

4.4.4 Polda consumptive pool salinity

In 2021, sampling results from 18 wells in the Quaternary aquifer of the Polda lens in the Musgrave PWA range between 512 mg/L and 3364 mg/L with a median of 860 mg/L (Figure 4.10).

In the ten years to 2021, 9 of 14 wells (65%) show trends of increasing salinity. Ten-year trends show that rates of change in salinity vary from a decrease of 3.0% per year to an increase of 1.5% per year, with a median rate of 0.3% increase per year (see Section 2.2.2 for details of the calculation; Figure 4.11).

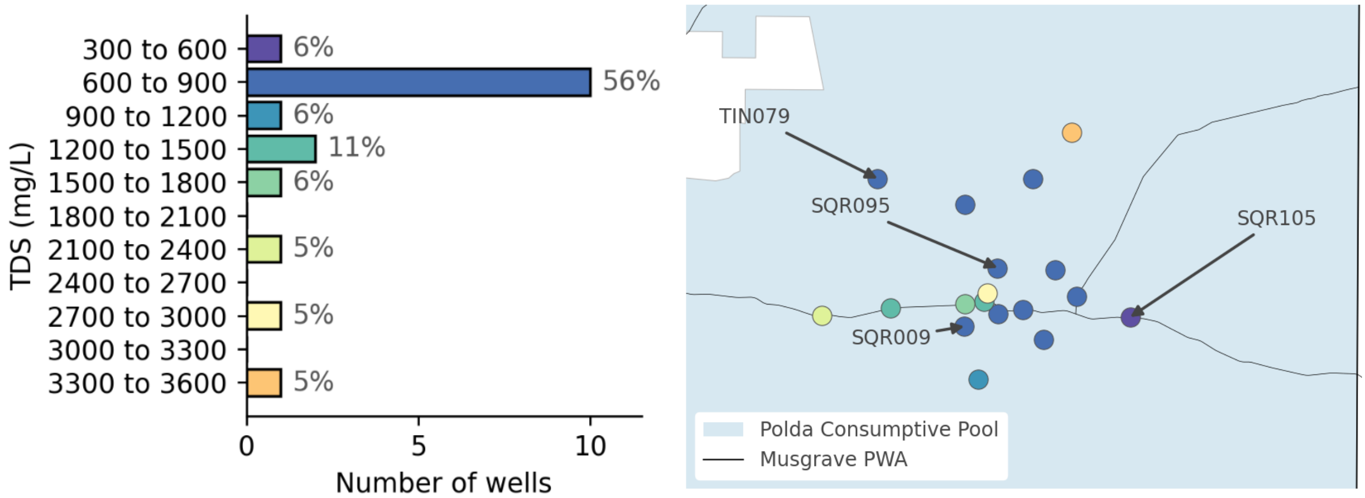


Figure 4.10 2021 salinity observations from wells in the Quaternary Limestone aquifer in the Polda consumptive pool

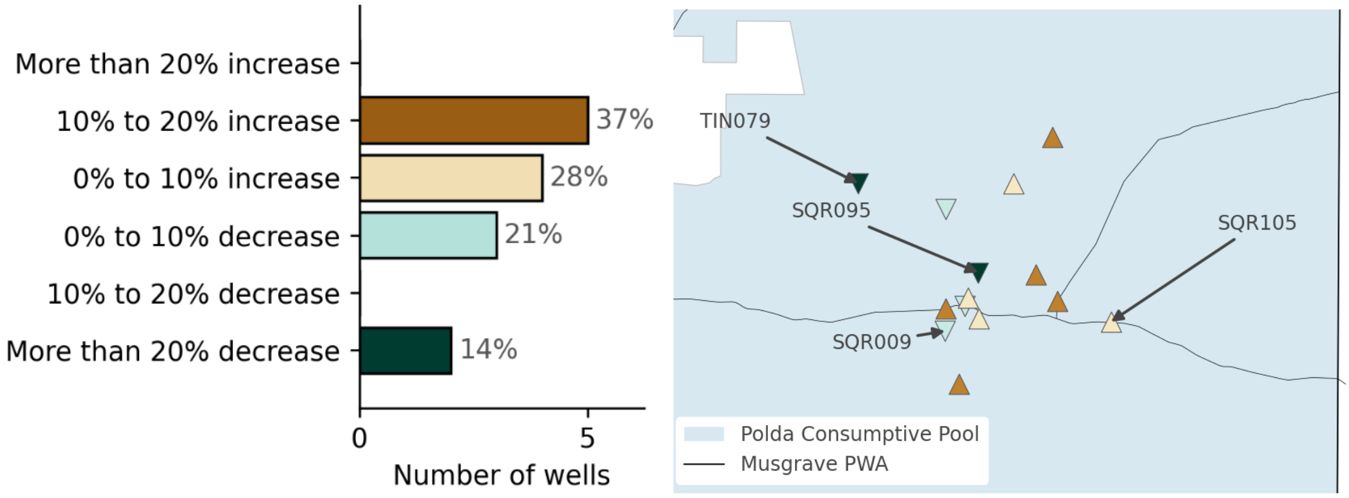


Figure 4.11 Salinity trend in the 10 years to 2021 for wells in the Quaternary Limestone aquifer in the Polda consumptive pool

Aquifer salinity measured from Quaternary Limestone aquifer monitoring wells in the Polda consumptive pool are generally low (representative wells are shown in Figure 4.12). Observation wells SQR009 and SQR105 show stable salinity over the past 10 years. TIN079 and SQR095 show aquifer freshening following above-average rainfall during 2010 to 2016, following the Millennium Drought that concluded in 2009.

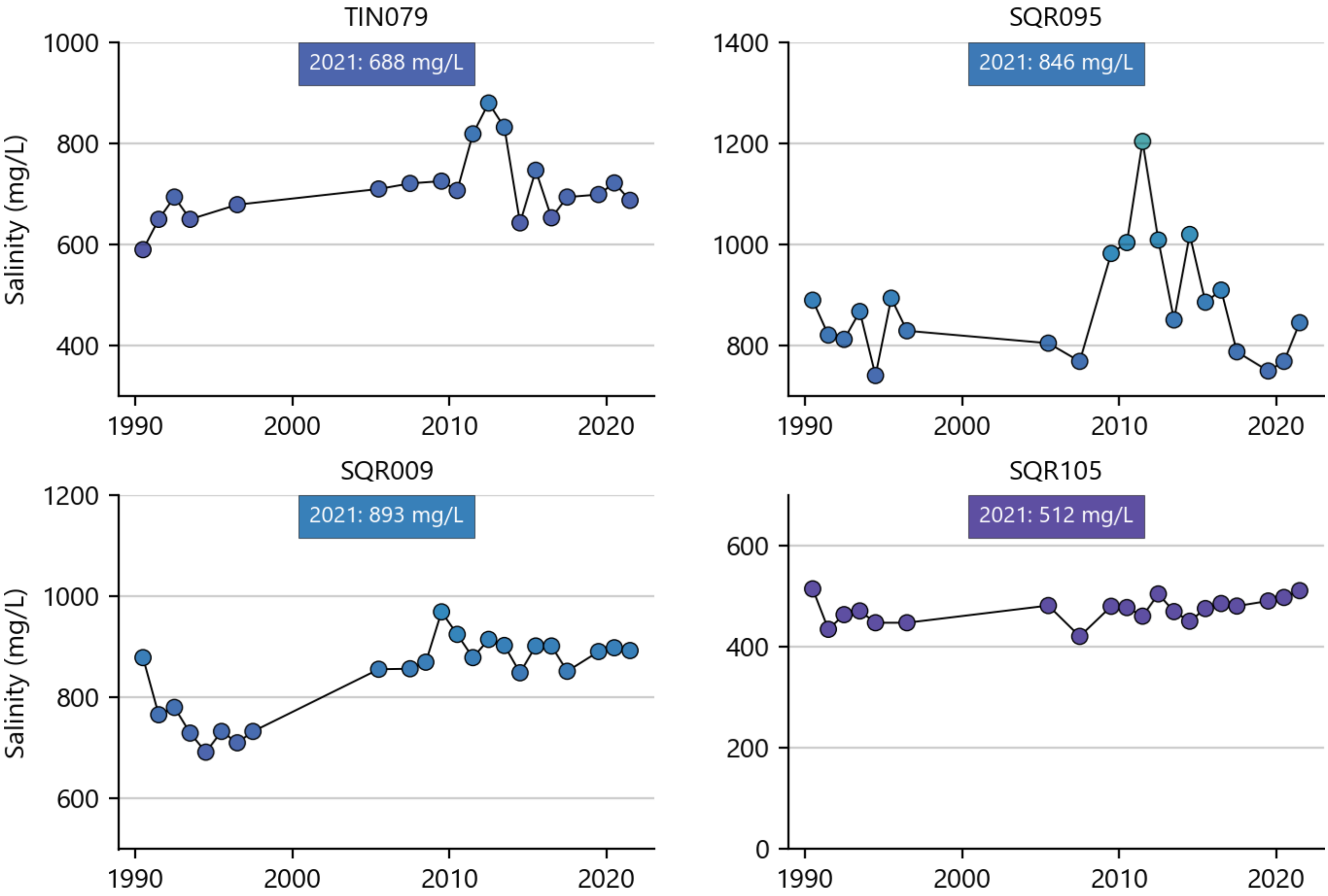


Figure 4.12 Selected salinity graphs for wells in the Quaternary Limestone aquifer in the Polda consumptive pool

4.5 Southern Basins PWA

4.5.1 Coffin Bay consumptive pool water level

In 2021, winter-recovered water levels in 5 out of 7 (71%) monitoring wells in the Quaternary aquifer of the Coffin Bay lens in the Southern Basins PWA are classified as 'Above average' or higher (Figure 4.13).

Over the past 30 years, variations in water level in 5 wells range from a decline of 0.06 m to a rise of 0.21 m (median change is a rise of 0.04 m).

Five-year trends show rising water levels in the majority of wells (67%), with rates of rise ranging between 0.01 to 0.04 m/y (median is a rise of 0.01 m/y, Figure 4.14).

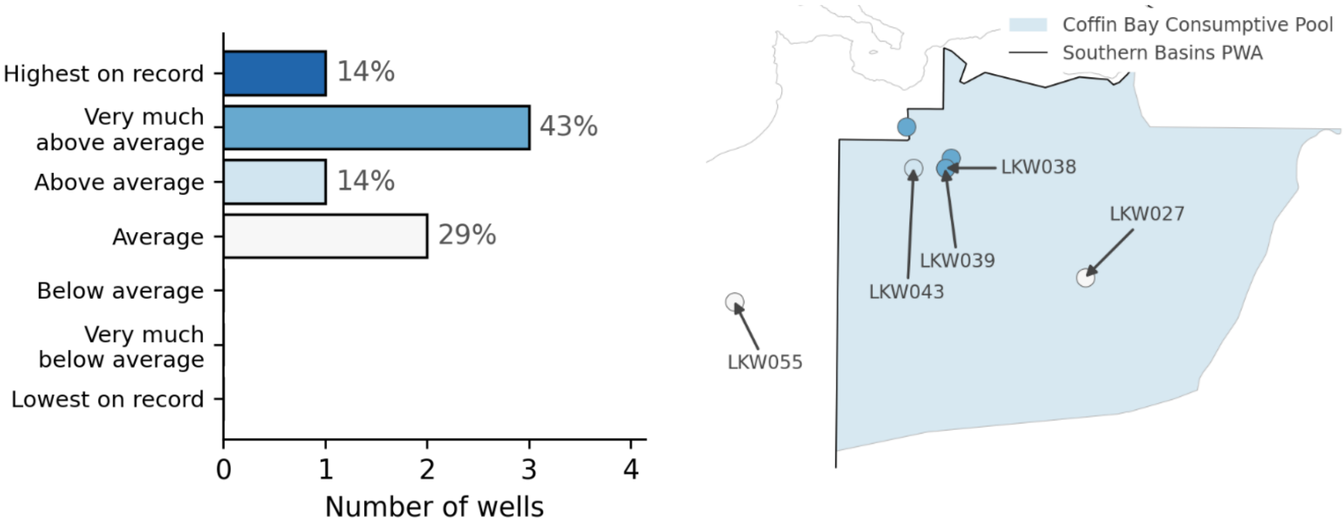


Figure 4.13 2021 winter-recovered water levels for wells in the Quaternary Limestone aquifer for the Coffin Bay consumptive pool

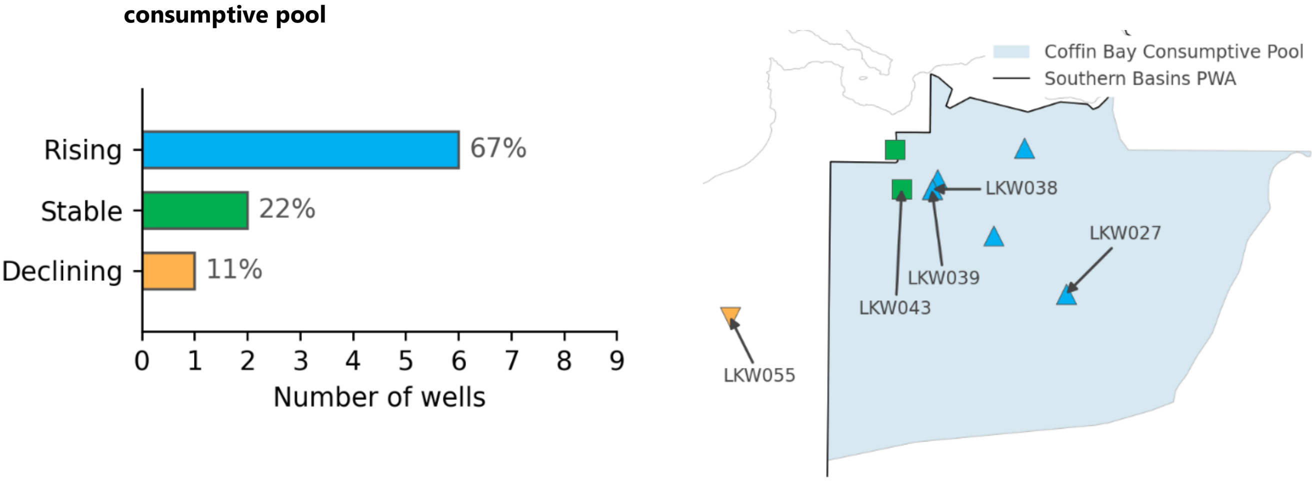


Figure 4.14 2017 to 2021 trend in winter-recovered water levels for wells in the Quaternary Limestone aquifer for the Coffin Bay consumptive pool

Representative Quaternary Limestone aquifer monitoring wells for the Coffin Bay consumptive pool (Figure 4.15) include LKW038 and LKW039, which are located within the wellfield that supplies public water supply to the township of Coffin Bay. Water levels in both wells are stable over the past thirty years. Water levels that are classified 'Lowest on record' for both wells in 2006 coincide with below-average rainfall at Westmere and Big Swamp stations.

LKW043 and LKW055 are located in the western part of the Coffin Bay area (Figure 4.14) and also show generally stable water levels. LKW027 is located at a higher elevation to the south-east., where the direction of groundwater flow is generally to the north-west. Water levels were typically classified 'Above average' or greater prior to 1992 but have subsequently declined to 'Average' or 'Below average'. In 2021. Most monitoring wells record a rise in water levels that corresponds with the above average rainfall in 2021.

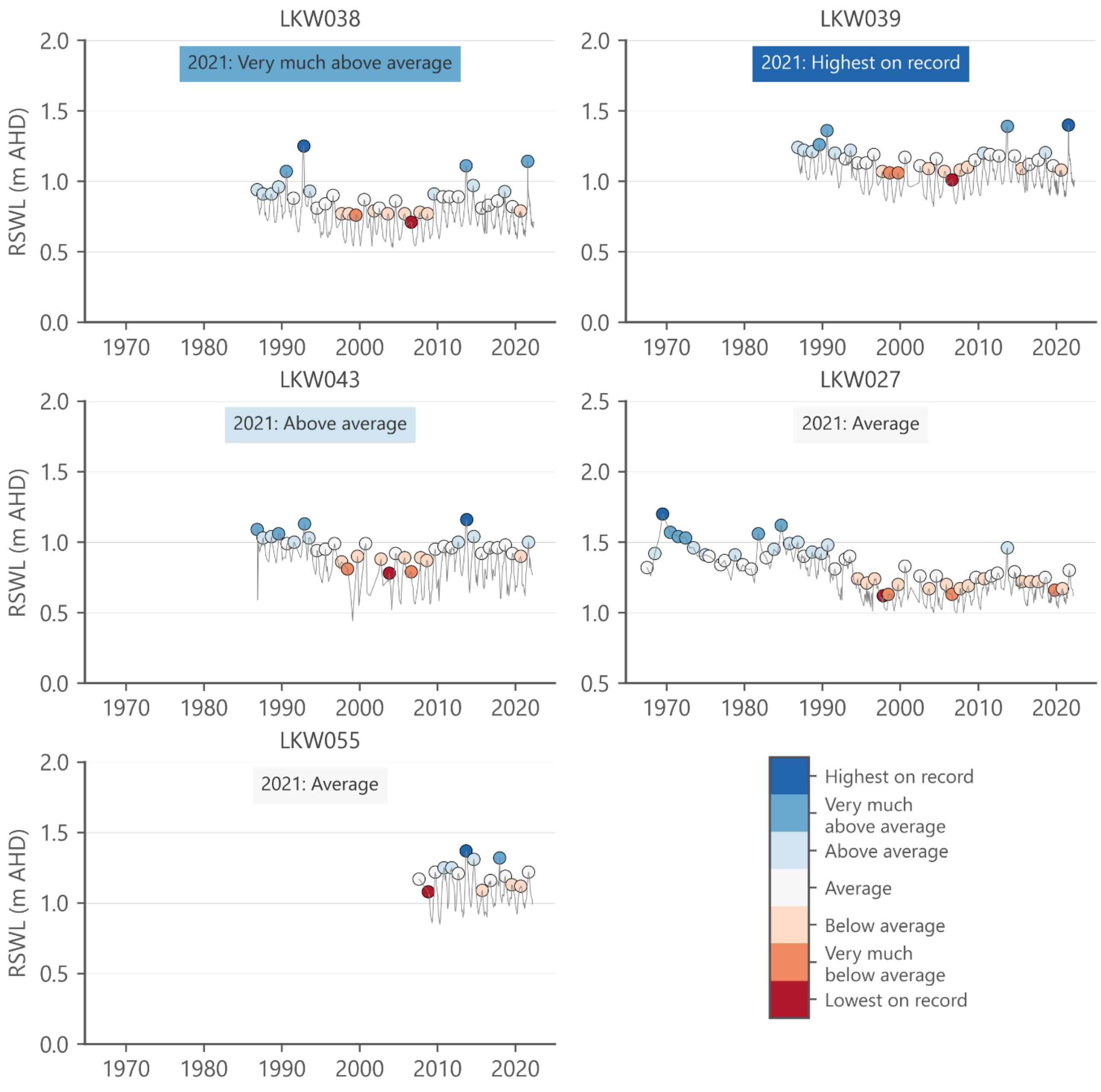


Figure 4.15 Selected hydrographs for wells in the Quaternary Limestone aquifer in the Coffin Bay consumptive pool

4.5.2 Coffin Bay consumptive pool salinity

In 2021, sampling results from 9 wells in the Quaternary aquifer of the Coffin Bay lens in the Southern Basins PWA range between 346 mg/L and 1,116 mg/L with a median of 427 mg/L (Figure 4.16). The majority of salinity monitoring wells are located within the Coffin Bay public water supply wellfield.

In the ten years to 2021, all wells show trends of increasing salinity (Figure 4.17). Ten-year trends show that rates of change in salinity vary from an increase of 0.2 to 1.2% per year, with a median rate of 0.4% increase per year.

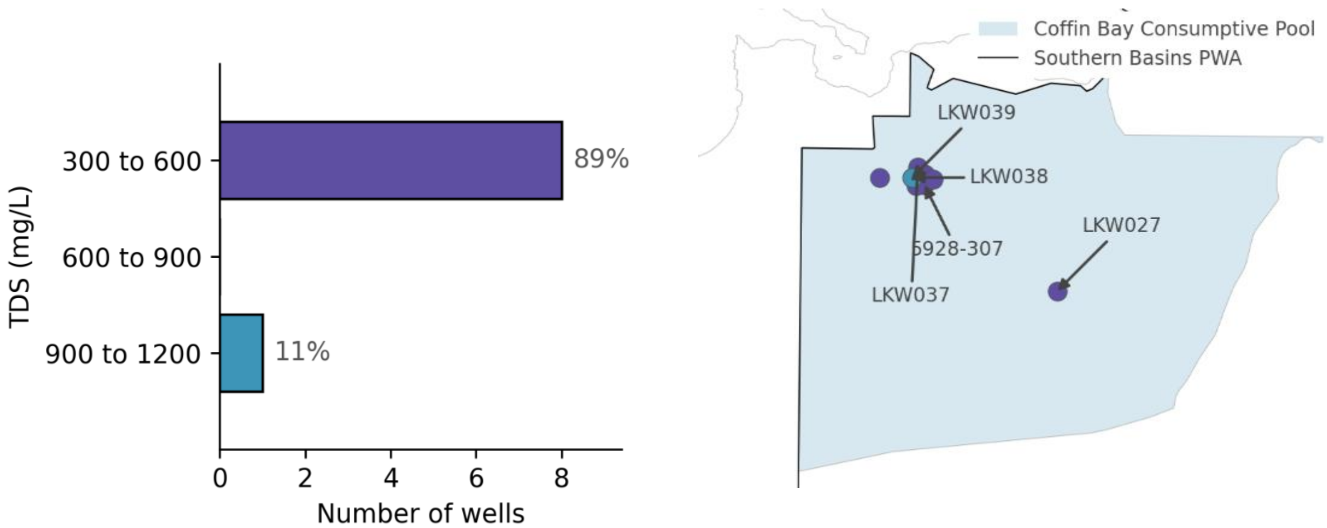


Figure 4.16 2021 salinity observations from wells in the Quaternary Limestone aquifer in the Coffin Bay consumptive pool

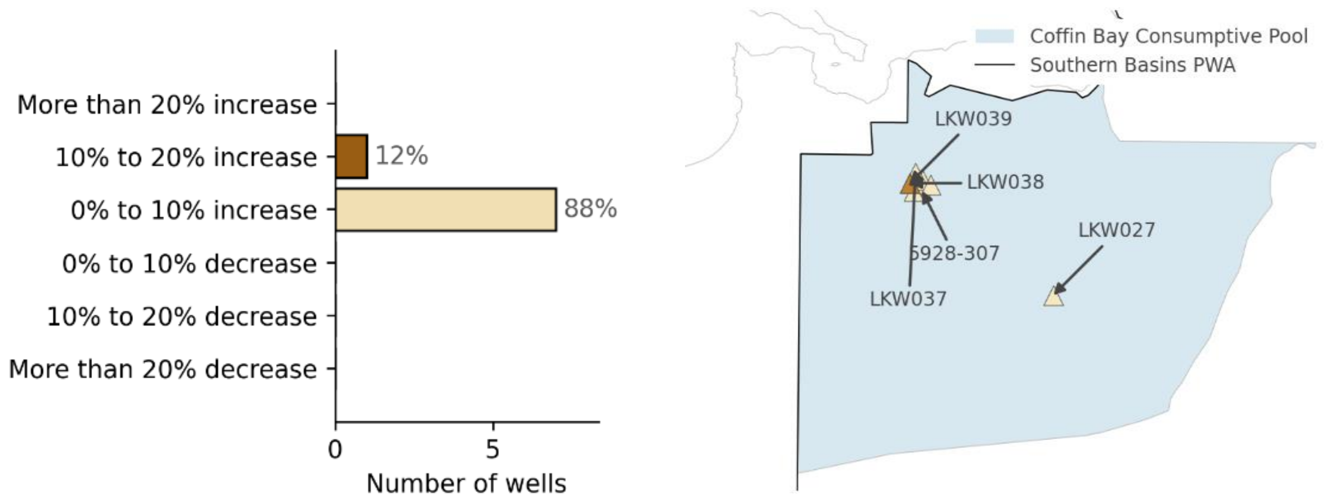


Figure 4.17 Salinity trend in the 10 years to 2021 for wells in the Quaternary Limestone aquifer in the Coffin Bay consumptive pool

Representative Quaternary Limestone aquifer monitoring wells in the Coffin Bay area (Figure 4.18) show generally stable groundwater salinity over the past 30 years.

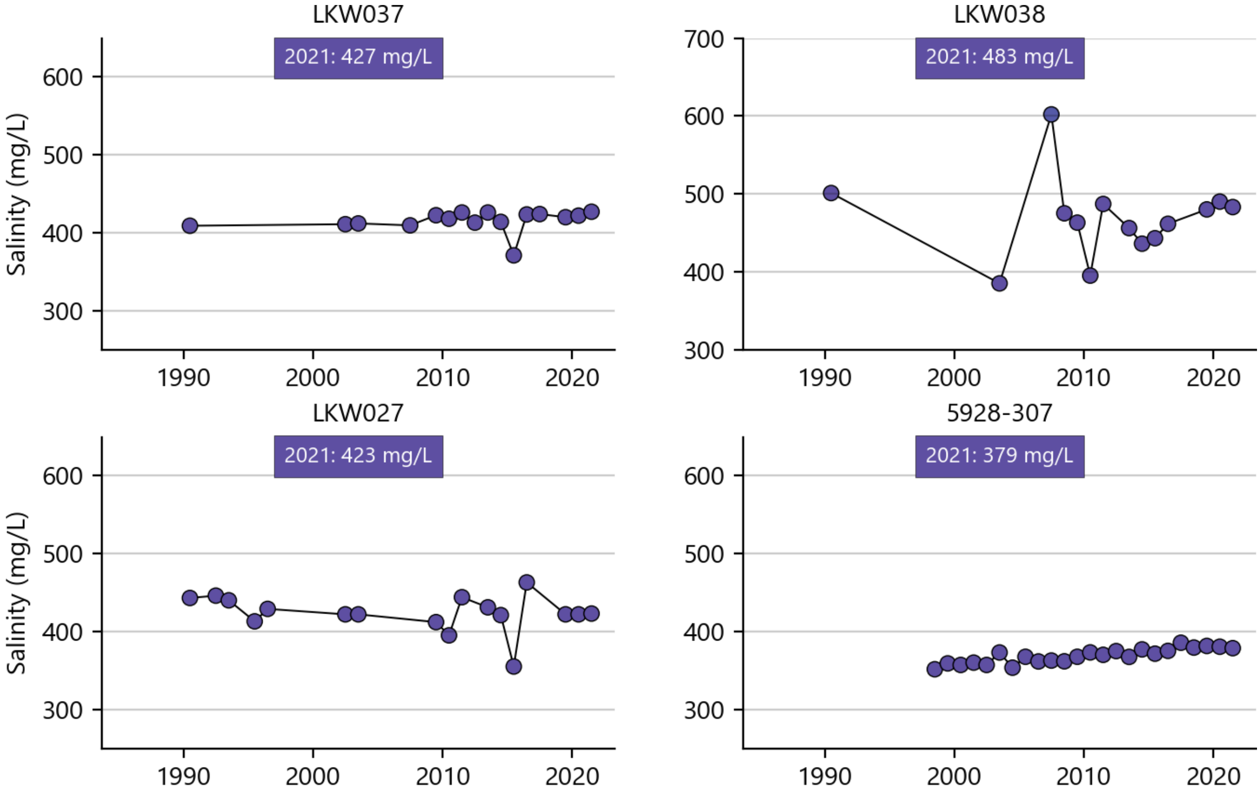


Figure 4.18 Selected salinity graphs for wells in the Quaternary Limestone aquifer in the Coffin Bay consumptive pool

4.5.3 Uley South PWS consumptive pool water level

In 2021, winter-recovered water levels in 20 out of 38 (53%) monitoring wells in the Quaternary aquifer of the Uley South lens in the Southern Basins PWA are classified as 'Below average' or lower (Figure 4.19) and 15 out of 38 (39%) wells are classified 'Average'. (See Section 2.2.1 for details of the classification.)

Over the past 30 years, variations in water level in 25 wells range from a decline of 1.64 m to a decline of 0.78 m (median is a decline of 1.1 m).

Five-year trends show declining water levels in the majority of wells (95%), with rates of decline ranging between 0.11 to 0.01 m/y (median is a decline of 0.05 m/y, Figure 4.20).

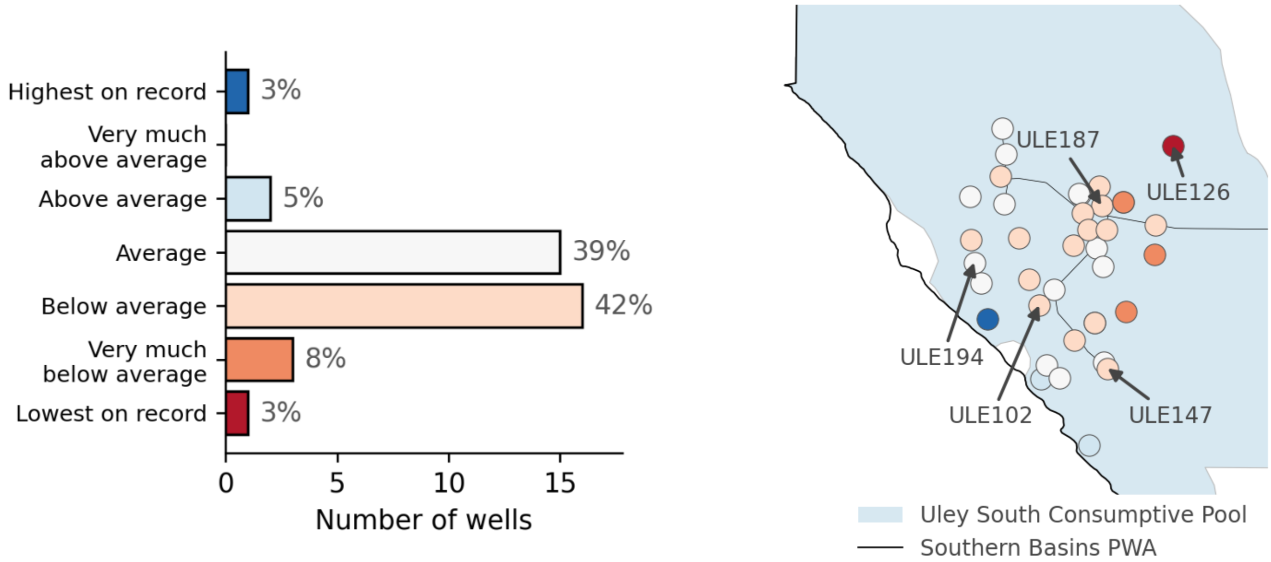


Figure 4.19 **2021 winter-recovered water levels for wells in the Quaternary Limestone aquifer in the Uley South PWS consumptive pool**

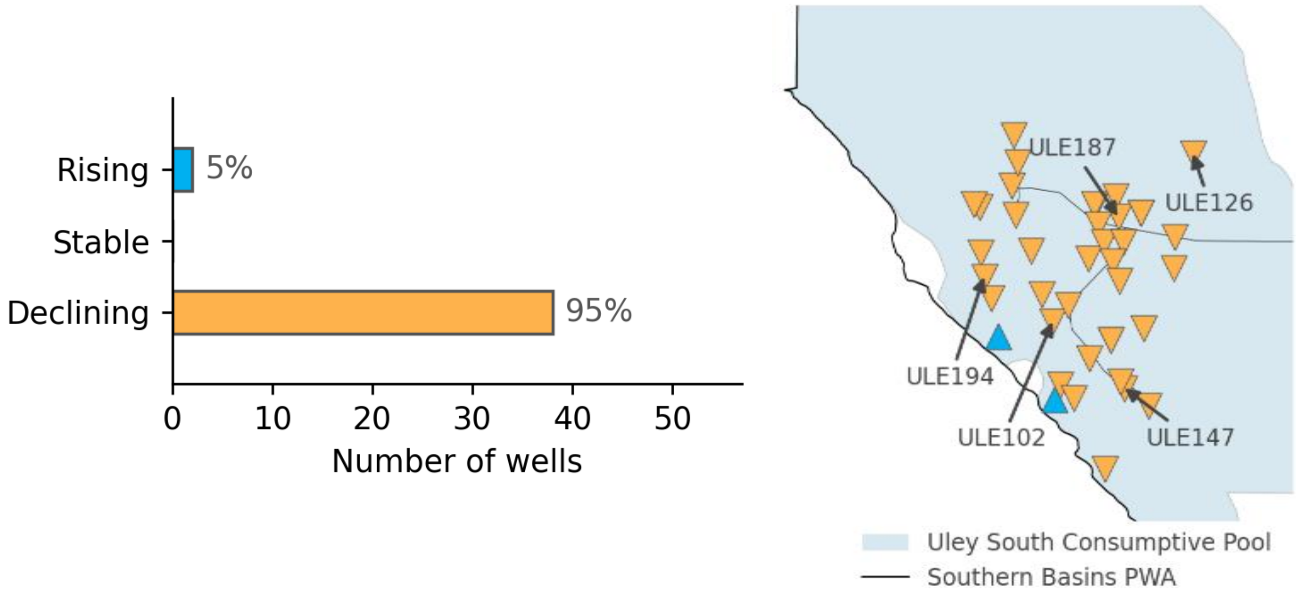


Figure 4.20 **2017 to 2021 trend in winter-recovered water levels for wells in the Quaternary Limestone aquifer in the Uley South PWS consumptive pool**

Representative monitoring wells illustrate common or important trends in the Uley South PWS consumptive pool (Figure 4.21). Groundwater extraction from the Uley South lens began in 1977 (Figure 5.6). During the period 1969 to 1976, before extraction from Uley South lens commenced, rainfall was above average, yet water levels declined by around 2 m (EP NRM Board 2016). Recovery in water levels was observed during 1977 in 86 wells, despite the commencement of extraction at rates in excess of 5 GL/y (e.g., ULE102, ULE147). Between 1986 and 2000, water levels declined; however, annual rainfall totals and rates of extraction were both variable over this period.

During the Millennium drought (2001 to 2009), water levels in most wells stabilised. This period corresponds with an expansion of the PWS borefield that enabled extraction to be spread across the lens, and a reduction in the rate of pumping from a peak of around 7 GL/y (circa 1999 to 2005) down to around 5 GL/y (circa 2010 to present), which was the result of demand management. Over the period 2010 to 2015, water levels generally increased while rates of extraction were stable at around 5 GL/y and rainfall was generally above average.

Water levels have been declining since 2015 in almost all wells, which corresponds with a period of generally below-average rainfall while extraction remains stable at around 5 GL/y. In 2021, most monitoring wells record a rise or stable water levels compared to their respective levels in 2020.

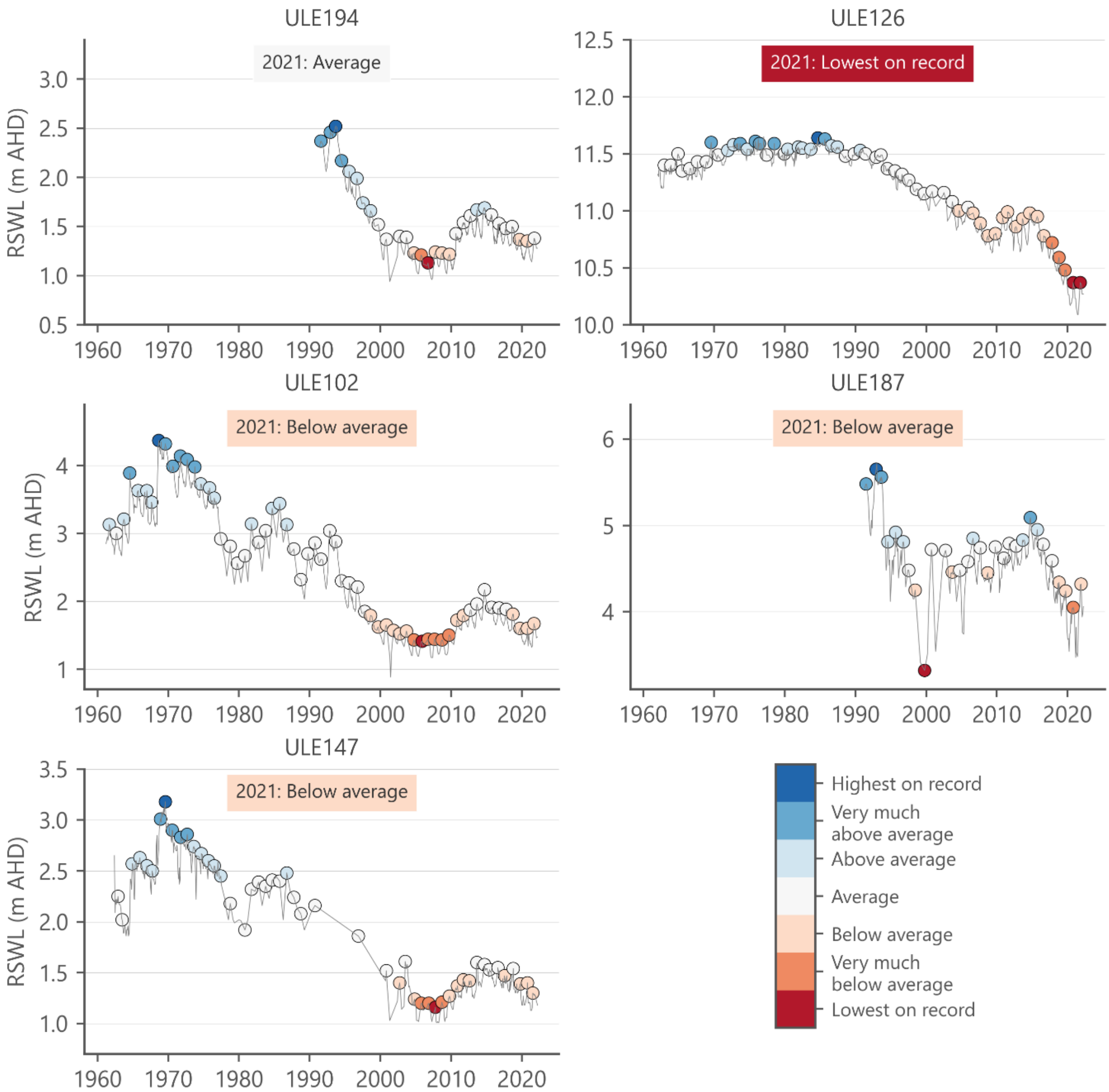


Figure 4.21 Selected hydrographs for wells in the Quaternary Limestone aquifer in the Uley South PWS consumptive pool

4.5.4 Uley South PWS consumptive pool salinity

In 2021, sampling results from 30 wells in the Quaternary aquifer of the Uley South lens in the Southern Basins PWA range between 443 mg/L and 3,022 mg/L with a median of 545 mg/L (Figure 4.22). Salinity samples are obtained from a combination of PWS production bores and DEW monitoring wells.

In the ten years to 2021, 7 of 9 wells (78%) show an increasing trend in salinity (see Section 2.2.2 for details of the calculation). Ten-year trends show that rates of change in salinity vary from a decrease of 2.8% per year to an increase of 0.8% per year, with a median rate of 0.3% increase per year (Figure 4.23).

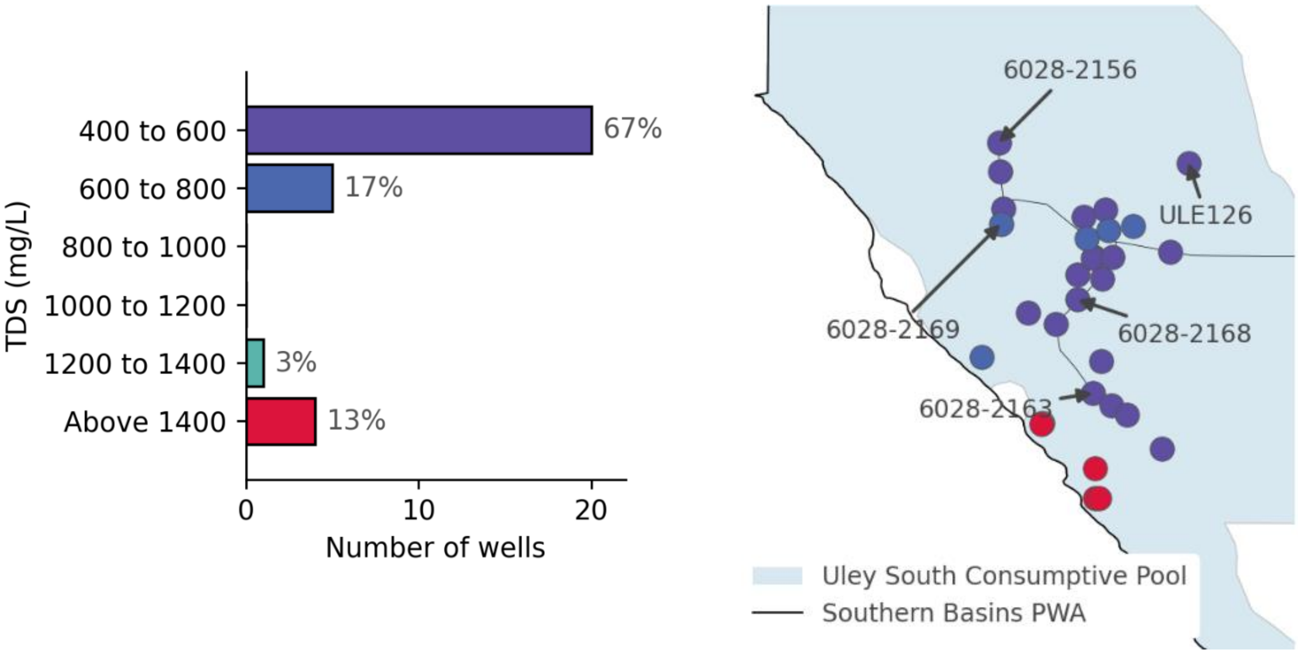


Figure 4.22 2021 salinity observations from wells in the Quaternary Limestone aquifer in the Uley South PWS consumptive pool

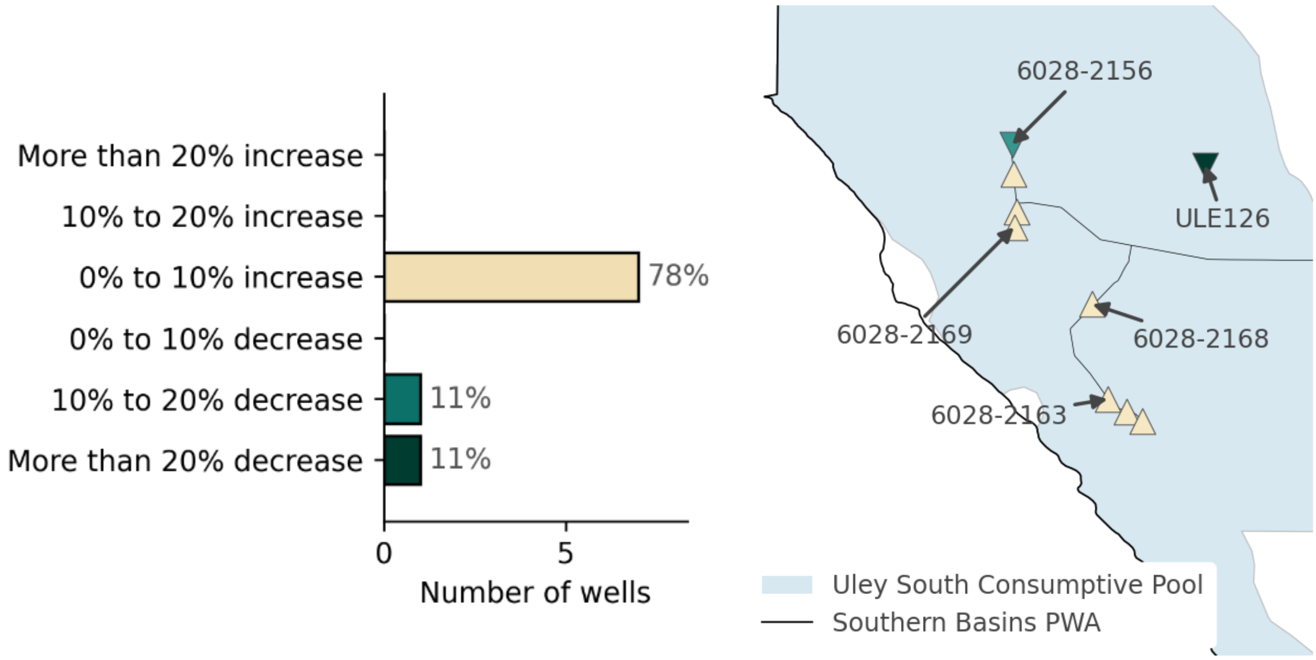


Figure 4.23 Salinity trend in the 10 years to 2021 for wells in the Quaternary Limestone aquifer in the Uley South PWS consumptive pool

Representative monitoring wells illustrate common or important trends in the Uley South PWS consumptive pool (Figure 4.24). In all wells, salinity is low and generally stable over the long term. Some variation in salinity has been measured at the observation well ULE126. The remaining wells are PWS production bores, which are the most reliable measure of aquifer salinity due to the volume of groundwater each bore extracts. Production bore 6028-2169 shows gradually increasing salinity since the start of monitoring up until 2017, after which the salinity stabilised. The salinity is still very low at this site and measured at 616 mg/L in 2021.

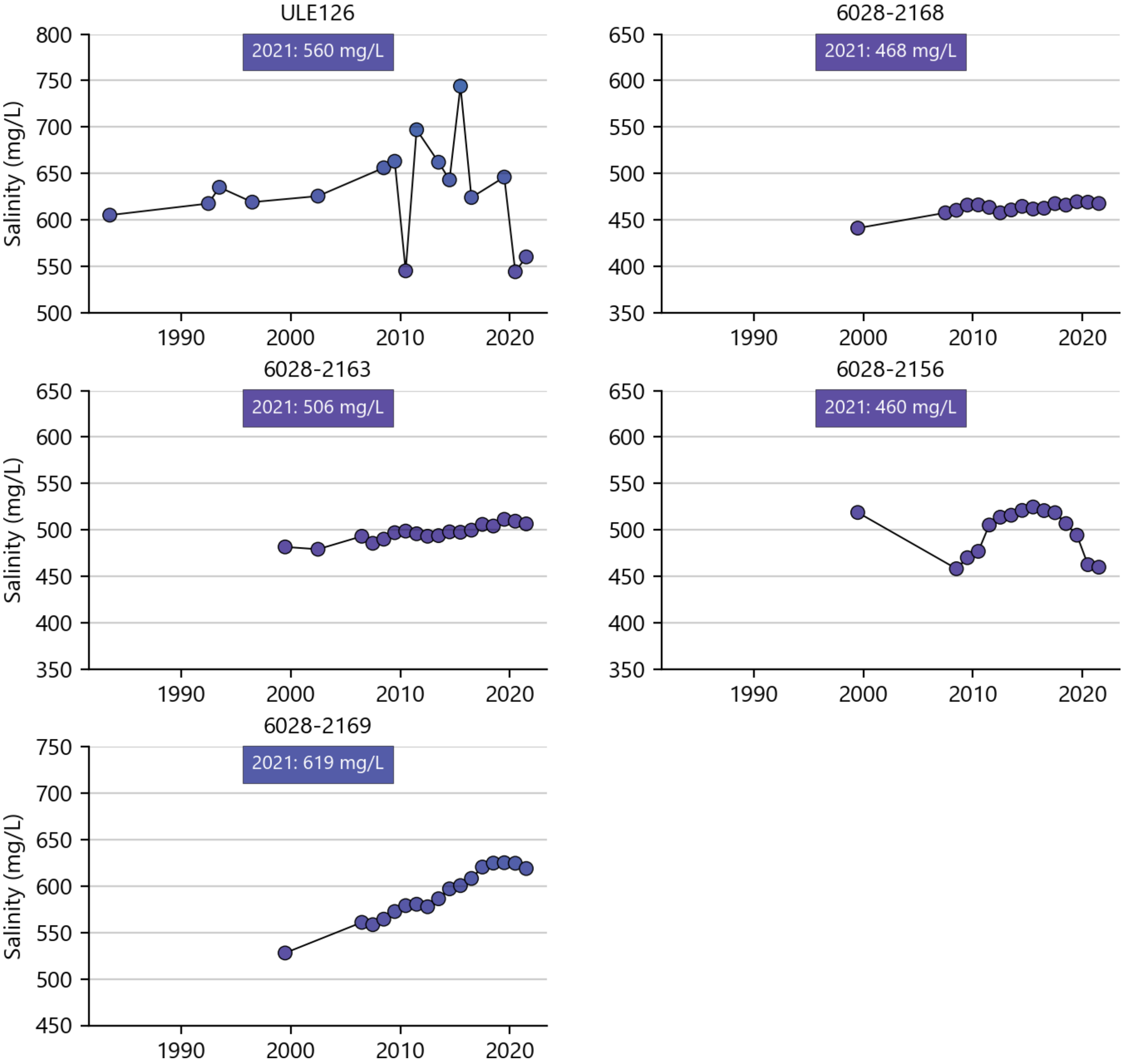


Figure 4.24 Selected salinity graphs for wells in the Quaternary Limestone aquifer in the Uley South PWS consumptive pool

4.5.5 Uley Wanilla PWS consumptive pool water level

In 2021, winter-recovered water levels in 13 out of 15 (87%) monitoring wells in the Quaternary aquifer of the Uley Wanilla lens in the Southern Basins PWA are classified 'Below average' or lower (see Section 2.2.1 for details of the classification; Figure 4.25).

Over the past 30 years, variations in water level in 15 wells range from a decline of 4.52 m to a decline of 0.97 m (median is a decline of 2.3 m).

Five-year trends show declining water levels in all wells, with rates of decline ranging between 0.18 to 0.04 m/y (median is a decline of 0.14 m/y; Figure 4.26).

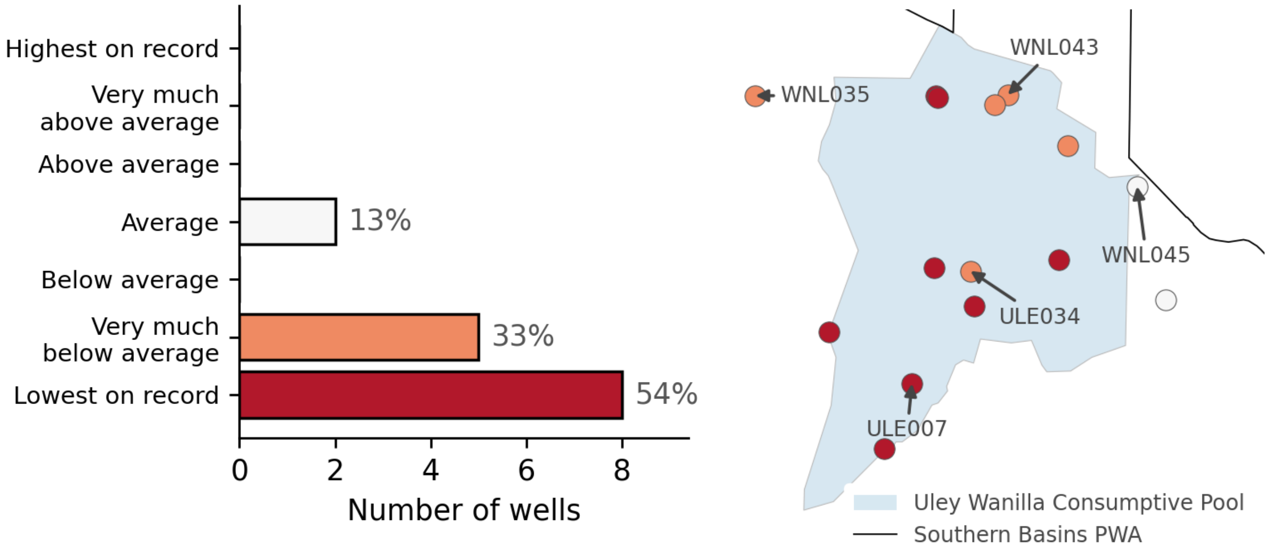


Figure 4.25 **2021 winter-recovered water levels for wells in the Quaternary Limestone aquifer in the Uley Wanilla PWS consumptive pool**

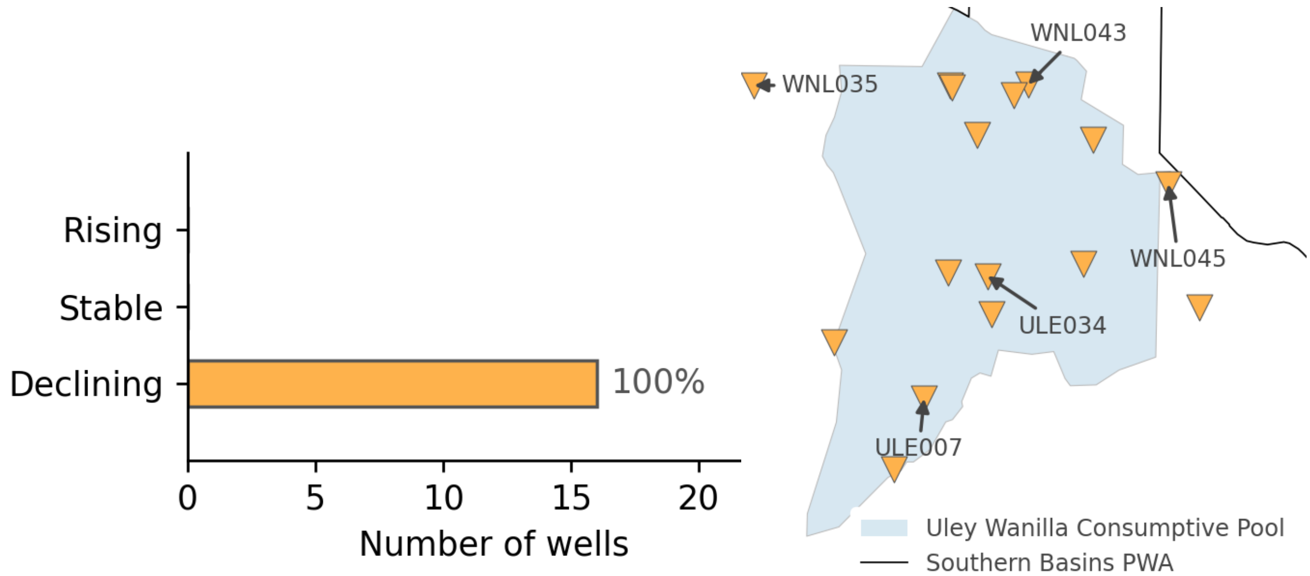


Figure 4.26 **2017 to 2021 trend in winter-recovered water levels for wells in the Quaternary Limestone aquifer in the Uley Wanilla PWS consumptive pool**

Representative monitoring wells illustrate common or important trends in the Uley Wanilla PWS consumptive pool (Figure 4.27).

The dominant driver of groundwater levels is not known with certainty e.g., ULE007 shows a large rise in levels between 1968 to 1972 that coincides with above-average rainfall and large increases in extraction, whereas a slower decline in levels between 1973 to 1978 corresponds with a large increase in extraction with rainfall commensurate with the long-term average.

Since 2010, rates of extraction have been very low (Figure 5.3). During 2010 to 2016, which was a period of mostly above-average rainfall, water levels have recovered. Since 2016, annual rainfall totals have been very low and most levels have been declining sharply, with the majority of wells currently classified 'Lowest on record' (Figure 4.25).

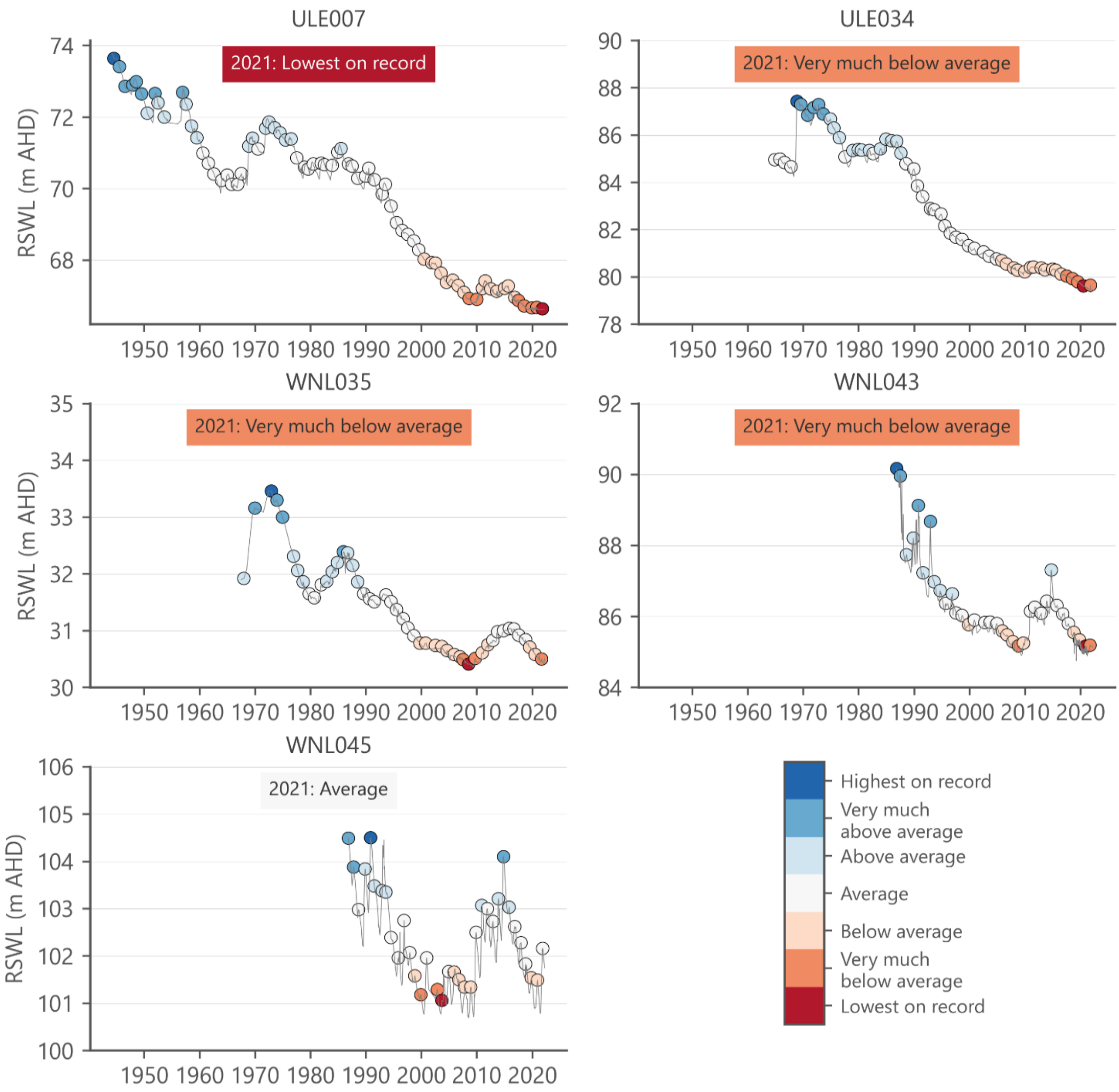


Figure 4.27 Selected hydrographs for wells in the Quaternary Limestone aquifer in the Uley Wanilla consumptive pool

4.5.6 Uley Wanilla PWS consumptive pool salinity

In 2021, sampling results from 10 wells in the Quaternary aquifer of the Uley Wanilla lens in the Southern Basins PWA range between 499 mg/L and 1,075 mg/L with a median of 559 mg/L. The majority of wells are located within the PWS wellfield (Figure 4.28).

In the ten years to 2021, 4 of 6 wells (67%) show an increasing trend in salinity (see Section 2.2.2 for details of the calculation; Figure 4.29). Ten-year trends show that rates of change in salinity vary from a decrease of 0.4% per year to an increase of 3.3% per year, with a median rate of 0.7% increase per year.

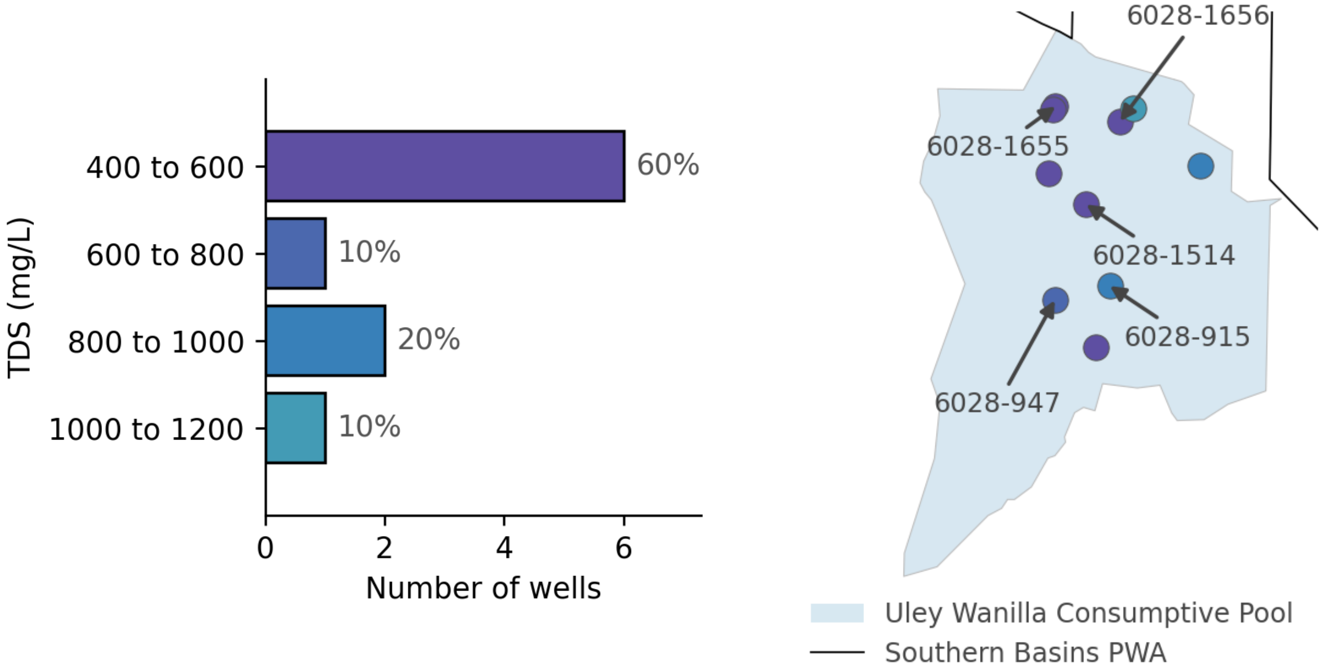


Figure 4.28 2021 salinity observations from wells in the Quaternary Limestone aquifer in the Uley Wanilla PWS consumptive pool

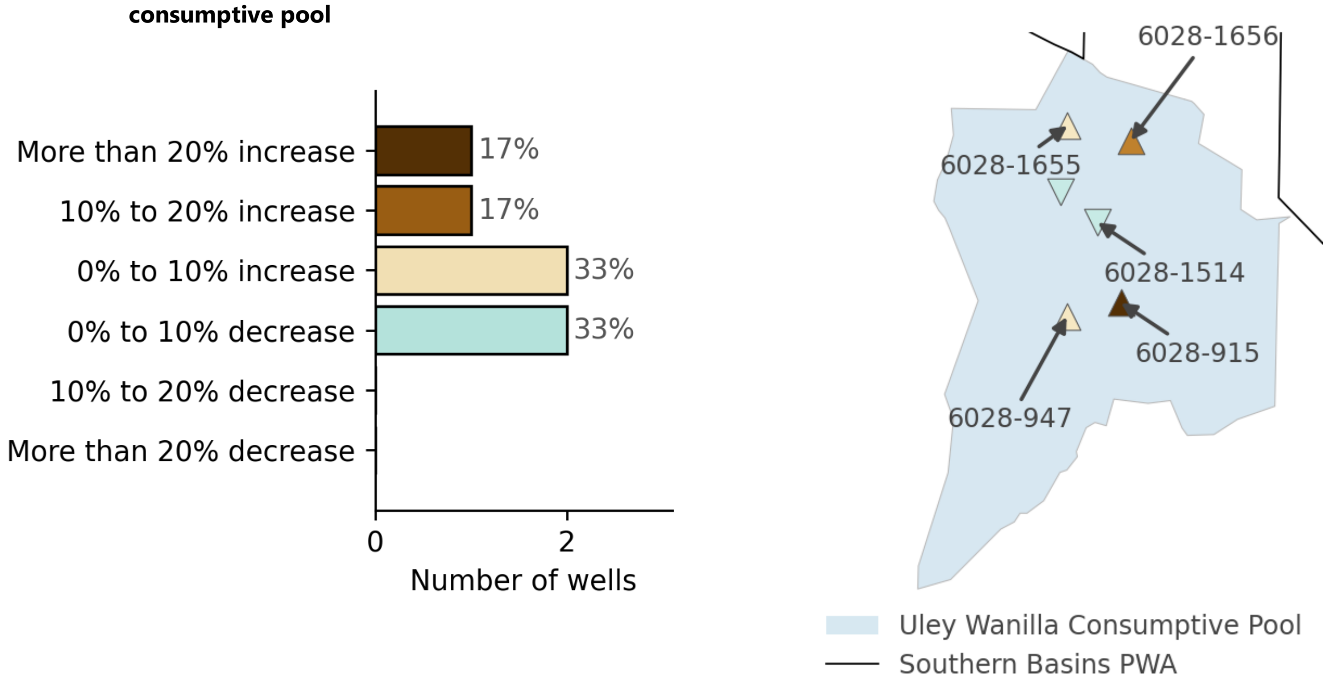


Figure 4.29 Salinity trend in the 10 years to 2021 for wells in the Quaternary Limestone aquifer in the Uley Wanilla PWS consumptive pool

PWS production bores illustrate common or important trends in the Uley Wanilla PWS consumptive pool (Figure 4.30). Over the past 30 years, most production bores show stable salinity (e.g., 6028-1656 and 6028-1655). Over the past 40 years, one production bore (6028-1514) shows aquifer freshening while one production bore (6028-947) shows gradually increasing salinity, at a rate of around 5 mg/L per year, although salinity is still low (less than 750 mg/L).

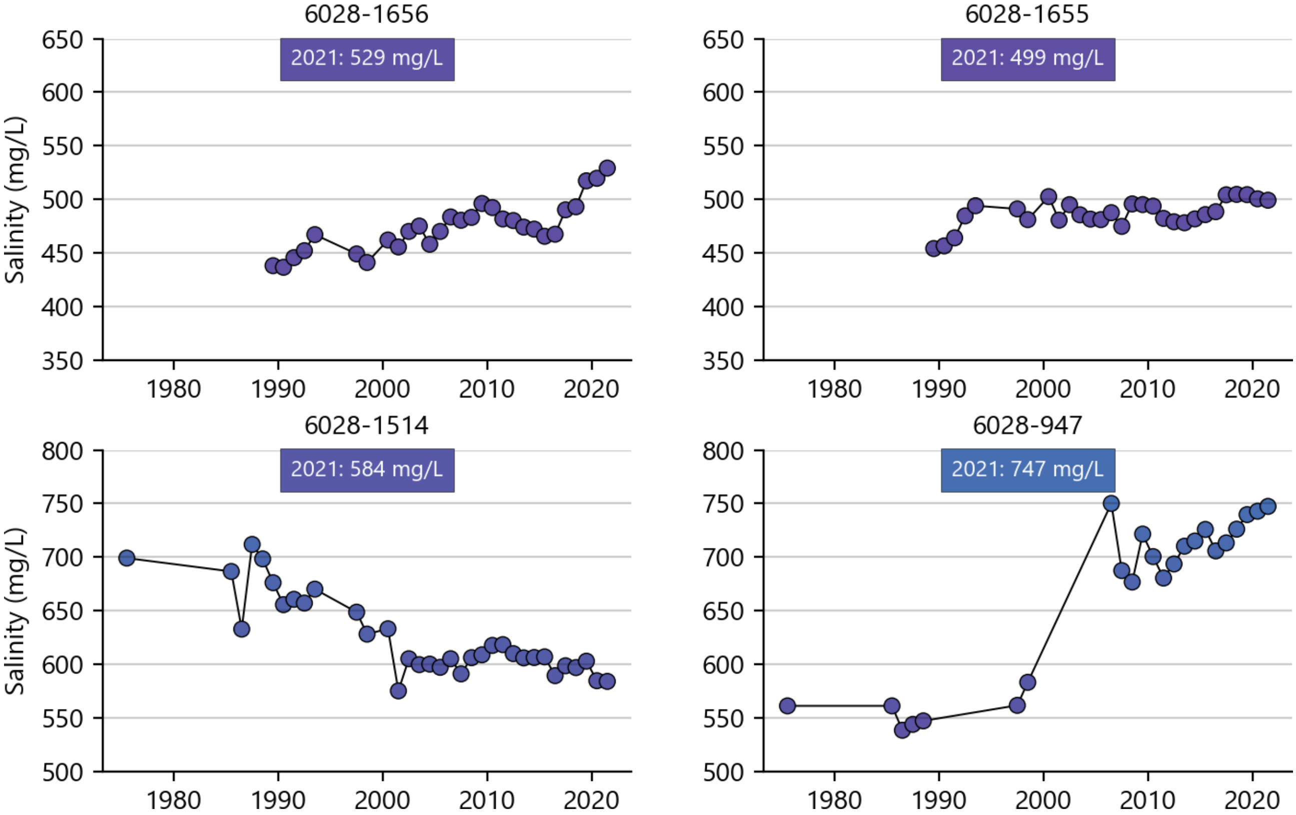


Figure 4.30 Selected salinity graphs for wells in the Quaternary Limestone aquifer in the Uley Wanilla PWS consumptive pool

4.5.7 Lincoln South PWS consumptive pool water level

In 2021, winter-recovered water levels in all 21 monitoring wells in the Quaternary aquifer of the Lincoln South lens in the Southern Basins PWA are classified 'Below average' or lower (Figure 4.31).

Over the past 30 years, variations in water level in 13 wells range from a decline of 1.90 m to a decline of 0.32 m (median is a decline of 0.7 m).

Five-year trends show declining water levels in all of the wells, with rates of decline ranging between 0.10 to 0.01 m/y (median is a decline of 0.05 m/y) (Figure 4.32).

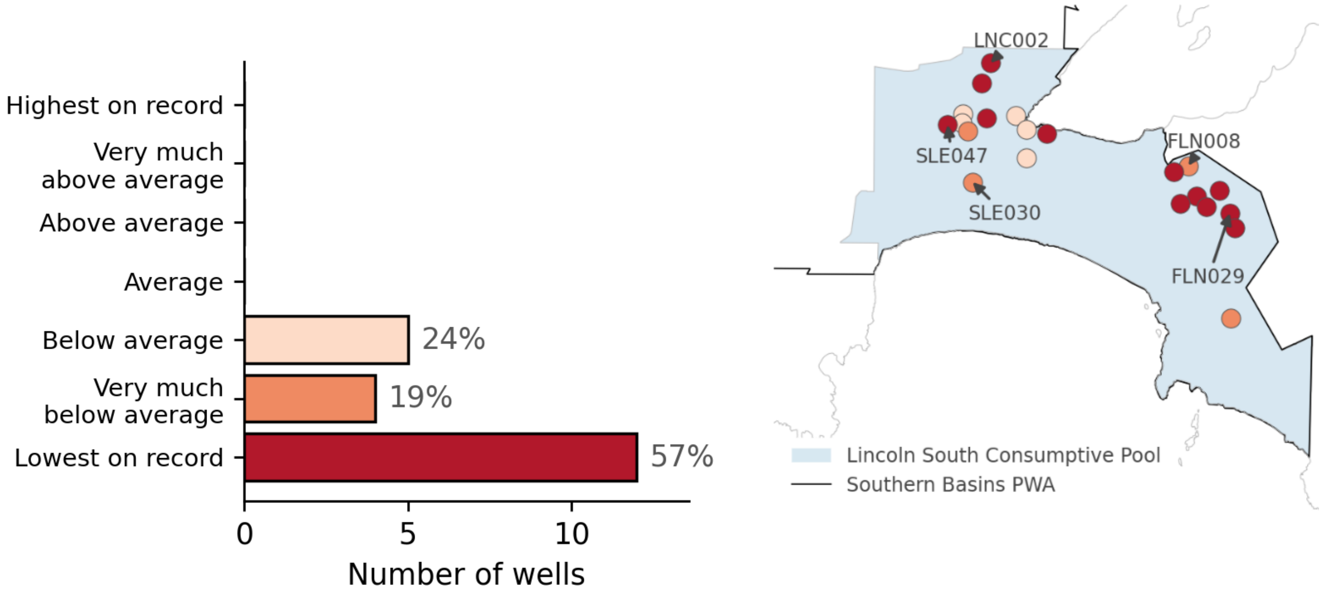


Figure 4.31 2021 winter-recovered water levels for wells in the Quaternary Limestone aquifer in the Lincoln South PWS consumptive pool

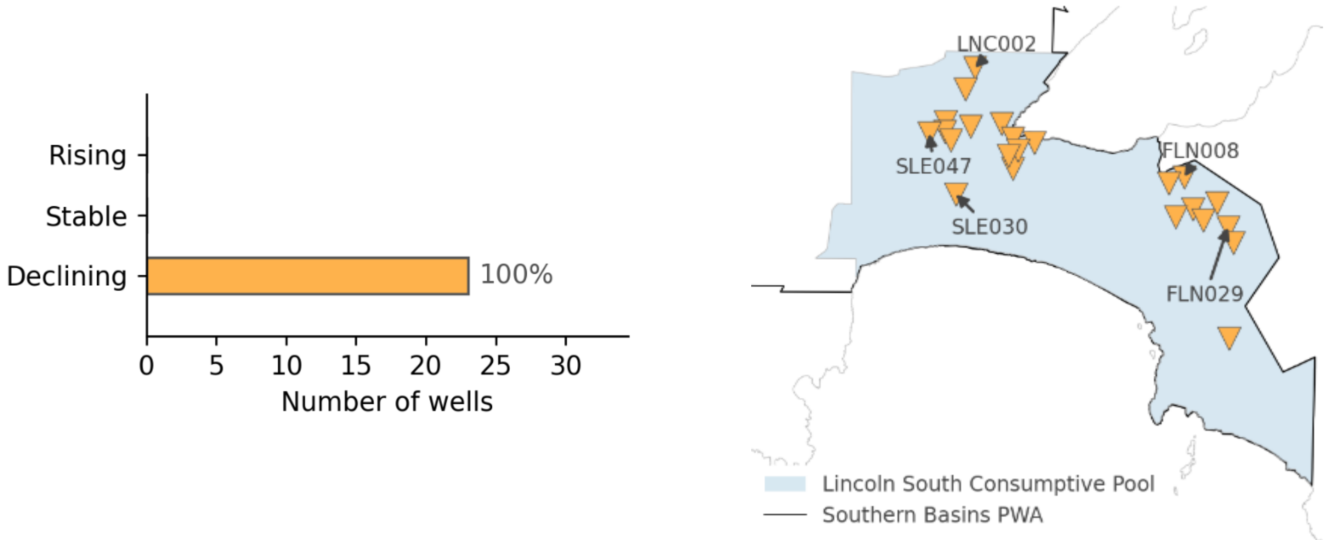


Figure 4.32 2017 to 2021 trend in winter-recovered water levels for wells in the Quaternary Limestone aquifer in the Lincoln South PWS consumptive pool

Representative monitoring wells illustrate common or important trends in the Lincoln South PWS consumptive pool (Figure 4.33). Since the 1960s, long-term declines in water levels are evident in all wells. While rates of groundwater extraction were high in the 1960s and 1970s (Figure 5.3), rates of extraction were negligible between 2012–13 and 2018–19 (Figure 5.5).

SLE047 and SLE030 are located towards the western margin of the Lincoln South PWS consumptive pool and show a gradual declining trend over the past 50 years with a total decline of 0.93 m and 0.43 m, respectively. Similarly, toward the east of the consumptive pool, FLN029 and FLN008 display a gradual declining trend over the past 50 years with respective total declines of 1.22 m and 0.71 m.

LNC002 is located further inland, to the north-west of the consumptive pool, and is also showing a declining trend since 1971 with a total decline of 1.87 m.

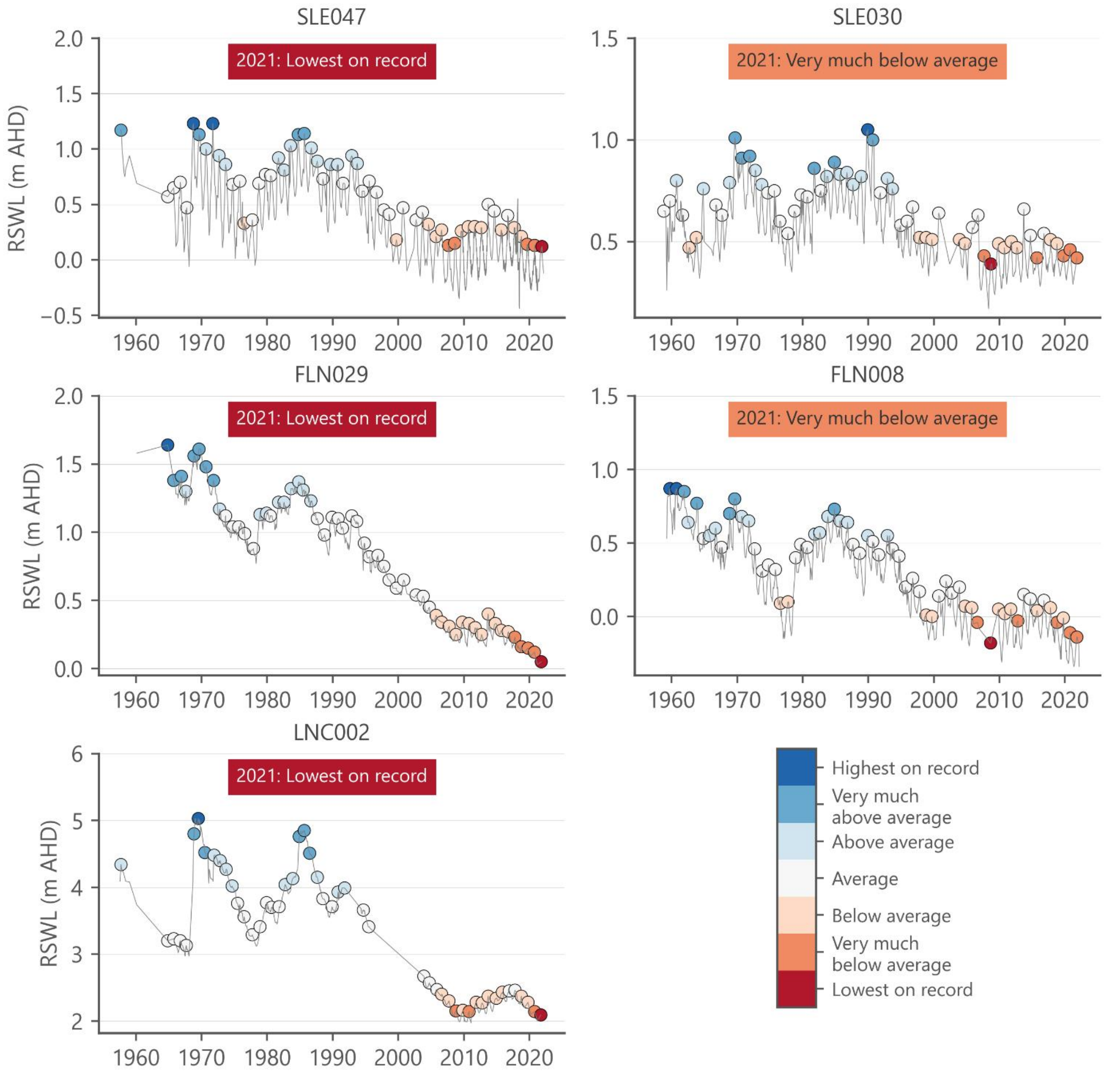


Figure 4.33 Selected hydrographs for wells in the Quaternary Limestone aquifer in the Lincoln South PWS consumptive pool

4.5.8 Lincoln South consumptive pool salinity

In 2021, sampling results from 16 wells in the Quaternary aquifer of the Lincoln South lens in the Southern Basins PWA range between 603 mg/L and 1,535 mg/L with a median of 1,115 mg/L (Figure 4.34).

In the ten years to 2021, 7 of 8 wells (88%) show trends of increasing salinity (see Section 2.2.2 for details of the calculation, Figure 4.35). Ten-year trends show that rates of change in salinity vary from a decrease of 0.3% per year to an increase of 1.4% per year (the median trend is a 0.3% increase per year).

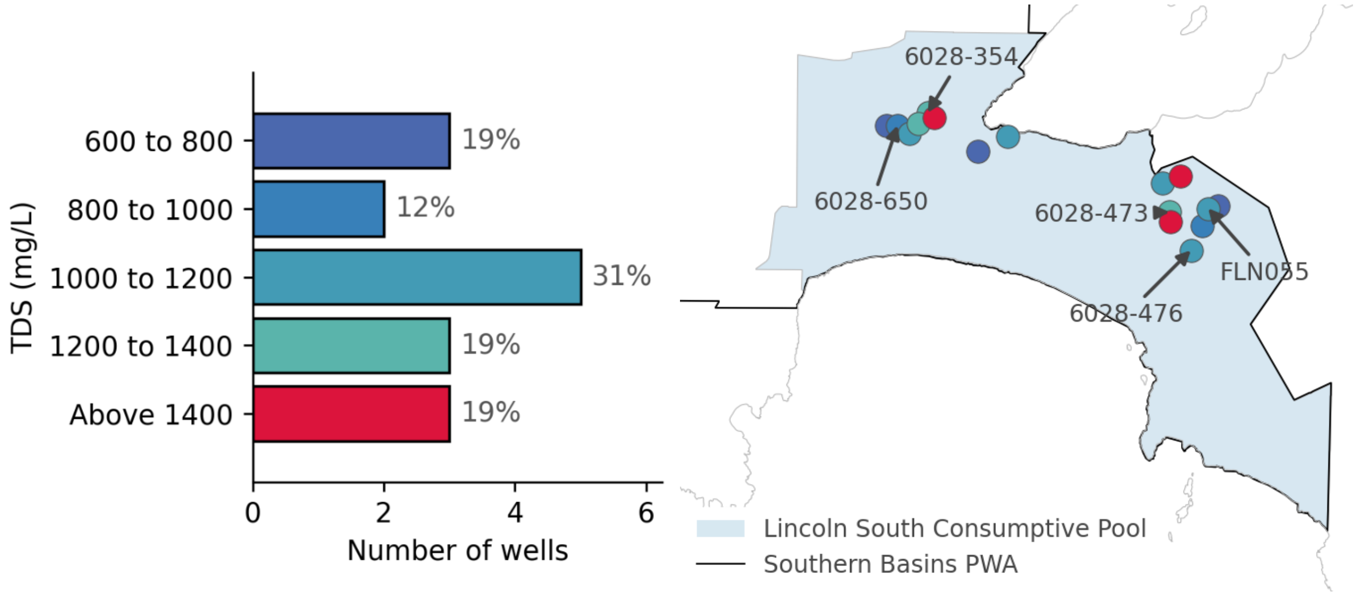


Figure 4.34 2021 salinity observations from wells in the Quaternary Limestone aquifer in the Lincoln South PWS consumptive pool

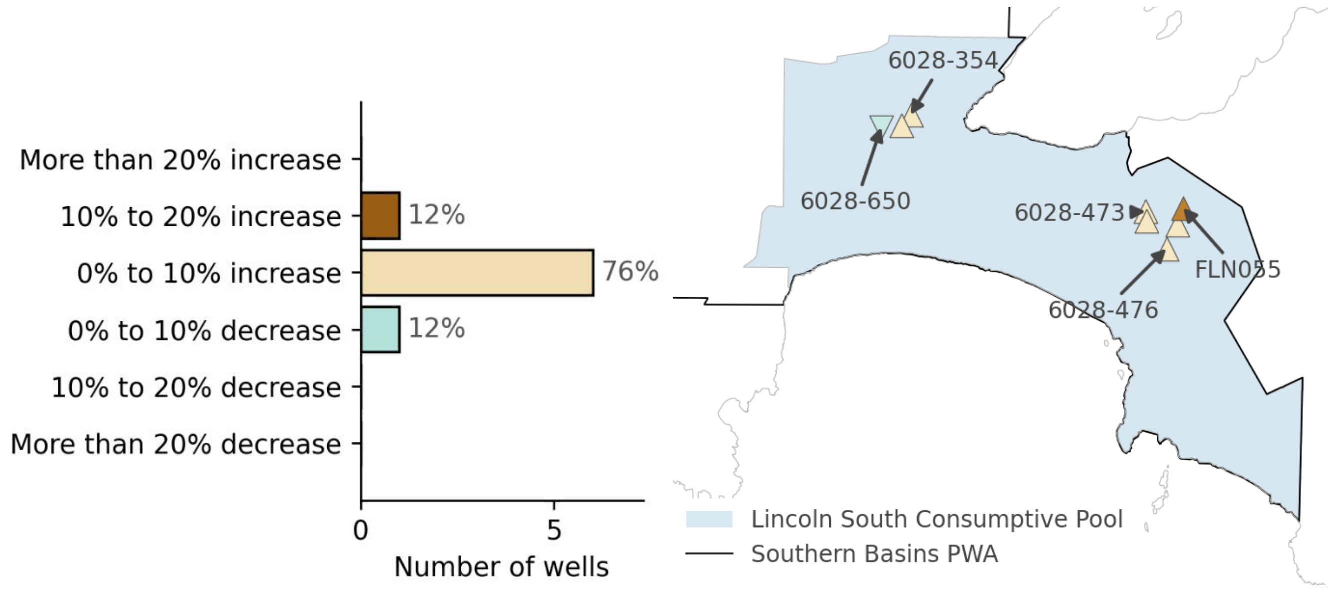


Figure 4.35 Salinity trend in the 10 years to 2021 for wells in the Quaternary Limestone aquifer in the Lincoln South PWS consumptive pool

Representative monitoring wells illustrate common or important trends in the Lincoln South PWS consumptive pool (Figure 4.36). From the late-1970s, all wells show a gradual and continuous decrease in salinity, which coincides with reductions in rates of extraction (Figure 5.3), due to establishment of the Uley South PWS. Groundwater salinity generally increased between the mid-1980s and 2010, after which salinity has been stable.

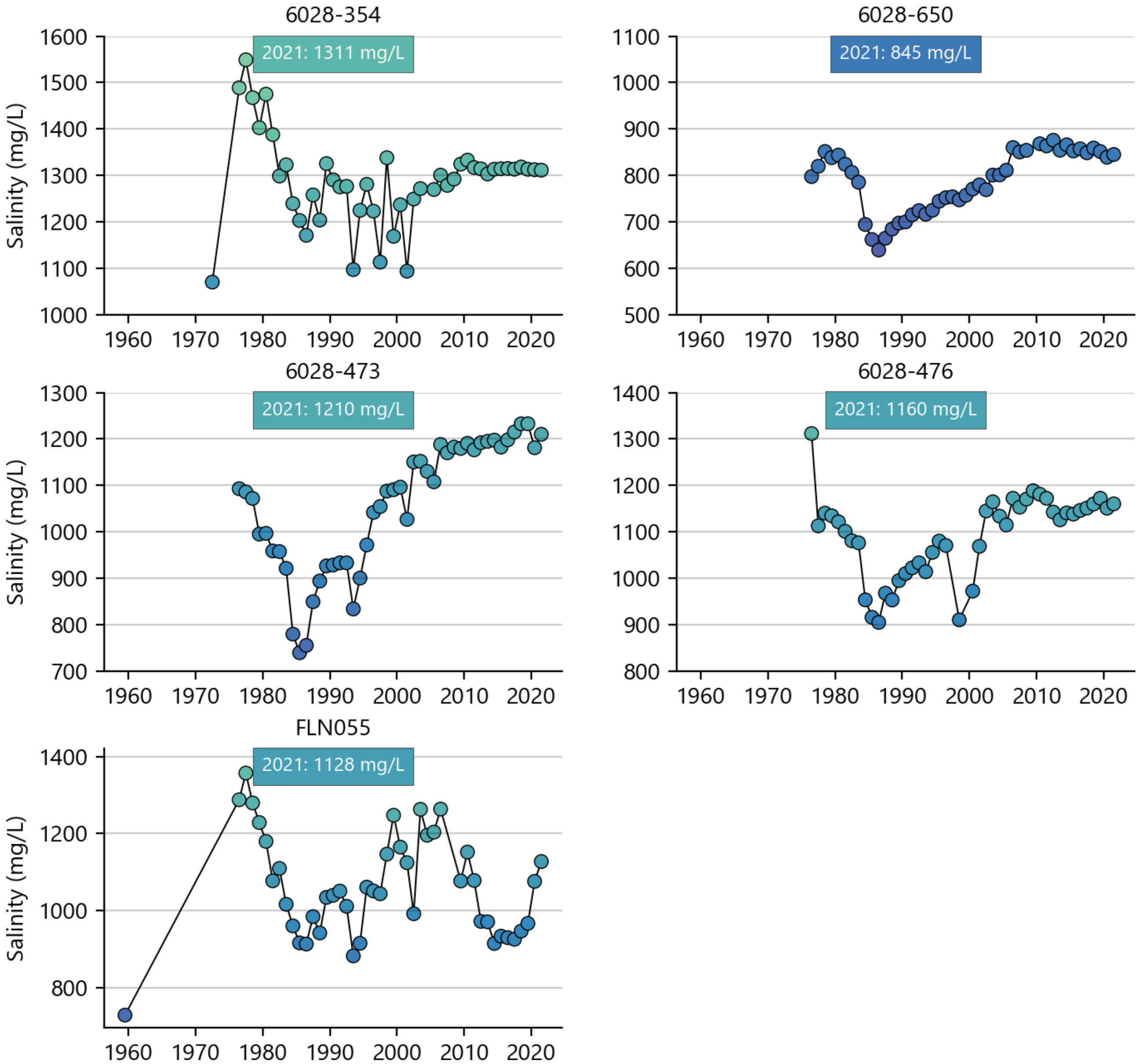


Figure 4.36 Selected salinity graphs for wells in the Quaternary Limestone aquifer in the Lincoln South PWS consumptive pool

5 Water use

In Eyre Peninsula, there are very few surface-water resources and there is generally a scarcity of potable groundwater. The fresh groundwater resources in both the Musgrave and Southern Basins PWAs are used for a variety of purposes, but mainly for public water supply (PWS), stock and domestic use, irrigation of green recreational spaces and industrial purposes.

5.1 Musgrave PWA

Groundwater extraction in the Musgrave PWA began in the 1960s; rates of extraction from Polda have varied considerably over time (Figure 5.1). Total licensed groundwater use in 2020–21 is 69 ML (Figure 5.2), all of which is extracted from the Bramfield consumptive pool (Figure 5.2), which is a slight decrease from 70 ML in 2019–20. The rate of extraction from Bramfield consumptive pool has been stable at around 70 ML/y since 2002–03.

Extraction from the Polda consumptive pool for PWS ceased in 2008 due to increasing salinity (EP NRM Board 2016). During 2008 to 2016, a Notice of Prohibition prevented extraction for all licensed uses from the Polda consumptive pool (Figure 5.2) and in 2015, SA Water voluntarily relinquished their (PWS) licence to extract from this resource.

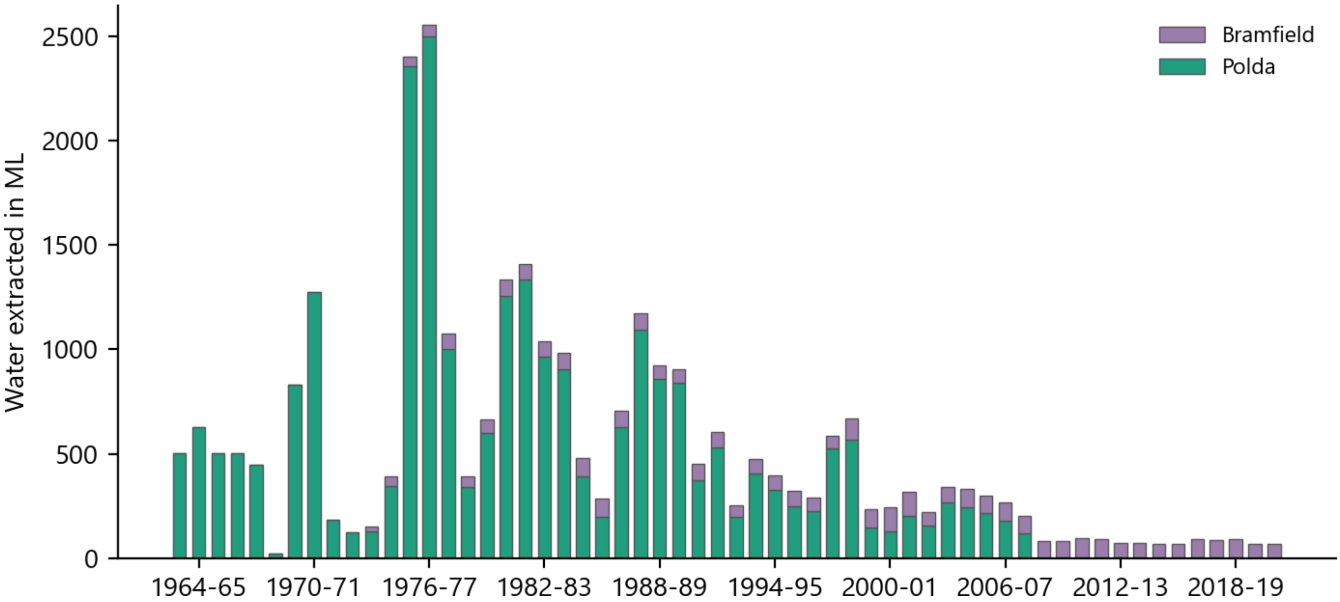


Figure 5.1 Historical groundwater extraction from groundwater resources in the Musgrave PWA

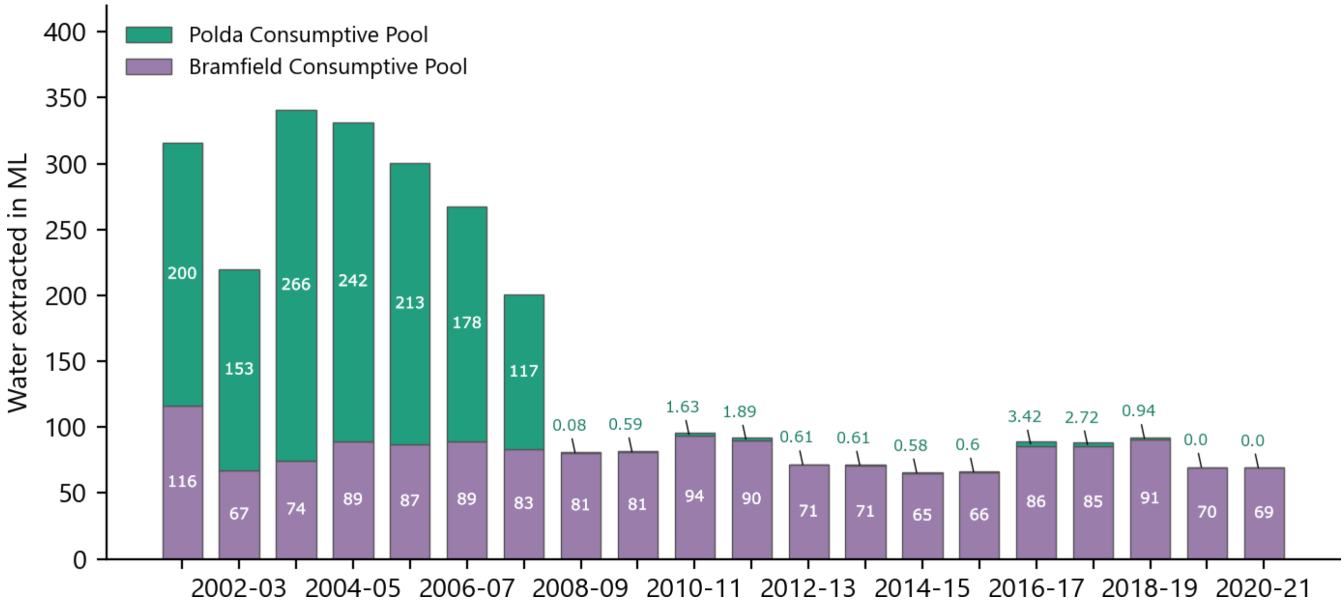


Figure 5.2 Licensed groundwater extraction between 2001–02 and 2020–21 in the Musgrave PWA

5.2 Southern Basins PWA

In the Southern Basins PWA, historical patterns of groundwater extraction have varied markedly since groundwater extraction began in the 1950s. Since the late 1970s, the majority of extraction has occurred from the Uley South lens (Figure 5.3). In 2020–21, total licensed groundwater use in the Southern Basins PWA is 5,449 ML (Figure 5.4), with 86% of this volume sourced from the Uley South PWS consumptive pool.

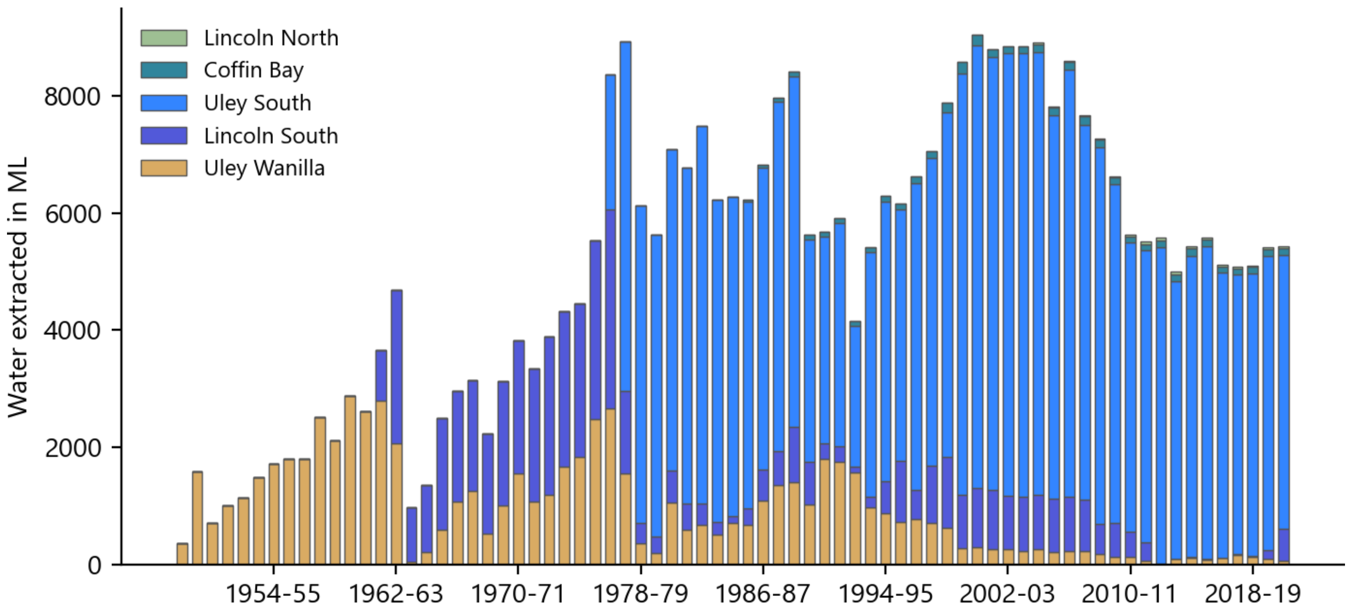


Figure 5.3 Historical groundwater extraction from groundwater resources in the Southern Basins PWA

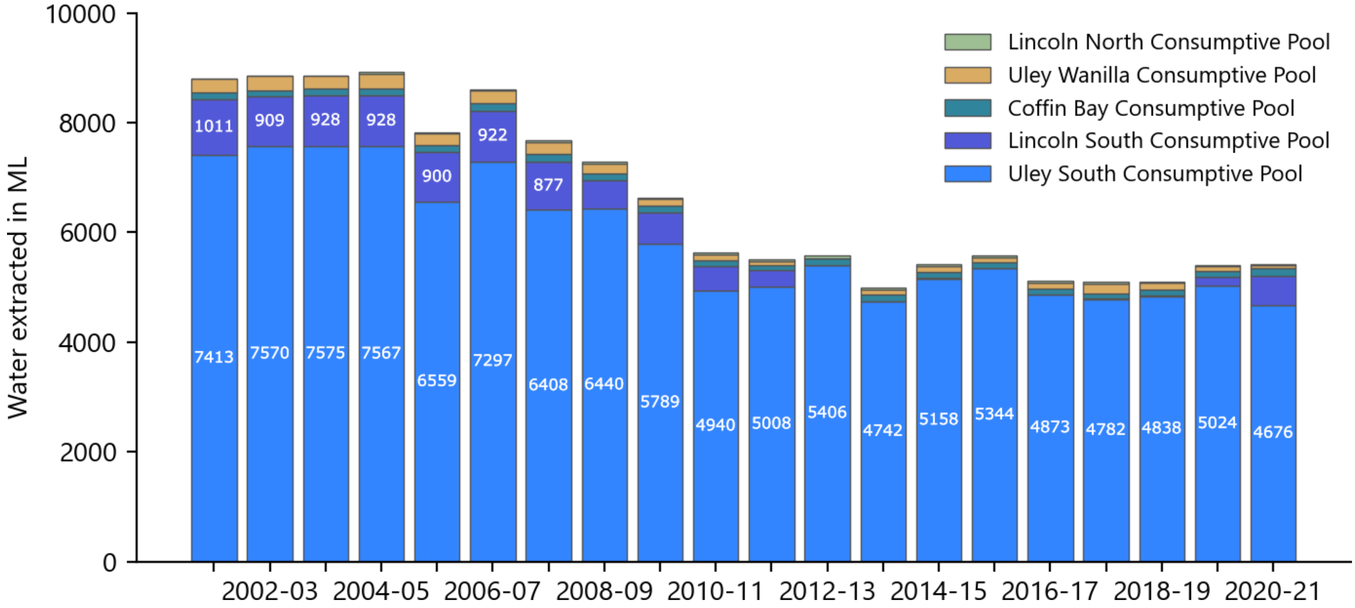


Figure 5.4 Licensed groundwater extraction between 2001–02 and 2020–21 in the Southern Basins PWA

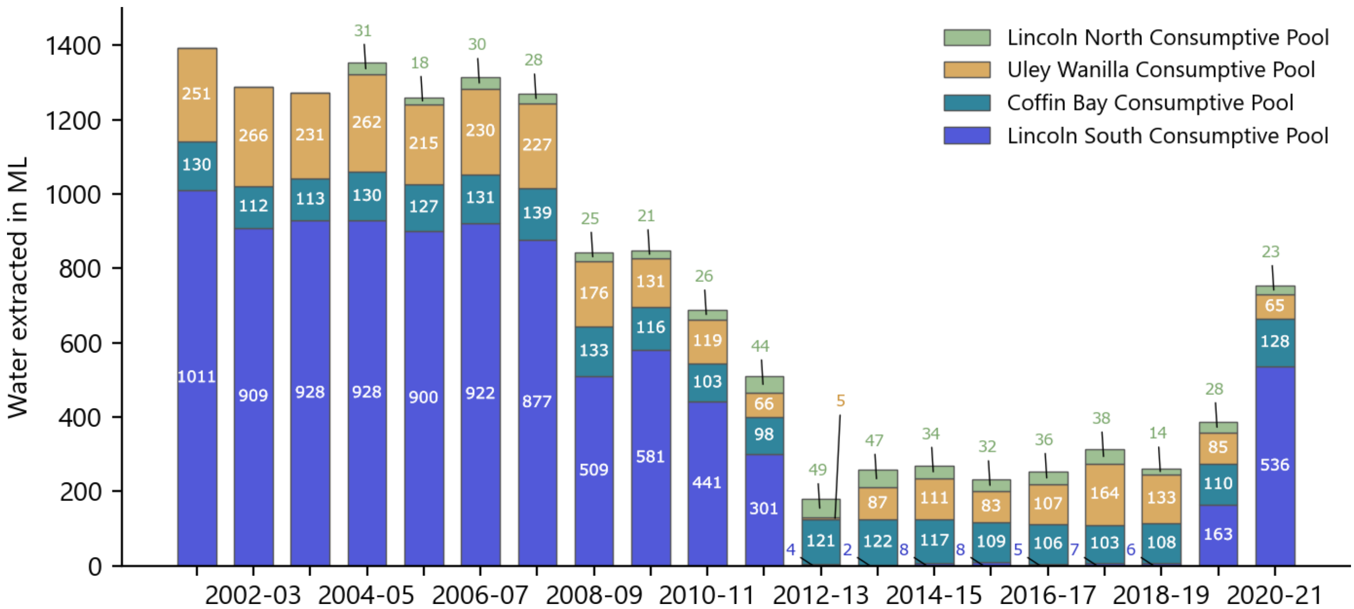


Figure 5.5 Licensed groundwater extraction between 2001–02 and 2020–21 in the Southern Basins PWA for the Lincoln North, Uley Wanilla PWS, Coffin Bay, and Lincoln South PWS consumptive pools

5.2.1 Uley South PWS consumptive pool

Licensed extractions in 2020–21 from the Uley South PWS consumptive pool total 4,676 ML, a decrease of 7% compared to 2019–20. The rate of extraction has remained stable since 2010–11, after gradually reducing from approximately 7,500 ML/y prior to 2006–07 (Figure 5.4 and Figure 5.6).

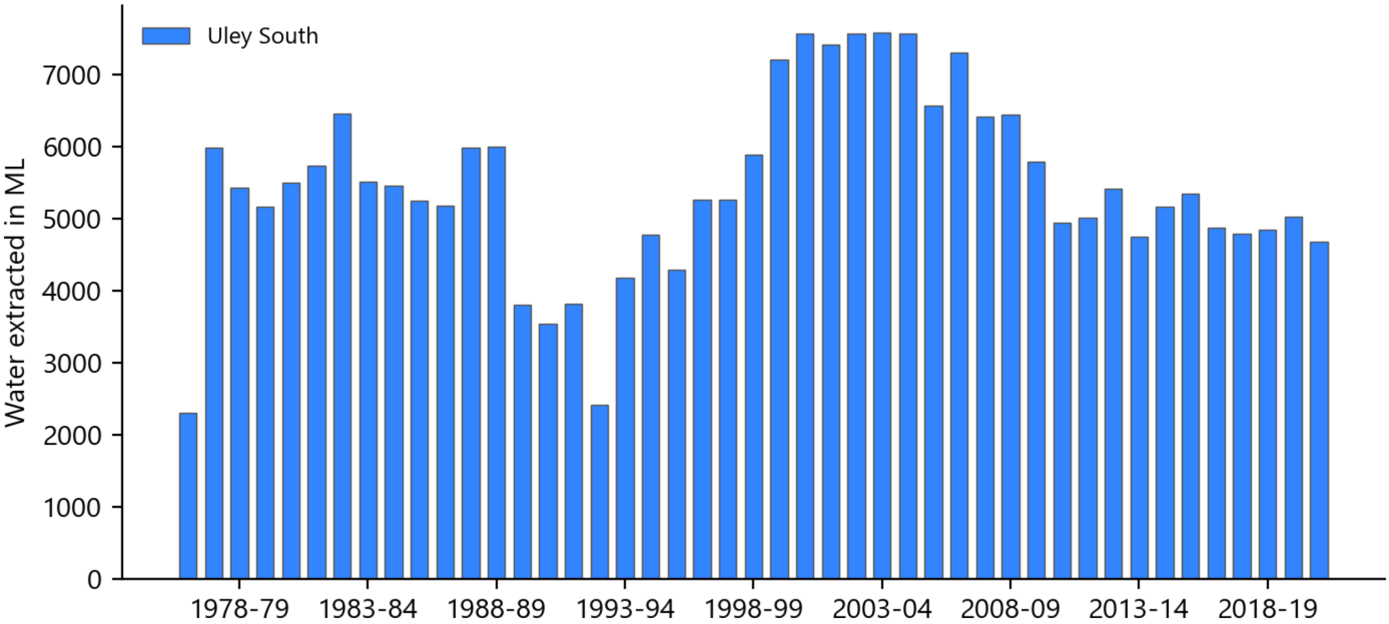


Figure 5.6 Historical groundwater extraction from the Uley South groundwater resource

5.2.2 Uley Wanilla PWS consumptive pool

The Uley Wanilla basin was the first groundwater basin to be developed in 1949, after recognition that the Tod River Reservoir was insufficient to supply the region's growing demand for water. Extractions from Uley Wanilla have been decreasing steadily since 1993 (Figure 5.3), with marked reductions from 2008 (Figure 5.5). Extraction in 2020–21 is 65 ML, a reduction of 23% compared to 2019–20, and less than 40% of the annual volumes extracted prior to 2008–09.

5.2.3 Lincoln South PWS consumptive pool

Groundwater extraction from the Lincoln South basin commenced in 1961 (Figure 5.3). From the late 1990s, rates of extraction varied between around 900 to 1,000 ML/y, until reductions began in 2008–09, and decreased further in 2012–13 (Figure 5.5), due to operational constraints resulting from up-coning of underlying high-salinity groundwater. Extraction from this area was negligible between 2012–13 and 2018–19. Extraction recommenced in 2019–20. In 2020–21, licensed extractions increased to 536 ML compared to 163 ML in 2019–20.

5.2.4 Coffin Bay consumptive pool

Licensed groundwater extraction from the Coffin Bay consumptive pool in 2020–21 is 128 ML, which is an increase of 16% compared to 110 ML extracted in 2019–20 (Figure 5.5, Figure 5.7).

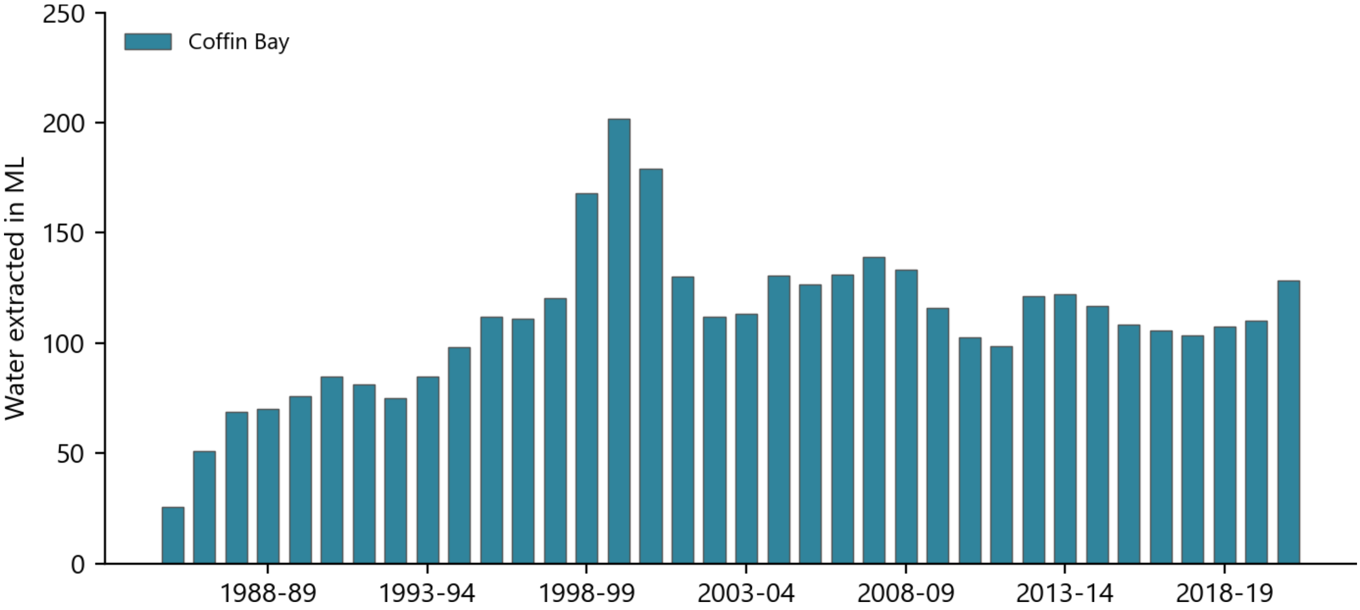


Figure 5.7 Historical rates of groundwater extraction from the Coffin Bay consumptive pool

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