McLaren Vale Prescribed Wells Area 2019–20 water resources assessment

Department for Environment and Water
December, 2021

DEW Technical Note 2021/12

Government of South Australia
Department for Environment and Water

Department for Environment and Water

Government of South Australia

December 2021

81-95 Waymouth St, ADELAIDE SA 5000

Telephone +61 (8) 8463 6946

Facsimile +61 (8) 8463 6999

ABN 36702093234

www.environment.sa.gov.au

ISBN 978-1-922027-09-2

Preferred way to cite this publication

DEW (2021). *McLaren Vale Prescribed Wells Area 2019–20 water resources assessment*, DEW Technical Note 2021/12, Government of South Australia, Department for Environment and Water, Adelaide.

Download this document at https://www.waterconnect.sa.gov.au

Contents

1	**Summary**	**1**
1.1	Purpose	1
1.2	Regional context	1
2	**Methods and data**	**3**
2.1	Rainfall	3
2.2	Groundwater	3
2.2.1	Water level	3
2.2.2	Salinity	4
2.3	Water use	4
2.4	Further information	5
3	**Rainfall**	**6**
4	**Groundwater**	**9**
4.1	Hydrogeology	9
4.1.1	Quaternary	9
4.1.2	Port Willunga Formation	9
4.1.3	Maslin Sands	9
4.1.4	Fractured rock aquifer	10
4.2	Port Willunga Formation Aquifer - water level	11
4.3	Port Willunga Formation Aquifer - salinity	13
4.4	Maslin Sands aquifer - water level	15
4.5	Maslin Sands aquifer - salinity	17
4.6	Fractured rock aquifers - water level	19
4.7	Fractured rock aquifers - salinity	21
5	**Water use**	**23**
6	**References**	**25**

1 Summary

Rainfall in 2019–20

- Rainfall at Willunga is 658 mm, which is 9% greater than the long-term average of 609 mm (1979–2020).
- Rainfall at Mount Bold Reservoir is 851 mm, which is 6% greater than the long-term average of 807 mm (1979–2020).
- Total annual rainfall is highest along the Mount Lofty Ranges, and decreases markedly towards the coast.
- Rainfall trends for the period 1979–2020 are relatively stable though Willunga has experienced an extended period of below-average rainfall when comparing average annual rainfall for this period (609 mm) to average annual rainfall for the period 1900–2021 (636 mm).

Groundwater

- In 2020, and in the Port Willunga Formation aquifer, water levels in monitoring wells that are located towards the north-east of the Willunga Basin (where the aquifer is unconfined) have declined, with most wells (62%) classified 'Lowest on record'.
- In 2020, 25% of the monitoring wells in the Maslin Sands aquifer and 18% of monitoring wells in the fractured rock aquifers are classified 'Lowest on record'.
- Fifteen-year trends in the Port Willunga Formation aquifer show that salinity is increasing in most wells (76%), with a median rate of 0.35% increase per year.
- Fifteen-year trends in the Maslin Sands aquifer show that salinity is increasing in the majority of wells (84%), with a median rate of 0.39% increase per year.
- Fifteen-year trends in the fractured rock aquifers show that salinity is increasing in the majority of wells (57%), with a median rate of 0.14% increase per year.

Water use in 2019–20

- Total groundwater extractions in the McLaren Vale Prescribed Wells Area is 4473 ML, which is 12% lower than the preceding water-use year.
- The greatest annual volume of groundwater extraction is from the Port Willunga Formation aquifer (64%), while lower annual volumes of extraction are from the Maslin Sands aquifer (18%) and the fractured rock aquifers (18%).

1.1 Purpose

The Department for Environment and Water (DEW) has a key responsibility to monitor and report annually on the status of South Australia's 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 detailed information for each resource
- **Fact sheets**: provide summary information for each resource
- **State-wide summary**: outlines the status of the main water resources in a quick-reference format.

This document is the Technical Note for the McLaren Vale Prescribed Wells Area (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 McLaren Vale PWA is located approximately 35 km south of Adelaide (Figure 1.1) and falls mostly within the Hills and Fleurieu Landscape region (the western margin of the PWA lies within the Green Adelaide region). The McLaren Vale PWA is a regional-scale resource for which groundwater has been prescribed under South Australia's *Landscape SA Act 2019* and a water allocation plan, which was adopted in 2000, provides for sustainable management of the water resources. Groundwater is mostly extracted from three main aquifers: two sedimentary aquifers (the Port Willunga Formation and Maslin Sands aquifers) and the fractured rock aquifers. At the time of writing this report, the Pirramimma Sandstone is considered to be part of the Port Willunga Formation, as per the current water allocation plan.

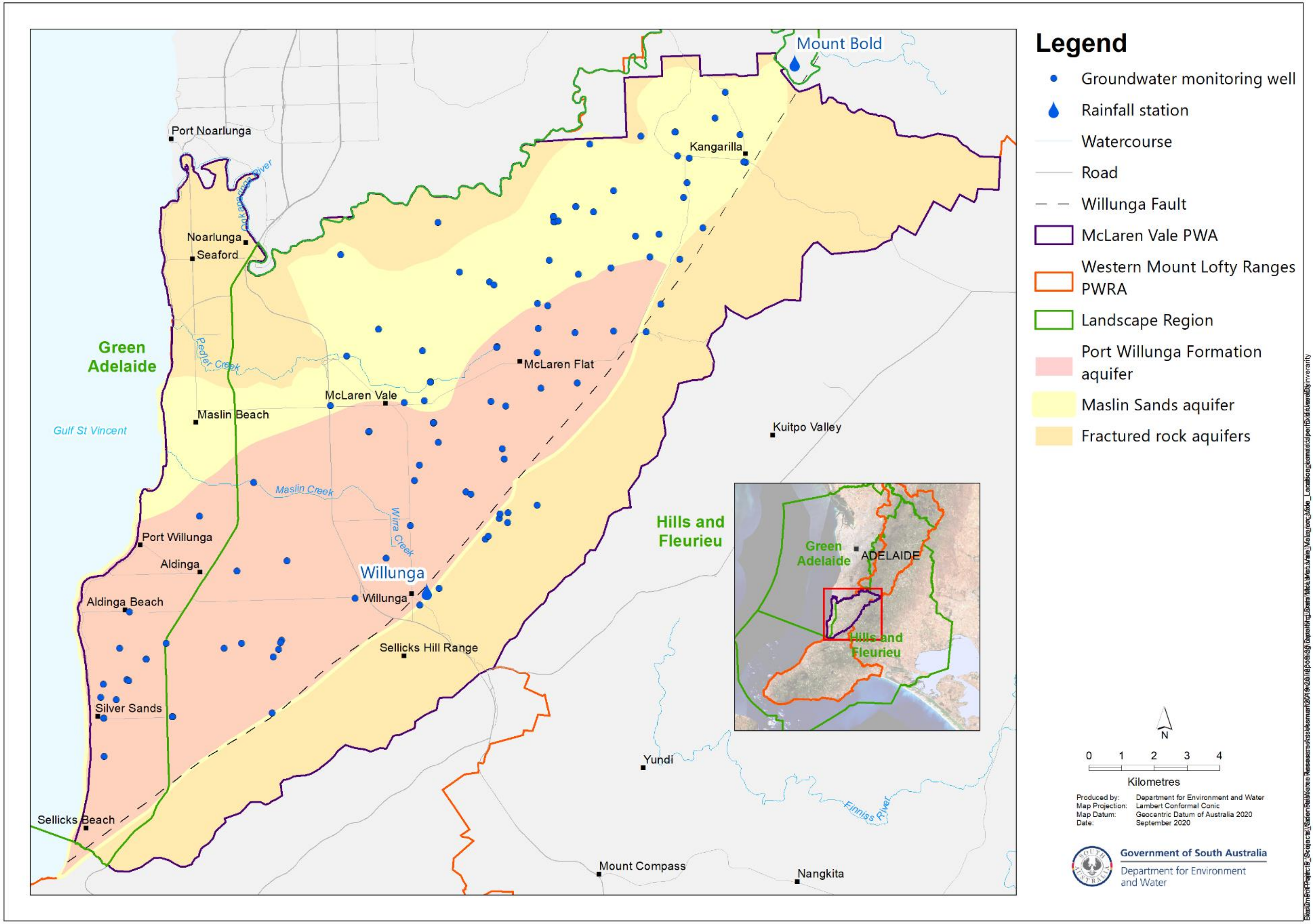

Figure 1.1 Location of the McLaren Vale PWA

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 (Figure 3.1 and Figure 3.2).

Rainfall maps were compiled using gridded datasets obtained from the BoM (Figure 3.3). 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 McLaren Vale PWA monitoring network 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, the aquifers in the McLaren Vale 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 McLaren Vale 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 summarized for each aquifer (e.g. Figure 4.1). Hydrographs are shown for a selection of wells to illustrate common or important trends (e.g. Figure 4.3).

Five-year trends are calculated using annual recovered water levels for those wells which have at least five measurements (i.e. at least one measurement a year). The trend line was calculated by linear regression and the well is given a status of 'declining', 'rising', or 'stable', depending on whether the slope of this trend line is below, above or within a given tolerance threshold. This threshold allows for the demarcation of wells where water levels are changing at very low rates and the water level can therefore be considered stable. The threshold also

[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.

accommodates very small measurement errors. The number of rising, declining and stable wells are then summarized for each aquifer (e.g. Figure 4.2).

Moderately-sized, sedimentary, confined and unconfined aquifers such as the Port Willunga Formation and Maslin Sands are given tolerance thresholds of 2 cm/y, while fractured rock aquifers with lower storages are given a tolerance threshold of 1 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. Since 2017, 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).

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 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 McLaren Vale PWA.

[3] Bureau of Meteorology Annual climate statement

2.4 Further information

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

Other important sources of information on water resources on the McLaren Vale PWA are:

- summary reports on the groundwater resources of the McLaren Vale PWA and annual groundwater level and salinity status reports (*Water Resource Assessments* page on WaterConnect)
- the Water Allocation Plan for the McLaren Vale PWA (AMLR NRM Board, 2007)
- a review of salinity trends in the McLaren Vale PWA (Herczeg and Leaney, 2002; Villeneuve and Harrington, 2012)
- a review of groundwater recharge processes in the McLaren Vale PWA (Batlle-Aguilar and Cook, 2012; Harrington, 2002; Herczeg and Leaney, 2002; Irvine et al., 2017)
- a review of saltwater intrusion in the McLaren Vale PWA (Morgan et al., 2013; Post and Banks, 2015; Post et al., 2018; Short et al., 2014)
- a detailed description of the hydrogeology of the Willunga Basin (Smith et al., 2015).

3 Rainfall

The climate of the McLaren Vale PWA is described as temperate, typically comprising cold, wet winters and hot, dry summers (BoM, 2021). Long-term data (1986–2015) indicate a high rainfall gradient across the PWA, increasing from around 500 mm/y at the coast to around 900 mm/y at the peak of the Mount Lofty Ranges in the north-east, which is a distance of around 20 km.

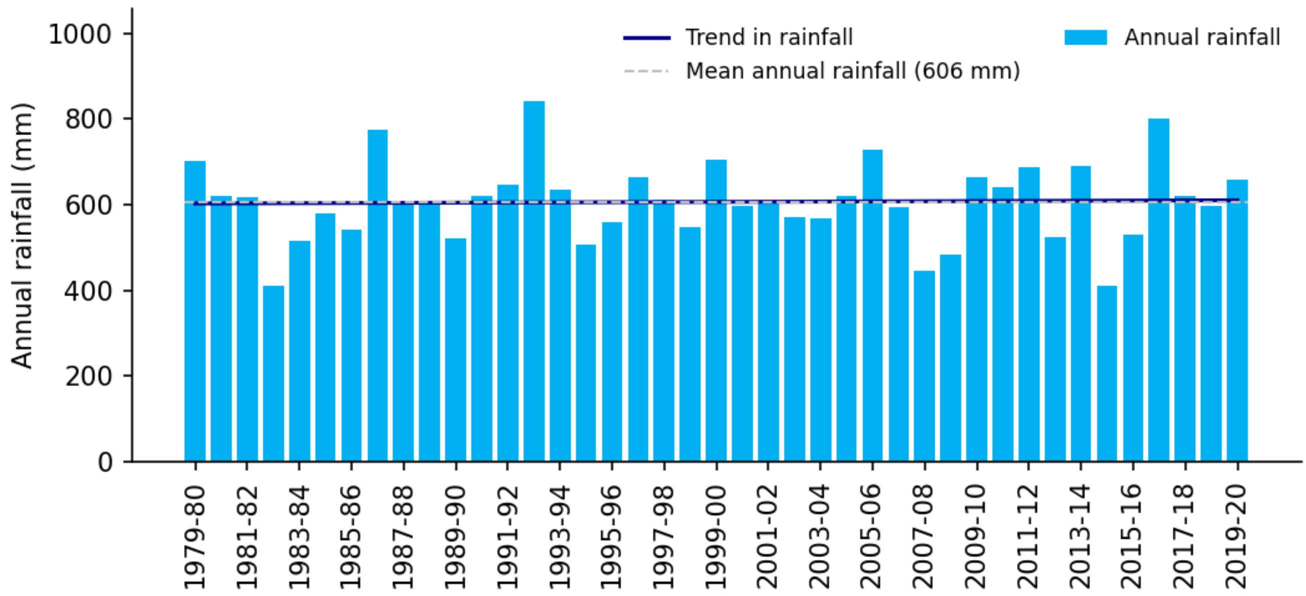

Figure 3.1 Annual rainfall between 1979–2020 at Willunga (Bom station 23753)

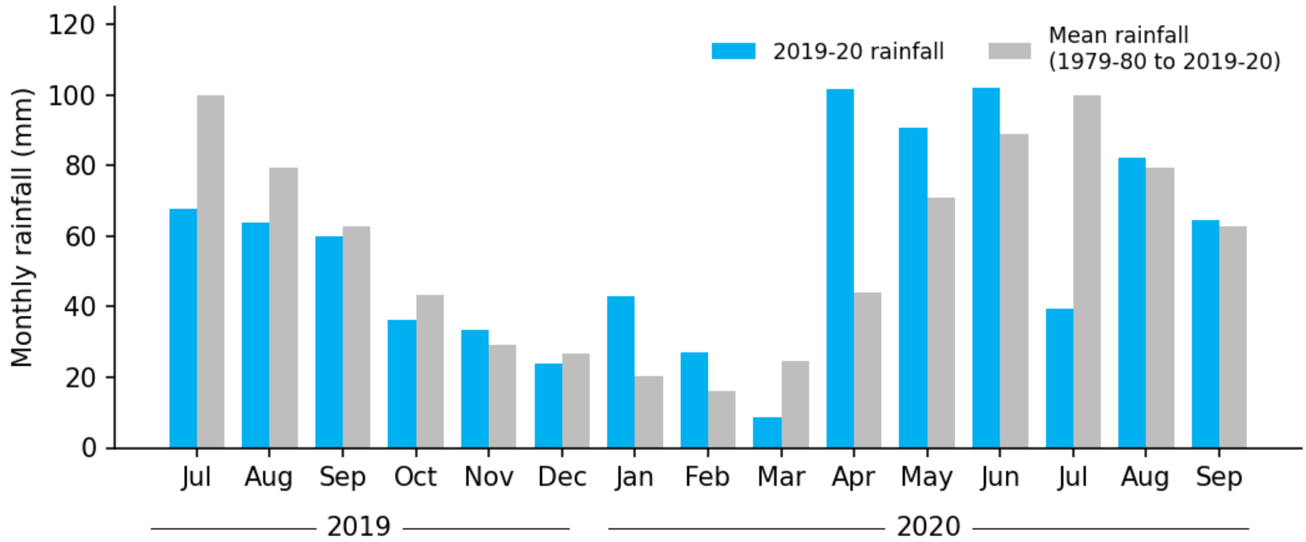

Figure 3.2 Monthly rainfall between July 2019 and September 2020, compared to the long-term monthly average (1979–2020) at Willunga (Bom station 23753)

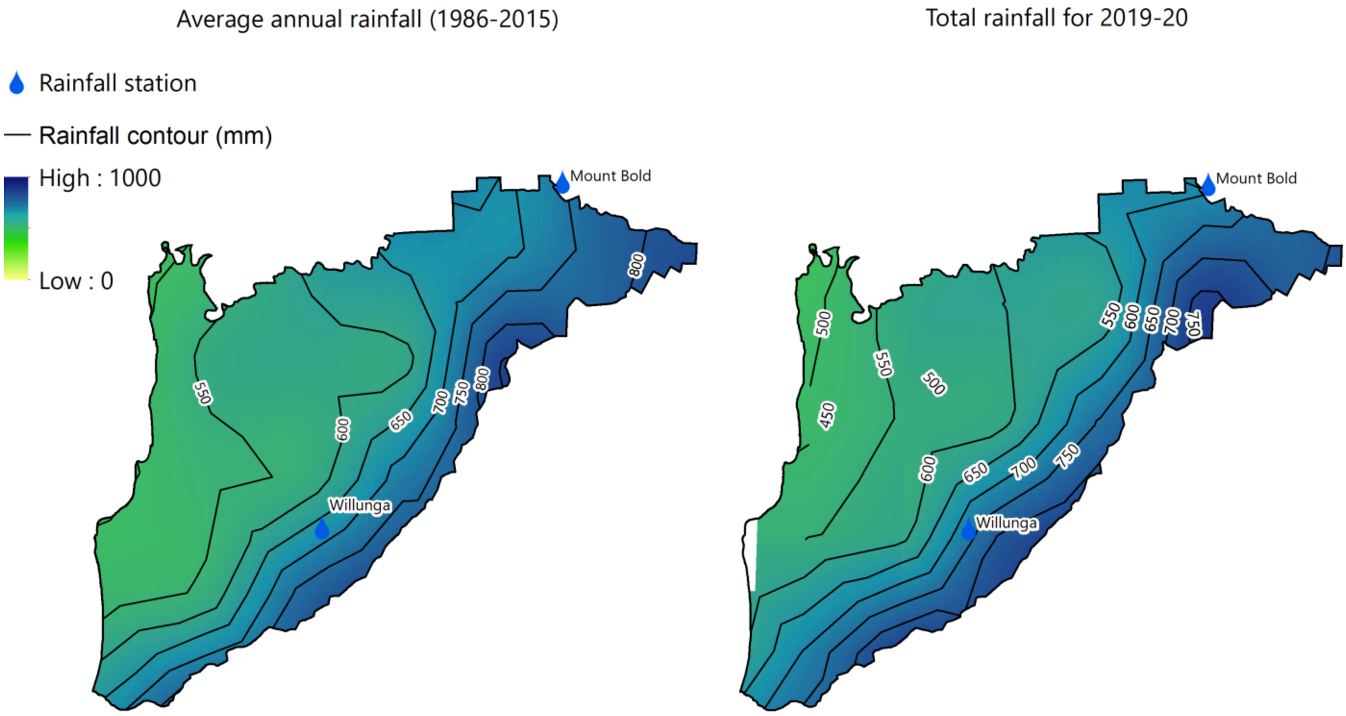

Figure 3.3 Rainfall in the McLaren Vale PWA for 2019–20 compared to the long-term average annual rainfall (1986–2015)

- The Willunga rainfall station (BoM station 023753) is located near the foot of the Mount Lofty Ranges, towards the south of the PWA (Figure 3.3)[4]. In 2019–20, total annual rainfall is 658 mm, which is 9% greater than the long-term average (1979–2020) of 606 mm/y (Figure 3.1).
- Long-term data (1979–2020) indicate that the trend in rainfall (Figure 3.1) has been stable. However, there have been periods of above-average rainfall (e.g. 1992–93 and 2016–17) and below-average rainfall (e.g. 1982–86, 2007–09 and 2014–16). Willunga has experienced an extended period of below-average rainfall since 1975 in comparison to the average annual rainfall of 636 mm for the period 1900–2021, with the exception of wet years in 1992–93, 2000 and 2016-17 (DEW, 2022).
- In 2019–20 at Willunga, monthly rainfall (Figure 3.2) is below average from July to December 2019 and March 2020. During the months of January, February and April, rainfall was well above the long-term monthly average (1979–2020).

[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.

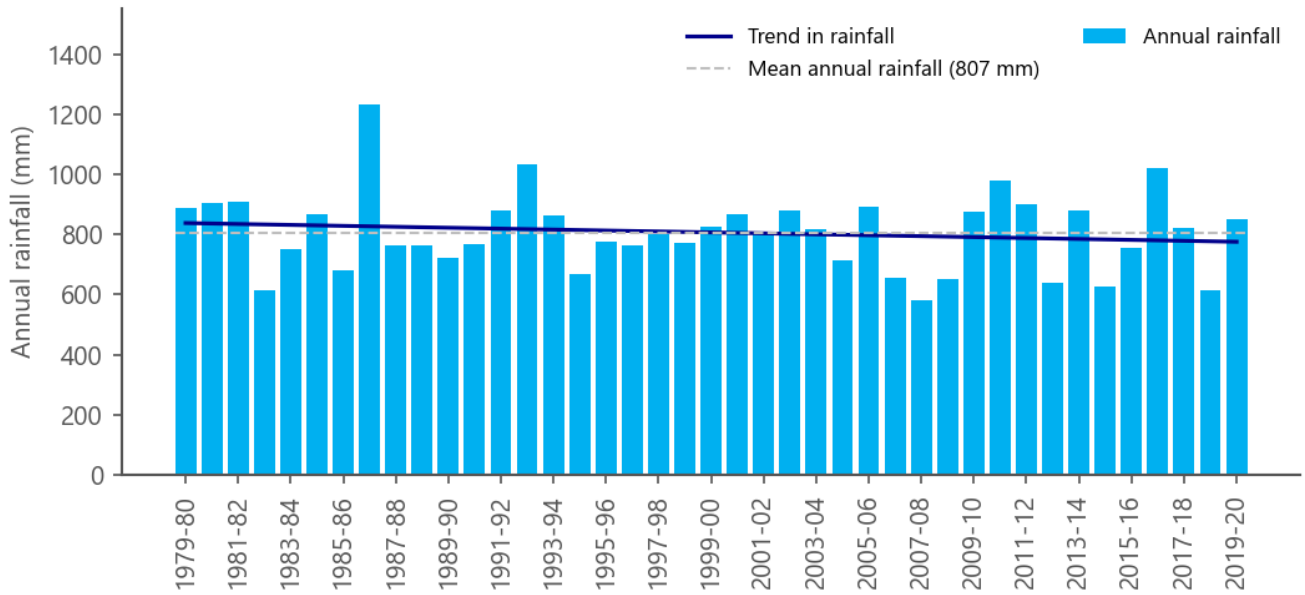

Figure 3.4 Annual rainfall between 1979–2020 at Mount Bold Reservoir (BoM station 23734)

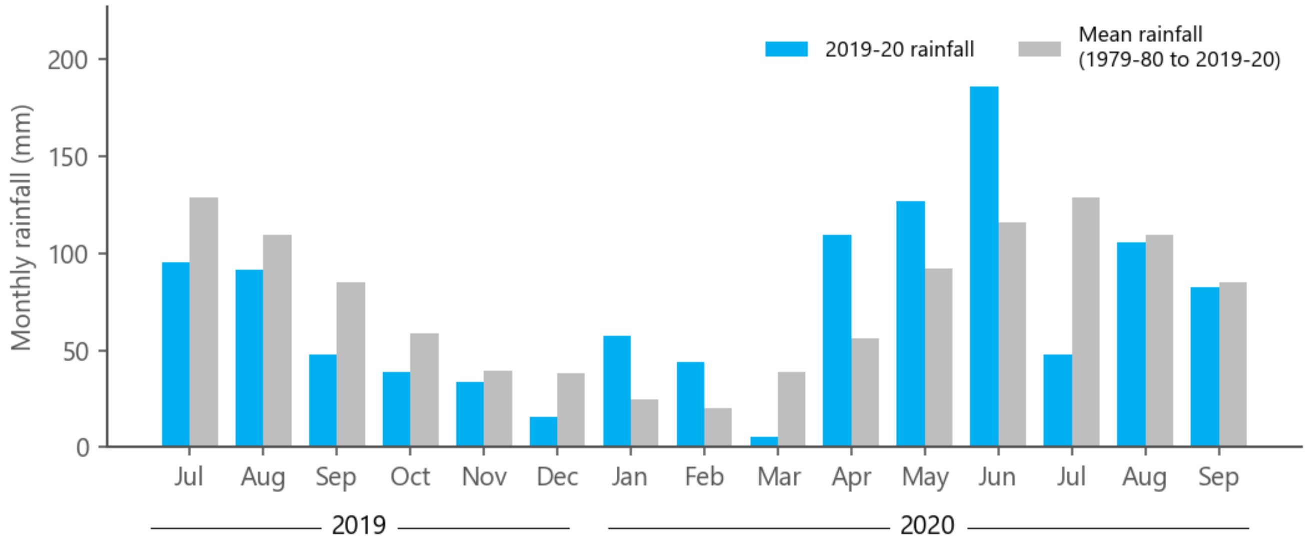

Figure 3.5 Monthly rainfall between July 2019 and September 2020 compared to the long-term average (1979–2020) at Mount Bold Reservoir (BoM station 23734)

- The Mount Bold Reservoir rainfall station (BoM station 023734) is situated immediately north, and just outside of the boundary of the McLaren Vale PWA (Figure 3.3) and is representative of the north-east of the PWA. In 2019–20, total annual rainfall was 851 mm (Figure 3.4), which is 6% greater than the long-term average (1979–2020).
- Long-term data (1979–20) indicate that rainfall at the Mount Bold Reservoir station has been slightly decreasing (by -2 mm/y, Figure 3.4).
- In 2019–20 at Mount Bold Reservoir, monthly rainfall (Figure 3.5) is below average between July–December 2019 and March 2020. Rainfall is above average between January–June 2020 (except March) (Figure 3.5).

4 Groundwater

4.1 Hydrogeology

The hydrogeology of the McLaren Vale PWA comprises sedimentary aquifers of Quaternary and Tertiary age, and a fractured rock aquifer that takes the form of the Mount Lofty Ranges east of the Willunga Fault and the undulating hills towards the north of the PWA (Figure 1.1). The sedimentary aquifers are located in the Willunga Basin which is a structurally controlled trough bounded in the south-east by the Willunga Fault and to the north by basement outcrop. The depth of the basin increases toward the southeast and reaches a maximum depth of approximately 250 m near the Willunga Fault. Groundwater occurs in three main aquifers of Tertiary age or greater, and a low-yielding Quaternary aquifer:

- the unconfined Quaternary aquifer
- the confined and unconfined Port Willunga Formation (PWF) aquifer (including the Pirramimma Sandstone)
- the confined and unconfined Maslin Sands aquifer
- the confined and unconfined fractured rock aquifer.

4.1.1 Quaternary aquifer

Sands and interbedded clays form shallow unconfined aquifers which are generally low yielding and provide mostly stock and domestic supplies, with limited extraction for irrigation. Recharge is predominantly derived from local rainfall and runoff through drainage features. In the north-east of the Willunga Basin, the Quaternary Pirramimma Sandstone lies unconformably alongside the Port Willunga Formation. For the purposes of the water allocation plan and this report, the Pirramimma Sandstone is deemed to be part of the Port Willunga Formation.

4.1.2 Port Willunga Formation aquifer

The Port Willunga Formation aquifer is the main source of groundwater in the Willunga Basin. It consists of sandstone, limestone, silt and sand, which are confined by Quaternary sediments in the south and south-western parts of the PWA. Elsewhere (i.e. to the north near McLaren Vale and McLaren Flat), the Port Willunga Formation aquifer is unconfined. Well yields are generally between 2 L/s and 16 L/s. Recharge to the Port Willunga Formation aquifer primarily occurs where the aquifer is unconfined or outcrops towards the north-east of the basin; groundwater flow occurs in a south-westerly direction before discharging to Gulf St Vincent. Groundwater residence times range up to around 2,000 years. Marls, mudstone, silts, clay and marly limestone of the Blanche Point Formation aquitard separate the Port Willunga Formation aquifer from the underlying Maslin Sands aquifer.

4.1.3 Maslin Sands aquifer

The Maslin Sands aquifer comprises the North Maslin Sand Member and the South Maslin Sand Member and directly overlies the fractured rock aquifer. The North Maslin Sand Member comprises upward-fining, cross-bedded quartz sands with poorly sorted gravel that were deposited in a braided river environment (Smith et al., 2015). The South Maslin Sand Member comprises fine to coarse carbonaceous and pyritic sand, clay and glauconitic marginal marine deposits (Smith et al., 2015). The unconfined extent of the Maslin Sands aquifer is recharged by rainfall in the north-east of the PWA, where the aquifer outcrops near Kangarilla and Mount Bold. Groundwater flow is towards the south-west with groundwater residence times ranging from around 5,000 to greater than 20,000 years. Elsewhere, the aquifer is confined and separated from the overlying Port Willunga Formation aquifer by the Blanche Point Formation, which acts as an aquitard consisting of low-permeability marine mudstone and limestone.

4.1.4 Fractured rock aquifer

The Fractured rock aquifers occur in basement rocks (slate, quartzite, shale and limestone) which underlie the sedimentary aquifers within the Willunga Basin, and also take the form of the Mount Lofty Ranges to the east of Willunga Fault and the Onkaparinga Gorge to the north. Infiltration of incident rainfall provides recharge to the fractured rock aquifers in these areas and groundwater flow generally follows the topography, beginning from high elevations around the basin margin, flowing towards the centre of the basin. Some groundwater discharges to the overlying sedimentary aquifers, while the balance flows towards the south-west before discharging to Gulf St Vincent.

4.2 Port Willunga Formation Aquifer – water level

During 2019–20, water levels in the majority of PWF aquifer monitoring wells (61%) are classified 'Lowest on record' (Figure 4.1). These wells are in the central and northern portion where the PWF aquifer is unconfined and rates of extraction are greatest.

Over the past 30 years, wells in the PWF aquifer show declining water levels (Section 2.2.1), ranging between 2.29 –7.52 m (with a median decline of 4.48 m).

Five-year trends show declining water levels (Figure 4.2) in the majority of wells (93%), with rates ranging from a decline of 0.27 m/y to a rise of 0.11 m/y (with a median rate of 0.18 m decline per year). Most wells showing a trend of declining water levels monitor the unconfined sand portion of the aquifer and are clustered to the east of McLaren Vale.

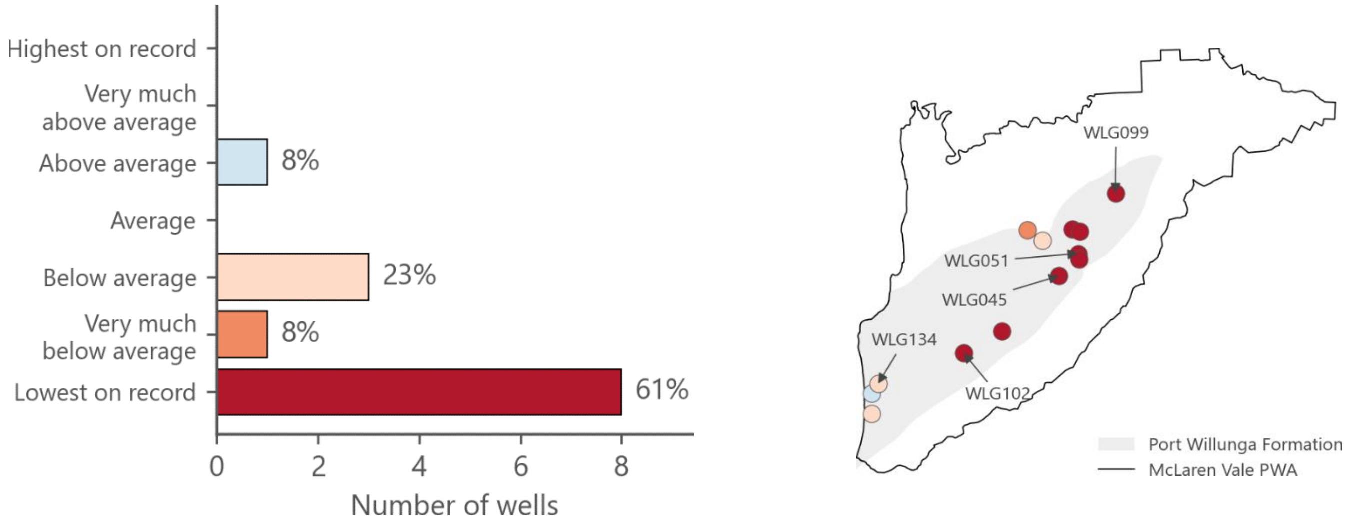

Figure 4.1 2020 recovered water levels for wells in the Port Willunga Formation aquifer

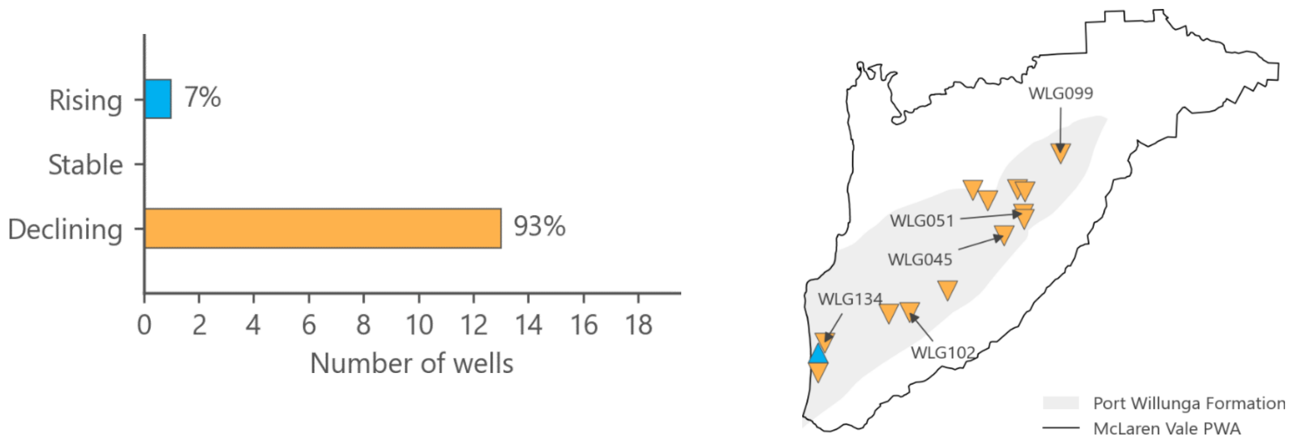

Figure 4.2 2016–20 trend in recovered water levels for wells in the Port Willunga Formation aquifer

Hydrographs from a selection of representative PWF aquifer monitoring wells are shown to illustrate common or important trends. Over the longer term, in the south-west of the PWF aquifer where it is confined and rates of extraction are low, water levels have typically been stable (e.g., WLG134, Figure 4.1 Figure 4.3). However, in 2020, water levels in four of the five wells (WLG045, WLG051, WLG099 and WLG102) are classified 'Lowest on record'.

Over the past 20 years, towards the southern extent of the Willunga Basin, the PWF aquifer shows declines in winter-recovered water levels of approximately two metres (e.g. WLG102). Over the past 30 years, towards the centre of the Willunga Basin, recovered water levels have declined by more than five metres (e.g. WLG051). Further north where rates of extraction are greatest, declines in water levels are up to 10 metres (e.g. WLG045 and WLG099).

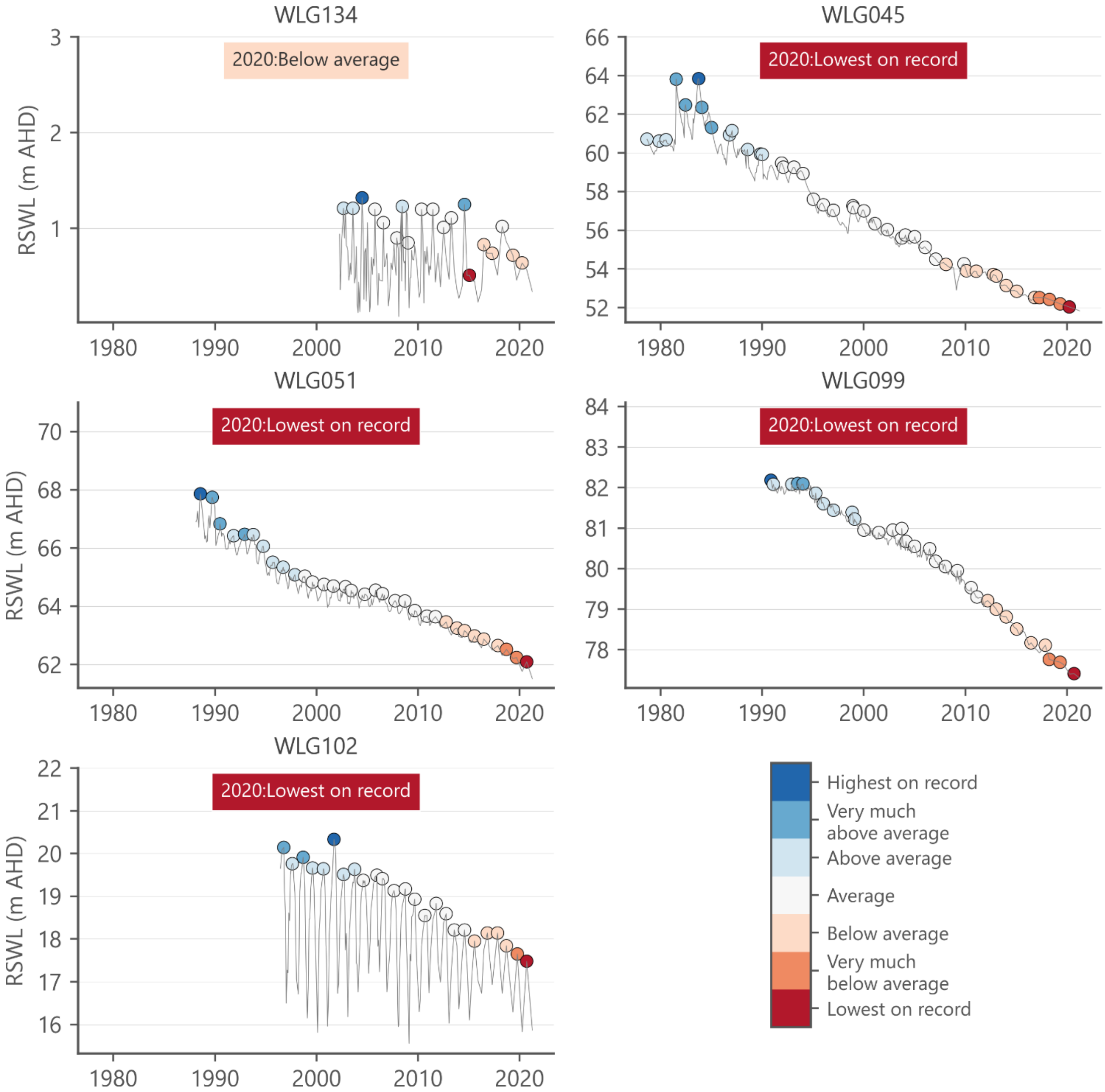

Figure 4.3 Selected Port Willunga Formation aquifer hydrographs

4.3 Port Willunga Formation Aquifer – salinity

Since 2017, irrigators in the McLaren Vale PWA have submitted groundwater samples that DEW have tested for salinity concentration. In 2020, salinity samples from 96 irrigation wells in the PWF aquifer (Figure 4.4) range between 206–3316 mg/L, with a median of 1064 mg/L. Typically, salinities are lower (<1,000 mg/L) towards the centre of the Willunga Basin, with the lowest salinities near the township of McLaren Vale, and extending north-east towards McLaren Flat. Salinity in the PWF aquifer increases to approximately 2000 mg/L towards the coast and to the north-east.

In the 15 years to 2020, the majority of wells (76%) show an increase in groundwater salinity (Figure 4.5, Section 2.2.2). Trends in salinity over the past 15 years vary from a decrease of 5.61% per year to an increase of 2.85% per year (with a rate of 0.35% increase per year).

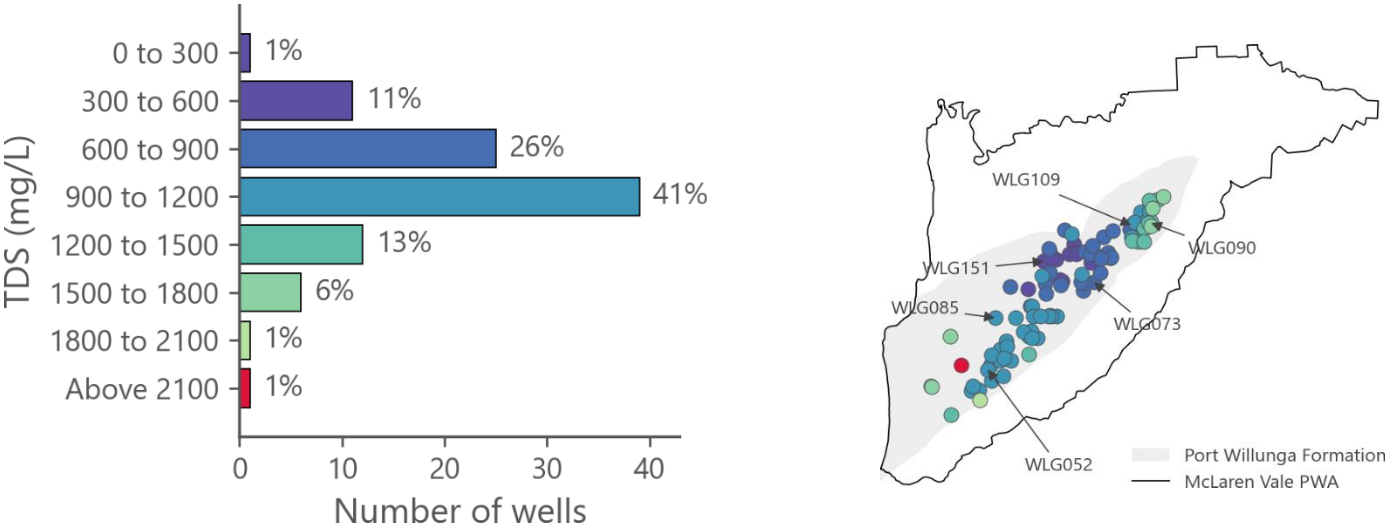

Figure 4.4 2020 salinity observations from wells in the Port Willunga Formation aquifer

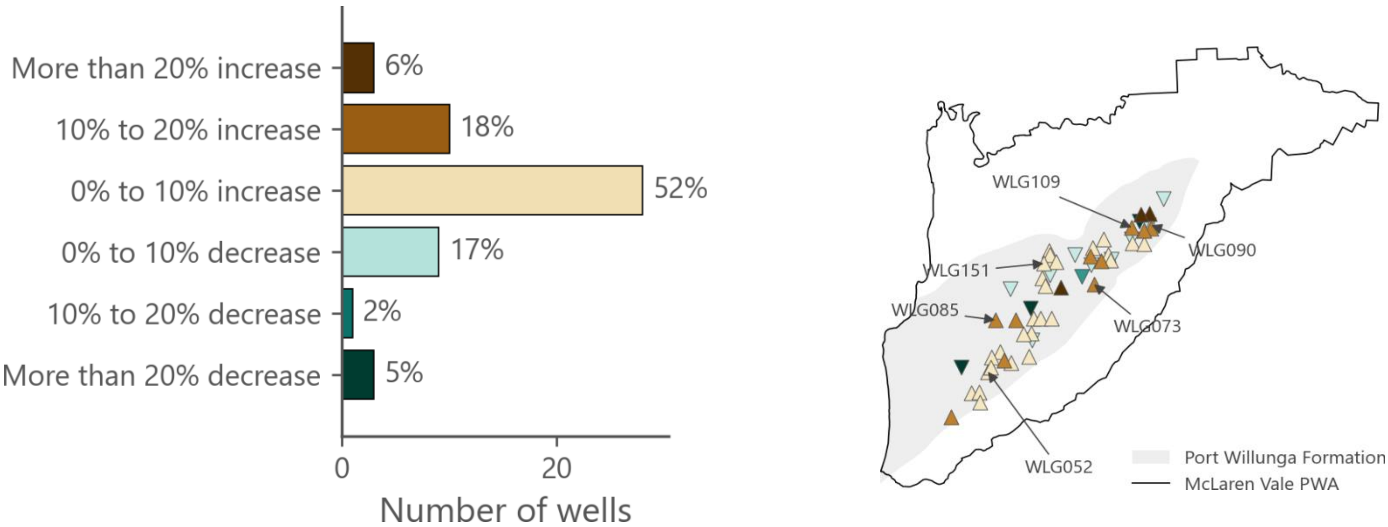

Figure 4.5 Salinity trend in the 15 years to 2020 for wells in the Port Willunga Formation aquifer

Salinity charts from a selection of representative PWF aquifer monitoring wells are shown to illustrate common or important trends. Towards the north-eastern extent of the aquifer, monitoring well WLG109 (Figure 4.5) is screened at 75–80 m depth and shows a large increase in salinity in the late 2000s (Figure 4.6), but has since stabilised. The nearby well WLG090 is screened in the lower part of the aquifer at 92-108 m depth and shows relatively stable salinity since the early 1990s.

Towards the centre and southern extent of the aquifer, monitoring wells WLG073, WLG151, WLG052 and WLG085 show decreases in groundwater salinity from the 1990s until around 2007, after which salinity increased. Some of the trends in salinity may be explained by low rainfall and greater rates of extraction during later stages of the Millennium Drought (2001–10), although increasing salinity in some wells has persisted after the drought ended in 2010 (Barnett and Judd, 2019).

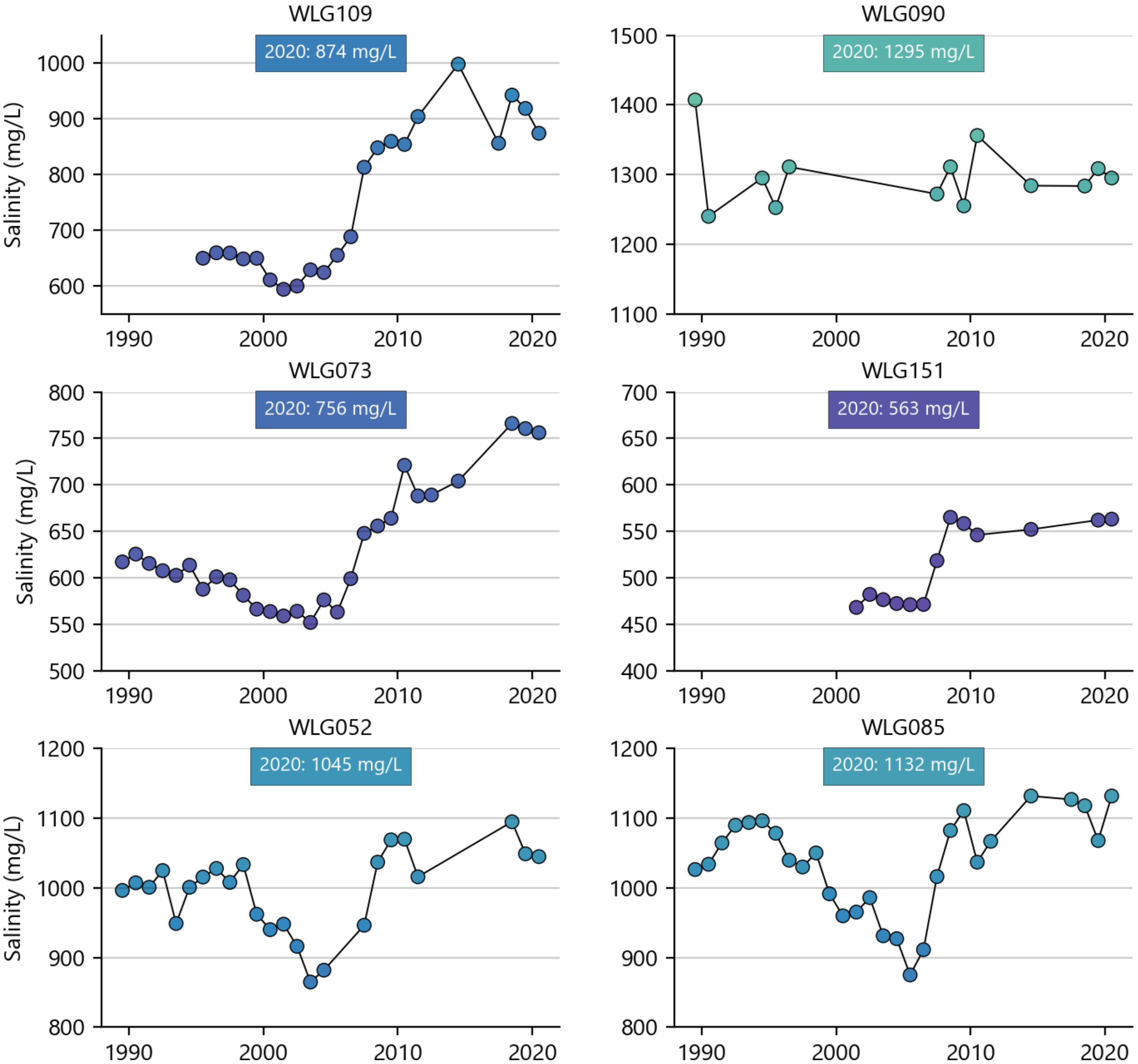

Figure 4.6 Selected Port Willunga Formation aquifer salinity graphs

4.4 Maslin Sands aquifer – water level

In 2019-20, water levels in the majority of Maslin Sands aquifer monitoring wells (63%) are classified 'Below average' to 'Lowest on record' (Figure 4.7). These wells are widespread across the PWA from the north-east near Kangarilla where the aquifer is unconfined, to the west and south-west where the aquifer is confined.

Over the past 30 years, the majority of wells (75%) show a decline in water levels (Section 2.2.1). Changes in water levels range from a decline of 4.06 m to a rise of 1.22 m (with a median decline of 0.82 m).

Five-year trends show that water levels are declining in the majority of wells (87%) (Figure 4.8), with rates ranging from a decline of 0.36 m/y to a rise of 0.36 m/y (with a median rate of 0.10 m decline per year).

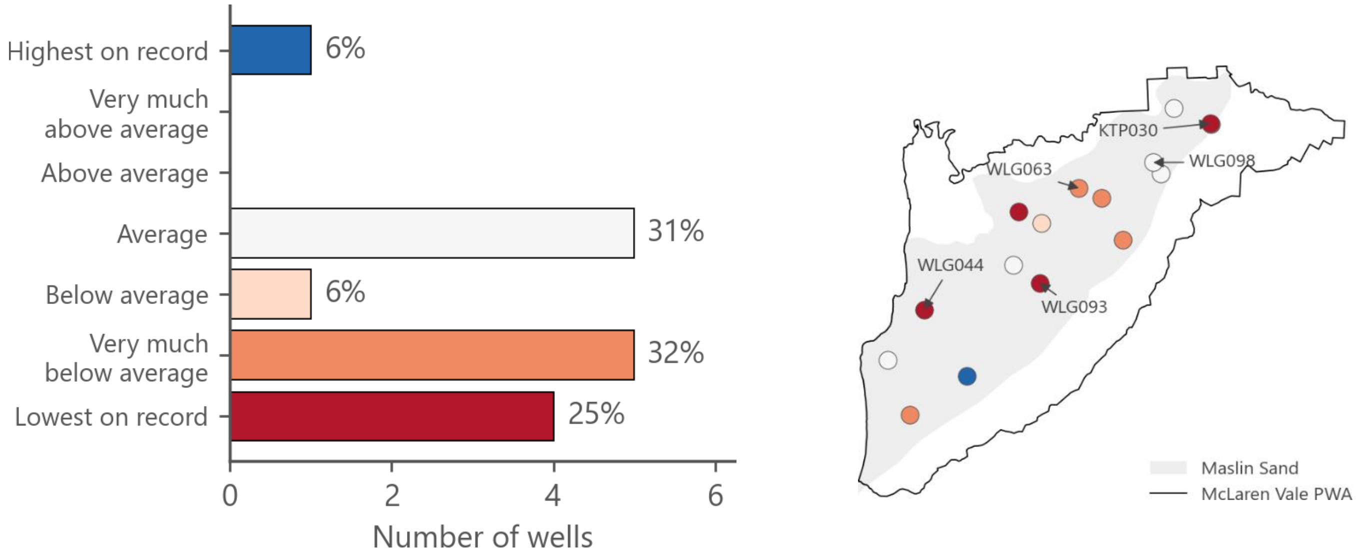

Figure 4.7 2020 recovered water levels for wells in the Maslin Sands aquifer

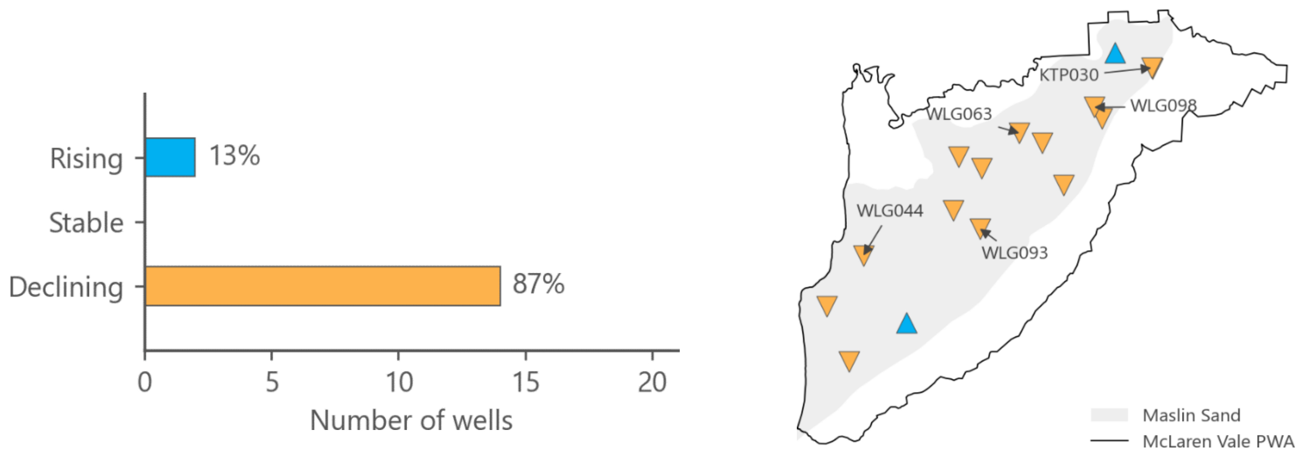

Figure 4.8 2016–20 trend in recovered water levels for wells in the Maslin Sands aquifer

Hydrographs from a selection of representative Maslin Sands aquifer monitoring wells are shown to illustrate common or important trends. In 2020, water levels in three of five representative monitoring wells (WLG044, WLG093 and KTP030) are classified 'Lowest on record' (Figure 4.9), while WLG063 is classified 'Very much below average'.

In general, the rate at which water levels towards the centre of the Willunga Basin (e.g. WLG063 and WLG093) have been declining has slowed or stabilised from around 2000. Towards the west (e.g. WLG044) and the north-east (e.g. KTP030), the same pattern is apparent from around 2010. At monitoring well WLG098, which is located in the north-east, a rise in water level is apparent between around 1998–2012, after which the water level has stabilised.

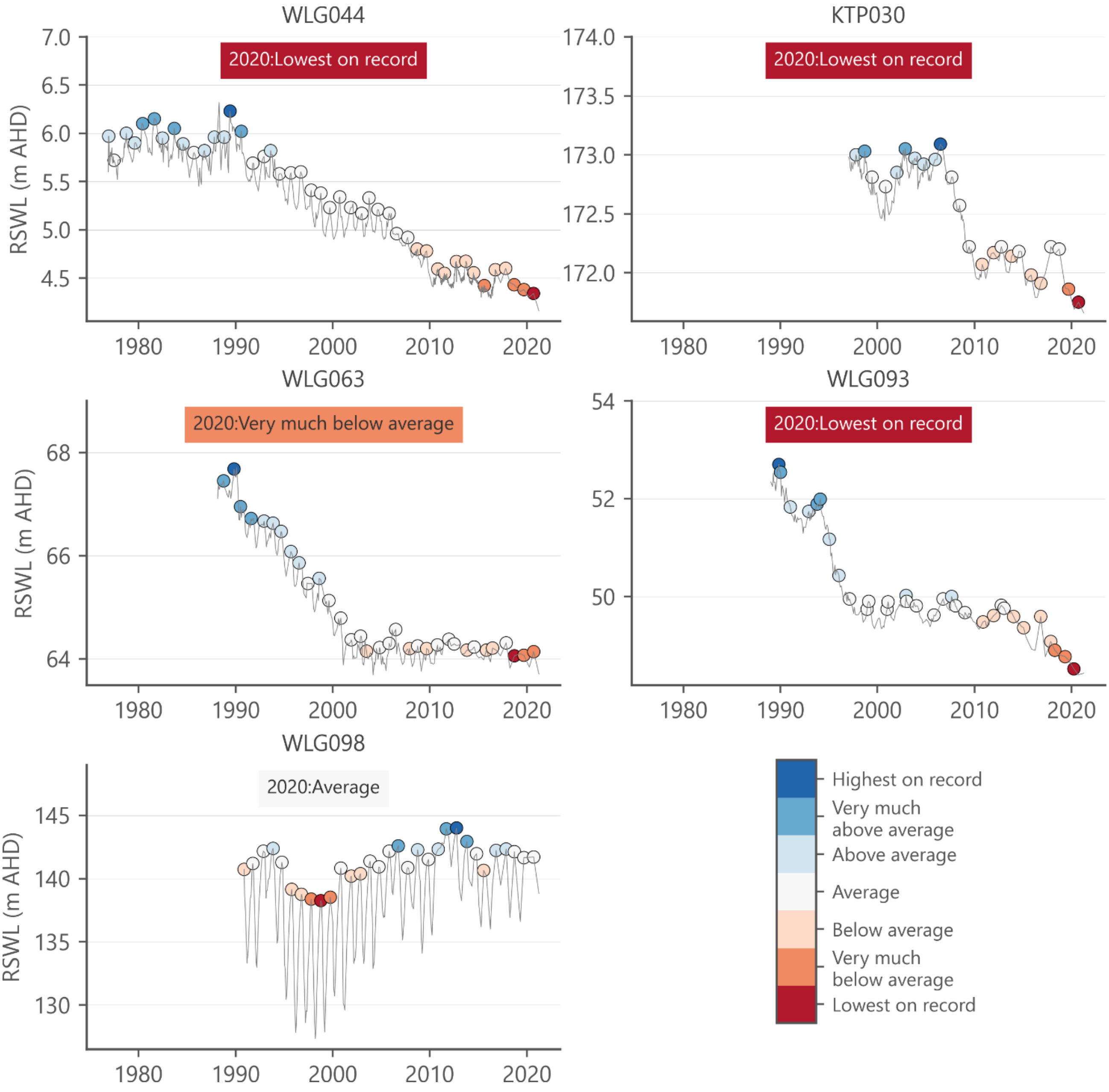

Figure 4.9 Selected Maslin Sands aquifer hydrographs

4.5 Maslin Sands aquifer – salinity

Since 2017, irrigators in the McLaren Vale PWA have submitted groundwater samples that DEW have tested for salinity concentration. In 2020, salinity at 36 irrigation wells in the Maslin Sands aquifer (Figure 4.10) ranges between 300–2058 mg/L, with a median of 879 mg/L. Most salinity measurements in the Maslin Sands aquifer are from an area between Kangarilla, McLaren Vale and Willunga. This area aligns with the highest rates of extraction from the Maslins Sands aquifer.

Towards the north-east of the Maslins Sands aquifer where the aquifer outcrops and receives direct rainfall recharge, salinities are typically low (<1,000 mg/L). Salinity increases towards the western and the south-western margins of the PWA.

In the 15 years to 2020, the majority of wells in the Maslins Sands aquifer (84%) show an increase in groundwater salinity (Figure 4.11). Fifteen-year trends in salinity vary from a decrease of 5.98% per year to an increase of 4.83% per year, with a median rate of 0.39% increase per year.

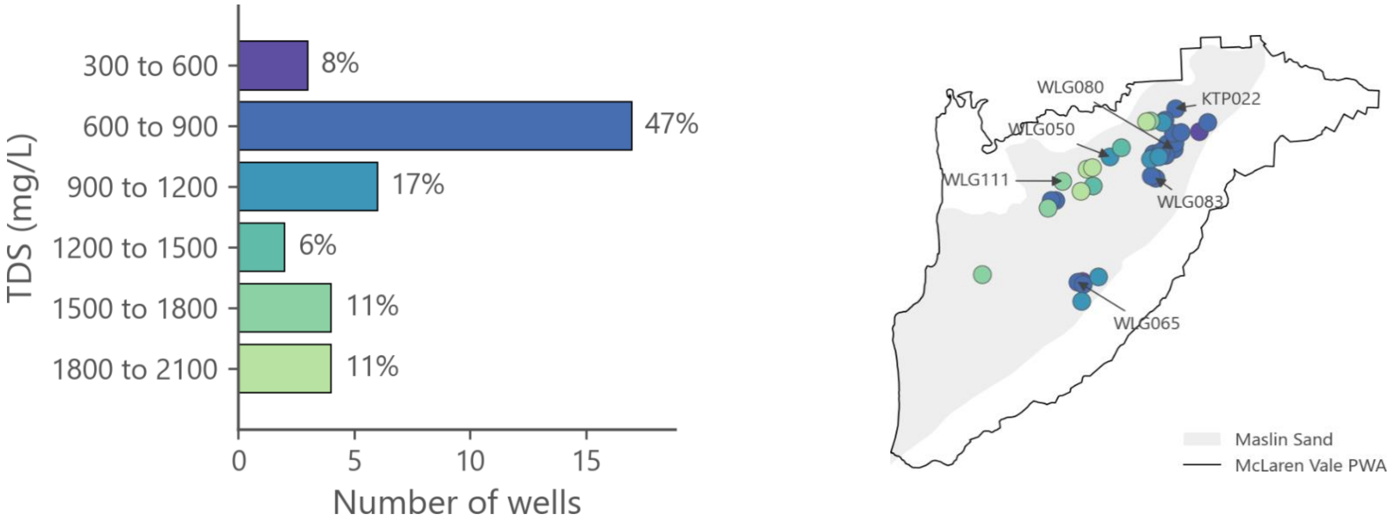

Figure 4.10 2020 salinity observations in the Maslin Sands aquifer

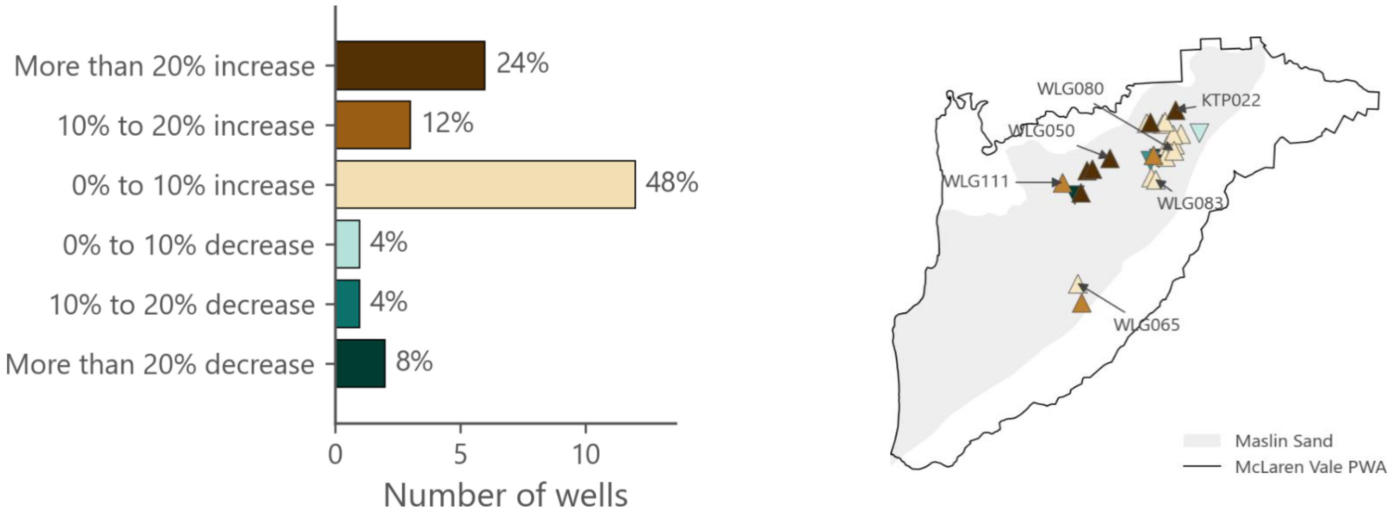

Figure 4.11 Salinity trend in the 15 years to 2020 for wells in the Maslin Sands aquifer

Salinity charts from a selection of representative Maslins Sands aquifer monitoring wells are shown to illustrate common or important trends. Towards the centre of the aquifer, representative wells (e.g. WLG065, WLG080, WLG083) show decreasing groundwater salinity from 1990s until 2006, after which salinity typically increases until around 2010, before salinity stabilises.

In the past 20-30 years, salinity has been increasing north of McLaren Vale and McLaren Flat (e.g. WLG050, WLG111, KTP022) where the Maslin Sands aquifer outcrops and overlies basement rocks. Monitoring data suggests a stabilisation in some wells (e.g. KTP022) while persistently increasing salinity is observed in others (e.g. WLG050). A possible source of high-salinity groundwater is the underlying confined fractured rock aquifer that has a greater hydraulic head relative to the Maslin Sands aquifer. This can lead to inter-aquifer leakage, especially when extractions from the Maslin Sands aquifer cause drawdown, thereby increasing the gradient between aquifers (Barnett and Judd, 2019).

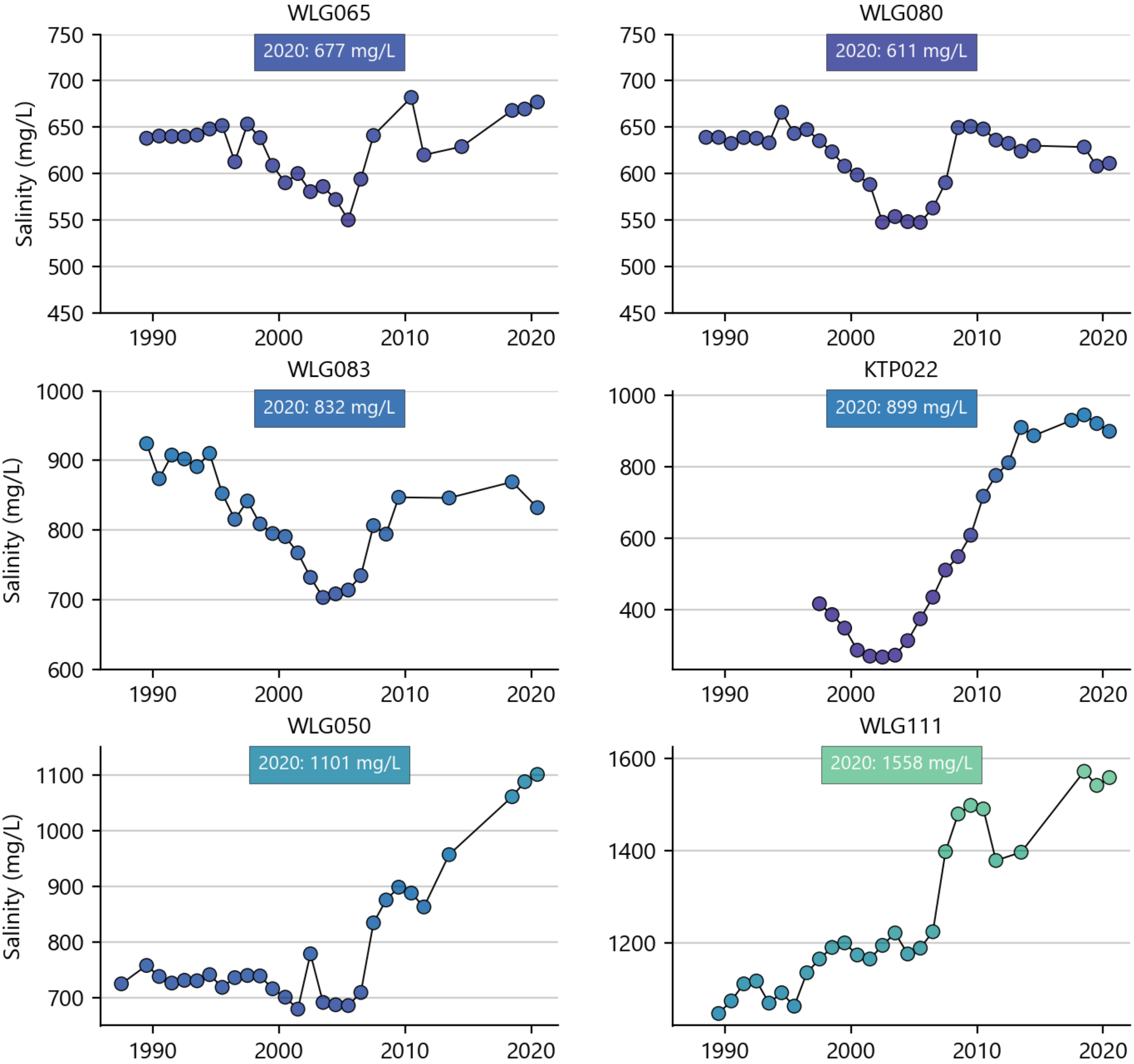

Figure 4.12 Selected Maslin Sands aquifer salinity graphs

4.6 Fractured rock aquifers - water level

The wells that monitor the fractured rock aquifers are located along the ranges east of Willunga Fault and along Onkaparinga Gorge (Figure 1.1). In 2020, more than half of these wells (53%) show winter-recovered water levels that are classified 'Below average' to 'Lowest on record' (Figure 4.13).

Over the past 20 years, the majority of monitoring wells (80%) show a decline in water level (Section 2.2.1). Changes in water level range from a decline of 6.23 m to a rise of 1.03 m (the median change is a decline of 0.60 m).

Five-year trends show that water levels are declining in the majority of wells (84%) (Figure 4.14); rates of change range from a decline of 1.17 m/y to a rise of 0.04 m/y (the median rate is 0.24 m decline per year).

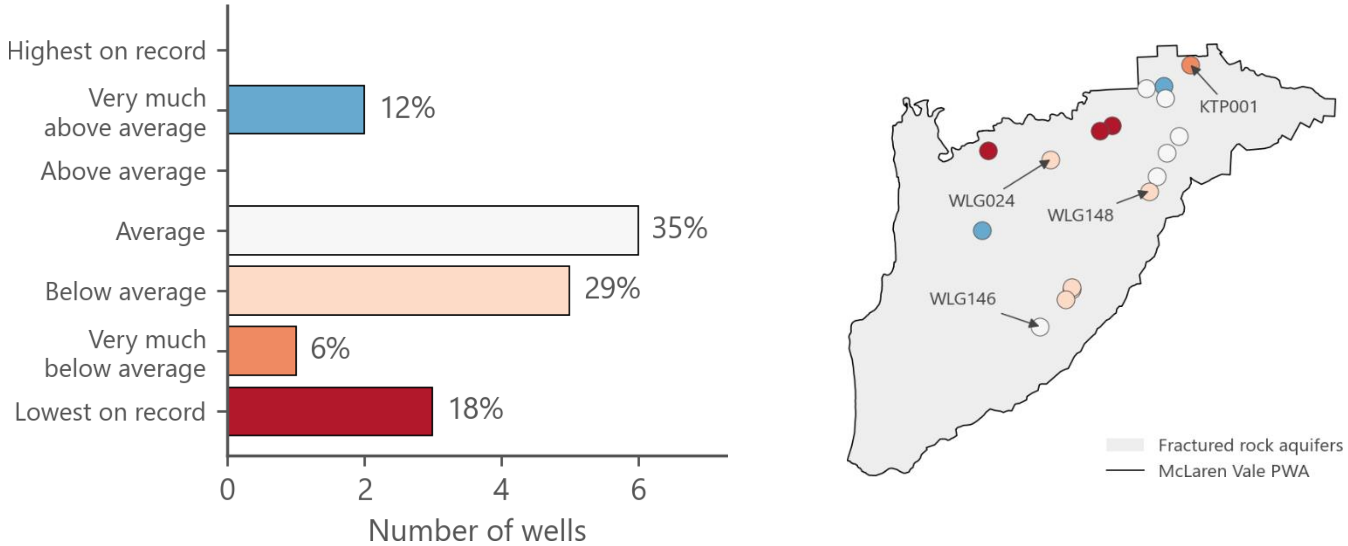

Figure 4.13 2020 recovered water levels for the fractured rock aquifers of the McLaren Vale PWA

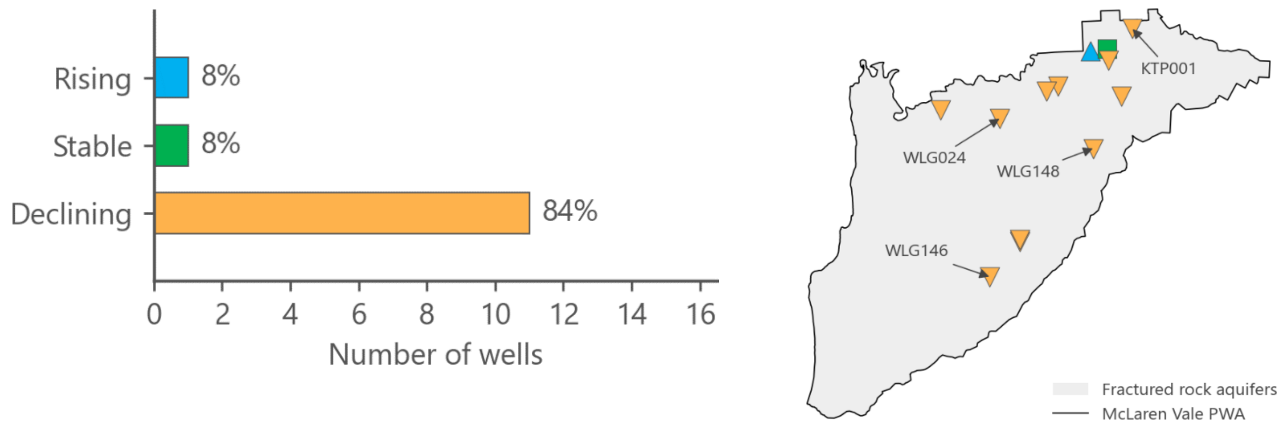

Figure 4.14 2016–20 trend in recovered water levels for wells in the fractured rock aquifers of the McLaren Vale PWA

Hydrographs from a selection of representative fractured rock aquifer monitoring wells are shown to illustrate common or important trends. Groundwater levels in the fractured rock aquifers are generally very responsive to incident rainfall (Figure 4.15), especially where basement rock outcrops and receives direct rainfall recharge.

East of Willunga, water levels in the fractured rock aquifer have been relatively stable over the longer term (e.g. WLG146). Over the past five years, water levels recovered from 'Lowest on record' (measured in 2015), although water levels have declined in recent years, which is likely due to below-average rainfall.

East of McLaren Flat, there have been large water level declines of up to 30 m (e.g. WLG148), but water levels have stabilised in recent years. North of McLaren Flat (e.g. WLG024) and north of Kangarilla (e.g. KTP001), water levels in the fractured rock aquifer have declined by up to five metres since the mid-1970s.

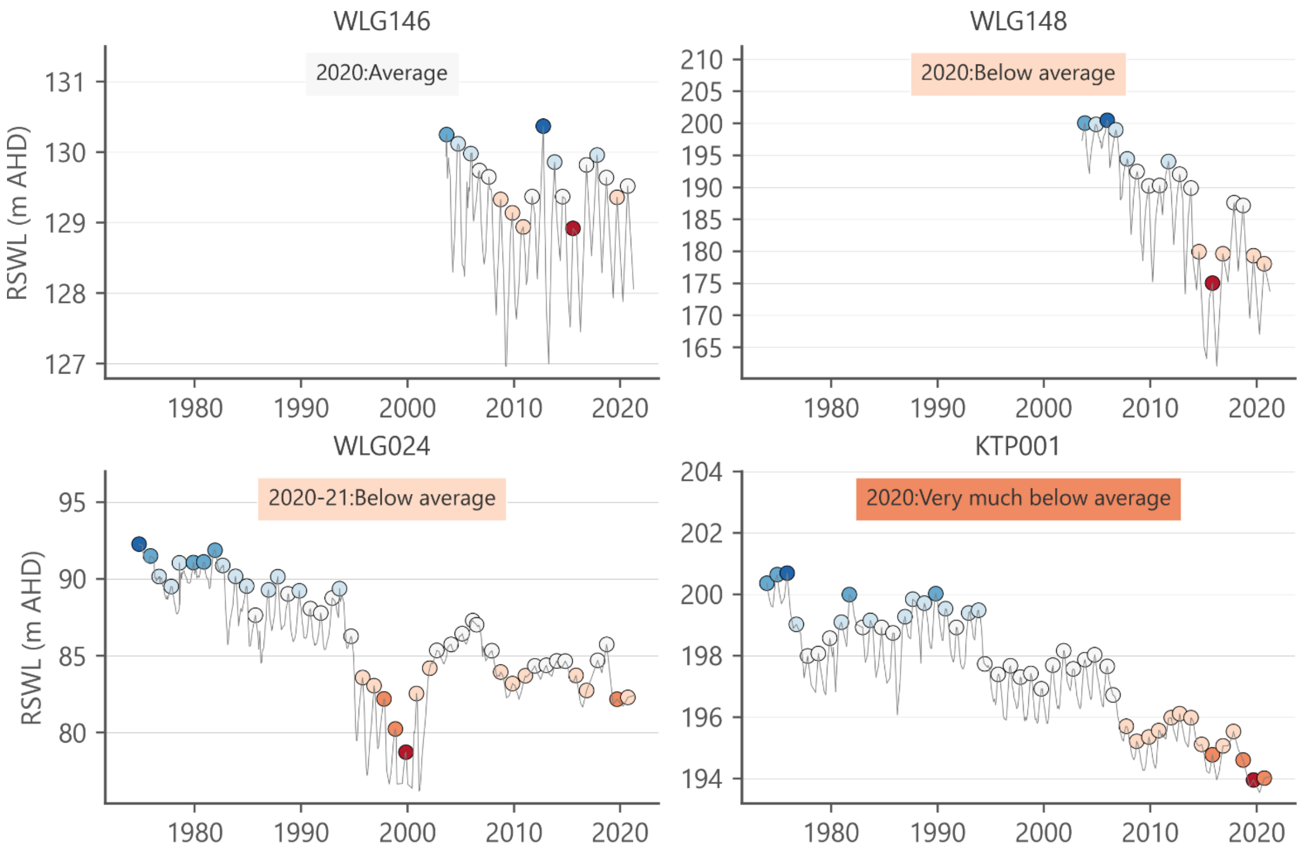

Figure 4.15 Selected hydrographs for wells in the fractured rock aquifers of the McLaren Vale PWA

4.7 Fractured rock aquifers - salinity

Since 2017, irrigators in the McLaren Vale PWA have submitted groundwater samples that DEW has tested for salinity concentration. In 2020, salinity samples from 31 irrigation wells in the fractured rock aquifers (Figure 4.16) range between 513–2493 mg/L, with a median of 1569 mg/L.

In the 15 years to 2020, more than half of monitoring wells (57%) show an increase in groundwater salinity (Section 2.2.2). Fifteen-year trends in salinity (Figure 4.17) vary from a decrease of 0.61% per year to an increase of 1.25% per year, with a median rate of 0.14% increase per year.

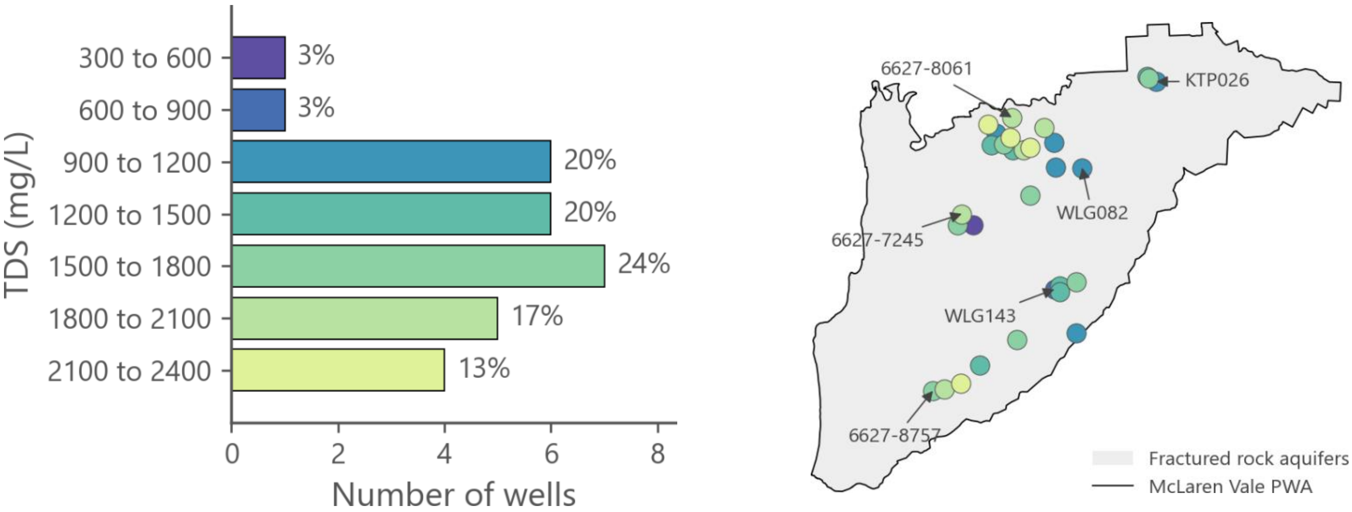

Figure 4.16 2020 salinity observations in the fractured rock aquifers of the McLaren Vale PWA

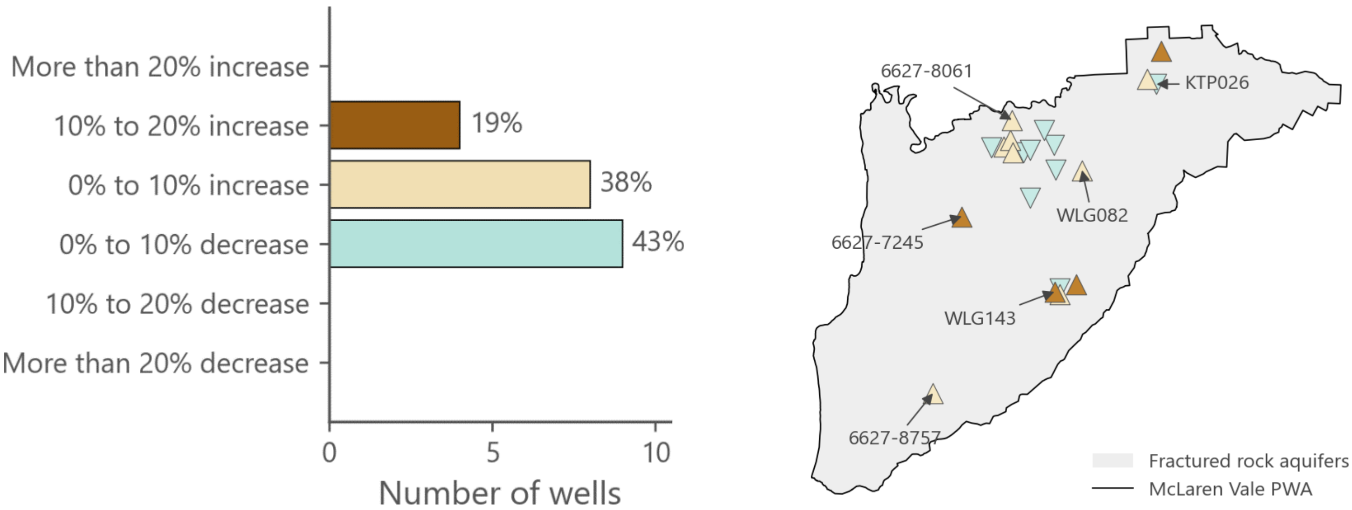

Figure 4.17 Salinity trend in the 15 years to 2020 for wells in the fractured rock aquifers of the McLaren Vale PWA

Salinity charts from a selection of representative fractured rock aquifer monitoring wells are shown to illustrate common or important trends. Groundwater salinity in fractured rock aquifers can be highly variable due to the complex system of preferential flow paths that influence recharge and groundwater flow through the aquifer, which leads to uncertainty in the interpretation of salinity time-series data. Groundwater salinity trends in the fractured rock aquifer can vary temporally in response to pumping patterns and spatially subject to whether the basement rock outcrops and receives direct rainfall recharge.

Representative monitoring wells located near McLaren Flat (e.g. WLG082) and Kangarilla (e.g. KTP026) show decreases in groundwater salinity from the 1990s until 2006, after which salinity has generally increased (Figure 4.18). South-east of McLaren Vale (e.g. WLG143), salinity has been relatively stable since monitoring began in 2003, with the exception of a higher value measured in October 2016, which may be anomolous.

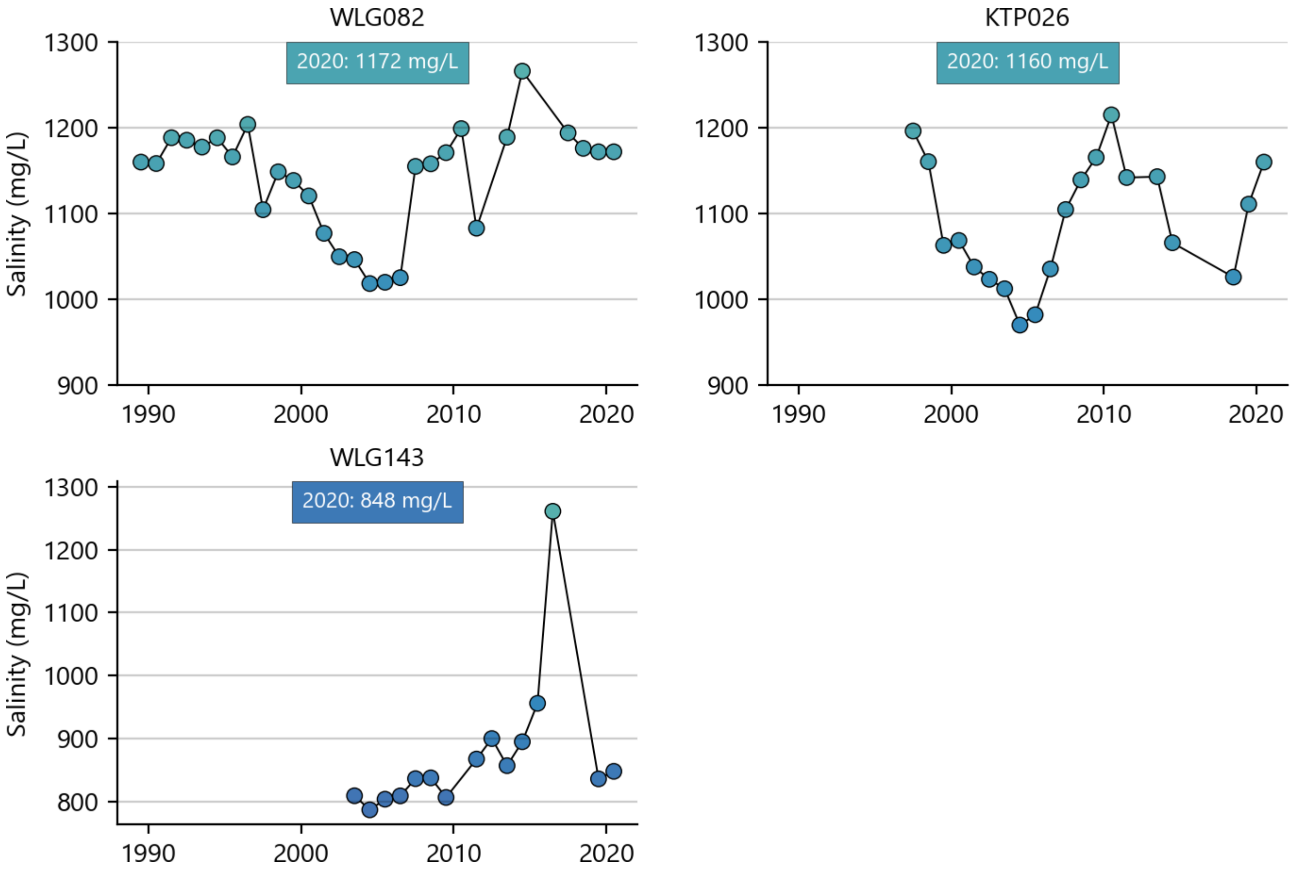

Figure 4.18 **Selected salinity graphs for wells in the fractured rock aquifers of the McLaren Vale PWA**

5 Water use

In 2019–20, licensed groundwater extractions in the McLaren Vale PWA totalled 4471 ML (Figure 5.1), a decrease in extraction of 622 ML from the preceding water-use year and 9% greater than the long-term (2004–20) average annual volume of 4114 ML. In 2019–20:

- 2840 ML (64% of the total extraction) was sourced from the Port Willunga Formation aquifer, which is approximately 9% greater than the long-term (2004–20) average annual extraction (Figure 5.2).
- 822 ML (18% of the total extraction) was sourced from the fractured rock aquifer, which is commensurate with the long-term (2004–20) average annual extraction of 818 ML.
- 809 ML (18% of the total extraction) was sourced from the Maslin Sands aquifer, which was approximately 16% greater than the long-term (2004–20) average annual extraction.

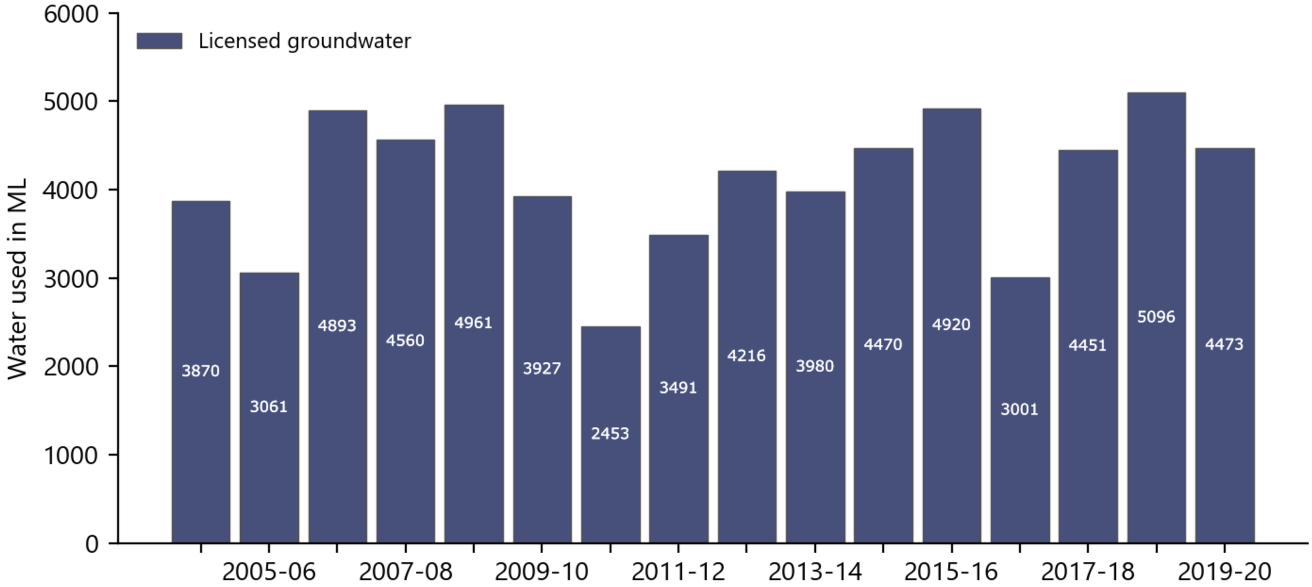

Figure 5.1 **Groundwater extraction between 2004–20 for the McLaren Vale PWA**

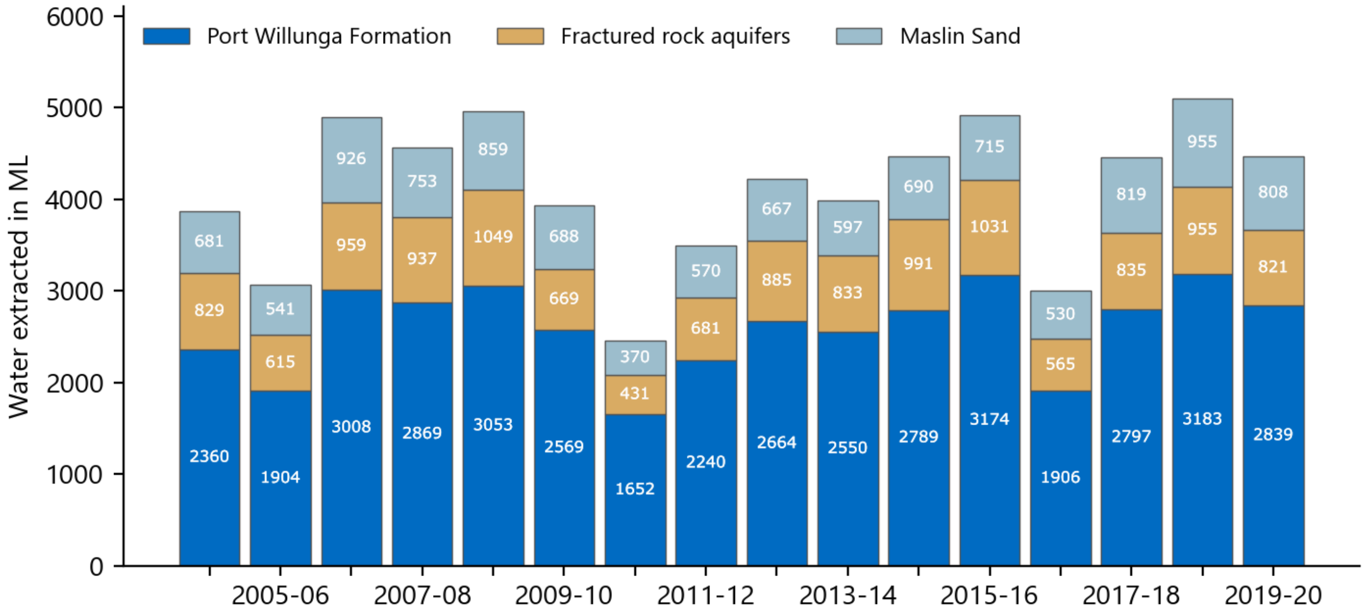

Figure 5.2 Licensed groundwater extraction for the McLaren Vale PWA

Two managed aquifer recharge schemes operate in the McLaren Vale PWA. Reclaimed water provides an alternative source of water for irrigation and relieves pressure on supplies of groundwater. The two schemes are located on Plains Road at Aldinga and Hart Road at Aldinga Beach and have design capacity to inject up to 550 ML/y into the Port Willunga Formation aquifer.

6 References

Adelaide and Mount Lofty Ranges NRM Board (2007). Water Allocation Plan for the McLaren Vale Prescribed Wells Area. Government of South Australia.

Barnett SR & Judd RJ (2019). McLaren Vale Prescribed Wells Area – Groundwater salinity investigation. DEW Technical note 2019/02, Government of South Australia, Department for Environment and Water, Adelaide.

Batlle-Aguilar J and Cook P (2012). Transient infiltration from ephemeral streams: A field experiment at the reach scale, Water Resour. Res., 48, W11518, doi:10.1029/2012WR012009.

Bureau of Meteorology (2021). Climate classification maps, [online], available:
http://www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications/index.jsp?maptype=kpngrp#maps

Department for Environment and Water (DEW) 2022. McLaren Vale Prescribed Wells Area groundwater resource assessment. DEW Technical Note 2022/08, Government of South Australia, Adelaide.

Harrington GA (2002). Recharge mechanisms to Quaternary sand aquifers in the Willunga Basin, South Australia. South Australia. Department of Water, Land and Biodiversity Conservation. Report, DWLBC 2002/016.

Herczeg AL and Leaney FW (2002). Groundwater Flow Systems and Recharge in the McLaren Vale Prescribed Wells Area, Final report to: Onkaparinga Catchment Water Management Board, CSIRO Land and Water Technical Report 10/02.

Irvine DJ, Kurylyk BL, Cartwright I, Bonham M, Post VEA, Banks EW and Simmons CT(2017). Groundwater flow estimation using temperature-depth profiles in a complex environment and a changing climate, Science of the Total Environment 574 (2017) 272-281, http://dx.doi.org/10.1016/j.scitotenv.2016.08.212

Morgan LK, Werner AD, Morris MJ and Teubner MD (2013). Application of a rapid-assessment method for seawater intrusion vulnerability: Willunga Basin, South Australia. In: Wetzelhuetter C. ed. Groundwater in the Coastal Zones of Asia-Pacific, pp. 205–225. Springer, Amsterdam.

Post VEA and Banks E (2015). Appendix G Seawater intrusion and sources of groundwater salinity, In Bresciani, et al., 2015, Assessment of Adelaide Plains Groundwater Resources: Appendices Part I – Field and Desktop Investigations, Goyder Institute for Water Research Technical Report Series No. 15/32, Adelaide, South Australia.

Post VEA, Banks E and Brunke M (2018). Groundwater flow in the transition zone between freshwater and saltwater: a field-based study and analysis of measurements errors, Hydrogeology Journal, Springer-Verlag, https://doi.org/10.1007/s10040-018-1725-2.

Short MA, Lamontagne S, Cook PG & Cranswick R (2014). Characterising the distribution of near-shore submarine groundwater discharge along a coastline using 222Rn and electrical conductivity, Australian Journal of Earth Sciences: An International Geoscience Journal of the Geological Society of Australia, DOI:10.1080/08120099.2014.884018.

Smith ML, Fontaine K, Lewis SJ (2015). Regional Hydrogeological Characterisation of the St Vincent Basin, South Australia: technical report for the National Collaboration Framework Regional Hydrogeology Project. Record 2015/16. Geoscience Australia, Canberra. http://dx.doi.org/10.11636/Record.2015.016

Villeneuve S and Harrington N (2012). Salinity trends in the McLaren Vale PWA, National Centre for Groundwater Research and Training Report

Government
of South Australia

Department for
Environment and Water