Far North Prescribed Wells Area 2018-19 water resources assessment

Department for Environment and Water
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DEW Technical report 2020/33

Government of South Australia
Department for Environment and Water

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81-95 Waymouth St, ADELAIDE SA 5000

Telephone +61 (8) 8463 6946

Facsimile +61 (8) 8463 6999

ABN 36702093234

www.environment.sa.gov.au

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Contents

1 Summary

Rainfall

- Rainfall across the region was lower than average in 2018–19. Rainfall at Marree in 2018–19 was 27 mm, 85% below average, while rainfall at Marla was 162 mm, 24% below average.
- Rainfall occurrence in the arid lands can be sporadic. Sometimes the region may go without significant rainfall for years, whilst the intensity of rainfall is highly variable with a single event capable of delivering average annual totals.

Groundwater

- Water levels in the GAB J-K aquifer monitoring wells were generally at average and above-average levels when compared to their respective long-term record, with the median ranked well at average levels.
- In the five years to 2019, 46% of monitoring wells recorded stable groundwater level trends; 26% recorded rising water level trends, and 28% recorded declining water level trends.
- Groundwater salinity was generally stable across the Far North PWA; 93% of wells display a stable trend.

Water use

- Water use for mining and petroleum purposes in 2018-19 was 4% greater than the previous water-use year and 42% higher than the long-term average.
- Groundwater extraction for stock and domestic purposes is not currently metered in the Far North 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, 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 the Far North Prescribed Wells Area (PWA) for 2018-19 and addresses groundwater data collected up until December 2019.

1.2 Regional context

The Far North PWA is located in the South Australian Arid Lands (SAAL) Landscape Region and is bounded in the north and east by the state borders with New South Wales, Queensland and the Northern Territory. The Far North PWA (FNPWA; Figure 1.1) is an administrative region within which groundwater has been prescribed under South Australia's Landscape SA Act 2019. Further, groundwater allocation and sustainable management of groundwater resources within the FNPWA is administered under the Far North Water Allocation Plan, adopted in 2009. Groundwater in the Far North PWA is vital for the success of the mining, petroleum, pastoral and tourism industries and the provision of community water supplies in the SAAL Landscape Region.

Groundwater in the Far North PWA is sourced predominately sourced from the Cadna-owie Formation and Algebuckina Sandstone (and lateral equivalents), which form a single hydrogeological unit known as the Jurassic-Cretaceous (J-K) aquifer. The J-K aquifer contains the largest and regionally most important groundwater resource within the FNPWA. Other groundwater resources in the PWA include:

- the shallow Quaternary and Tertiary sedimentary aquifers, including the Kati Thanda - Lake Eyre Basin.
- Palaeozoic sedimentary aquifers, including sandstones of the Winton and Mackunda Formations as well as minor sandstones in the Rolling Downs Group, such as the Coorikiana and Bellinger Sandstone.
- the underlying Permo-Carboniferous to Early Triassic sediments of the Cooper, Arckaringa and Pedirka basins
- the basement crystalline fractured rock aquifers.

These aquifer units are further described in Section 4. Detailed descriptions can be found in the references provided in Section 2.

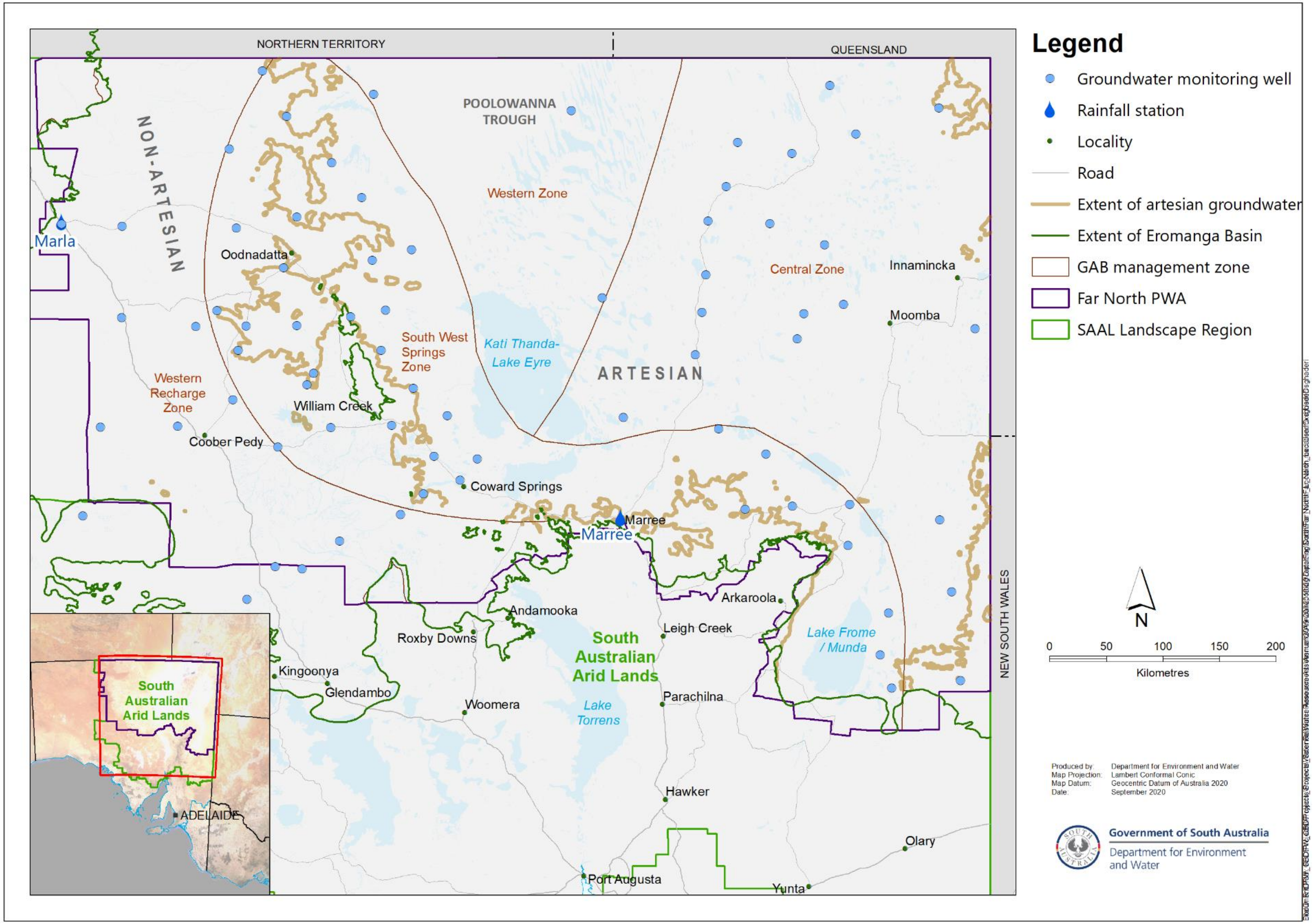

Figure 1.1 Location of Far North PWA

2 Methods and data

This section describes the source of rainfall, surface water, groundwater, and water use data presented in this report, and also 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 (Figure 3.1 and Figure 3.2).

2.2 Groundwater

2.2.1 Water level

Water level[1] data were obtained from wells in the Far North PWA monitoring network from manual observations taken every six months. The water level in non-artesian wells was measured by dipping tape, while the pressure level in artesian wells is measured through a shut-in pressure test. All available water level data were verified and anomalous data excluded. The mean water level for each calendar year, for each well, was calculated and used for further analysis.

For wells with at least three years of data, the mean annual water level was ranked and described according to their decile range[2] from lowest to highest on record (Table 2.1). For the most recent year, the number of wells in each decile range was then summarized 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 mean annual 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 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).

The artesian portion of the GAB is given a tolerance threshold based on the most recent water temperature for the well, as higher temperatures (correlated to higher pressure levels) can lead to higher measurement errors. A tolerance threshold of 20 cm/y is applied for artesian wells with water temperatures greater than 40 degrees Celsius; other artesian wells have a tolerance threshold of 10 cm/y applied, and non-artesian wells have a tolerance threshold of 2 cm/y applied.

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[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.

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 Bureau of Meteorology[3]

2.2.2 Salinity

Water samples are collected from monitoring wells located across the Far North PWAs from flowing artesian wells biannually. These samples are tested for electrical conductivity (EC) and the salinity (total dissolved solids measured in mg/L, abbreviated as TDS) is calculated. Where more than one water sample has been collected in the course of a year, the annual mean salinity is used for analysis. An example of the results is shown in Figure 4.4.

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).

Five-year salinity trends are calculated where there are at least five 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:

$$\text{Percentage change in salinity (\%)} = \frac{\text{Slope of linear trend line (mg/L/y)} * 5}{\text{Value of trend line at start of period (mg/L)}} * 100$$

If the percentage change is greater than 10% then the well is given a status of 'increasing' or 'decreasing' depending on how the salinity is changing, while if the absolute percentage change is less than 10% it is given a status of 'stable'. The latter is intended to reflect the fact that salinity measurements based on the measurement of the electrical conductivity of a water sample are often subject to small instrument errors. The number of increasing, decreasing and stable wells are then summarized in for each resource (e.g. Figure 4.5).

2.3 Water use

The water use information in Section 5 is based on metered extraction volumes where possible (i.e. for mining and petroleum purposes). Where meters are not installed (mainly stock and domestic uses), allocated volumes are reported instead.

[3] Bureau of Meteorology Annual climate statement 2019

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 of the Far North PWA are:

- Summary reports on the groundwater resources of the Far North PWA and annual groundwater level and salinity status reports (*Water Resource Assessments* page on WaterConnect).
- The Water Allocation Plan for the Far North PWA (SAAL NRM Board, 2009).
- Far North PWA Groundwater Level and Salinity Status Report (DFW 2011).
- Hydrogeological Framework of the Western Great Artesian Basin (Keppel et al. 2013).
- Groundwater recharge, hydrodynamics and hydrochemistry of the Western GAB (Love et al. 2013).
- Groundwater-dependent ecosystems (Gotch, 2013).

3 Rainfall

The local rainfall within the Far North PWA has very little influence on groundwater pressure levels as the aquifer is confined. Rainfall occurrence and intensity is episodic, sometimes without significant rainfall for years, while intense rainfall can deliver annual amounts in a single event. Rainfall is generally less than 250 mm per year. However, rainfall in the arid areas of the state is highly variable and consequently, averages can be misleading. Average annual evaporation is extremely high, ranging from 2400 to over 3700 mm, significantly exceeding rainfall and resulting in the rapid evaporation of surface water runoff.

Long-term annual rainfall (1970-2019) from a selection of rainfall stations in the Far North PWA varies from 164 mm at Coober Pedy in the south-west of the area to 213 mm at Marla in the north-west of the PWA. During 2018-19, rainfall was appreciably lower than the long-term average with rainfall varying from 27 mm at Marree to 162 mm at Marla.

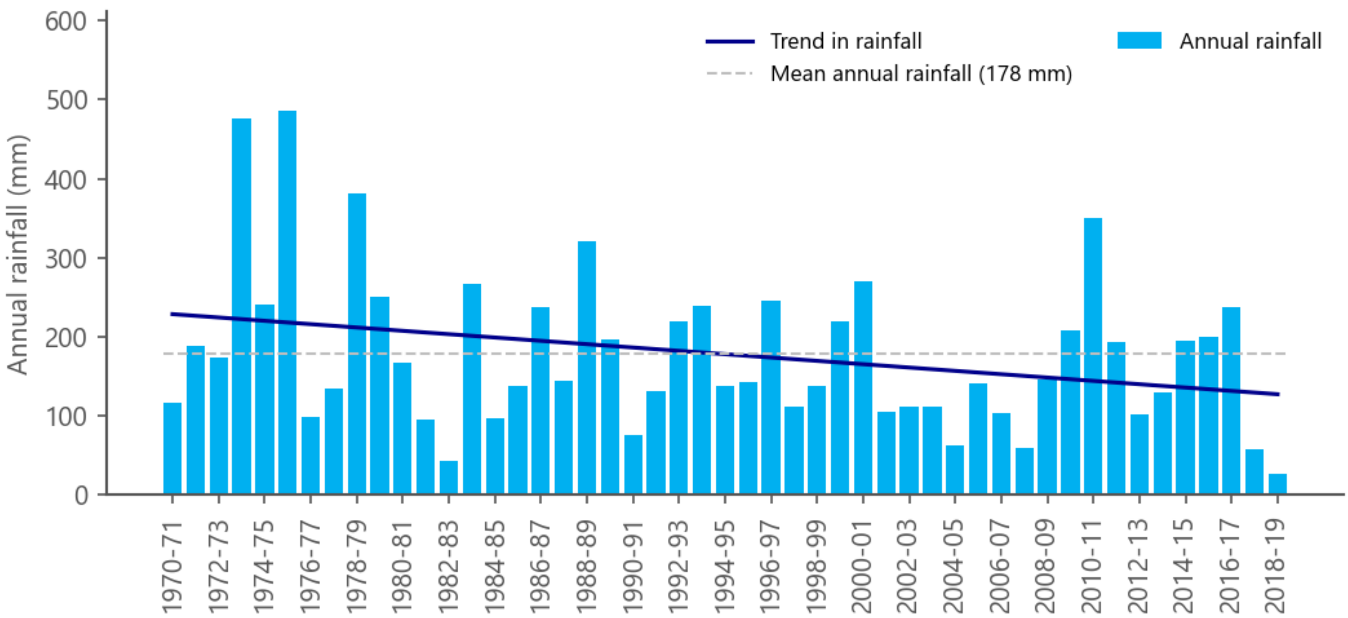

Figure 3.1 Annual rainfall from 1970-71 to 2018-19 at the Maree rainfall station (17031)

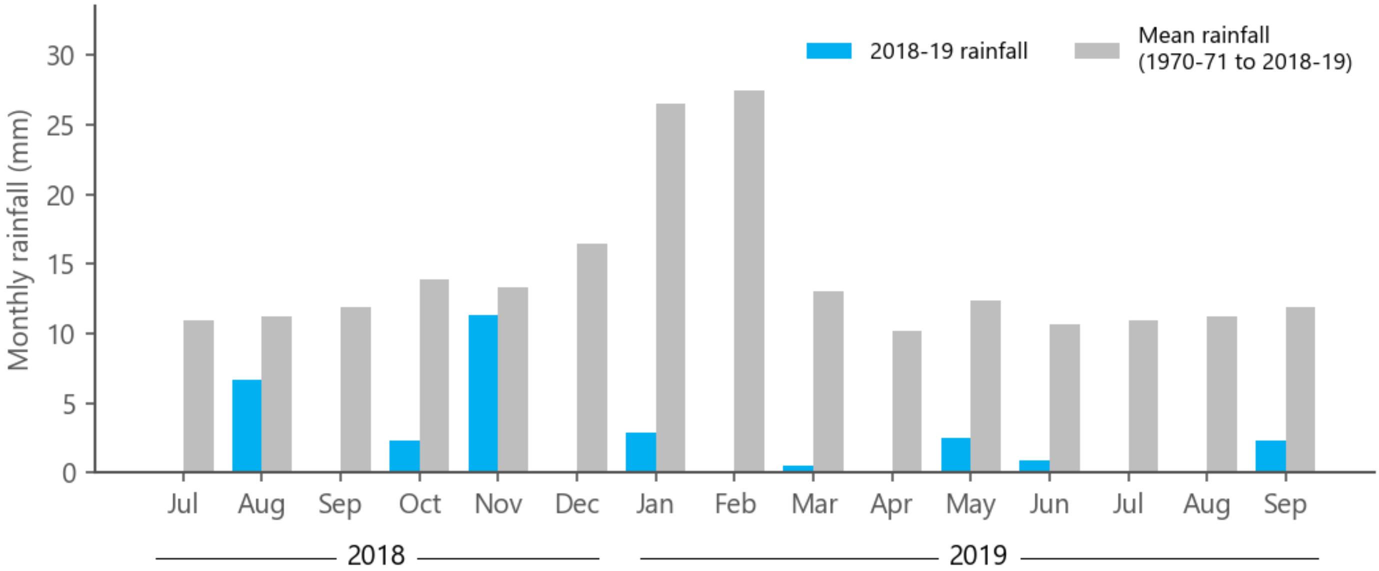

Figure 3.2 Monthly rainfall between July 2018 and September 2019, compared to the long-term monthly average at the Maree rainfall station (17031)

- The Marree rainfall station (BoM station 17031) is located at the township of Marree (Figure 1.1) and demonstrates historical rainfall conditions in the southern part of the PWA. In 2018-19, annual rainfall was 27.1 mm, noticeably less than the long-term (1979-80 to 2018-19) average of 178 mm (Figure 3.1).
- The long-term rainfall trend over this period has been declining.
- In 2018-19, below-average rainfall was observed in all seasons at Marree (Figure 3.2).

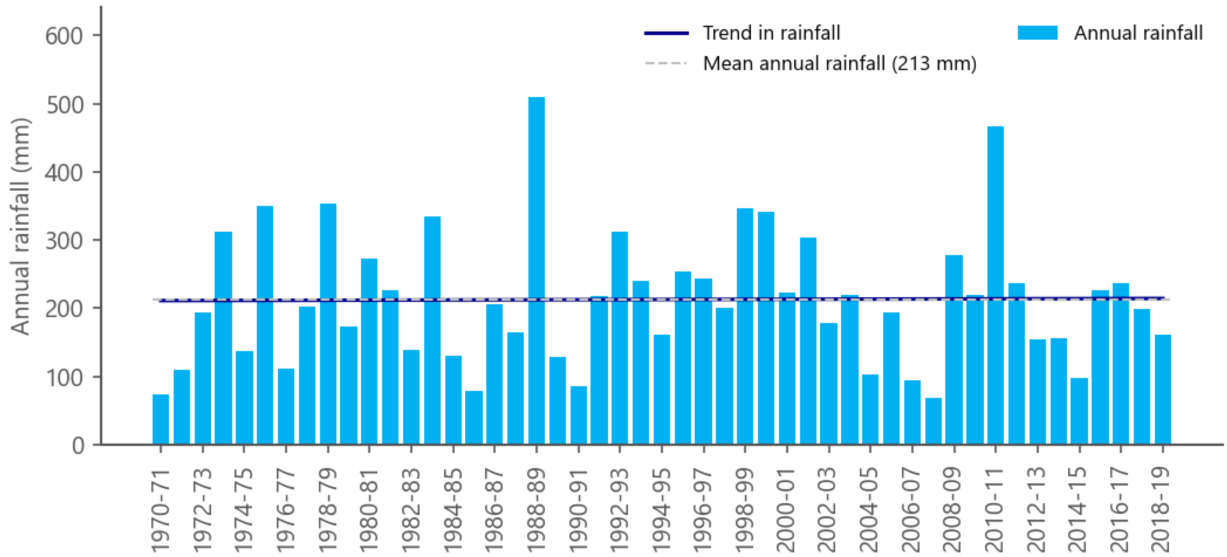

Figure 3.3 Annual rainfall from 1970-71 to 2018-19 at the Marla rainfall station (16085)

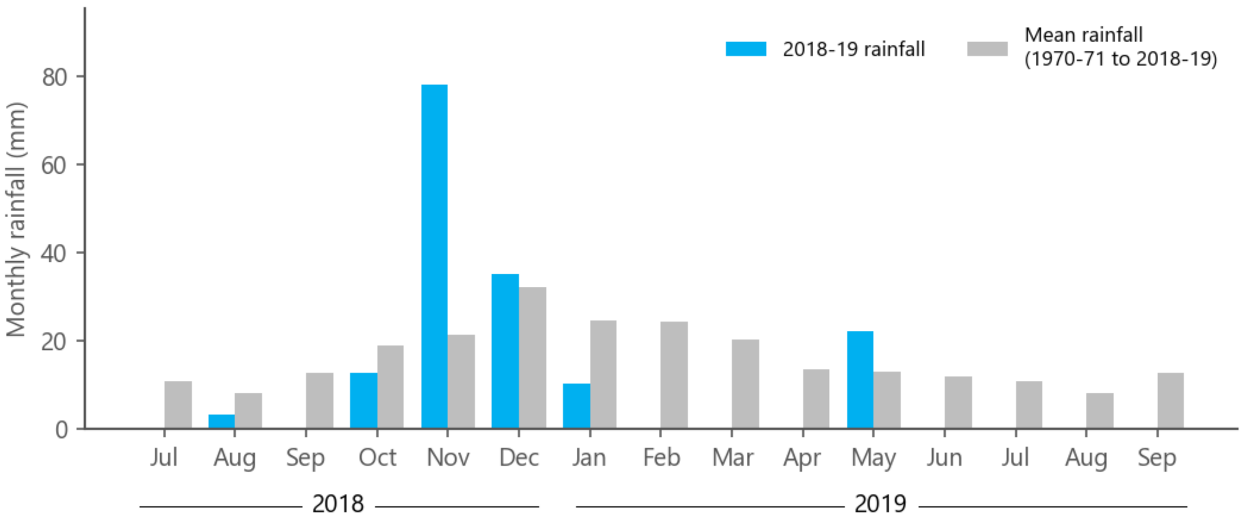

Figure 3.4 Monthly rainfall between July 2018 and September 2019 at the Marla rainfall station (16085)

- The Marla rainfall station (BoM station 16085) is situated at the township of Marla and provides a representative record of rainfall occurring in the north-west of the PWA where the J-K aquifer is non-artesian. The annual rainfall total for 2018-19 was 162 mm, 51 mm less than the long-term average rainfall at Marla between 1970-71 and 2018-19 (Figure 3.3).
- Marla station has observed a stable rainfall trend over the long-term record (1970-71 to 2018-19).
- Apart from wet conditions in late spring-early summer (2018) and May 2019, drier than average conditions were recorded in 2018-19 at Marla station compared to the long-term average (Figure 3.4).

4 Groundwater

4.1 Hydrogeology

The Great Artesian Basin (GAB) is a Jurassic to Cretaceous-aged super-basin containing non-marine and marine sediments that covers approximately one-fifth of the Australian continent (Krieg et al, 1995). The GAB predominantly comprises the Eromanga, Surat and Carpentaria Basins. In South Australia, the GAB is composed largely of Eromanga Basin sediments that vary in thickness from less than 100 m on the margins of the basin to over 3000 m in the north-east of the State within the basin depocentres.

Within the GAB, the Cadna-owie Formation, Algebuckina Sandstone and lateral equivalents form the major water-bearing aquifer system (hereafter referred to as the J-K aquifer). Depth to the J-K aquifer is as much as 2400 m in the State's north-east but rapidly decreases westwards with the aquifer cropping out along the western margin (Figure 1.1).

Groundwater in the Far North PWA is predominately sourced from the J-K aquifer, whose thickness ranges from less than 50 m around the basin's western margin to greater than 500 m near the Poolowanna Trough (Figure 1.1). For this reason, all groundwater data presented in this report relates to the J-K aquifer unless otherwise stated. The majority of wells completed in the J-K aquifer within the Far North PWA are flowing artesian wells.

Recharge to the J-K aquifer in South Australia primarily occurs through lateral in-flow from Queensland, New South Wales and the Northern Territory. For the western margin of the J-K aquifer, some recharge occurs through flooding of ephemeral rivers in South Australia and the Northern Territory, although this was likely to be higher magnitude under past climatic conditions.

4.2 GAB J-K aquifer - water level

In 2019, nearly half (44%) of J-K aquifer monitoring wells recorded average water levels when compared to their respective water level record. A total of seven wells recorded their lowest level on record and these wells are primarily located in the Central Zone (Figure 4.1), with four wells located in the western part of the basin recording their highest levels on record.

Five-year trends in water levels are variable, with many wells showing a stable trend (46%), and almost as many wells showing rising (26%) and declining (28%) trends. Rates range from a decline of 4.09 m/y to a rise of 1.79 m/y (the median change is 0.00 m/y) (Figure 4.2).

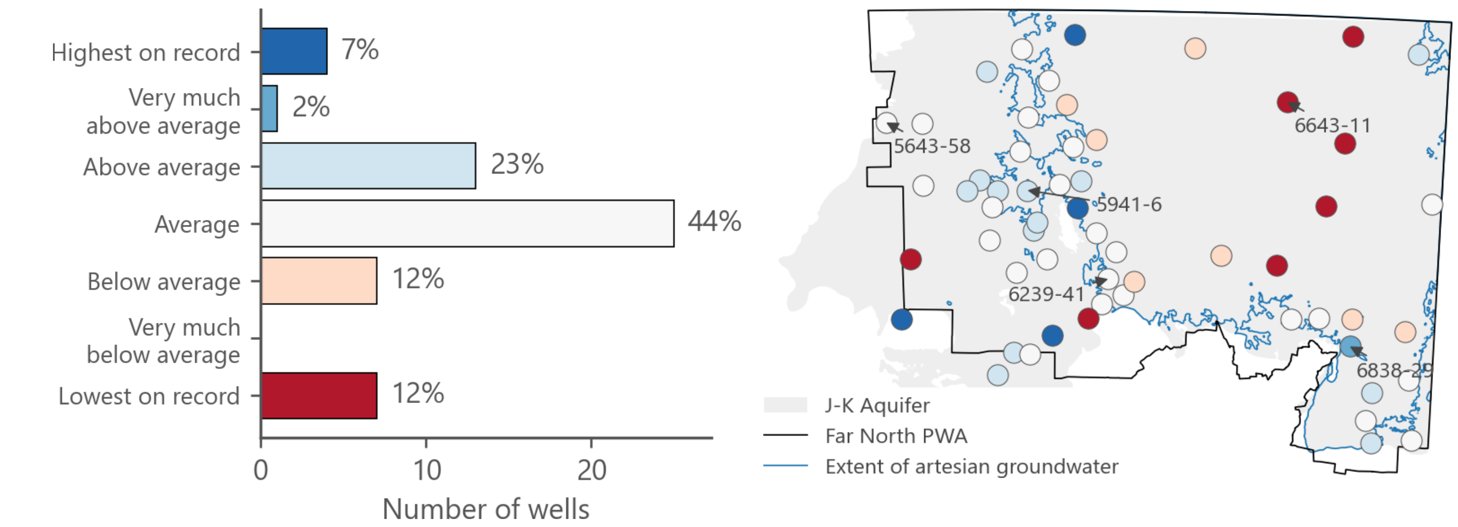

Figure 4.1 2019 recovered water levels for wells in the GAB J-K aquifer

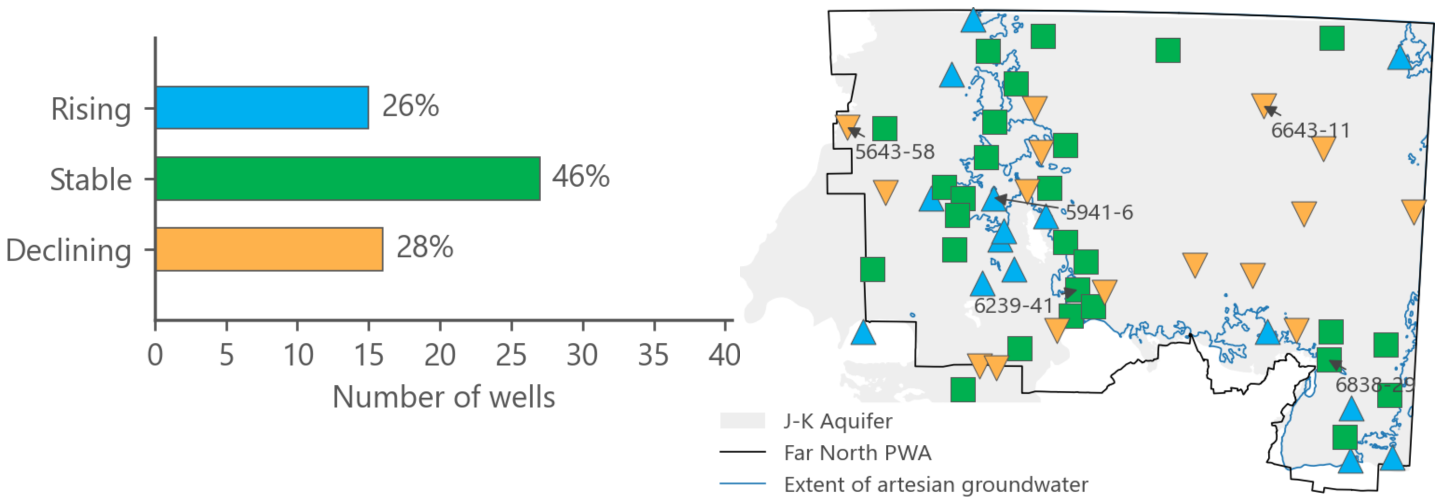

Figure 4.2 2015-2019 trend in recovered water levels for wells in the GAB J-K aquifer

Figure 4.3 shows representative hydrographs from a selection of J-K monitoring wells. Monitoring well 5643-58 is located at Marla where the aquifer is confined but not artesian. The groundwater level experienced a sudden rise in 1989 which could be due to an extreme rainfall event in 1988-89 (Figure 3.3). Groundwater levels remained relatively stable from 2000 to 2019 with a slight declining trend of 0.03 m/y over the past five years. 6239-41 (Strangways Bore 2) is located to the southeast of William Creek and shows a gradual rise since 1996 which may be due to decommissioning of the original flowing well (6239-1, Strangeways Bore 1) at this location in 1993.

6838-29 (Woolatchi Bore) in the south-eastern region, and 5941-6 (Fergy's Bore) south of Oodnadatta recorded rising trends in the 1990s-early 2000, possibly associated with artesian well rehabilitation work that occurred at these sites in 1994 and the late 1980s, respectively.

6643-11 is located at Goyder's Lagoon to the north of the PWA. It shows a declining trend since the late 1980s. Although the water level observed in 2019 was the lowest on record, historical data suggest that the water level was at a considerably lower level in 1940 due to uncontrolled flowing of the well such that a non-artesian condition was experienced.

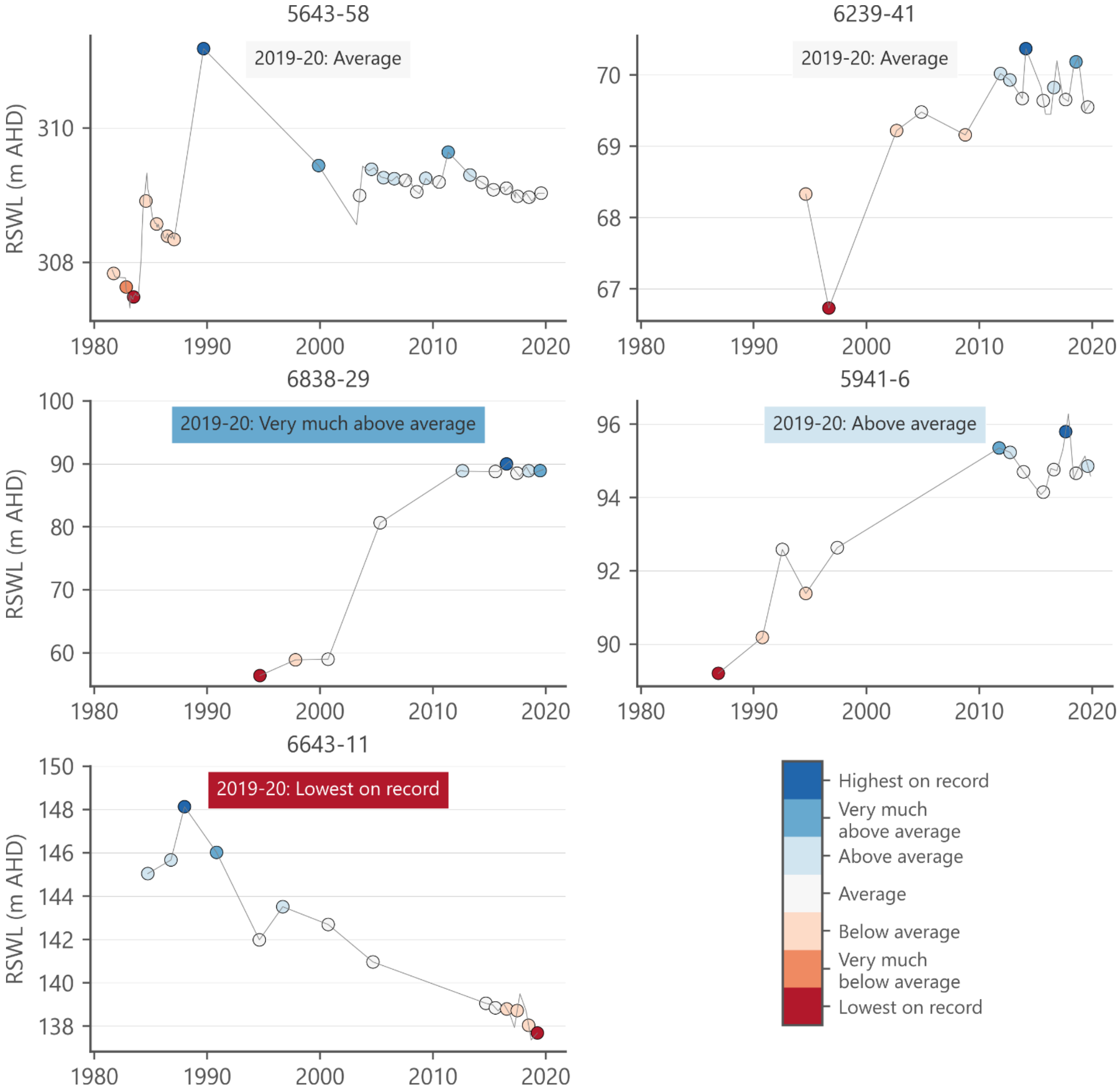

Figure 4.3 Selected GAB J-K aquifer hydrographs

4.3 GAB J-K aquifer - salinity

In 2019, results from 50 wells in the GAB J-K aquifer show groundwater salinity varies from 507 to 5243 mg/L, with a median of 1884 mg/L. The lower salinities are generally in the Central Zone management area in the eastern part of the PWA (Figure 4.4).

For the five-year period between 2015 and 2019, salinity of the J-K aquifer was predominantly stable (Figure 4.5).

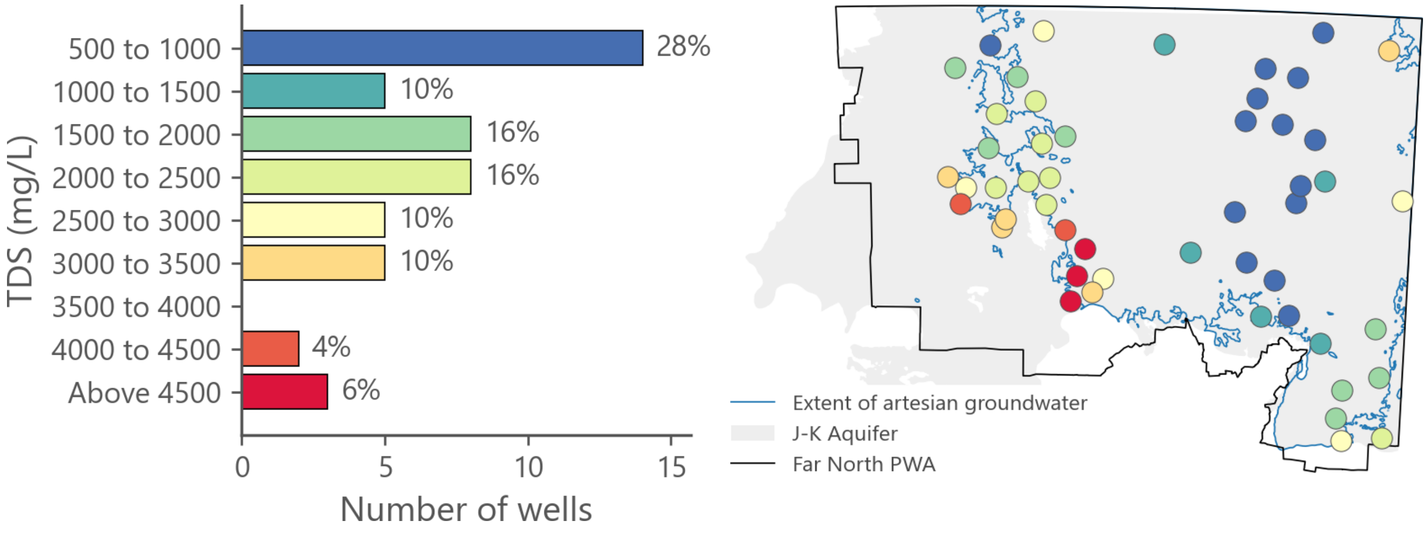

Figure 4.4 2019 salinity observations from wells in the GAB J-K aquifer

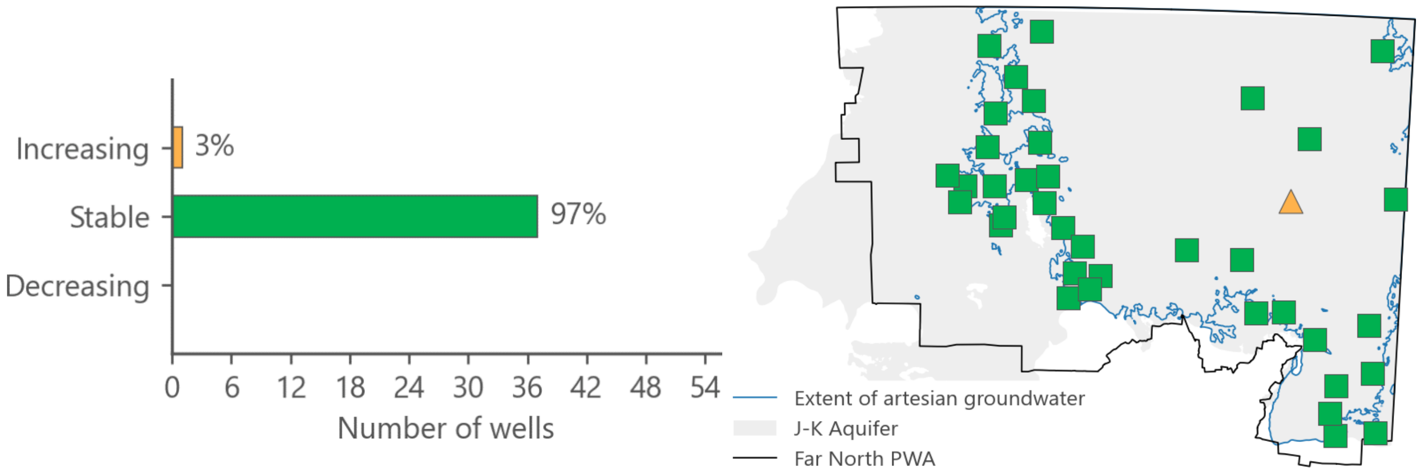

Figure 4.5 2015-2019 trend in groundwater salinities for wells in the GAB J-K aquifer

5 Water use

The Great Artesian Basin provides most (~75%) of the groundwater supplies in the Far North PWA, although there is also significant groundwater extraction from other aquifers including the underlying Arckaringa Basin and the overlying Kati Thanda-Lake Eyre Basins.

Within the Far North PWA, groundwater is predominantly extracted for mining, petroleum and stock and domestic purposes. Groundwater extractions is generally metered only for mining, petroleum and town water supply purposes. Groundwater extraction for stock, domestic and other purposes are not currently metered in the Far North PWA. Groundwater extractions for mining and petroleum purposes totalled 30 621 ML for 2018-19 (Figure 5.1), an increase in extraction of 1149 ML from the preceding water-use year and 9059 ML higher than the twenty-year average annual volume of groundwater extraction (21 562 ML). Despite the increase, groundwater extractions are still within current licenced allocations.

Allocated volumes across the Far North PWA in 2018-19 for other purposes are:

- 10719 ML of groundwater is allocated for stock and domestic purposes.
- 630 ML of groundwater is allocated for town water supply purposes.
- 3083 ML of groundwater is allocated for amenities and camp water purposes.
- 2754 ML of groundwater is allocated for other purposes.

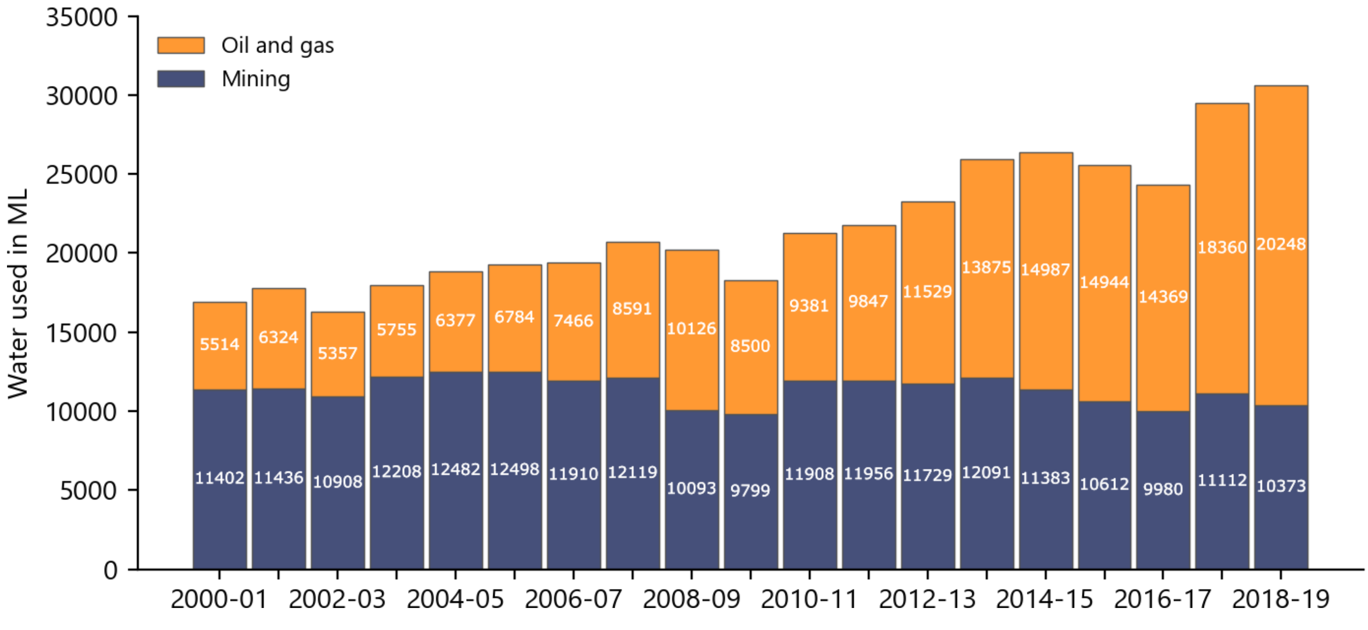

Figure 5.1 Water extraction for mining and petroleum from 2000–01 to 2018–19 in the Far North PWA

6 References

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