Mallee and Peake-Roby-Sherlock Prescribed Wells Areas 2019–20 water resources assessment

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1 Summary

Mallee PWA	Murray Group Limestone	Below average
Peake, Roby and Sherlock PWA	Confined aquifer	Above average

LEGEND

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

Rainfall

- Rainfall at Pinnaroo measures 326 mm in 2019–20, which is commensurate with the long-term average of 319 mm (1980–2020).
- Rainfall at Peake measures 302 mm, which is less than the long-term average of 376 mm (1980–2020).
- Above-average monthly rainfall was recorded in February and April 2020, while below-average monthly rainfall was recorded in October and December 2019 and July 2020.
- Annual rainfall data indicate a long-term declining trend at Peake (1980–2020).

Groundwater

- Water levels in the Murray Group Limestone aquifer are mostly classified 'Below-average' or lower (55%). These wells are located predominantly towards the eastern margin of the Mallee PWA, close to the Victorian border, where most irrigation occurs. 37% recorded average recovery levels, The 5 year trend indicates that 72% of wells show declining levels in 2020. Likely drivers for these low recovery levels are reduced rainfall, resulting in increased groundwater extraction.
- Water levels in the confined aquifer are all average (40%) or above average (60%) throughout the Peake Roby and Sherlock PWA. The 5 year trend indicates that 84% of water levels are declining.
- Ten-year salinity trends at Mallee PWA are decreasing in most wells (74%) with a median trend being a decrease of 0.46%/year. Ten-year salinity trends at Peake, Roby and Sherlock PWA are stable for all wells with salinities ranging ±5% over the ten-year period.

Water use

- Groundwater extraction in Mallee PWA from the Murray Group Limestone for 2019–20 was 33 378 ML, similar to the long-term average and predominantly used for irrigation.
- Groundwater extraction in Peake, Roby and Sherlock PWA from the confined aquifer for 2019–20 was 687 ML, 30% lower than the long-term average and predominantly used for irrigation.

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 both the Mallee Prescribed Wells Area (PWA) and the Peake, Roby and Sherlock PWA for 2019–20 and collates rainfall and water use 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 Mallee PWA (Figure 1.1) is located around 150 km east of Adelaide in the Murraylands and Riverland Landscapes region and is underlain by sediments of the Murray Basin. It is a regional-scale resource for which groundwater resources are prescribed under the *Landscape South Australia Act 2019* (the Act) and a water allocation plan, which was adopted in 2012, provides for sustainable management of the groundwater resources. The area within 20 km of the state border between South Australia and Victoria is jointly managed with Victoria through the *Groundwater (Border Agreement) Act 1985*.

In the Mallee PWA, groundwater occurs in three main aquifers, namely the confined Renmark Group aquifer, the semi-confined Murray Group Limestone (MGL) aquifer and the unconfined Pliocene sands aquifer. All licensed groundwater extractions in the Mallee PWA are from the MGL aquifer, with most extractions occurring towards the north-east of the PWA where the aquifer is confined.

The Peake, Roby and Sherlock PWA (Figure 1.1) is located around 120 km south-east of Adelaide in the Murraylands and Riverland Landscapes region. It is underlain by sedimentary aquifers of the Murray Basin and is a local-scale groundwater resource mainly used for public water supply, feedlots and by a small number of irrigators. Groundwater is prescribed under the Act and a water allocation plan, which was adopted in 2011, provides for sustainable management of the groundwater resources.

The Peake, Roby and Sherlock PWA has two distinct aquifers—an unconfined aquifer and a confined aquifer. Almost all licensed groundwater extractions are from the confined aquifer.

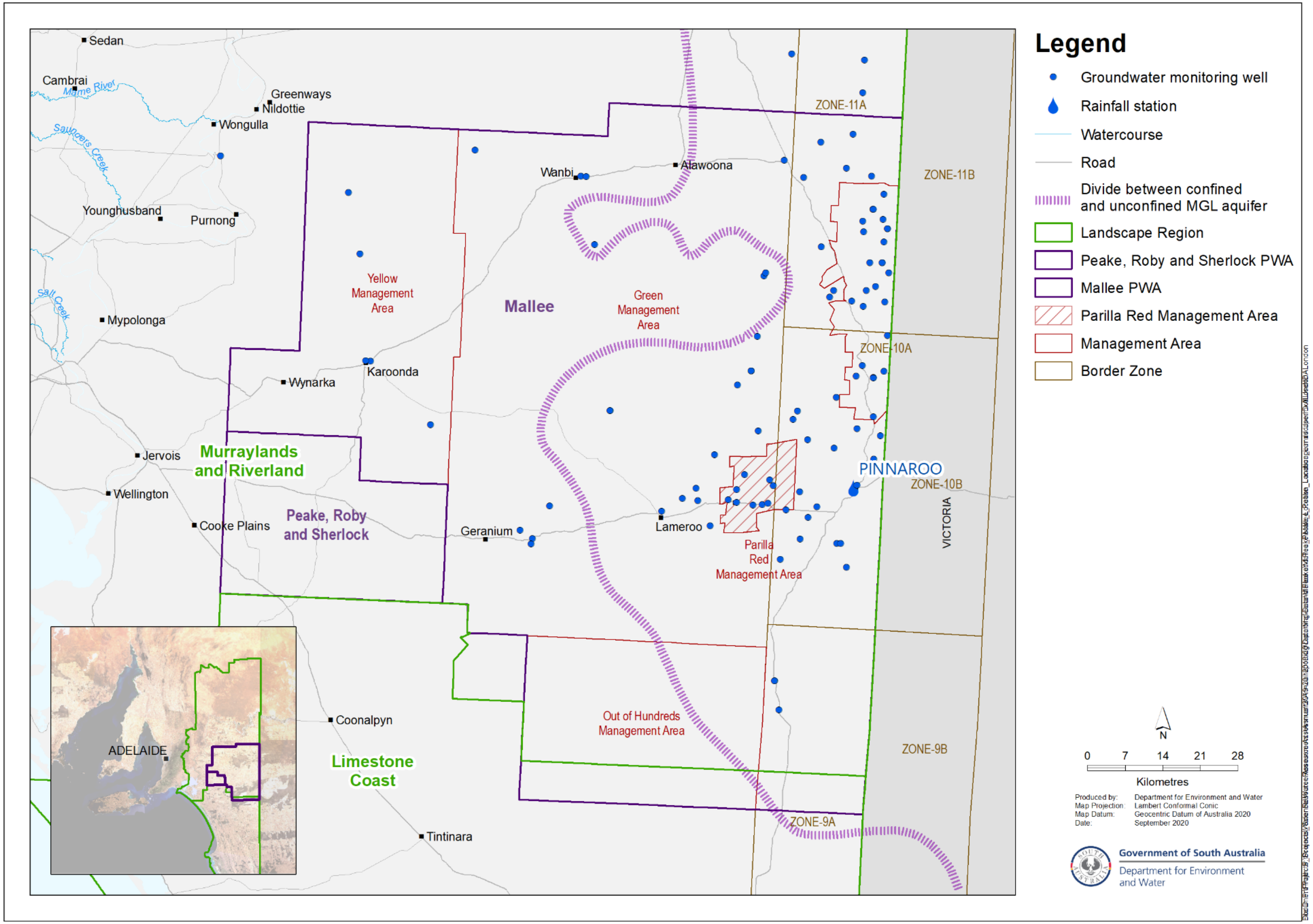

Figure 1.1 Location of the Mallee and Peake, Roby and Sherlock Prescribed Wells Areas

2 Methods and data

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

2.1 Rainfall

Daily rainfall observations have been used from selected Bureau of Meteorology (BoM) stations in order to calculate monthly and annual totals. The data have been obtained from the SILO Patched Point Dataset service provided by the Queensland Government, which provides interpolated values to fill gaps in observations (see rainfall graphs in section 3).

Rainfall maps were compiled using gridded datasets obtained from the BoM (Figure 3.1). The long-term average annual rainfall map (1986–2015) was obtained from Climate Data Online. The map of total rainfall in 2019–20 was compiled from monthly rainfall grids obtained for the months July 2019 to June 2020 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 Mallee PWA and Peake, Roby and Sherlock PWA monitoring networks, from both manual and continuous logger measurements. All available water level data were verified and the maximum annual water level for each well was identified for further analysis. The maximum annual water level represents the unstressed or recovered water level following seasonal irrigation pumping 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 water level provides a reliable indicator of the status of the groundwater resource. The period of recovery each year was reviewed for each well. In general, wells in the MGL aquifer in the Mallee PWA return to a maximum recovered level between August and September while wells in the confined aquifer in the Peake, Peake and Sherlock PWA return to a maximum recovered level between September and November.

For wells with suitable long-term records, the annual recovered water level was ranked and described according to their decile range[2] from lowest to highest on record (Table 2.1). The definition of a suitable long-term record varies depending on the history of monitoring activities in different areas; for the Mallee PWA and the Peake, Roby and Sherlock PWA, any well with 10 years or more of recovered water level data is included. For the most recent year, the number of wells in each decile range was 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 for each 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

[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).

[2]. 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.

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 summarized for each aquifer (for example see

Figure 4.2). Regionally extensive sedimentary confined and unconfined aquifers such as the Murray Group Limestone in the Mallee PWA and the confined aquifer in the Peake, Roby and Sherlock PWA are given tolerance thresholds of 2 cm/y.

Table 2.1. Percentile/decile descriptions*

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

* Deciles and descriptions as defined by the BoM[3]

2.2.2 Salinity

Salinity data were obtained from a network of irrigation wells. Irrigators have submitted groundwater samples that DEW has tested for salinity. The results have improved the understanding of temporal and spatial salinity trends. 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 4.4).

10-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. 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 4.5).

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

2.3 Water use

Meter readings are used to calculate licensed extraction volumes for all groundwater sources in the both the Mallee PWA and Peake, Roby and Sherlock PWAs.

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

[3] Bureau of Meteorology Annual climate statement

the Well Details page on WaterConnect. Other important sources of information about water resources in the Mallee PWA and Peake, Roby and Sherlock PWAs are:

- Summary reports on the groundwater resources of the Mallee PWA (DFW 2012a) and the Peake, Roby and Sherlock PWA (DFW 2012b) and annual groundwater level and salinity status reports (DEW 2019a,b).
- The Water Allocation Plans for the Mallee PWA (SAMDB NRM Board, 2017) and Peake, Roby and Sherlock PWA (SAMDB NRM Board, 2017).
- Assessment of the groundwater resource capacity of the Peake–Roby–Sherlock PWA (DWLBC, 2008).

3 Rainfall

The climate of the Mallee PWA and the Peake, Roby and Sherlock PWA is characterised by hot, dry summers and cool to cold, wet winters. Long-term annual rainfall (1986–2015; Figure 3.1) varies from less than 300 mm/y towards the north-east of the Mallee PWA to greater than 350 mm/y towards the south-west of the Peake, Roby and Sherlock PWA. The spatial distribution of total annual rainfall for 2019–20 is very similar to the long-term average[4].

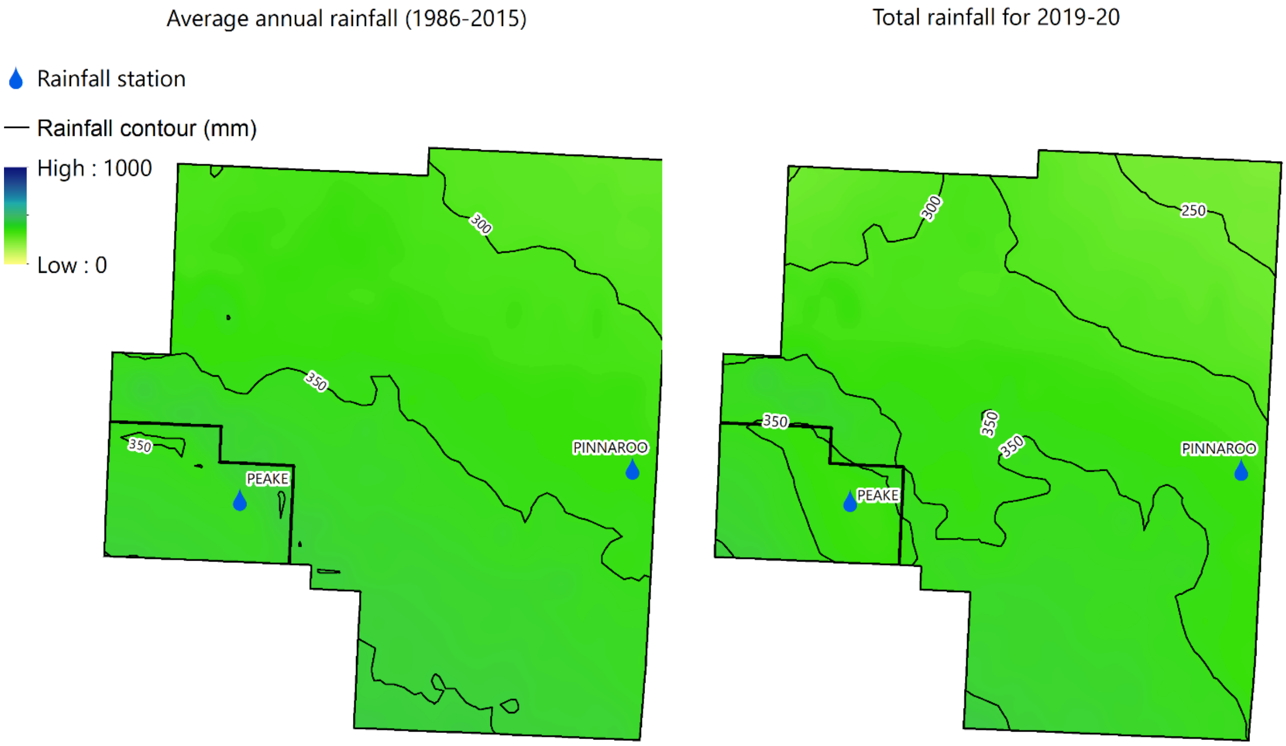

Figure 3.1 Total annual rainfall in the Mallee PWA for 2019–20, compared to long-term average annual rainfall (1986–2015)

[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 (Section 2.1).

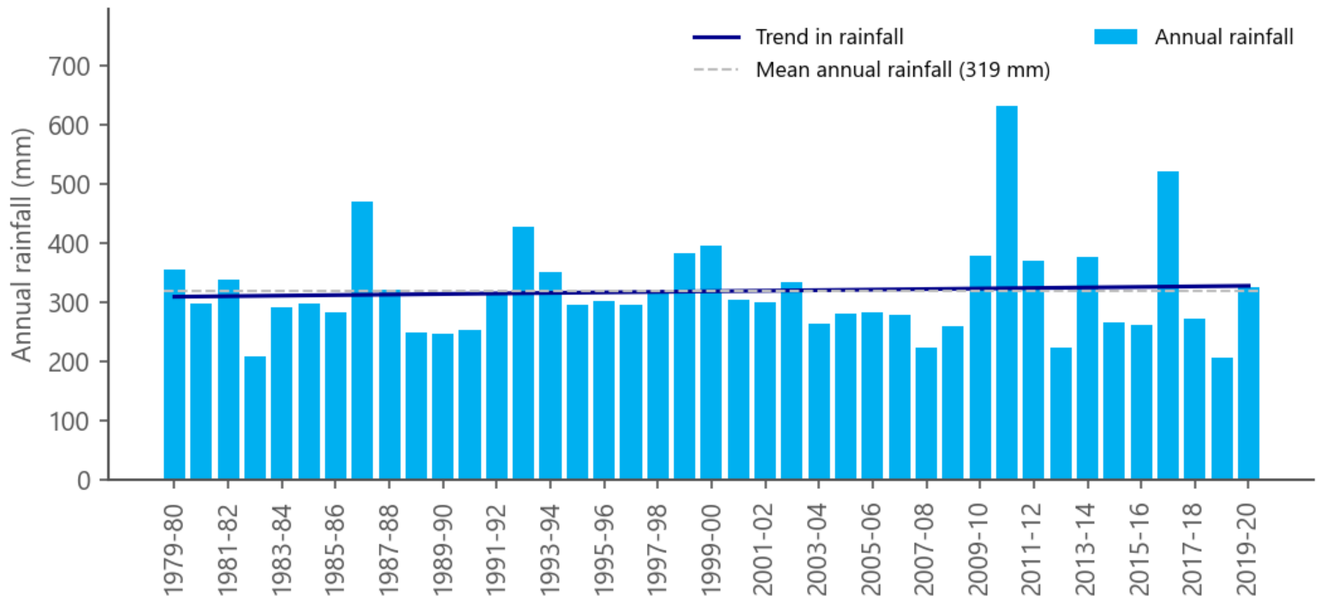

Figure 3.2. Annual rainfall between 1980–2020 at Pinnaroo (BoM Station 25015)

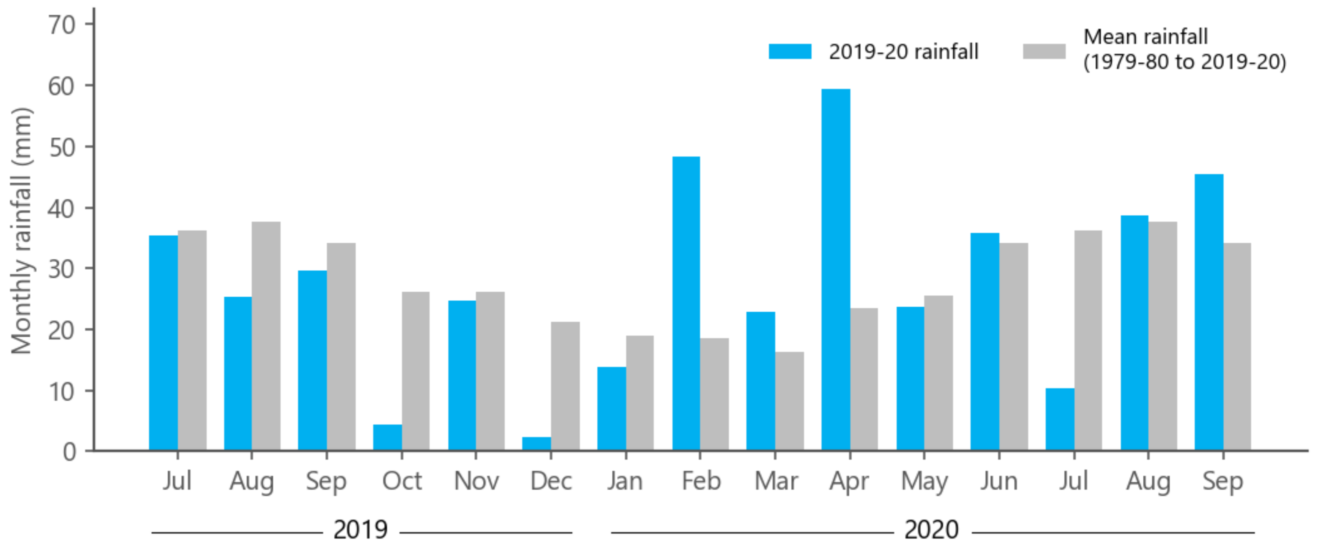

Figure 3.3 Monthly rainfall between July 2019 and September 2020, compared to the long-term monthly average at Pinnaroo (BoM Station 25015)

The Pinnaroo rainfall station (BoM Station 25015) is located towards the eastern margin of the Mallee PWA (Figure 3.1).

In 2019–20, total annual rainfall is 326 mm, which is commensurate with the long-term average (1980–2020) of 319 mm/y (Figure 3.2). Above-average total monthly rainfall occurred in February and April 2020, while October and December 2019, and July 2020, are considerably below-average (Figure 3.3).

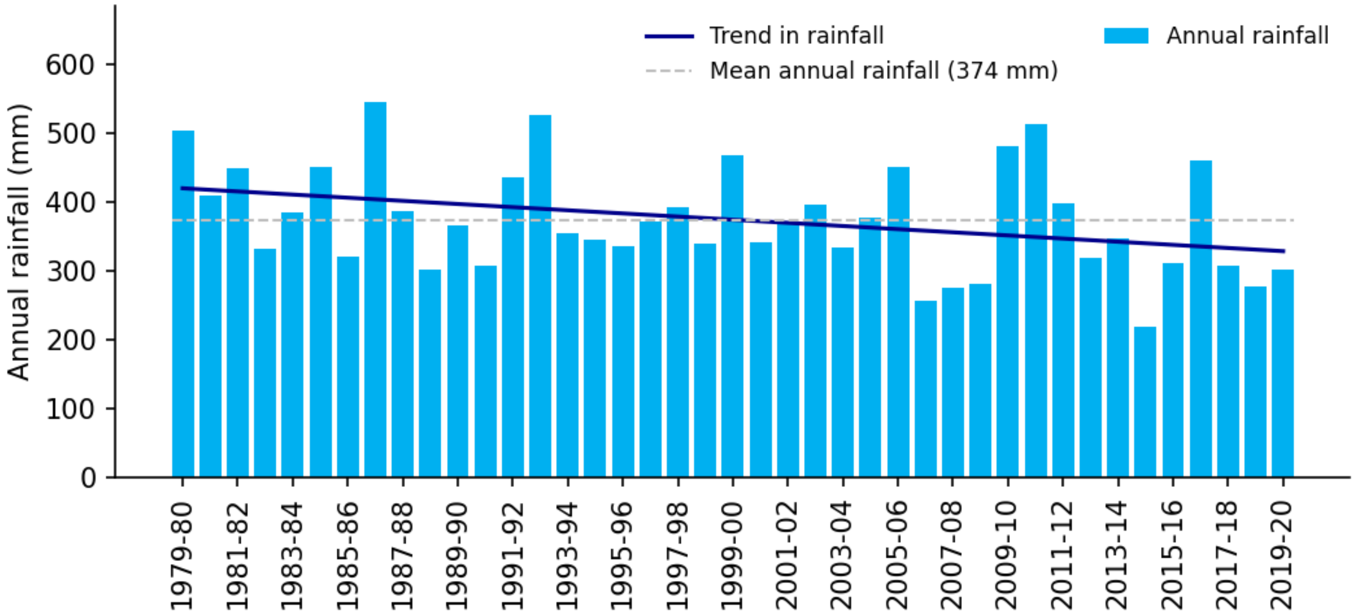

Figure 3.4 Annual rainfall between 1980–2020 at Peake (BoM Station 25513)

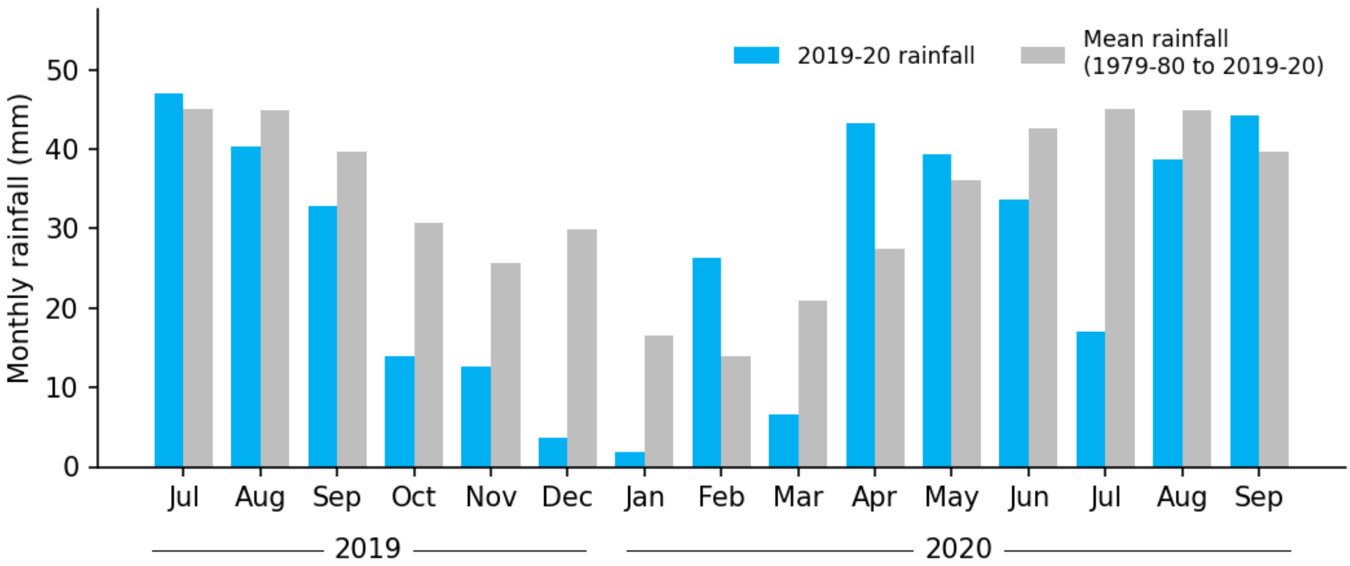

Figure 3.5 Monthly rainfall between July 2019 and September 2020 at Peake (BoM Station 25513)

The Peake rainfall station (BoM station 25513) is located towards the west of the Peake, Roby and Sherlock PWA (Figure 3.1). In 2019–20, total annual rainfall was 302 mm which is 19% less than the long-term average (1980–2020) of 376 mm/y (Figure 3.4). Annual rainfall over the long-term shows a decreasing trend.

Rainfall at Peake is below average during the spring and summer of 2019–20), while above-average monthly rainfall is recorded in February and April 2020 (Figure 3.5).

4 Groundwater

4.1 Hydrogeology

The Mallee PWA comprises three main groundwater systems, namely the Renmark Group confined aquifer, the Murray Group Limestone (MGL) aquifer and the Pliocene Sands aquifer. All licensed groundwater extractions in the Mallee PWA are from the MGL aquifer, primarily towards the northeast of the PWA where the aquifer is confined. The MGL aquifer comprises a consolidated, highly fossiliferous fine to coarse-grained limestone, which has an average thickness of around 100 m. The MGL aquifer is recharged in southwest Victoria; groundwater flows radially towards the north, northwest and west of the Mallee PWA. Where the aquifer is unconfined, the large depth to the watertable (40–60 m) results in low correlation between groundwater levels and variations in rainfall. However, there can be an indirect relationship, with higher rainfall resulting in decreased rates of groundwater extraction, which in turn may lead to a recovery in groundwater levels.

The Peake, Roby and Sherlock PWA has two distinct aquifers, an unconfined aquifer and a confined aquifer. Almost all licensed groundwater extractions in the PWA are from the confined aquifer, which comprises the Buccleuch Group and Renmark Group formations. The Buccleuch Group consists of a consolidated bryozoal limestone or 'coral' that begins at a depth of 90–100 m below ground level and varies in thickness from 5–25 m. In the eastern area of the PWA, this coral layer begins to merge laterally with the Renmark Group. The Renmark Group comprises interbedded sands and clays and has not been developed for supplies. As the Buccleuch and Renmark Group aquifers are confined, they are not recharged by local rainfall. The primary source of recharge is the lateral inflow of groundwater from aquifers located in south-western Victoria. Despite the confined nature of the aquifer, the intensity and timing of local rainfall can have an effect on groundwater levels and salinities through related variations in rates of groundwater extraction.

The unconfined aquifer is continuous across the PWA but can be divided into two main regions: the low-lying Coastal Plain and the Mallee Highlands, where each has different hydrogeological characteristics. Beneath the Coastal Plain, the unconfined aquifer comprises Quaternary limestone which contains groundwater with high salinity, and consequently extractions do not currently occur from this resource. Beneath the Mallee Highlands, unconfined groundwater is found in the MGL aquifer at a depth of about 40–50 m below ground level and is used mostly for stock and domestic purposes with a small amount extracted for irrigation (unlike the adjoining Mallee PWA where the MGL aquifer is used extensively for irrigation).

4.2 Mallee PWA: Murray Group Limestone aquifer – water level

In 2020, winter-recovered water levels in the majority of monitoring wells in the MGL aquifer (55%) are classified 'Below-average' or lower (Section 2.2.1; Figure 4.1). These wells are located towards the eastern extent of the MGL aquifer where it is confined and the concentration of irrigation extraction is highest.

Over the past 20 years, water levels in 90% of wells show long-term declines; changes range from a decline of 6.88 m to a rise of 0.90 m (median is a decline of 1.65 m).

Five-year trends show declining water levels in the majority of wells (72%), with rates ranging from a decline of 0.60 m/y to a rise of 0.23 m/y (median rate is a decline of 0.09 m/y) (Figure 4.2).

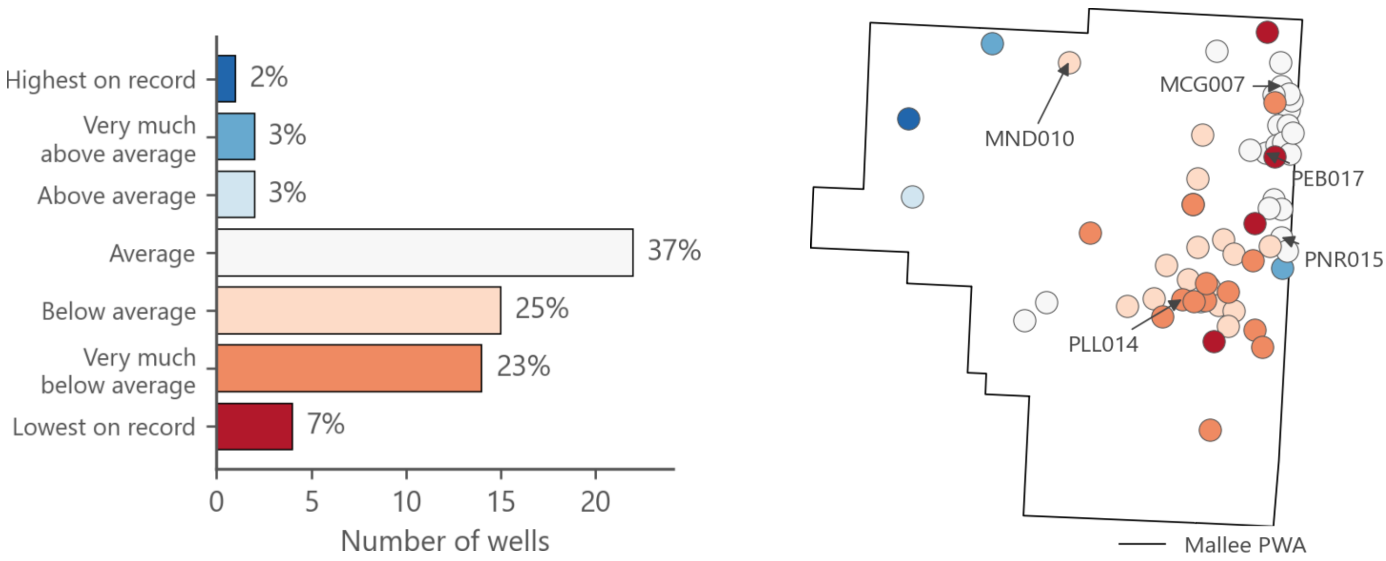

Figure 4.1 2020 winter-recovered water levels for wells in the Murray Group Limestone aquifer

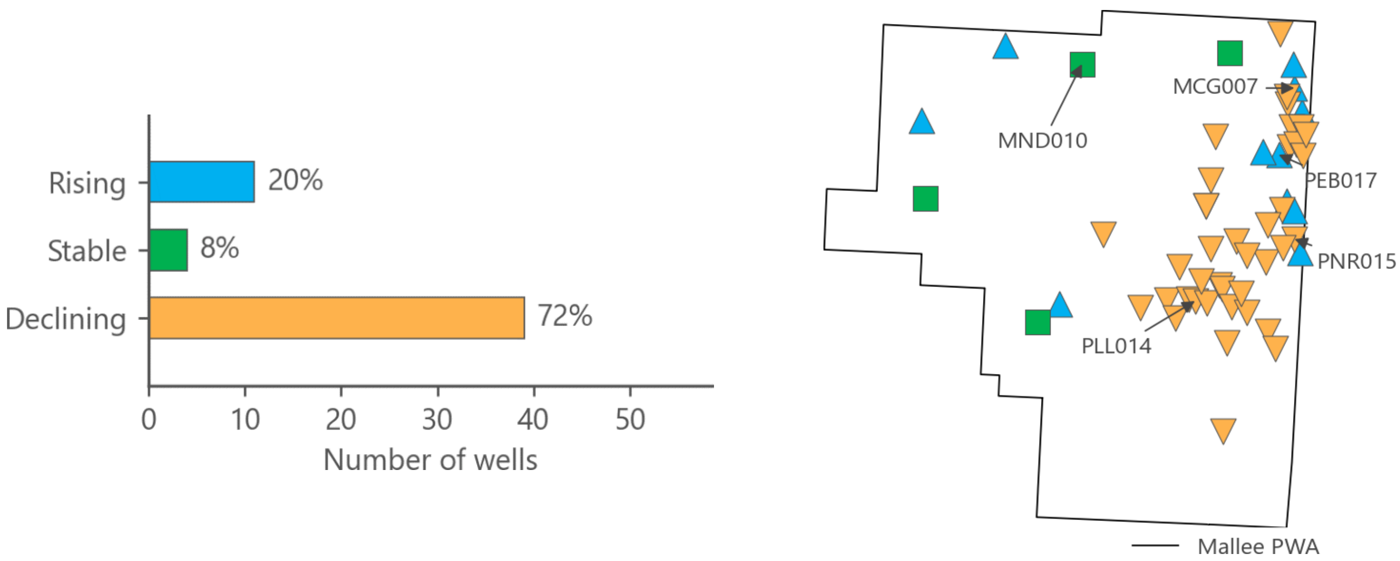

Figure 4.2 2016–20 trend in winter-recovered water levels for wells in the Murray Group Limestone aquifer

Figure 4.3 shows representative hydrographs from a selection of MGL monitoring wells. Over the past 20 years, the majority of wells towards the east of the Mallee PWA show trends of declining water levels due to the concentration of pumping activities in areas such as Parilla, Pinnaroo and Peebinga where low-salinity groundwater is common and soils are suited to irrigated horticulture.

Zone 10A of the Border Zone (Figure 1.1) includes Pinnaroo and the area north up to Zone 11A. In this area, PEB017 and PNR015 show a decline in pressure levels until 2009, which coincides with increased extraction between 2006–09. Since 2010, the aquifer appears to have reached a new state of equilibrium.

At Parilla, PLL014 shows a consistent decline in pressure levels since monitoring began in the late 1980s.

To the north of the Mallee PWA, MND010 and MCG007 showed declining pressure levels up until mid-2000s but, pressure levels have stabilised in the past 15 years.

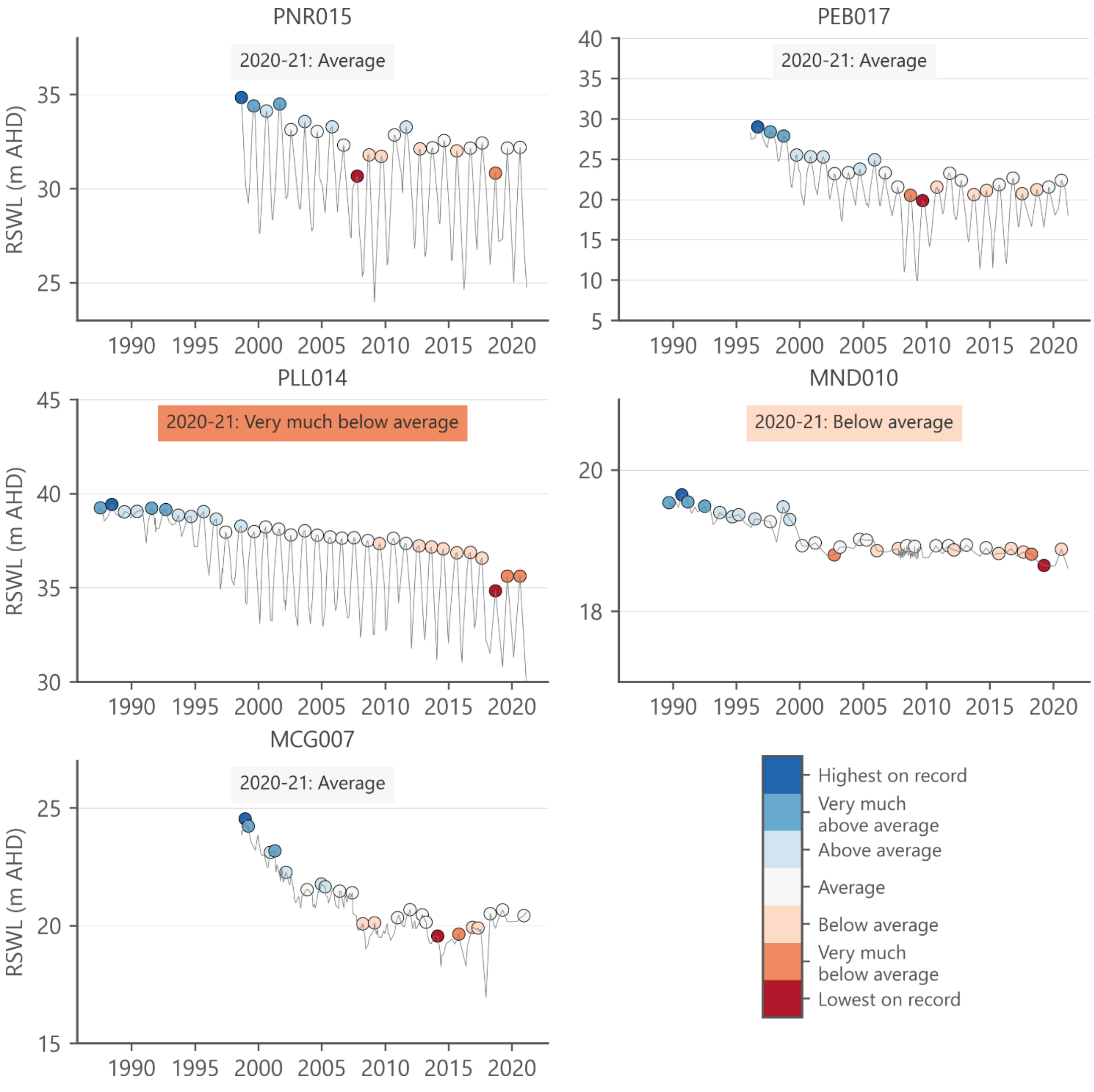

Figure 4.3. Selected Murray Group Limestone aquifer hydrographs

4.3 Mallee PWA: Murray Group Limestone aquifer – salinity

In 2020, groundwater samples from 107 wells in the MGL aquifer show salinities ranging between 548–3690 mg/L, with a median of 1172 mg/L (Figure 4.4). Higher salinities are measured towards the northern and western extents of the Mallee PWA while the lowest salinities are observed towards the eastern margin near the Victorian border. Potential causes of increasing salinity are downward leakage of saline water from the overlying Pliocene Sands aquifer and also lateral inflow of more saline groundwater from the north.

In the ten years to 2020, the majority of wells (74%) show a decrease in groundwater salinity (Section 2.2.2). Trends in salinity over this period vary from a decrease of 2.03% per year to an increase of 1.36% per year, with a median rate of 0.46% decrease per year (Figure 4.5).

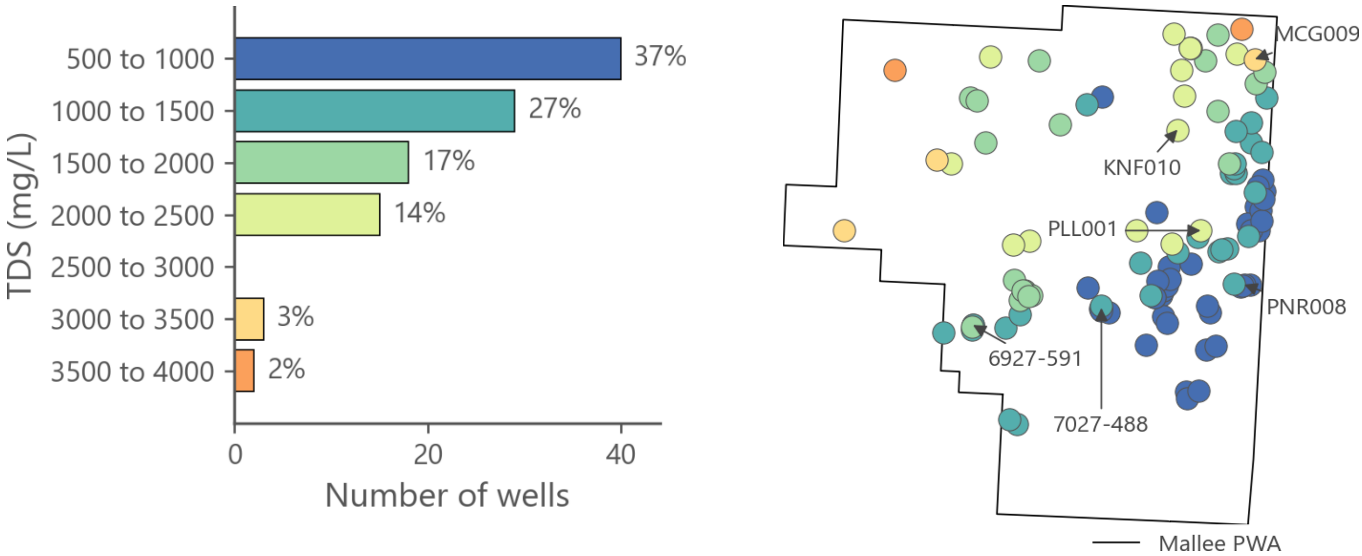

Figure 4.4 2020 salinity observations from wells in the Murray Group Limestone aquifer

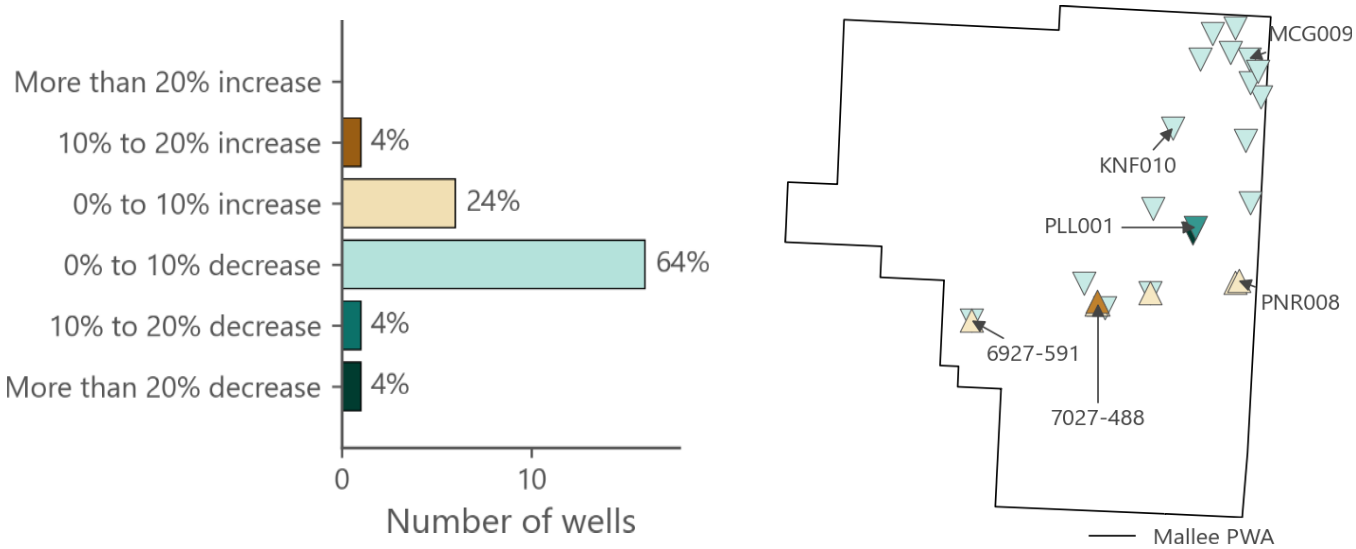

Figure 4.5 Salinity trends in the ten years to 2020 for wells in the Murray Group Limestone aquifer

Salinity data from a selection of representative monitoring wells in the MGL aquifer (Figure 4.6) show salinity trends over time. Towards the northeast (e.g. MCG009), salinity gradually increased between 2001–16, followed by a decrease in salinity over the past five years. Similar trends are ovserved at KNF010 and PLL001, which are located further to the south, where a sharp decrease in salinity is observed over the past few years.

At Pinnaroo and Lameroo, where low-salinity groundwater is used for town water supply, production bores PNR008 and 7027-488 show stable salinity.

Towards the west, Geranium town water supply production bore 6927-591 shows gradually increasing salinity of around 100 mg/L over the past 20 years.

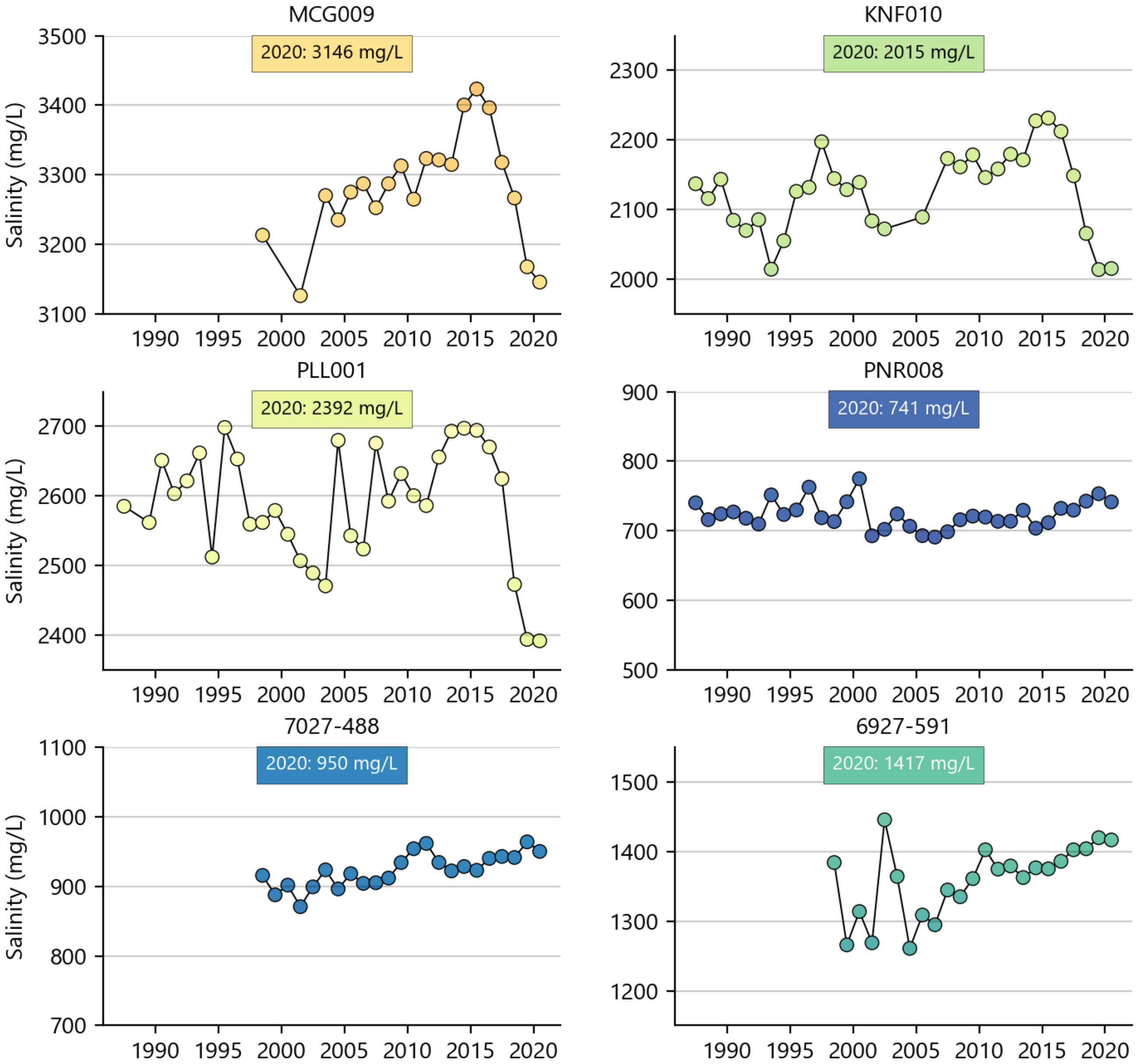

Figure 4.6. Selected Murray Group Limestone aquifer salinity graphs

4.4 PRS PWA: Confined aquifer – water level

In 2020, winter-recovered water levels in 60% of monitoring wells in the confined aquifer of the Peake Roby and Sherlock PWA are classified 'Above-average' (Section 2.2.1), while the remaining 40% of water levels are classified 'Average' (Figure 4.7).

All wells show trends of rising water levels over the past 10 years, with rises ranging between 0.29–3.16 m (median rise of 1.45 m).

Five-year trends show water levels are predominantly declining (84%); rates of change range between a decline of 0.17 m/y to a rise of 0.05 m/y (median rate is a decline of 0.07 m per year; Figure 4.8).

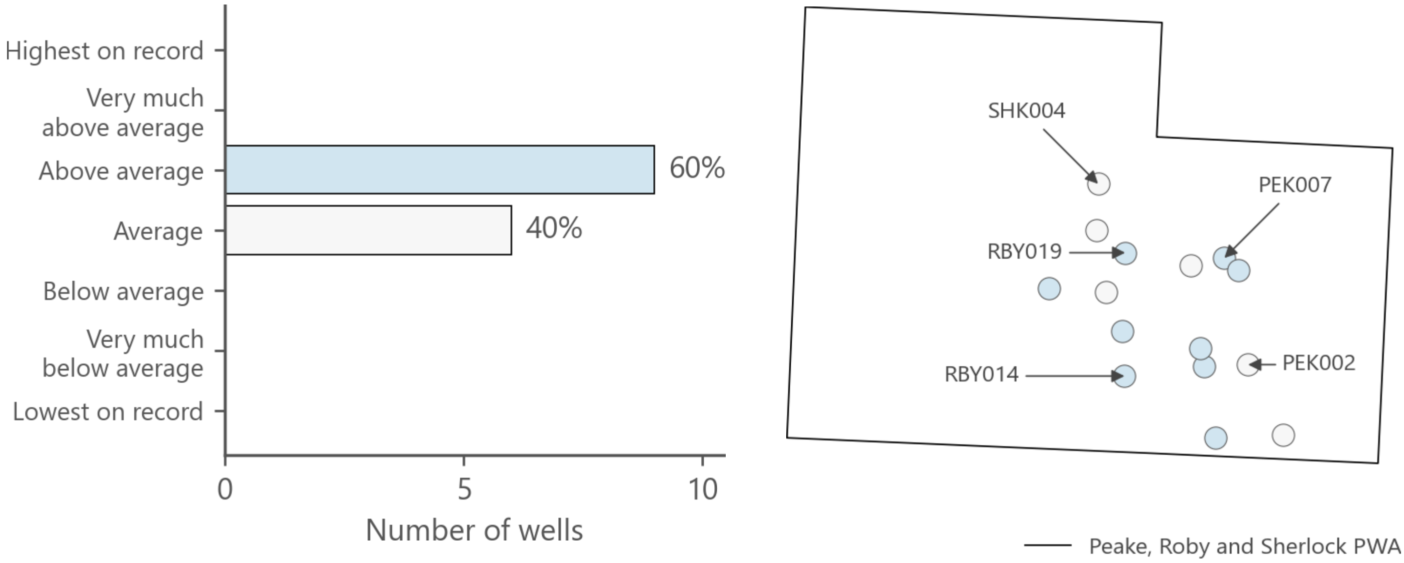

Figure 4.7 2020 winter-recovered water levels for wells in the confined aquifer

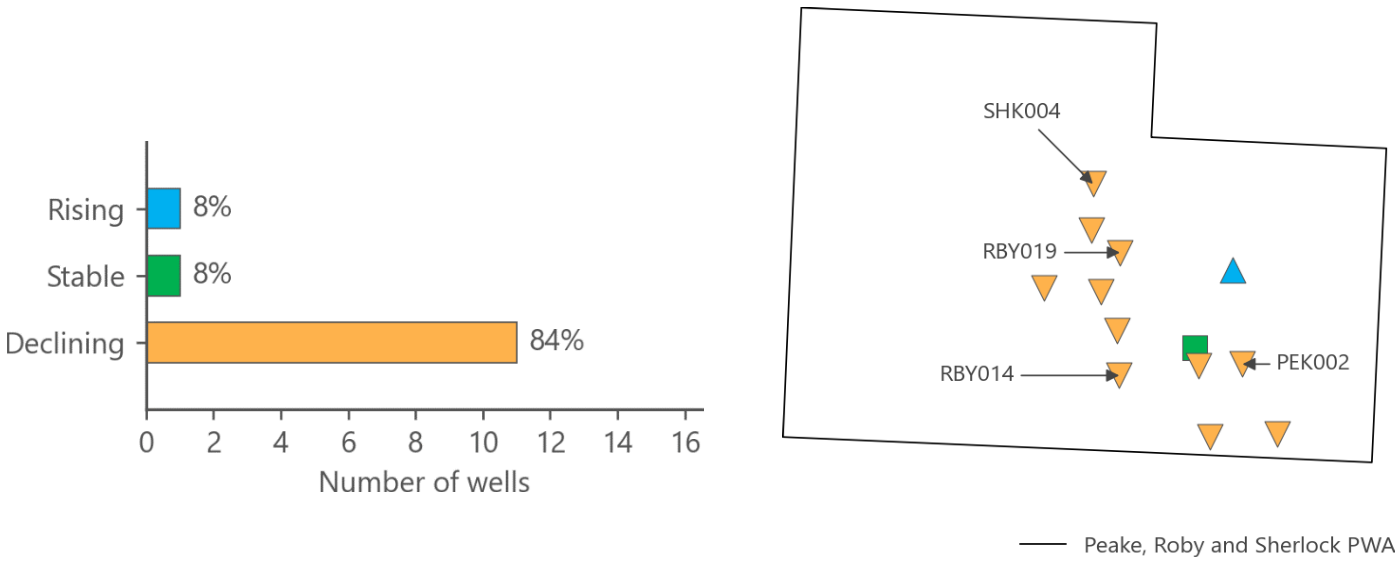

Figure 4.8 2016–20 trend in winter-recovered water levels for wells in the confined aquifer

Representative hydrographs from a selection of Peake Roby and Sherlock PWA monitoring wells (

Figure 4.9) show that in 2020, water levels are classified 'Average' (e.g. PEK002, SHK004) or 'Above-average' (e.g. PEK007, RYB014, RBY019). Large seasonal drawdowns have developed since large-scale irrigation commenced in 2004, with the measured drawdown decreasing with distance from the areas of intensive irrigation. The magnitude of drawdown increased each year until 2009–10, at which point water levels were classified 'Lowest on record'. Since then, drawdowns have reduced in magnitude as a result of decreasing rates of extraction, and water levels have largely recovered and now appear to be stable.

Peake town water supply production bore (PEK007) is located at a distance of three kilometres from the area of concentrated pumping for irrigation; observation well PEK002 is located four kilometres away and SHK004 is at a distance of 15 km. There is no direct relationship between pressure level responses in the confined aquifer and seasonal variations in rainfall; however above-average rainfall in spring (e.g. 2016) may result in a delayed start to pumping for the irrigation season and consequently, a greater winter-recovery in pressure levels may result.

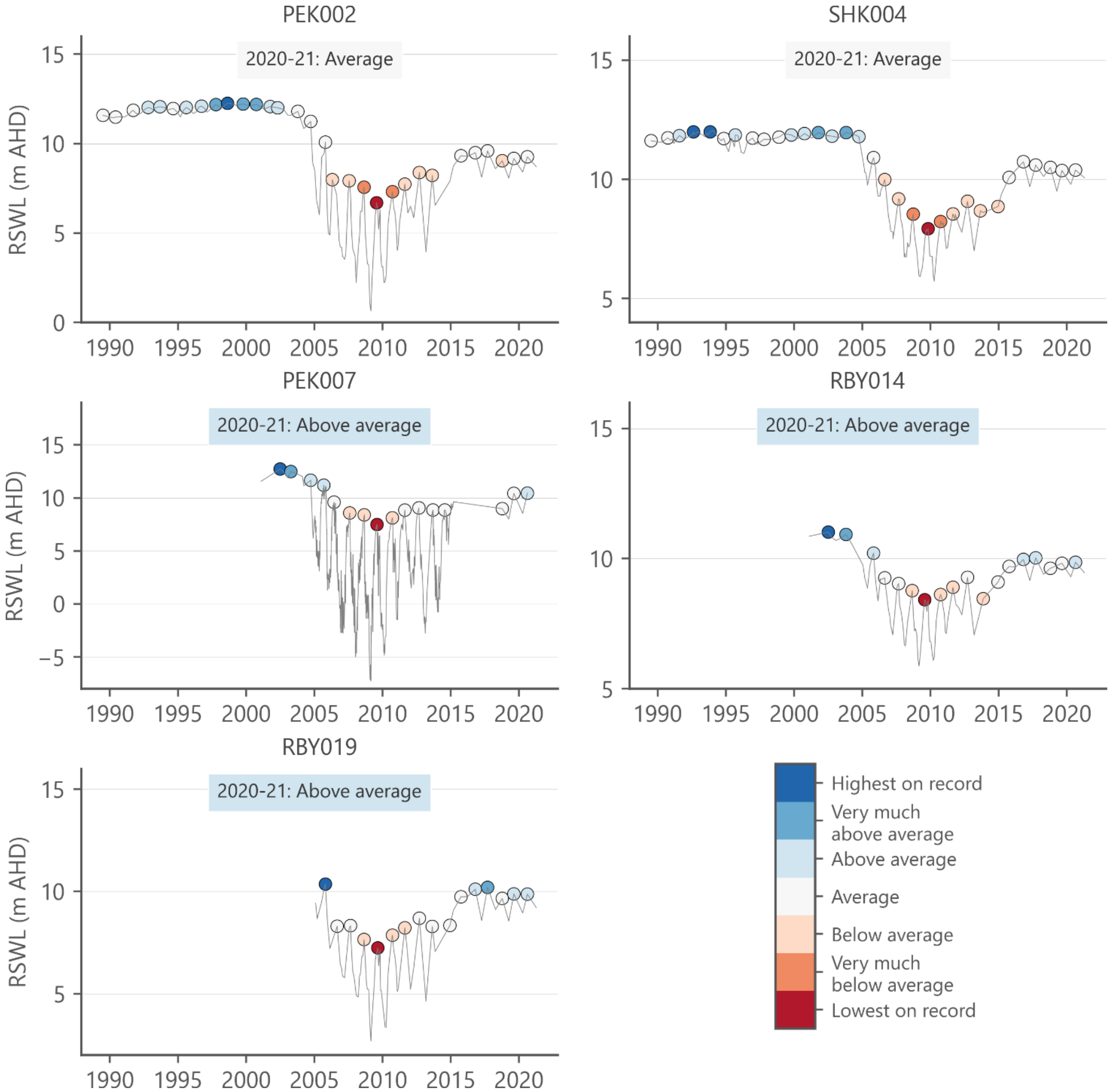

Figure 4.9 Selected confined aquifer hydrographs in the Peake, Roby and Sherlock PWA

4.5 PRS PWA: Confined aquifer - salinity

In 2020, groundwater samples from 16 wells in the confined aquifer of the Peake Roby and Sherlock PWA show salinities ranging between 1535–5226 mg/L, with a median of 3558 mg/L (Figure 4.10).

In the ten years to 2020, all wells show stable groundwater salinities (Section 2.2.2). Trends in salinity over the past ten years vary from a decrease of 0.13% per year to an increase of 0.37% per year, with a median rate of 0.16% increase per year (Figure 4.11).

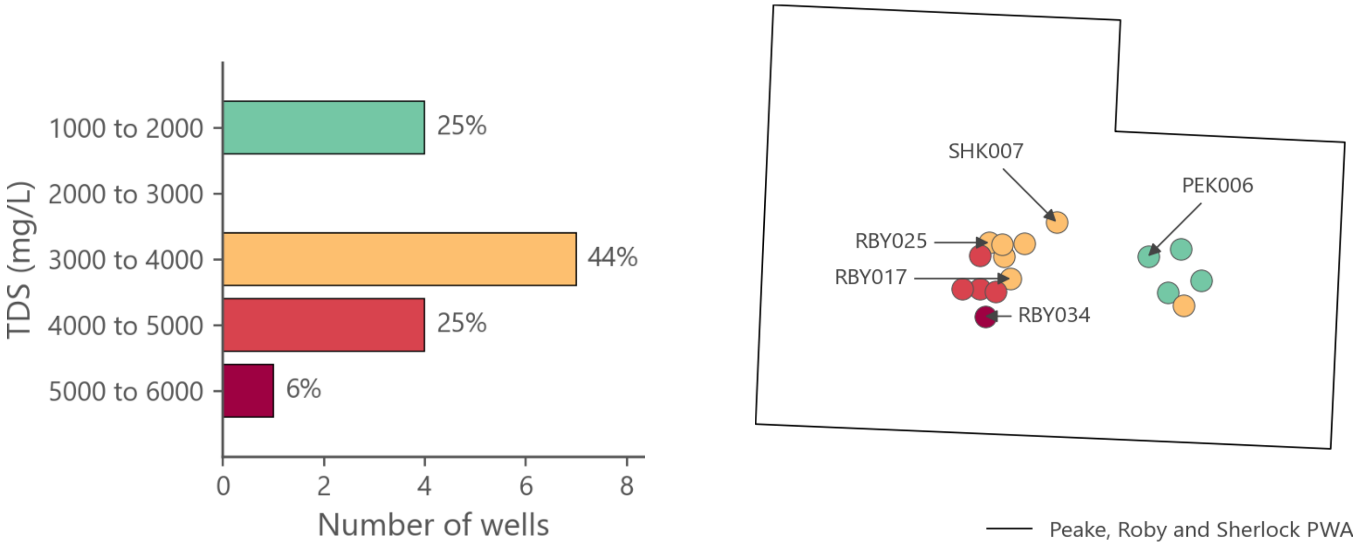

Figure 4.10 2020 salinity observations for wells in the confined aquifer

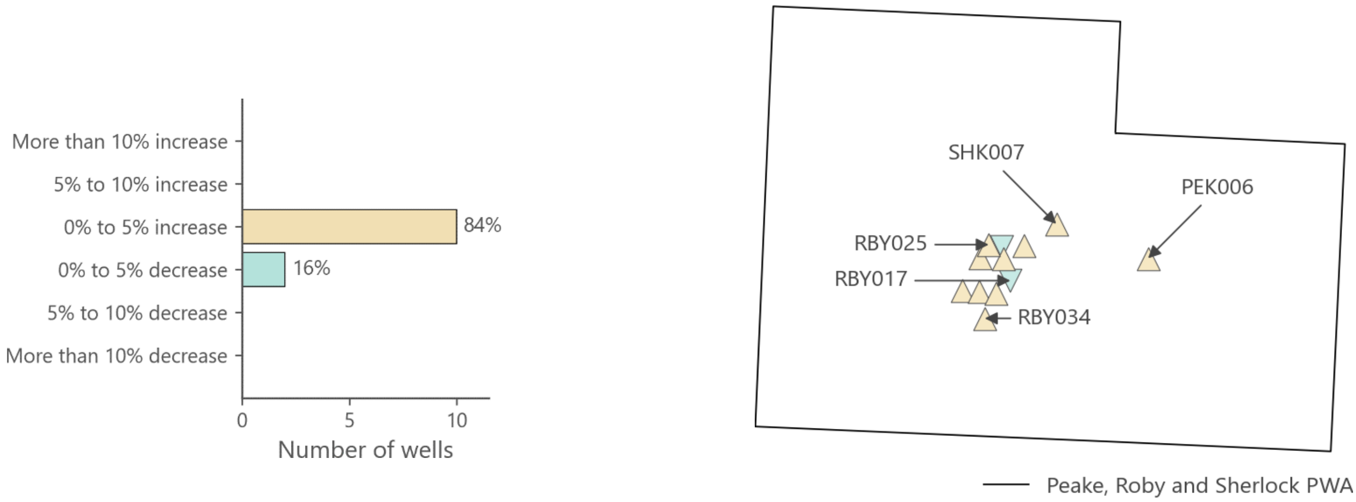

Figure 4.11 Salinity trends in the ten years to 2020 for wells in the confined aquifer

The confined aquifer shows very high groundwater salinity to the west of the Peake Roby and Sherlock PWA. Lowered pressure levels in the Peake area arising from groundwater extraction increase the risk of reversal of groundwater flow and consequently, high-salinity groundwater being gradually mobilised towards the main irrigation area in the east.

Representative salinity data from a selection of monitoring wells (Figure 4.12) show generally stable salinity, with minor variability from year to year. Contemporary and historic (circa-1960s) salinity measurements show generally stable salinity in the longer term (DEW 2020). These results are not unexpected, given the drawdowns that might lead to a reversal of groundwater flow towards the east have been present for only the past 10 years. Given the consistency in salinity measurements over the longer term and current rates of extraction, the current risk to the resource is very low (DEW 2020).

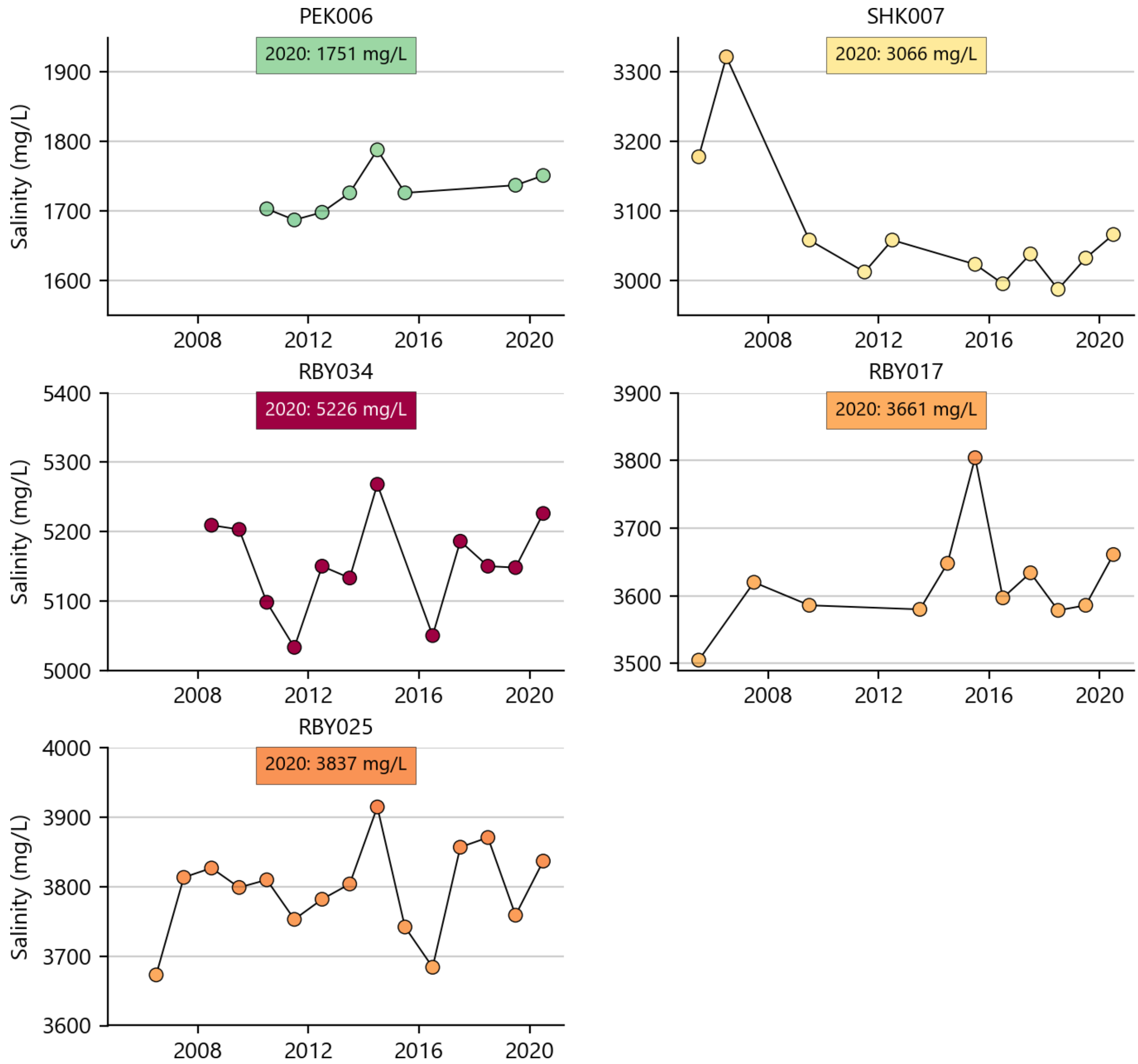

Figure 4.12 Selected confined aquifer salinity graphs

5 Water use

In 2019–20, metered groundwater extraction from the MGL aquifer in the Mallee PWA totalled 33 378 ML (Figure 5.1), which is a decrease of 3002 ML from the preceding water-use year and 1% lower than the average annual volume of groundwater extraction (33 682 ML) between 2004–20. The predominant water use in the PWA is irrigation (more than 90%), followed by industrial, recreation and town water supply.

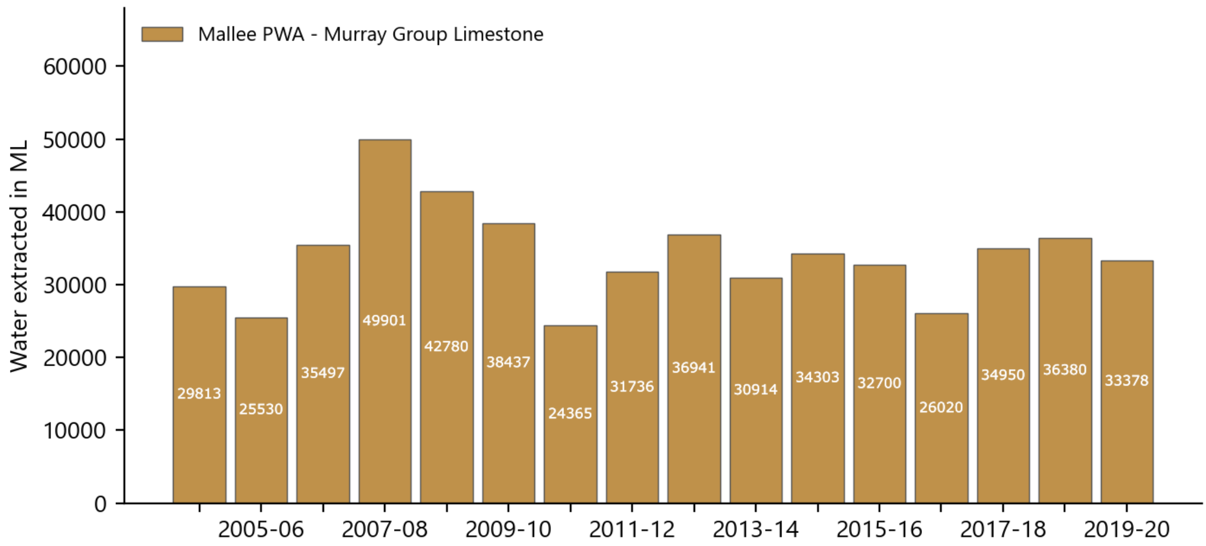

Figure 5.1 Licensed groundwater extraction for 2004–05 to 2019–20 for the Mallee PWA

In 2019–20, metered groundwater extraction from the confined aquifer in the Peake, Roby and Sherlock PWA totalled 687 ML (Figure 5.2), which is an increase in extraction of 37 ML from the preceding water-use year and 30% lower than the average annual volume of groundwater extraction (979 ML) between 2004–20. The predominant water use in the PWA is for irrigation (more than 98%), followed by intensive farming and town water supply.

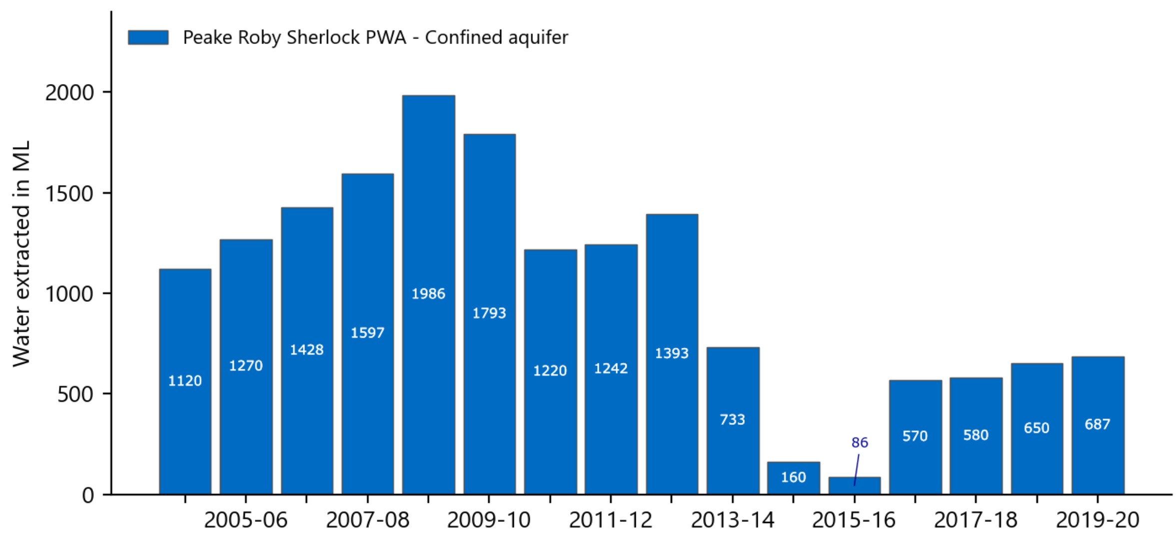

Figure 5.2 Licensed groundwater extraction for 2004–05 to 2019–20 in the Peake, Roby and Sherlock PWA

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