Adelaide Plains Prescribed Wells Areas 2020–21 water resources assessment

Department for Environment and Water
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DEW Technical Note 2022/17

Government of South Australia
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Contents

1 Summary

Central Adelaide PWA	T1 aquifer
Kangaroo Flat region	T2 aquifer
Northern Adelaide Plains PWA	T1 aquifer
	T2 aquifer

LEGEND

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

Rainfall

- In 2020–21, total annual rainfall is between 321 mm and 380 mm, which is around 25% below long-term average annual rainfall (1980 to 2021)
- Long-term annual rainfall is stable at both the Gawler and Smithfield rainfall stations and shows a declining trend at the North Adelaide station.
- All rainfall stations across the prescribed areas recorded below-average rainfall during the past 4 years.

Groundwater

- In 2021, groundwater levels in the T1 aquifer are classified 'Very much above average'.
- Groundwater levels in the T2 aquifer are classified 'Average'. In the Kangaroo Flat area, water levels are classified 'Average' to 'Below average'.
- Five-year trends show water levels are rising in the T1 aquifer of the Central Adelaide Prescribed Wells Area (PWA) and declining in the remaining aquifers and management areas.
- Median groundwater salinity is 1,284 mg/L in Central Adelaide T1 aquifer, 866 mg/L in the Northern Adelaide Plains (NAP) T1 aquifer, 1,010 mg/L in NAP T2 aquifer and 1,950 mg/L in Kangaroo Flat T2 aquifer.
- Salinity has been stable (within ±10%) in most wells over the past 10 years.

Water use

- In 2020–21, the total volume of groundwater extraction (excluding managed aquifer recharge (MAR) extraction) from the NAP PWA (including the Kangaroo Flat area) is 12,964 ML, which is a similar volume to the previous water-use year.
- In 2020–21, MAR schemes injected a total of 879 ML into the T1 aquifer and 3,407 ML into the T2 aquifer; most injection (64%) was into the T2 aquifer of the NAP PWA.

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 responsibility, 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** presents high-level information for the main water resources across most regions in a quick-reference format.

This document is the Technical Note for the Adelaide Plains Prescribed Wells Areas for 2020–21 and collates rainfall, groundwater and water-use data for 2020–21.

1.2 Regional context

The Central Adelaide Prescribed Wells Area (PWA) mostly lies within the Green Adelaide management area, with small areas in the Hills and Fleurieu, and Northern and Yorke Landscape Regions. It encompasses most of the Adelaide metropolitan area, extending from Outer Harbor and Evanston South in the north, to Noarlunga in the south.

The Northern Adelaide Plains (NAP) PWA is located immediately north of the Central Adelaide PWA, in Green Adelaide and the Northern and Yorke Landscape Region. The Kangaroo Flat area is in the north-east area of the NAP PWA, encompassing an area of around 80 km^2. Groundwater extraction in the Kangaroo Flat area was restricted in 2000 and the area was prescribed in 2004 as an addition to the NAP PWA.

Groundwater is a prescribed resource in the Central Adelaide and NAP PWAs under South Australia's *Landscape SA Act 2019*. Rules for management of those resources is set out in the Adelaide Plains Water Allocation Plan (WAP), which was adopted on 1 July 2022. This new WAP supersedes the previous NAP WAP and covers the groundwater of the Central Adelaide, NAP and Dry Creek PWAs.

Groundwater occurs in multiple aquifers across this region; however, most groundwater is extracted from the T1 and T2 aquifers of the Adelaide Plains. For this reason, the four areas where the most intensive extraction occurs from these aquifers are reported on here: the T1 aquifer of the Central Adelaide PWA; the T1 and T2 aquifers of the NAP PWA; and the T2 aquifer of the Kangaroo Flat region.

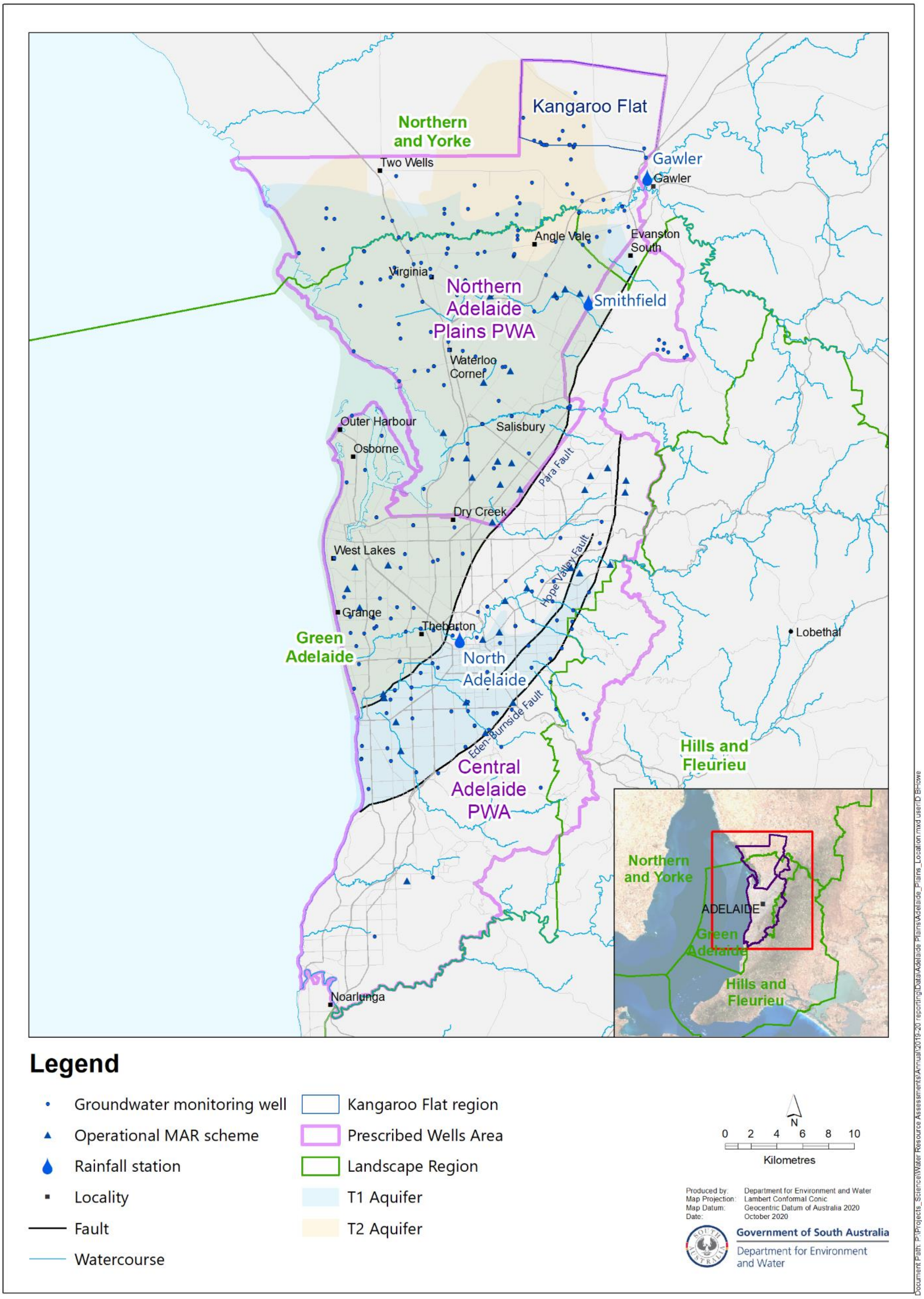

Figure 1.1 Location of the Central Adelaide and Northern Adelaide Plains PWAs

2 Methods and data

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

Table 2.1 Reporting period description

Parameter	Reporting period	Comment
Rainfall	1 July 2020 to 30 June 2021	Monthly data for July to September 2021 are also presented to provide additional context.
Groundwater	1 January to 31 December 2021	Groundwater levels typically show a delayed response to incident rainfall and aggregate groundwater extraction, hence the lag in reporting period (Section 0).
Water use	1 July 2020 to 30 June 2021	In South Australia, water accounting is reported between 1 July through to 30 June of the following year

For rainfall and water-use data, the financial year or 'water year' was adopted, as defined in the BOM Australian Water Information Dictionary.

2.1 Rainfall

Daily rainfall observations have been used from selected Bureau of Meteorology (BoM) stations 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 Section 3).

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

2.2 Groundwater

2.2.1 Water level

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

[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).

resource. In general, the aquifers in the Central Adelaide and NAP PWAs return to a recovered maximum level between July and November of the same year.

For those wells with suitable long-term records, the annual recovered water levels were then ranked from lowest to highest and given a description according to their decile range[2] (Table 2.2). The definition of a suitable long-term record varies depending on the history of monitoring activities in different areas; for the Central Adelaide PWA any well with 20 years or more of recovered water levels is included, while for the NAP PWA and Kangaroo Flat area any well with 10 years or more is included.

Table 2.2 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 Bureau of Meteorology[3]

The number of wells in each description class for the most recent year is then summarised for each aquifer (e.g. Figure 4.1) and 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 that have at least five measurements (i.e., at least one measurement a year). The trend line was calculated by linear regression and the well is given a status of 'declining', 'rising', or 'stable', depending on whether the slope of this trend line is below, above, or within a given tolerance threshold. This threshold and the status of 'stable' is intended to allow for the demarcation of wells where water levels are changing at very low rates and would normally be considered stable, and to accommodate very small human or instrument measurement errors. The number of rising, declining and stable wells are then summarised for each aquifer (e.g., Figure 4.2). Regional-scale confined and unconfined sedimentary aquifers such as the T1 and T2 aquifers are given tolerance thresholds of 2 cm/y.

Twenty-year changes in water level were calculated as the difference between the average water level in a three-year period twenty years ago (i.e., 2001–2003) and the average water level in 2021.

2.2.2 Salinity

Salinity samples are obtained from two primary sources: via periodic monitoring conducted by DEW, where monitoring wells have infrastructure that allows collection of a sample, and via samples from irrigation wells, collected and submitted by DEW license holders.

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

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[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.

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

Where more than one salinity sample has been collected in a year, the annual mean salinity is used for analysis. The results are shown in Figure 4.4.

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

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

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

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

2.3 Groundwater extraction

Meter readings are used to estimate licensed extraction volumes for groundwater sources. Where meter readings are not available, licensed or allocated volumes are used (Figure 5.1).

2.4 Further information

Both surface water and groundwater data can be viewed and downloaded using the *Surface Water Data* and *Groundwater Data* pages under the Data Systems tab on WaterConnect. 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 of the NAP and Central Adelaide PWAs and Kangaroo Flat region, are:

- summary reports on the groundwater resources of the NAP and Central Adelaide PWAs and Kangaroo Flat region (DEWNR, 2011), and annual groundwater level and salinity status reports (DEW, 2019a-d)
- Adelaide Plains Water Allocation Plan, adopted 1 July 2022 (DEW 2022)
- Managed Aquifer Recharge Schemes in the Adelaide Metropolitan Area (Kretschmer 2017)
- Gerges (2006) provides an overview of the hydrogeology of the Adelaide metropolitan area.

3 Rainfall

The main aquifers of the Adelaide Plains are confined, so incident rainfall has minimal direct impact on groundwater conditions via local recharge. However, rainfall does impact demands for irrigation water and therefore groundwater extraction trends. Further, rainfall trends influence availability of runoff water for managed aquifer recharge scheme operations, which also influence groundwater level trends.

The Adelaide Plains PWAs have mild, wet winters and hot, dry summers that are typical of a Mediterranean climate. Rainfall is consistently higher in the south-east portion of the Central Adelaide PWA where topographical changes occur and lower across the lower-lying Adelaide Plains. Three stations were selected to represent the different areas and PWAs across the Adelaide Plains. The Gawler rainfall station (BoM station 23078) represents the Kangaroo Flat region, the Smithfield rainfall station (BoM station 23025) represents the NAP PWA, and the North Adelaide rainfall station (BoM station 23011) represents the Central Adelaide PWA.

Total annual rainfall for 2020–21 across the region ranges between 300 mm and 800 mm which is considerably lower than the 350 to 1,000 mm range of long-term average annual rainfall (1986 to 2015) (Figure 3.1)[4].

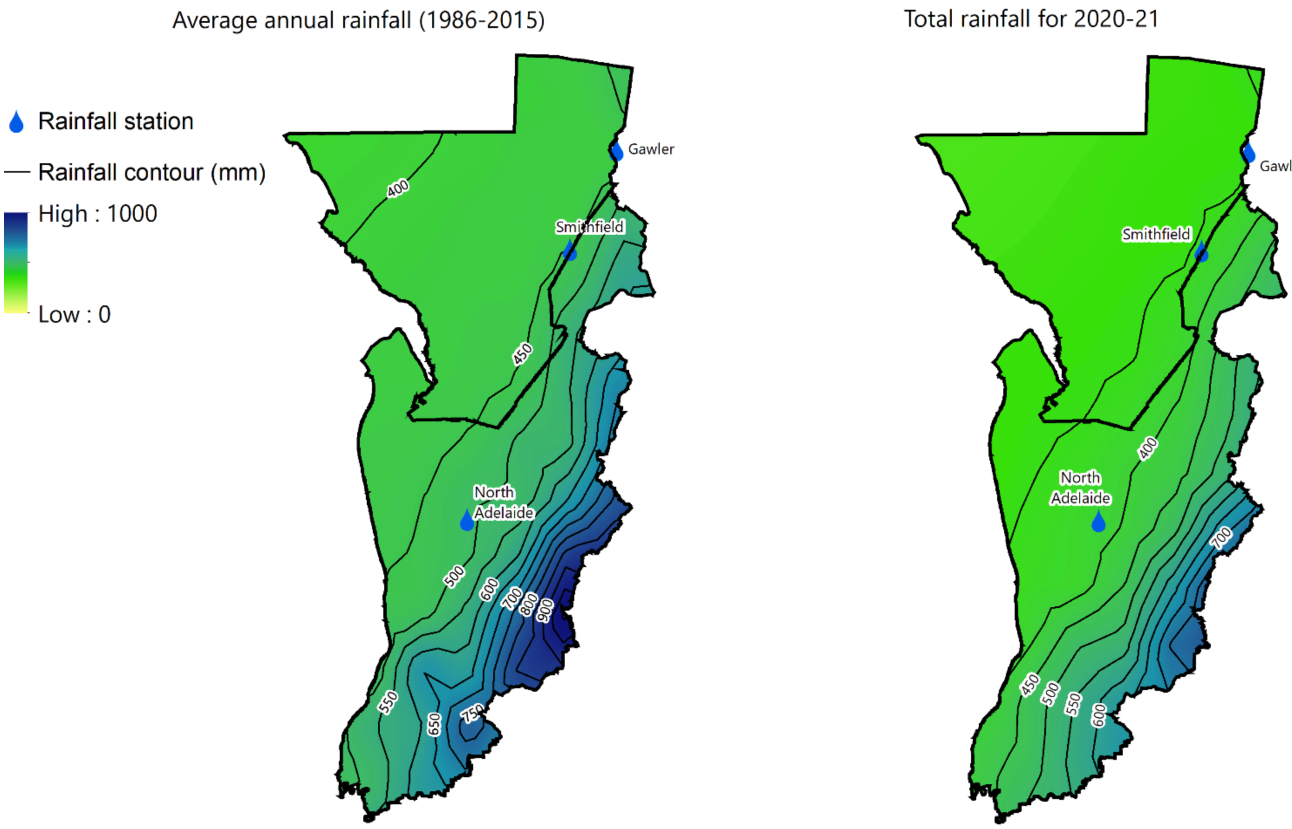

Figure 3.1 Rainfall in the Central Adelaide and NAP PWAs for 2020–21 compared to the standard 30-year climatological average (1986 to 2015)

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

Total annual rainfall recorded at the Gawler station in 2020–21 is 321 mm, which is 26% below the long-term annual average rainfall of 433 mm/y (1980 to 2021). The long-term trend in annual rainfall (1980 to 2021) is stable for the Gawler station; however, the past 4 years were below-average (Figure 3.2). Below-average and average monthly conditions are observed throughout the period, except for the above-average months of October 2020 and June and July 2021 (Figure 3.3).

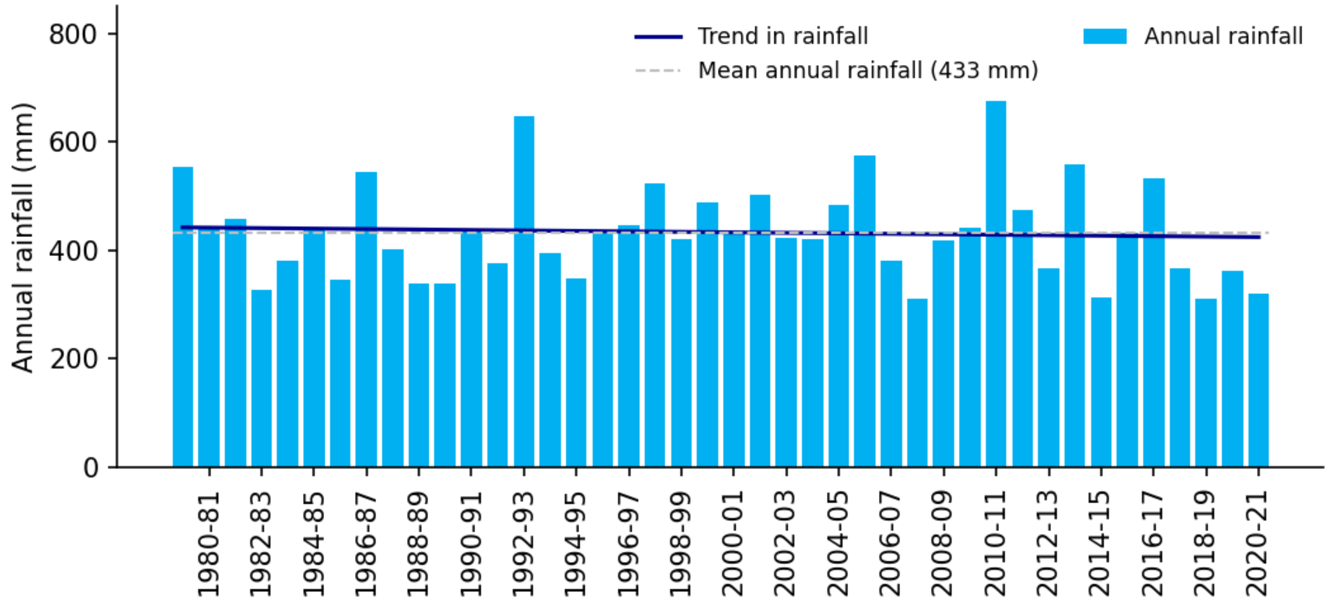

Figure 3.2 Annual rainfall for 1979–80 to 2020–21 at the Gawler rainfall station (BoM station 23078)

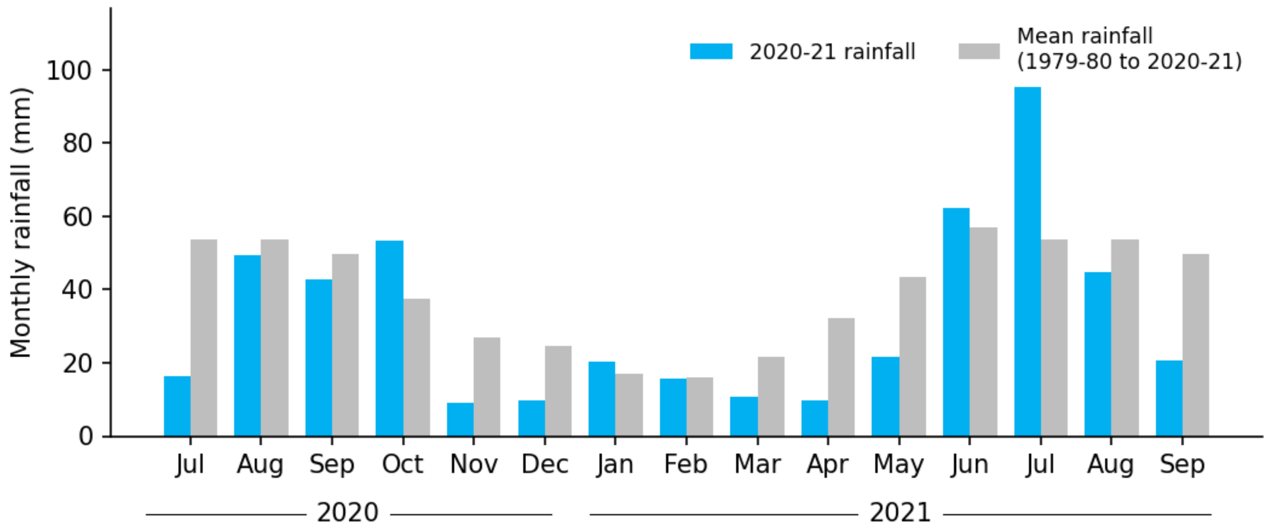

Figure 3.3 Monthly rainfall between July 2020 and September 2021, compared to the long-term monthly average at the Gawler rainfall station (BoM station 23078)

Total annual rainfall recorded at the Smithfield station in 2020–21 is 380 mm, which is 22% below the long-term annual average rainfall of 487 mm/y (1980 to 2021). The long-term trend in annual rainfall (1980 to 2021) is stable for the Smithfield station; however, the past 4 years were below-average (Figure 3.4). Below-average and average monthly rainfall are observed throughout the period, except for the above-average months of October 2020, and February and July 2021 (Figure 3.5).

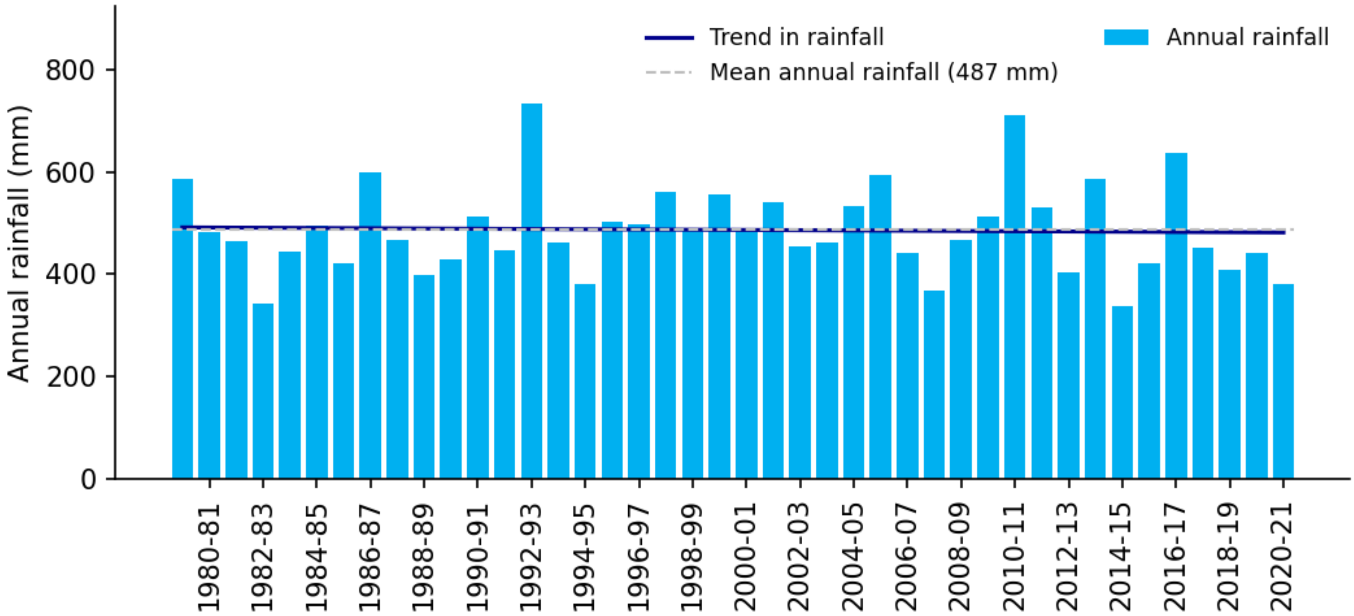

Figure 3.4 Annual rainfall for 1979–80 to 2020–21 at the Smithfield rainfall station (BoM station 23025)

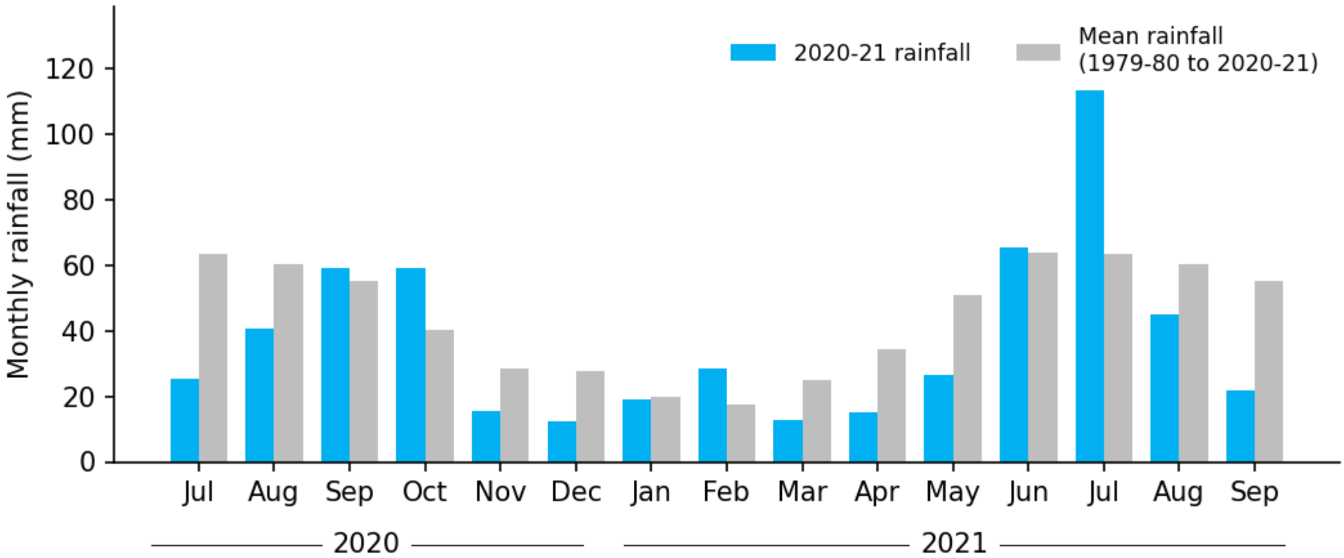

Figure 3.5 Monthly rainfall between July 2020 and September 2021, compared to the long-term monthly average at the Smithfield rainfall station (BoM station 23025)

Total annual rainfall recorded at the North Adelaide station in 2020–21 is 375 mm, which is 24% below the long-term annual average rainfall of 492 mm/y (1980 to 2021). The long-term trend in annual rainfall (1980 to 2021) is declining for the North Adelaide station with the past 4 years showing below-average annual rainfall (Figure 3.6). Below-average and average monthly rainfall is observed throughout the period, except for the above-average months of June and July 2021 (Figure 3.7).

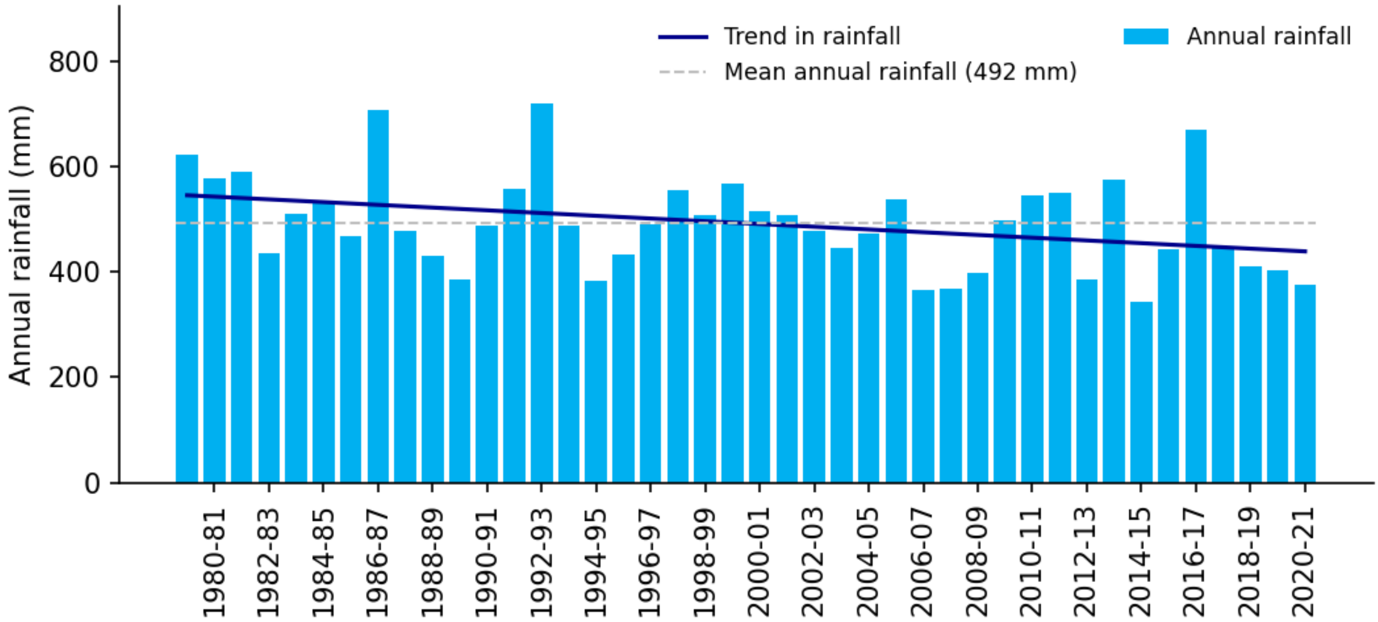

Figure 3.6 Annual rainfall for 1979–80 to 2020–21 at the North Adelaide rainfall station (BoM station 23011)

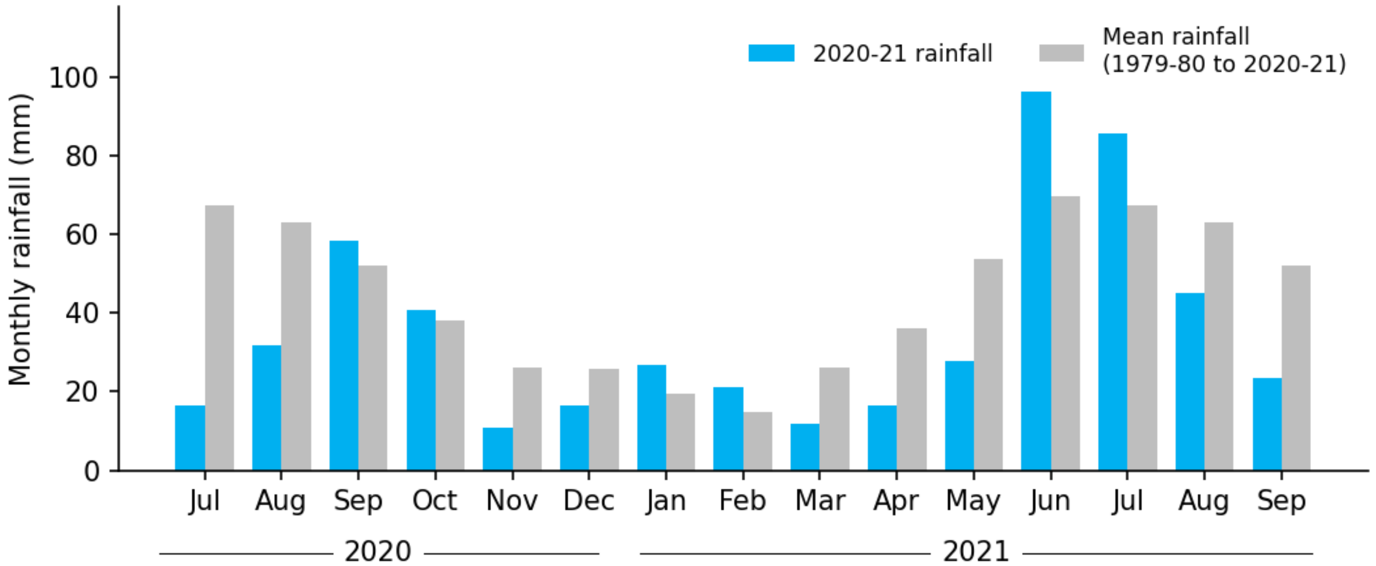

Figure 3.7 Monthly rainfall between July 2020 and September 2021, compared to the long-term monthly average at the North Adelaide rainfall station (BoM station 23011)

4 Groundwater

4.1 Hydrogeology

The following discussion of hydrogeology focuses on the T1 and T2 aquifers as these aquifers support most of the extraction in the Adelaide Plains area, so are the focus of this report. A comprehensive summary of hydrogeology is provided by Gerges (2006).

Potentiometric surfaces for T1 and T2 aquifers are provided in Appendix A.

4.1.1 T1 aquifer

The T1 aquifer primarily comprises Hallett Cove Sandstone, Dry Creek Sand and limestone of the upper Port Willunga Formation. Tertiary sands that have been deposited immediately adjacent to the faulted boundary between the basin sediments and the Mount Lofty Ranges are also considered part of the T1 aquifer. The direction of groundwater flow is generally westward from the ranges to Gulf St Vincent. The two main sources of recharge are thought to be lateral throughflow from fractured rock aquifers of the ranges and infiltration of surface water from streams that flow onto the plains from the ranges. Outflows from the groundwater system occur through groundwater extraction and discharge to Gulf St Vincent.

The T1 aquifer can be divided into two main areas that are separated by the Para Fault: the Adelaide Plains sub-basin and the Golden Grove Embayment. The T1 aquifer differs markedly in thickness and extent between these two areas. In the Golden Grove Embayment (east of the Para Fault), the T1 aquifer occurs as a semi-confined or unconfined aquifer and is relatively thin. In the Adelaide Plains sub-basin (west of the Para Fault), the aquifer is thicker, but also more uniform and continuous in terms of thickness and spatial distribution and consequently, most groundwater extraction from the T1 aquifer occurs in this area. The T1 aquifer is absent in the north-east portion of the NAP PWA.

The T1 aquifer is generally confined, except where it becomes shallow or crops out in the northern Golden Grove Embayment, particularly north of the River Torrens, and near the Eden–Burnside Fault (Figure 1.1). Despite the generally confined nature of the T1 aquifer, the intensity and timing of rainfall (and related variations in rates of groundwater extraction) can influence groundwater levels and salinities. For example, if the Central Adelaide PWA experienced above-average rainfall, this could result in less groundwater being extracted from the T1 aquifer for irrigation purposes and rises in groundwater levels might result. Summer irrigation extraction causes major seasonal fluctuations, while industrial extractions are continuous throughout the year.

4.1.2 T2 aquifer

The T2 aquifer consists of well-cemented limestones of the lower Port Willunga Formation. The two main sources of groundwater recharge to the T2 aquifer are thought to be lateral inflow from the adjacent fractured rock aquifers of the Mount Lofty Ranges and the infiltration of surface water from streams that flow onto the plains from the ranges. Outflows from the groundwater system occur through groundwater extraction and discharge to Gulf St Vincent. The T2 aquifer occurs extensively across the Adelaide Plains sub-basin portion of the Central Adelaide PWA and most of the NAP PWA and Kangaroo Flat region.

Although there is no direct recharge from incident rainfall to the confined T2 aquifer, there may be an indirect correlation between groundwater levels and rainfall, as periods of below-average rainfall will likely result in increased rates of groundwater extraction, which may lead to declines in groundwater levels and increases in salinities. Conversely, above-average rainfall may result in increased recharge and decreases in extractions, which can cause groundwater levels to rise and salinities to stabilise or decrease.

4.2 Central Adelaide PWA T1 aquifer water level

In 2021, winter-recovered water levels in 19 out of 31 monitoring wells (61%) in the T1 aquifer of the Central Adelaide PWA are classified 'Very much above average' or 'Highest on record'. All wells, with the exception of 2 that are located towards the eastern extent of the T1 aquifer, are classified 'Average' or higher (see Section 2.2.1 for details of the classification; Figure 4.1).

Over the past 20 years, variations in water level in 32 wells range from a decline of 1.76 m to a rise of 12.66 m (median is a rise of 3.7 m).

Five-year trends show rising water levels in most wells (56%), with rates of rise ranging between 0.11 and 0.97 m/y (median is a rise of 0.33 m/y) (Figure 4.2). Wells with stable water levels or rising trends are located towards the western part of the PWA, while wells with declining trends are predominantly located towards the east.

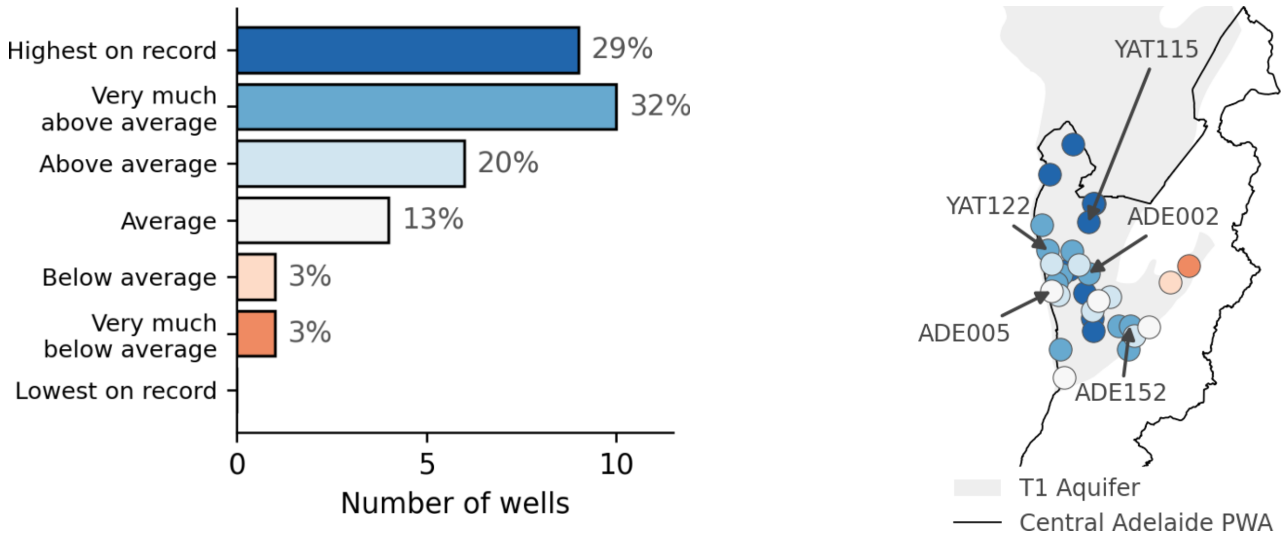

Figure 4.1 2021 recovered water levels for wells in the Central Adelaide T1 aquifer

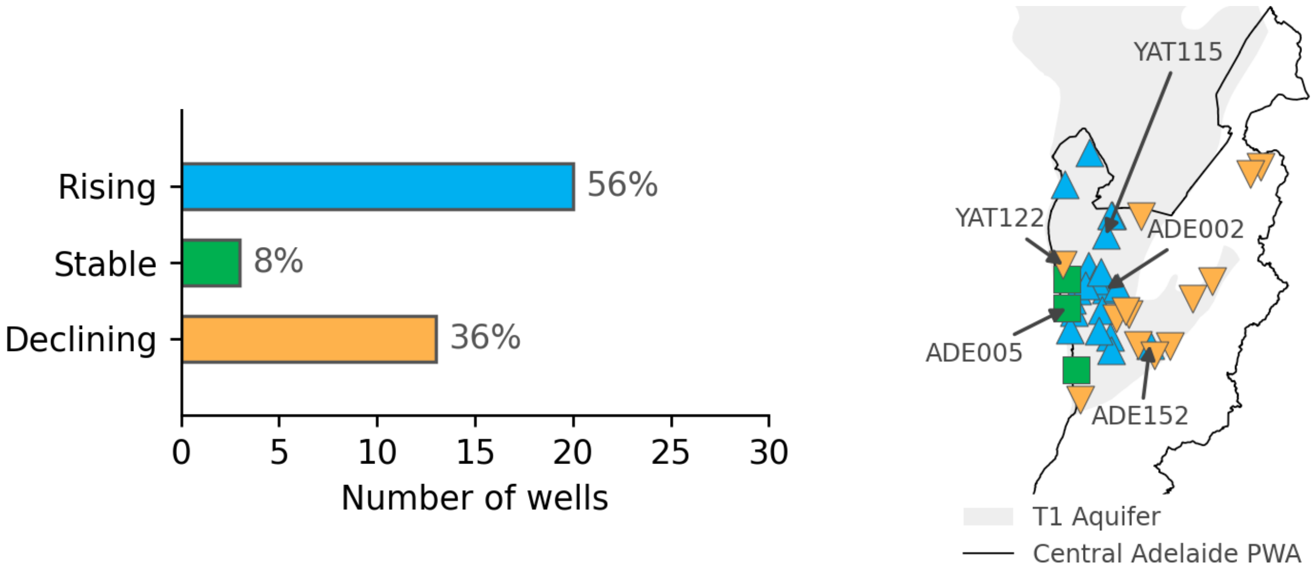

Figure 4.2 2017 to 2021 trend in recovered water levels for wells in the Central Adelaide T1 Aquifer

Over the past several years, water levels in some parts of the T1 aquifer (and T2 aquifer) have risen in response to a combination of net injection from operational managed aquifer recharge (MAR) schemes and a reduction in groundwater extraction (DEW 2021).

Monitoring wells ADE002 and ADE005 are located west of the Adelaide central business district near the central part of the T1 aquifer of the Central Adelaide PWA; both show generally rising water levels since around 2010 (Figure 4.3).

YAT122 is located in the western suburbs at Grange; water levels here have been generally rising since 2010 and are classified 'Very much above average'. Numerous T1 MAR schemes associated with turf irrigation are operational in the area.

In the northern area of the PWA, water levels are currently 'Highest on record' (e.g., YAT115). This is likely due to a combination of net MAR injection to the T1 aquifer in the southern part of the NAP PWA and a reduction in industrial extractions in 2013.

In the southern portion of the Central Adelaide PWA, the Para Fault and Golden Grove Embayment influences groundwater flow directions and levels. Water levels in ADE152 have been generally rising since around 2010 and are classified 'Very much above average'. The operational Heywood Park T1 MAR scheme is less than 1km away.

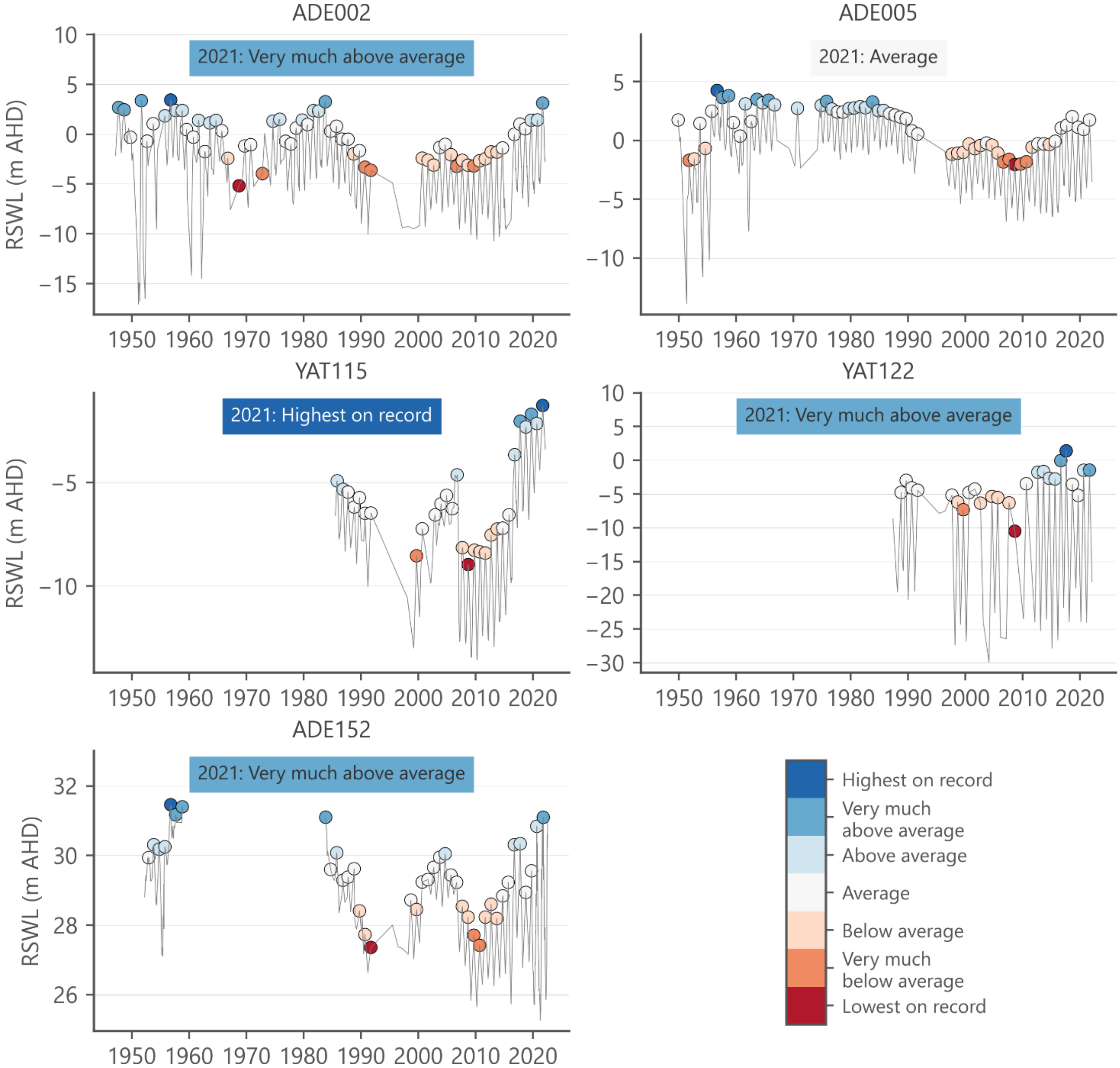

Figure 4.3 Selected Central Adelaide PWA T1 aquifer hydrographs

4.3 Central Adelaide PWA T1 aquifer salinity

In 2021, salinity sampling results from 15 wells in the T1 aquifer of the Central Adelaide PWA range between 818 mg/L and 3,764 mg/L with a median of 1,284 mg/L (Figure 4.4).

In the ten years to 2021, groundwater salinity is stable (within ±10%) (see Section 2.2.2 for details of salinity calculations; Figure 4.5). Ten-year trends show that rates of change in salinity vary from a decrease of 0.7% per year to an increase of 0.4% per year, with a median rate of 0.2% decrease per year.

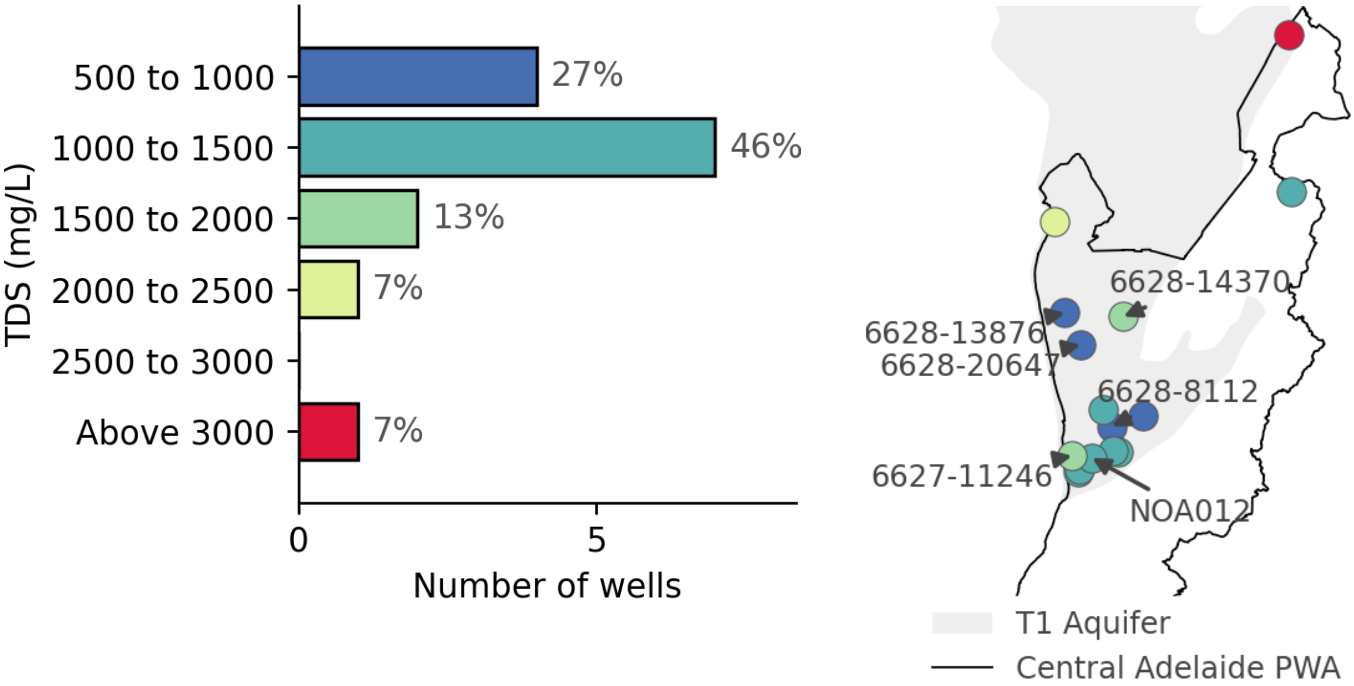

Figure 4.4 2021 salinity observations from wells in the T1 aquifer of the Central Adelaide PWA

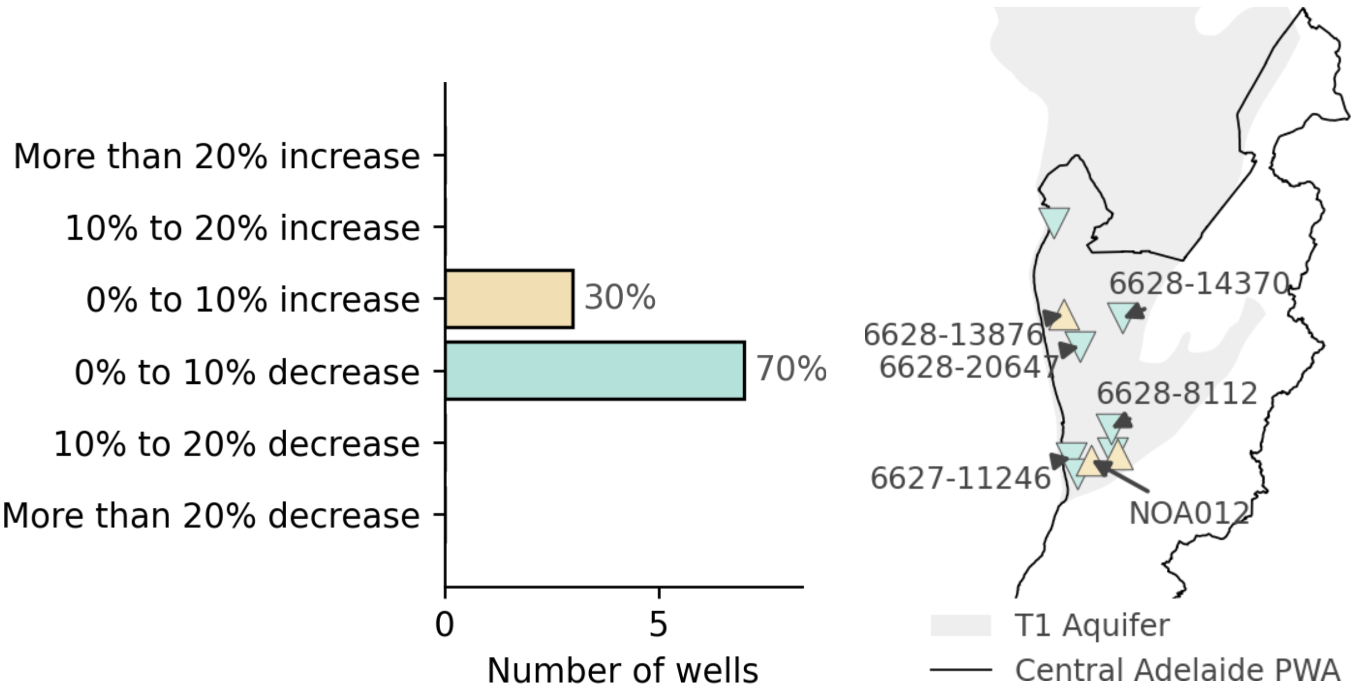

Figure 4.5 Salinity trend in the 10 years to 2021 for wells in the T1 aquifer of the Central Adelaide PWA

Salinity graphs from a selection of representative wells are shown to illustrate common or important trends in the confined T1 aquifer of the Central Adelaide PWA (Figure 4.6). For most of the PWA, long-term salinity data is available since the early 2000s (mainly from groundwater wells used for the irrigation of school ovals). Selected wells in the north-western suburbs of Adelaide (6628-14370, 6628-13876 and 6628-20647) and the southern suburbs of Adelaide (6628-8112, NOA012 and 6627-11246) indicate that while salinity is variable from location to location, salinity is relatively stable throughout the monitoring period for each well.

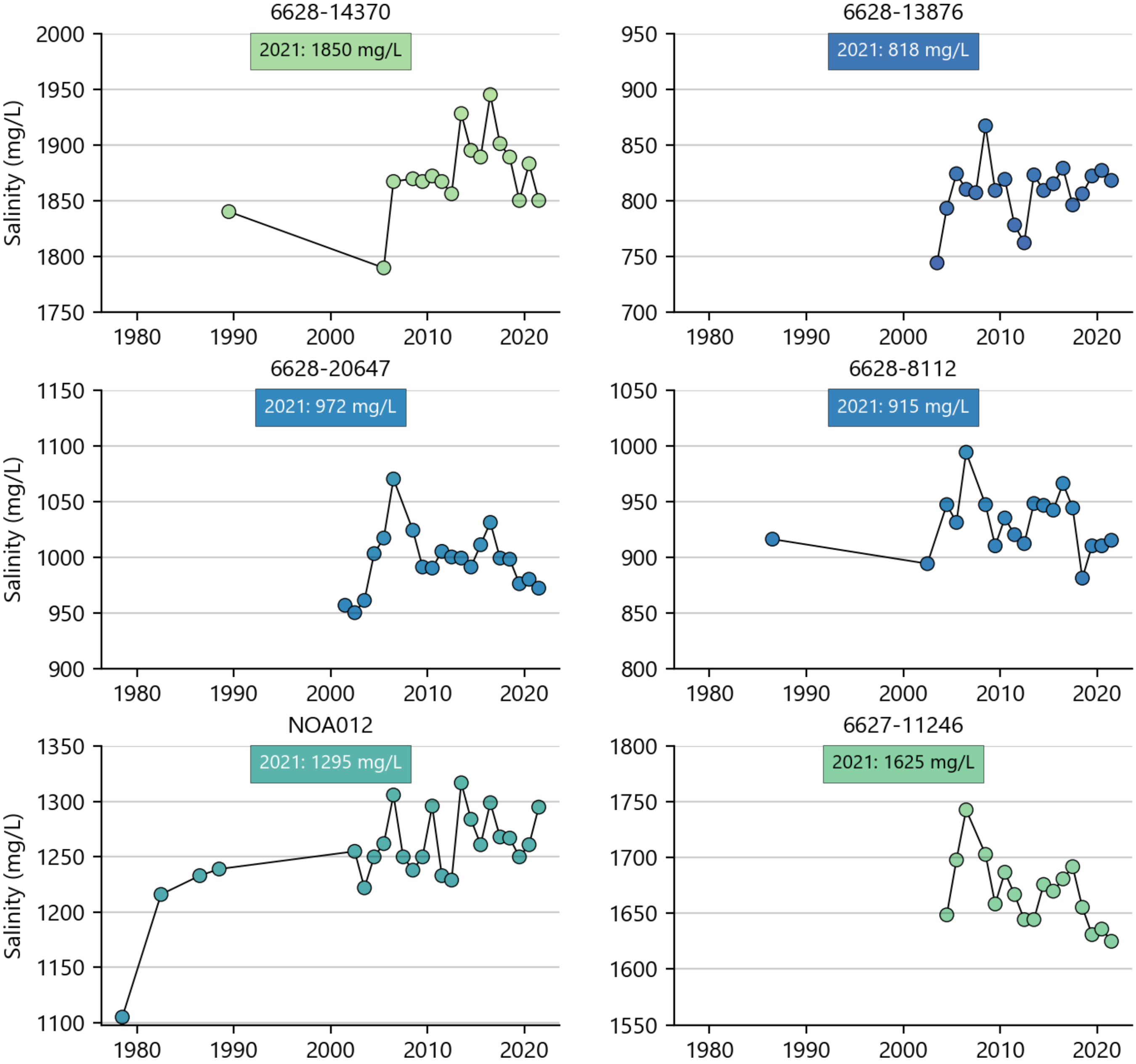

Figure 4.6 Selected Central Adelaide PWA T1 aquifer salinity graphs

4.4 NAP PWA T1 aquifer water level

In 2021, winter-recovered water levels in 15 out of 21 monitoring wells (57%) in the T1 aquifer of the NAP PWA are classified 'Very much above average' or 'Highest on record' (see Section 2.2.1 for details of the classification; Figure 4.7). Wells classified 'Average' or lower tend to be located towards the north-west of the PWA.

Over the past 20 years, variations in water level in 21 wells range from a decline of 2.68 m to a rise of 7.97 m (median is a rise of 1.9 m).

Five-year trends show water levels in most wells are declining (85%), with rates of decline ranging between 1.09 and 0.04 m/y (median is a decline of 0.26 m/y) (Figure 4.8).

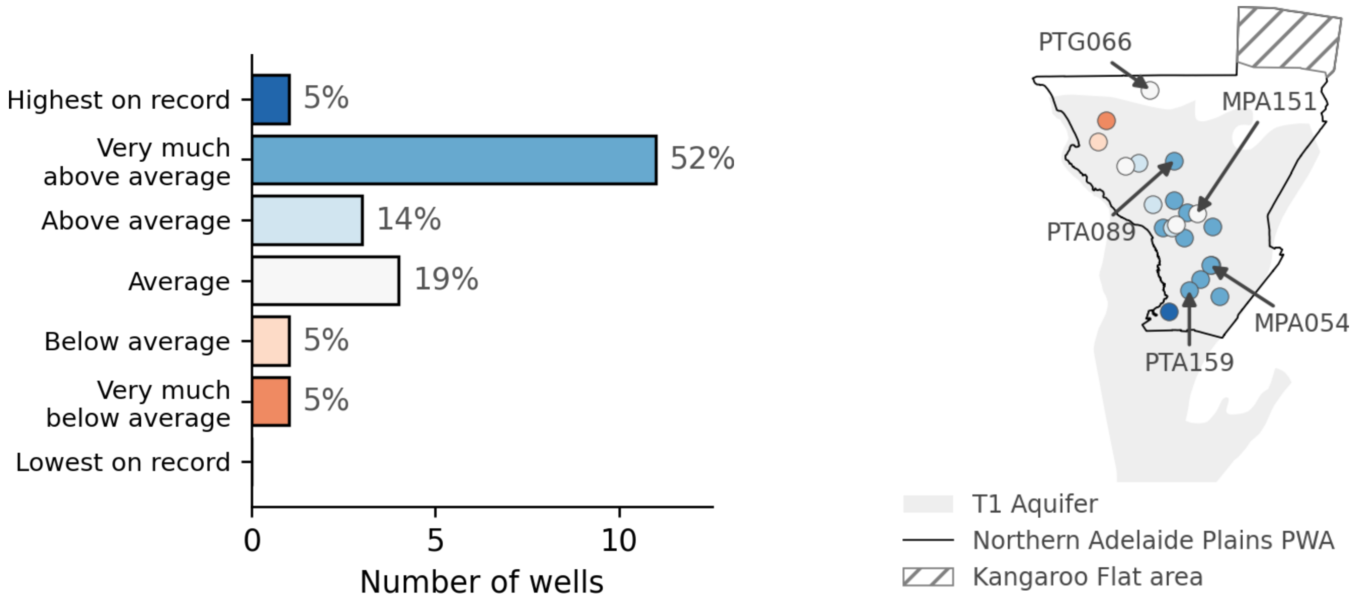

Figure 4.7 2021 recovered water levels for wells in the T1 aquifer of the NAP PWA

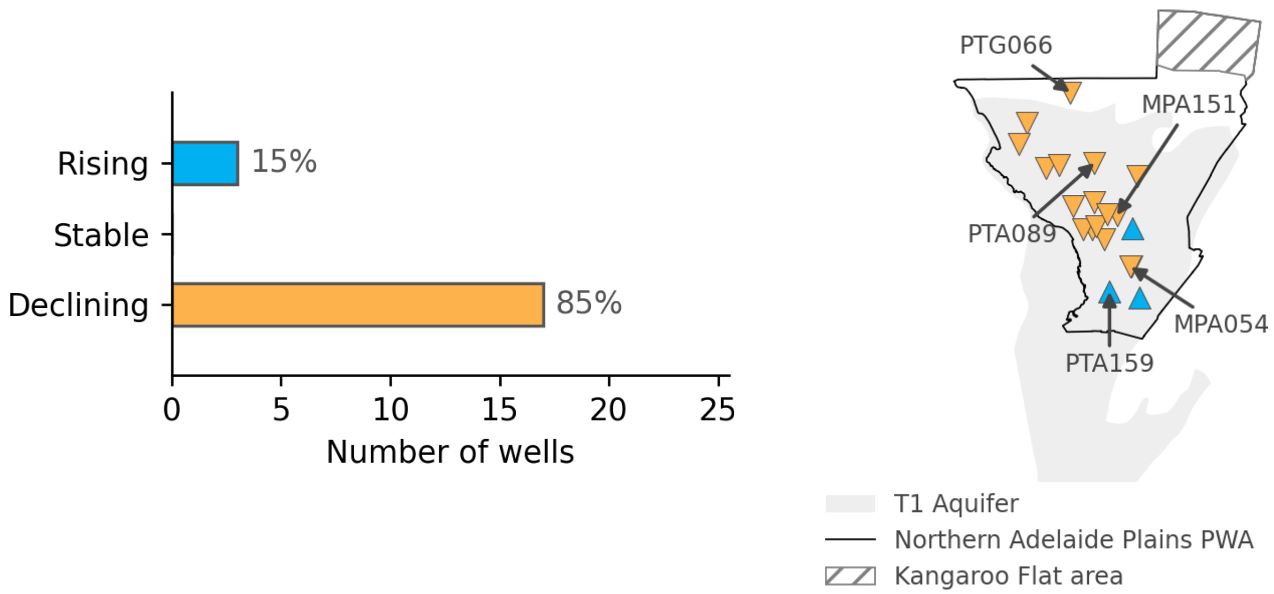

Figure 4.8 2017 to 2021 trend in recovered water levels for wells in the T1 aquifer of the NAP PWA

Hydrographs from a selection of representative monitoring wells are shown to illustrate common or important trends in the T1 aquifer of the NAP PWA (Figure 4.9).

Towards the south of the PWA near Salisbury and Dry Creek (e.g., MPA054 and PTA159), groundwater levels are classified 'Very much above average'. In this area, a distinct rise in levels is observed from 2017, which is likely due to the combined impact of operational MAR sites (with positive net injection) coincident with a marked reduction in industrial extractions around Dry Creek.

In the central part of the PWA near Virginia, PTA089 shows a trend of generally rising water level since the mid-1990s and is now classified 'Very much above average'. Near Waterloo Corner, MPA151 shows a relatively stable water level since monitoring began in 2000 and is classified 'Average'.

Towards the north of the PWA near Two Wells, PTG066 shows relatively stable water levels since around 2000 and is classified 'Average'.

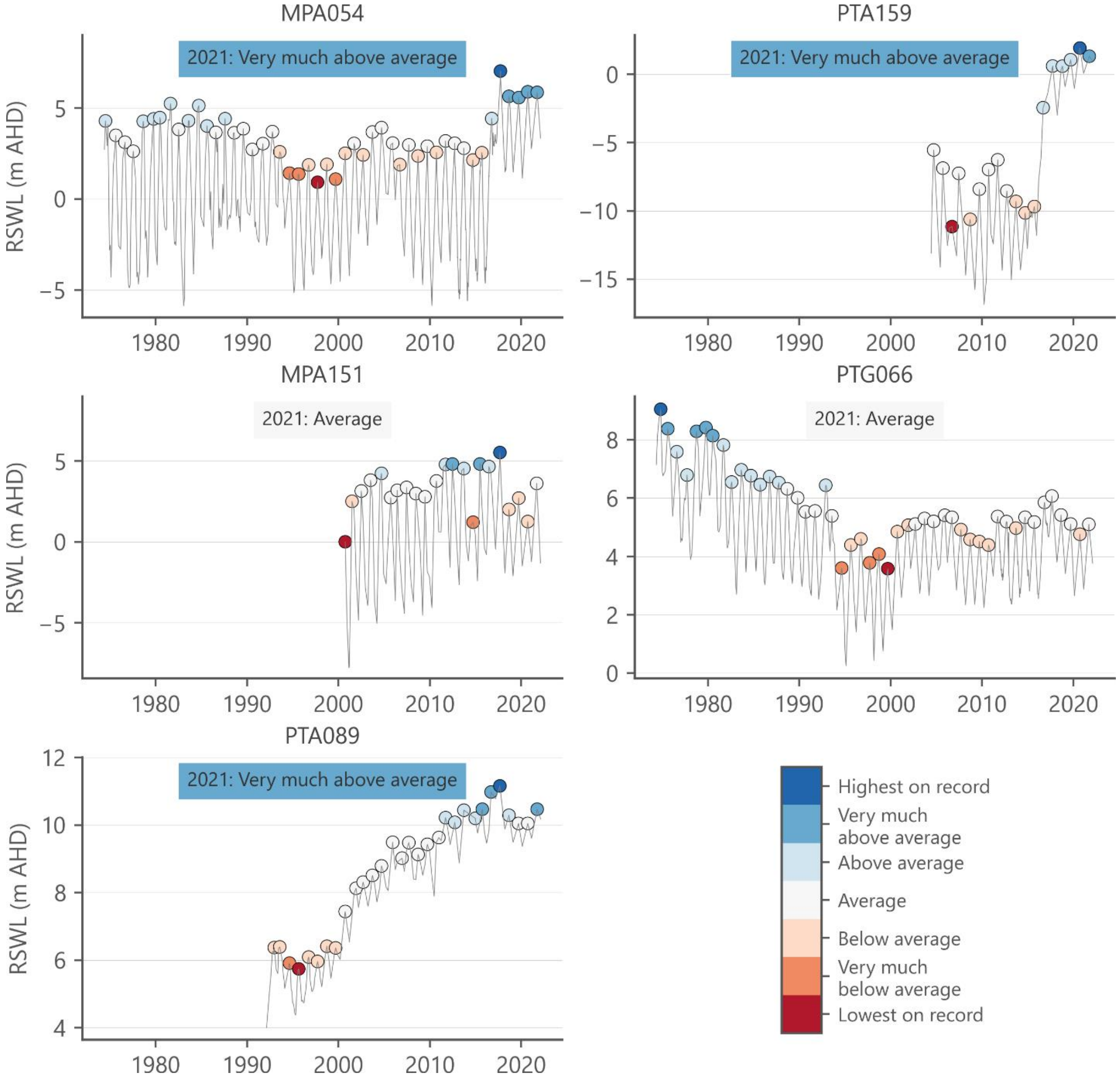

Figure 4.9 Selected NAP T1 Aquifer hydrographs

4.5 NAP PWA T1 aquifer salinity

In 2021, salinity sampling results from 76 wells in the T1 aquifer of the NAP PWA range between 558 mg/L and 2,802 mg/L with a median of 866 mg/L. Most wells (62%) are less than 1,000 mg/L and occur along the Little Para River and around the central-eastern area of the aquifer (Figure 4.10).

In the 10 years to 2021, groundwater salinity in most monitoring wells (81%) is stable (within ±10%) (see Section 2.2.2 for details of salinity calculations; Figure 4.11). The trends in salinity over the ten-year period vary from a decrease of 11.2% per year to an increase of 3.5% per year, with a median trend being a decrease of 0.2% per year.

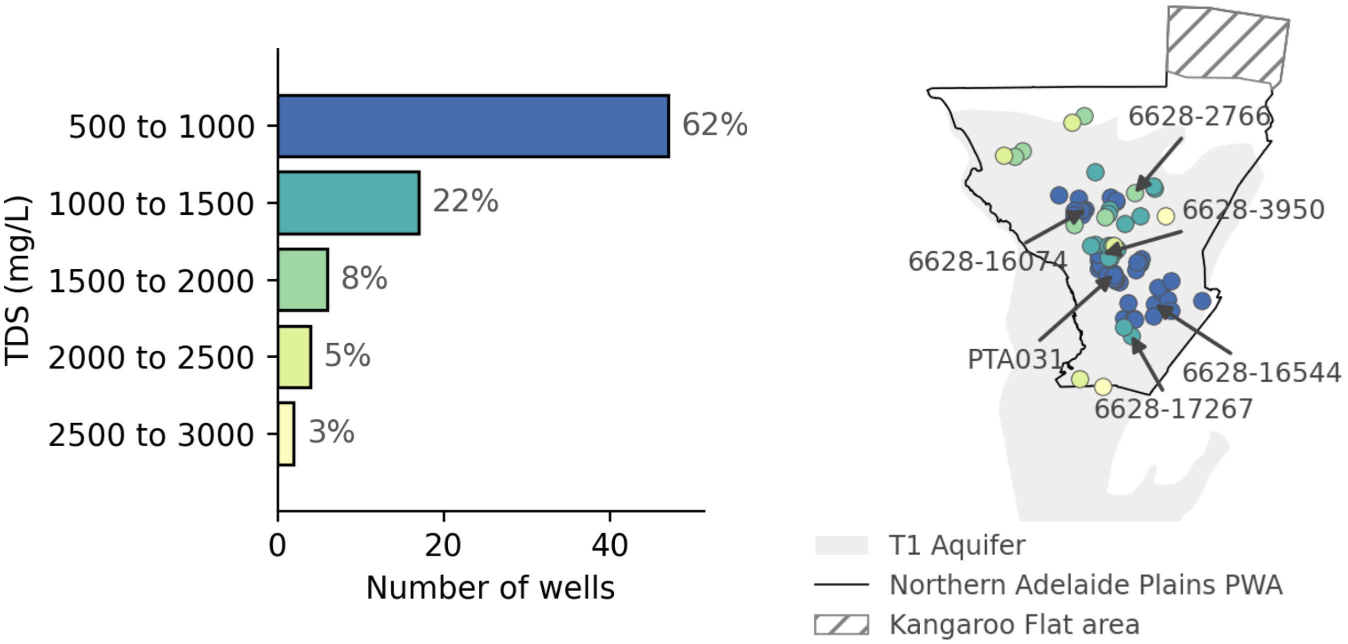

Figure 4.10 2021 salinity observations in the T1 aquifer of the NAP PWA

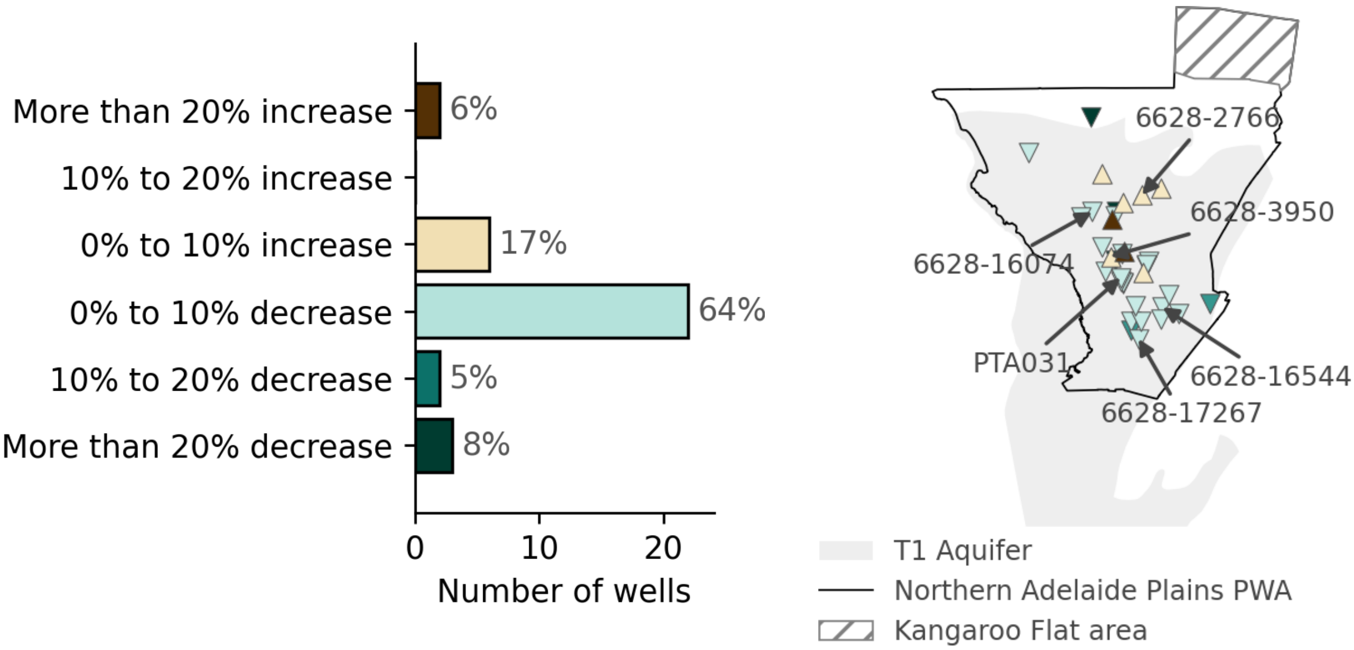

Figure 4.11 Salinity trend in the 10 years to 2021 for wells in the T1 aquifer of the NAP PWA

Salinity graphs from a selection of monitoring wells in the T1 aquifer of the NAP PWA (Figure 4.12) show that salinity is generally very low. Selected wells from the northern extent of the PWA, around Waterloo Corner and Virginia (e.g., 6628-2766, 6628-16074 and 6628-3950), show trends of slowly increasing salinity. The rate of rise is around 10 mg/L per year over the past 20 years. These increases are most likely due to corroded casing allowing ingress of shallow saline groundwater, or the lateral movement of more saline plumes from nearby 'leaky' wells.

Selected wells in the southern part of the PWA, around Bolivar and Salisbury (e.g., PTA031, 6628-16544 and 6628-17267), show relatively stable salinity over the period of monitoring for each well.

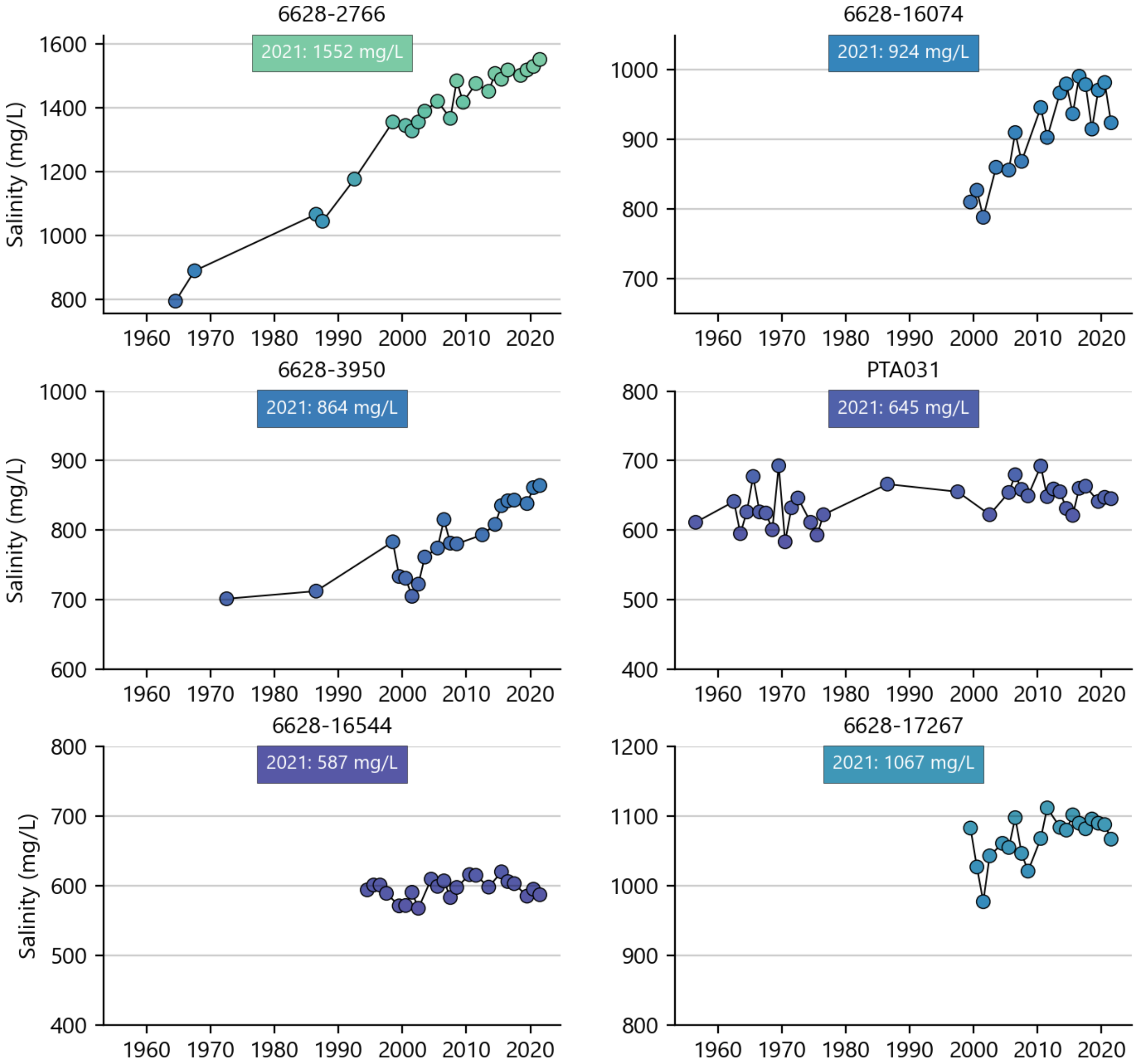

Figure 4.12 Selected NAP T1 Aquifer salinity graphs

4.6 NAP PWA T2 aquifer water level

In 2021, winter-recovered water levels in 27 out of 37 monitoring wells (73%) in the T2 aquifer of the NAP PWA are classified 'Average', or higher (see Section 2.2.1 for details of the classification; Figure 4.13).

Over the past 20 years, variations in water level in 33 wells range from a decline of 6.16 m to a rise of 9.97 m (median is a decline of 0.3 m). Most wells (64%) show a decline in water level over this time.

Five-year trends show that water levels are declining in most wells (90%), with rates of decline ranging between 3.28 and 0.12 m/y (median is a decline of 0.84 m/y) (Figure 4.14). Wells with a stable water level or rising trend are located towards the south of the PWA. This trend may be explained by the presence of operational T2 MAR schemes in the southern part of the PWA.

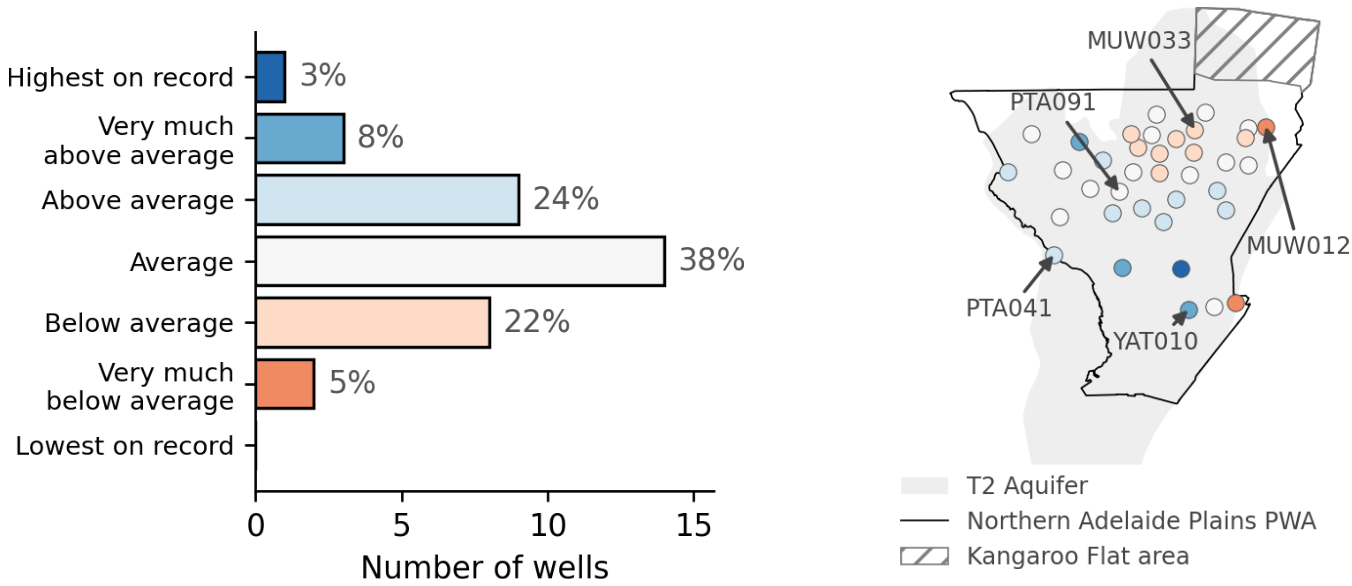

Figure 4.13 2021 recovered water levels for the T2 aquifer of the NAP PWA

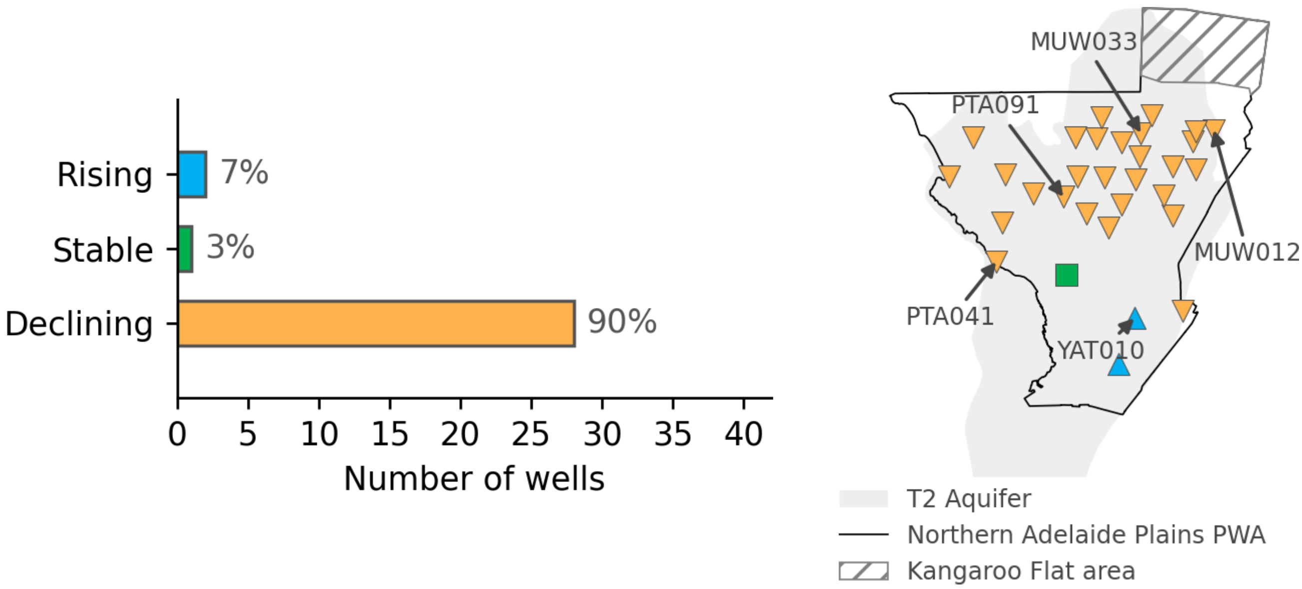

Figure 4.14 2017 to 2021 trend in recovered water levels for wells in the T2 aquifer of the NAP PWA

Hydrographs from a selection of monitoring wells completed in the T2 aquifer of the NAP PWA are shown in Figure 4.15.

Most groundwater extraction from the NAP T2 aquifer is in the northern part of the PWA, supporting the horticulture industry that is concentrated in Virginia and Angle Vale. PTA091 (located near Virginia) has recovered from historically low levels observed around 2000 and is now classified 'Average'. This water level recovery could be attributable to the reduced groundwater demand resulting from the alternative water source made available via the Virginia Pipeline Scheme. This pipeline was established in 1997 and distributes approximately 20 GL/y of recycled water from the Bolivar Wastewater Treatment Plant to irrigators throughout Virginia and surrounds (DEW 2021).

In the area north of Angle Vale and towards Gawler (e.g., in wells MUW033 and MUW012), water levels are classified 'Below average' or lower, following a decline in the past few years.

PTA041 is located on the coast to the north-west of St Kilda, and removed from the intensive irrigation areas.

YAT010 is located in Salisbury and shows recent increases in seasonal fluctuations, with a generally rising water level since the mid-2000s, and is classified 'Very much above average'. These trends may be associated with operational T2 MAR schemes located in the vicinity, where source water (predominantly urban runoff) is seasonally available.

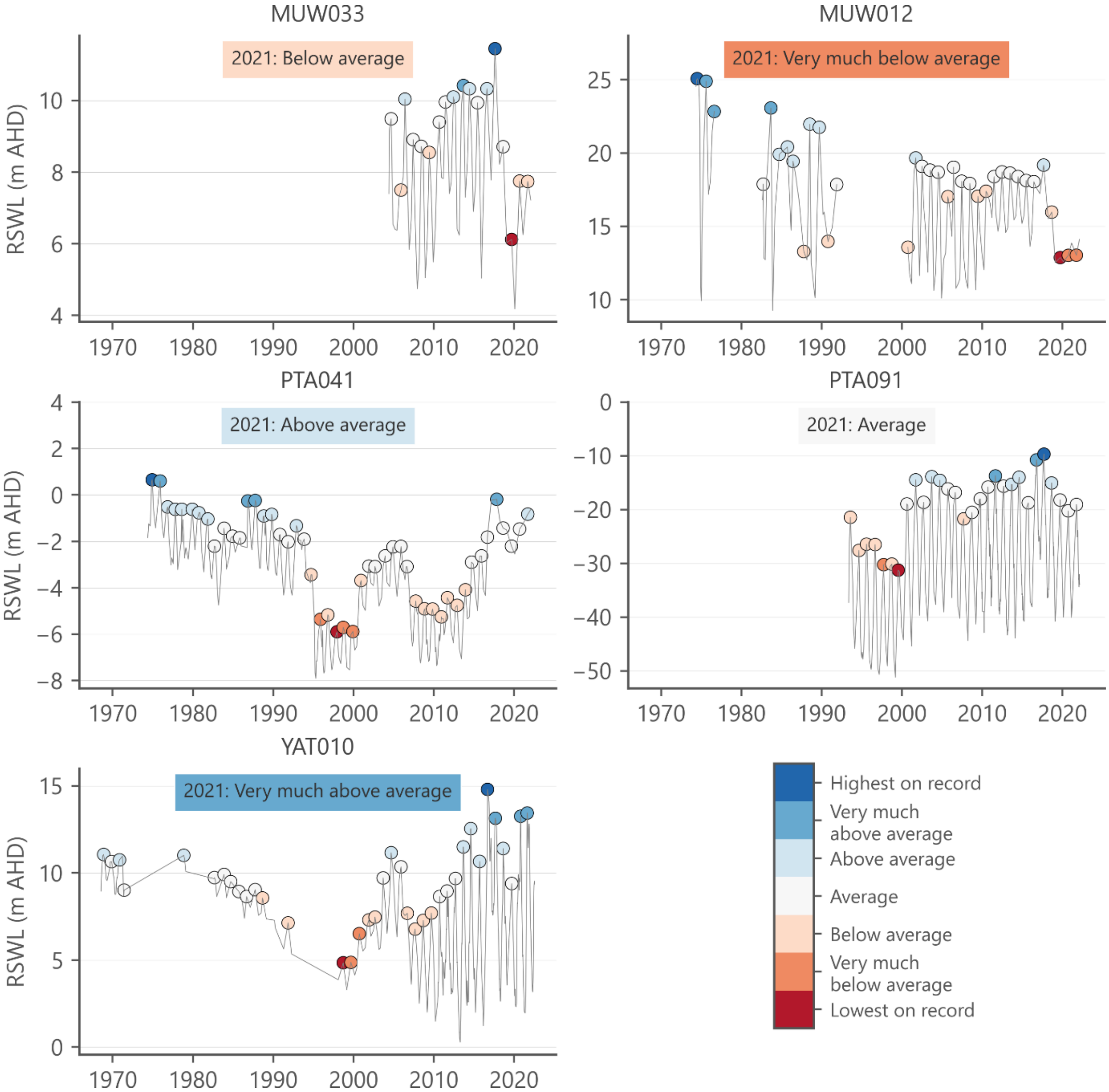

Figure 4.15 Selected hydrographs for wells in NAP T2 aquifer

4.7 NAP PWA T2 aquifer salinity

In 2021, sampling results from 280 wells in the T2 aquifer of the NAP PWA range between 571 mg/L and 3,719 mg/L with a median of 1,010 mg/L (Figure 4.16). The salinity in most wells (84%) is below 1,500 mg/L. Most salinity data have been obtained from licensed irrigation wells distributed through the central-north section of the PWA.

In the 10 years to 2021, groundwater salinity in most wells (77%) is stable (within ±10%) (see Section 2.2.2 for details of salinity calculations; Figure 4.17). The trends in salinity over the 10-year period vary from a decrease of 4.3% per year to an increase of 3.8% per year, with a median trend of 0.1% decrease per year.

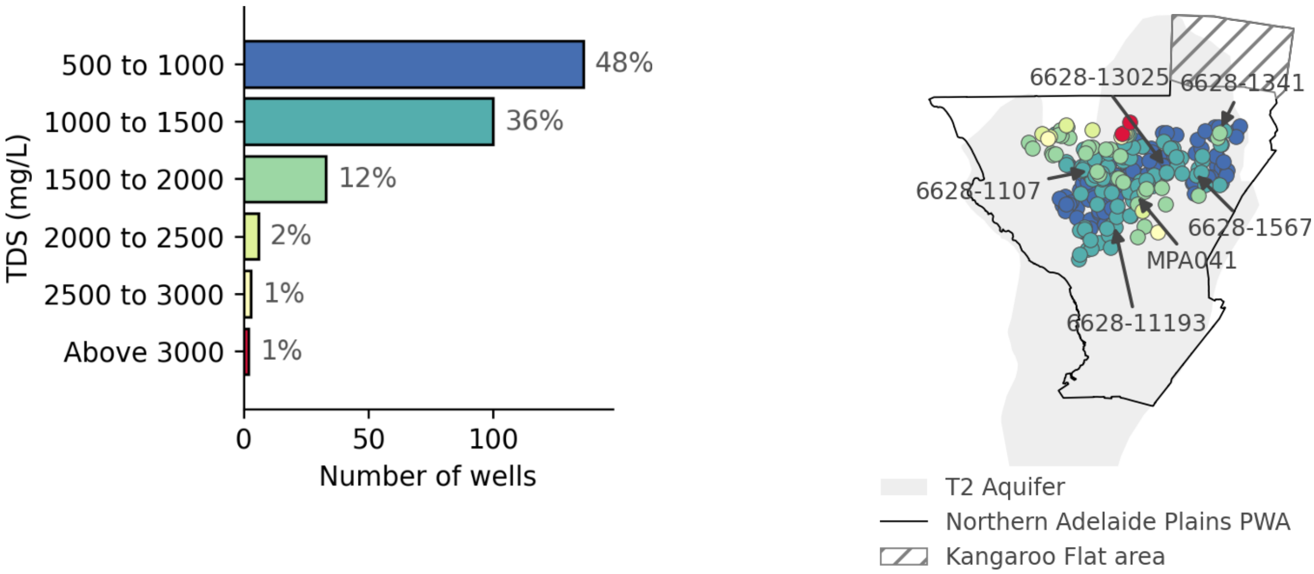

Figure 4.16 2021 salinity observations in the T2 aquifer of the NAP PWA

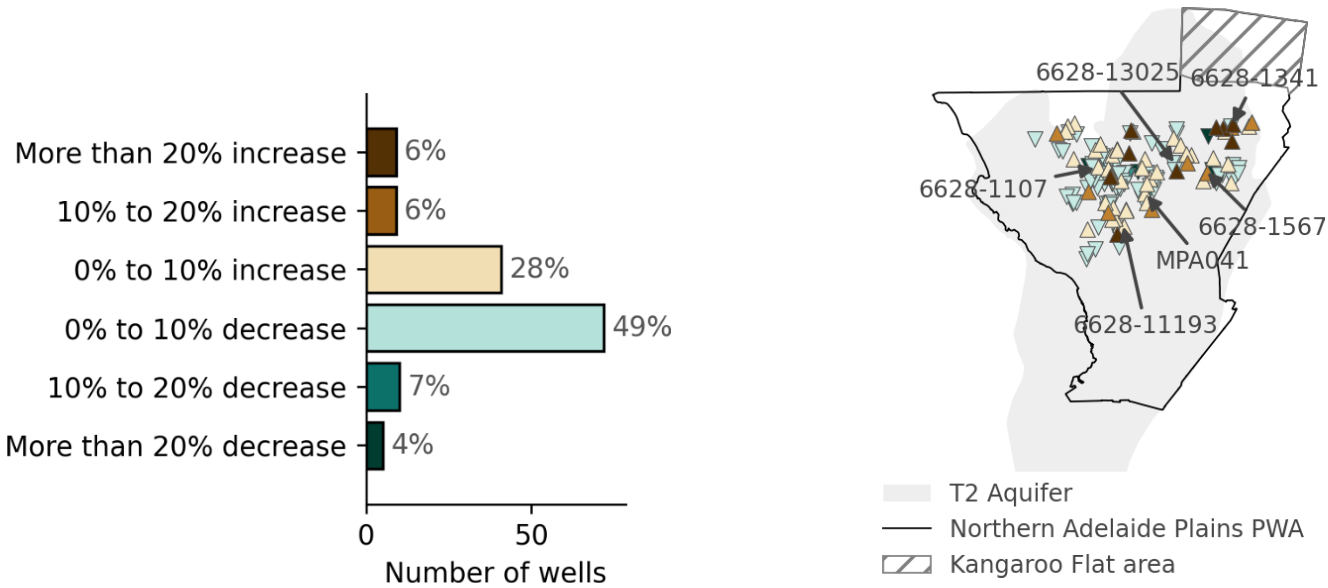

Figure 4.17 Salinity trend in the 10 years to 2021 for wells in the T2 aquifer of the NAP PWA

Long-term salinity records are available from irrigation extraction bores located in the horticultural areas in the north central part of the PWA around Virginia and Angle Vale. Salinity graphs from a selection of monitoring wells in the T2 aquifer of the NAP PWA (

Figure 4.18) show that trends in salinity are variable.

Two wells located near Angle Vale (6628-13025 and MPA041) show relatively stable salinity since the 1990s. Wells 6628-1341 and 6628-1567 (in the north-east of the PWA) and 6628-11193 and 6628-1107 (near Waterloo Corner and Virginia respectively) show trends of rising salinity. Corroded casing and leakage of shallow saline groundwater into these wells could explain some of these observed increases in groundwater salinity.

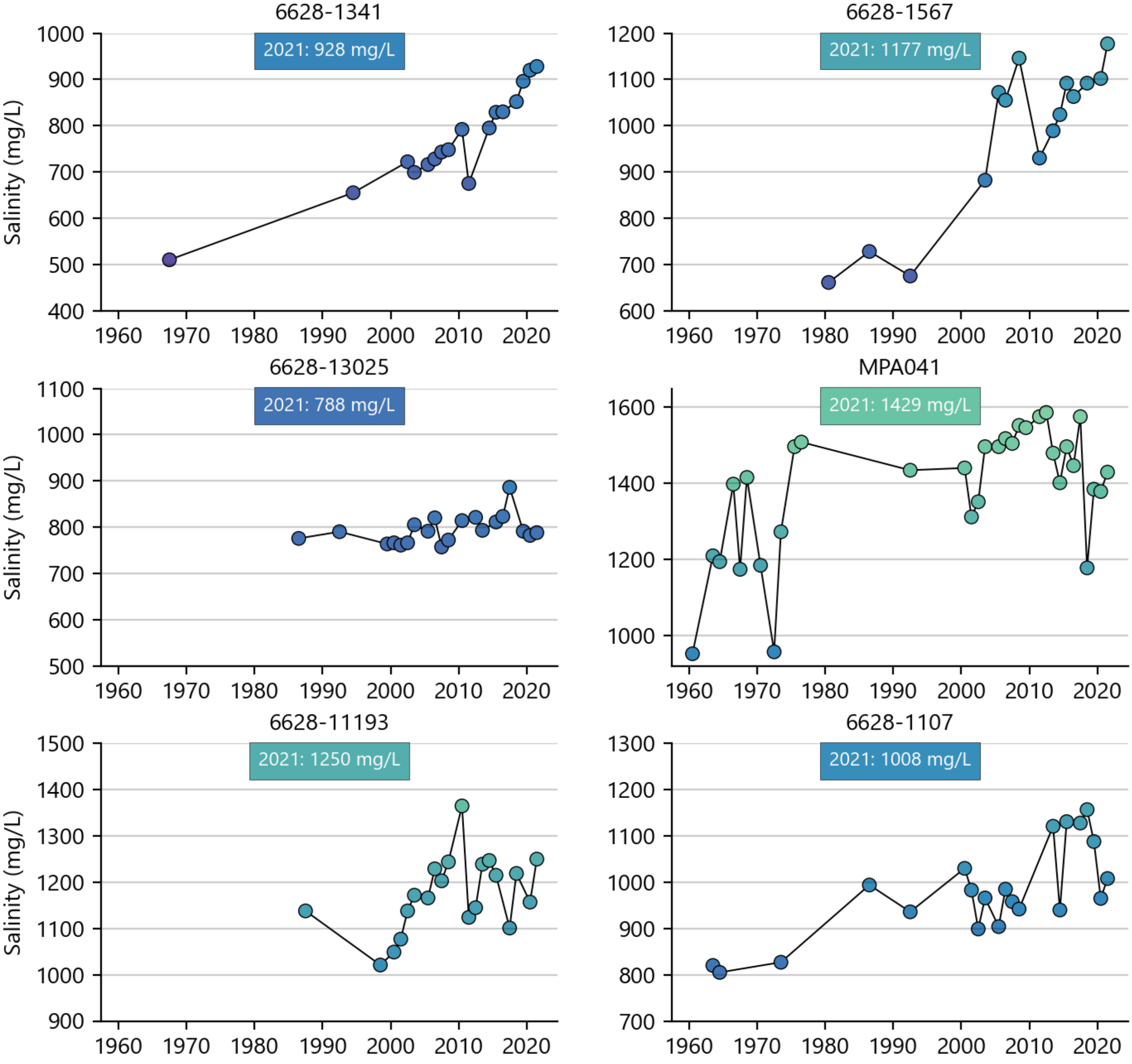

Figure 4.18 Selected salinity graphs for wells in NAP T2 aquifer

4.8 Kangaroo Flat T2 aquifer water level

In 2021, winter-recovered water levels in 2 out of 4 monitoring wells (50%) in the T2 aquifer of the Kangaroo Flat area are classified 'Average' (see Section 2.2.1 for details of the classification; Figure 4.19).

Over the past 20 years, variations in water level in 3 wells range from a decline of 1.92 m to a decline of 0.59 m (median decline of 1.1 m).

Five-year trends show water levels are declining in most wells (75%), with rates of decline ranging between 2.10 and 0.29 m/y (median is a decline of 0.42 m/y) (Figure 4.20).

Importantly, statistics reported in the Kangaroo Flat area should be considered with caution as their calculation are based on a limited dataset (i.e. data from 4 wells in the T2 aquifer).

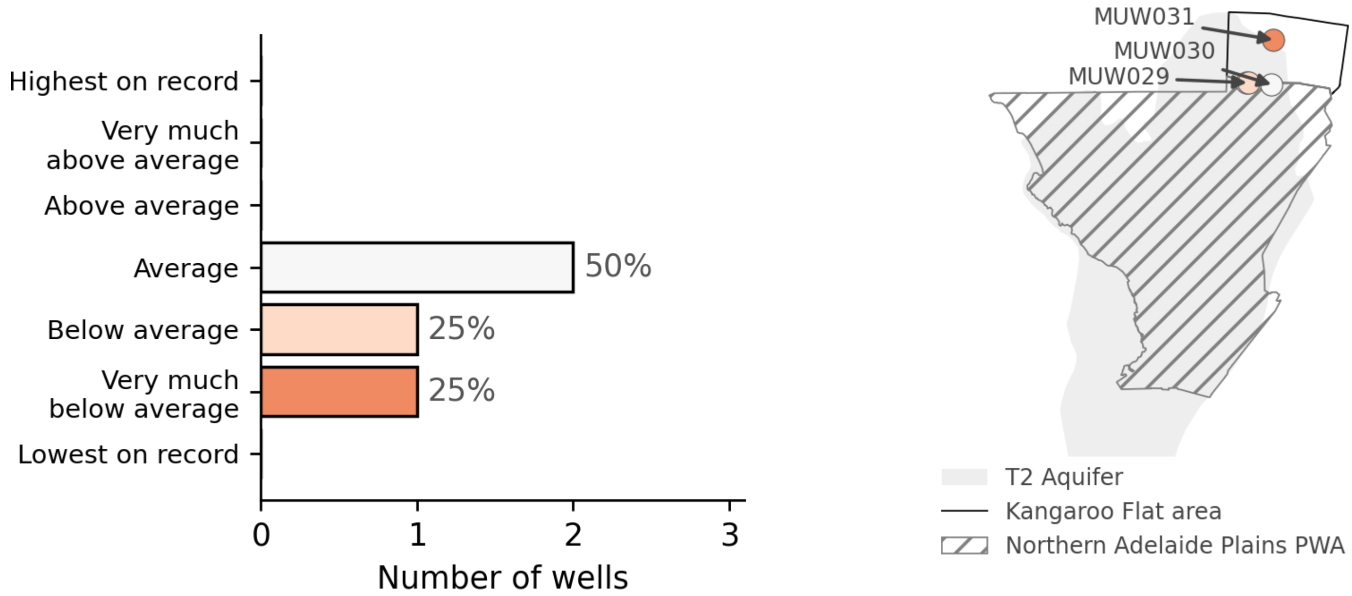

Figure 4.19 2021 recovered water levels for the T2 aquifer of the Kangaroo Flat region

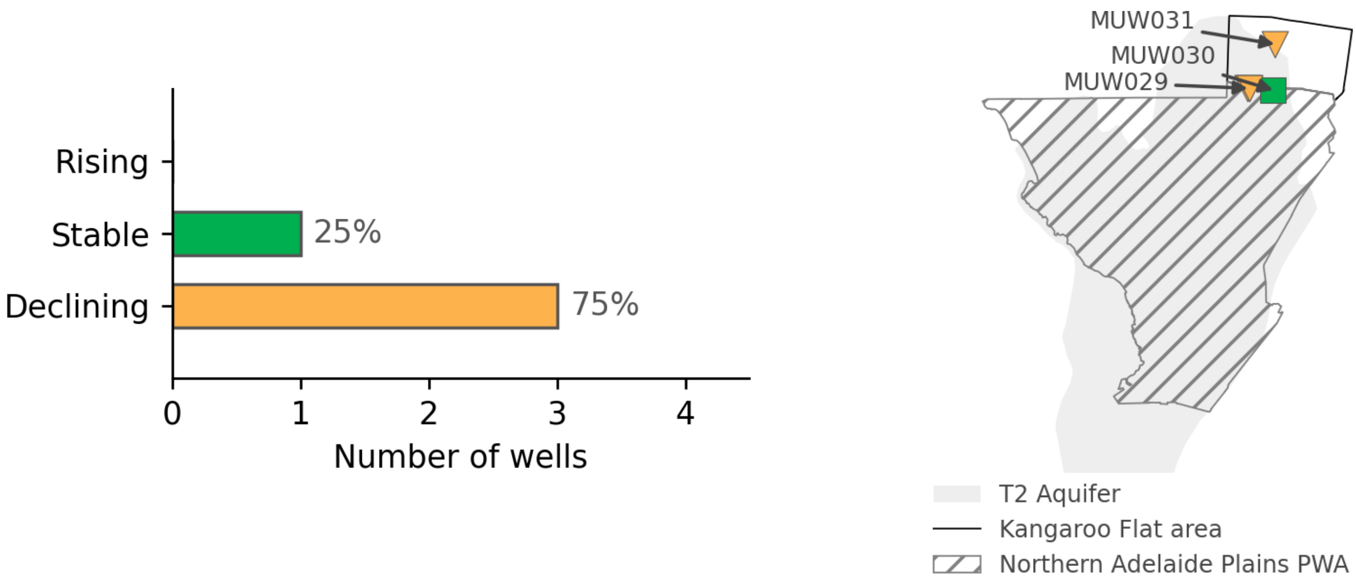

Figure 4.20 2017 to 2021 trend in recovered water levels for wells in the T2 aquifer of the Kangaroo Flat region

Hydrographs from 3 monitoring wells completed in the T2 aquifer all show a consistent gradual decline in water levels since monitoring commenced in the early 2000s. A localised cone of depression in the T2 aquifer, centred in the south-western corner of the region, has been observed on a seasonal basis since 2011, due to a regular and intensive spring to early-summer extraction regime (DEW 2019b).

Groundwater is extracted from this aquifer predominantly at the southern extent of the region, where water levels show large seasonal fluctuations in response to pumping (e.g., MUW029 and MUW030). In contrast, the water level in a well located further north (MUW031) shows a subdued seasonal response.

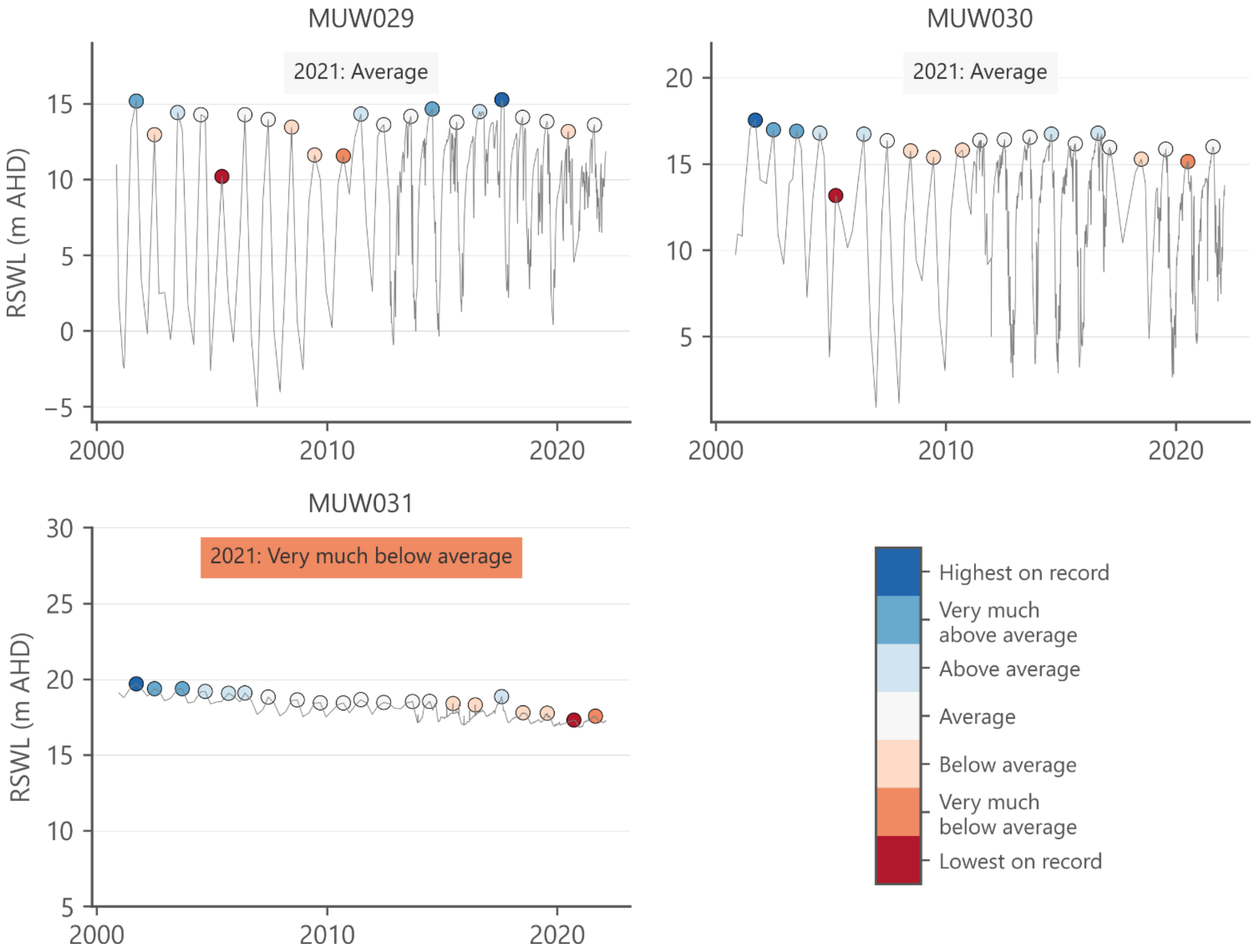

Figure 4.21 Selected hydrographs for wells in the T2 aquifer of the Kangaroo Flat region

4.9 Kangaroo Flat T2 aquifer salinity

In 2021, sampling results from 12 wells in the T2 aquifer of the Kangaroo Flat area range between 1,121 mg/L and 3,776 mg/L with a median of 1,950 mg/L (Figure 4.22).

In the past 10 years, trends show salinity is decreasing at 0.5% per year in one well, and a second well shows salinity is increasing at 0.1% per year (Figure 4.23) (see Section 2.2.2 for details of salinity calculations and criteria for selecting wells for analysis).

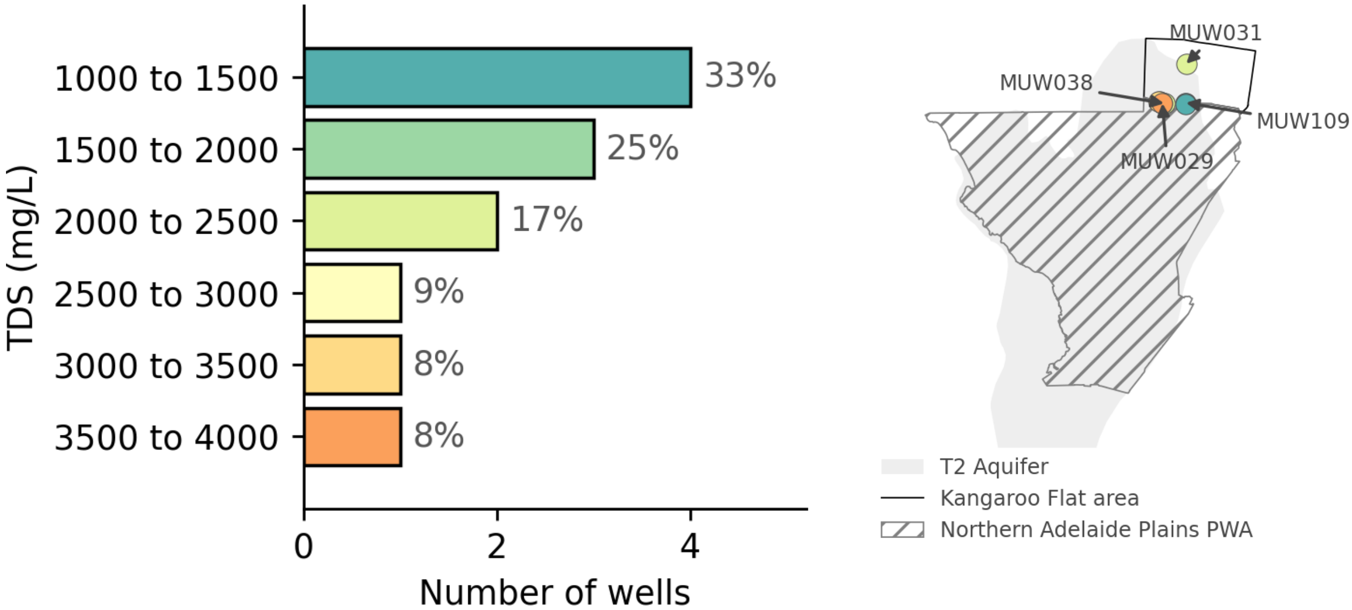

Figure 4.22 2021 salinity observations in the T2 aquifer of the Kangaroo Flat region

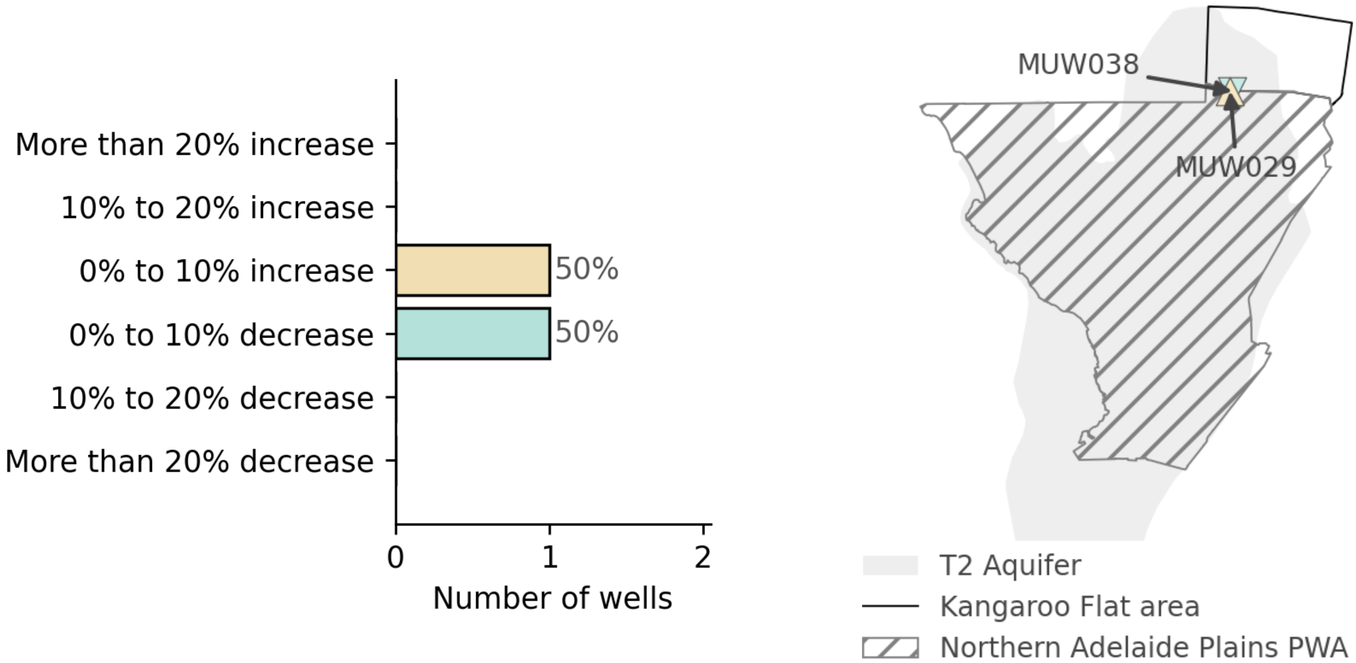

Figure 4.23 Salinity trend in the 10 years to 2021 for wells in the T2 aquifer of the Kangaroo Flat region

Horticulture is the main land use in the Kangaroo Flat area, where there is a strong relationship between rates of extraction and salinity (Barnett 2013). Seasonal groundwater extraction for irrigation leads to lowered water (pressure) levels, creating potential for downward movement of more saline water from overlying aquifers. This potential exists in other parts of the NAP; however, the risk is greater in the Kangaroo Flat area due to the absence of an effective confining layer (i.e. the Munno Para Clay). This results in a direct hydraulic connection between the T2 aquifer and the overlying Carisbrook Sand aquifer, which has a typical salinity of 3,000 to 5,000 mg/L (DFW 2010).

Salinity charts show seasonal variability in salinity where periods of higher salinity likely correlate with periods of higher local extraction and drawdown in water levels. MUW029 and MUW031 show long-term increases in salinity since monitoring commenced during the 2000s. MUW038 and MUW109 show salinity generally less than 1,500 mg/L and salinity is stable.

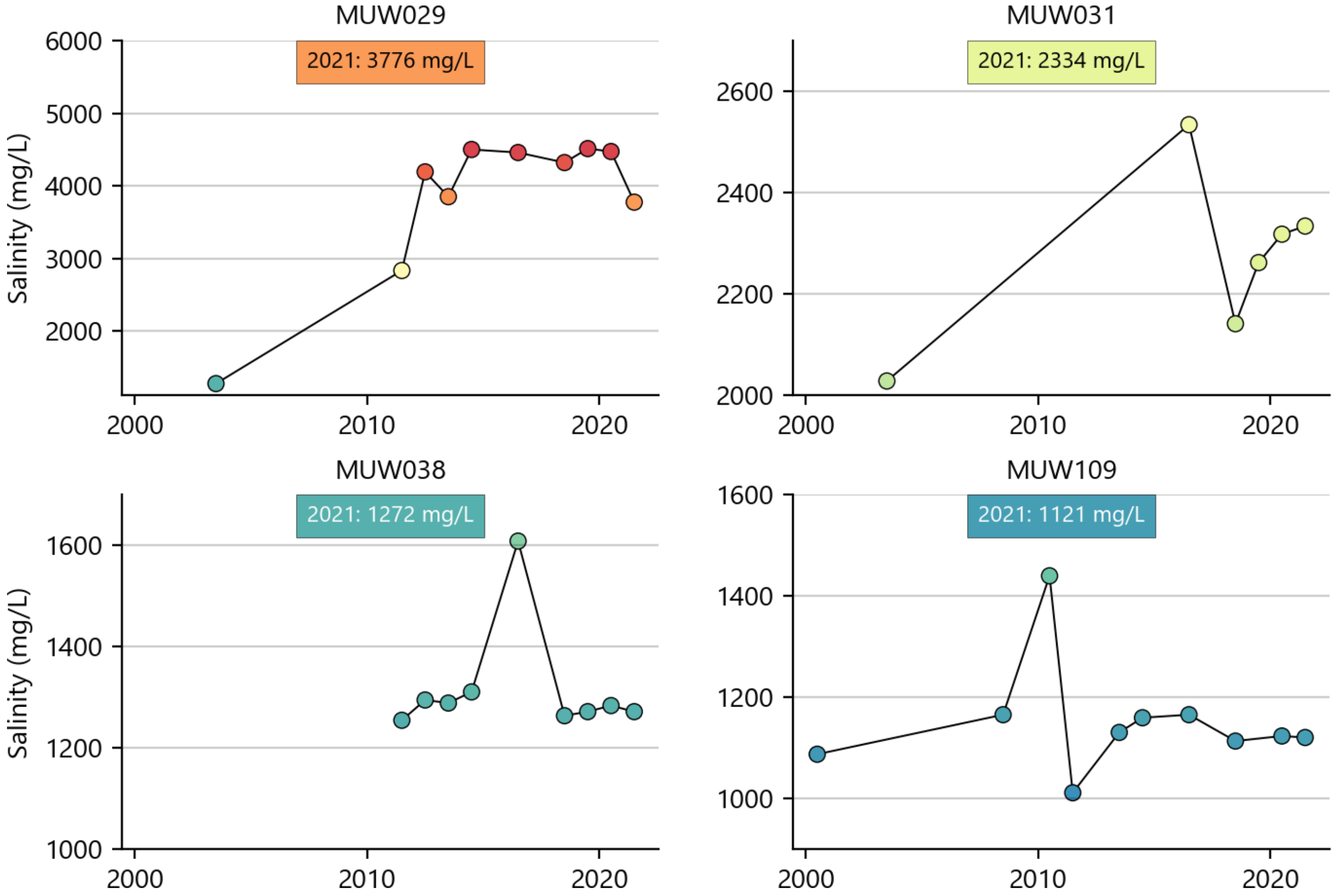

Figure 4.24 Selected salinity graphs for wells in the T2 aquifer of the Kangaroo Flat region

5 Water use

Water use data includes groundwater extracted from licensed wells and water injected into and extracted from the T1 and T2 aquifers by managed aquifer recharge (MAR) schemes. Following adoption of the Adelaide Plains WAP, comprehensive metering of extractions from licensed wells will soon be available (currently only available for the NAP PWA). However, there are some data available for the MAR schemes that operate in both the NAP and Central Adelaide PWAs.

5.1 Groundwater extraction

In 2020–21, licensed groundwater extraction from the NAP PWA (T1 and T2 aquifers) and Kangaroo Flat area (T2 aquifer), excluding MAR schemes extraction, is 12,964 ML. Both the overall volume of extraction and proportion of extraction from each management zone is consistent with recent years (Figure 5.1).

The year of lowest extraction volumes (2016–17) correlates with an increase in rainfall (Section 3), which also lead to a marked increase in MAR water injection volumes (see Section 5.2). Conversely, since 2016–17, relatively lower rainfall correlates with increased annual extraction volumes.

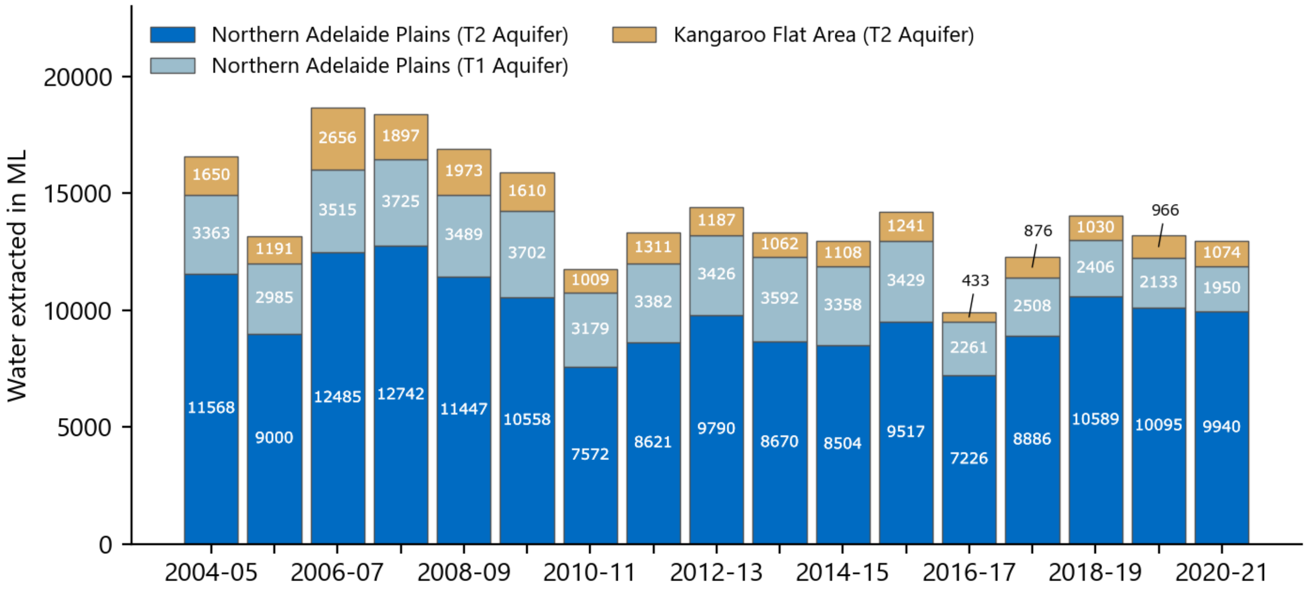

Figure 5.1 Metered groundwater extraction in aquifers of the NAP PWA, including the Kangaroo Flat region from 2004–05 to 2020–21

5.2 Managed aquifer recharge

Managed aquifer recharge has been adopted across the greater Adelaide metropolitan area as a storage method, providing an alternative water source to potable water for irrigation of public open spaces and industrial uses. Additionally, MAR contributes to Adelaide's water security by providing additional supply of water during summer when demand for e.g., turf irrigation is high. There are 23 approved MAR schemes operating across the NAP and Central Adelaide PWAs that target the T1 and T2 aquifers. Several new MAR projects are proposed for the Adelaide metropolitan area, but are either not yet licensed, or are licensed but not yet operational (DEW 2021).

MAR schemes in any given reporting period may have a net positive (injecting) or net negative (extracting) effect on water storage and therefore water levels. For example, during wetter periods the availability of injection source water will be greater and demand for irrigation water likely lower; hence, operational MAR schemes are likely to be injecting more than they are extracting, i.e., net injecting. Conversely, during drier periods, the availability of source water will be lower and MAR schemes may become net extractors. The impacts on groundwater (pressure) levels will be cumulative (where multiple schemes are operational in a single aquifer) and inversely proportional to distance, that is, fluctuations in water levels will be greater in areas closer to a MAR scheme.

5.2.1 Central Adelaide PWA

In 2020–21, licensed groundwater injections to the T1 aquifer of the Central Adelaide PWA total 598 ML, a 20% decrease from the previous year (Figure 5.2). MAR associated extraction from the T1 aquifer in 2020–21 is 710 ML, resulting in a net annual groundwater extraction of 112 ML. MAR operations in the T1 aquifer of the Central Adelaide PWA have resulted in a net annual extraction of groundwater every year since 2009–10, with a total net extraction in the order of 3,500 ML.

In 2020–21, injection to the T2 aquifer of the Central Adelaide PWA is 647 ML while extraction is 610 ML. Despite injection in the T2 aquifer being 14% lower than the previous year, MAR operations in the T2 aquifer of the Central Adelaide PWA result in a net injection of groundwater (as has been the case every year since 2010–11). The total volume of net injection since 2010–11, when operations commenced in this aquifer, is in the order of 2,000 ML.

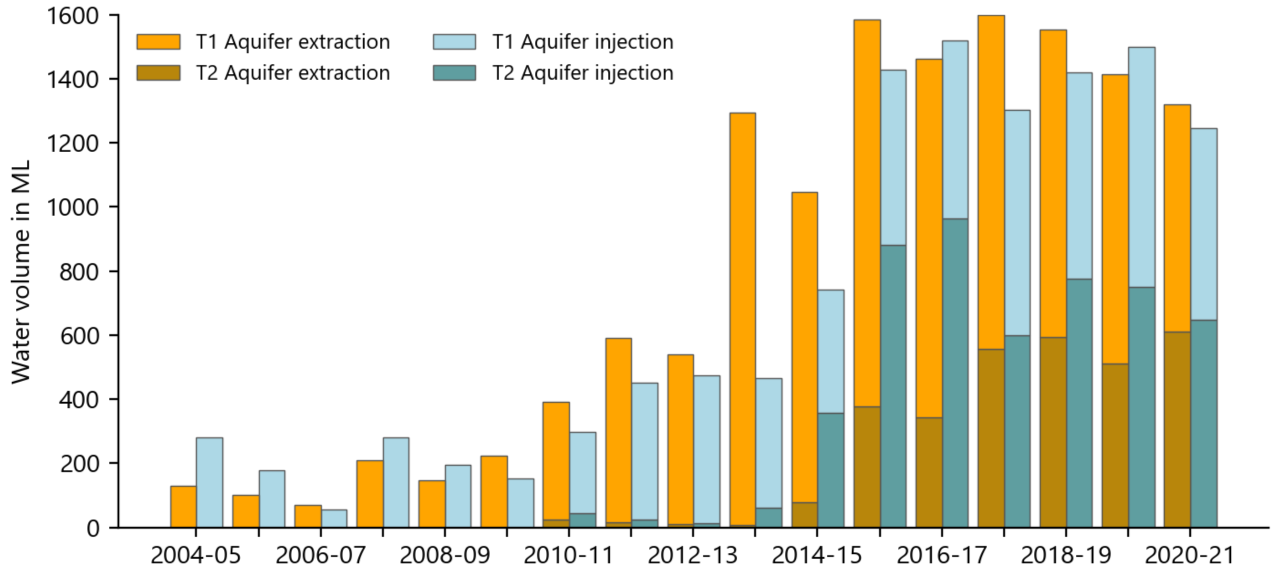

Figure 5.2 Metered water injection and extraction volumes for MAR schemes of the Central Adelaide PWA from 2004–05 to 2020-21

5.2.2 NAP PWA

In 2020–21, groundwater injection to the T1 aquifer of the NAP PWA is 281 ML; a 25% decrease from the previous year (Figure 5.3). Despite the decrease, injection exceeds extraction by 214 ML. Since operations began, MAR in the T1 aquifer of the NAP PWA has resulted in net injection of groundwater in most years; the cumulative total is over 4,000 ML.

In recent years, MAR injection and extraction volumes in the T2 aquifer have been an order of magnitude greater compared with those in the T1 aquifer. In 2020–21, groundwater injection to the T2 aquifer of the NAP PWA is 2,760 ML, which is also a decrease (12%) from the previous year's injection total. The net impact of MAR operations in the T2 aquifer of the NAP PWA is positive in 2020–21 (injection volume of 462 ML); the cumulative injection volume since operations began is over 12,000 ML.

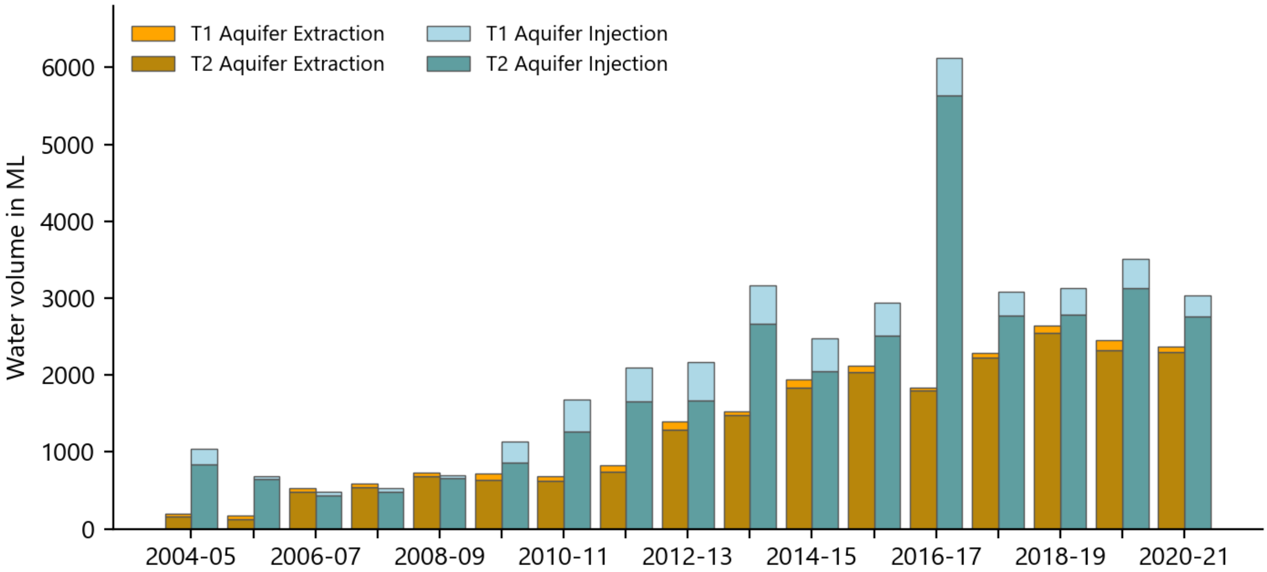

Figure 5.3 Metered water injection and extraction volumes for MAR schemes in the T1 and T2 aquifers of the NAP PWA from 2004–05 to 2020–21

6 References

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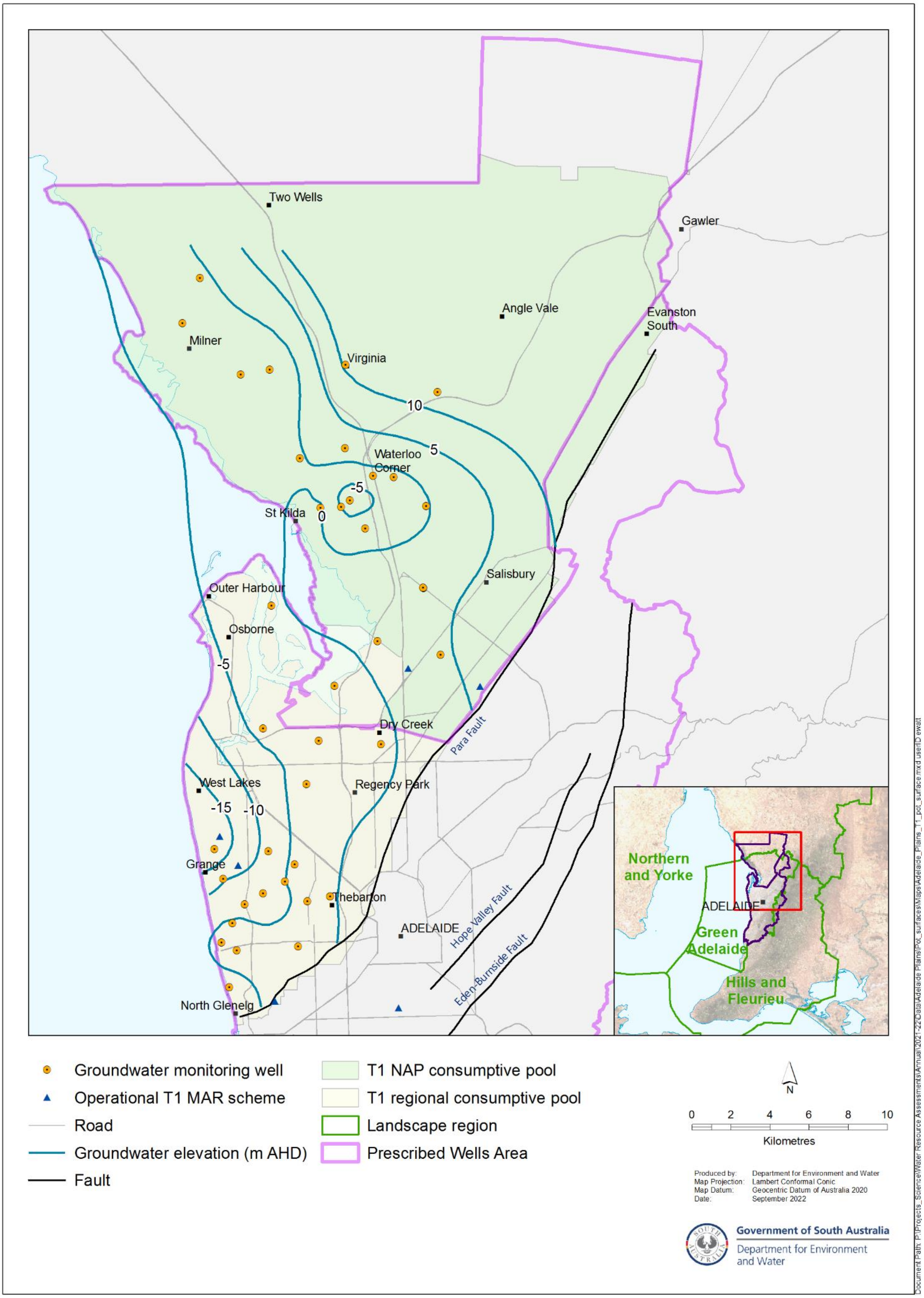
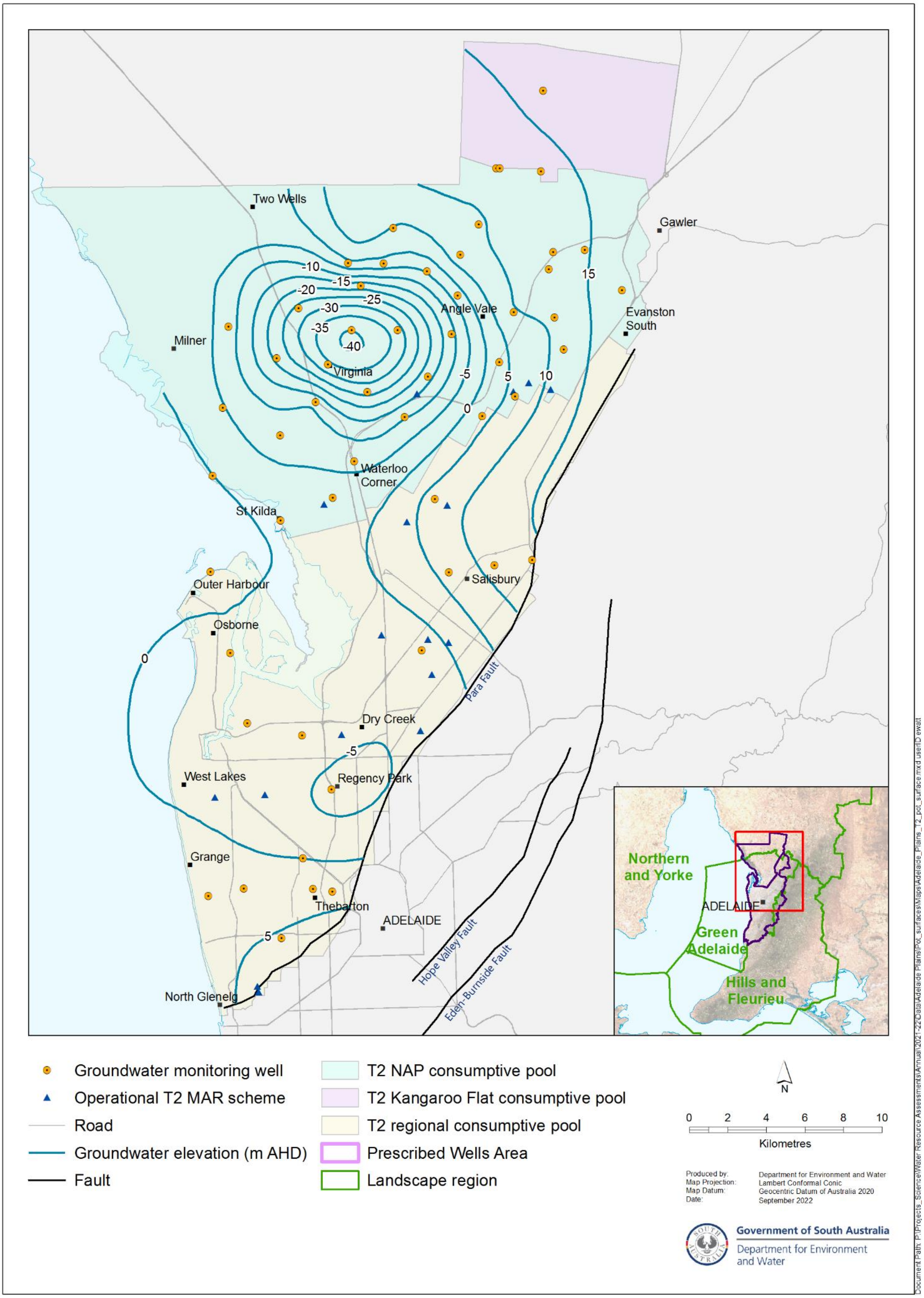
Appendix A

1. Potentiometric surface T1 aquifer February 2022.
2. Potentiometric surface T2 aquifer February 2022.



Appendix A-1 Potentiometric surface T1 aquifer February 2022



Appendix A-2 Potentiometric surface T2 aquifer February 2022

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