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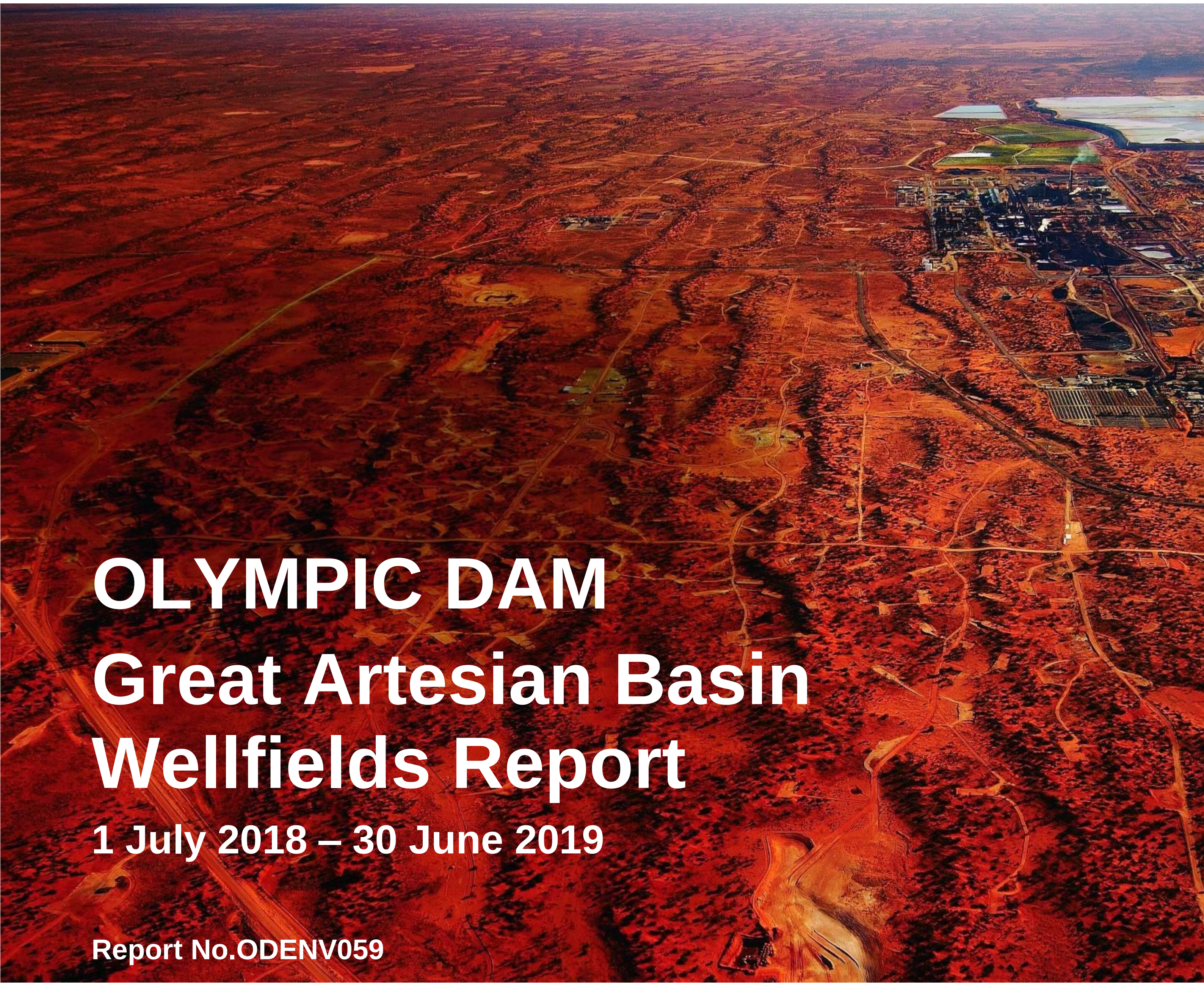

OLYMPIC DAM
Great Artesian Basin Wellfields Report

1 July 2018 – 30 June 2019

Report No.ODENV059

OLYMPIC DAM

GREAT ARTESIAN BASIN WELLFIELDS REPORT

1 JULY 2018- 30 JUNE 2019

The Hon. Dan Van Holst Pellekaan, MP
Minister for Energy and Mining
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1 EXECUTIVE SUMMARY

The Wellfields Report is prepared annually in accordance with the conditions of the Roxby Downs (Indenture Ratification) Act 1982, and the Olympic Dam and Stuart Shelf Indenture (the Indenture) ratified by that Act. This report presents data that relates to the operation of the BHP Olympic Dam Great Artesian Basin water supply Wellfields A and B for the FY19 period 1 July 2018 to 30 June 2019.

1.1 Abstraction

The average abstraction of Olympic Dam during FY19 was 28.4 ML/d comprising 4.5 ML/d from Wellfield A and 23.9 ML/d from Wellfield B, representing 12% increase for Wellfield A and a 0.5% increase for Wellfield B compared with FY18. Monthly total abstraction rates were variable, ranging from 13.6 to 36.5 ML/d, with lowest total abstraction in September 2018 and the highest in January 2019.

Total estimated abstraction from the wellfields area, including Olympic Dam sources and pastoral wells in FY19 is estimated at 43.4 ML/d.

1.2 Wellfield A

Overall drawdown decreased in the vicinity of Wellfield A and the North East Hydrogeological Zones. Drawdown remained stable in the South West Hydrogeological Zone.

In FY19, average drawdown between sites GAB8 and HH2 was 1.35 m, which is less than the 4 m compliance criteria. The hydraulic gradient between North East Sub Basin bores and HH2 remained at 0.0009 m/m which is equal to the leading indicator and continues the stable trend seen since 2000.

1.3 Wellfield B

For Wellfield B, the drawdown pattern in FY19 is similar to that of earlier reports, consistent with a confined aquifer response to a wellfield that has operated for some 20 years.

The area contained within the 10 m drawdown footprint for Wellfield B is 2,294 km^2, well within the 4,450 km^2 compliance criterion. The average drawdown at monitoring bores S1 and S2 (dedicated monitoring wells closest to key GAB springs) is 1.5 m, which is less than the 4 m drawdown compliance criterion. In general, drawdown and percentage wellhead pressure loss at pastoral bores remained less than the predicted long-term impact (as presented in the Environmental Impact Statement; Kinhill Engineers, 1997 – updated Golder Associates 2016).

1.4 Spring Flow

Spring flows decreased slightly in the Wellfield A, Western Lake Eyre South and South Eastern Hydrogeological zones and increased in the South West and North Eastern Hydrogeological Zones. Reductions in GAB spring discharges remained less than the predicted long-term impact (as presented in the Environmental Impact Statement; Kinhill Engineers, 1997 – updated Golder Associates 2016).

Spring electrical conductivity data indicate no significant change from previously identified trends.

1.5 Monitoring Data

Monitoring of GAB bores and springs was conducted as per the Monitoring Program – Great Artesian Basin (GAB) 2017 (BHP , 2018a). A summary of compliance to monitoring plan is presented in Appendix 1.

2 INTRODUCTION

2.1 Scope

This report is produced in accordance with the conditions of the Roxby Downs (Indenture Ratification) Act 1982, and the Olympic Dam and Stuart Shelf Indenture (**Indenture**) ratified by that Act.

The Indenture states that an annual hydrogeological report shall be prepared to define the following:

- Aquifer response to wellfields operation.
- Ability of the resource to maintain the supply.
- Strategy for future abstraction and management.
- Requirements for further exploration or development.

Data presented relate to the operation of the BHP Olympic Dam Corporation Pty Ltd (**ODC**) Great Artesian Basin (**GAB**) water supply wellfields A and B, for FY19. The objectives are to:

- Meet the requirements of Clause 13 of the Indenture;
- Report total abstraction and individual well abstraction on a monthly basis.
- Report water pressure and levels in monitoring and production wells and at the boundary of Designated Areas.
- Report water quality at monitoring and production wells on a quarterly basis.
- Compare actual impacts to predictions in the Environmental Impact Statement (EIS) by Kinhill Engineers, 1997 (updated Golder Associates 2016). Ensure that impacts are within predictions and expectations.
- Evaluate drawdown response of the aquifer to ODC abstraction, particularly within the Designated Areas of both wellfields.
- Delineate the drawdown induced by the wellfields, and particularly the impact on pastoral water supplies and environmental flows.
- Identify possible changes in water chemistry that may occur.
- Assess compliance with legal requirements for the operation of the GAB water supply.

2.2 Background

Water used at Olympic Dam and the Roxby Downs Township is pumped from two wellfields located within the GAB. Wellfield A is located 100 km north of the operation at the southwest margin of the GAB. Wellfield B is located an additional 80 km to the northeast of Wellfield A, further into the basin.

The local hydrogeology has been previously described by WMC during investigations for the establishment of Wellfield B (WMC, 1995). Wellfield A is located at the margin of the GAB, where there is a relatively complicated basin architecture and strong influence of aquifer boundary effects. There are separate hydrogeological domains with distinctively different responses to the Wellfield A abstraction. The distribution of the aquifer is strongly influenced by both the depositional setting of the aquifer sediments and post-depositional faulting, which has formed sub-basins that are hydraulically separated. Wellfield B is located further into the basin where the aquifer is much thicker, aquifer zonation is less marked and the effects of faulting greatly reduced. The drawdown around Wellfield B is more radially symmetrical that from Wellfield A.

A detailed description of the physical environment of the wellfields is contained in the Draft EIS (Kinhill-Stearns Roger, 1982) and the Survey and Assessment Report (Kinhill Engineers, 1995). Wellfield construction details are contained in 'Wellfield A Construction' (AGC, 1987) and 'Borefield B Development' (WMC, 1997) and related documents.

3 MONITORING PROGRAM

A full and detailed description of monitoring sites, frequency, priorities and methodologies is maintained in the Monitoring Program – Great Artesian Basin (GAB) 2017 (BHP , 2018a).

4 ABSTRACTION

4.1 Development History

Trends in long-term abstraction (Table 4-1, Figure 4-1 and Figure 4-2) can be summarised as follows:

- Abstraction from Wellfield A commenced in July 1983 and remained uniform at 1.3 ML/d until December 1986.
- Through 1987 and 1988 there was a gradual increase to approximately 10 ML/d, associated with construction and increase of mill production to 45,000 t/yr copper.
- Abstraction continued at approximately 10 ML/d from 1989 until 1992.
- From 1992 to 1995 abstraction was approximately 12 ML/d following the first optimisation at Olympic Dam and an increase in production to 66,000 t/yr copper.
- From 1995 to September 1996 Wellfield A abstraction was typically 14–16 ML/d, following a second optimisation which saw production rise to 85,000 t/yr copper.
- Wellfield B came on line in October 1996, and since this time abstraction from Wellfield A has typically been at approximately 5 ML/d.
- Wellfield B abstraction rose continuously from 4 ML/d in October 1996 to 12 ML/d in November 1998, with total abstraction remaining at approximately 16 ML/d.
- From December 1998 to October 1999 total abstraction rose to 30 ML/d as copper production was ramped up to the full capacity of the mine and processing plant.
- During FY00 to FY09 a reasonably stable abstraction pattern developed. Average total abstraction over the 9 year period was 32.3 ML/d, comprising 27.0 ML/d from Wellfield B and 5.3 ML/d from Wellfield A. Rates varied seasonally between 27–37 ML/d, with typical rates of 3–6 ML/d from Wellfield A and 22–32 ML/d from Wellfield B. Higher abstraction rates generally occurred during summer months.
- During FY10 abstraction fell dramatically due to the failure of the main ore haulage shaft (Clark Shaft) in October 2009 and the subsequent reduction in processing in the hydrometallurgical plant. Abstraction for the 12 months averaged 21.9 ML/d comprising 2.3 ML/d from Wellfield A and 19.6 ML/d from Wellfield B.
- From FY11 to FY14 total abstraction increased to pre-October 2009 levels and averaged 33.2 ML/d total (5.8 ML/d from Wellfield A and 27.4 Ml/d from Wellfield B).
- In FY15 average abstraction decreased to 28.8 ML/d due to the failure of the Svedala Mill and subsequent reduction in ore processing.
- In FY18 average abstraction decreased to 27.7 ML/d due to the planned SCM17 smelter campaign shutdown.
- In FY19 average abstraction increased slightly to 28.4 ML/d but was affected by the acid plant outage between August to October 2018.

4.2 Olympic Dam Abstraction during the Current Review Period

The average abstraction during FY19 was 28.4 ML/d comprising 4.5 ML/d from Wellfield A and 23.9 ML/d from Wellfield B, representing 12% increase for Wellfield A and a 0.5% increase for Wellfield B compared with FY18 (Table 4-1).

Monthly total abstraction rates were variable, ranging from 13.6 to 36.5 ML/d, with lowest total abstraction in September 2018 and the highest in January 2019 (Table 4-2).

4.3 Total Abstraction

Flow rate from 29 important pastoral bores in the wellfields area, where variation in flow rate could produce short-term impacts on regional monitoring, is measured or estimated at the end of the review period. Pastoral abstractions from those 29 bores and those from Wellfields A and B are shown in Figure 4-2.

Total abstraction from the wellfields area, including ODC wellfields and the 29 pastoral bores rose from approximately 40 ML/d in 1995 to 60–70 ML/d in 2000–01 and subsequently declined to 45-50 ML/d since 2010 (Figure 4-2). Total abstraction from the wellfields area in FY19 is estimated at 43.4 ML/d due to reduced ODC abstraction.

Pastoral flows have declined due to the significant bore closure program ODC has implemented since 2000. Water savings of approximately 42 ML/d have been achieved through the sponsored closure of free flowing pastoral wells in the ODC wellfield area.

Table 4-1 Wellfields average annual daily abstraction rate in ML/d

Year Ended	Wellfield A	Wellfield B	Total
30-Jun-1986	1.3	0.0	1.3
30-Jun-1987	2.2	0.0	2.2
30-Jun-1988	4.4	0.0	4.4
30-Jun-1989	8.9	0.0	8.9
30-Jun-1990	10.0	0.0	10.0
30-Jun-1991	10.6	0.0	10.6
30-Jun-1992	11.6	0.0	11.6
30-Jun-1993	12.6	0.0	12.6
30-Jun-1994	12.1	0.0	12.1
30-Jun-1995	13.5	0.0	13.5
30-Jun-1996	15.1	0.0	15.1
30-Jun-1997	8.2	7.4	15.6
30-Jun-1998	5.3	12.3	17.6
30-Jun-1999	4.9	17.3	22.1
30-Jun-2000	5.2	26.2	31.4
30-Jun-2001	6.1	25.5	31.5
30-Jun-2002	6.0	24.7	30.7
30-Jun-2003	6.1	25.3	31.4
30-Jun-2004	5.4	26.0	31.4
30-Jun-2005	5.9	28.1	34.0
30-Jun-2006	4.9	29.4	34.3
30-Jun-2007	4.5	27.9	32.5
30-Jun-2008	4.3	29.1	33.5
30-Jun-2009	4.6	27.8	32.4
30-Jun-2010	2.3	19.6	21.9
30-Jun-2011	5.8	27.4	33.2
30-Jun-2012	4.1	28.2	32.3
30-Jun-2013	4.5	27.9	32.4
30-Jun-2014	5.2	27.8	33.0
30-Jun-2015	4.9	23.9	28.8
30-Jun-2016	4.5	26.9	31.4
30-Jun-2017	4.0	25.2	29.2
30-Jun-2018	4.0	23.7	27.7
30-Jun-2019	4.5	23.9	28.4

Table 4-2 Monthly average abstraction rate (ML/d), FY19

	Wellfield A							Wellfield B				Wellfields
	GAB06	GAB12	GAB14	GAB15	GAB16	GAB18	Total	GAB51	GAB52	GAB53	Total	Total
Jul-18	0.50	0.19	0.59	0.00	0.58	0.55	2.42	10.44	8.54	9.35	28.32	30.74
Aug-18	0.27	0.05	0.14	0.00	0.82	0.50	1.77	4.99	4.24	3.62	12.85	14.62
Sep-18	0.00	0.00	1.12	0.00	0.01	0.00	1.12	5.05	2.98	4.50	12.53	13.65
Oct-18	0.34	0.34	1.59	0.00	0.59	0.28	3.14	4.62	3.89	4.35	12.86	16.00
Nov-18	0.07	0.36	2.15	0.00	2.92	2.06	7.56	9.54	7.67	8.25	25.46	33.01
Dec-18	0.06	0.55	0.75	0.00	2.19	1.83	5.39	11.57	9.31	10.09	30.97	36.36
Jan-19	0.17	2.81	0.00	0.00	0.20	2.33	5.50	11.61	9.35	10.07	31.02	36.52
Feb-19	0.14	2.13	0.00	0.00	0.63	2.23	5.14	10.98	8.62	9.32	28.93	34.06
Mar-19	0.10	1.54	0.51	0.00	1.39	2.01	5.55	10.33	8.11	8.86	27.30	32.85
Apr-19	0.11	1.33	2.14	0.00	0.67	2.04	6.29	10.00	7.94	8.59	26.53	32.82
May-19	0.34	0.05	1.44	0.00	1.49	1.69	5.00	8.46	6.71	7.31	22.49	27.50
Jun-19	0.45	0.04	1.29	0.00	2.52	0.94	5.24	10.32	8.24	9.02	27.57	32.81
Average	0.21	0.78	0.98	0.00	1.17	1.37	4.50	8.98	7.13	7.77	23.87	28.37
Total ML	77.9	283.2	356.4	0.0	426.1	498.6	1642.2	3276.9	2601.1	2835.0	8713.0	10355.2

Note:

- Sum of individual rows may not exactly match the totals due to rounding

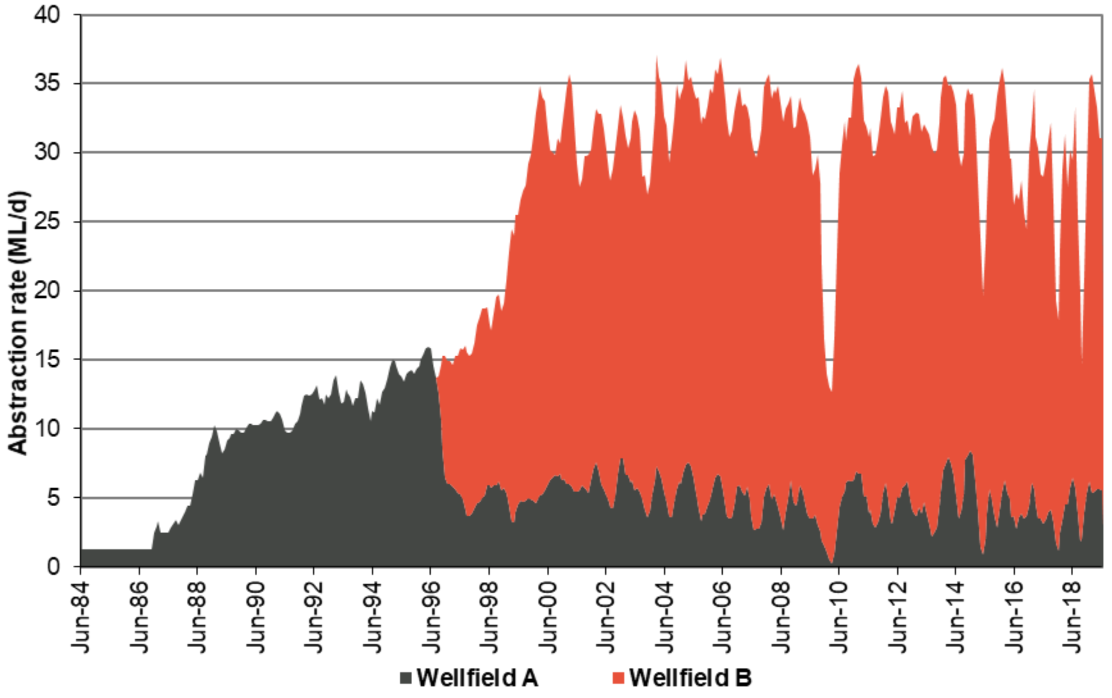


Figure 4-1 Historical abstraction from Wellfields A and B – 3 month moving average

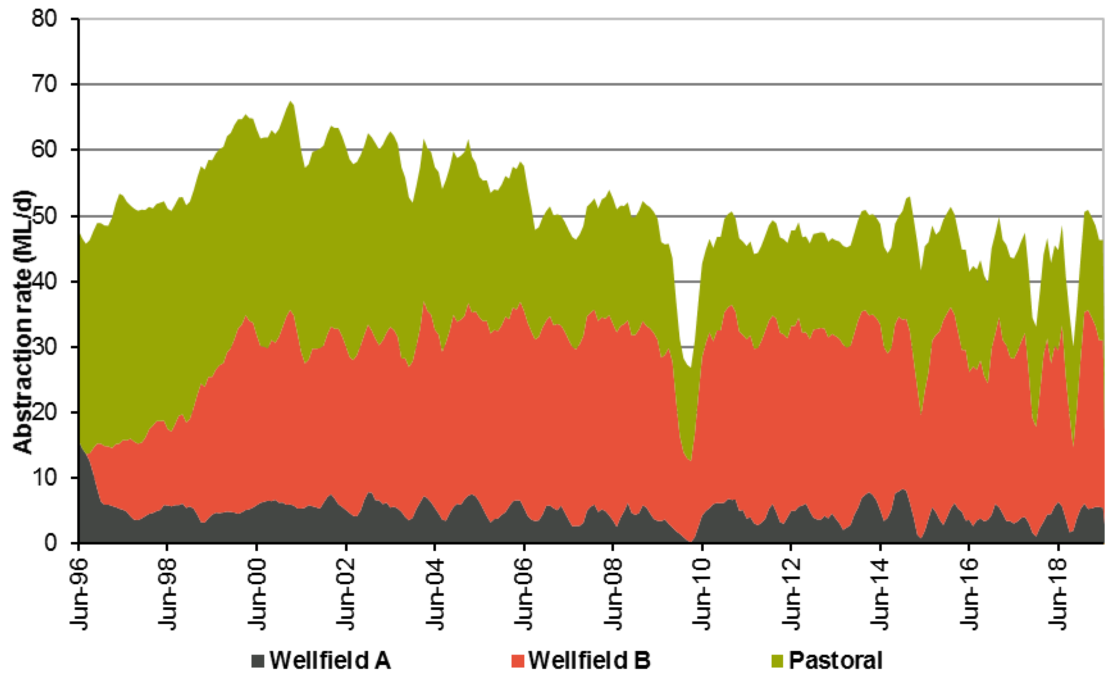


Figure 4-2 Historical abstraction from the Wellfields area – 3 month moving average

- See Appendix 7 for list of pastoral bores used to estimate pastoral GAB abstraction

5 WELLFIELD A AQUIFER PRESSURE RESPONSE

For the purposes of compliance, Wellfield A drawdown is measured in relation to reference heads established in May 1986 and, for monitoring bores MB1, MB5 and MB6, as a difference between contemporary and estimated 1996 Practical Reference Heads (**PRHs**) (BHP, 2010).

5.1 Compliance Criteria

- A 4 m drawdown limit at the point on the designated area for Wellfield A that is mid-way between GAB8 and HH2 based on the 12-month moving average.

5.2 Leading Indicators

- A hydraulic gradient between wells in the NESB and HH2 exceeding 0.0009 m/m, calculated as the six-monthly moving mean hydraulic gradient between HH2 and NESB wells GAB7, GAB8, GAB10, GAB11 and GAB19.

5.3 Wellfield A Monitoring Program Requirements

5.3.1 Purpose

- Quantify by routine and appropriate methods water pressures and water levels in all monitoring and production wells, and at the boundary of the Designated Areas, as agreed with the State.
- Measure or infer the magnitude of the drawdown according to the relevant compliance criteria for Wellfield A.
- Provide data to support the leading indicator for GAB impacts, and alert management when levels approach the leading indicator value.

5.3.2 Deliverables

- Records of artesian pressure and groundwater level data for assessment of drawdown.

5.4 Groundwater responses to Wellfield A

A summary of reference heads in m AHD is shown in Table 5-1. It is noted that some of these reference heads incorporate localised, prior drawdown due to the early operation of production bore GAB6. Average drawdown contours for FY19 are presented in Figure 5-1. The contour map for Wellfield A includes the geological structures that are interpreted to influence the hydrogeology of the Wellfield A region and has been drawn using the kriging process for contouring as outlined for Wellfield B in Monitoring Program – Great Artesian Basin (GAB) 2018 (BHP , 2018a).

5.4.1 Wellfield A Hydrogeological Zone

Average drawdowns within the zone have increased during FY19 (Table 5-1) and are greater than the 5-year average drawdown for the period FY14-18. Wellfield A abstraction rates were low (1.12 - 3.14 ML/d) in early FY19 but higher in mid-late FY19 (5.0 – 7.56 ML/d) (Table 4-2) resulting in increased drawdowns measured near the production wells. Drawdowns at wells further from the production centre show slight increases.

Drawdown for wells within the Wellfield A zone range from 17.4m at GAB18A to 5.1 m at Venables Bore.

Drawdown propagation within the sub-basin is controlled by hydraulic barriers (grey shaded areas in Figure 5-1) causing drawdown to spread asymmetrically and preferentially to the northwest and southeast. The drawdown pattern in Figure 5-1 is similar to those presented since FY12.

5.4.2 North East Hydrogeological Zone (NESB)

Average drawdowns within the zone have increased slightly during FY19 (Table 5-1) and are comparable with the 5 year average drawdown.

Drawdowns for wells within the North East zone ranged from 0.9 m at HH2 to 2.6 m at GAB 10 and GAB 11.

Groundwater head in the NESB would be expected to respond to changes in abstraction from Wellfield A to a lesser extent than the Wellfield hydrological zone due to the increased distance from Wellfield A and the damping effect of hydraulic barriers associated with structural faults. Drawdown has always appeared to spread from the Wellfield sub-basin first southeast and northwest; and subsequently to the NESB. As a result, heads in the NESB are not expected to change as abruptly as they do near the Wellfield A production bores.

5.4.3 South Western Hydrogeological Zone

Average drawdowns within the zone have increased slightly during FY19 at HH1 and HH3 and have decreased at HH4 (Table 5-1).

Table 5-1 Wellfield A – summary of drawdown FY19

Area	Well	Reference Elevation (m AHD)	Mean Drawdown FY19 (m)	Mean Drawdown FY18 (m)	FY14-18 Mean Drawdown (m)
Wellfield Sub-basin	GAB1	22.4	8.0	7.2	7.7
	GAB2	22.8	7.5	7.2	7.6
	GAB5A	27.7	6.8	5.9	6.5
	GAB6A	22.2	9.8	8.5	9.2
	GAB12A	27.2	15.3	13.4	14.2
	GAB13A	30.4	15.8	12.9	14.2
	GAB14A	30.1	17.9	15.9	15.8
	GAB16A	24.5	13.2	12.5	12.3
	GAB17	28.4	9.7	13.6	9.6
	GAB18A	28.8	17.4	15.3	14.9
	GAB21	25.4	12.6	11.4	11.8
	GAB22	24.7	12.7	10.7	11.4
	GAB23	27.7	9.4	13.2	12.3
	MB2	22.2	5.8	5.3	5.8
	New Years Gift	22.6	8.6	8.2	8.2
	Venables	20.6	5.1	4.9	5.1
Northeast Sub-basin	GAB7	16	2.4	2.2	2.9
	GAB8	11.7	1.8	1.7	1.8
	GAB10	19	2.6	2.2	2.6
	GAB11	20.7	2.6	2.3	2.5
	GAB19	15.1	2.3	2.0	2.2
	HH2	8.2	0.9	0.8	0.8
South West Sub-basin	HH1	11.1	0.1	-0.1	-0.1
	HH3	9.3	0.0	-0.1	-0.1
	HH4	14	0.1	0.6	0.4
Extension	GAB24	39.2	5.5	5.2	5.4

Area	Well	Practical reference head (m AHD)	Mean Drawdown FY19 (m)	Mean Drawdown FY18 (m)	FY14-18 Mean Drawdown (m)
Open GAB	MB1	55.5	0.2	0.1	0.0
	MB5	75.5	0.6	0.6	0.5
	MB6	75.0	0.5	0.6	0.5

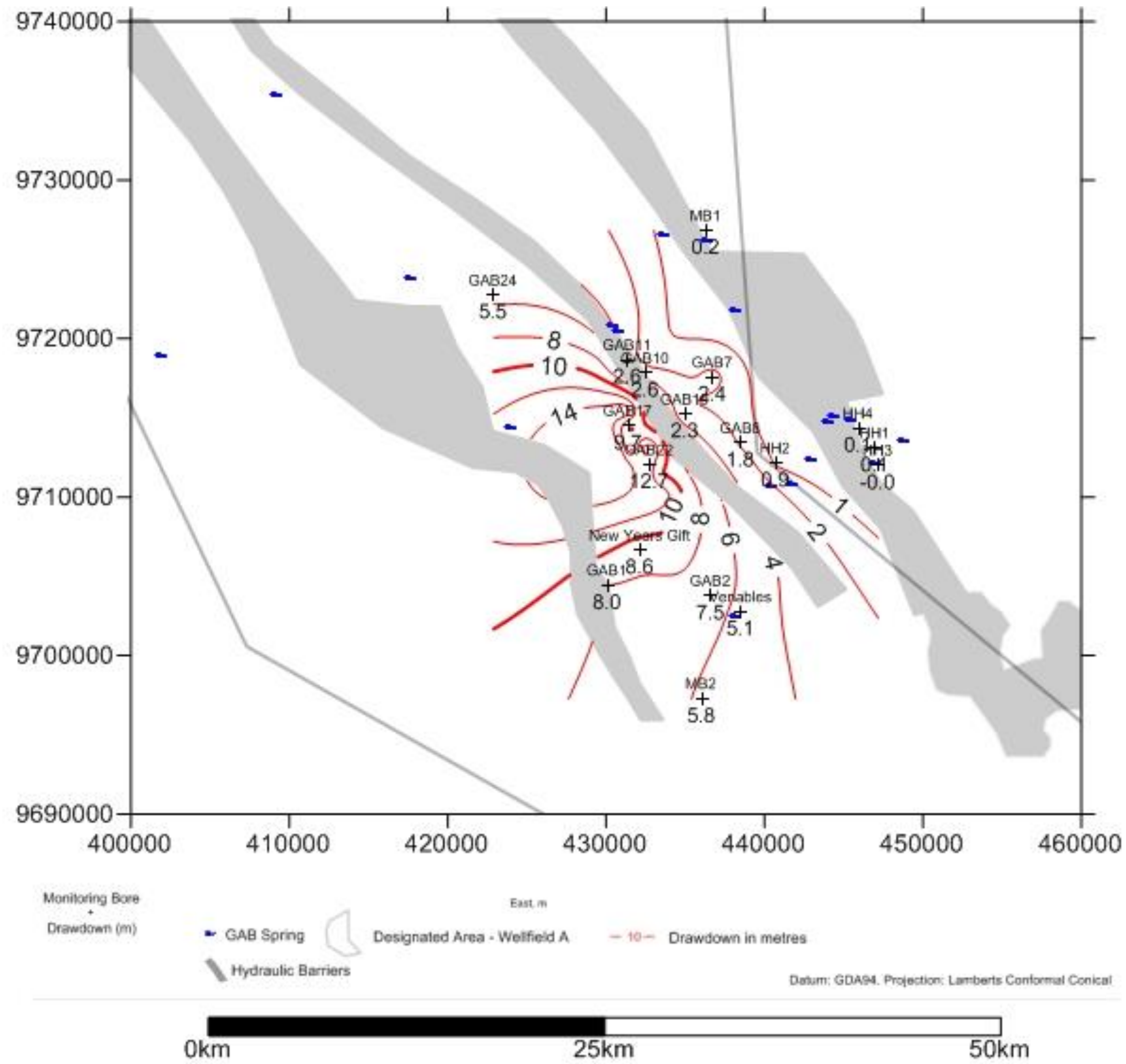


Figure 5-1 Wellfield A total drawdown contours for FY19

5.5 Evaluation against Compliance Criteria

5.5.1 Compliance Bores

The Wellfield A designated area boundary runs between bores GAB8 and HH2. Boundary drawdown is determined as the 12-month moving average drawdown at a point midway between these two sites.

The FY19 average drawdown at GAB8 was 1.8 m and 0.9 m at HH2 (Table 5-1), therefore average boundary drawdown was 1.35 m, similar to that reported since 2010 and less than the 4 m compliance criteria (Figure 5-2).

5.6 Evaluation against Leading Indicator

GAB spring flows are primarily driven by groundwater pressure in the GAB aquifer, representing a head that is greater than the elevation of the spring vent. This head, in turn, is maintained by the distribution of potentiometric head across the aquifer in the vicinity of the spring.

The FY19 hydraulic gradient between wells in the NESB (GAB7, GAB8, GAB10, GAB11, and GAB19) and HH2 was 0.0009 m/m, equal to the leading indicator and similar to those reported since 2000 (Figure 5-3) and no management action is required.

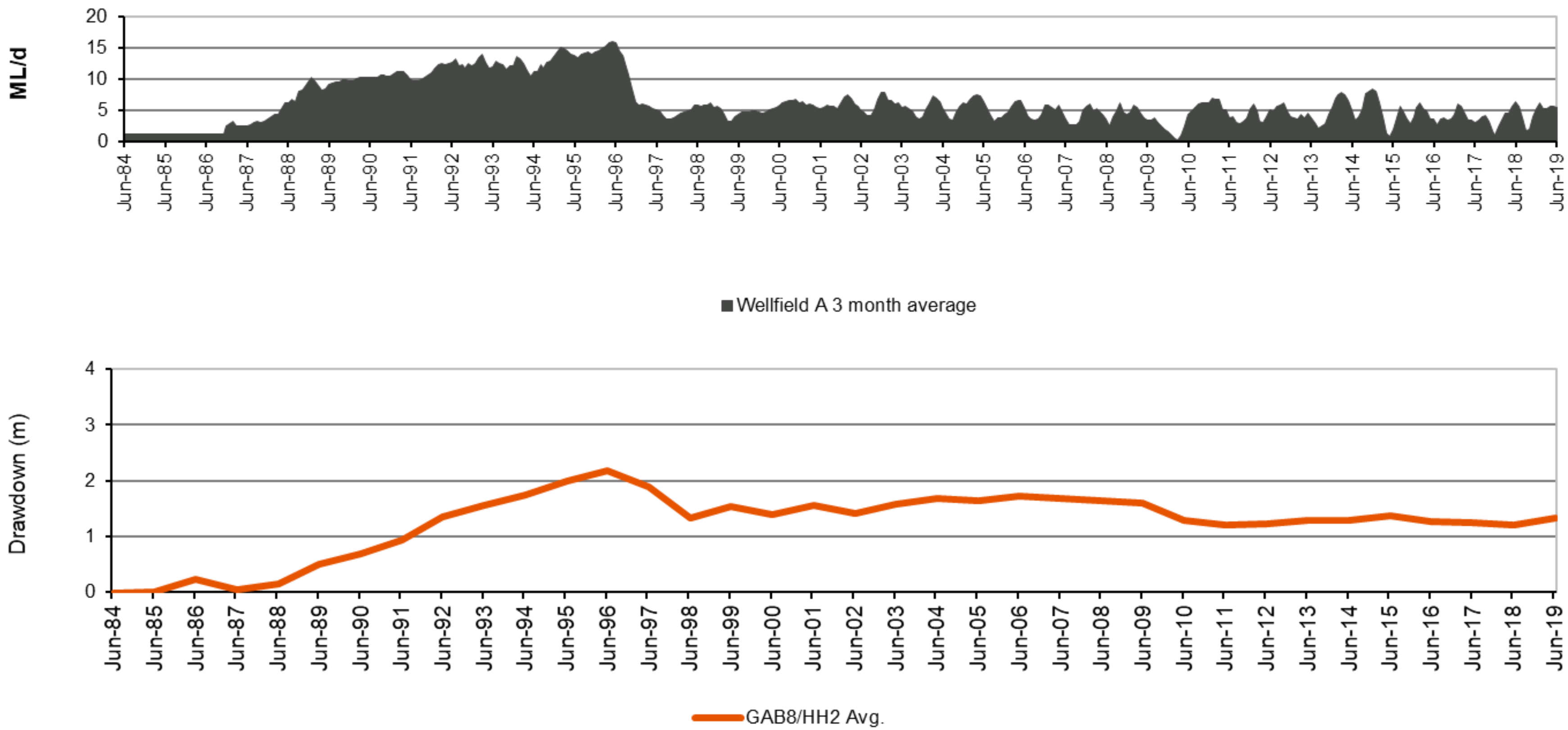


Figure 5-2 Wellfield A Compliance Bores – GAB8/HH2

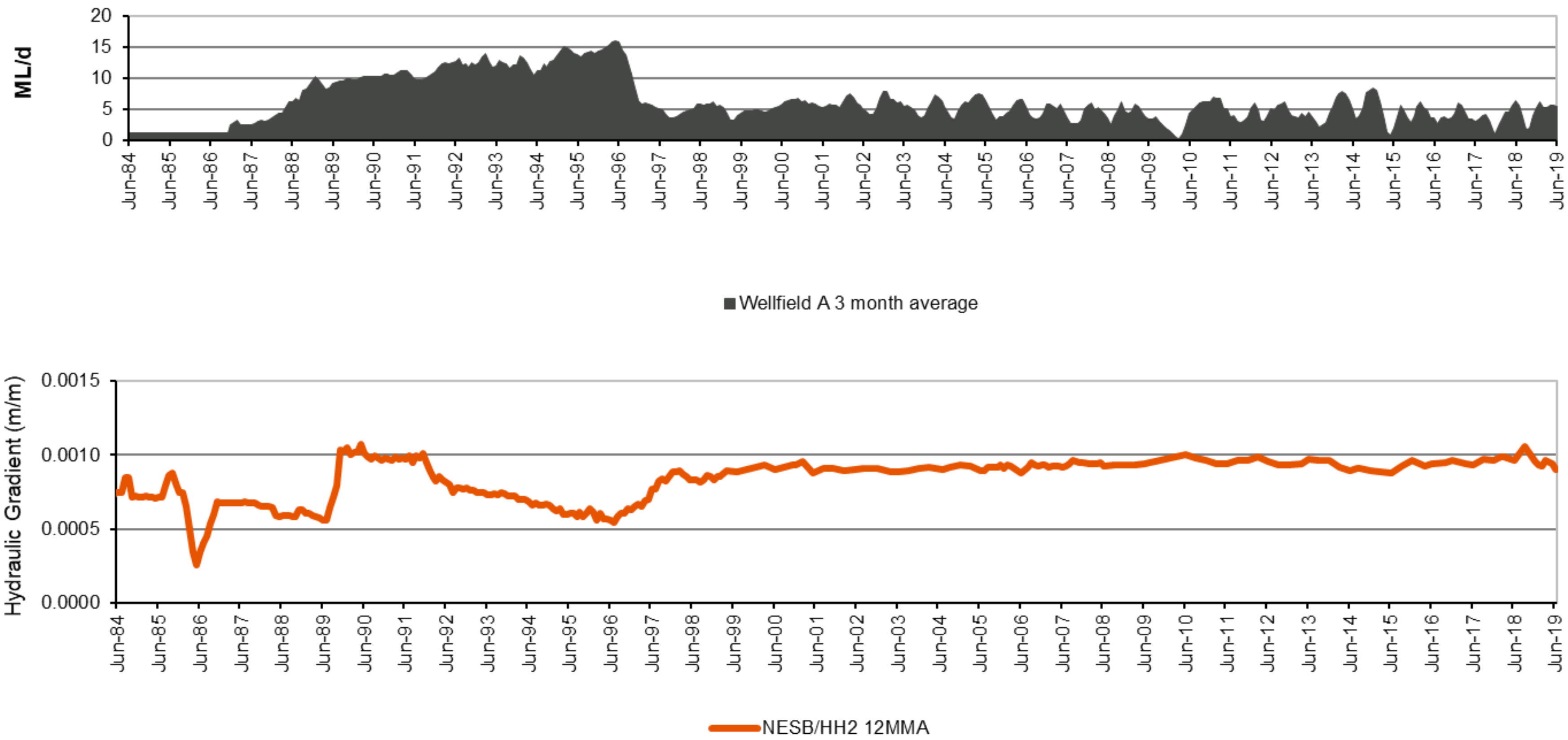


Figure 5-3 Wellfield A Leading Indicator – NESB Hydraulic Gradient

6 WELLFIELD B AQUIFER PRESSURE RESPONSE

Drawdown responses due to Wellfield B are measured and reported to the State in accordance with the Indenture as:

- *Temperature-exclusive drawdown*: wellhead pressure difference from reference pressures (**PRPs**) established for the bores monitored; or
- *Temperature-inclusive drawdown:* as a difference between current measurement and estimated 1996 practical reference heads (**PRHs**).

6.1 Compliance Criteria

- A 4 m drawdown limit for Wellfield B at the point between monitoring bores S1 and S2 (measured as the average drawdown of the two bores) and based on the 12-month moving average.
- A drawdown footprint for Wellfield B, measured as the area contained within the 10 m drawdown contour, that is less than or equal to 4,450 km^2.

6.2 Leading Indicators

- A drawdown trend at monitoring bore S1 that may exceed 4.5 m in the next 12 months.
- A drawdown footprint for Wellfield B, measured as the area contained within the 10 m drawdown contour that is greater than 4,000 km^2.
- A continuing drawdown trend at GAB pastoral bores that may exceed the predictions of the Olympic Dam Environmental Impact Statement of 1997.

6.3 Monitoring Program Requirements

6.3.1 Purpose

- Quantify by routine and appropriate methods water pressures and water levels in all monitoring and production wells, and at the boundary of the Designated Areas, as agreed with the State in accordance with the Indenture.
- Measure or infer the magnitude of the drawdown according to the relevant compliance criteria for Wellfield B.
- Provide data to support the leading indicator for GAB impacts, and alert management when levels approach the leading indicator value.

6.3.2 Deliverables

- Records of artesian pressure and groundwater level data for assessment of drawdown.

6.4 Groundwater responses to Wellfield B

6.4.1 Whole-of-Wellfield Drawdown Pattern

The drawdown pattern shows marked asymmetry, reflecting structural and palaeogeographical control over drawdown impacts. The production wells are situated in a northwest oriented trough that contains a thicker, more transmissive aquifer sequence. The trough is flanked by lower transmissivity zones that limit the relative propagation of drawdown to the east and west (WMC, 1995).

The drawdown pattern shown in Figure 6-1 is similar to that of FY18 and earlier reports. Individual drawdown at bores used to create Figure 6-1 are listed in Table 6-1. General interpretative comments, describing the drawdown pattern or drawdowns reported at individual sites, are:

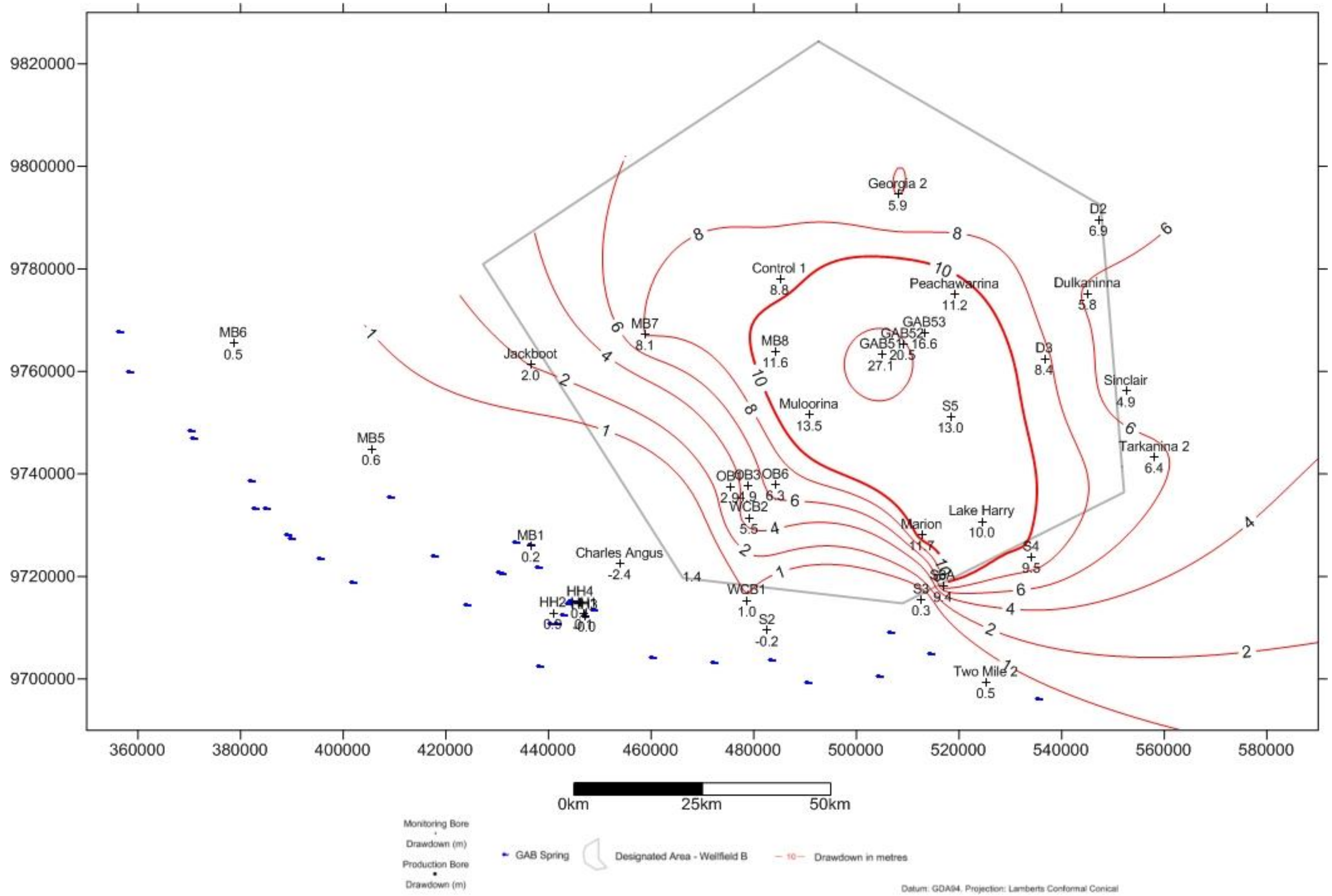
- Drawdowns are reported at the production bores GAB51, GAB52, and GAB53 as the average difference between respective PRHs and flow pressures. The 3 production wells were not shut in during FY19.
- The largest drawdown reported in an observation bore in FY19 is 13.5 m at Muloorina.
- Reported drawdown exceeds 10 m in six bores (Muloorina H/S, Peachawarrina, S5, Lake Harry, Marion and MB8).
- WCB1 reports a drawdown of 1.0m, down from 2.4m in FY18. The well reticulation infrastructure noted as broken in FY18 has been repaired and the flow rate reduced. WCB1 is not an ODC owned well.
- Monitoring well S1 has recorded a sudden increase in drawdown to 3.9m in June 2019 and an FY19 average of 1.4m (Figure 6-4). The scale of drawdown increase in a short time period and other wells closer to wellfield B not showing a similar response (OB1, OB3, OB6, and WCB2). This suggests the cause of drawdown may be due to infrastructure leak underground. ODC is conducting investigations during early FY20 to identify the drawdown cause. S1 is not used for drawdown contouring in FY19.
- Drawdown along an arc of bores, situated in the west to south/south-east of Wellfield B, and closest to the GAB springs is less than 1 m and in many cases reported drawdown is 0 m.
- As indicated earlier, Figure 6-1 presents total drawdown, caused by both Wellfield B and third-party abstractions. The reported total drawdown at pastoral bores or at those used for any purposes other than dedicated monitoring, may be affected by both Wellfield B and third-party abstractions. This is best illustrated by Jackboot Bore, a pastoral bore, discharging at variable rates into a pipeline network until FY09. The pastoral flow was eliminated and the monitoring process was converted to ‘cold’ measurements. As a result, the reported “apparent” drawdown has significantly decreased from 3.9 m in 2009 to 2.0 m in FY19, revealing larger than previously expected drawdown due to pastoral abstraction.
- An artefact of the kriging process for contour preparation appears to be the over-projection of drawdown trends from near Wellfield B to areas without any observations, such as from the north-west to the north-east of Georgia bore in Figure 6-1. Kriging would have left the 2, 4 and 6 m contours open (i.e. these contours would not be closed within the northern extent of Figure 6-2). Contouring by hand would have closed the 4, 6 and 8 m contour lines within the extent of Figure 6-1. For these reasons, the 1, 2, 4 and 6 m contours in Figure 6-1were blanked outside the Designated Area, from the north-west to the north-east of Wellfield B. This blanking, however, did not significantly influence the size of the 10 m drawdown footprint.

Table 6-1 Summary of drawdowns used for Wellfield B contouring June 2019

Bore	PRH (m AHD)	Mean Drawdown FY19 (m)	Mean Drawdown FY18 (m)	Change in Mean Drawdown (m)
Charles Angus	50.5	-2.4	-2.4	0.0
D2	90.5	6.9	6.7	0.3
D3	86	8.4	8.3	0.0
Dulkaninna 2	88	5.8	6.0	-0.2
GAB51[1]	87.5	27.1	23.5	3.6
GAB52[1]	87.5	20.5	19.5	1.0
GAB53[1]	88	16.6	21.1	-4.5
Georgia 2	83.5	5.9	6.5	-0.5
HH1	11.1	0.1	-0.1	0.1
HH2	8.2	0.9	0.8	0.1
HH3	9.3	0.0	-0.1	0.0
HH4	14	0.1	0.6	-0.5
Jackboot	84	2.0	2.0	0.0
Lake Harry	84.9	10.0	10.2	-0.2
Marion	87.5	11.7	11.5	0.2
MB1	55.5	0.2	0.1	0.1
MB5	75.5	0.6	0.6	0.0
MB6	75	0.5	0.6	-0.1
MB7	87	8.1	8.4	-0.3
MB8	88	11.6	11.7	-0.2
Muloorina	85.4	13.5	14.1	-0.6
OB1	80	2.9	2.9	0.0
OB3	82	4.9	5.0	-0.1
OB6	83	6.3	6.0	0.4
Peachawarrina	85.2	11.2	9.9	1.2
S1[2]	70.5	1.4	0.6	0.8
S2	54	-0.2	-0.3	0.1
S3	72.5	0.3	0.1	0.2
S3A	85	9.4	9.0	0.4
S4	87	9.5	10.0	-0.6
S5	86.5	13.0	12.8	0.3
Sinclair	87	4.9	5.0	-0.1
Tarkanina 2	86.8	6.4	5.8	0.6
Two Mile 2	72	0.5	-0.2	0.7
WCB1	64.5	1.0	2.4	-1.4
WCB2	83	5.5	5.4	0.1

Notes:

1. Drawdown for wells GAB51-53 was measured with flow pressures during FY19
2. S1 was not used for contouring during FY19 as the greatly increased drawdown is suspected to indicate a potential failure of the well casing below ground.
3. Negative numbers indicate a reduction in drawdown (i.e. an increase in head) during FY19



Note: Total drawdown includes those caused by Wellfield B and third party abstractions

Figure 6-1 Wellfield B total drawdown contours for FY19, generated by kriging

6.4.2 Drawdown Pattern around Wellfield B

The drawdown map presented in Figure 6-1 followed the procedure as described in the Monitoring Program – Great Artesian Basin (GAB) 2018 (BHP, 2018a). One control point was used to the north-west of Wellfield B, between MB8 and Georgia Bore.

The drawdown for the control point in the north-west (Control 1 in Figure 6-1) was determined as follows:

1. Drawdowns at Wellfield B (21.4 m, average of GAB51-53), MB8 (11.6 m) and Georgia Bore (5.9 m) were plotted vs. their respective distance from Wellfield B. For Wellfield B, a nominal distance of 1 m was used.
2. A logarithmic trend was fitted to the distance-drawdown relationship, a standard groundwater hydraulic relationship for an extensive aquifer.
3. Using the logarithmic distance-drawdown trend from 2, the distance from Wellfield B where drawdown should equal 8.7 m (the average for MB8 and Georgia) was determined, and a control point for the purpose of contouring was placed at that distance and to the north-west of Wellfield B (red marker in Figure 6-2 and "Control 1" in Figure 6-1).

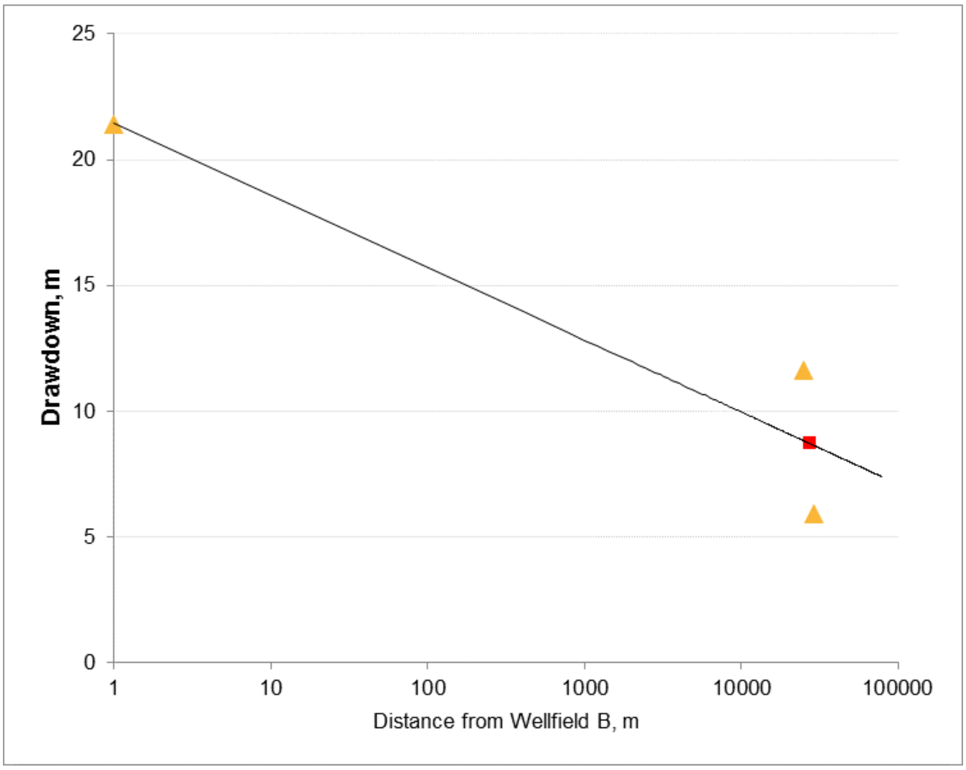


Figure 6-2 Assessment of drawdown at the control point

6.5 Evaluation against Compliance Criteria

6.5.1 The Area Contained Within the 10 m Drawdown Contour

The area contained within the 10 m drawdown contour line in Figure 6-1 is 2,294 km^2, below the 4,450 km^2 compliance criterion. As Figure 6-3 indicates, measured values (black) for the 10 m drawdown contour are below modelled values (red markers) with the exception of FY2008 when drawdowns significantly influenced by temperature or pastoral use at two sites were reported.

The GAB aquifer near Wellfield B is highly confined with no recharge, other than through-flow from the north/northeast. Therefore drawdown at all sites is expected to increase (even if the abstraction at Wellfield B remains constant) although the rate of increase is expected to slow down with time. The area within the 10 m drawdown contour line, as Figure 6-3 indicates, is less than the modelled area due to ODC not abstracting the full modelled volume of 36 Ml/d (FY19 abstraction was 23.9 ML/d).

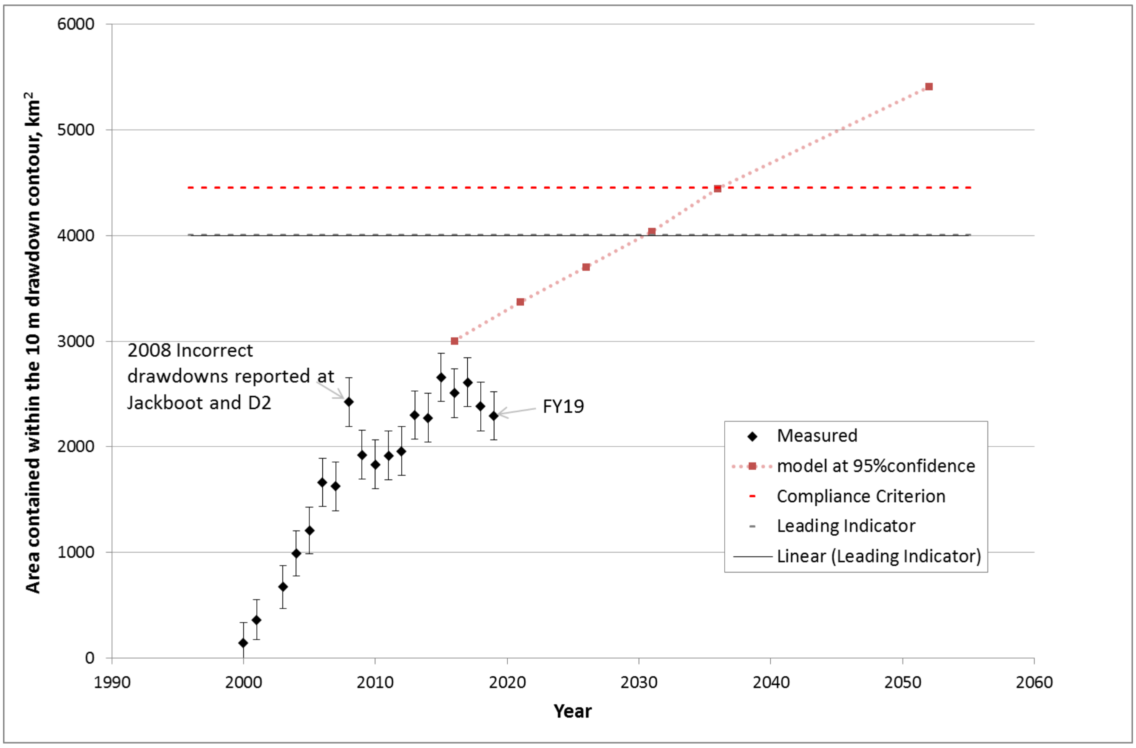


Figure 6-3 Area Contained within the 10 m Drawdown Contour

6.5.2 Drawdown at bores S1 and S2

Sites S1 and S2 are the closest dedicated monitoring bores to GAB springs and were therefore selected as compliance sites.

Table 6-2 Summary of drawdown at S1 and S2, to June 2019

Bore	PRH (m AHD)	Mean Potentiometric Head FY19 (m AHD)	Mean Drawdown FY19 (m)
S1	70.5	69.9	3.2
S2	54.0	54.3	- 0.2
S1 – S2 12 month moving drawdown average			1.5

As Figure 6-4 indicates, the average drawdown for these sites has fluctuated between -0.5 and +0.6 m and has remained very close to 0 m since 2010. The latest reported drawdown at the point between monitoring bores S1 and S2 (measured as the average drawdown of the two bores based on the 12-month moving average) is 1.5 m, less than the 4 m drawdown compliance criteria.

The sudden increase in drawdown to 3.2m at S1 is localised to the monitoring well. Other wells closer to wellfield B do not record a similar response (OB1, OB3, OB6, and WCB2) (Table 6-1). The cause of the anomalous drawdown is under investigation but is suspected to be a partial failure of the well casing underground. Investigations have commenced to identify the failure.

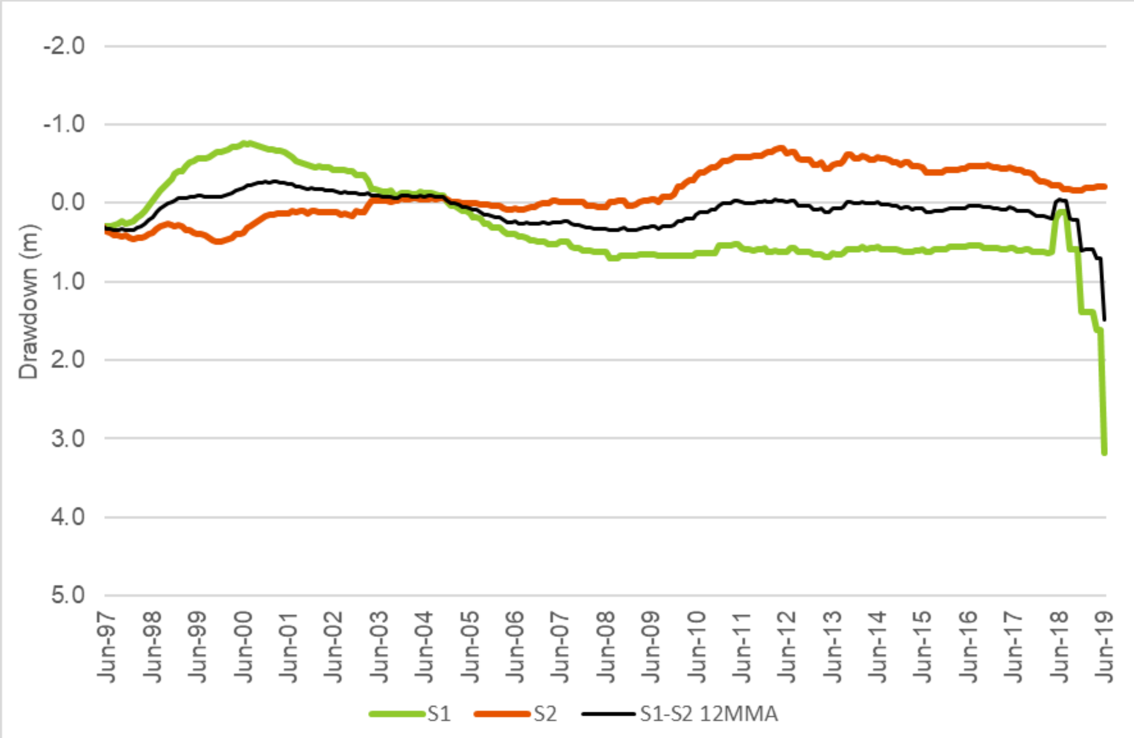


Figure 6-4 Drawdown at Wellfield B Compliance Bores S1 and S2

6.6 Evaluation against Leading Indicator

Pastoral wells are monitored to increase the density of observation points and to confirm that artesian pressures are preserved. The pastoral properties are large (~ 5000 km^2), the water supply lines for their livestock are long, exceeding 20 km in places. The area is remote, and the drilling costs for bores that are several hundred metres deep are high. As a consequence, many of these pastoral wells are used more or less continuously and therefore may influence pressure and temperature measurements. The recovery of shut-in pressure at Jackboot Bore after its closure is a practical demonstration of over-estimating drawdown in head, caused by wellfields by several metres. The separation of drawdown caused by Wellfield B from that caused by pastoral wells, is uncertain. The drawdowns presented in this report, therefore, are total drawdowns caused by both Wellfield B and pastoral abstractions.

Total drawdown at EIS pastoral bore sites (Kinhill Engineers, 1997, updated Golder Associates 2016) can be assessed from Figure 6-1, which shows drawdown contours in the Wellfield B area due to all groundwater abstractions. A summary of measured drawdown is shown in Table 6-3.

Table 6-3 Drawdown at 1997 EIS Pastoral bores

Well	Temp Inclusive Drawdown		EIS predicted drawdown
	PRH (m AHD)	Drawdown (m)	(m)
Callanna	48.9	0.0	0.8
Cannuwaukaninna	90.3	8.0	5.6
Chapalana 2	92	2.2	2.7
Charles Angus	50.5	-2.4	2.7
Clayton #1*	71.5		10.9
Clayton #2*	73.8		10.9
Cooranna	43.3	-16.1	4.3
Cooryaninna	96.3	7.5	4.1
Dulkaninna 2	89	5.8	7.4
Jackboot	84	2.0	5.0
Kopperamanna	92.1	11.4	3.7
Lake Harry	84.9	10.0	15.2
Marion	87.5	11.7	15.0
Maynards	55.4	-0.1	1.4
Morphetts	54.3		0.9
Morris Creek#2	63	-5.1	4.1
Muloorina	85.4	13.5	16.2
Peachawarrina	85.2	11.2	13.4
Peters	52.4	4.0	12.0
Tarkanina #2*	86.8		6.4
Yarra Hill*	87.7		2.5

Notes:

1. EIS (Kinhill Engineers, 1997, updates Golder Associates 2016) predicted drawdown is for the period 2016-2036.
2. PRH is calculated as the temperature corrected EIS pressure
3. Cooranna baseline pressure was given in the 1997 EIS as 61kPa. This is an incorrect value for the bore and represents a flow pressure rather than a shut-in pressure.
4. Measured pressures and calculated heads at Peters appear to be below those of adjacent GAB bores. Although drawdown is calculated the reference level for the well may be incorrect.
5. * Wells were not shut in at the request of land owner
6. # Well was not shut in due to poor headworks condition

Drawdown is not reported for all 1997 EIS pastoral sites in Table 6-3. The reasons for this vary. For some bores there is no baseline head or pressure available or those assigned proved to be incorrect; for others contemporary measurements are not possible (the bore cannot be accessed or shut-in). For some bores, the shut-in times appear to be insufficient (not long enough to minimise the influence of antecedent flow). Leaks inside bores or on the wellhead or the delivery infrastructure also render some pressure measurements non-representative of the GAB aquifer (the pressure measured is lower than the correct pressure at the same place and time in the aquifer) and hence would report incorrect drawdowns.

The Practical Reference Head for EIS pastoral bores has been calculated as the temperature corrected 1997 EIS kPa value.

In general, drawdown at pastoral bores remains less than the predicted long-term impact as presented in the EIS (Kinhill Engineers, 1997, updated Golder 2016). Maximum drawdown (13.5m) was at Muloorina in FY19.

Shut in pressures could not be collected from several sites in FY19. Clayton 1 and 2, and Yarra Hill were not shut in at the request of the land holder. Tarkaninna # 2 has failed below ground and has an uncontrolled flow to surface. Morphetts bore was not shut in due to poor headworks condition.

Two monitoring wells recorded drawdown in excess of the 1997 EIS predictions. Cannuwaukaninna and Kopperamanna have large pastoral antecedent flows and, similarly to Jackboot Bore in the past, the measured drawdowns may overestimate actual drawdown from Wellfield B. Drawdown from dedicated monitoring well D2 which is closer to Wellfield B reports a drawdown of 6.9m.

Cooryaninna measured a drawdown of 8.0 m, of which a large portion is regarded as pastoral antecedent flow and not representative of wellfield effects as demonstrated by monitoring wells D2 and Sinclair which are to the west of Cooryaninna and closer to Wellfield B but report lower drawdowns of 6.9 and 4.9 m respectively.

7 GAB SPRING FLOWS

Groundwater abstraction from the GAB has the potential to reduce the flow of water from springs in the vicinity of a wellfield, in turn reducing the area of habitat that is available to organisms or increasing the rate of spring extinctions. A core group of 41 GAB springs in the vicinity of the wellfields are monitored annually (BHP 2017a). During this monitoring, flow rates and field chemistry (pH, EC and temperature) are recorded.

7.1 Leading Indicator

- Evidence that flow reductions at GAB springs in the vicinity of the wellfields may exceed the predictions made in the Olympic Dam Environmental Impact Statements of 1982 and 1997; that can be attributed to water extraction from Wellfields A and B.

7.2 Monitoring Program Requirements

7.2.1 Purpose

- Determine the extent of flow change at GAB springs within each hydrogeological zone of impact that may be attributed to water abstraction from Wellfields A and B.
- To provide data to support the leading indicator for GAB impacts, and alert management when levels approach the leading indicator value.

7.2.2 Deliverables

- Records of spring flow data for assessment of flow trends and possible drawdown impacts.

7.3 Evaluation against Leading Indicator

Spring flows are presented by hydrological zone based on Kinhill Stearns (1984) and Kinhill Engineers (1997a) (updated Golder Associates 2016) and further refined in the BHP GAB Contingency Plan (BHP 2015). Individual springs within each zone are listed in Appendix 8.

Total Monitored Spring Flow (TMSF) and Monitored Spring Zone Flows (MSZF) are shown in Figure 7-1. Flows are calculated as a 3 year rolling average (Table 7-1).

Since 2000, Olympic Dam has conducted an ongoing program of pastoral bore flow restrictions in conjunction with GABSI with a focus on recovering pressure in the Wellfields A & B area. Through the provision of closed reticulation systems, decommissioning wells and restricting flows ODC has realised approximately 42 ML/D in ongoing water savings for the GAB region. The targeted reduction in local GAB abstraction has resulted in increased aquifer pressure and spring flows in the Wellfields area (Figure 7-1).

Table 7-1 Summary of Spring Flow data FY19

Hydrogeological Zone	No. of records in period	2017-2019 average (L/s)	1996-1998 average (L/s)	Predicted Loss (%) 1982 EIS	Predicted Change (% 1996-2016) 1997 EIS[1]	EIS Predicted Decline (%)	2017-2019 Flow Change (%)
Coward	3	11.579	9.679	<1	0	<1	+19.6
South West	3	1.325	1.127	<1<3	-1	<1-<3	+17.5
Western Lake Eyre South	3	3.896	4.024	2[2]	- 3-17	3-17	- 3.2
South East	3	2.912	2.520	<1	- 3-16.5	3-16.5	+ 15.5
North East	3	1.577	1.596	8-20	- 1	8-20	- 1.1
Wellfield A	3	0.300	0.388	60-100*	-	60-100	- 22.5

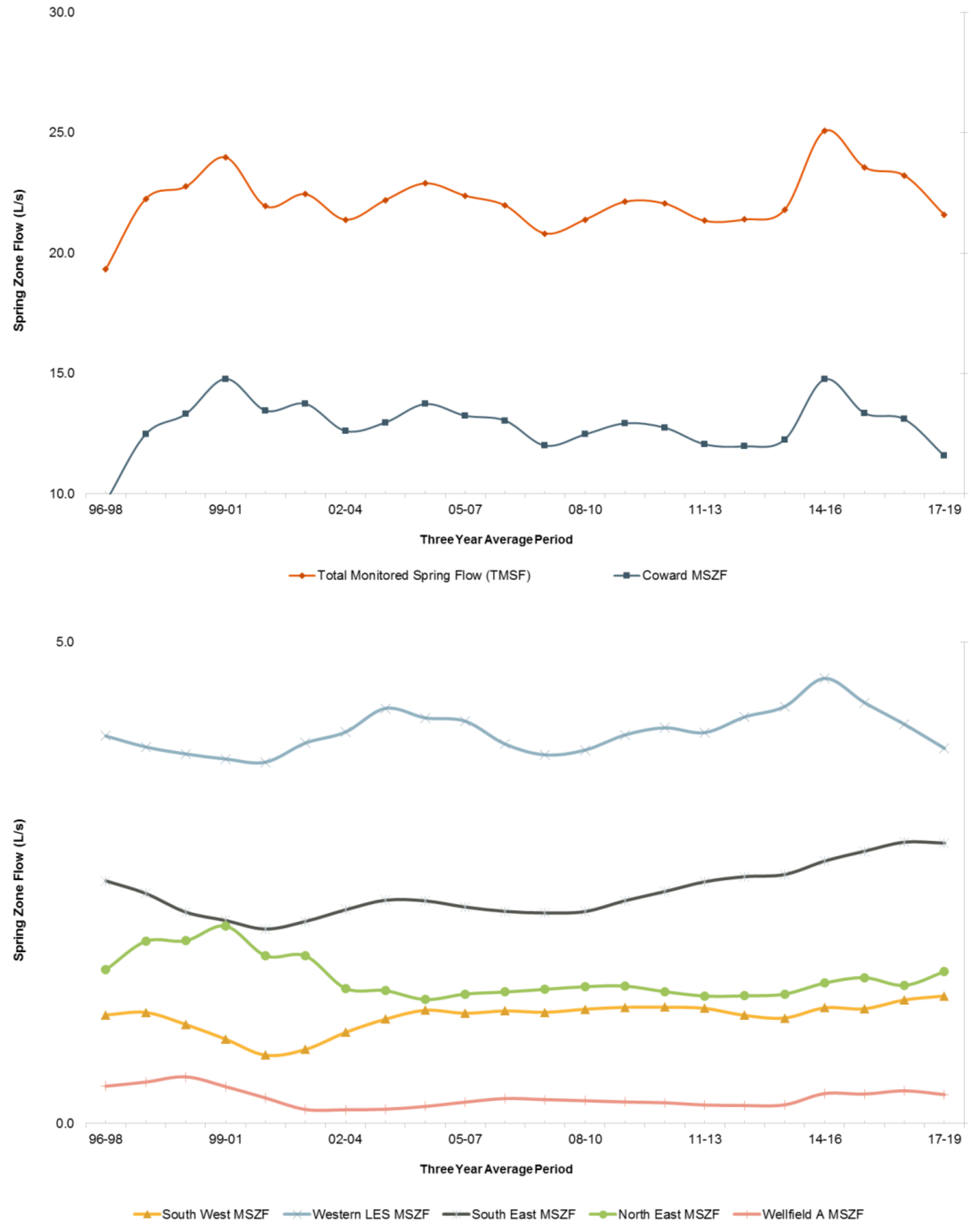


Figure 7-1: Total Monitored Spring Flow (TMSF) and Monitored Spring Zone Flows (MSZF)

7.3.1 Coward Zone

GAB spring flows in the Coward hydrogeological zone are not influenced by ODC abstractions but are monitored as a background for the wider GAB. Springs in the zone have been observed to produce highly variable flow rates. Measured flow decreased slightly in FY19 within historical ranges.

The flow rate was 19% higher than EIS background (Table 7-1).

7.3.2 South West Zone

GAB Spring flow rates in the South Western Zone increased within historical ranges. The flow rate was 17.5% higher than EIS background (Table 7-1).

7.3.3 Western Lake Eyre South Zone

GAB Spring flow rates in the Western LES zone decreased slightly within the range of historical observations. The flow rate was 3.2% lower than EIS background (Table 7-1) but within the predicted decline of 3.17%.

7.3.4 South Eastern spring Zone

GAB Spring flow rates in the South Eastern Zone decreased slightly but maintain the increase in flow observed since 2008. The flow rate was 15.5 % higher than EIS background (Table 7-1).

7.3.5 North East Zone

GAB spring flow rates in the North East Zone increased slightly within the range of historical observations. The flow rate was 1.1% lower than EIS background (Table 7-1) but within the predicted decline of 8-20%.

7.3.6 Wellfield A Zone

GAB Spring flow rates in the Wellfield A Zone decreased slightly within the range of historical observations. The flow rate was 22.5% lower than EIS background (Table 7-1) but within the predicted decline of 60-100%.

8 GROUNDWATER CHEMISTRY

Assessment of spatial variation of groundwater chemistry throughout the wellfield and monitored area has been discussed previously by AGC (1982) and Habermehl (1983) and is not included in this report. In general, spatial variations in chemistry of the GAB aquifer occur on a very broad scale. A review of groundwater chemistry data collected in the vicinity of the OD Wellfields has been provided in a previous wellfield report (WMC, 2002).

Shallow aquifers containing saline water (20,000–50,000 mg/L TDS) occur in the vicinity of Wellfields A and B. A reduction in aquifer pressures caused by abstraction could conceivably reverse the potential for upward groundwater movement from the GAB aquifer to the shallow aquifers and potentially affect water quality in the main GAB aquifer in the very long term.

Salinity, measured as Electrical Conductivity (**EC**) is the simplest, most robust diagnostic monitoring parameter and is the focus of the monitoring program.

8.1 Leading Indicator

- Evidence of water quality change (measured as pH or conductivity) at GAB springs that can be attributed to water extraction from Wellfields A and B.

8.2 Monitoring Program Requirements

8.2.1 Purpose

- Quantify by routine and appropriate methods, water qualities in all monitoring and production wells on a quarterly basis, as stated in the Indenture.
- Identify any changes in EC at bores and springs in the region of either Wellfields A or B that, combined with other influencing factors, may be attributed to abstraction.
- Provide data to support the leading indicator for GAB impacts, and alert management when levels approach the leading indicators.

8.2.2 Deliverables

- Records of GAB water EC, pH and temperature data for assessment of changes and trends in water quality.

8.3 Evaluation against Leading Indicator

A summary of EC and pH variations during FY19 and the previous reporting period is provided in Appendix 3. Large variations in average EC quality can occur at many springs from year to year. Despite such fluctuations, averages of field water quality generally remained within or close to the historical ranges.

As in previous years, statistically significant linear regression coefficients over the entire record (different from zero at the 95% confidence level) were identified and are shown in Figure 8-1. Sites identified by this method that had a regression coefficient (the slope of a regression line fitted to the dataset) outside the range of -0.15 to +0.15 were further analysed. Of the 125 groundwater and spring sites, four were identified as having regression coefficients outside that range, with three (Bopeechee HBO007, Welcome WWS001 and Welcome WWS013) indicating increasing salinity and one (Old Finniss HOF033) showing a decreasing trend (Figure 8-1).

Data shown in Appendix 3 also include the 5^{th} and 95^{th} percentile values for the historical range of values, and identify where the FY19 average is above the 95^{th} percentile. This method identified twenty eight (28) locations in FY19, Boocaltaninna, Callanna, Cannawaukaninna, Chapalanna 2, Charles Angus, Clayton #2, Cooryaninna, D3, Dulkaninna, GAB 12, GAB 14, GAB 16, GAB 18, GAB 21, Jewellery Creek, Marion, Maynards, Morris Creek, Muloorina, OB1, OB6, Peachawarrinna, Peters, Sinclair, WCB2, Welcome WWS002, Welcome WWS 013 and Yarra Hill.

ODC has conducted an investigation to identify the cause of 28 high EC readings. It has been identified that the water quality probes used during sampling are not temperature rated above 50°C. Water temperatures measured during GAB monitoring can be as high as 85°C.

ODC sourced a water quality probe with a temperature rating appropriate to GAB wells and undertook re-sampling of the 28 wells which were above the 95th percentile in August 2019. All wells except 2 (GAB 21, OB1) recorded EC values below the 95th percentile during re-sampling.

The two Welcome Springs are highly disturbed due to stock grazing and defecation and high EC values have been historically recorded. They were not sampled during August.

Individual trend graphs for these sites are provided in Appendix 5 including the August re-testing data.

8.3.1 Wellfield A Salinity Trends

Three of the seven sites identified in Section 8.3 are within the Wellfield A region:

- One (Bopeechee HBO007) with increasing salinity trend,
- One site with decreasing salinity trend (Old Finniss HOF033),
- One site (GAB 21) where FY19 measurement exceeded the 95 percentile.

The results above are consistent with the general rise in salinity for Wellfield A, discussed in a previous wellfield report (BHP, 2005). It should be noted from the graphs however, that correlations (as measured by the correlation coefficient square) in Appendix 5, particularly for springs, are generally poor.

An increasing trend was detected at Bopeechee HBO007 (Figure 16-1). Salinity at other Bopeechee vents are in line with the historical range for the springs. The decreasing trend continued at Old Finniss HOF033 (Figure 16-2).

The anomalous measurement in FY19 above the 95th percentile at GAB 21 (Figure 16-3) is not reflective of any significant trends at this well.

8.3.2 Wellfield B Salinity Trends

Four of the seven sites identified in Section 8.3 are at sites within the Wellfield B region.

- Two with increasing salinity trend; Welcome Spring WWS001 (Figure 16-4) and Welcome Spring WWS013 (Figure 16-5)
- Three sites; OB1 (Figure 16-6), Welcome WWS002 (Figure 16-7) and Welcome Spring WWS013 (Figure 16-5) where FY19 measurements exceeded the 95 percentile.

The Welcome group of springs are highly disturbed due to stock grazing, at the edge of the GAB and historically have exhibited large variations in salinity. OB1 does not display an increasing trend of EC and will be monitoring during FY20 with further trend analysis as appropriate.

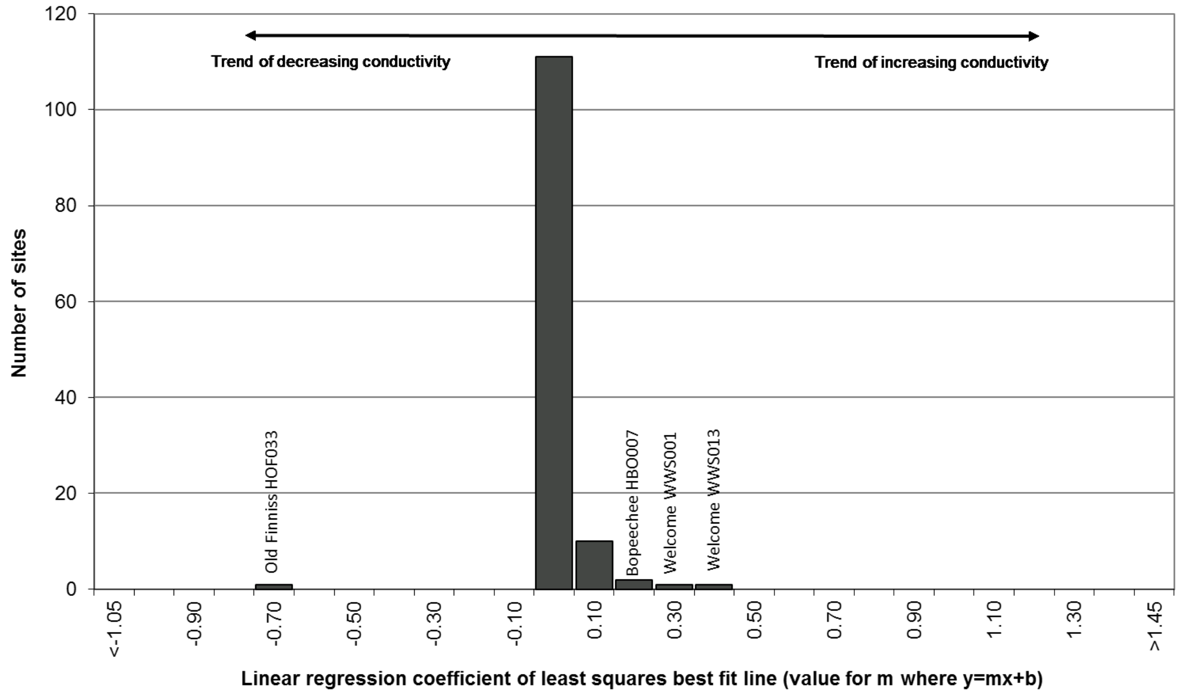


Figure 8-1 Frequency distribution of conductivity trends for the wellfields area

9 GAB WATER USE EFFICIENCY

The efficiency of water use at Olympic Dam and Roxby Downs is a significant driver in minimising the rate of water abstraction from the GAB. Efficient water use practice at the operation and at Roxby Downs is promoted through education and engineering controls. Targets and key performance indicators are developed to promote continuous improvement in water use efficiency. An efficiency rate of 1.24 kL of water per tonne of ore milled (kL/t), for a production rate of 200,000 tonnes per annum was anticipated in the 1997 EIS (Kinhill Engineers, 1997). The EIS approval required Olympic Dam to improve efficiency of water use and supply practices.

9.1 Monitoring Program Requirements

9.1.1 Purpose

- Measure the industrial water use efficiency of the operation and total potable water use of associated townships and accommodation villages, including Andamooka.
- Quantify by routine and appropriate methods total water quantities withdrawn from any wellfield on both an individual well and wellfield basis, with abstraction added to the record on a monthly basis, as required by the Indenture.
- Provide a 10-year forward schedule for abstraction of groundwater from the GAB.

9.1.2 Deliverable(s)

- Collated domestic and industrial water use efficiency data, to assess performance against improvement targets.
- Ten-year water use schedule to be submitted to the Indenture Minister by 1 January annually.

9.2 Results

In FY19 the GAB Industrial Water Efficiency of the operation was 1.1kL/t compared to the target of 1.16 kL/t and actual of 1.19kL/t for FY18. Despite a decrease in volume of GAB water per tonnes milled compared to FY18, overall water efficiency was impacted by the Acid Plant Outage in early FY19 and decreased production efficiency during this time. Domestic water use during FY19 averaged 2.0 ML/d compared to 2.3 ML/d in FY18.

The current 10-year water use schedule, as provided to the Minister for Mineral Resources Development in January 2019, is presented in Appendix 6. An updated schedule will be provided by 1 January 2020.

10 RESOURCE SUSTAINABILITY AND MANAGEMENT

10.1 Further Exploration and Development

Further development of existing wellfield infrastructure may be required to supply additional capacity to the operation as part of the 10 year water forecast. The 10 year forecast includes current business as usual (Bau) operations only and does not include the water demand of up to 50 ML/d being studied as part of the Olympic Dam Resource Development Strategy (OD-RDS).

To realise the abstraction rate of 50 ML/d to support the OD-RDS additional production wells and associated pipeline infrastructure will be required. This additional water take is expected to come from Wellfield B and no exploration for additional wellfields is currently planned.

10.2 Future Perspective

The 10-year Bau forecast (Appendix 6) predicts total wellfield abstraction to reach 41.7 ML/day by 2023 and remain constant to 2029. Abstraction rates for Wellfield A are expected to remain at an annual average of 5 ML/d and at 36.7 ML/d for Wellfield B.

The OD-RDS GAB water demand of up to 50 ML/d is being studied and is subject to State, Federal and BHP Board approval.

10.3 Sustainability Comments

Since 2000, Olympic Dam has conducted an ongoing program of pastoral bore flow restrictions in conjunction with GABSI with a focus on recovering pressure in the Wellfields A&B area. Through the provision of closed reticulation systems, decommissioning wells and restricting flows ODC has realised approximately 250 GL in cumulative water savings for the GAB region since 1999 (Figure 10-1) at an ongoing rate of approximately 42 ML/d – above the projected abstraction rate of ~ 34 ML/d (Appendix 6). The targeted reduction in local GAB abstraction has resulted in increased aquifer pressure and spring flows in the Wellfields area.

In the Wellfield A area groundwater heads and spring flow rates have now been approximately stable for more than 15 years. Boundary drawdown, determined as the average drawdown at GAB8 and HH2, was 1.35 m, similar to those reported since 2000.

For Wellfield B, the drawdown cone continues to show marked asymmetry, reflecting structural and palaeogeographical control over drawdown propagation. The production wells are situated in a north-west oriented wide basin trough, which contains a thicker, more transmissive aquifer sequence. The drawdown pattern is similar to that of earlier reports and in line with modelled predictions.

The area contained within the 10 m drawdown contour line is 2,294 km^2, below the 4,450 km^2 compliance criteria and consistent with modelling predictions. The latest reported average drawdown for bores S1 and S2 was 1.5 m, below the 4 m drawdown limit set for Wellfield B. As discussed in 6.5.2, the sudden increase in drawdown at S1 is related to a well casing failure and is under investigation.

Given the rates of drawdown and current compliance margins, continued GAB abstractions are sustainable at the planned rate.

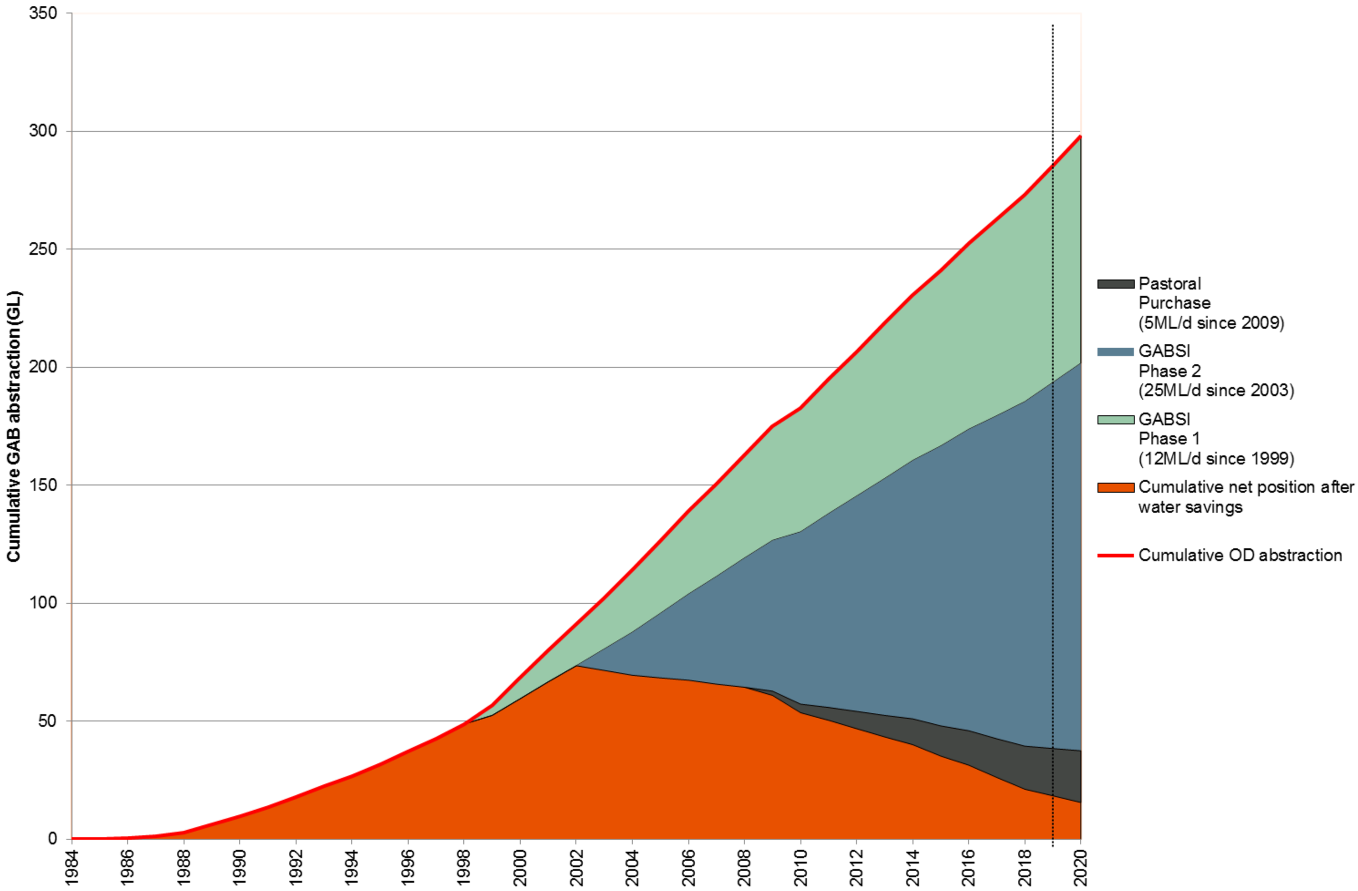


Figure 10-1 ODC cumulative GAB water savings

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12 Appendix 1: SUMMARY OF MONITORING RECORDS FOR FY19

Site	SIP/SWL		Flow Pressure		Flow Rate		Quality		Comments
	Required	Actual	Required	Actual	Required	Actual	Required	Actual	
Beatrice Bore HBS004					1	1	1	1	
Boocaltaninna	1	1	1	1	1	1	1	1	
Bopeechee Bore HBO013		7			1	6	4	4	
Bopeechee HBO004					1	1	1	1	
Bopeechee HBO007					1	1	1	1	
Bopeechee HBO011					1	1	1	1	
Callanna	1	1	1	1	1	1	1	1	
Cannuwaukaninna	1	1	1	1	1	1	1	1	
Chapalanna 2	1	1	1	1	1	1	1	1	
Charles Angus	1	1	1	1	1	1	1	1	
Clayton #1	1	0	1	1	1	1	1	1	Well was not shut in at land owners request
Clayton #2	1	0	1	1	1	1	1	1	Well was not shut in at land owners request
Clayton Dam 2	1	0	1	1	1	1	1	1	Well was not shut in at land owners request
Cooranna	1	2	1	1	1	1	1	2	
Cooryaninna	1	1	1	1	1	1	1	1	
Coward CBC001					1	1	1	1	
Coward CBC002					1	1	1	1	
Coward CBC013					1	1	1	1	
D2	4	4					4	4	
D3	4	4					4	4	
Davenport WDS001					1	1	1	1	
Davenport WDS042					1	1	1	1	
Davenport WDS052					1	1	1	1	
Dead Boy HDB004					1	1	1	1	
Dead Boy HDB005					1	1	1	1	
Dulkaninna 2	1	1	1	1	1	1	1	1	

Site	SIP/SWL		Flow Pressure		Flow Rate		Quality		Comments
	Required	Actual	Required	Actual	Required	Actual	Required	Actual	
Emerald LES001					1	1	1	1	
Fred LFE001					1	1	1	1	
Fred LFE006					1	1	1	1	
GAB1	4	4					4	4	
GAB2	4	4					4	0	Well is currently sub artesian and WQ cannot be collected
GAB5A	4	4					4	4	
GAB6	4	2			Continuous		4	4	SIP only measured is production well not in use.
GAB6A	4	4					4	4	
GAB7	4	8					4	4	
GAB8	4	8					4	4	
GAB10	4	8					4	4	
GAB11	4	8					4	4	
GAB12	4	2			Continuous		4	3	When well is not running WQ cannot be collected. SIP only measured is production well not in use.
GAB12A	4	4					4	4	
GAB13A	4	4					4	0	When well is sub artesian WQ cannot be collected
GAB14	4	0			Continuous		4	2	When well is not running WQ cannot be collected. SIP only measured is production well not in use.
GAB14A	4	4					4	0	When well is sub artesian WQ cannot be collected
GAB16	4	2			Continuous		4	3	When well is not running WQ cannot be collected. SIP only measured is production well not in use.
GAB16A	4	4					4	4	
GAB17	4	1			Continuous		4	1	When well is not running WQ cannot be collected

Site	SIP/SWL		Flow Pressure		Flow Rate		Quality		Comments
	Required	Actual	Required	Actual	Required	Actual	Required	Actual	
GAB18	4	0			Continuous		4	2	When well is not running WQ cannot be collected. SIP only measured is production well not in use.
GAB18A	4	4					4	0	When well is sub artesian WQ cannot be collected
GAB19	4	8					4	4	
GAB21	4	4					4	4	
GAB22	4	4					4	4	
GAB23	4	4					4	1	When well is sub artesian WQ cannot be collected
GAB24	4	4					4	4	
GAB30A	4	4					4	4	
GAB31A	4	4					4	4	
GAB33A	4	4					4	4	
GAB51	4		4	4	Continuous		4	4	Production wells were not shut in
GAB52	4		4	3	Continuous		4	4	Production wells were not shut in
GAB53	4		4	3	Continuous		4	4	Production wells were not shut in
Georgia 2	1	4	1	3	1	1	1	4	
Gosse LGS002					1	1	1	1	
Gosse LGS004					1	1	1	1	
Hermit Hill HHS028					1	1	1	1	
Hermit Hill HHS035					1	1	1	1	
Hermit Hill HHS101					1	1	1	1	
Hermit Hill HHS125A					1	1	1	1	
Hermit Hill HHS137					1	1	1	1	
Hermit Hill HHS170					1	1	1	1	
HH1	4	4					4	4	
HH2	4	8					4	4	
HH3	4	4					4	0	Sub artesian well, WQ cannot be collected
HH4	4	4					4	4	
Highway	1	1	1	1	1	1	1	1	
Jackboot	4	4	4	4	1	1	4	4	

Site	SIP/SWL		Flow Pressure		Flow Rate		Quality		Comments
	Required	Actual	Required	Actual	Required	Actual	Required	Actual	
Jewellery Creek	1	1	1	1	1	1	1	1	
Kopperamanna	1	1	1	1	1	1	1	1	
Lake Billy #2	4	4	4	4	1	1	4	4	
Lake Harry	2	2	2	2	1	1	2	2	
Marion	1	2	1	2	1	1	1	2	
Maynards	1	1	1	1	1	1	1	1	
MB1	4	4					4	4	
MB2	4	4					4	0	Sub artesian well, WQ cannot be collected
MB5	4	4					4	4	
MB6	4	4					4	4	
MB7	4	4					4	4	
MB8	4	4					4	4	
McLachlan LMS004B					1	1	1	1	
Morphetts	1	0	1	0	1	1	1		Did not shut in due to headworks condition
Morris Creek	1	1	1	1	1	1	1	1	
Muloorina	2	2	2	2	1	1	2	2	
New Years Gift	4	4	4	4	1	1	4	4	
OB1	4	4					4	4	
OB3	4	4	4	4	1	1	4	4	
OB6	4	4					4	4	
Old Finniss HOF004					1	1	1	1	
Old Finniss HOF033					1	1	1	1	
Old Finniss HOF081					1	1	1	1	
Old Finniss HOF094					1	1	1	1	
Old Finniss HOF096					1	1	1	1	
Old Woman HOW009					1	1	1	1	
Old Woman HOW015					1	1	1	1	
Old Woman HOW025					1	1	1	1	
Peachawarrina	1	1	1	1	1	1	1	1	
Peters	1	1	1	1	1	1	1	1	

Site	SIP/SWL		Flow Pressure		Flow Rate		Quality		Comments
	Required	Actual	Required	Actual	Required	Actual	Required	Actual	
S1	4	4					4	4	
S2	4	4					4	4	
S3	4	4					4	0	WQ cannot be collected – well does not sustain flow
SA	4	4					4	4	
S4	4	4					4	4	
S5	4	4					4	4	
Sinclair	1	1	1	1	1	1	1	1	
Sulphuric HSS011					1	1	1	1	
Sulphuric HSS012					1	1	1	1	
Sulphuric HSS024					1	1	1	1	
Tarkanina #2	4	0	4	0	1	0	4	2	Well has failed below ground and cannot be shut in
Tent Hill	4	4					4	0	WQ cannot be collected – well does not sustain flow
Two Mile #2	4	1					1	0	The installed pump at two mile #2 could not be shut off on several occasions – land owner needs to be present
Venables	4	7			1	1	1	1	
WCB01	4	4	4	4	1	1	4	4	
WCB02	4	4	4	4	1	1	4	4	
Welcome WWS001					1	1	1	1	
Welcome WWS002					1	1	1	1	
Welcome WWS004					1	1	1	1	
Welcome WWS013					1	1	1	1	
Well Creek #2	4	4	4	4	1	1	4	4	
West Finniss HWF002					1	1	1	1	
West Finniss HWF003					1	1	1	1	
West Finniss HWF048					1	1	1	1	
Wirringinna Spring MWI001	4	4					1	2	

Site	SIP/SWL		Flow Pressure		Flow Rate		Quality		Comments
	Required	Actual	Required	Actual	Required	Actual	Required	Actual	
Yarra Hill	1	0	1	0	1	1	1	1	Well was not shut in at land owners request

Notes:

- Categories are defined in Monitoring Program – Great Artesian Basin (GAB) 2018 (BHP 2018a).

13 Appendix 2: CALIBRATION CERTIFICATES FOR DRUCK PRESSURE TRANSDUCER

Abstec CALIBRATIONS®

Abstec Calibrations Australia Pty Ltd
A.C.N. 074 824 847 ABN 91 751 155 014
79 Ledger Road, Beverley SA 5009
Telephone (08) 8244 1355
Facsimile (08) 8445 1377
Toll Free: 1800 247 555
www.abstec-calibrations.com.au

CALIBRATION REPORT
PRESSURE MEASURING INSTRUMENT

Customer: BHP Billiton - Olympic Dam
Address: Olympic Way, Olympic Dam SA 5725

Order Number: N/A

Description:

Manufacturer: Druck
Model: DPI 705
Serial Number: 70556163
ID No.: n/a
Display size: Digital display
Range max: 2000 kPa
Cardinal div: 0.1 kPa
Min divisions: 0.1 kPa
Mount angle: Vertical
Calibration Interval: 12 months

Test Information: The instrument readings were taken from known applied pressure, both rising and falling
The test medium was nitrogen. The readings were taken after a settling time of 15 seconds.
Any unit conversions as per AS 1376.
The instrument was allowed to warm up as per the manufacturers specification.

Temperature at time of test: **20 ± 1 °C**
References Used: 32640-L
Test Procedure: MSA Test method 1 - 2008 Calibration of Pressure Calibrators, Indicators & Transducers
Specification: The instrument was tested to the manufacturers specifications of: **±0.1% fsd**

Uncertainty: The tabulated information relating to the uncertainty of each test is expressed at approximately 95% confidence level. k= *2.0*

Maximum error as found : **0.07 % fsd**
Max. error as a % of full scale as left: **0.04 % fsd**

Applied Pressure kPa		Rising Pressure in kPa reading	correction	Falling Pressure in kPa reading	correction	*Uncertainty in kPa*
0.0		0.0	*+0.0*	0.0	*+0.0*	*±0.12*
200.0		200.2	*-0.2*	200.2	*-0.2*	*±0.12*
400.0		400.4	*-0.4*	400.4	*-0.4*	*±0.12*
600.0		600.7	*-0.7*	600.7	*-0.7*	*±0.12*
800.0		800.8	*-0.8*	800.8	*-0.8*	*±0.16*
1000.0		1000.7	*-0.7*	1000.7	*-0.7*	*±0.20*
1200.0		1200.6	*-0.6*	1200.6	*-0.6*	*±0.24*
1400.0		1400.4	*-0.4*	1400.4	*-0.4*	*±0.28*
1600.0		1600.3	*-0.3*	1600.3	*-0.3*	*±0.32*
1800.0		1800.1	*-0.1*	1800.1	*-0.1*	*±0.36*
2000.0		1999.8	*+0.2*			*±0.40*

The unit was: Adjusted. Conforms to test specification

Date of test: 11-Jul-2018 **Report Date:** 11-Jul-2018 **Report No:** A28972PB

Checked By: **Signed:**

N.T.Doherty Authorised Signatory

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ilac-MRA NATA Accreditation No. 11087

Accredited for compliance with ISO/IEC 17025 - Calibration.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports. This document shall not be reproduced except in full. NATA accreditation number 11087.

Abstec CALIBRATIONS®

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Facsimile (08) 8445 1377
Toll Free: 1800 247 555
www.abstec-calibrations.com.au

CALIBRATION REPORT
PRESSURE MEASURING INSTRUMENT

Customer: BHP Billiton - Olympic Dam
Address: Olympic Way
Olympic Dam SA 5725

Order Number: N/A

Description:

Manufacturer: Druck | **Range max:** 2000 kPa
Model: DPI 705 | **Cardinal div:** 0.1 kPa
Serial Number: 70526779 | **Min divisions:** 0.1 kPa
ID No.: n/a | **Mount angle:** Vertical
Display size: Digital display | **Calibration Interval:** 12 months

Test Information: The instrument readings were taken from known applied pressure, both rising and falling
The test medium was nitrogen. The readings were taken after a settling time of 15 seconds.
Any unit conversions as per AS 1376.
The instrument was allowed to warm up as per the manufacturers specification.

Temperature at time of test: 20 ± 1 °C
References Used: 32640-L
Test Procedure: MSA Test method 1 - 2008 Calibration of Pressure Calibrators, Indicators & Transducers
Specification: The instrument was tested to the manufacturers specifications of: **±0.1% fsd**

Uncertainty: The tabulated information relating to the uncertainty of each test is expressed at approximately 95% confidence level. k= *2.0*

Maximum error as found : 0.06 % fsd
Max. error as a % of full scale as left: 0.04 % fsd

Applied Pressure kPa		Rising Pressure in kPa reading	correction	Falling Pressure in kPa reading	correction	*Uncertainty in kPa*
0.0		0.0	*+0.0*	0.0	*+0.0*	*±0.12*
200.0		199.6	*+0.4*	199.6	*+0.4*	*±0.12*
400.0		399.7	*+0.3*	399.7	*+0.3*	*±0.12*
600.0		599.8	*+0.2*	599.8	*+0.2*	*±0.12*
800.0		799.5	*+0.5*	799.5	*+0.5*	*±0.16*
1000.0		999.4	*+0.6*	999.4	*+0.6*	*±0.20*
1200.0		1199.3	*+0.7*	1199.3	*+0.7*	*±0.24*
1400.0		1399.4	*+0.6*	1399.4	*+0.6*	*±0.28*
1600.0		1599.5	*+0.5*	1599.5	*+0.5*	*±0.32*
1800.0		1799.5	*+0.5*	1799.5	*+0.5*	*±0.36*
2000.0		1999.9	*+0.1*			*±0.40*

The unit was: Adjusted. Conforms to test specification

Date of test: 11-Jul-2018 **Report Date:** 11-Jul-2018 **Report No:** A28972PA

Checked By: **Signed:**

N.T.Doherty Authorised Signatory

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14 Appendix 3: SUMMARY OF FIELD CHEMISTRY DATA FY19

Site	FY19 average			Historical range		FY19 average
	No. of records	EC25 (µS/cm)	pH	5th percentile	95th percentile	above 95th percentile
Beatrice Bore HBS004	1	4401	8.89	3260	4453	
Boocaltaninna	1	2000	6.81	1280.4	1810.6	True*
Bopeechee Bore HBO013	4	3973	7.08	3410	4314	
Bopeechee HBO004	1	3965	7.62	3488	4690.5	
Bopeechee HBO007	1	5904	8.77	3490	6102	
Bopeechee HBO011	1	4305	7.75	3525.5	6068	
Callanna	1	3630	7.51	2539	3588	True*
Cannuwaukaninna	1	2620	7	1666.8	2357.4	True*
Chapalanna #2	1	2440	7.08	1686	2656	True*
Charles Angus	1	3470	7.13	2548	3324	True*
Clayton #1	0			1668.5	2340.3	No record in FY19 - Pastoralist requested well not be opened
Clayton #2	1	3100	7.12	1641.85	2233.5	True*
Clayton Dam #2	1	3000	7.5	2620	2980	
Cooranna	2	2644	7.81	2159.6	2672	
Cooryaninna	1	2150	7	1187.1	2029.2	True*
Coward CBC001	1	7556	7.6	6225.9	7805	
Coward CBC002	1	4994	7.14	2988.5	5607	
Coward CBC013	1	5755	7	4736	5800	
D2	4	2108	6.95	1698.5	2137.4	
D3	4	2543	7.55	1917.25	2448	True*
Davenport WDS001	1	3786	7.86	3000	4204	
Davenport WDS042	1	3833	7.93	2965	4820	
Davenport WDS052	1	3890	8.56	2525	5650	
Dead Boy HDB004	1	4801	7.72	2710	4708	
Dead Boy HDB005	1	4304	7.81	3194.5	5101.5	
Dulkaninna 2	1	2150	7.17	1529.3	2076.15	True*
Emerald LES001	1	3916	8.34	3077	4696.5	
Fred LFE001	1	3220	8.59	2800	4300	
Fred LFE006	1	3279	7.85	2590	4880	

Site	FY19 average			Historical range		FY19 average
	No. of records	EC25 (µS/cm)	pH	5th percentile	95th percentile	above 95th percentile
GAB1	4	5303	7.01	4405.5	5680	
GAB2	0					No samples. Well non-artesian in FY19
GAB5A	4	3073	7.87	2672.5	3300	
GAB6	4	3925	7.04	3148.2	3959	
GAB6A	4	3610	7.16	3186	3982	
GAB7	4	3380	7	3000	3690	
GAB8	4	3455	7.18	2986	3946	
GAB10	4	3103	7.02	2606	3406	
GAB11	4	3445	7.05	2950	3707.5	
GAB12	3	4107	7.12	3252.5	4093.5	False*
GAB12A	4	3643	7.15	3322	3921.5	
GAB14	1	3820	7	3125	3779	True*
GAB16	3	4040	7.04	3261	3953	True*
GAB16A	4	3558	7.04	3437.5	4002.5	
GAB17	1	3660	6.84	3681	4211	
GAB18	2	4940	7.17	3440	4528.5	True*
GAB19	4	3145	6.83	2767.5	3490	
GAB21	4	4738	7.13	3343.05	4453	True
GAB22	4	3673	7.21	3232	3970	
GAB23	1	3730	7.35	3424.5	3876	
GAB24	4	3850	6.87	3049.8	3972	
GAB30A	4	3613	6.96	3110	3830	
GAB31A	4	3593	7.07	3036.5	3707	
GAB33A	4	4243	6.94	3620	4536	
GAB51	4	3060	7.22	2508	3188.5	
GAB52	4	3033	7.01	2412	3141	
GAB53	4	2970	7.04	2478	3062	
Georgia #2	4	2535	6.61	2130	2656	
Gosse LGS002	1	2907	7.29	2700	3200	
Gosse LGS004	1	2979	7.41	2516	3104	
Hermit Hill HHS028	1	4386	8.59	2971.5	5506	
Hermit Hill HHS035	1	3449	8.95	2925	6722.5	
Hermit Hill HHS125A	1	2651	8.04	2183	3792.5	

Site	FY19 average			Historical range		FY19 average
	No. of records	EC25 (µS/cm)	pH	5th percentile	95th percentile	above 95th percentile
Hermit Hill HHS137	1	2994	8.68	2730	5162.5	
Hermit Hill HHS170	1	3021	8.65	2610	3750	
HH1	4	3078	7.28	2727	3486	
HH2	4	3390	7.17	2795	3625	
HH4	4	3123	7.08	2825	5400	
Highway	1	3790	7.58	2975	3831	
Jackboot	4	4798	7.22	4010	4900	
Jewellery Creek	1	2250	6.88	1412.65	1920.35	True*
Kopperamanna	1	2050	6.82	1532.55	2084.65	
Lake Billy #2	4	6418	7.2	4937	6560	
Lake Harry	2	2645	7.29	2109.5	2650.5	
Marion	2	2685	7.25	2046	2618	True*
Maynards	1	3820	6.96	2745	3771	True*
MB1	4	2898	7.18	2400.5	3100	
MB02	0					No sample. Well Sub artesian
MB5	4	4198	6.98	3581	4450	
MB6	4	7348	6.67	6219	7614	
MB7	4	2903	6.86	2370	2940	
MB8	4	2890	6.95	2265.35	2959.5	
McLachlan LMS004B	1	2907	8.28	2685	3607	
Morphetts	1	4110	6.88	3293	4168	
Morris Creek	1	3380	7.28	2525	3302.5	True*
Muloorina	2	2965	7.41	2387.5	2952.5	True*
New Years Gift	4	4953	7.25	3783	5212.5	
OB1	4	2905	7.66	2288	2850	True
OB3	4	2995	7.51	2595	3081	
OB6	4	2978	7.61	2461.5	2970	True*
Old Finniss HOF004	1	3391	8.23	2358	4628	
Old Finniss HOF033	1	5328	7.82	3935	12725	
Old Finniss HOF081	1	3816	7.79	3000	4747.5	
Old Finniss HOF094	1	7295	9.12	3159	8105	
Old Finniss HOF096	1	3522	8.27	2932.5	3545.8	
Old Woman HOW009	1	10170	7.89	7248	10795	
Old Woman HOW015	1	4350	9.04	3982	8622.5	

Site	FY19 average			Historical range		FY19 average
	No. of records	EC25 (µS/cm)	pH	5th percentile	95th percentile	above 95th percentile
Old Woman HOW025	1	4819	8.21	2701	5044	
Peachawarrina	1	3200	7.3	2382	3098	True*
Peters	1	2760	7.54	2066.6	2513.3	True*
S1	4	2935	7.56	2472.5	3055.5	
S2	4	3400	7.9	2945	3830	
S3	0					No sample. Well does not sustain flow
S3A	4	2349	7.46	2049	2508	
S4	4	2858	7.53	2304	2932	
S5	4	2259	7.1	1953	2480	
Sinclair	1	2530	7.12	1723.7	2214.35	True*
Sulphuric HSS011	1	3896	8.21	3159.5	4004.5	
Sulphuric HSS012	1	4057	7.67	3075.5	5001.5	
Sulphuric HSS024	1	3901	8.78	2680	4500	
Tarkanina #2	4	2330	7.5	1882.5	2330	
Venables	0			5310.5	6962.5	No samples. Well non-artesian in FY19
WCB1	3	2868	7.86	2582	3138	
WCB2	4	2608	7.74	2151.5	2608.5	True*
Welcome WWS001	1	7477	7.88	4186	7566.2	
Welcome WWS002	1	8755	7.74	6231	9105	True
Welcome WWS004	1	3567	7.99	3485	4210.5	
Welcome WWS013	1	7428	8.54	2622.5	7342.2	True
Well Creek #2	4	2755	7.77	2162	2804.5	
West Finniss HWF002	1	3812	8.68	3079.7	5425	
West Finniss HWF003	1	3649	8.89	3079	5775	
West Finniss HWF048	1	3812	8.6	2812.5	5645	
Wirringinna Spring MWI001	4	1860	9.72	3285	9715	
Yarra Hill	1	2360	7.51	1718.45	2358.8	True*

Note* : EC value recorded in FY19 exceeded 95 percentile upper limit. ODC has conducted an investigation to identify the cause of 28 high EC readings. It has been identified that the water quality probes used during sampling are not temperature rated above 50°C. Water temperatures measured during GAB monitoring can be as high as 85°C. ODC sourced a water quality probe with a temperature rating appropriate to GAB wells and undertook re-sampling of the 28 wells which were above the 95th percentile in August 2019. All wells except 2 (GAB 21, OB1) recorded EC values below the 95th percentile during re-sampling.

15 Appendix 4: PRESSURE TREND DATA

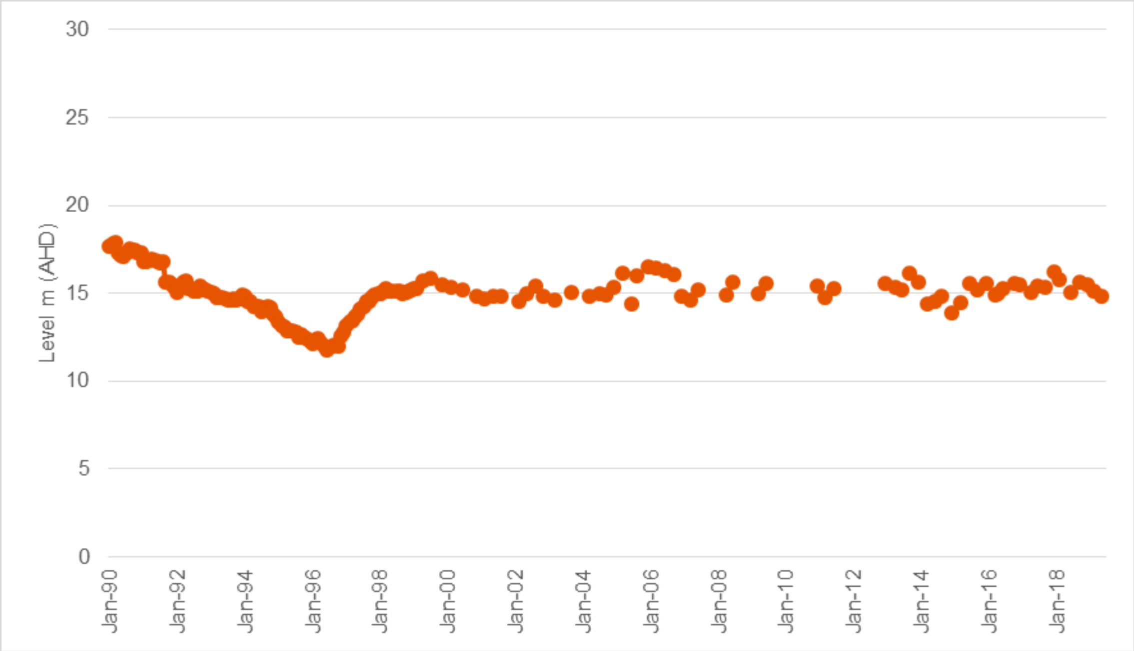


Figure 15-1 Groundwater Level for GAB2

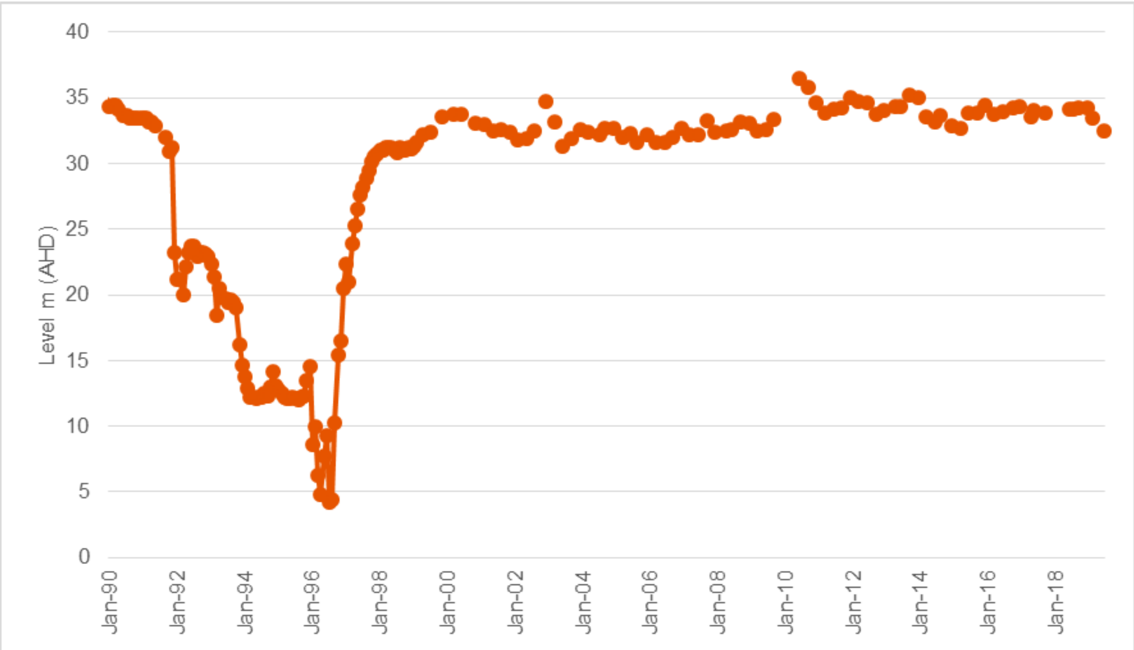


Figure 15-2 Groundwater Level for GAB24

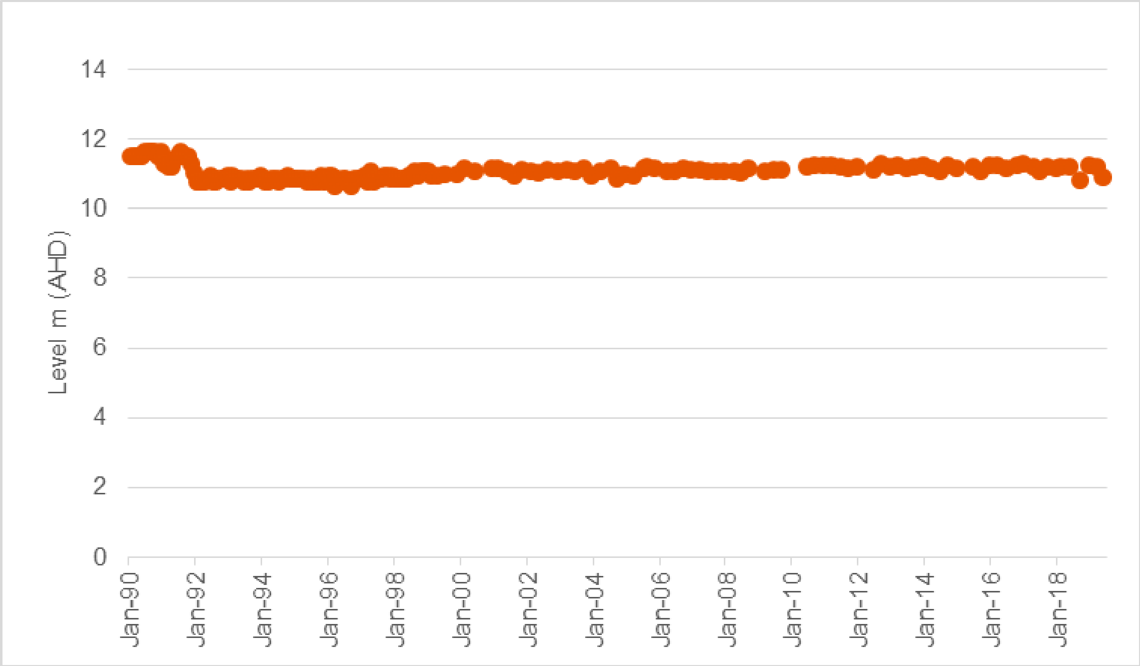


Figure 15-3 Groundwater Level for HH1

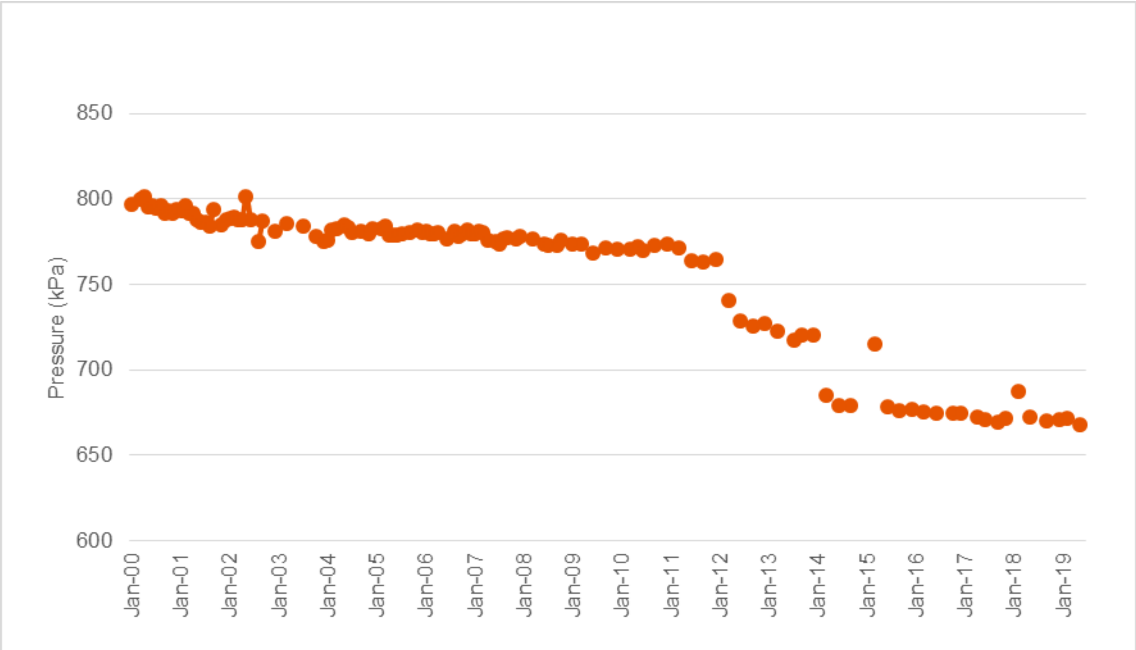


Figure 15-4 Groundwater Pressure for D2

* Pressure measurements at D2 are taken as cold shut in pressure since 2014. Prior to this a pre-heat procedure was used measuring maximum pressure rather than cold pressure.

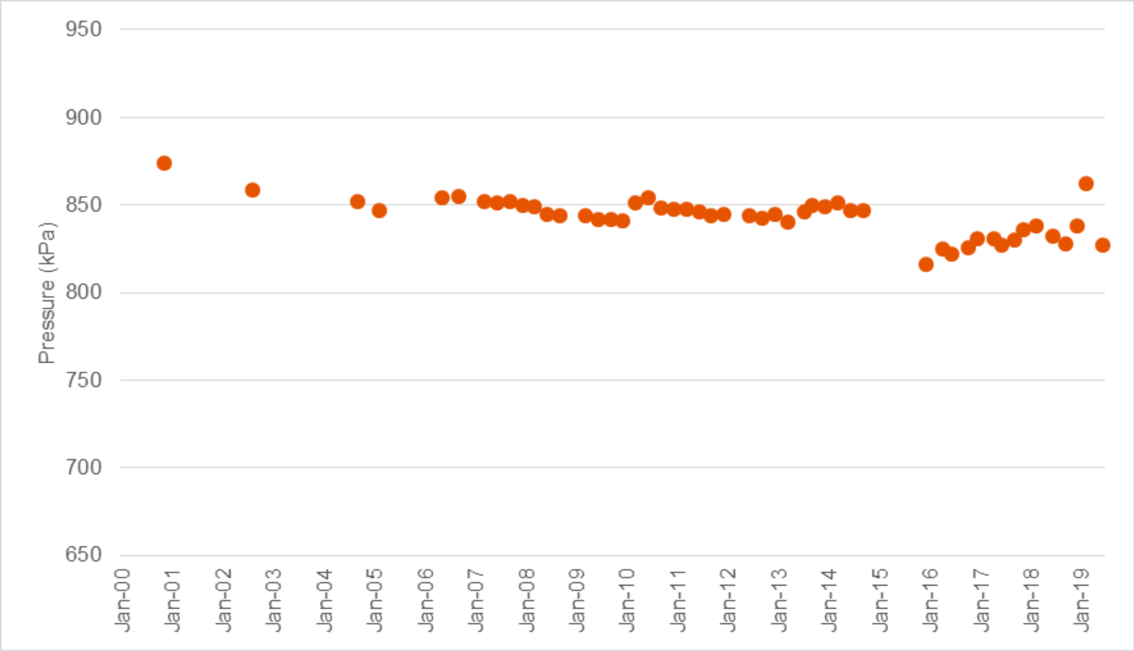


Figure 15-5 Groundwater Pressure for Georgia/Georgia 2

Measurements from October 2016 are from Georgia 2 – this well has a higher reference AHD hence a change in measured kPa.

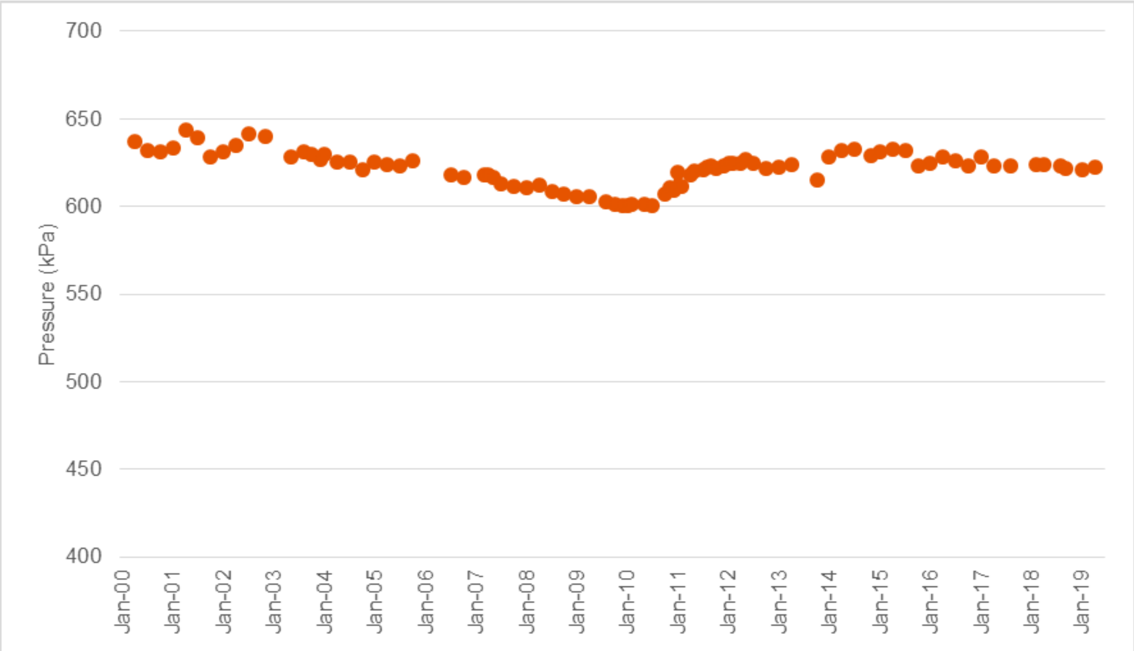


Figure 15-6 Groundwater Pressure for Jackboot

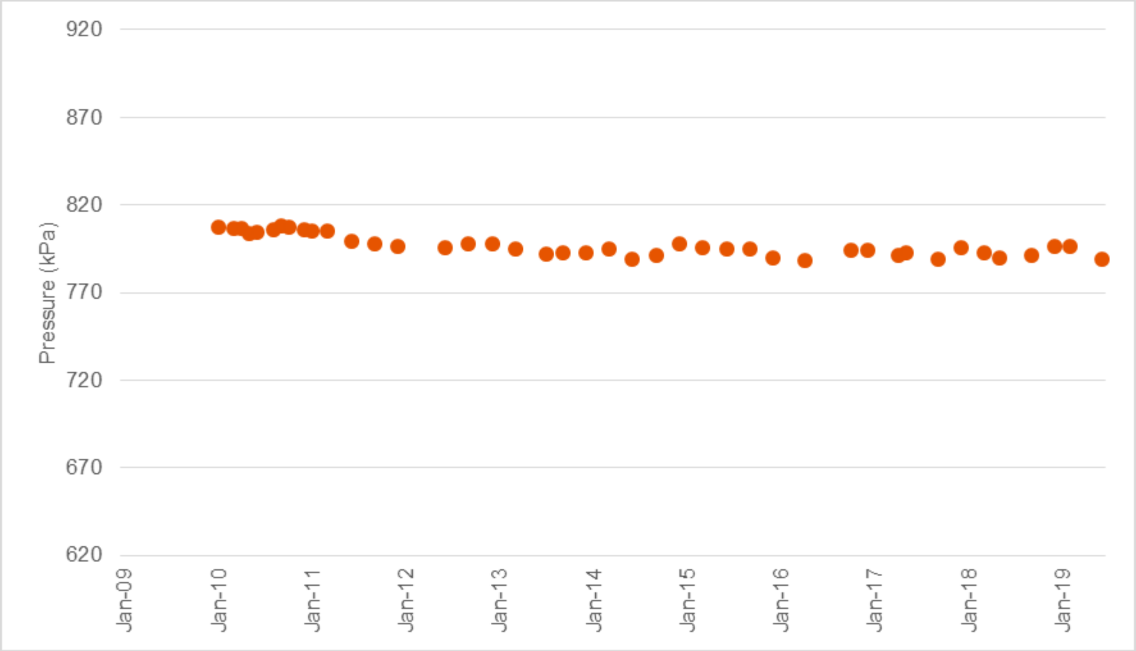


Figure 15-7 Groundwater Pressure for MB8

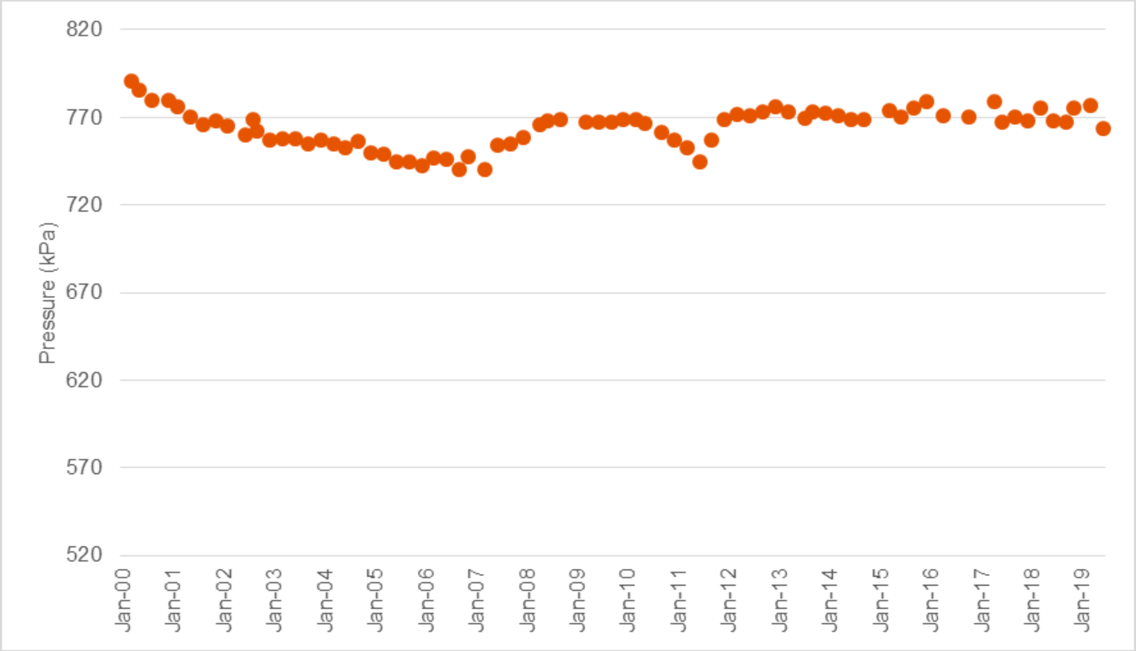


Figure 15-8 Groundwater Pressure for OB3

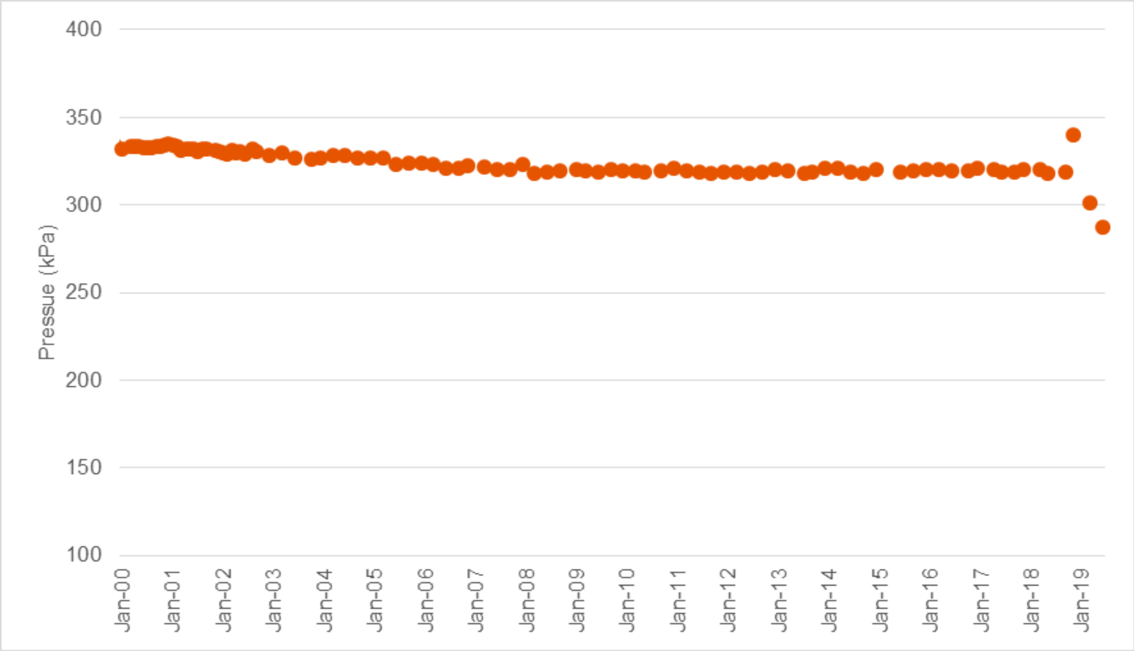


Figure 15-9 Groundwater Pressure for S1

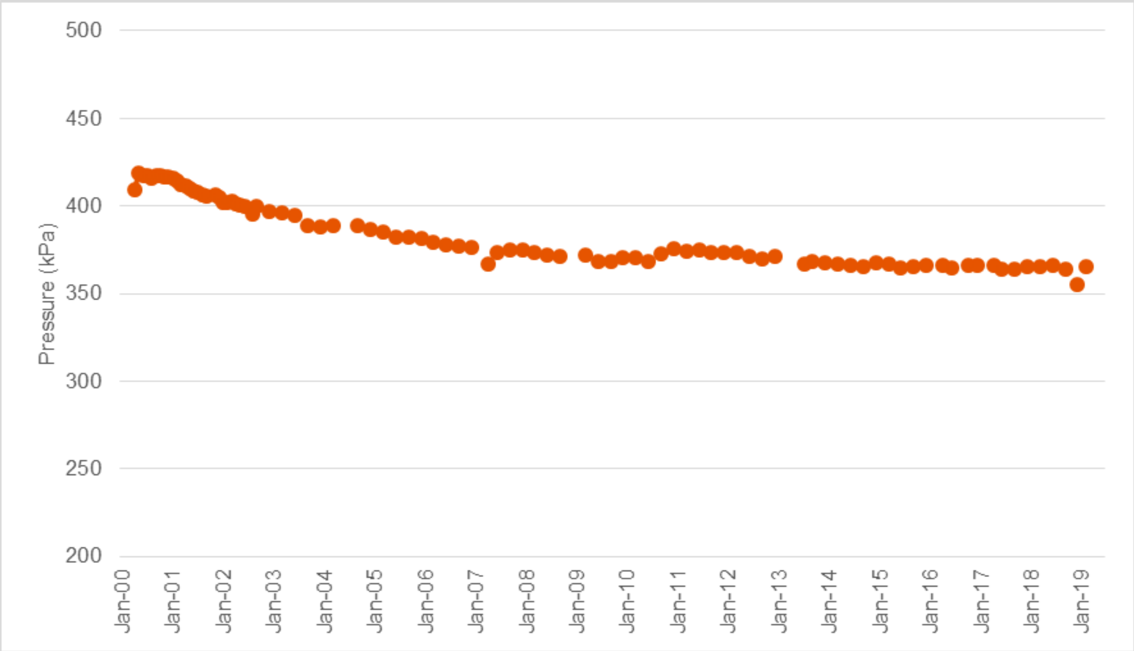


Figure 15-10 Groundwater Pressure for S3A

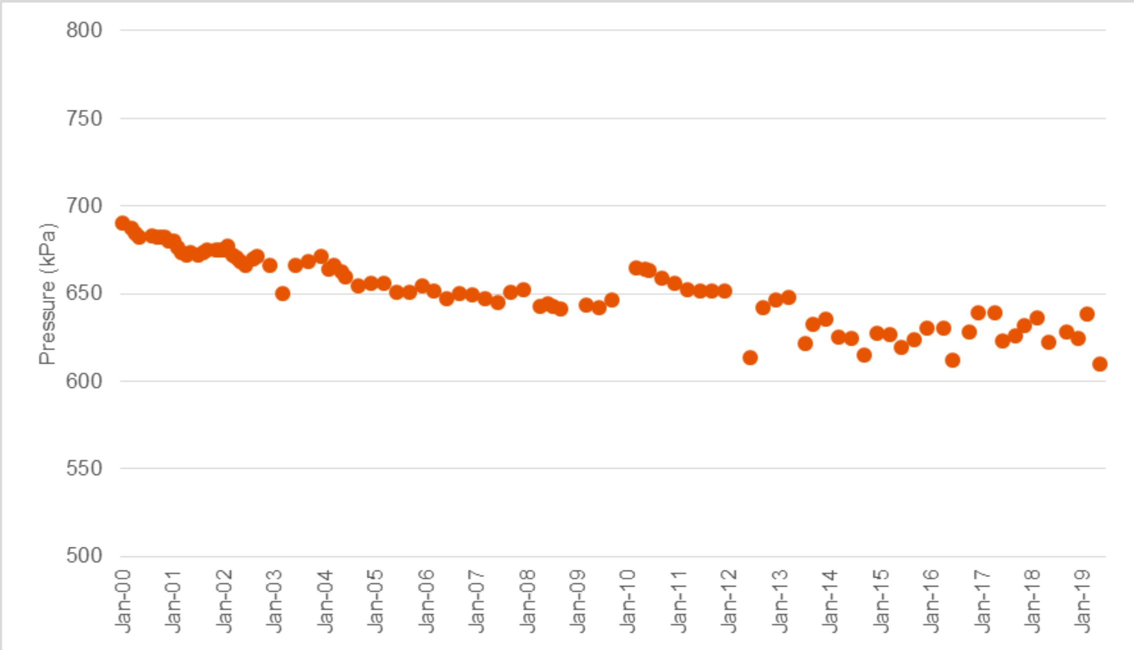


Figure 15-11 Groundwater Pressure for S5

16 Appendix 5: CONDUCTIVITY TREND DATA

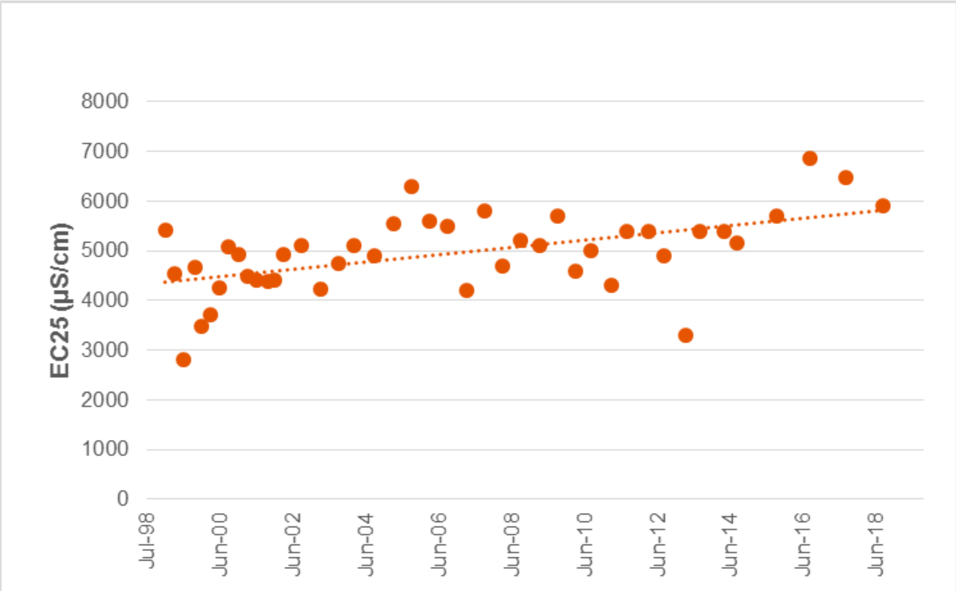
Conductivity trend graphs are provided here for:

- Bores and springs that have a regression coefficient that statistically differs from zero at the 95% confidence level and is greater than 0.10 or less than -0.10.
- Bores and springs that have an average conductivity for FY19 that is greater than the 95th percentile for that bore or spring.

Refer to Section 8 for discussion of these data.

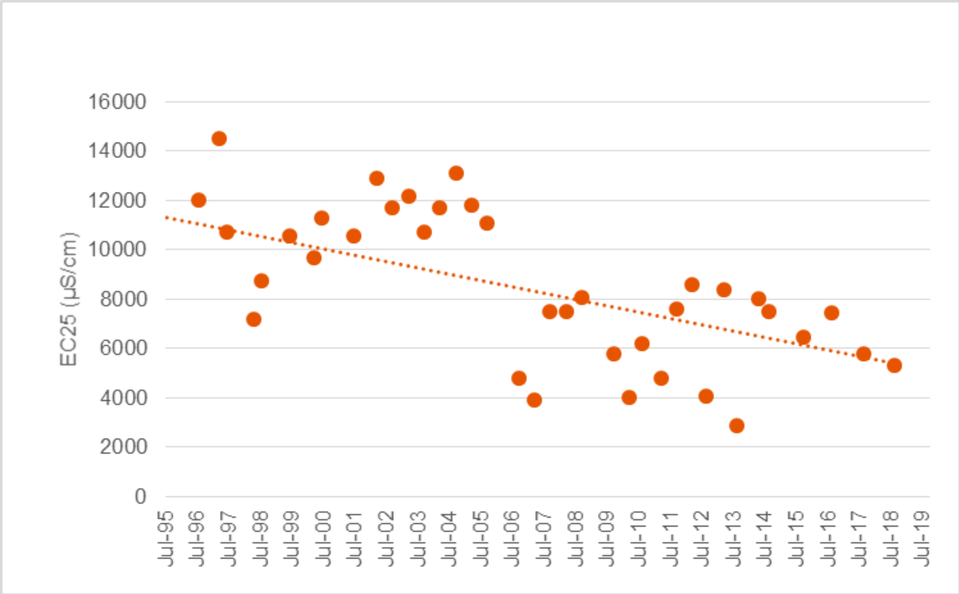
The following statistics are provided for each graph in this section:

n	The number of data points used in the regression calculation.
F	Overall F test value for null hypothesis H0:m=0 versus the alternative Ha:m≠0, where m is the slope of the line (regression coefficient) in the equation y=mx+b.
p	The associated significance value for the F test at the 95% confidence level.
r^2	R squared.



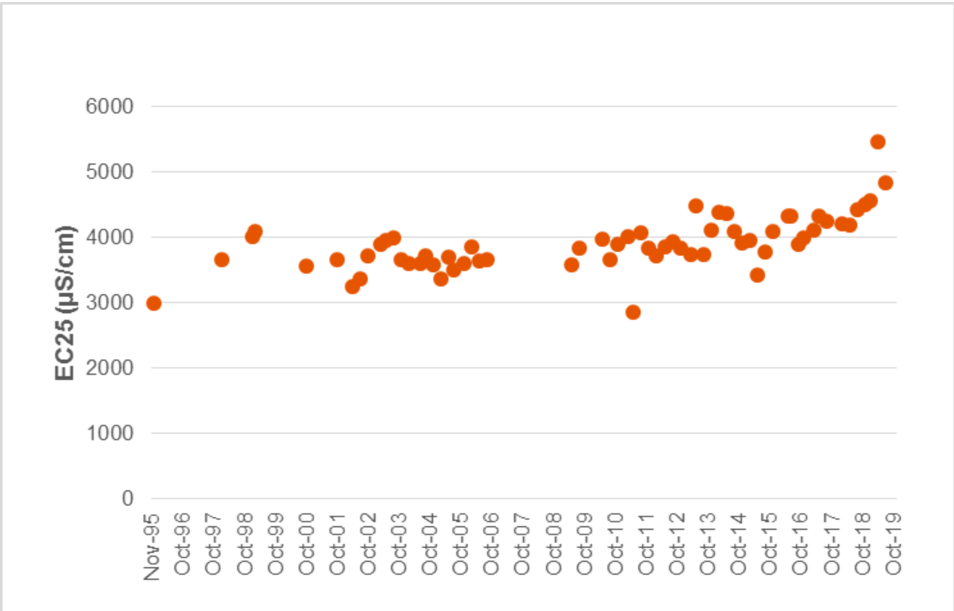
- n = 43, F = 15.8, p= 0.0002, r^2 = 0.28, significant (P<0.05) trend

Figure 16-1 Conductivity trend for Bopeechee HBO007



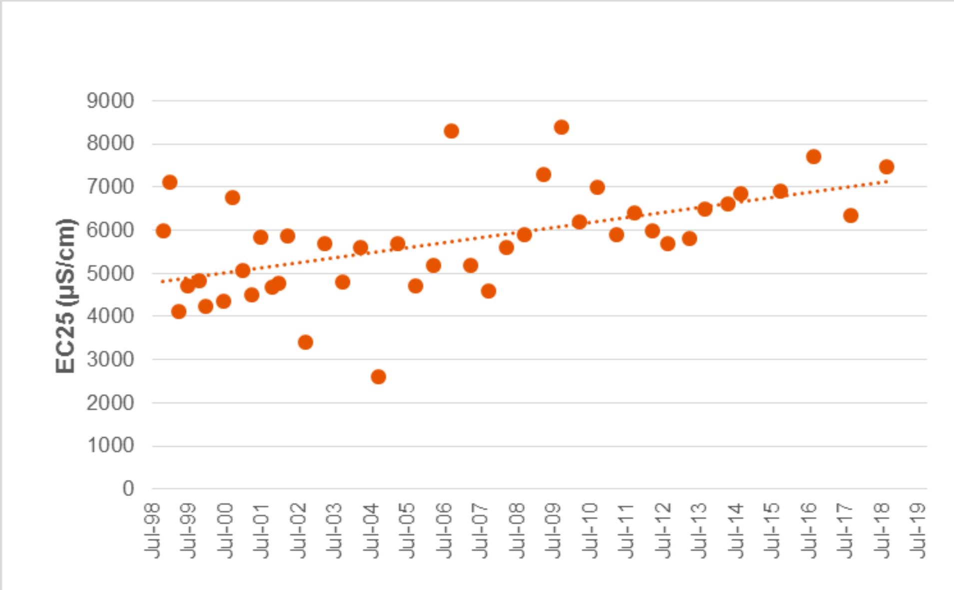
- n = 39, F = 24.9, p = 1.45E-05, r^2 = 0.40, significant (P<0.05) trend

Figure 16-2 Conductivity trend for Old Finniss HOF033



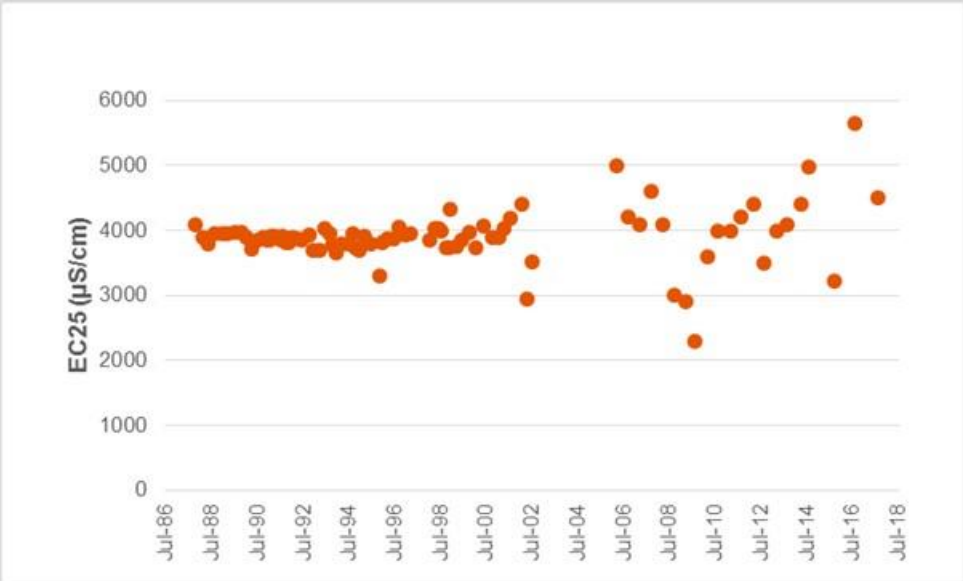
- FY19 measurement exceeds 95%-ile

Figure 16-3 Conductivity trend for GAB 21



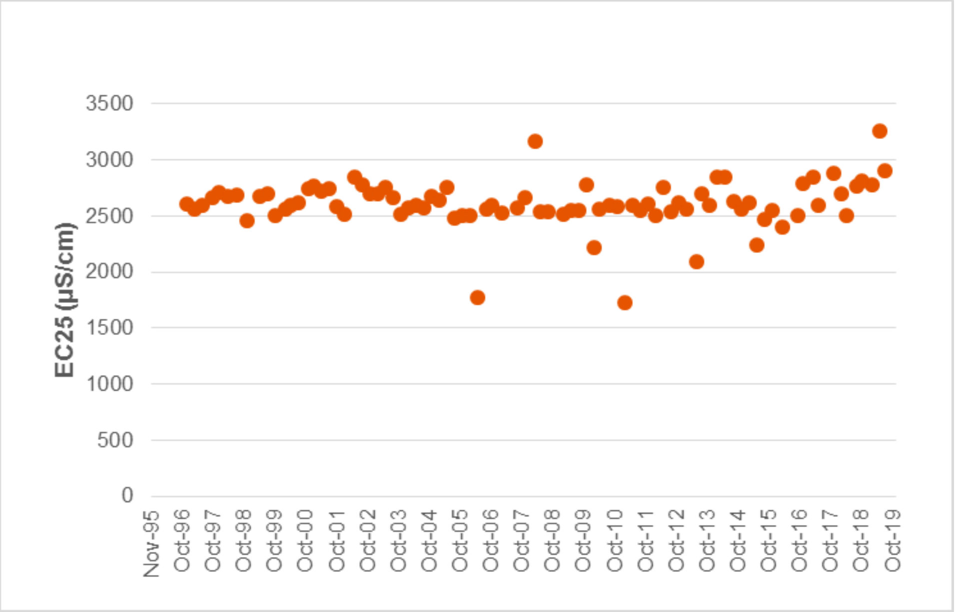
- n = 43, F = 17.71, p= 0.0001, r^2 = 0.301, significant (P<0.05) trend,

Figure 16-4 Conductivity trend for Welcome WWS001



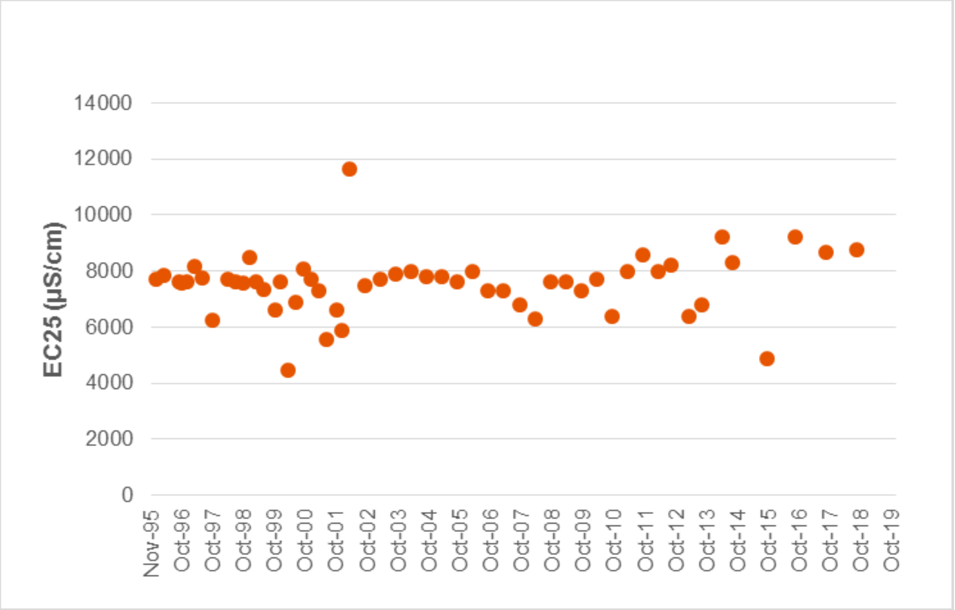
- n = 42, F = 14.73, p= 0.0004, r^2 = 0.269, significant (P<0.05) trend,

Figure 16-5 Conductivity trend for Welcome WWS013



- FY19 measurement exceeds 95%-ile

Figure 16-6 Conductivity trend for OB 1



- FY19 measurement exceeds 95%-ile

Figure 16-7 Conductivity trend for Welcome WWS002

17 Appendix 6: TEN YEAR FORWARD SCHEDULE FOR GAB ABSTRACTION

Year	Potable Water Township ML/day	Potable Water Plant & Mine ML/day	Non-potable Water Plant & Mine ML/day	Total Water Requirement ML/day	Source of Water GAB Borefield A ML/day	Source of Water GAB Borefield B ML/day
2019	2.8	8.7	22.6	34.1	5.0	29.1
2020	3.6	8.6	22.0	34.2	5.0	29.2
2021	5.0	8.1	20.5	33.6	5.0	28.6
2022	4.3	10.0	26.3	40.6	5.0	35.6
2023	4.3	10.0	27.4	41.7	5.0	36.7
2024	4.3	10.0	27.4	41.7	5.0	36.7
2025	4.3	10.0	27.4	41.7	5.0	36.7
2026	4.3	10.0	27.4	41.7	5.0	36.7
2027	4.3	10.0	27.4	41.7	5.0	36.7
2028	4.3	10.0	27.4	41.7	5.0	36.7
2028	4.3	10.0	27.4	41.7	5.0	36.7

Notes:

- As provided to the Minister for Mineral Resources Development in January 2019. An updated schedule will be provided by 1 January 2020.

18 Appendix 7: PASTORAL BORES IN THE WELLFIELD AREA

Bore	Flow Measured (M) / Estimated (E)
Boocaltaninna	E
Cannuwaukaninna	E
Chapalanna 2	M
Charles Angus	M
Clayton 1	E
Clayton 2	E
Clayton Dam 2	E
Cooranna	E
Cooryaninna	E
Dulkaninna	E
Georgia	E
Highway (Brolga)	M
Jewellery Creek	E
Kopperamanna	E
Lake Harry	E
Marion	E
Maynards	E
Morphetts	E
Morris Creek	M
Mulka	E
Muloorina	M
Mungeranie	E
Peachawarinna	E
Peters	E
Poonarunna	E
Prices	E
Sinclair	E
Tarkanina #2	M
Yarra Hill	M

19 Appendix 8: GAB SPRING ZONES

Hydrogeological zone	Springs within zone
Coward	Blanche Cup
South West	Hermit Hill, Old Finniss, Old Woman
Western Lake Eyre South	Emerald, Gosse, McLachlan
South East	Davenport, Welcome
North East	Bopeechee, Sulphuric, Dead Boy, West Finniss
Wellfield A	Beatrice, Venables, Fred