Barossa Prescribed Water Resources Area 2019–20 water resources assessment

Department for Environment and Water
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Department for Environment and Water

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Contents

1 Summary

Barossa PWRA		
	Fractured rock aquifers	Below average
	Lower aquifer	Very much below average
	Upper aquifer	Below average
	Surface water	Very much below average

LEGEND

- Highest on record
- Very much above average
- Above average
- Average
- Below average
- Very much below average
- Lowest on record

Rainfall

- Rainfall at Tanunda measured 430 mm in 2019–20, which was lower than the average of 530 mm/y. The long-term trend is stable but the last 3 years have been below-average.
- Rainfall is typically higher over the Tanunda and Jacobs Creek sub-catchments, decreasing to the north-east and south-west; this was the case in 2019–20.
- Reduced total winter (June to September) rainfall was observed, consistent with observations across other areas in South Australia.

Surface water

- Four principal streamflow gauging stations are operational, of which Penrice recorded the lowest streamflow on record in 2019–20. Mount McKenzie, Yaldara and Tanunda Creek streamflow gauging stations were also lower-than-average in 2019–20.
- Minimal or no flow was experienced between December 2019 and April 2020 at Mount McKenzie at all four principal streamflow gauging stations. Long-term data trends show a decline in streamflow, with the last 12 of 15 years recording below-average streamflow.
- The highest salinities in 2019–20 were 3841 mg/L at Yaldara and 1538 mg/L at Bethany (Tanunda Creek). These values remain within the historical ranges experienced at each site.

Groundwater

- 85% of groundwater wells show below-average water levels.
- Nearly half of the wells show their lowest recovered water level on record in 2020: 50% of wells in the Upper Aquifer, 50% in the Lower Aquifer and 42% of wells in fractured rock aquifers.
- Five-year trends in water level indicate that the majority of wells (96%) show declining water levels.
- 61% of wells show trends of increasing salinity over the past 15 years.

Water use

- Water use for irrigation, commercial, stock and domestic purposes comes from a variety of sources. These include pumping and diversions from watercourses and aquifers, interception and storage by farm dams, imported water from the SA Water mains network and water supply from Barossa Infrastructure Ltd (BIL) via SA Water infrastructure. Approximately 67% of water use was from imported sources.
- Water consumption in 2019–20 was the second highest in the past 15 years, with a total of 18 034 ML extracted, including licensed surface water take: 904 ML, estimated non-licensed surface water demand: 1100 ML, imported water: 12 157 ML (10 465 ML from the BIL scheme and 1 692 ML from SA Water) and groundwater: 3873 ML.

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 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 Barossa Prescribed Water Resources Area (PWRA) for 2019–20 and collates rainfall, surface water and water use (i.e. surface water and groundwater) data collected between July 2019 and September 2020, and groundwater level and salinity data collected between July 2019 and December 2020.

1.2 Regional context

The Barossa PWRA includes both the highland areas of the Mount Lofty Ranges and the Barossa Valley (Figure 1.1). It is located approximately 60 km north-east of Adelaide and lies within the Northern and Yorke Landscape region and includes both groundwater and surface water resources. These are prescribed resources under the *Landscape South Australia Act 2019*. A water allocation plan adopted in 2009 provides rules for their management.

Groundwater occurs in three main groundwater systems: two sedimentary aquifers (Upper and Lower) and fractured rock aquifers. The sedimentary aquifers are largely contained within central Barossa Valley between Nuriootpa and Lyndoch (Figure 1.1). The largest volume of groundwater extraction occurs from the fractured rock aquifers that extend across the entire PWRA.

The North Para River is the main watercourse in the PWRA. All streams are ephemeral and feature seasonally disconnected, permanent pools sustained predominantly by groundwater.

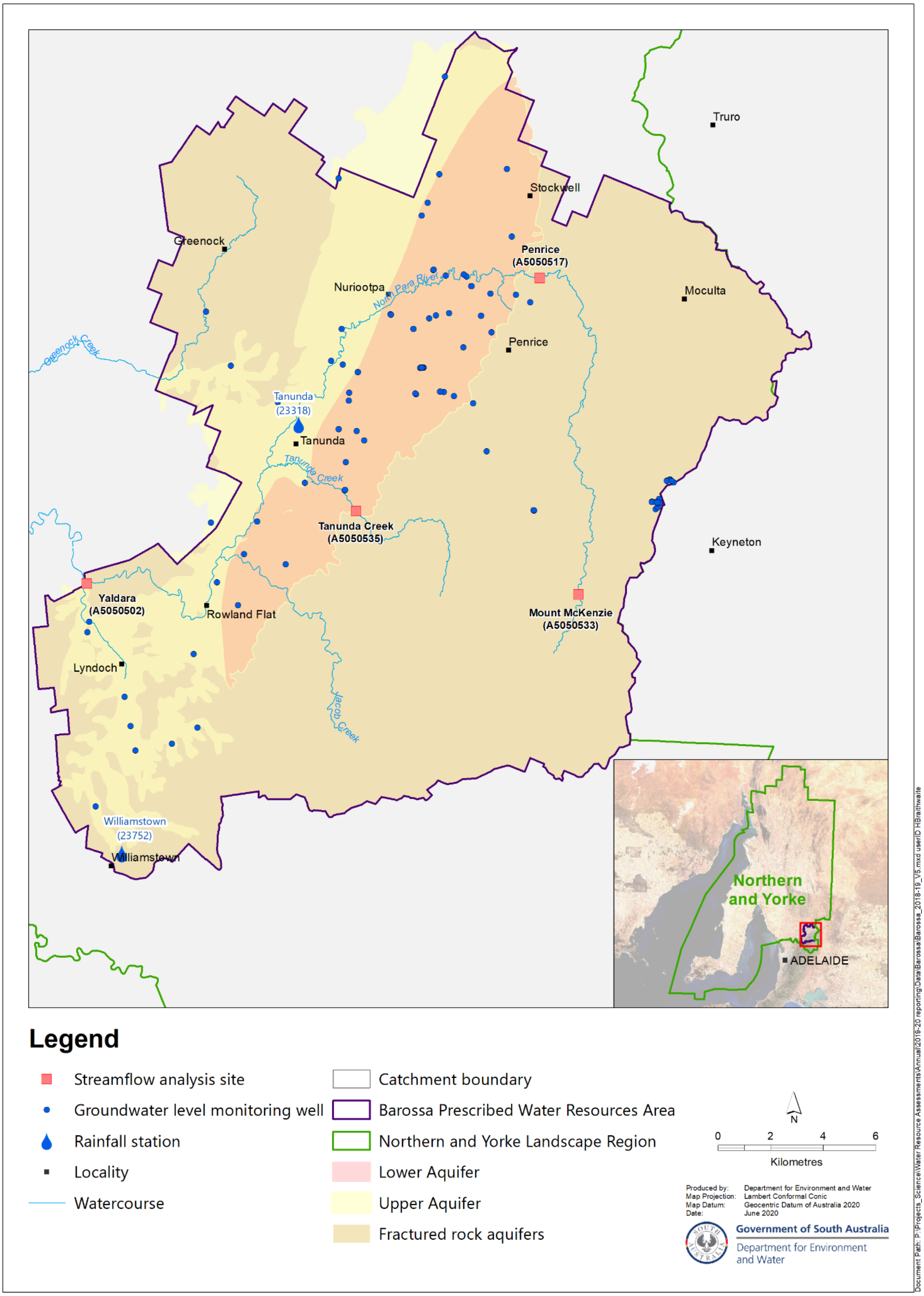

Figure 1.1 Location of Barossa PWRA

2 Methods and data

This section describes the source of rainfall, surface water, groundwater and water use data presented in this assessment and the methods used to analyse and present these data.

2.1 Rainfall

Daily rainfall observations were used from selected Bureau of Meteorology (BoM) stations in order to calculate monthly and annual totals. The data were obtained from the SILO Patched Point Dataset[1] service provided by the Queensland Government, which provides interpolated values to fill gaps in observations (Figure 3.1 and Figure 3.2).

Rainfall maps were compiled using gridded datasets obtained from the BoM (Figure 3.5). The long-term average annual rainfall map (1986–2015) was obtained from Climate Data Online[2]. The map of total rainfall in 2019–20 was compiled from monthly rainfall grids obtained for the months between July 2019 and June 2020 from the Australian Landscape Water Balance[3] website.

2.2 Surface water

2.2.1 Annual streamflow

The status of each of the streamflow gauging stations is determined by expressing the annual streamflow for the applicable year as a percentile[4] of the total period of data availability. The period of data availability for the Yaldara streamflow gauging station is 1977–20. Streamflow data were then given a description based on their percentile and decile[4] (Table 2.1 and Figure 4.1).

Table 2.1. 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 BoM[5]

[1] https://www.data.qld.gov.au/dataset/silo-patched-point-data

[2] http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall/index.jsp

[3] http://www.bom.gov.au/water/landscape/#/rr/Actual/year/-28.4/130.4/3/Point////2020/12/31/

[4] The nth percentile of a set of data is the value at which n% of the data is below it. For example, if the 75th percentile annual flow is 100 ML, 75% of the years on record had annual flow of less than 100 ML. Median streamflow: 50% of the records were above this value and 50% below. Decile: a division of a ranked set of data into ten groups with an equal number of values. In this case e.g. the first decile contains those values below the 10th percentile.

[5] Bureau of Meteorology Annual climate statement at http://www.bom.gov.au/climate/current/annual/aus/

Annual streamflow data (Figure 4.2) is presented as the deviation of each year's streamflow from the long-term average with the bars shaded using the BoM classification shown in Table 2.1.

2.2.2 Monthly streamflow

Monthly streamflow for the applicable year is assessed alongside the long-term average monthly streamflow for the period 1977–20 (Figure 4.3A) and long-term monthly statistics including (a) high flows (25th percentile), (b) median flows (50th percentile) and low flows (75th percentile).

2.2.3 Daily streamflow

Daily streamflow is presented to show the detailed variability throughout the applicable year (Figure 4.3B).

2.2.4 Salinity

Box plots on a monthly basis are used to assess surface water salinity (Figure 2.1 and Figure 4.4). This enables the salinity (TDS; total dissolved solids in mg/L) for the applicable year to be presented against long-term salinity statistics (maximum, 75th percentile, median or 50th percentile, 25th percentile and minimum).

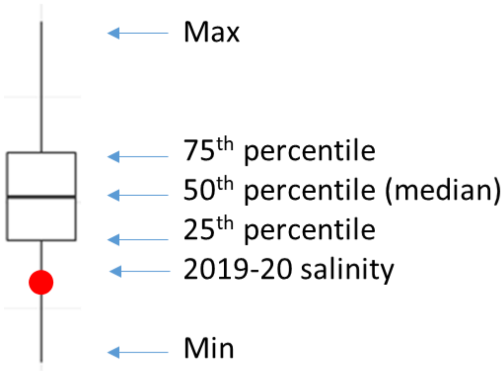

Figure 2.1. Box and whisker plot

2.3 Groundwater

2.3.1 Water level

Water level[6] 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 and other uses. The amount of pumping can vary from year to year, and the proximity of pumping wells to observation 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 the aquifers in the Barossa PWRA return to a recovered maximum level between June and January of the following year.

[6] "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 those wells that meet the selection criteria (see below), the annual recovered water levels are ranked from lowest to highest according to their decile range (Table 2.1) and given a description in a similar way as annual streamflow. The thresholds for criteria by which wells are selected varies depending on the history of monitoring activities in different areas; for the Barossa PWRA, any well with 10 years or more of recovered water level data is included. The number of wells in each description class for the most recent year is then summarised for each aquifer (e.g. Figure 5.1). Hydrographs are shown for a selection of wells to illustrate common or important trends (e.g. Figure 5.3).

Five-year trends are calculated using annual recovered water levels for those wells that 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 5.2).

Moderately sized, sedimentary, confined and unconfined aquifers such as the Upper and Lower Aquifers are given tolerance thresholds of 2 cm/y, while fractured rock aquifers with lower storages are given a tolerance threshold of 1 cm/y.

Twenty-year (or thirty-year) changes in water level were calculated as the difference between the average water level in a three-year period twenty years ago (i.e. 2000-2002) and the average water level in 2020.

2.3.2 Salinity

Since 2018, irrigators in the Barossa PWRA have submitted groundwater samples from which DEW has measured groundwater salinity (total dissolved solids measured in mg/L, abbreviated as TDS). Where multiple samples were submitted from a well in a calendar year, the mean salinity is used for analysis. The results are shown for each aquifer (e.g. Figure 5.4).

15-year salinity trends are calculated where there are at least six 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:

$$\text{Percentage change in salinity (\%)} = \frac{\text{Slope of linear trend line (mg/L/y)} * 15}{\text{Value of trend line at start of period (mg/L)}} * 100$$

The percentage of change over the trend period is then summarised in categories, depending on the range of change for each resource. The salinity measurements are based on the measurement of the electrical conductivity of a water sample and are often subject to small instrument errors (e.g. Figure 5.5).

Salinity graphs are shown for a selection of wells to illustrate common or important trends (e.g. Figure 5.6)

2.4 Water use

Meter readings are used to estimate licensed extraction volumes for both surface water and groundwater sources. Where meter readings are not available, licensed or allocated volumes are used for surface water sources (Figure 6.1 and Figure 6.2).

Non-licensed water use (stock and domestic) from farm dams is not metered and is estimated at 30% of dam capacity (AMLR NRM Board, 2019). Futher information on the number, type and distribution of farm dams in the PWRA is provided in Section 6.3. Dam capacity estimates are undertaken using different methods with data derived from aerial surveys one of the primary sources.

2.5 Further information

Both surface water and groundwater data can be viewed and downloaded using the *Surface Water Data* and *Groundwater Data* pages under the Data Systems tab on WaterConnect[7]. For additional information related to groundwater monitoring well nomenclature, please refer to the Well Details page on WaterConnect[8].

Other important sources of information on water resources in the Barossa PWRA are:

- Summary reports on the surface water (DEWNR, 2011) and groundwater resources of the Barossa PWRA (DEWNR, 2014) and annual surface water status reports such as DEW (2019a) and groundwater level and salinity status reports such as DEW (2019b, c, d).
- The Water Allocation Plan for the Barossa Prescribed Water Resources Area (AMLR NRM Board, 2009).
- Jones-Gill and Savadamuthu (2014) describe the development of a hydrological model of the PWRA (i), to assess the impacts of current water use and potential future water management scenarios on the flow regime and (ii) provide model outputs for ecological water requirement analysis within the PWRA.
- Montazeri and Savadamuthu (2018) provide an update to the surface water modelling undertaken by Jones-Gill and Savadamuthu (2014) to aid in assessing the impacts of current water use, urban development and future climate projections on the Barossa PWRA flow regime.
- Cranswick et al. (2015) provide a detailed background and conceptual model of the hydrogeology of the Barossa PWRA. Hancock et al. (2014) studied interactions between groundwater and surface water systems in the Barossa PWRA. These studies were completed to support water planning in the Barossa PWRA.

[7] https://www.waterconnect.sa.gov.au/Systems/GD/Pages/default.aspx

[8] https://www.waterconnect.sa.gov.au/Systems/GD/Pages/Well-Details.aspx

3 Rainfall

The Barossa PWRA has mild, wet winters and hot, dry summers which are typical of a Mediterranean climate. Annual rainfall varies from more than 750 mm at the highest elevations in the Barossa Ranges to about 300 mm north of Angaston.

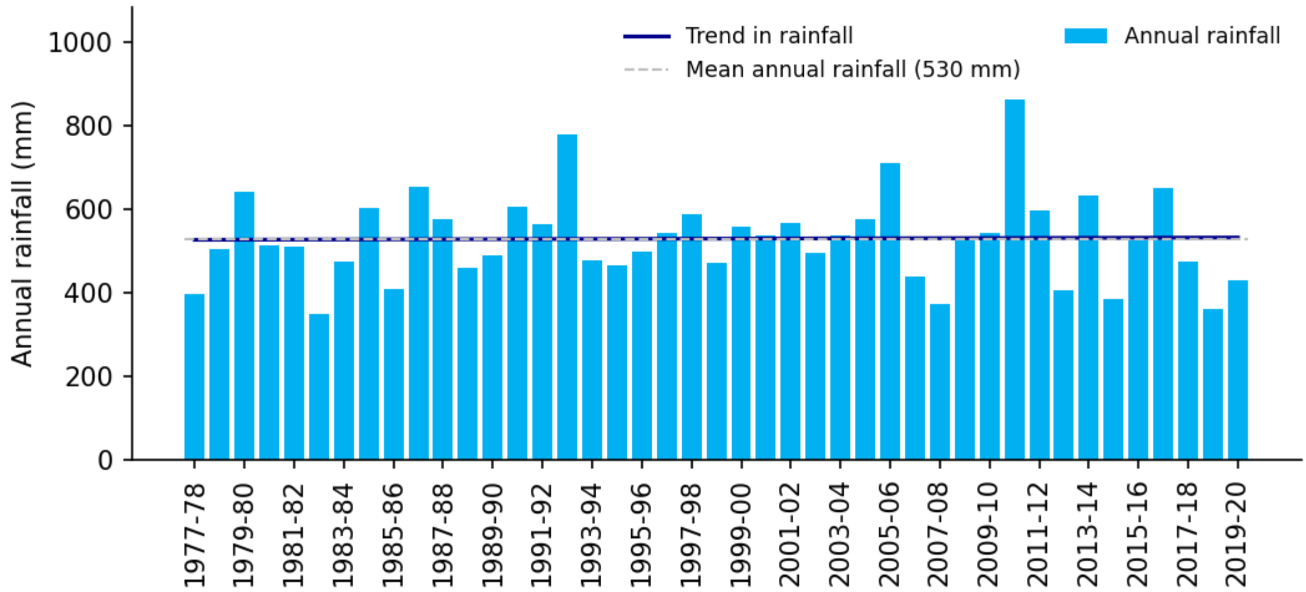

Figure 3.1. Annual rainfall for 1977–78 to 2019–20 at the Tanunda rainfall station (23318)

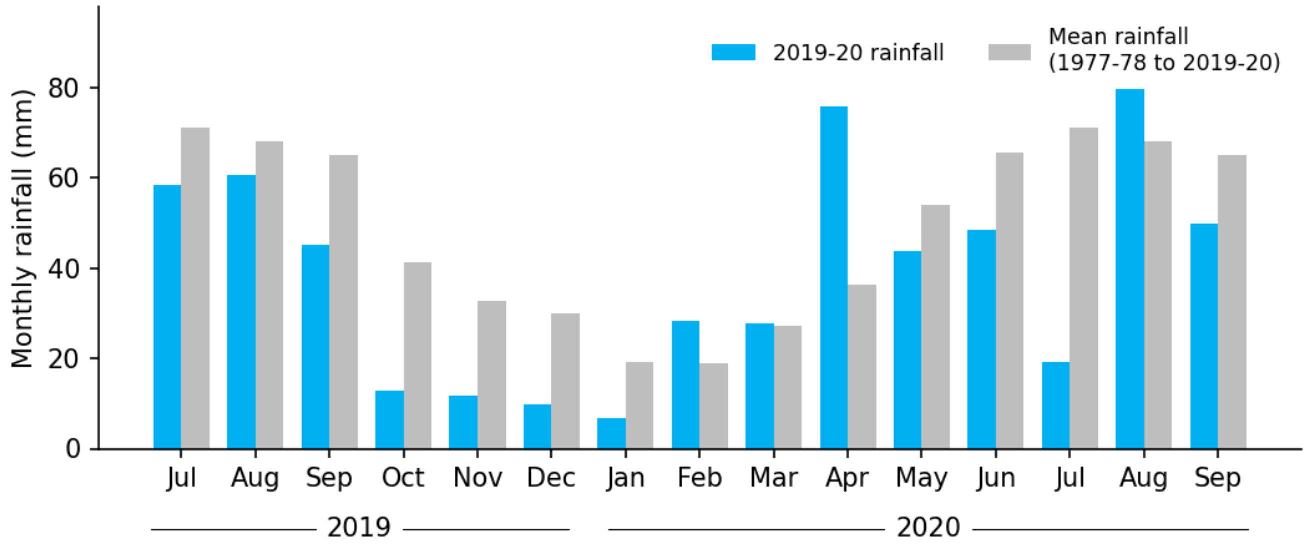

Figure 3.2. Monthly rainfall between July 2019 and September 2020 at the Tanunda rainfall station (23318)

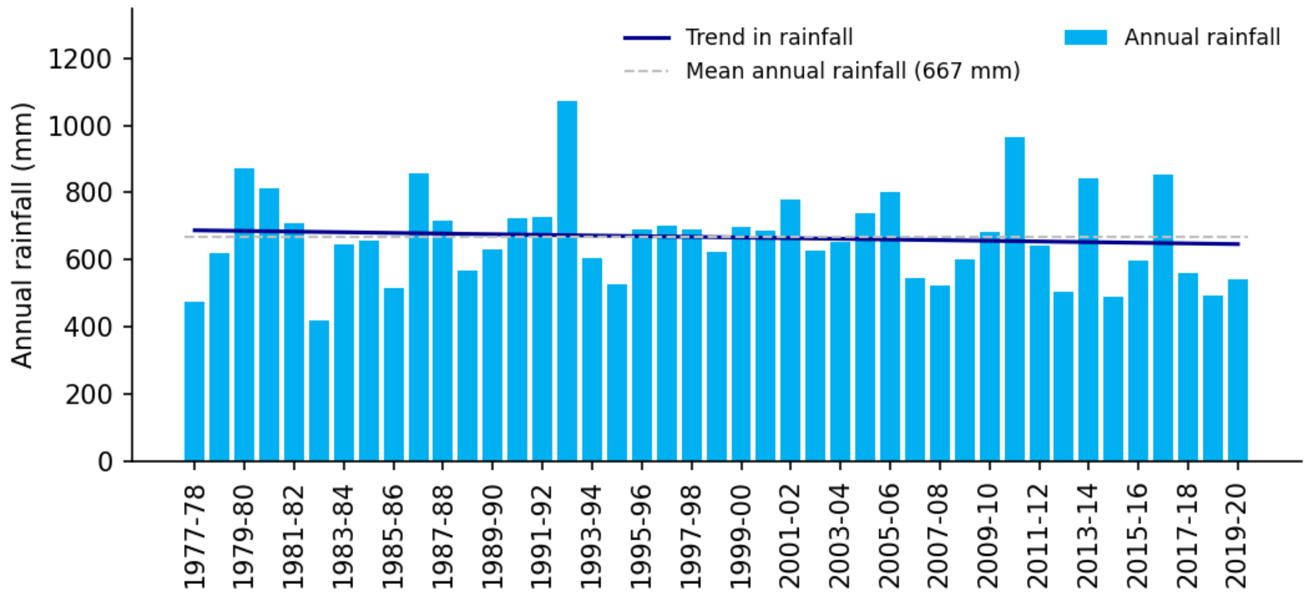

Figure 3.3. Annual rainfall for 1977–78 to 2019–20 at the Williamstown rainfall station (23752)

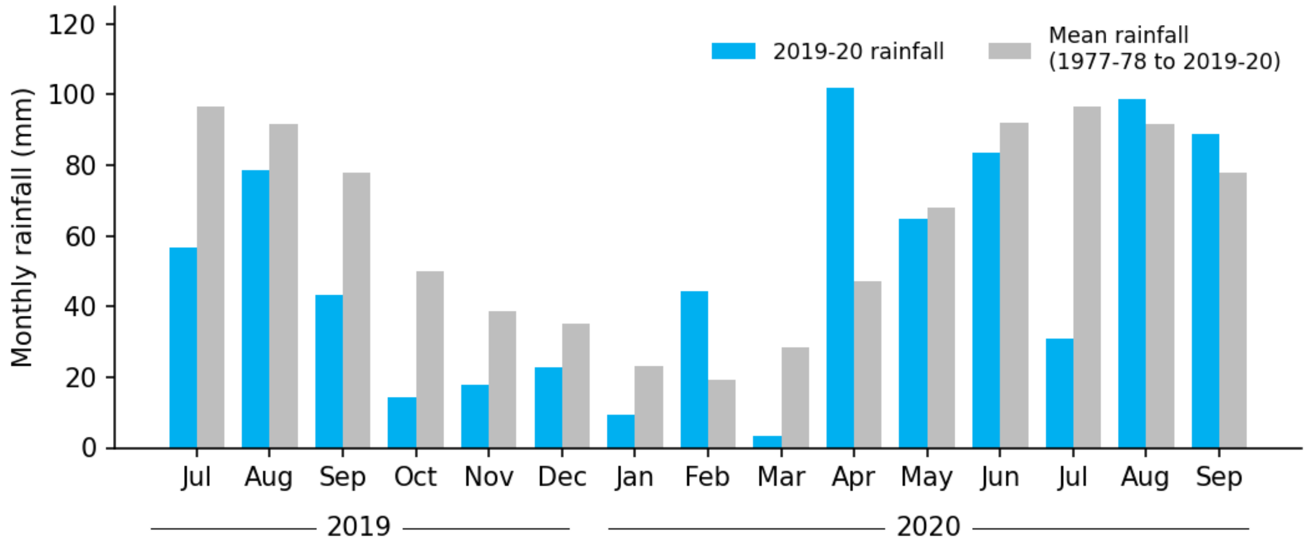

Figure 3.4. Monthly rainfall between July 2019 and September 2020 at the Williamstown rainfall station (23752)

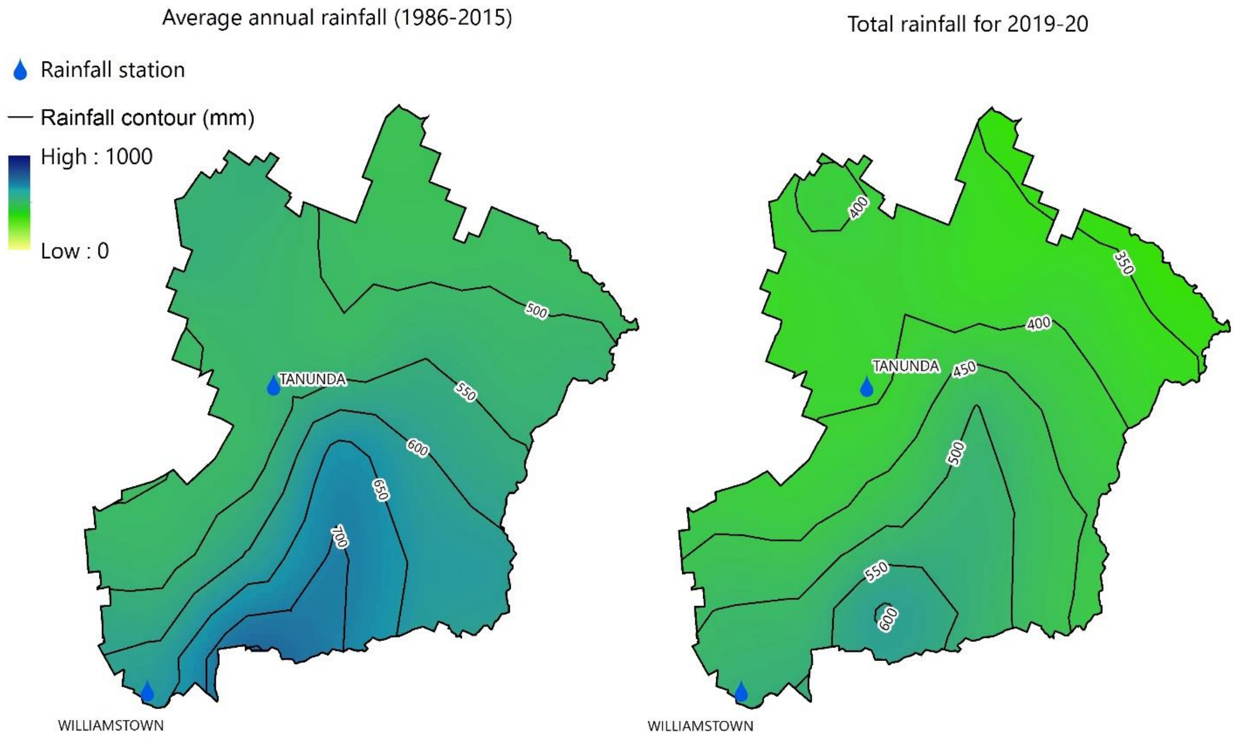

Figure 3.5. Rainfall in the Barossa PWRA for 2019–20 compared to the long-term average annual rainfall (1986–2015)

- The Tanunda rainfall station (BoM station 23318) is used as a representative rainfall station for the central and northern parts of the Barossa PWRA. The annual total recorded for 2019–20 was 430 mm. This was 100 mm lower than the average annual rainfall of 530 mm/y (1977–20). The long-term trend is stable over this period (Figure 3.1) but the last 3 years have been below-average.
- The Williamstown rainfall station (BoM station 23725) is used as a representative rainfall station for the southern part of the Barossa PWRA which generally experiences higher rainfall. The annual total recorded for 2019–20 was 541 mm. This was 126 mm lower than the average annual rainfall of 667 mm/y (1977–20). The long-term trend is decreasing over this period (Figure 3.3).
- Below-average rainfall was also observed at other rainfall stations in the PWRA.
- Dry conditions were observed throughout 2019 (July-December) with the 2019 winter being drier than the 2020 winter. The spring and summer months were also extremely dry in comparison to the long-term average (Figure 3.2). Above-average rainfall was recorded in February, April and August in 2020.
- Rainfall in 2019–20 was markedly lower in all parts of the PWRA compared to average annual rainfall patterns. The long-term average annual rainfall shows the higher rainfall bands (>650 mm/y) extending north to the Tanunda Creek catchment whereas these higher bands were absent in the PWRA in 2019–20 (Figure 3.5)[9].

[9] 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 and further detail is provided in Section 2.1.

4 Surface water

4.1 Streamflow

The North Para River is the main watercourse in the Barossa PWRA and flows south to north in the eastern-side of the PWRA between Mount McKenzie and Penrice streamflow gauging stations (Figure 1.1). The river then heads in a south-westerly direction between the Penrice and Yaldara streamflow gauging stations. Major tributaries include Tanunda Creek and Jacobs Creeks. All streams are ephemeral and feature seasonally disconnected permanent pools, sustained predominantly by groundwater. Trends in streamflow and salinity are primarily rainfall driven, i.e. below-average winter rainfall will result in reduced annual streamflow volumes. Conversely, higher rainfall will result in increased surface water availability.

Four streamflow gauging stations (Figure 1.1) are used as representative sites when assessing streamflow in the Barossa PWRA (Figure 4.1):

- Three stations on the North Para River: Mount McKenzie (A5050533), Penrice (A5050517) and Yaldara (A5050502).
- One station on the Tanunda Creek: Bethany (A5050535).

In 2019–20, lower-than-average streamflow was recorded in all four representative gauging stations (Figure 4.1), with Penrice recording 'lowest on record' streamflow. Further detail on methodologies used for analysis can be found in Section 2.

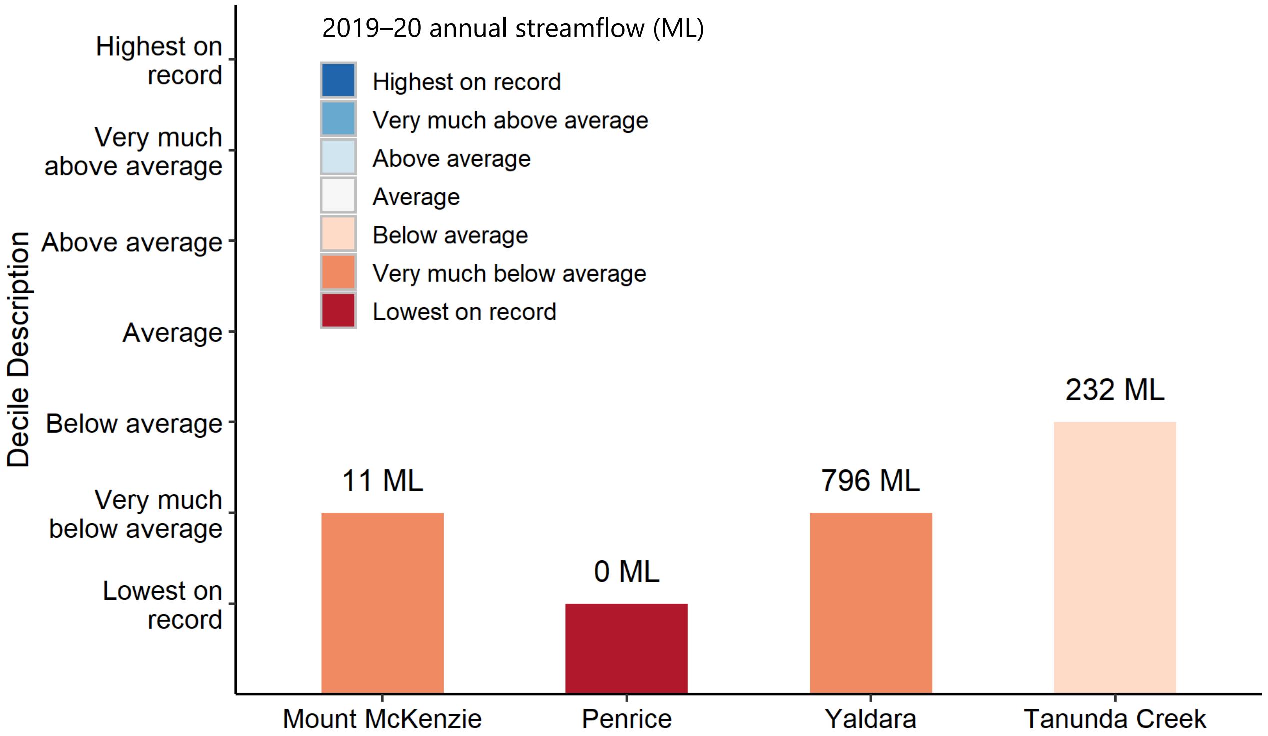

Figure 4.1. Barossa PWRA annual streamflow summary 2019–20

4.1.1 North Para River: Yaldara (A505050)

The principal long-term streamflow gauging station for the PWRA is located at Yaldara, at the outlet of the North Para catchment, and covers a catchment area of 376 km^2.

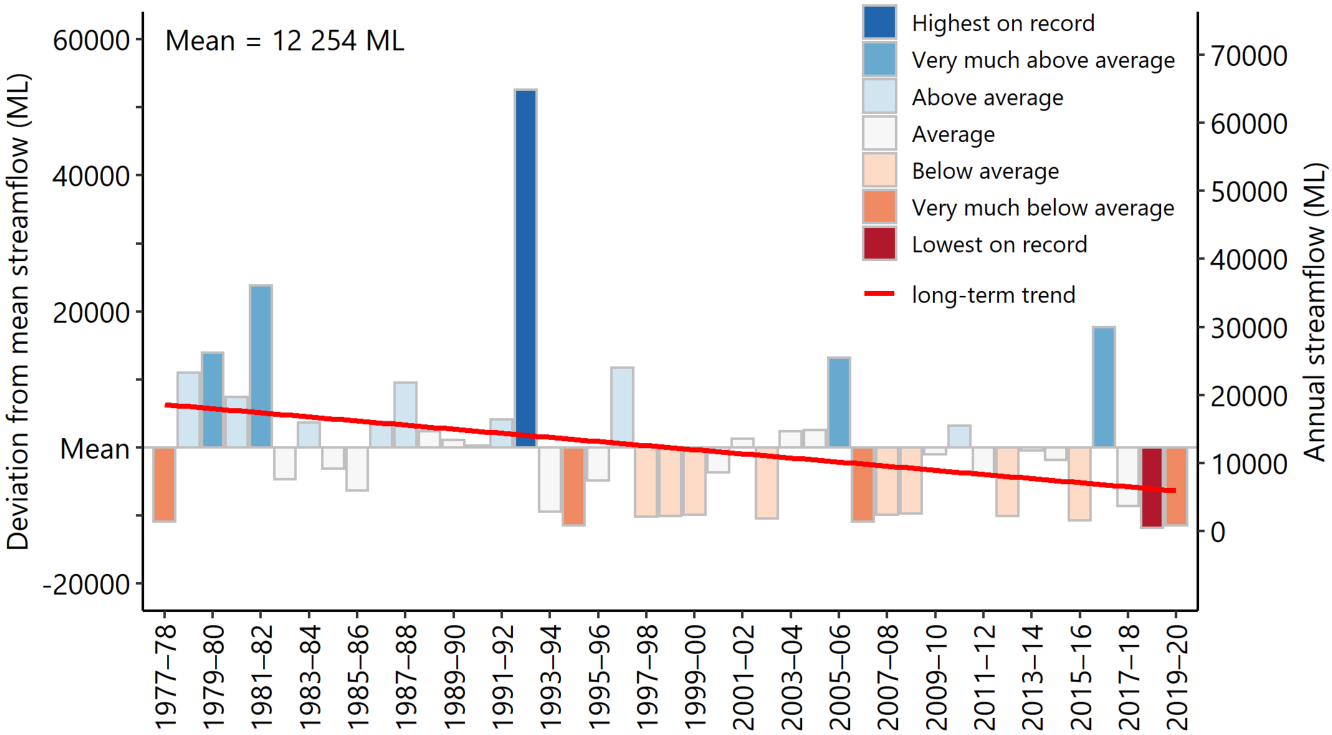

Figure 4.2. Annual deviation from mean streamflow at Yaldara (1977–78 to 2019–20)

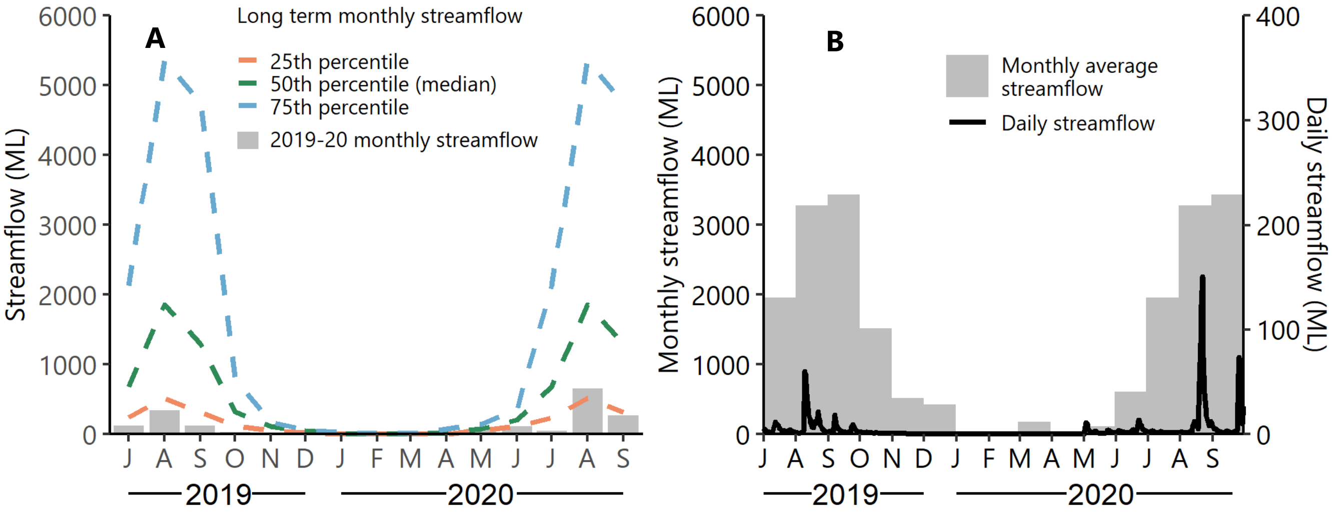

Figure 4.3. (A) Long-term monthly statistics and 2019–20 monthly streamflow at Yaldara; (B) Long-term average monthly streamflow and 2019–20 daily streamflow at Yaldara

The deviation of each individual year's streamflow from the long-term average streamflow is shown in Figure 4.2. Yaldara recorded an annual streamflow of 796 ML in 2019–20, which is 11 459 ML (94%) below the average annual streamflow of 12 254 ML (1977–20).

The annual total is ranked as 'very much below average' assessed for the period 1977–20. Annual streamflow at Yaldara indicates a long-term declining trend with 12 out of the last 15 years below the average annual streamflow (Figure 4.2).

Figure 4.3A shows the monthly streamflow for 2019–20 (grey bars) relative to the long-term monthly streamflow (1977–20) for (a) low flows (25th percentile), (b) median flows (50th percentile) and high flows (75th percentile). All months in 2019–20 except May and August 2020 were below the 25th percentile streamflow at the Yaldara streamflow gauging station with no flow recorded between December 2019 and April 2020 (Figure 4.3A). In the period from July to September 2019, flows remained below the long-term average monthly streamflow. Monthly streamflow recorded at Yaldara remained below the long-term average from July to September 2020.

Figure 4.3B presents the long-term average monthly streamflow (1977–20) and the daily flows for 2019–20. Maximum daily flows were recorded in August and flow was persistent during the months of July to mid-November 2019, and then ceased until early May 2020.

4.2 Salinity

Below-average summer rainfall can result in increased irrigation extractions. These two elements can cause salinities to increase by reducing the amount of streamflow available to dilute mobilised salts. Conversely, higher rainfall will result in increased surface water availability and decreased irrigation extractions, resulting in a reduction or stabilisation of salinity.

Salinity is recorded at the Yaldara, Penrice and Tanunda Creek streamflow gauging stations, with salinity typically increasing further downstream due to the accumulation of salts. Figure 4.4 shows the long-term monthly salinity statistics for the period 1992–2019 and median monthly values for 2019–20 (red dots) at the Yaldara streamflow gauging station.

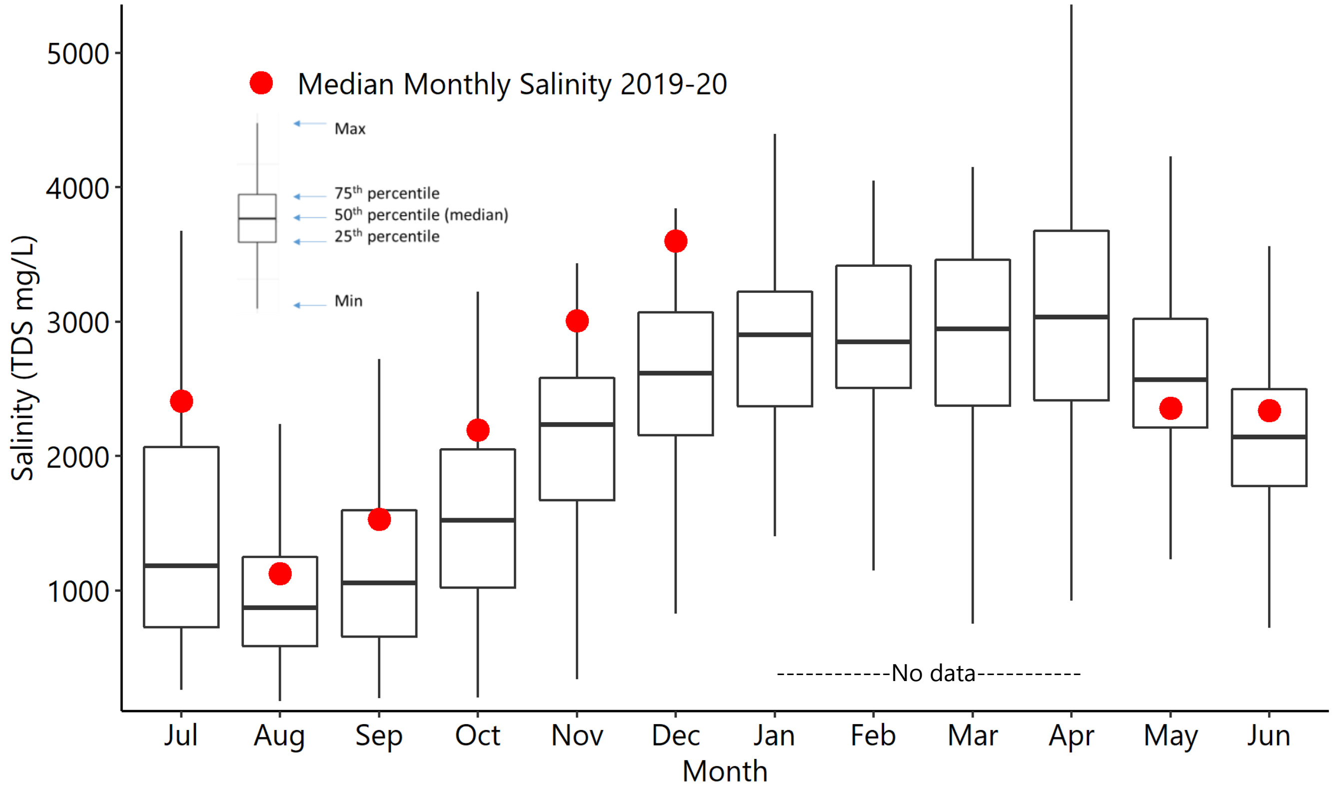

Figure 4.4. Long-term and 2019–20 monthly salinity at Yaldara streamflow gauging station (A5050502)

Salinity in the North Para River is generally greater than 1000 mg/L, increasing further down the catchment, and the highest salinity recorded at Yaldara in 2019–20 was 3841 mg/L. The long-term monthly data at this site indicates a high variability in monthly salinity, which is indicated by the greater range between the minimum and maximum values. The majority of the recorded salinity values were greater than the 75th percentile in 2019. This higher salinity is likely to be a result of the lower-than-average rainfall, and therefore streamflow experienced. There were no salinity levels recorded between January and April 2020 due to insufficient streamflow recorded at the site. However, streamflow salinity data was available in May and June 2020 as a result of the higher-than-average rainfall which occurred in late-April.

In comparison, salinity levels at Tanunda Creek were lower than 1000 mg/L for 80% of the available data period. The highest salinity recorded at Tanunda Creek in 2019–20 was 1538 mg/L.

5 Groundwater

5.1 Hydrogeology

The Barossa PWRA consists of three main groundwater systems: two sedimentary aquifers (Upper Aquifer and Lower Aquifer) that are located within the region's largest valley, and fractured rock aquifers of the Mount Lofty Ranges that form the eastern and western margins of the valley.

5.1.1 Upper Aquifer

The Upper Aquifer consists of sediments that are often referred to as the middle, upper gravel and watertable aquifers. They overlie a carbonaceous clay, confining layer. The Upper Aquifer includes Tertiary non-carbonaceous sands, lenticular sands and gravels within Quaternary clays and Holocene gravels and sands associated with drainage channels incised into the Quaternary clay. This aquifer is generally unconfined, however some of the sub-aquifers can be confined. In addition to the main valley, aquifers belonging to this groundwater system also occur in a broad valley to the south of Lyndoch.

5.1.2 Lower Aquifer

The Lower Aquifer is generally confined and consists of Tertiary carbonaceous clays, gravels, sands and silts that were deposited in the deepest part of the basin and form a complex system of interconnected sub-aquifers. It is separated from the overlying Upper Aquifer by a carbonaceous clay confining layer. Pressure levels in the Lower Aquifer are subject to large seasonal fluctuations in response to pumping. In general, groundwater in the Lower Aquifer flows towards the south and south-west.

5.1.3 Fractured rock aquifers

Pre-Cambrian and Palaeozoic sandstones, siltstones and schists form fractured rock aquifers where groundwater is stored and flows through fractures and fissures in the rock. Wells completed in this aquifer generally have low yields, although there are some exceptions. Beneath the valley sediments, the upper parts of the fractured rock aquifers are generally a highly weathered clay-rich layer, which can act as a confining layer between the fractured rock aquifers and the overlying sedimentary aquifers. Groundwater in the fractured rock aquifers beneath the valley floor generally flows to the south and south-west; in some areas steep hydraulic gradients can occur. The fractured rock aquifers are the most widely used in the PWRA.

5.2 Upper Aquifer - water levels

During 2019–20, the majority of Upper Aquifer monitoring wells recorded below-average (39%) or lowest-on-record (50%) levels when compared to their respective historical levels. Those wells that recorded lowest-on-record levels are primarily located north of Nuriootpa and south of Lyndoch. Wells in the central part of the valley, near Tanunda, recovered to levels which were generally below average (Figure 5.1).

The change in water level over the past 20 years (Section 2.3.1) ranged from a decline of 7.12 m to a rise of 0.49 m (the median change is a decline of 1.14 m). The majority of wells (78%) show a declining trend in water level over this period.

Five-year trends in water levels are declining in all wells, with rates of decline ranging from 0.07 m/y to 1.03 m/y (the median rate of decline is 0.38 m/y) (Figure 5.2).

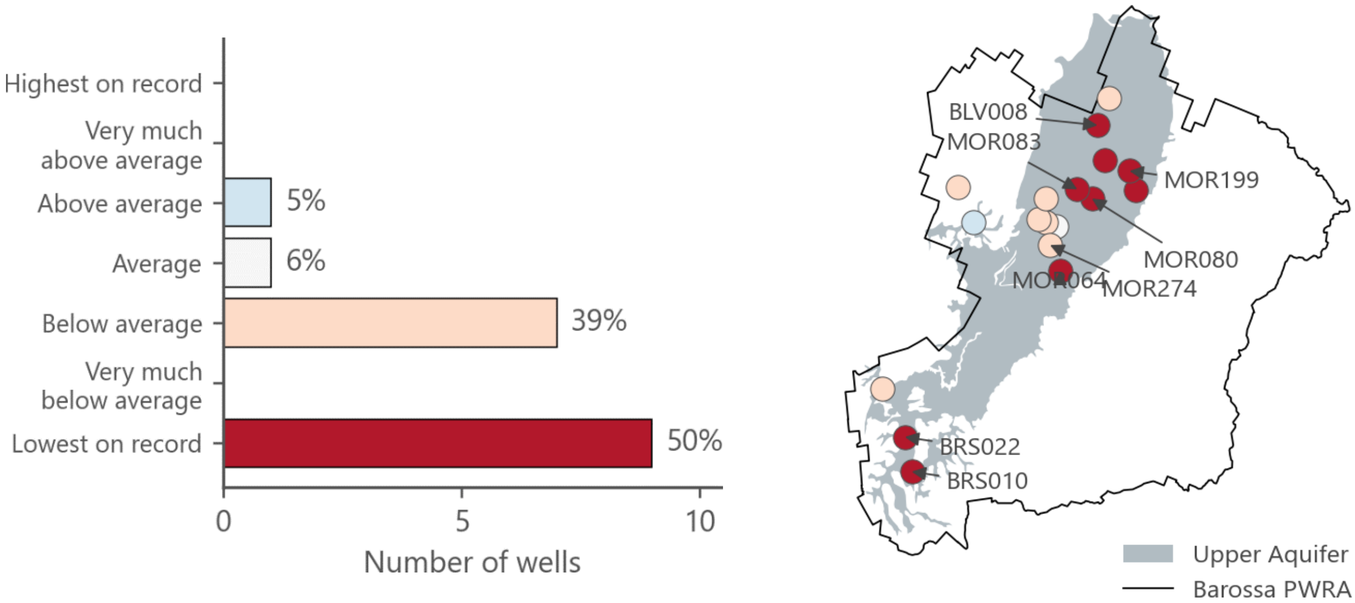

Figure 5.1. 2020 recovered water levels for wells in the Upper Aquifer

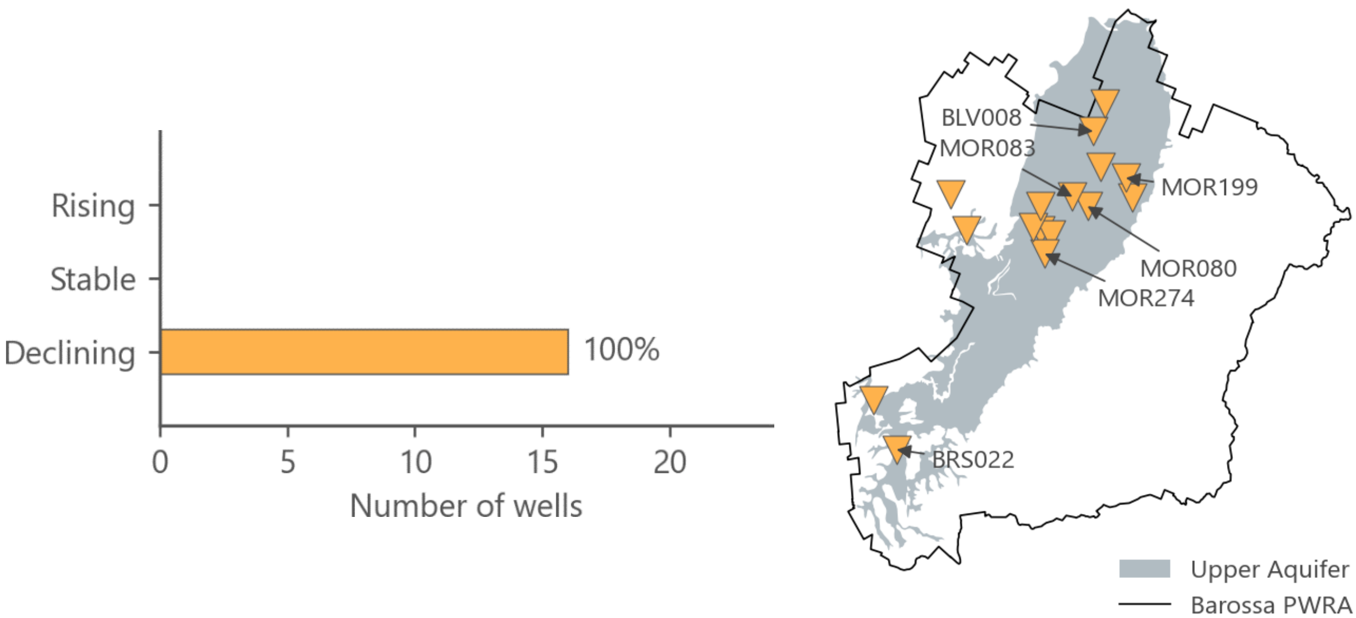

Figure 5.2. 2016–20 trend in recovered water levels for wells in the Upper Aquifer

Hydrographs from a selection of Upper Aquifer monitoring wells illustrate common or important trends (Figure 5.3). The majority of groundwater use from the Upper Aquifer occurs to the east and south of Nuriootpa where the Upper Aquifer is thickest and is recharged from the North Para River. Monitoring wells in the area showing below-average and lowest-on-record levels (e.g. since 1990, MOR080 and MOR199 show declines of 2.12 and 4.73 m, respectively.

Further south, near Tanunda and Lyndoch (e.g. MOR064 and BRS010), water levels have been declining gradually since the 1990s and were at their lowest levels on record in 2020.

In the north of the PWRA, shallow groundwater is more saline and is not suitable for irrigation. Gradual declines in level (e.g. BLV008) may be a caused by a decline in rainfall over the past 15 years and declining water levels in the underlying fractured rock aquifers.

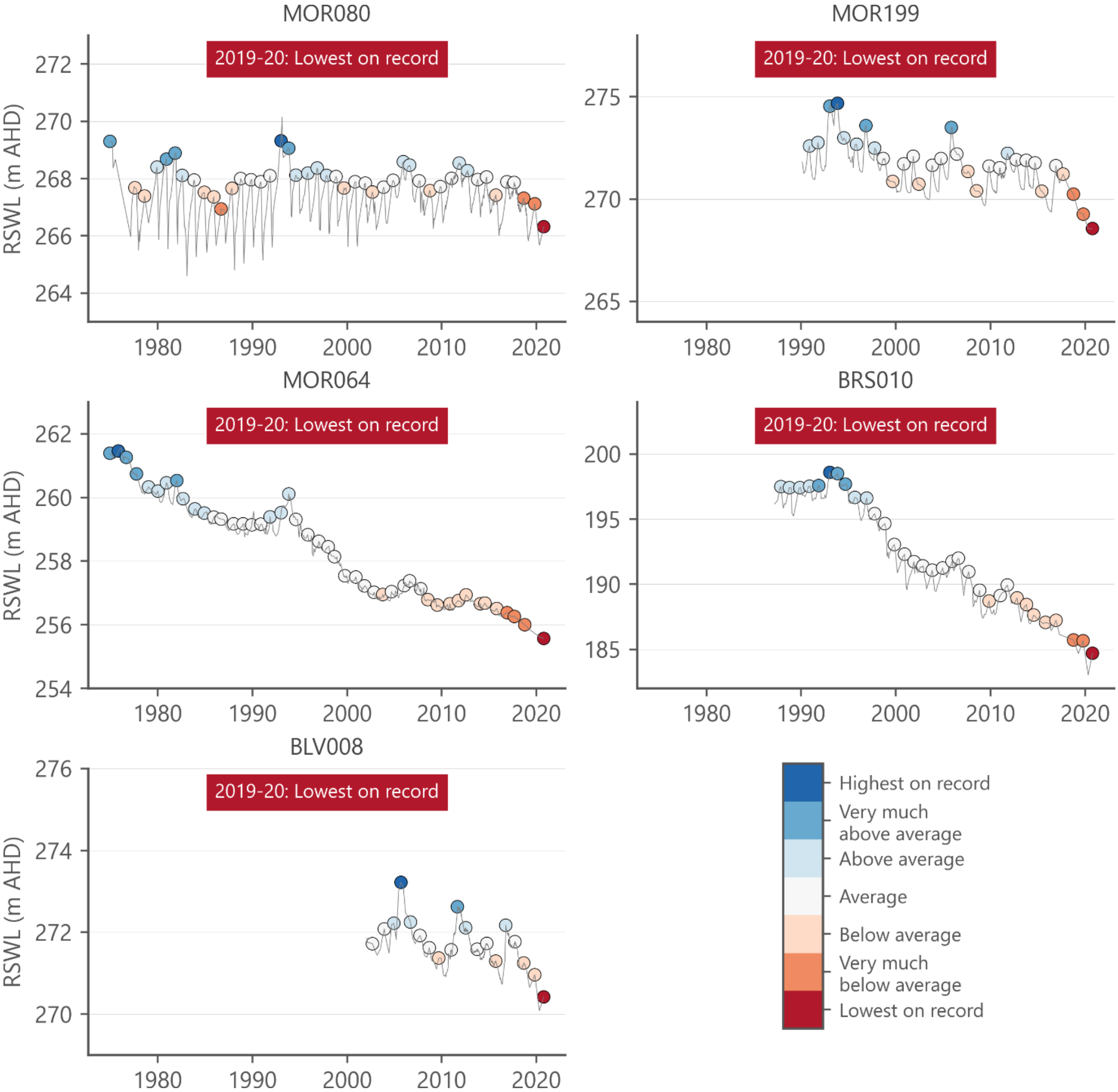

Figure 5.3. Selected Upper Aquifer hydrographs

5.3 Upper Aquifer - salinity

Groundwater salinity is highly variable in the Upper Aquifer, ranging from 960 to 12 000 mg/L. The lowest salinities are found in the vicinity of the North Para River as it flows into the Barossa Valley, near Angaston Creek and in the Lyndoch Valley. Generally, higher salinity groundwater is found to the north and west of the North Para River and to the east of Tanunda. Since 2018, irrigators in the Barossa PWRA have submitted groundwater salinity samples. In 2020, sampling results from 23 irrigation bores in the Upper Aquifer ranged between 666 mg/L and 2704 mg/L with a median of 1519 mg/L (Figure 5.4).

In the 15 years to 2020, nine of 14 wells (64%) show an increasing trend in salinity (Section 2.3.2) (Figure 5.5). These wells are generally located in the main valley near Nuriootpa where most of groundwater extraction from the Upper Aquifer occurs. The 15-year salinity trends vary from a decrease of 2.42% per year to an increase of 1.61% per year, with a median rate of 0.10% increase per year.

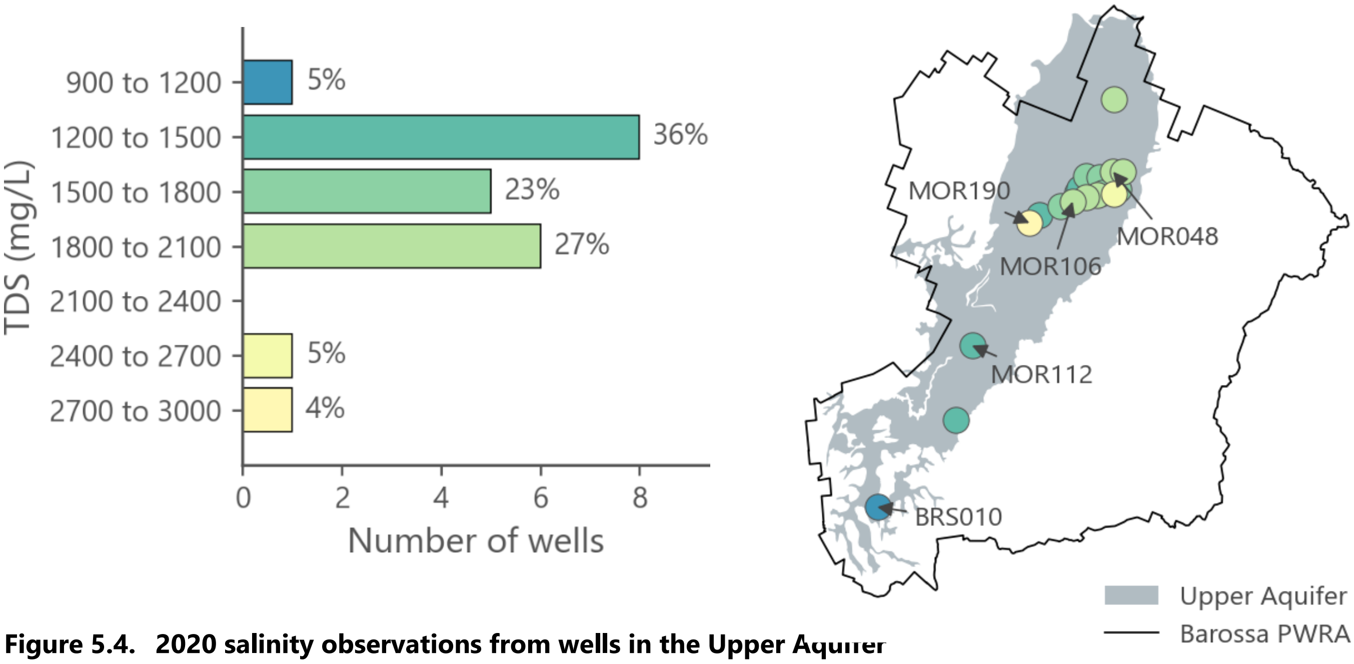

Figure 5.4. 2020 salinity observations from wells in the Upper Aquifer

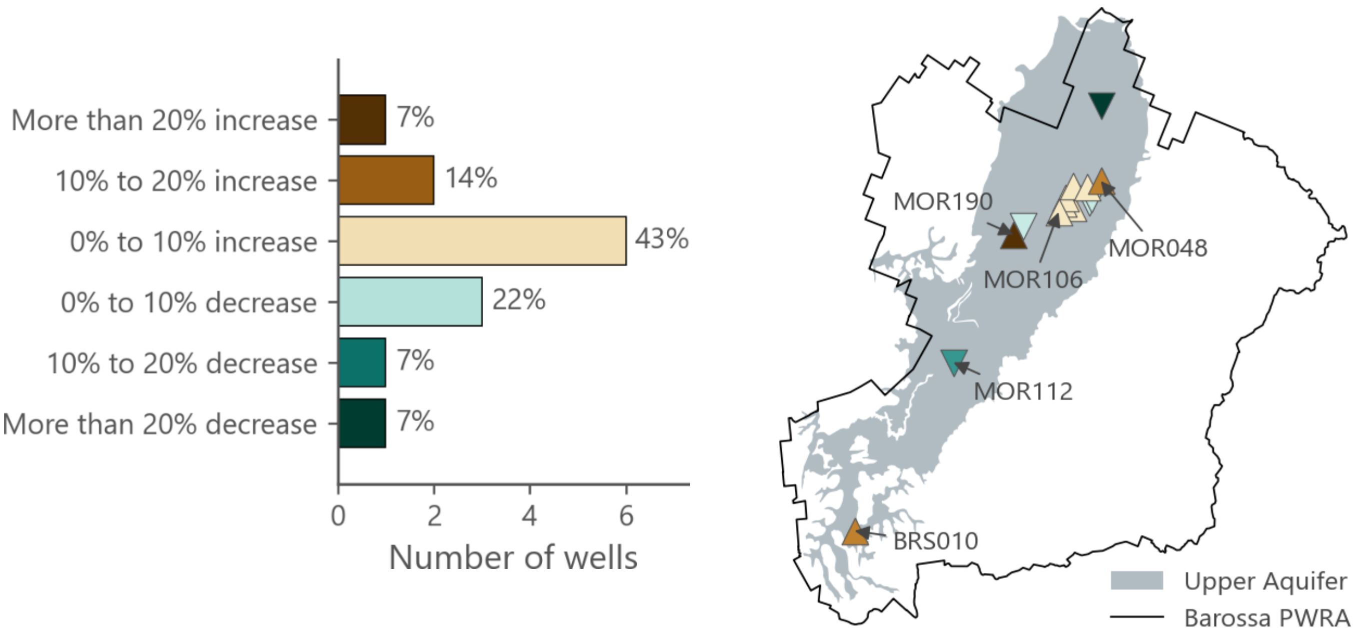

Figure 5.5. Salinity trend in the 15 years to 2020 in the Upper Aquifer

Hydrographs from a selection of Upper Aquifer monitoring wells illustrate common or important trends (Figure 5.6). Due to higher salinity of Upper Aquifer, water from the Barossa Infrastructure Limited (BIL) scheme is being mixed with groundwater to improve the water quality for irrigation purposes.

Long-term monitoring data at MOR048 shows a gradual increase in groundwater salinity from 1128 mg/L in 1960 to 1815 mg/L in 2020. Similarly, increases in salinity is observed at MOR106 at Nuriootpa since the early-2000s.

MOR190 shows a close relationship with rainfall with decreases in salinity in 1992 and 2005 likely due to aquifer freshening following above-average rainfall, while recent high salinity values may be due to below-average rainfall in the past three years (Figure 3.1). Further south MOR112 shows a decrease in salinity in the late 2000s but has since remained stable.

To the south of PWRA, near Lyndoch, BRS010 is showing an increase in groundwater salinity since 2005.

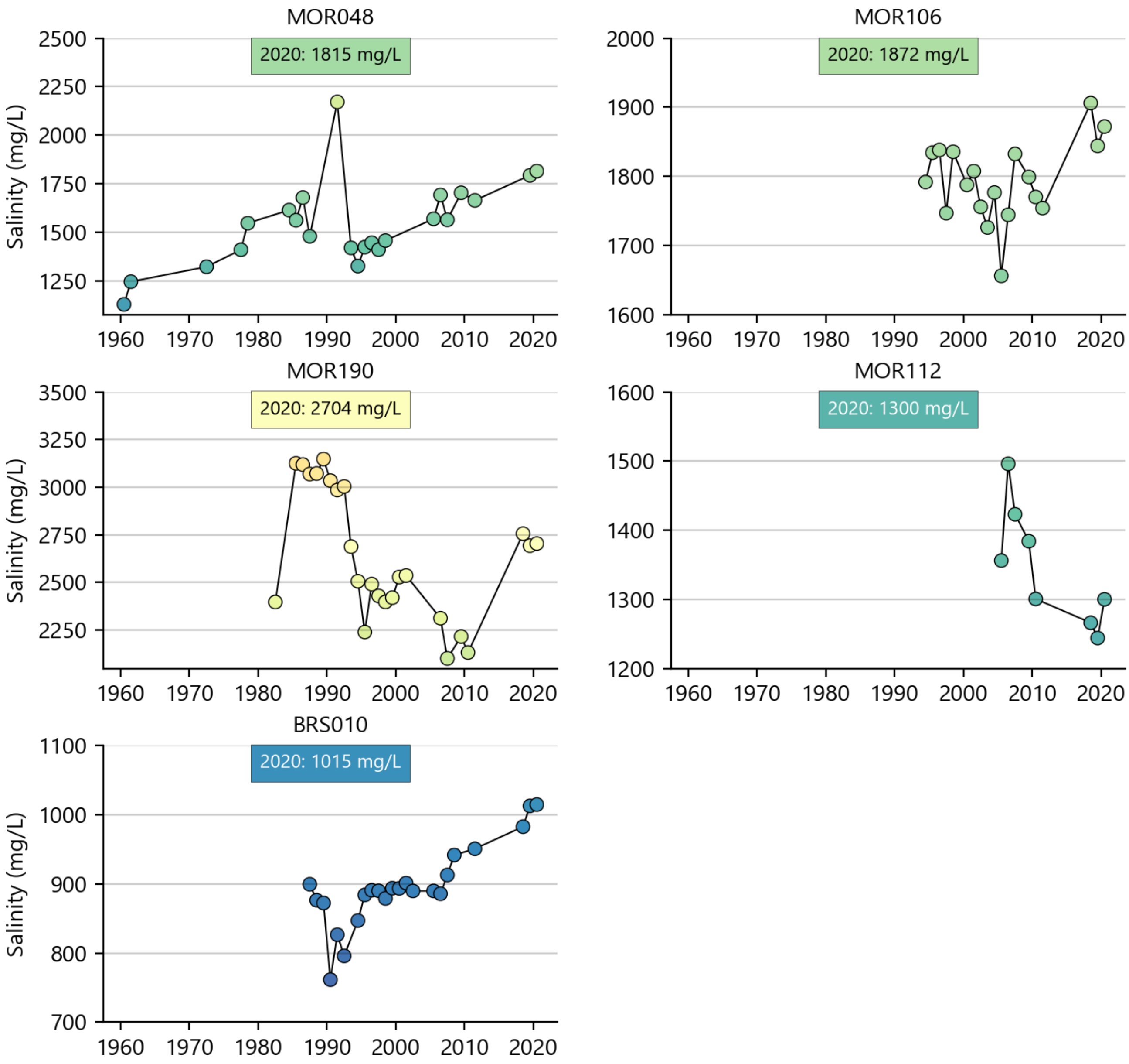

Figure 5.6. Selected Upper Aquifer salinity graphs

5.4 Lower Aquifer - water levels

Druing 2019–20, the majority (50%) of Lower Aquifer monitoring wells recovered to their lowest water level on record. These wells are primarily located north of Nuriootpa. The majority of wells (84%) show a decline in water level over the past 20 years (Section 2.3.1), ranging from declines of 4.62 m in MOR205 to 0.84 m in MOR202 (Figure 5.7).

The change in water levels over the past 30 years ranged from a decline of 5.25 m to a rise of 3.28 m (the median change is a decline of 2.37 m). The majority of wells (94%) show a declining trend in water level over this period.

Five-year trends in water levels are declining in all wells with rates of decline ranging from 0.08 m/y to 2.61 m/y (the median rate of decline is 0.60 m/y) (Figure 5.8).

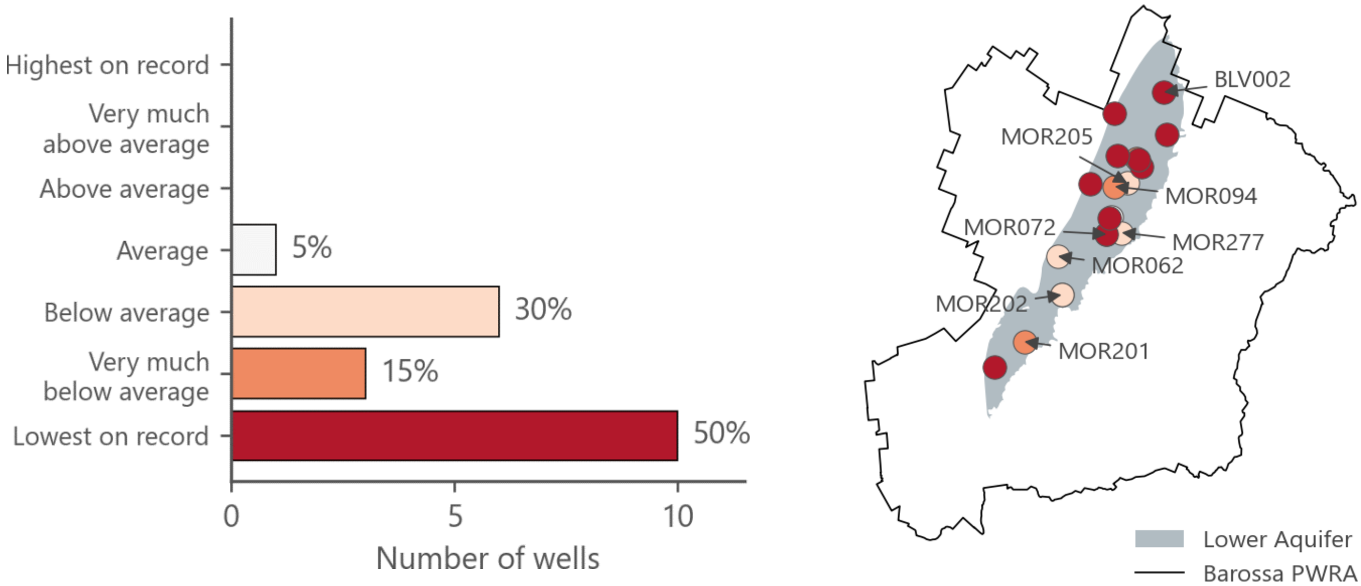

Figure 5.7. 2020 recovered water levels for wells in the Lower Aquifer

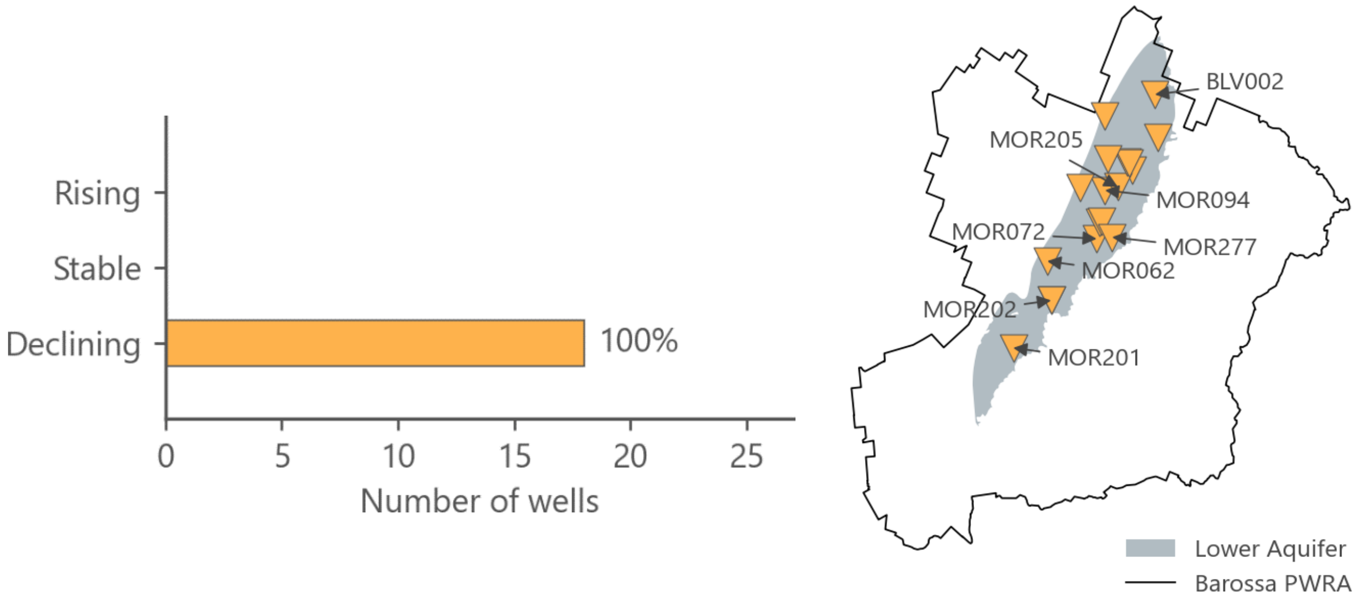

Figure 5.8. 2016–20 trend in recovered water levels for wells in the Lower Aquifer

Hydrographs from a selection of Lower Aquifer monitoring wells illustrate common or important trends (Figure 5.9). The majority of groundwater extraction from the Lower Aquifer occurs in the floor of the Barossa Valley from Light Pass to Rowland Flat. Where the aquifer is confined, monitoring wells show large seasonal drawdowns in response to groundwater pumping, followed by rapid recoveries after the irrigation season (e.g. MOR094, MOR062 and MOR201).

MOR072 is completed in the shallower part of the Lower Aquifer where the aquifer can be semi-confined and not as responsive to pumping and winter recovery. Nonetheless, the total decline in water levels over the past 30 years is approximately 5 m.

In the northern part of the PWRA, a smaller volume of groundwater is extracted from the Lower Aquifer and water levels are declining more gradually (e.g. BLV002).

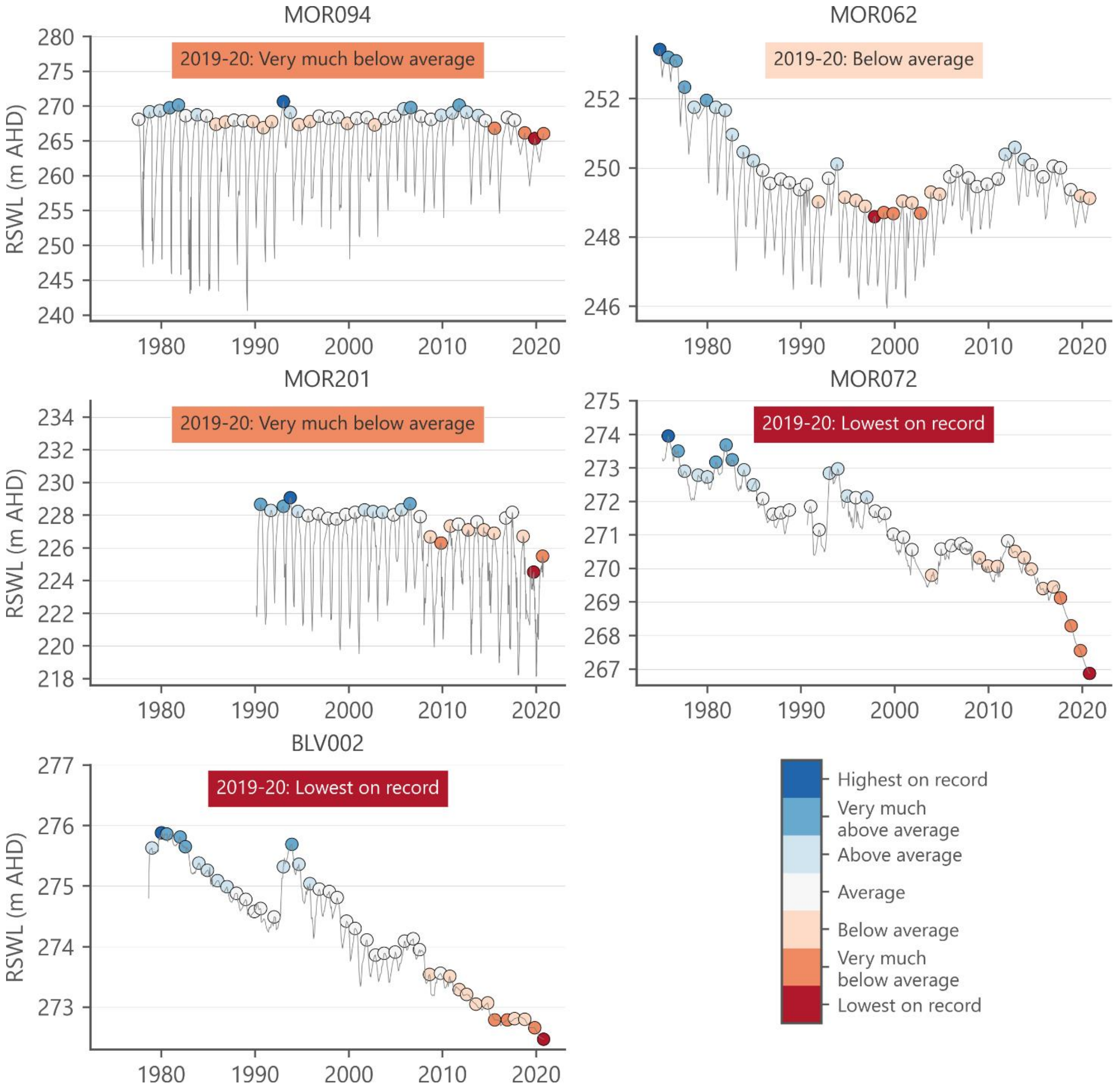

Figure 5.9. Selected Lower Aquifer hydrographs

5.5 Lower Aquifer - salinity

Since 2018, irrigators in the Barossa PWRA have submitted groundwater salinity samples. In 2020, salinity results from 33 irrigation wells in Lower Aquifer ranged between 497 mg/L and 2504 mg/L with a median of 1284 mg/L (Figure 5.10).

In the 15 years to 2020, the majority of wells (75%) recorded a change of less than ±10% (Figure 5.11). Salinity trends over the 15 year period vary from a decrease of 2.26% per year to an increase of 1.68% per year, with the median rate of 0.01% decrease per year.

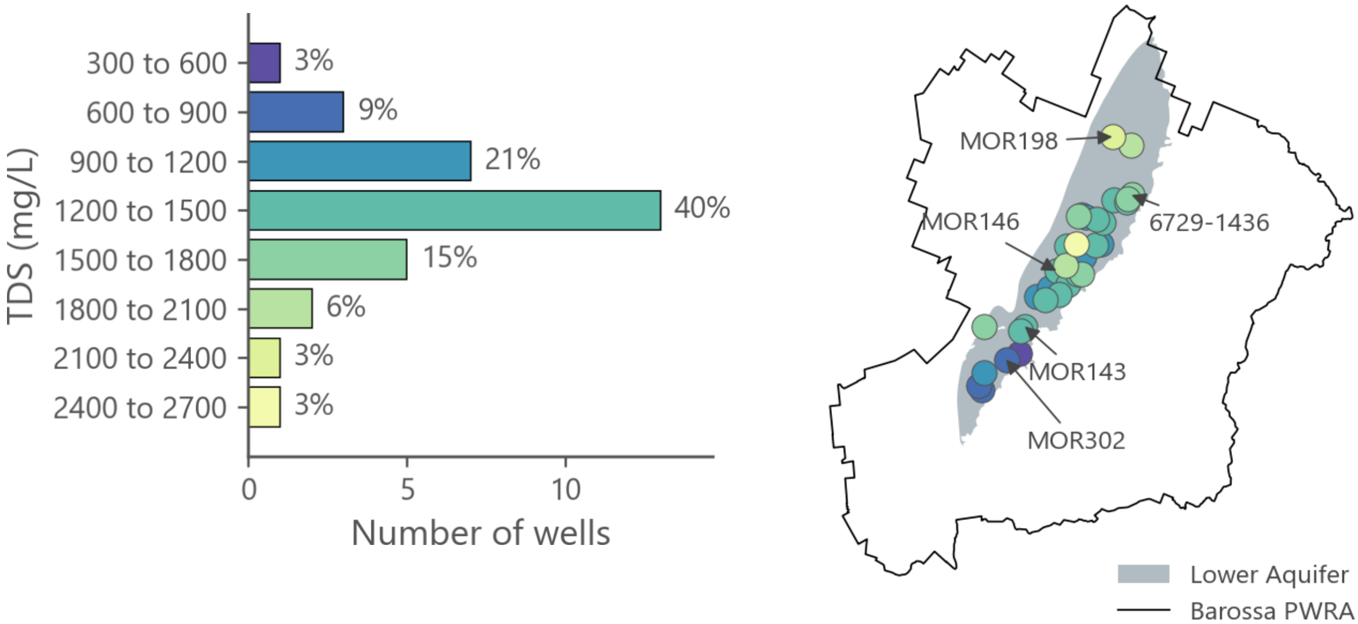

Figure 5.10. 2020 salinity observations in the Lower Aquifer

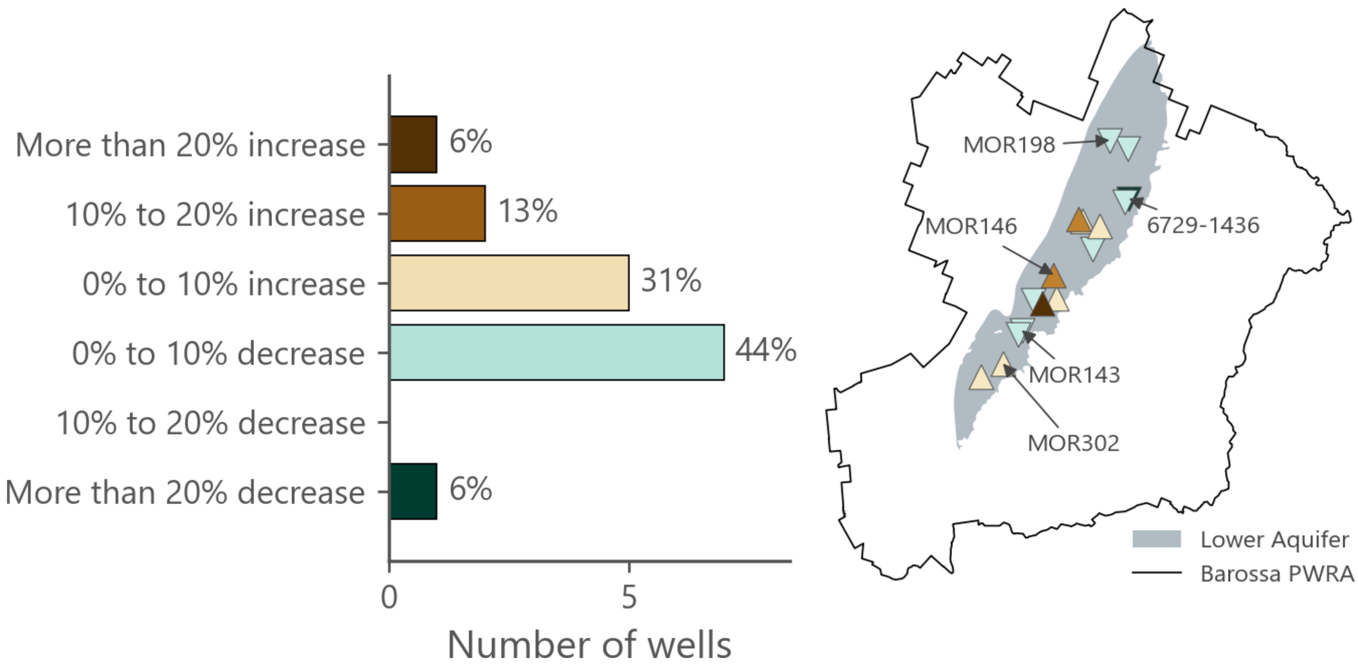

Figure 5.11. Salinity trend in the 15 years to 2020 in the Lower Aquifer

The salinity of the Lower Aquifer is generally below 3000 mg/L with wells showing higher salinity usually located to the north of the PWRA. Hydrographs from a selection of Lower Aquifer monitoring wells illustrate common or important salinity trends (Figure 5.12). MOR146, which is located to the northeast of Tanunda, shows a 15% increase in salinity since early 2000's which appears to have stabilised in the past three years.

To the north of the PWRA, MOR198 and 6729-1436 show a relatively stable or decreasing long-term trend. Decreases in groundwater salinity at 6729-1436 is likely to be due to managed aquifer recharge operations coincident with this well's location.

To the south, MOR143 shows a relatively stable salinity while MOR302 shows a gradual increase over the monitoring period. Despite the increase at MOR302, groundwater salinity in the lower aquifer is typically low at this location (Figure 5.10)

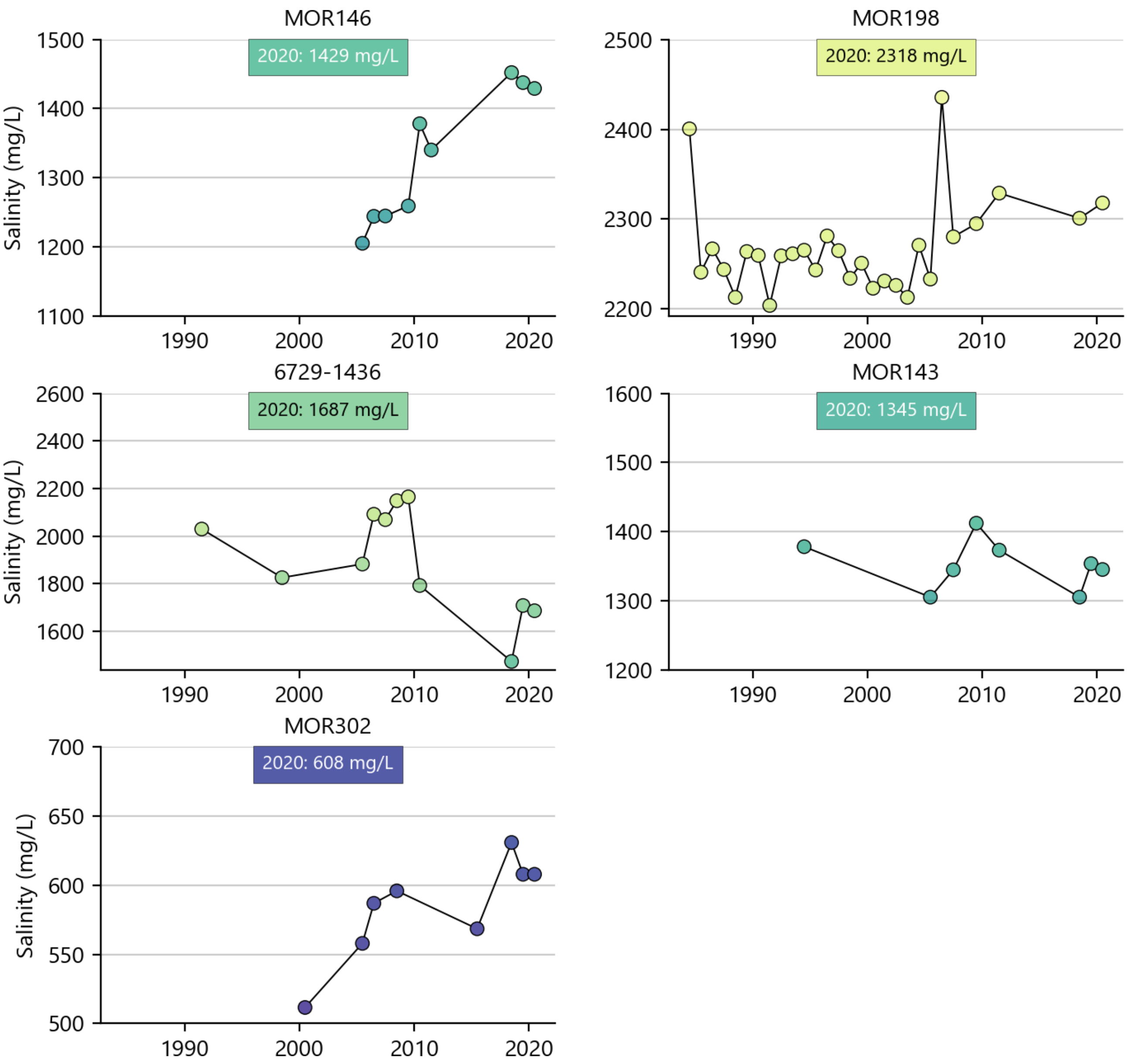

Figure 5.12. Selected Lower Aquifer salinity graphs

5.6 Fractured rock aquifer - water levels

During 2019–20, the water level in 42% of monitoring wells recovered to their lowest recovered level on record. Fewer than 25% of monitoring wells had levels which were average or above (Figure 5.13).

The change in water level over the past 20 years ranged from a decline of 16.95 m to a rise of 4.59 m (the median change is a decline of 2.73 m) (Section 2.3.1). The majority of wells (70%) show a declining trend in water levels over this period.

Five-year trends in water levels are declining in 87% of wells with rates ranging from a decline of 1.68 m/y to a rise of 0.21 m/y (the median rate is 0.58 m decline per year; Figure 5.14).

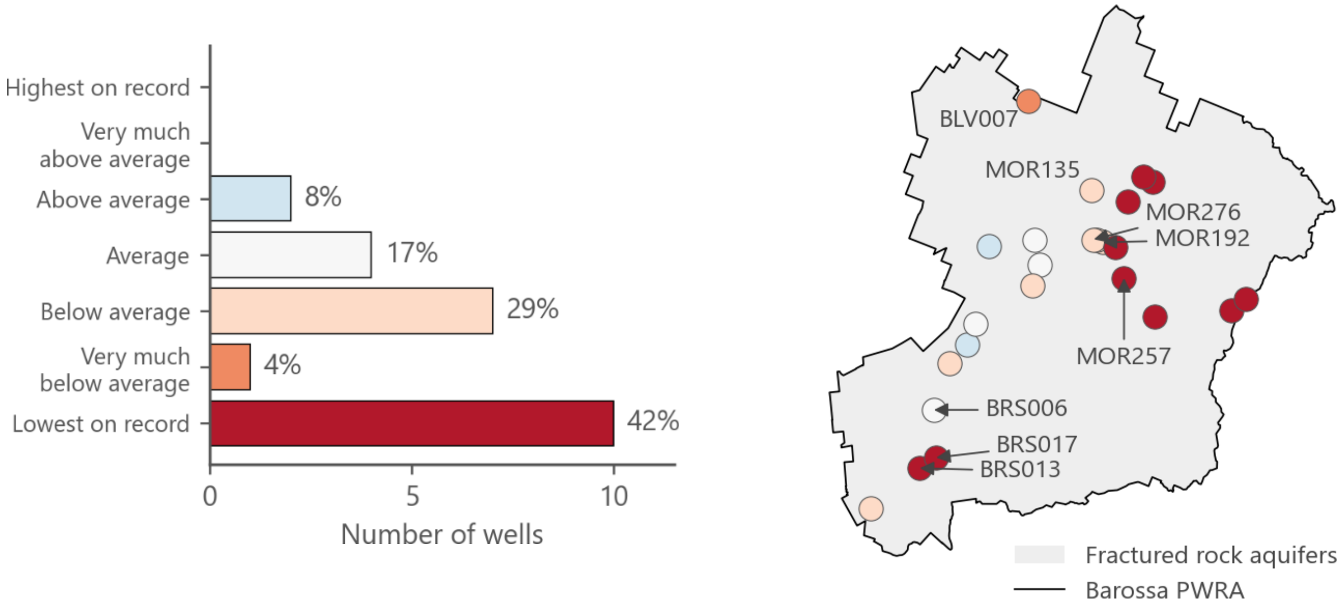

Figure 5.13. 2020 recovered water levels for fractured rock aquifers

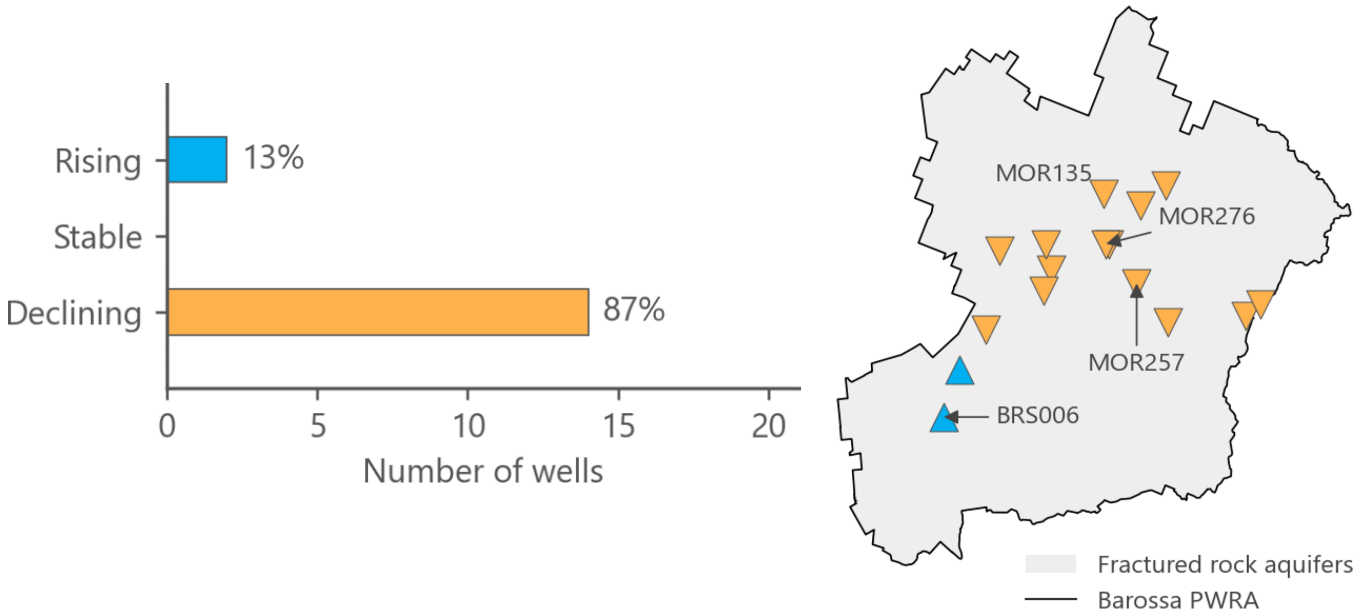

Figure 5.14. 2016–20 trend in recovered water levels for wells in fractured rock aquifers

Hydrographs from a selection of monitoring wells completed in fractured rock aquifers illustrate common or important trends (Figure 5.15). Groundwater is extracted from these aquifers across the PWRA with many users in the vicinity of Angaston and Lyndoch where sedimentary aquifers are absent. South of Angaston, at e.g. MOR257, water levels have declined in excess of 7 m in the past 20 years. This may be due to a combination of sustained groundwater pumping and below average rainfall in the area (e.g. at BoM rainfall station 23300 at Angaston). To the west of Angaston, groundwater levels are generally stable, possibly due to increased use of imported water since 2002 via the BIL scheme (e.g. MOR192). Near Lyndoch, most observation wells show trends of declining water levels (e.g. BRS013).

Fractured rock aquifers are used less frequently where shallower sedimentary aquifers are present and consequently, observation wells generally show stable water levels or gradual declines in these areas (MOR135).

Further north, fractured rock aquifers show higher salinities and as such, rates of groundwater extraction are low. BLV007 in this area show a trend of declining water levels since monitoring began in 1980.

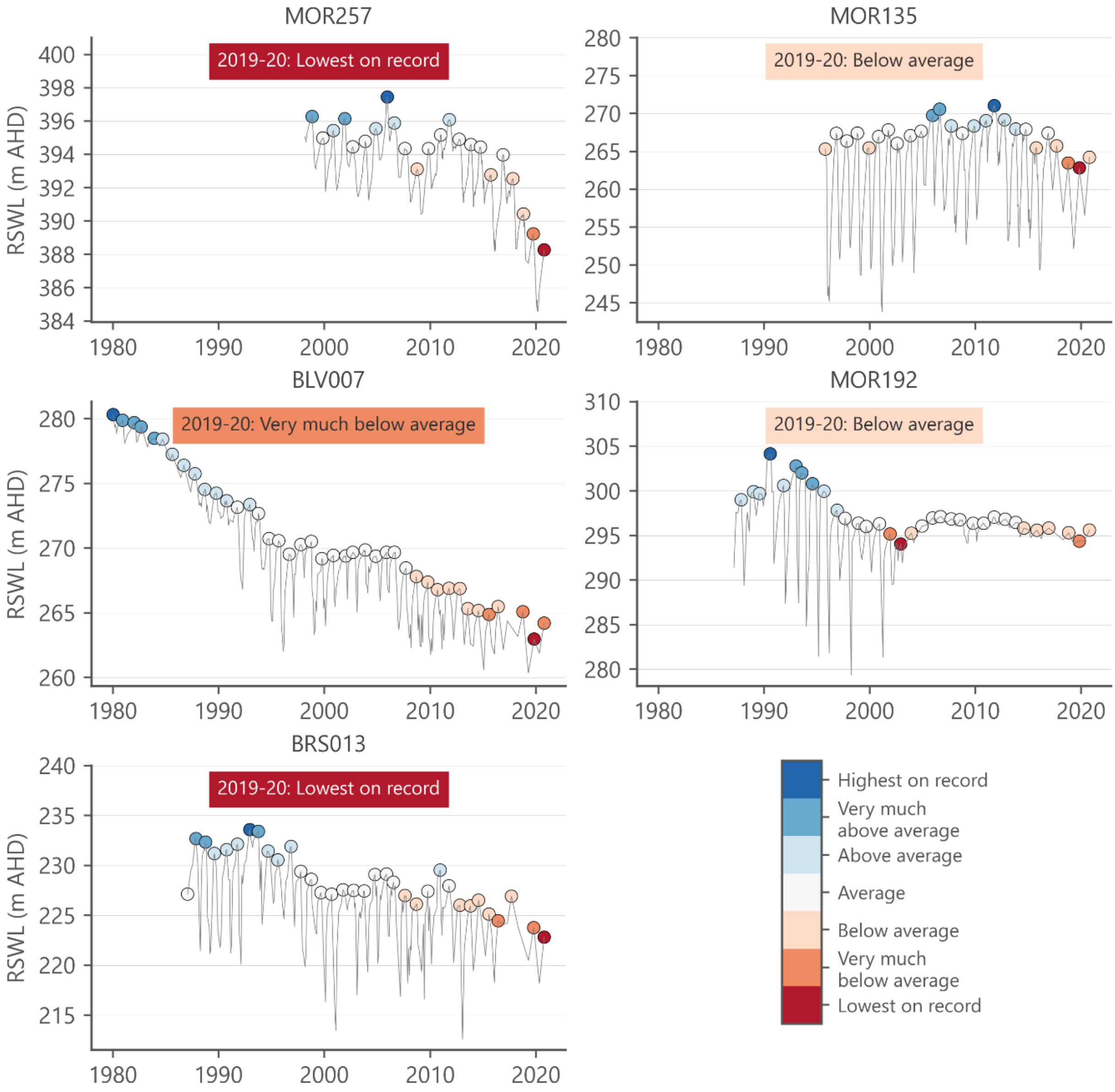

Figure 5.15. Selected hydrographs for wells in fractured rock aquifers

5.7 Fractured rock aquifer - salinity

Since 2018, irrigators in the Barossa PWRA have submitted groundwater salinity samples. In 2020, salinity results from 40 irrigation wells in fractured rock aquifers ranged between 727 mg/L and 2278 mg/L with a median of 1140 mg/L (Figure 5.16).

In the 15 years to 2020, the majority of wells (69%) show an increase in salinity levels (Section 2.3.2) (Figure 5.17). Two of these wells, located at Tanunda and Angaston, show increases greater than 20% over the past 15 years. Trends in salinity over the past 15 years vary from a decrease of 0.44% per year to an increase of 1.81% per year, with a median trend rate of 0.19% increase per year.

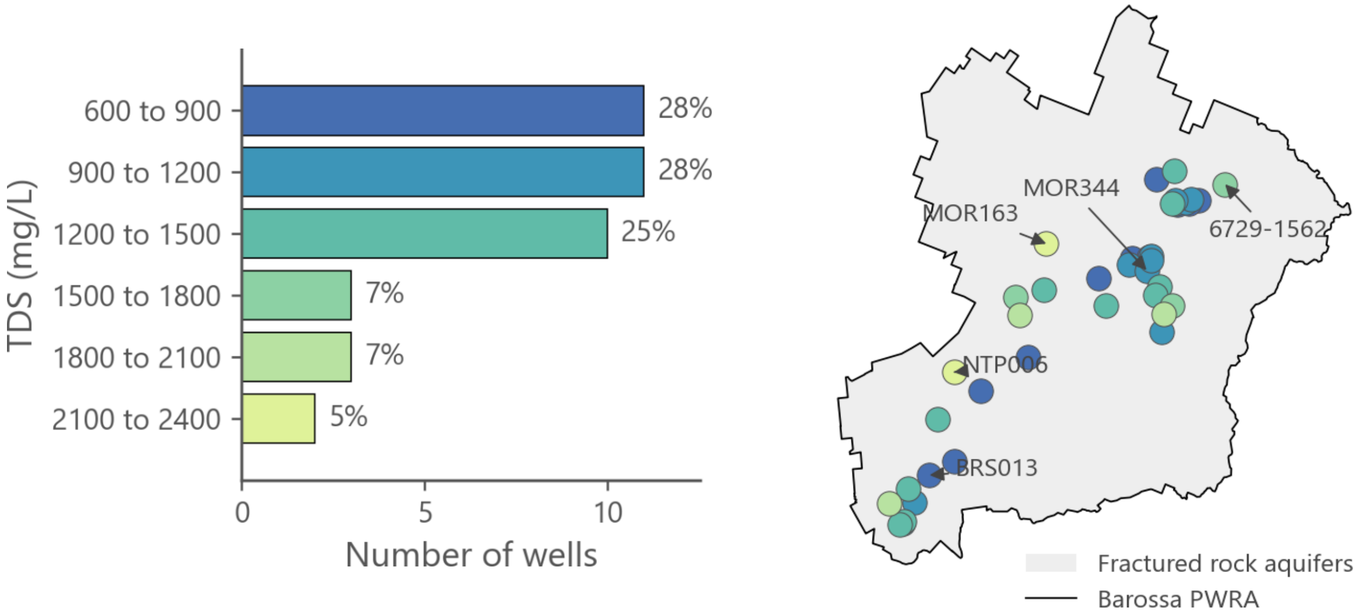

Figure 5.16. 2020 salinity observations in fractured rock aquifers

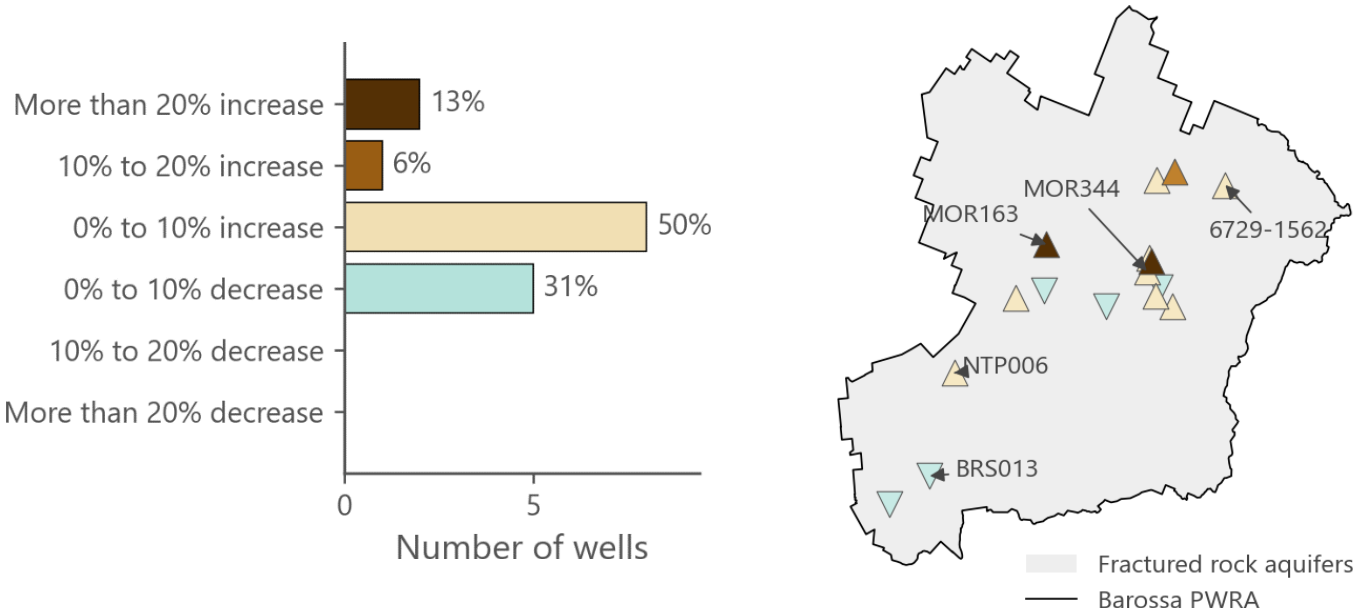

Figure 5.17. Salinity trend in the 15 years to 2020 in fractured rock aquifers

Groundwater salinity in fractured rock aquifers can be highly variable due to the complex system of preferential flow paths affecting recharge and movement through the aquifer. Groundwater salinity in the fractured rock aquifers of the Barossa PWRA is typically less than 3000 mg/L but can be greater than 6000 mg/L.

Hydrographs from a selection of fractured rock aquifers monitoring wells to illustrate common or important trends (Figure 5.18). In areas of intensive irrigation, and since the early-2000s, monitoring wells typically show increases in groundwater salinity (e.g. MOR163, MOR344 and 6729-1562). Further south at Rowland Flat, NTP006 shows a rapid increase in groundwater salinity in the 1990's but, since the early-2000s has been relatively stable.

At Lyndoch, BRS013 shows a relatively stable salinity since groundwater monitoring began in the 1980s.

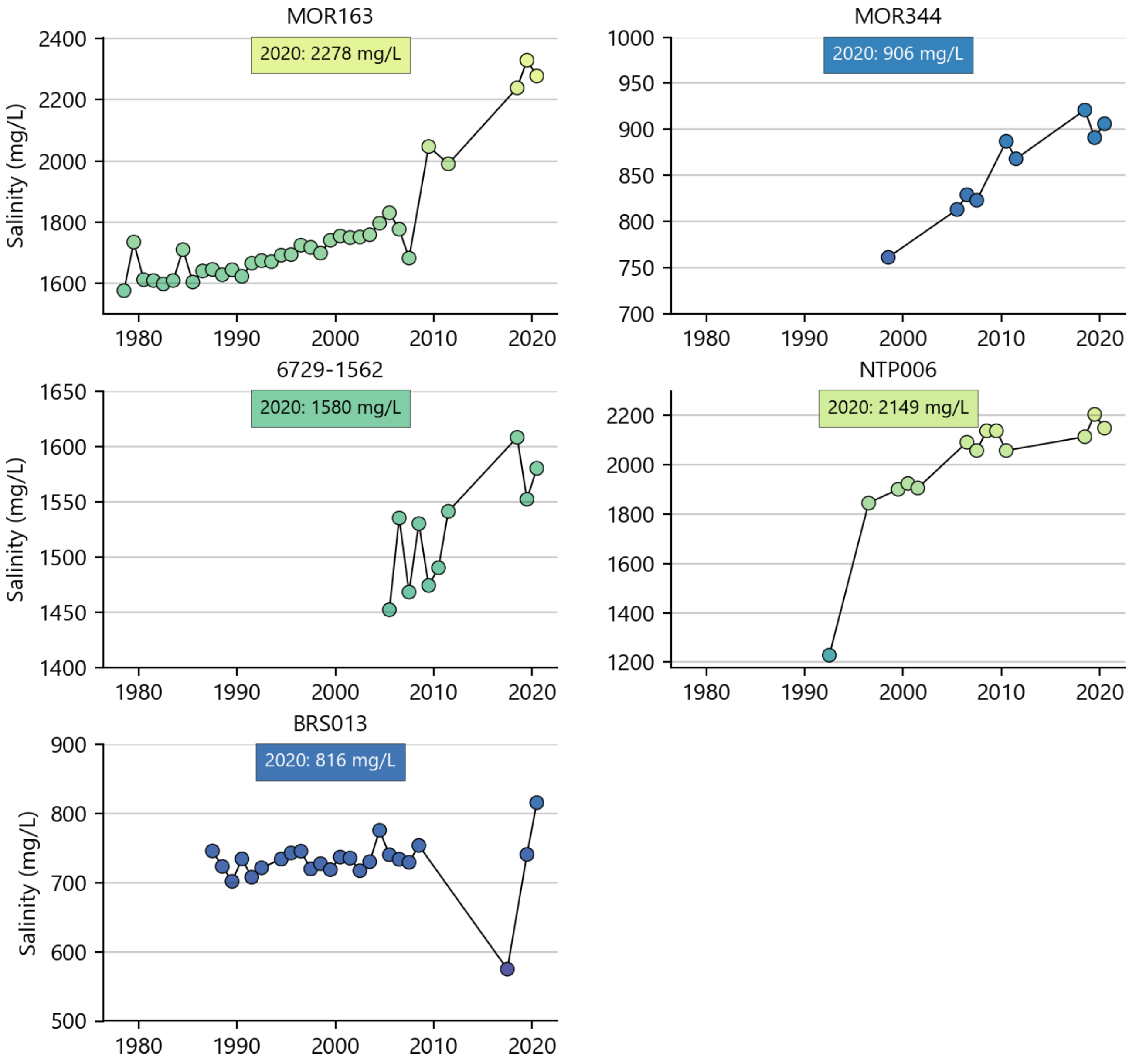

Figure 5.18. Selected fractured rock aquifers salinity graphs

6 Water use

In the Barossa PWRA, water sources include groundwater, watercourses, farm dams, imported water from the SA Water mains network and water supply from Barossa Infrastructure Ltd (BIL) via SA Water infrastructure. Imported water is transferred from the River Murray to the PWRA.

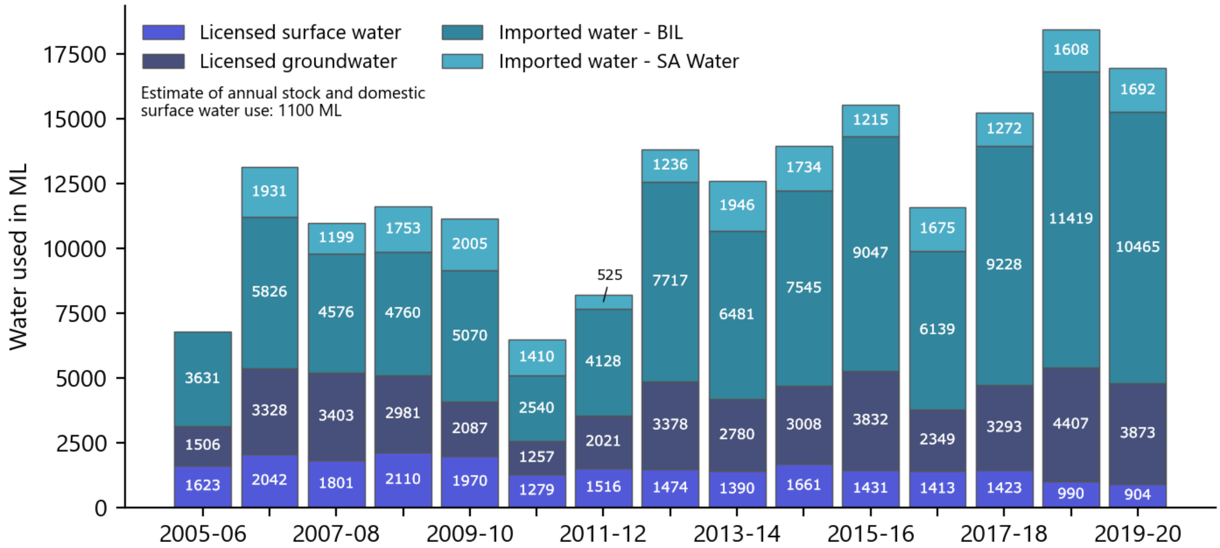

Figure 6.1 Water used from 2005–06 to 2019–20 for the Barossa PWRA

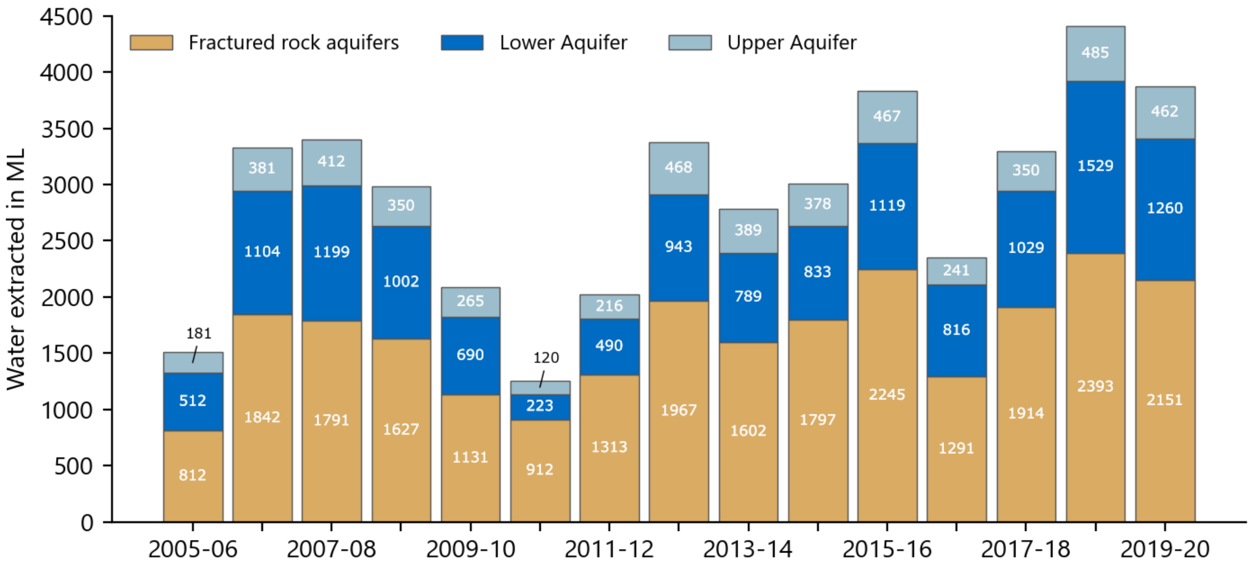

Figure 6.2 Metered groundwater extraction in aquifers of the Barossa PWRA from 2005–06 to 2019–20

The total volume of water used in 2019–20 was 18 034 ML (Figure 6.1). This includes:

- Metered groundwater extraction across the Barossa PWRA (Figure 6.2);
- Surface water volumes discussed below in Section 6.1; and
- Water imported into the PWRA via the BIL scheme and SA Water.

6.1 Groundwater use

In 2019–20, licensed groundwater extractions (from fractured rock aquifers, the Lower Aquifer, and Upper Aquifer) were 3873 ML, compared to 4407 ML in 2018–19 (Figure 6.1 and Figure 6.2). The greatest extractions are from the fractured rock aquifers (56%).

The Lower Aquifer also provides a considerable volume (32%), although the aquifer has a limited spatial extent. The smallest volumes are extracted from the Upper Aquifer (12%) due to its smaller spatial extent, the limited thickness of the aquifer in some areas and the unsuitability for irrigation due to higher salinity towards the north of the PWRA. There have been no significant changes in the relative distribution of the total extracted volumes between the three main aquifers.

6.2 Surface water use

In 2019–20, licensed surface water take (from dams and watercourses) was 904 ML compared to 990 ML in 2018–19. These data are based on meter readings from licensed water use. Non-licensed water demand (stock and domestic) was estimated at 1100 ML. This is non-metered and estimated at 30% of dam capacity based on analysis in the water allocation plan (AMLR NRM, 2019). This data is included in the consumptive use total every year but is not plotted on the bar chart as it is an estimate.

The region has a heavy reliance on imported water and the total volume was 12 157 ML in 2019–20. This comprised 10 465 ML from the Barossa Infrastructure Limited (BIL) Scheme and 1692 ML from SA Water. These values are shown in Figure 6.1.

6.2.1 Farm dams

There are a total of 1780 farm dams in the Barossa PWRA, 14% of which are licensed. Licensed dams represent 68% of the total estimated storage capacity of 8692 ML (Jones-Gill and Savadamuthu, 2014; Montazeri and Savadamuthu, 2018). Across the PWRA, smaller dams (capacity less than 5 ML) account for the majority of the number of dams (84%), but represent only a small proportion (18%) of the total storage capacity of dams. Larger dams (5 ML or greater capacity) make up only 16% of the total dam count but contribute to 82% of the total storage capacity (Figure 6.3). The average farm dam density of the PWRA is 17 ML/km^2, with the higher rainfall headwaters having a higher density in comparison to the lower rainfall areas (Figure 6.3).

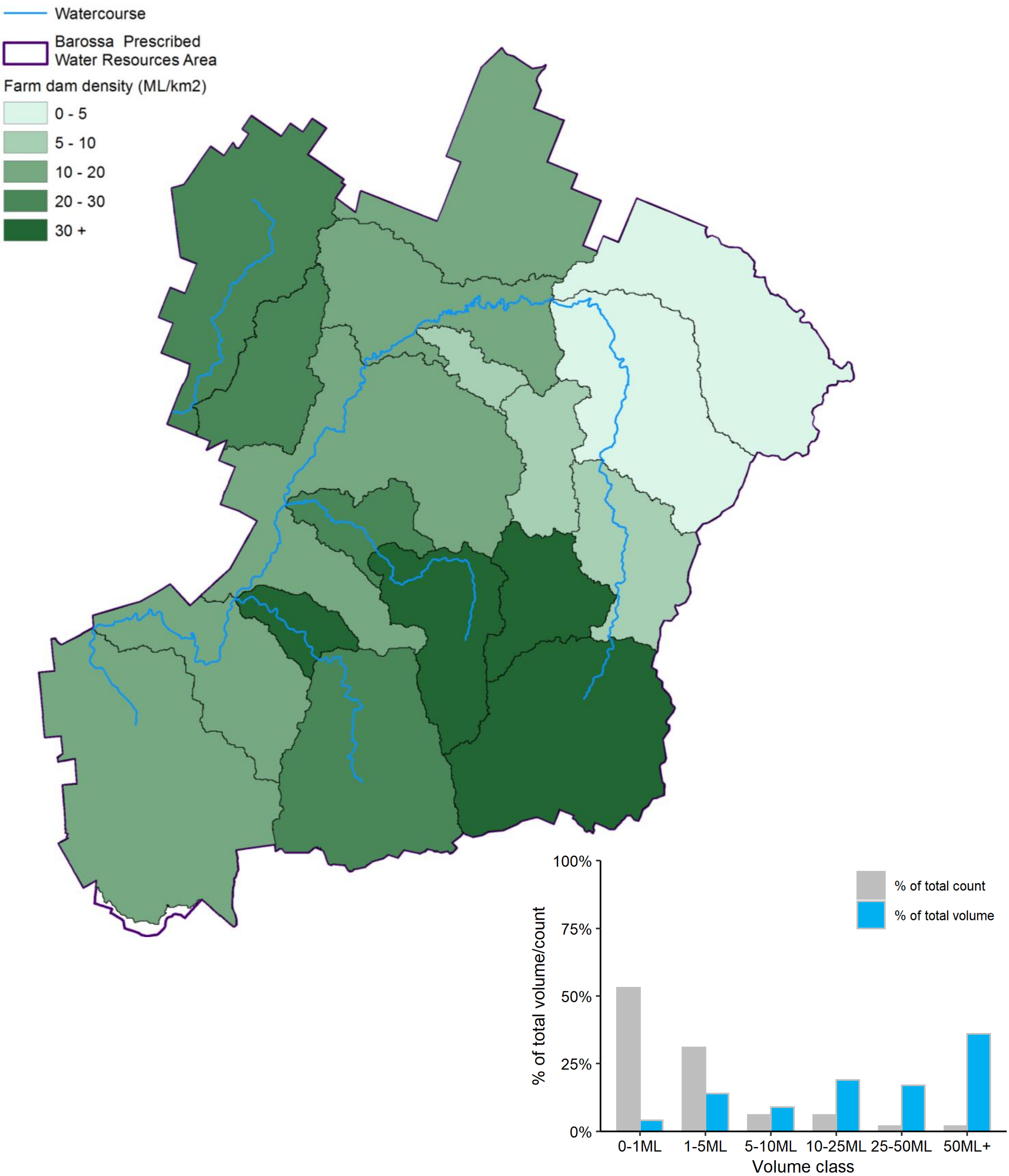

Figure 6.3 Farm dam volume, count analysis, and density in the Barossa PWRA

7 References

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