Mallee and Peake, Roby and Sherlock Prescribed Wells Areas 2018-19 water resources assessment

Department for Environment and Water
December, 2020

DEW Technical report 2020/35

Government of South Australia
Department for Environment and Water

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Disclaimer

ISBN 978-1-925964-86-8

Preferred way to cite this publication

DEW (2020). *Mallee and Peake, Roby and Sherlock Prescribed Wells Areas 2018-19 Water resources assessment*, DEW Technical report 2020/35, Government of South Australia, Department for Environment and Water, Adelaide.

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Contents

1 Summary

Rainfall

- Rainfall at Pinnaroo measured 206 mm in 2018-19, which was the lowest on record and less than the long-term average of 318 mm (1979-80 to 2018-19).
- Rainfall at Peake measured 277 mm, which was less than the long-term average of 375 mm (1979-80 to 2018-19).
- Higher than average rainfall totals were recorded in November 2018, December 2018, May 2019 and June 2019. Lower than average rainfall totals were recorded in September 2018, January 2019, February 2019, March 2019 and April 2019.
- Long-term data indicate relatively stable rainfall trends at Pinnaroo and a declining trend at Peake.

Groundwater

- Water levels in the Murray Group Limestone aquifer are mainly below average (74%). These wells are located predominantly in the eastern area of the Mallee PWA to the Victorian border, where the majority of irrigation wells are. 23% recorded average recovery levels, while 3% were the highest on record. 27% of the wells recorded lowest recovery levels on record. The 5 year trend indicates that 75% of wells show declining levels in 2019. Likely drivers for these low recovery levels are reduced rainfall, resulting in increased groundwater extraction.
- Water levels in the confined aquifer are all average (47%) or above average (53%) recovery levels throughout the Peake Roby and Sherlock PWA. The 5 year trend indicates that 58% of water levels are stable or rising compared to 42% which are declining.
- Salinity trends in both the Mallee PWA and Peake, Roby and Sherlock PWA show stable or declining levels.

Water use

- Water use in Mallee PWA extracted from the Murray Group Limestone for 2018-19 was 8% higher than the long-term average and predominantly used for irrigation.
- Water use in Peake, Roby and Sherlock PWA extracted from the confined aquifer for 2018-19 was 35% 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) build on the fact sheets to provide more comprehensive information 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 all resources across all regions in a quick-reference format.

This document is the Technical Note for both the Mallee Prescribed Wells Area and the Peake, Roby and Sherlock Prescribed Wells Area (PWA) for 2018-19 and addresses rainfall and water use data collected between July 2018 and September 2019 and groundwater data collected up until December 2019.

1.2 Regional context

The Mallee PWA 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 South Australia's Landscape SA Act 2019 and a water allocation plan, adopted in 2012, provides for sustainable management of the water resources. The area within 20 km of the State border is jointly managed with Victoria through the South Australian – Victorian Border Groundwater Agreement. Groundwater occurs in three main aquifers in the Mallee PWA, 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 pumping occurring towards the north-east of the PWA where the aquifer is confined.

The Peake, Roby and Sherlock PWA 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 South Australia's Landscape SA Act 2019 and a water allocation plan, adopted in 2011, provides for sustainable management of the water resources. The Peake, Roby and Sherlock PWA has two distinct aquifers—an unconfined aquifer and a confined aquifer. Almost all licensed groundwater extractions are taken from the confined aquifer.

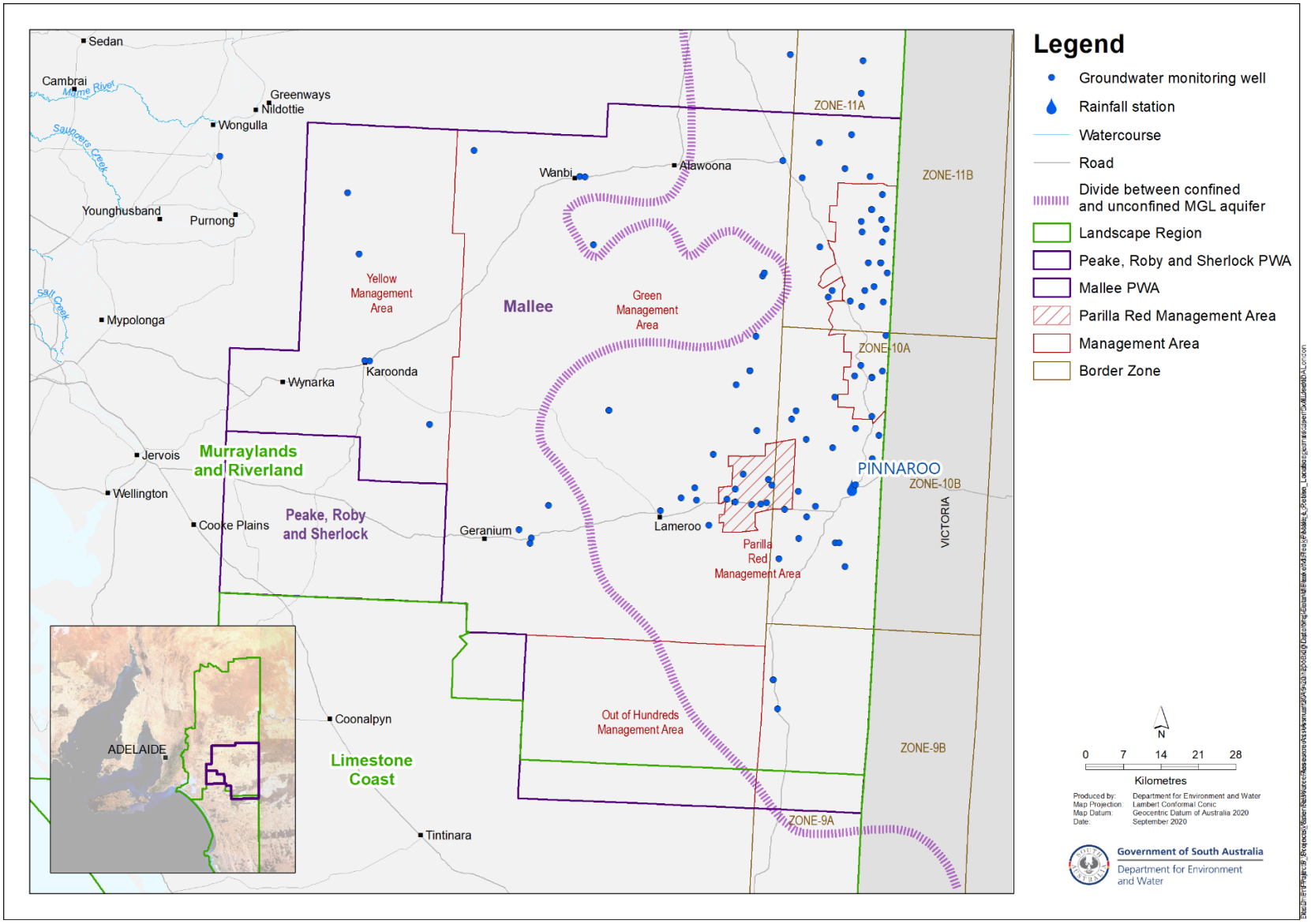

Figure 1.1 Location of the Mallee and Peake, Roby and Sherlock Prescribed Wells Areas

2 Methods and data

This section describes the source of rainfall, surface water, groundwater, and water use data presented in this report, and describes the methods used to analyse and present this 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 2018–19 was compiled from monthly rainfall grids obtained for the months July 2018 to June 2019 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 observations. 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 (for example see Figure 4.1). Hydrographs are shown for a selection of wells to illustrate common or important trends (for example see Figure 4.3).

Five-year trends were 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

[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.

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 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 (for example see Figure 4.4).

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 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] Bureau of Meteorology Annual climate statement 2019

3 Rainfall

The climate of the Mallee PWA and Peake-Roby-Sherlock PWA is characterised by hot, dry summers and cool to cold, wet winters. Long-term annual rainfall varies from up to 300 mm in the north-east to 350 to 400 mm in the south-west of the PWA (Figure 3.1). The rainfall distribution for 2018–19 is similar to the long-term average (1986–2015) for the entire Mallee PWA, however the 2018–19 annual rainfall was well below the long-term average[4].

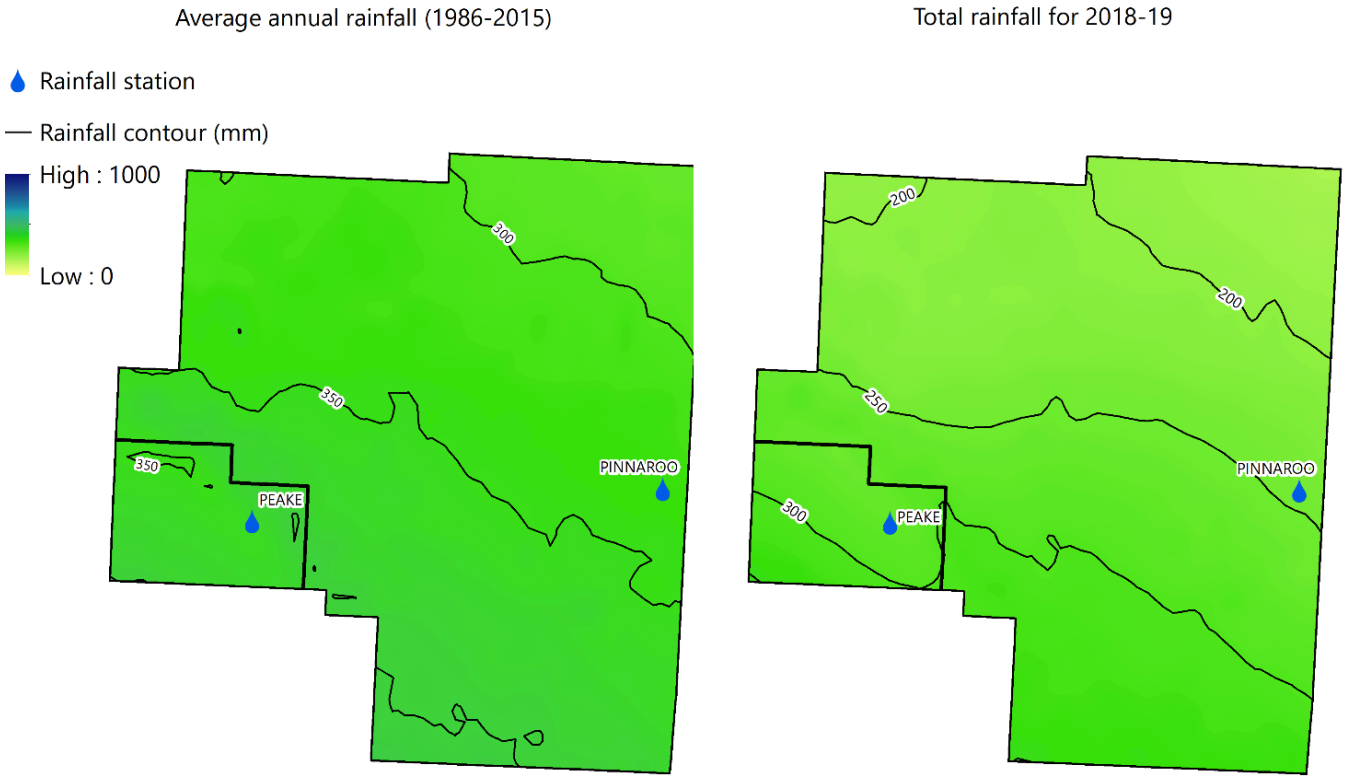

Figure 3.1 Rainfall in the Mallee PWA for 2018–19 compared to the long-term average annual rainfall

[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 and further detail is provided in Section 2.1.

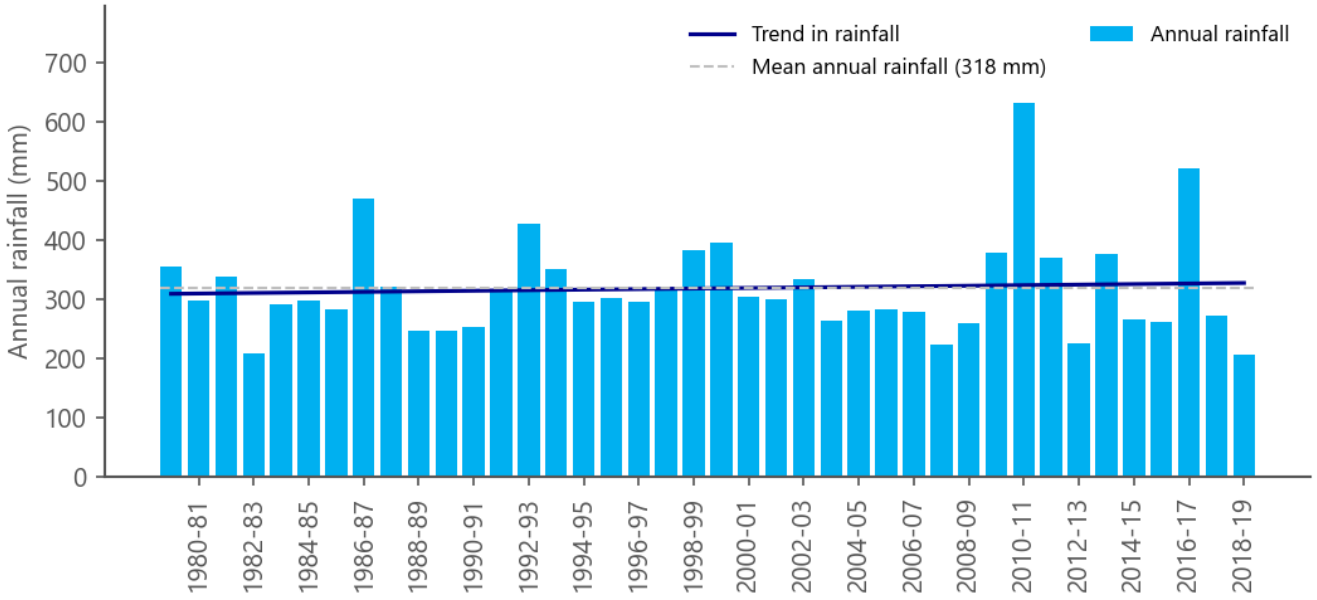

Figure 3.2. Annual rainfall from 1979–80 to 2018–19 at the Pinnaroo rainfall station (25015)

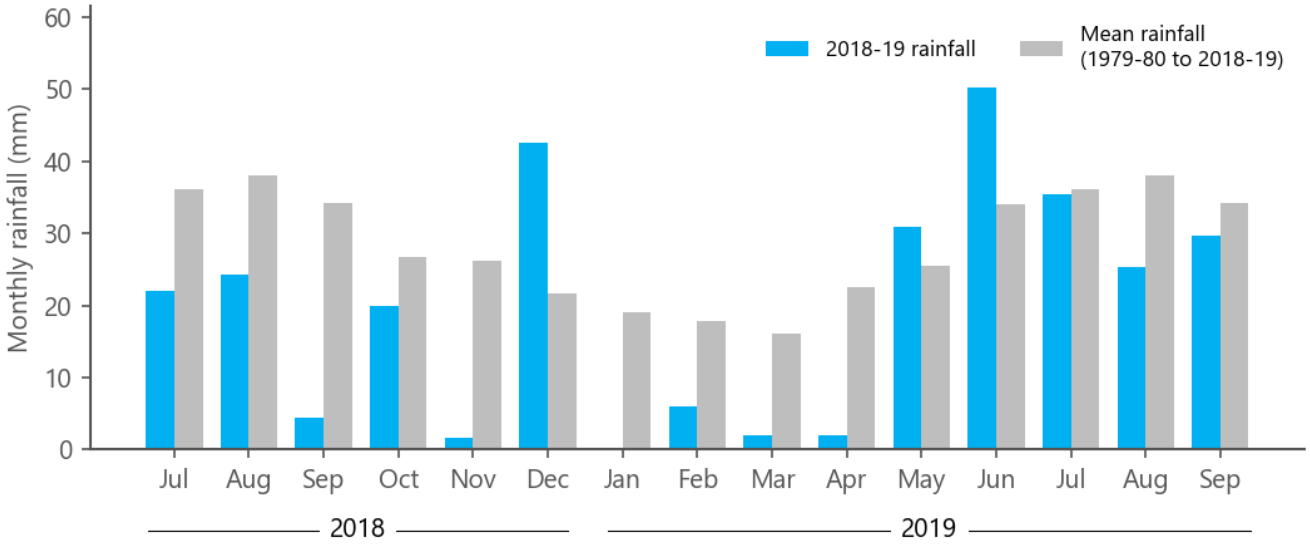

Figure 3.3 Monthly rainfall between July 2018 and September 2019, compared to the long-term monthly average at the Pinnaroo rainfall station (25015)

The Pinnaroo rainfall station (BoM station 25015) is located in the eastern part of the Mallee PWA, near Pinnaroo (Figure 3.2).

In 2018–19, annual rainfall was 206 mm, which was lowest on record since 1979 and less than the long-term (1979–80 to 2018–19) average of 318 mm. A drier than average spring (2018), summer (2018–19) and autumn (2019) were observed at Pinnaroo. Higher than average rainfall totals were recorded in December 2018 and June 2019 (Figure 3.3).

The long-term rainfall trend over this period has marginally increased with notable periods of above-average rainfall (e.g. 2010–11 and 2016–17) as well as below-average rainfall (e.g. 1988–89 to 1990–91 and 2003–04 to 2008–09).

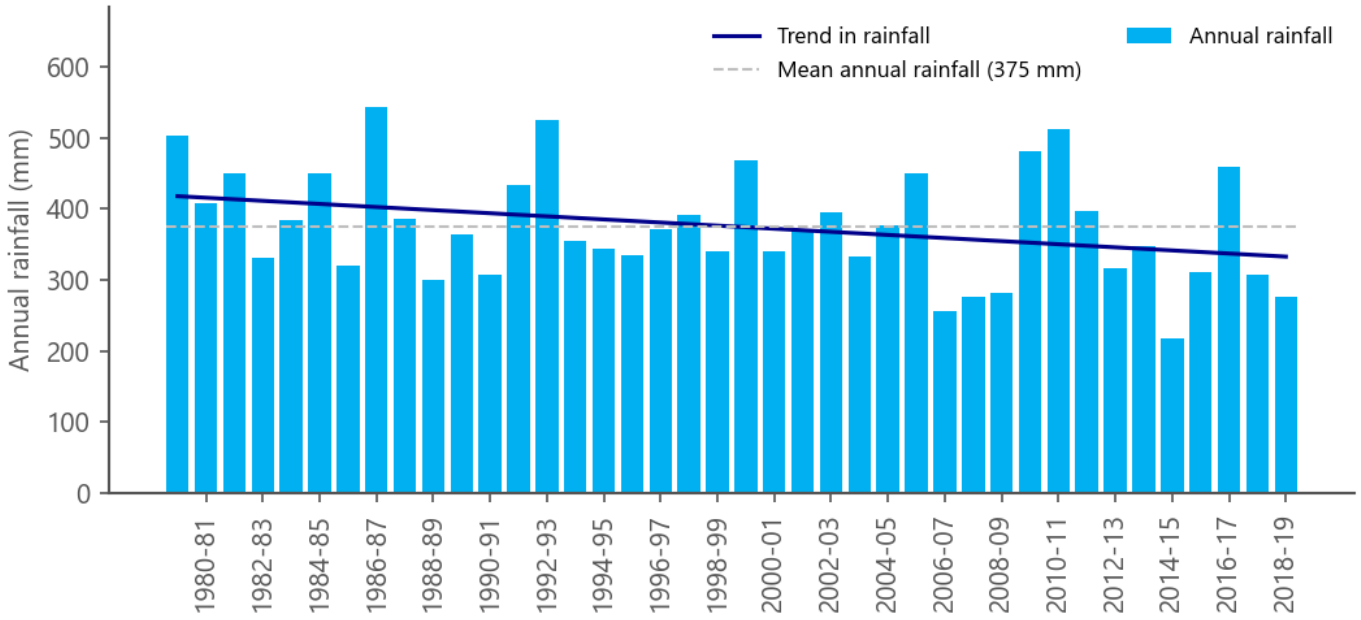

Figure 3.4 Annual rainfall from 1979–80 to 2018–19 at the Peake rainfall station (25513)

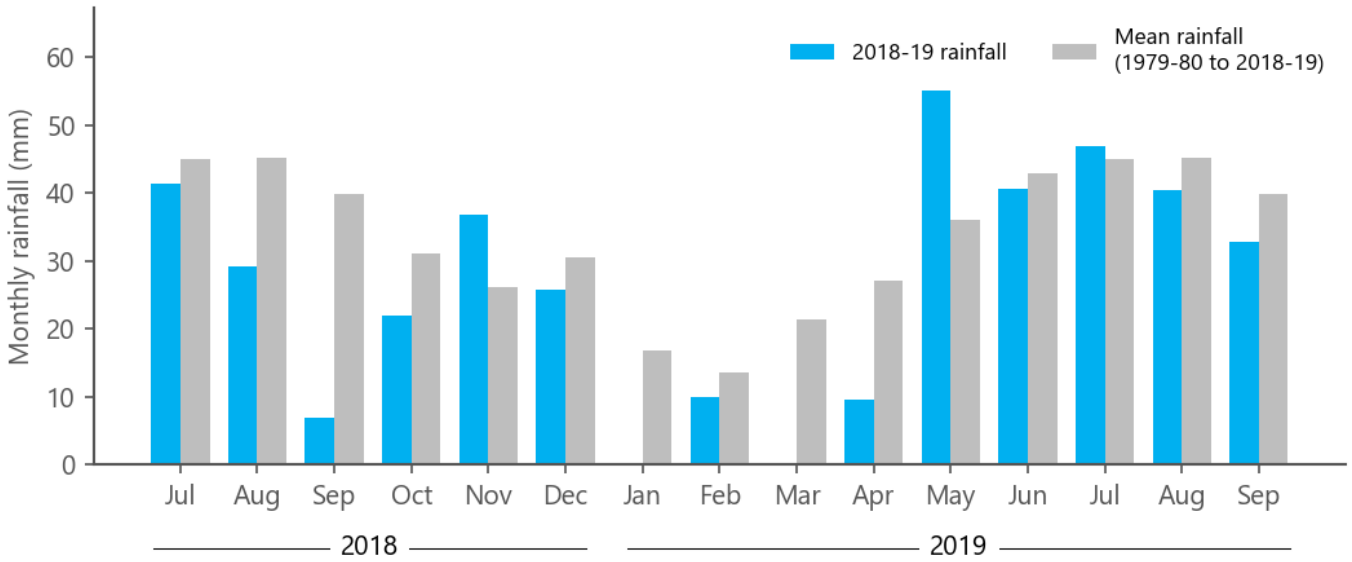

Figure 3.5 Monthly rainfall between July 2018 and September 2019 at the Peake rainfall station (25513)

The Peake rainfall station (BoM station 25513) is located in the western part of the Peake, Roby and Sherlock PWA, near the township of Peake. In 2018–19, annual rainfall was 277 mm and less than the long-term (1979–80 to 2018–19) average of 375 mm (Figure 3.4). A drier than average spring (2018) and summer (2018–19) were observed at Peake with zero rainfall being recorded in both January and March 2019 (Figure 3.5). A higher than average rainfall total was recorded in May 2019.

The long-term rainfall trend over this period has decreased with notable periods of well-below average rainfall (e.g. 2006–07 to 2008–09 and 2012–13 to 2015–16).

4 Groundwater

4.1 Hydrogeology

The Mallee PWA comprises three main aquifer 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, primarily where the aquifer is confined in the northeast of the PWA. The MGL aquifer comprises a consolidated, highly fossiliferous fine to coarse grained limestone which has an average thickness of 100 m. The MGL aquifer is recharged in southwest Victoria, with groundwater movement from this area towards the north, northwest and west of the Mallee PWA. The large depth to the watertable (40–60 m) means that there is little direct correlation between groundwater levels and variations in rainfall. However, there can be an indirect correlation, with higher rainfall resulting in decreased groundwater pumping, 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. The unconfined aquifer is continuous across the Peake, Roby and Sherlock PWA but can be divided into two main regions, the low-lying Coastal Plain and the Mallee Highlands, each with different hydrogeological characteristics. Beneath the Coastal Plain, the unconfined aquifer comprises Quaternary limestones which contain groundwater with high salinities, and consequently there are no current extractions from this resource. Beneath the Mallee Highlands, unconfined groundwater is found in the MGL aquifer at a depth of about 40–50 m below the ground and is mostly used for stock and domestic purposes with a small amount extracted for irrigation (unlike the adjoining Mallee PWA where this aquifer is used extensively for irrigation).

Almost all licensed groundwater extractions in the Peake, Roby and Sherlock PWA are from the confined aquifer, comprising the Buccleuch Group and Renmark Group formations. The Buccleuch Group consists of a consolidated bryozoal limestone or ‘coral’ that lies at a depth of 90–100 m below the ground and varies in thickness from 5–25 m. This coral layer begins to merge laterally with the Renmark Group in the eastern area of the PWA. 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 groundwater extraction rates.

4.2 Murray Group Limestone aquifer - water level

The majority of monitoring wells with suitable long-term records in the MGL aquifer recorded below-average or lower recovered water levels in 2019 (74%). Of those, 32% of monitoring wells in the MGL aquifer recorded below-average water levels, and 27% of wells recovered lowest on record water levels (Figure 4.1). These below-average wells are in the eastern portion of the aquifer where the MGL is confined and irrigation extraction is concentrated.

Long-term changes in water levels over the last 20 years show a decline in water levels in 96% of wells; changes range from a decline of 6.18 m to a rise of 0.42 m (the median change is a decline of 2.20 m).

Five-year trends in water levels are declining in the majority of wells (75%), with rates ranging from a decline of 0.70 m/y to a rise of 0.32 m/y (the median is a declining trend at a rate of 0.12 m/y) (Figure 4.2).

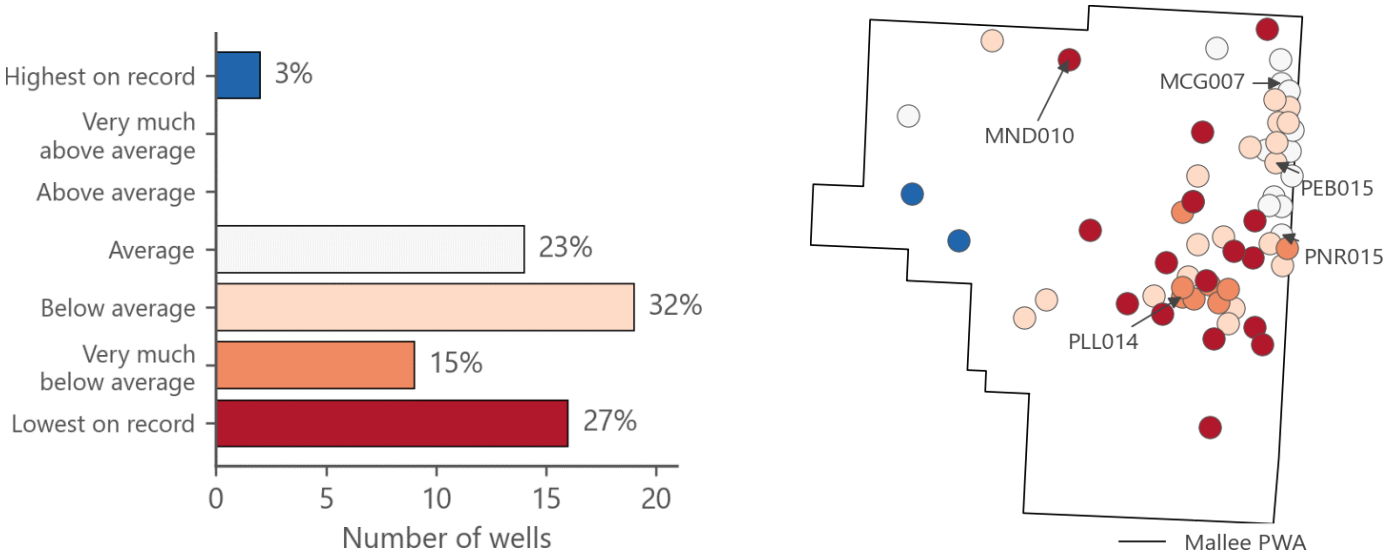

Figure 4.1 2019 recovered water levels for wells in the Murray Group Limestone aquifer

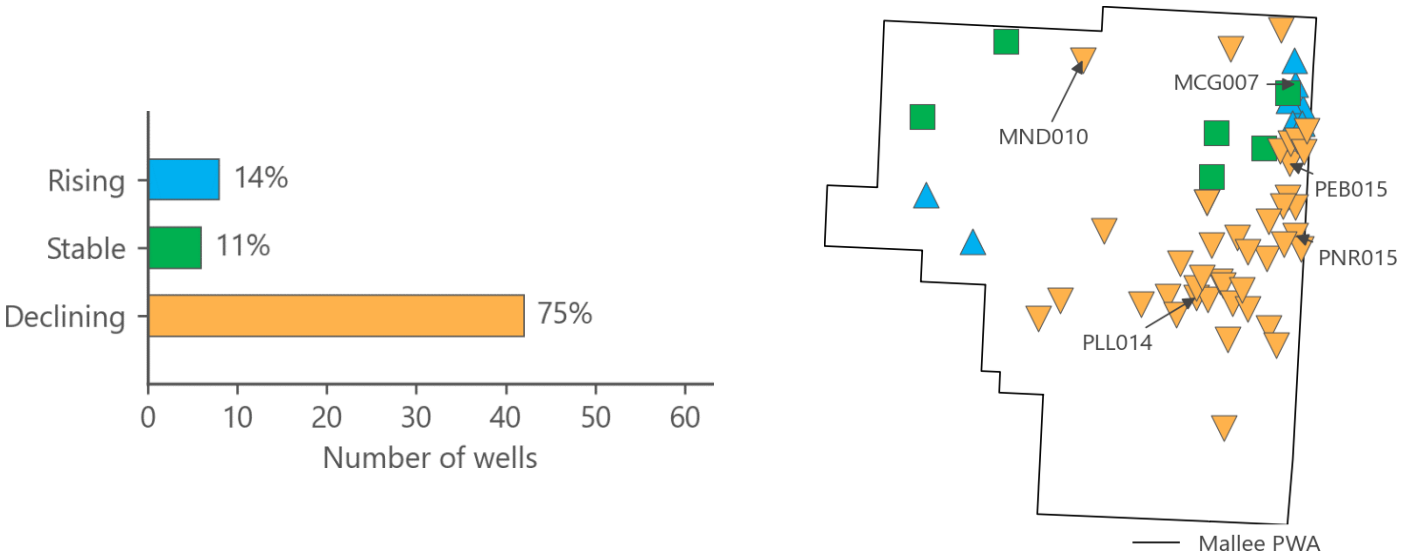

Figure 4.2 2015-2019 trend in recovered water levels for wells in the Murray Group Limestone aquifer

Figure 4.3 shows representative hydrographs from a selection of MGL monitoring wells. Three of the five representative monitoring wells (PEB015, PLL014 and MND010) recorded below-average water levels for 2019, with MND010 recording the lowest on record. Hydrographs for MCG007 and PNR015 display average water levels for 2019 showing stable trends. The majority of wells in the Mallee PWA show declining trends in water levels over the last 20 years due to the concentration of pumping activities in areas with low-salinity groundwater and suitable soils such as Parilla, Pinnaroo and Peebinga. Dry years result in increased reliance on groundwater and can lead to declining water levels as seen in PLL014.

Zone 10A of the South Australian–Victorian Border Groundwater Management Area includes Pinnaroo and the area north until Zone 11A (Figure 1.1). The hydrographs of selected wells PEB015 and PNR015, in this area, illustrate an overall decline in water levels until 2009 when the aquifer generally reaches an ongoing state of equilibrium. The below average, very much below average and lowest on record water levels recorded for these wells during 2007, 2008 and 2009 coincide with increased extraction occurring between 2006-2009 and can be seen in Figure 5.1 in the Water Use section of this report. The increased extraction was a result of the well-below average rainfall that occurred for three consecutive years (Figure 3.2). Zone 11A extends north above Zone 10A. Wells in this area reached an equilibrium around 2008 (MCG007) and more recently (since 2016) show rising water levels.

In other locations in the PWA, further from irrigation areas, water levels tend to show more stability in the last 20 years. An example of such a well is MND010, which is located in the unconfined portion of the MGL (Figure 1.1) where the water levels are responsive to rainfall. MDN010 recorded its lowest level on record in 2019 which correlates to 2018-19 being the driest year on record.

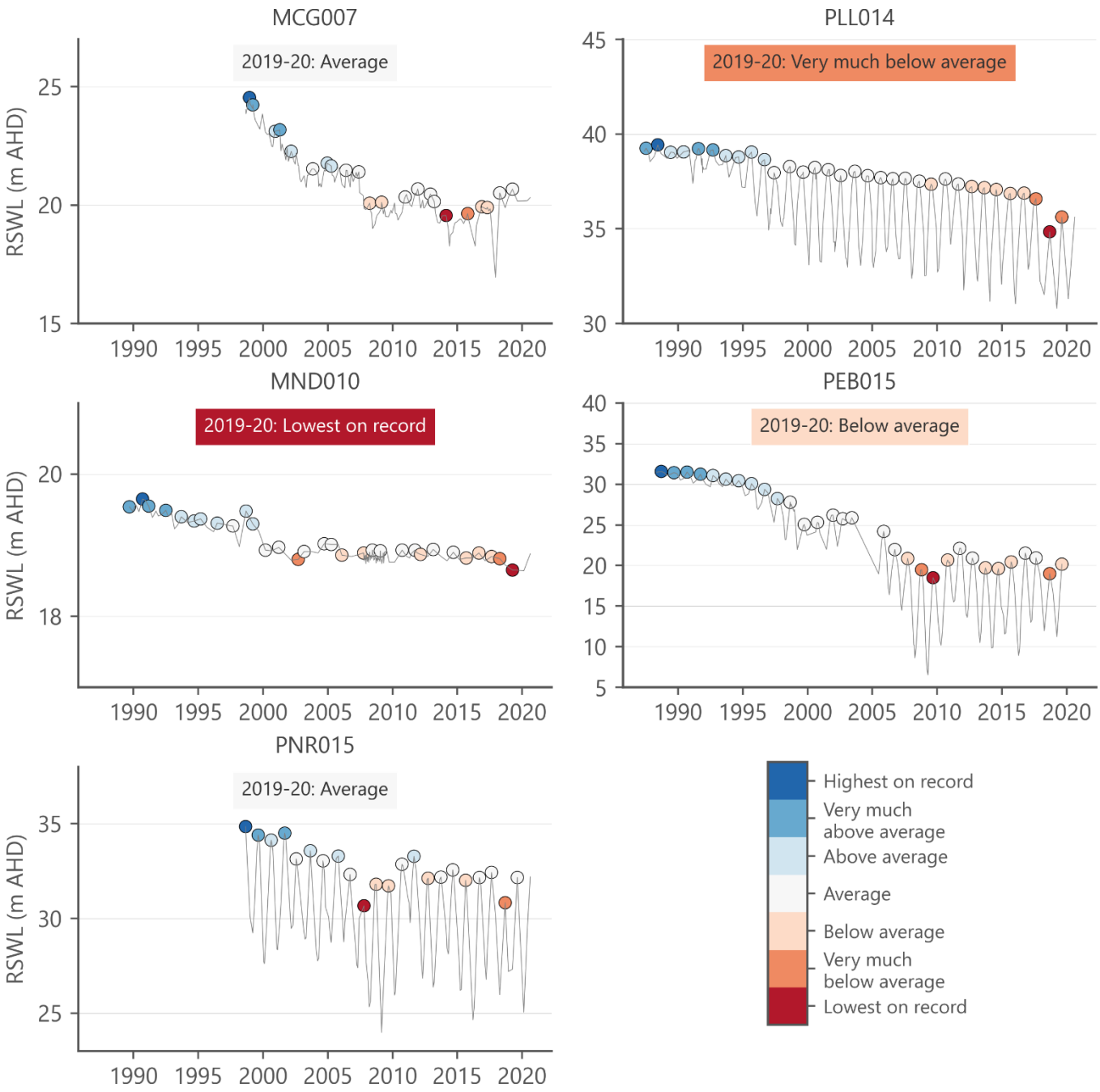

Figure 4.3. Selected Murray Group Limestone aquifer hydrographs

4.3 Murray Group Limestone aquifer - salinity

In 2019, groundwater samples from 149 wells in the MGL showed salinities ranging from 567 mg/L to 3742 mg/L, with a median of 1105 mg/L (Figure 4.4). The higher salinities are found in the northern and western part of the PWA while the lowest salinities are observed in the eastern part near the Victorian border. Potential sources of salinity increases are the downward leakage of saline water from the overlying Pliocene Sands aquifer and also lateral inflow of more saline groundwater from the north.

For the five-year period between 2015 and 2019, salinity of the MGL aquifer was predominantly stable (in 63% of wells) and decreasing in the remainder of the wells (Figure 4.5).

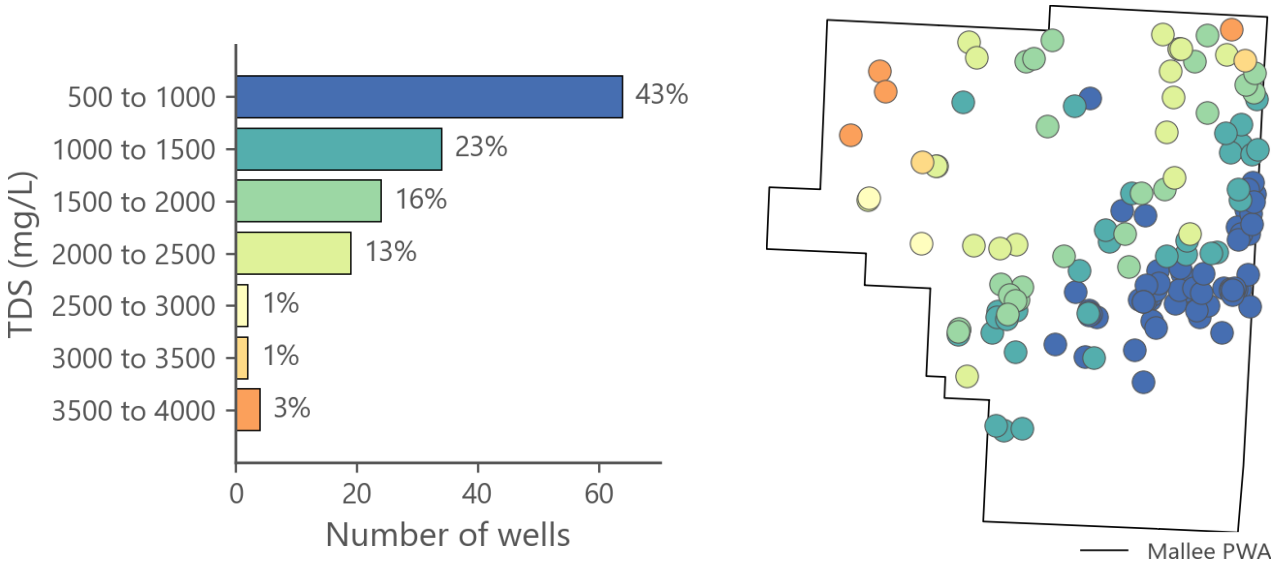

Figure 4.4 2019 salinity observations from wells in the Murray Group Limestone aquifer

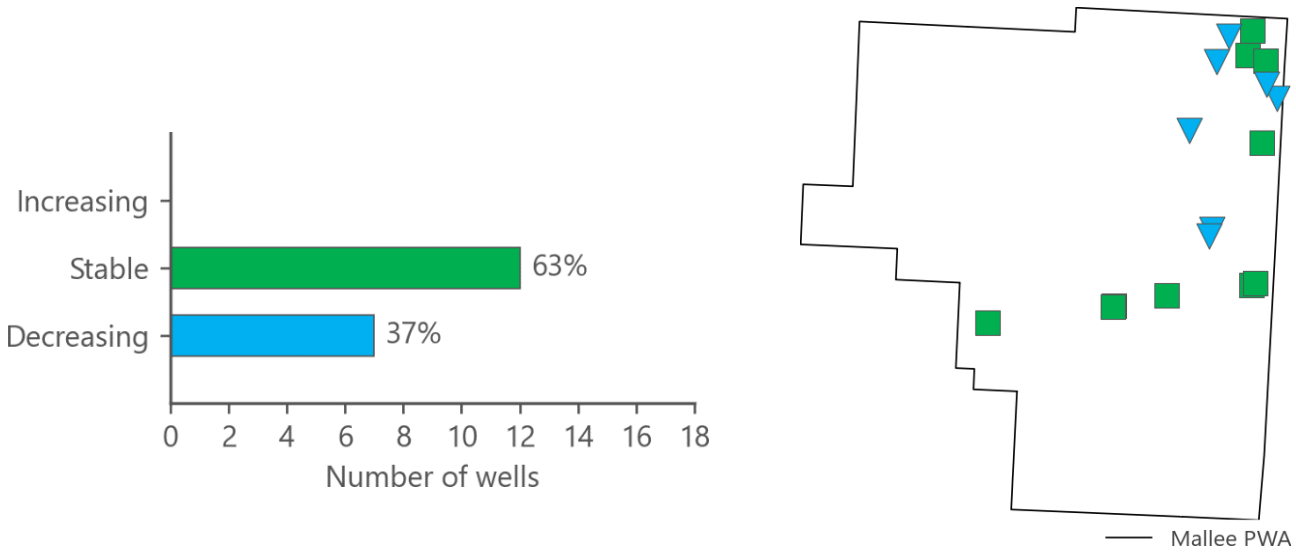

Figure 4.5 2015-2019 trend in groundwater salinity for wells in the Murray Group Limestone aquifer

4.4 Confined aquifer - water level

53% of monitoring wells in the confined aquifer with suitable long-term records recorded above-average recovered water levels in 2019, while the remaining 47% of wells recorded average water levels (Figure 4.6). These wells are located in the centre and eastern area of the Peake, Roby and Sherlock PWA.

All wells with suitable long-term records recorded a rise in water levels over the last 10 years, ranging from a rise of 0.53 m to 4.35 m (the median change is a rise of 1.77 m).

Five-year trends in water levels are predominantly stable (42% of wells) or declining (42% of wells), with rates ranging from a decline of 0.13 m/y to a rise of 0.04 m/y (the median for all wells is a declining trend at a rate of 0.02 m/y; Figure 4.7).

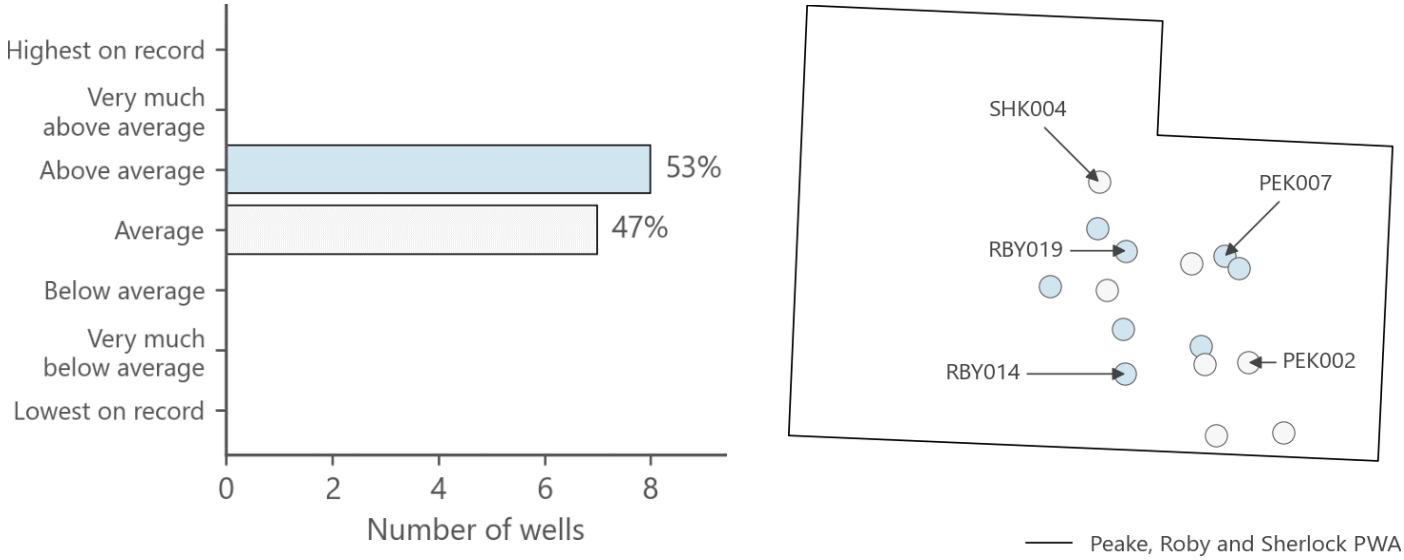

Figure 4.6 2019 recovered water levels for wells in the confined aquifer

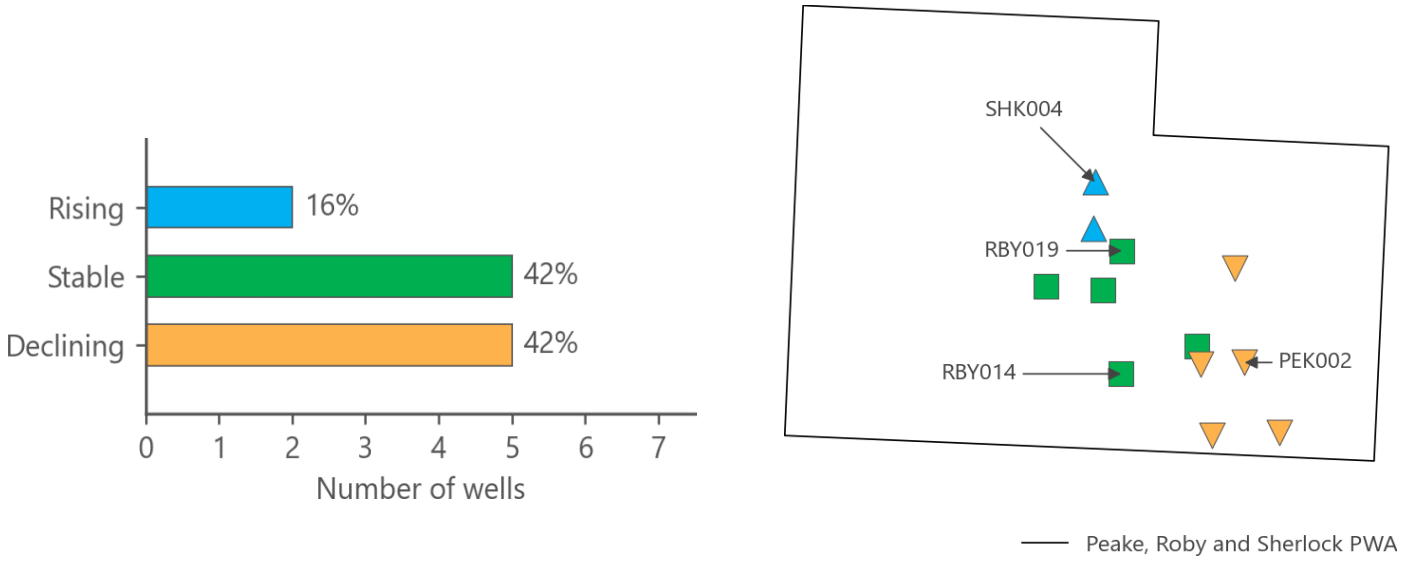

Figure 4.7 2015-2019 trend in recovered water levels for wells in the confined aquifer

Figure 4.8 shows representative hydrographs from a selection of monitoring wells. All five monitoring wells recorded average (PEK002, SHK004) and above-average (PEK007, RYB014, RBY019) water levels in 2019. Large seasonal variations in pressure levels have developed since large-scale irrigation commenced in 2004, with the seasonal drawdowns decreasing with distance from the areas of irrigation. Drawdowns increased every year until 2009–10 when water levels declined to their lowest level on record. Since then, drawdowns have reduced in magnitude as a result of decreasing extractions (Figure 5.2) and the water levels have significantly recovered and stabilised.

Observation well PEK007 is the Peake town water supply well 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. Since extractions come from the confined aquifer there is little direct correlation between groundwater levels and seasonal variations in rainfall, however a wetter than average spring such as that in 2016 may result in a delayed start to pumping for the irrigation season and therefore a higher than normal recovery in groundwater levels.

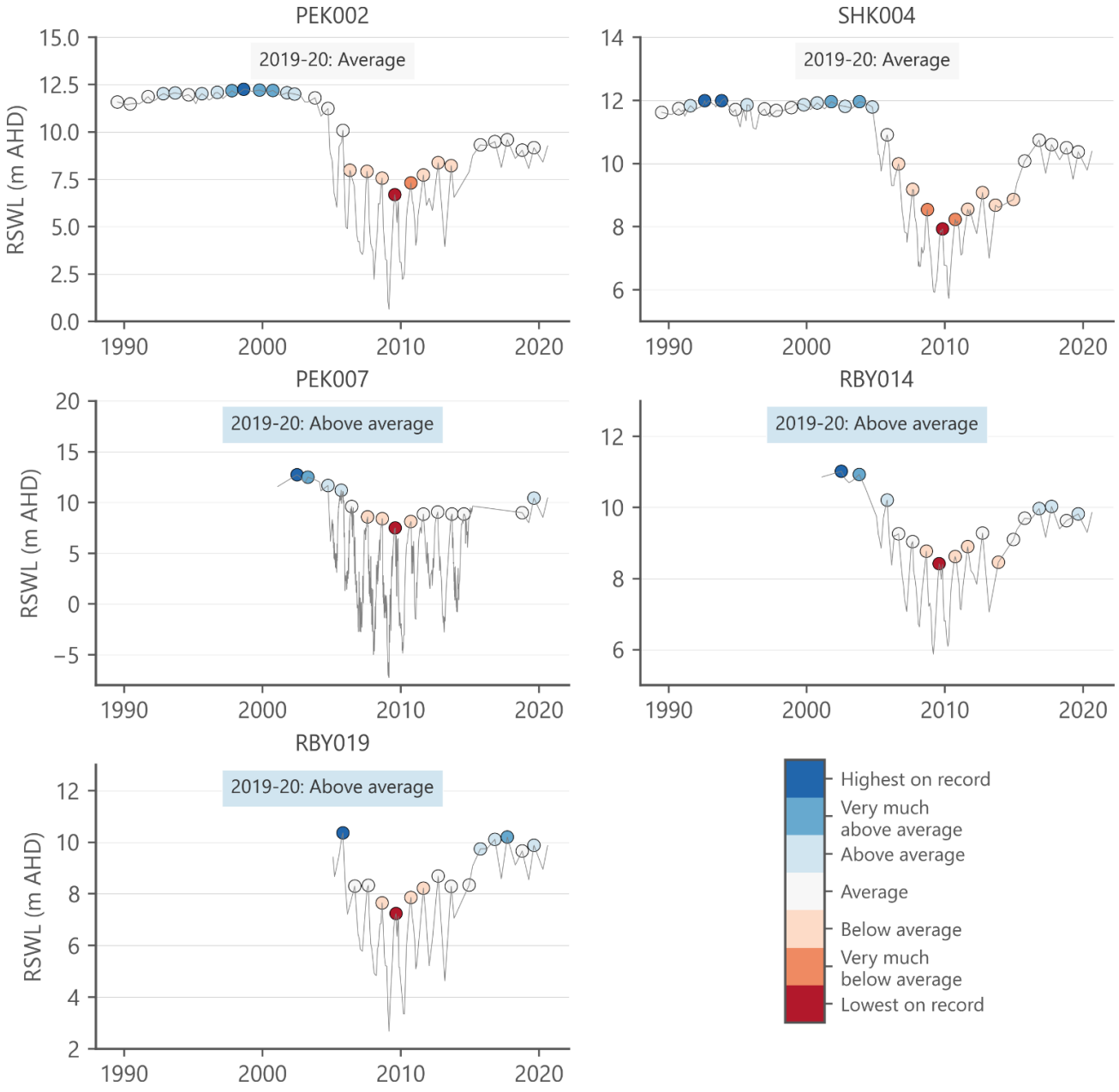

Figure 4.8 Selected confined aquifer hydrographs

4.5 Confined aquifer - salinity

In 2019, groundwater samples from 17 wells in the MGL showed salinities ranging from 1524 mg/L to 5148 mg/L, with a median of 3448 mg/L (Figure 4.8). Salinities increase toward the west of the PWA, with the lowest values located in the east of the PWA. Rising salinity in the western portion of the PWA is the greatest risk resulting from irrigation from the confined aquifer.

For the five-year period between 2015 and 2019, salinity for the confined aquifer (from wells located in the central portion of the PWA) was stable (Figure 4.9).

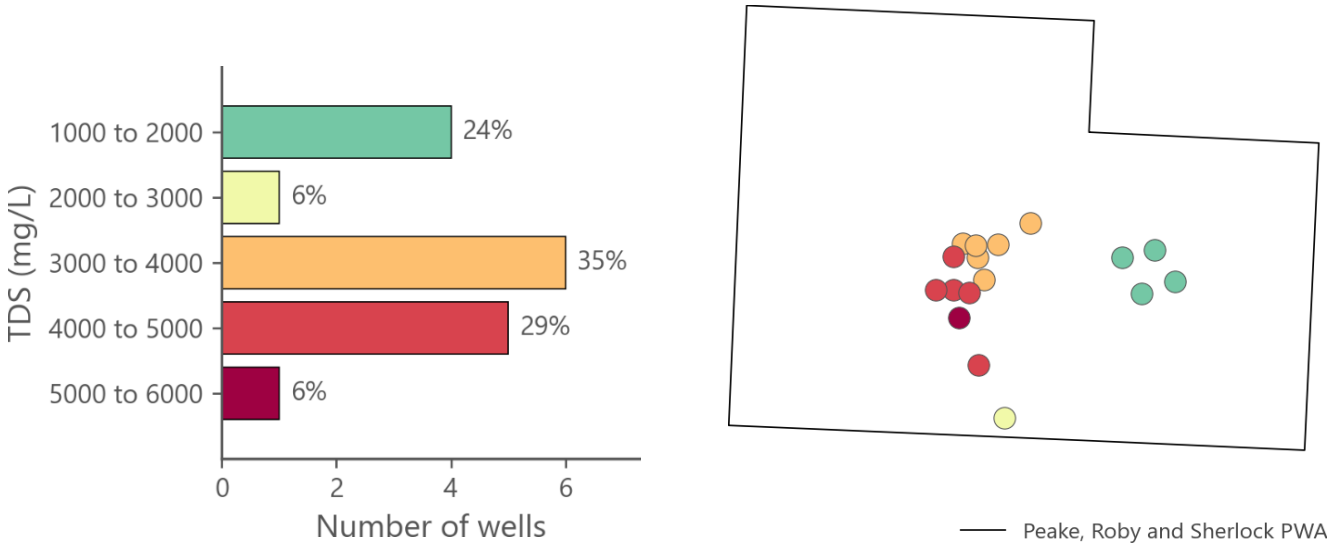

Figure 4.9 2019 salinity observations for wells in the confined aquifer

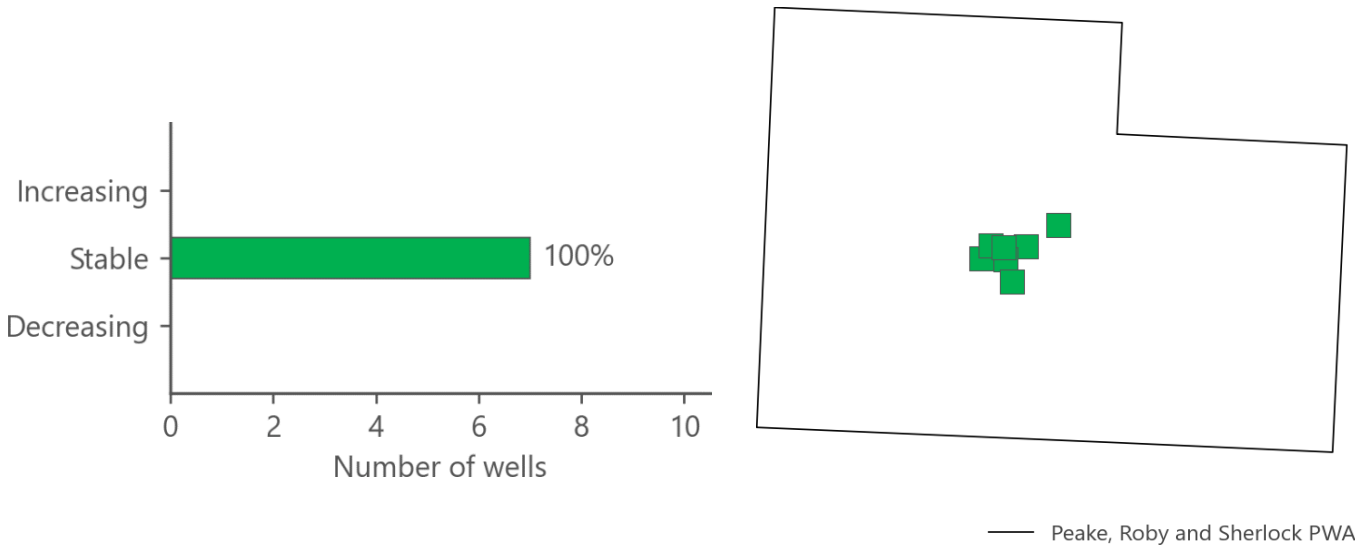

Figure 4.10 2015-2019 trend in groundwater salinity for wells in the confined aquifer

5 Water use

Metered groundwater extraction from the MGL aquifer in the Mallee PWA totalled 36 380 ML for 2018–19 (Figure 5.1), an increase in extraction of 1430 ML from the preceding water-use year and 8% higher than the average annual long-term volume of groundwater extraction (33 701 ML). The predominant water use in the PWA is irrigation, followed by industrial, recreation and town water supply.

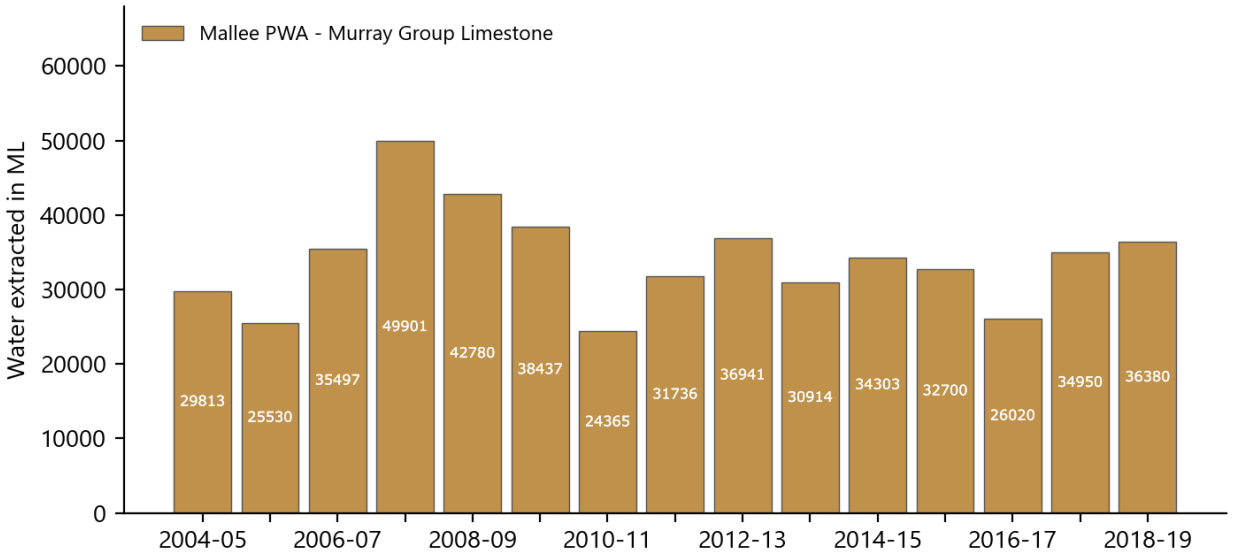

Figure 5.1 Licensed groundwater extraction for 2004–05 to 2018–19 for the Mallee PWA

Metered groundwater extraction from the confined aquifer in the Peake, Roby and Sherlock PWA totalled 650 ML for 2018–19 (Figure 5.2), an increase in extraction of 70 ML from the preceding water-use year and 35% lower than the average annual long-term volume of groundwater extraction (997 ML). The predominant water use in the PWA is for irrigation, followed by intensive farming and town water supply. The marked increase in extraction in 2008–09 coincided with the revocation of a Notice of Prohibition.

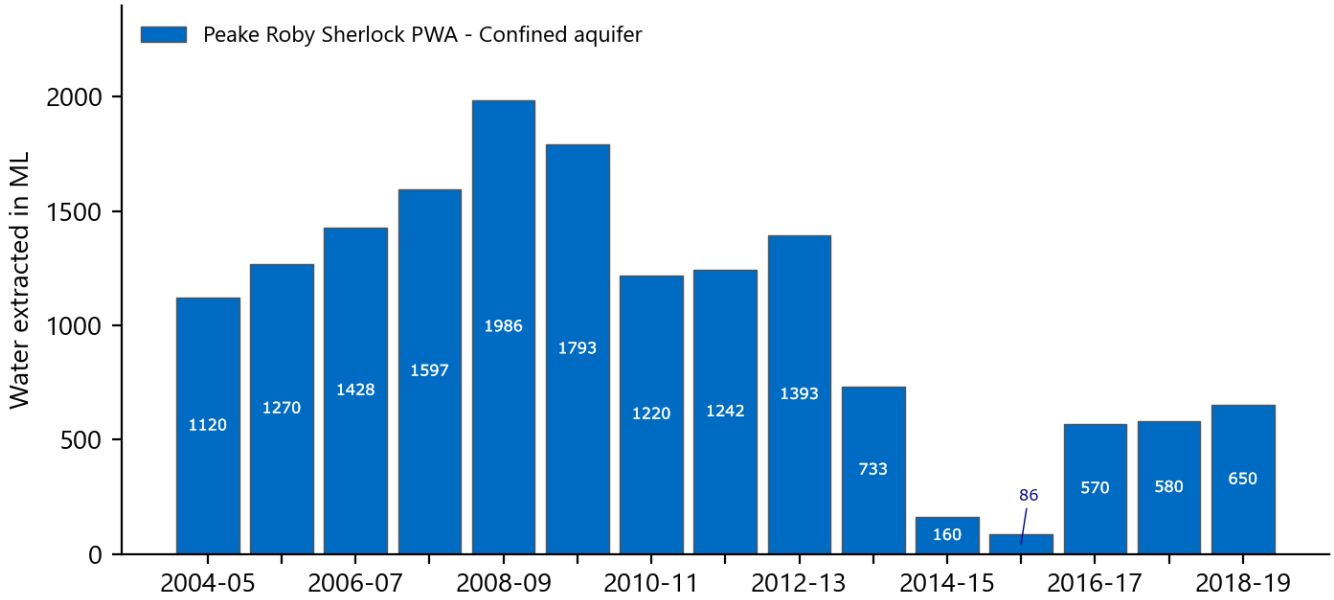

Figure 5.2 Licensed groundwater extraction for 2004–05 to 2018–19 in the Peake, Roby and Sherlock PWA

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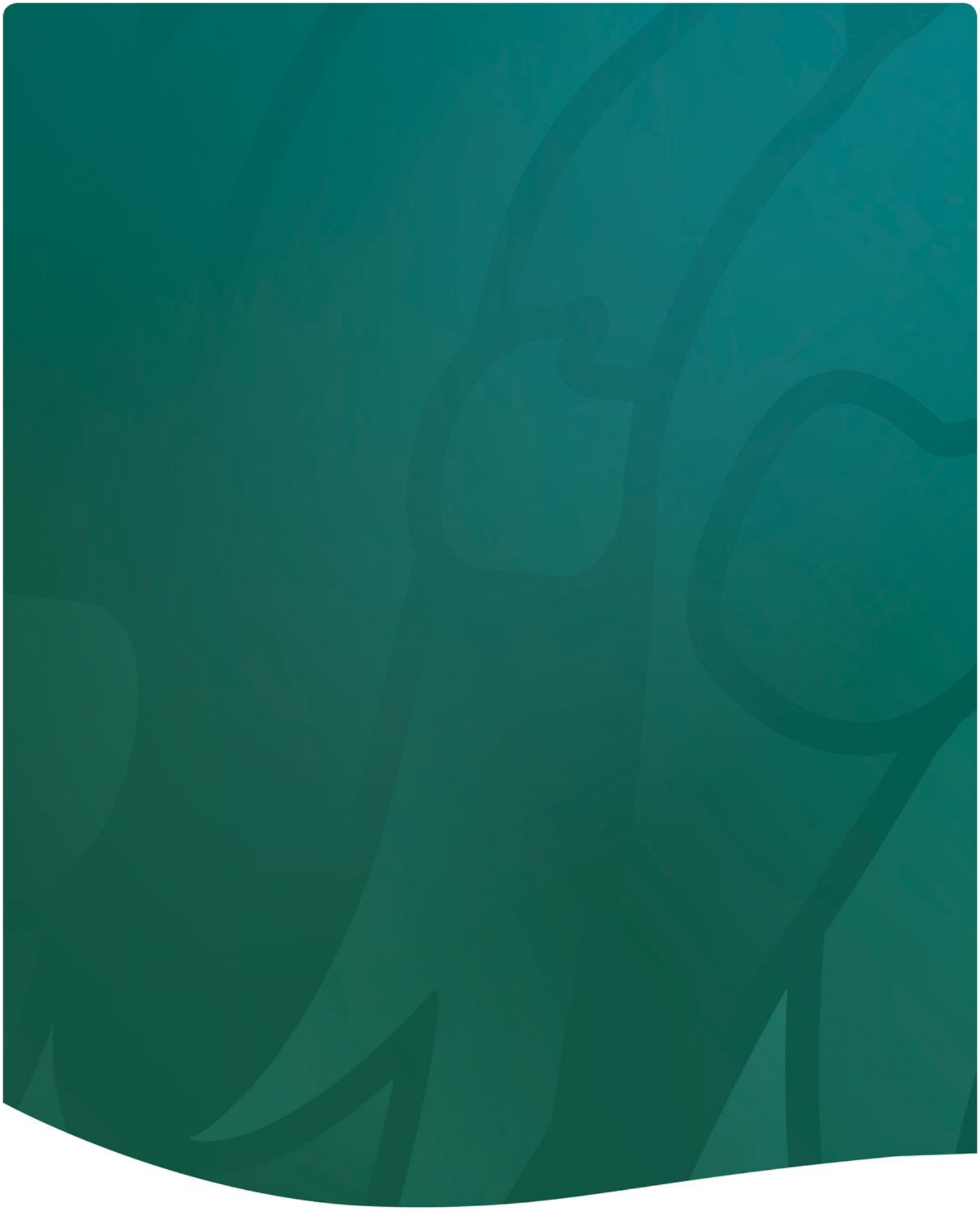

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