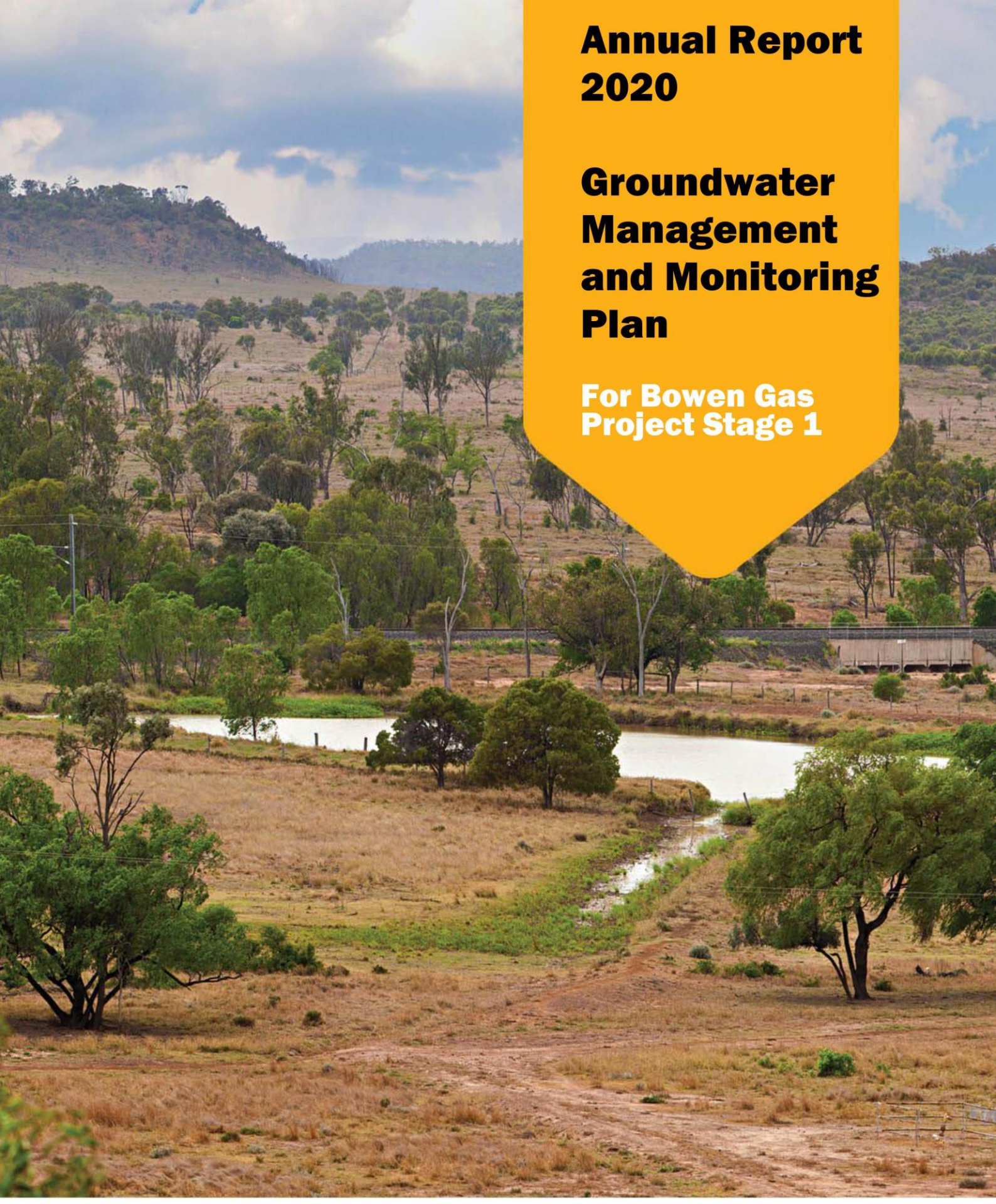

Annual Report 2020

Groundwater Management and Monitoring Plan

For Bowen Gas Project Stage 1

arrow energy
go further

May 2020

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EXECUTIVE SUMMARY

This report forms the first annual review of the Groundwater Monitoring and Management Plan (GMMP) for the Bowen Gas Project (BGP) Stage 1. This report also includes baseline data from Arrow's existing Moranbah Gas Project (MGP) operations (PL 191, 196, 223, and 224).

The BGP GMMP was approved with conditions by the (then) Department of Environment and Energy (DoEE), now the Department of Agriculture, Water and Environment (DAWE), and took effect on 24 October 2019. This report is due annually, 3 months after the anniversary date of the commencement of the BGP, which was triggered on 14 February 2019. DAWE was notified by email of the commencement on 7 March 2019 (reference: 2012/6377). On this basis, annual reports will be submitted to DAWE and uploaded to Arrow Energy's website by 14 May of each year.

This report satisfies the following requirements for the annual report as outlined in Section 6.2.4 of the GMMP. Significant updates during the report period include:

- Seven (7) wells have been installed, below the 1408 authorised operational wells. The seven wells are non-operational at present, with production of water from those wells expected to start in August 2020.

- Six (6) locations have been installed as a part of the BGP monitoring network to supplement the existing monitoring network established for Arrow's Moranbah Gas Project (MGP) network with the following summary:

    - There is no apparent influence of CSG production to the Tertiary Sediment, Fort Cooper Coal Measures (FCCM) and Rewan aquifers in the installed monitoring network for the BGP. This is expected given no water production as part of the BGP has commenced;

    - In comparison to the groundwater levels obtained in the deep monitoring bores, the 2018 BGP GMMP groundwater model predictions are over-estimating the impacts to the Moranbah Coal Measures (MCM) in the MGP area, with slight under-estimation of impacts in the FCCM and Back Creek Group (BCG); and

    - A review of the groundwater quality data indicates that there are no notable trends for both the shallow and deep aquifers in the MGP.

- Red Hill Central Petroleum Lease (within PL486) was granted in 2019 with production expected to commence in August 2020;

- Mavis Downs (within ATP 1103) water production is expected to be delayed until at least 2022;

- Ellensfield (within ATP1103) water production is expected to start in 2020 with no material water production.

- No non-compliances were recorded and therefore no remedial actions were undertaken;

- All monitoring obligations have been met, with no exceedances recorded across the monitoring network. Thus, no corrective actions were implemented;

- The project is has not advanced to the Lake Elphinstone area therefore MB11 is scheduled to be installed in 2029;

- Two research studies have been undertaken – Bowen subsurface constraints mapping and intrusion mapping using 3D seismic; and

- No out of cycle Underground Water Impact Report (UWIR) was submitted. The 2020 Annual Review of the Bowen UWIR concluded that there was no material change to water impacts as the water production forecast is significantly less than what was modelled in the 2019 UWIR. This report was submitted to Queensland's Department of Environment and Science (DES) on 22 April 2020.

1 INTRODUCTION

This report forms the first annual review of the Groundwater Monitoring and Management Plan (GMMP) for the Bowen Gas Project (BGP) Stage 1. The purpose of the GMMP is to addresses specific requirements for monitoring of groundwater and groundwater related impacts potentially resulting from the development of Stage1 and contains details of.

- A groundwater monitoring network to provide for early detection of any changes in groundwater regime and impacts on groundwater dependent ecosystems.
- A baseline monitoring data acquisition program.
- An Early Warning System (EWS) including:
    - early warning indicators, trigger thresholds and limits for detecting impacts on groundwater levels, and;
    - exceedance response actions and timeframes.
- The timeframe for a regular review of the GMMP aligned with the state required Bowen UWIR; and
- Provisions to make monitoring results publicly available.

This report also includes data from Arrow's existing MGP operations (within Petroleum Leases (PLs) 191, 196, 223, and 224) which was previously described in the GMMP for baseline groundwater purposes and also supplements the GMMP monitoring network. Full analysis of the monitoring network, water production, groundwater levels and groundwater quality for the MGP is available in the 2020 Annual Review of the Bowen UWIR and attached as Appendix A.

The location of Arrow Energy's tenure in the Bowen Basin is displayed in Figure 1 , with the project area for Stage 1 displayed in Figure 2.

The GMMP was approved with conditions by the then Department of Environment and Energy (DoEE), now the Department of Agriculture, Water and Environment (DAWE), and took effect on 24 October 2019.. This report is due annually, 3 months after the anniversary date of the commencement of the BGP, which was triggered on 14 February 2019. DAWE was notified of the commencement on 7 March 2019 (reference: 2012/6377). On this basis, annual reports will be submitted to DAWE and uploaded to Arrow Energy's website by 14 May of each year. Periodic revisions of the GMMP are required to be submitted to the DAWE every three years if it is deemed that there are material changes to forecast production or groundwater modelling impacts.

For the purposes of reporting and alignment with the annual review of Arrow Energy's Bowen UWIR, the data collected and analysed will be for the calendar year (i.e. 1 Jan 2019 to 31 Dec 2019) and include groundwater data for both Arrow's existing production area, the MGP and the BGP.

As per Section 6.2.4 of the GMMP, the annual report requires the following to be addressed:

- Report on any relevant ongoing studies and research projects and include any supporting technical studies as appendices to the annual report (Section 5);
- Document the number of coal seam gas wells, including (Section 2):
    - Total number of wells installed, the number of operational wells, the number of non-operational wells, and the number of decommissioned or failed wells; and
    - Confirmation that production is not from more than 1,408 operational wells.
- Provide an update on the implementation of the groundwater monitoring network and baseline monitoring, and summarise relevant monitoring results, including (Sections, 3 and 4):
    - Groundwater levels and trends (Section 4.2);

    - Groundwater chemistry results and trends (Section 4.3);
    - Analysis and interpretation of data and identification whether drawdown predictions made have changed materially (Section 4.2); and
    - An assessment of factors contributing to observed groundwater level changes e.g. non-CSG versus CSG influences (Section 4.2).
- Provide any updates to the groundwater monitoring network if required (Section 3);
- Detail any confirmed non-compliances along with details of any remedial actions (Sections 3 and 4);
- Document compliance against the approval conditions over the preceding 12 months, including monitoring obligations and implementation of the EWS (Sections 3 and 4);
- Document corrective actions implemented to address any exceedances of trigger thresholds, limits, or non-compliance with approval conditions (Sections 3 and 4);
- Report against the performance measure criteria (Section 3); and
- Identify if an out of cycle UWIR was submitted (due to a material change or error in the information or predictions) and if practical consider a review of the GMMP outside of the 3-yearly review schedule. No out of cycle UWIR was submitted. The 2020 Annual Review of the Bowen UWIR concluded that there was no material change to water impacts as the water production forecast is significantly less than what was modelled in the 2019 UWIR.

2 WATER PRODUCTION REVIEW

A review of actual water production and forecast water production for the MGP and BGP is presented in the 2020 Annual Review of the 2019 Bowen UWIR (Appendix A). Based on the findings of the report, it is expected that the modelled IAA impact predictions made in the 2019 Bowen UWIR overestimate impacts likely to occur (based on updated water production forecasts). Therefore, an out of cycle UWIR is not required to be prepared for submission.

Table 1 below displays the current status of production wells within the BGP. Production does not exceed the 1,408 authorised operational wells.

Table 1: BGP well status

		Approximate number of production wells[1]	Wells installed	Operational wells	Non-operational wells	Decommissioned or failed wells
Project Stage 1 FDP	Red Hill Central	31	7	0	7	0
	Mavis Downs	17	0	0	0	0
	Remainder of the Project Stage 1 area	1,360	0	0	0	0
	GMMP Total	1,408	7	0	0	0

Note 1: Well locations and numbers for Red Hill, Mavis Downs, and the remainder of Project Stage 1 area are indicative only. Total well count, however, will not exceed 1,408 for Project Stage 1. The well counts are for vertical production wells only.

As discussed in the 2020 Annual Review of the 2019 Bowen UWIR, the following changes to the field development plan (FDP) have occurred since the approval of the GMMP:

- Red Hill Central Petroleum Lease (within PL486) was granted in 2019 with production expected to commence in August 2020;
- Mavis Downs (within ATP 1103) water production is expected to be delayed until at least 2022; and
- Ellensfield (within ATP1103) water production is expected to start in 2020 with no material water production.

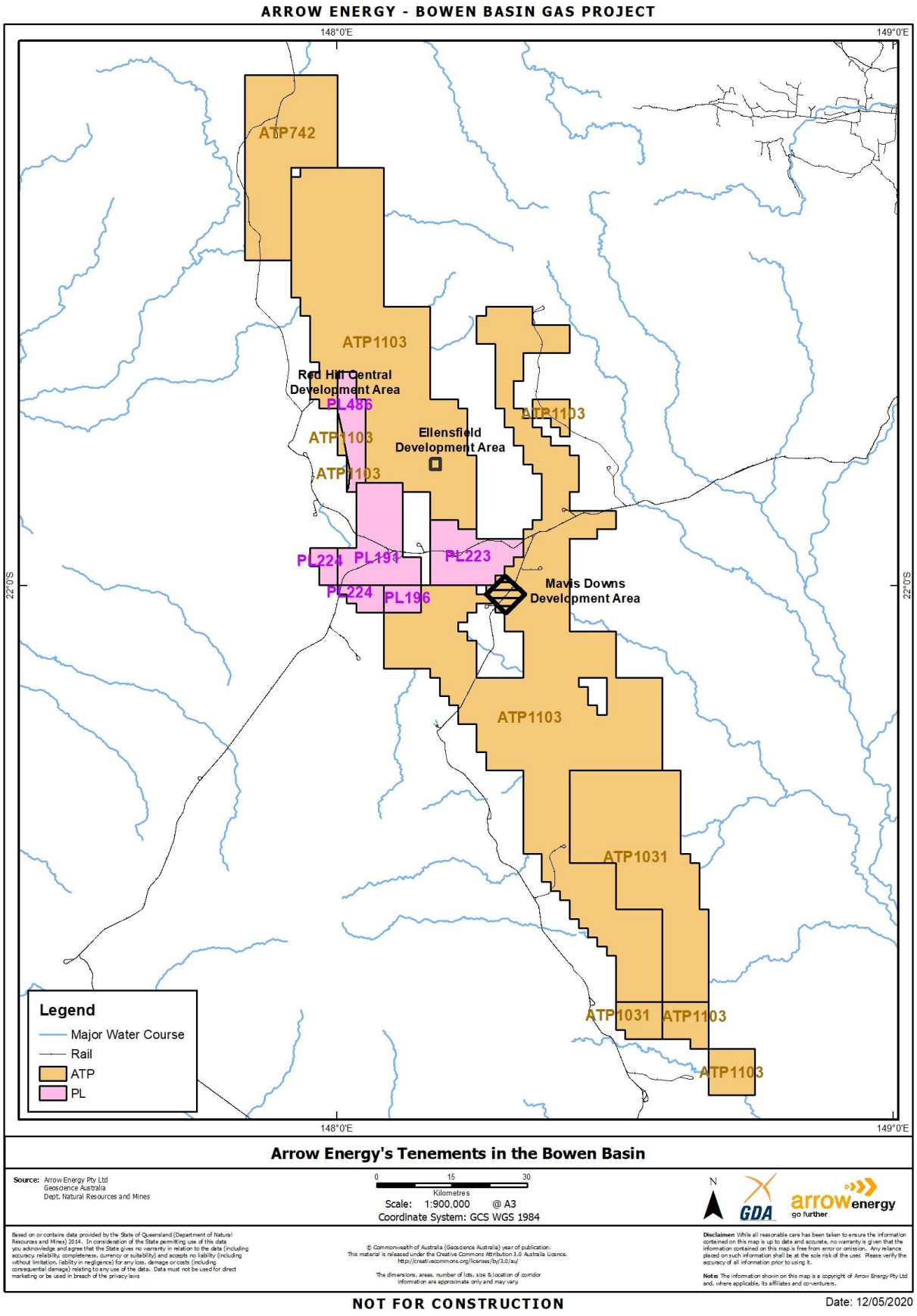


Figure 1: Arrow Energy's Tenements in the Bowen Basin

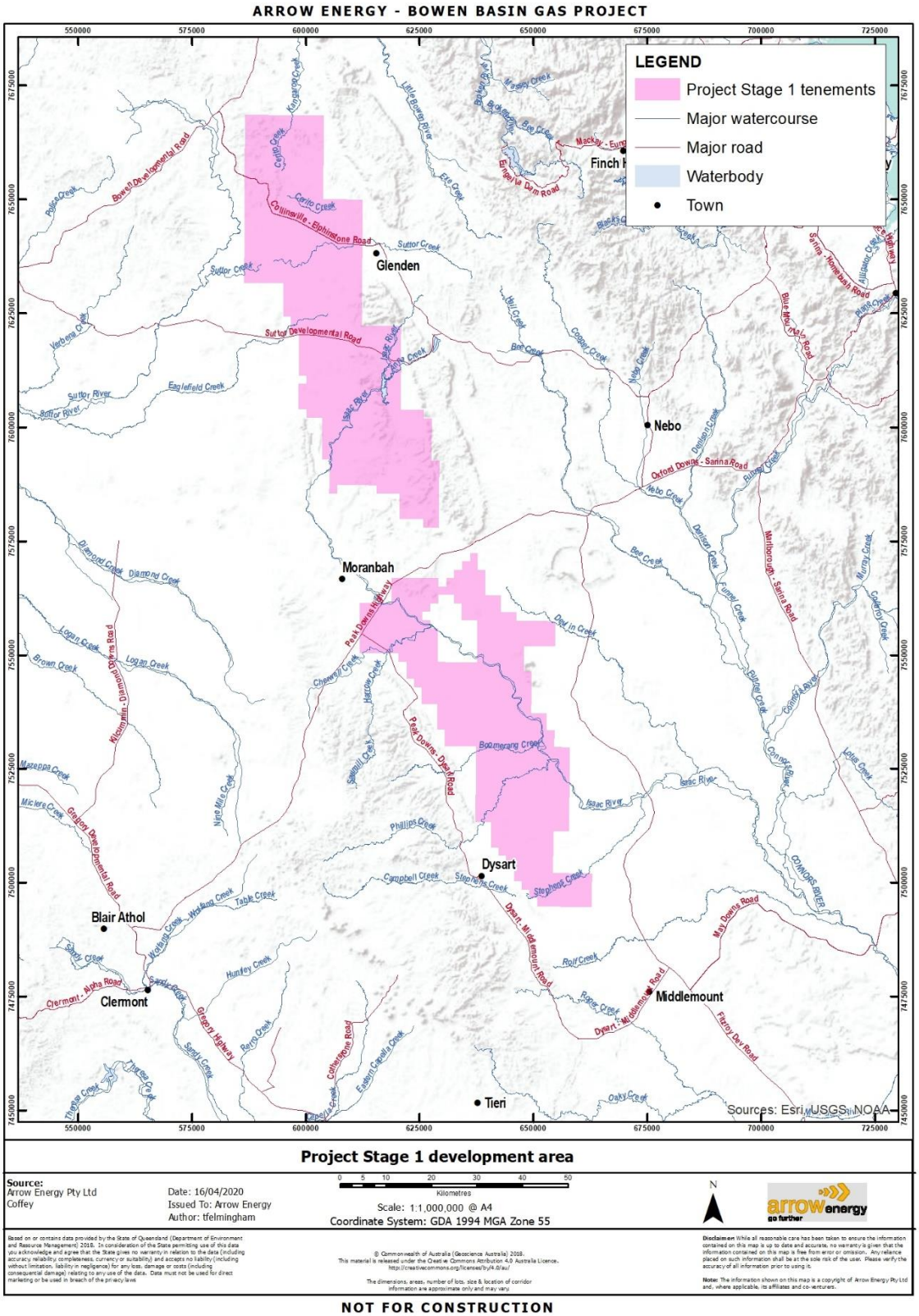


Figure 2: Stage 1 development area

3 WATER MONITORING STRATEGY (WMS)

3.1 MGP Area Groundwater Monitoring Network

A total of 16 groundwater monitoring bores form the groundwater monitoring network for the MGP Area. Figure 3 provides an overview of the spatial distribution of the groundwater monitoring network. Groundwater monitoring is being undertaken in these bores in accordance with the WMS in the approved 2019 Bowen UWIR and approval conditions. The data collected from this monitoring network is being used to supplement baseline data from the BGP groundwater monitoring network. Full discussion of the MGP groundwater monitoring network for the MGP is available in the 2020 Annual Review of the Bowen UWIR and attached as Appendix A.

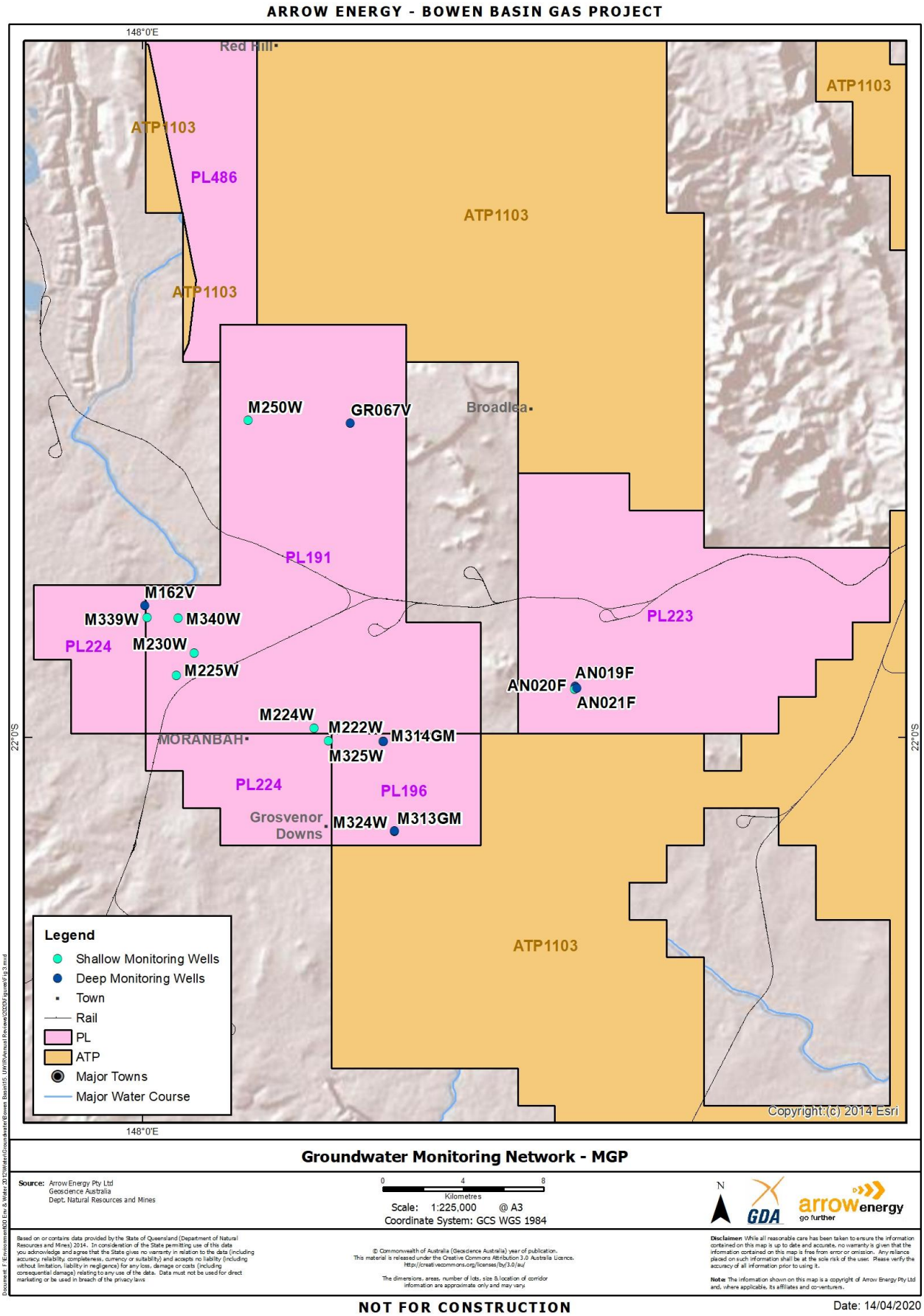


Figure 3: Groundwater Monitoring Network for MGP

3.2 BGP Area Groundwater Monitoring Network

The approved groundwater monitoring network for the BGP area is comprised of 35 monitoring intervals at 22 separate locations (comprising 12 single sites and 10 nested sites of 23 monitoring intervals). Figure 4 provides an overview of the spatial distribution of the groundwater monitoring network. Table 2 below displays the monitoring requirements of the BGP, along with the status of each location. Note that Table 2 displays the monitoring location name as per the 2019 Bowen Groundwater Monitoring and Management Plan (GMMP) which was approved by DAWE to comply with Arrow Energy's approval for the BGP. All subsequent reporting is based off this nomenclature.

At present, six locations have been installed as a part of the monitoring network; MB1-S/I/D, MB2, MB3, MB12, GW001 and GW007 as detailed below. The groundwater levels and water quality of these bores are presented in Section 4.2 and 4.3). No non-compliances have been recorded to date.

MB1-S/I/D

MB1 was installed as an appraisal (pilot) production well (originally named Red Hill-30) in January 2010. Groundwater pressure observations were made from the Moranbah Coal Measures (i.e. the deep interval) using the well from November 2011 to December 2011. Pumping from the well (for the pilot) was also undertaken during this time in the deep interval (MCM).

Pilot operation (and monitoring) ceased between December 2011 and November 2012.

The well was again monitored from 30 November 2012. The water level in Red Hill-30 had recovered to within 92% of its original baseline level prior to pumping for the pilot recommencing in December 2012.

From December 2012 the pilot was again operated (including production from Red Hill-30). Production from Red Hill-30 and the other pilot well in the pilot ceased in May and April 2013 respectively. Monitoring in Red Hill-30 continued until it was suspended in September 2013.

In October 2019 MB1 was modified to enable additional monitoring from the intermediate and shallow intervals to take place. Groundwater pressure data has been collected from all three intervals in MB1 since 11 November 2019. The target formations for MB1 as stated in the GMMP were the Quaternary / Tertiary Sediment, Rangal Coal Measures and the MCM. However, due to the insufficient thickness of the Quaternary / Tertiary Sediment and the Rangal Coal Measures and the shallow depths of the FCCM encountered when drilling, the shallow and intermediate monitoring points were installed within upper and lower sections of the FCCM, respectively.

This monitoring location is within 10 kilometres of the Red Hill Central development area.

MB2

MB2 was installed as an appraisal (pilot) production well (originally named Red Hill-60) in January 2011. Groundwater pressure observations were made from the Moranbah Coal Measures using the well from September to October 2015 (1.5 months), October 2017 to May 2018 (8 months), February 2019 to November 2019 (7 months) and, following a period of data loss between November 2019 to January 2020, from January 2020 until present. Pumping (intermittently) from the well (for the pilot) was undertaken between 2012 and 2018. The well was converted to a monitoring well using the existing downhole pressure gauge in February 2019.

This monitoring location is within 10 kilometres of the Red Hill Central development area.

MB3

MB3 was installed as an appraisal (pilot) production well (originally named Red Hill-51) in November 2011. Groundwater pressure observations were made from the Moranbah Coal Measures using the well from September 2013 to May 2014 (9 months), October 2017 to May 2018 (7 months), and February 2019 to November 2019 (7 months) before the downhole pressure gauge failed. The well was converted to a monitoring well using the existing downhole pressure gauge in February 2019.

An adjacent appraisal (pilot) production well (originally named Red Hill-50) will be converted to a monitoring well in May 2020 and which will then fulfil monitoring requirements for MB3.

This monitoring location is within 10 kilometres of the Red Hill Central development area.

MB12

MB12 was installed as a mine monitoring bore (originally named EFGW5D) by Fitzroy Mining in June 2008. Groundwater pressure observations were made from the Rewan Formation through both manual water level measurements and hourly data logger measurements since January and July (respectively) 2018. A data logger was installed in the monitoring bore in July 2018 which is still in operation.

This monitoring location is within 10 kilometres of the Red Hill Central development area.

GW001 and GW007

GW001 and GW007 were installed as mine monitoring bores by BHP Mitsubishi Alliance (BMA) in 2011. Arrow commenced monitoring these two bores in November 2019 however historical data for GW001 extends back to February 2017. GW001 is currently logging at 12-hour intervals, with planned installation of a pressure transducer in GW007 in 2020.

This monitoring location is within 10 kilometres of the Red Hill Central development area.

Table 2: BGP Monitoring network

Monitoring location	Monitoring interval and target formation	Development area	Installation by year (indicative)	Status
MB1	S – Quaternary / Tertiary	Red Hill Central	Current	Pressure monitoring required twice daily until 11/11/2020, and 6-monthly water level measurement for remainder of CSG production. Water quality sampling required from MB1-D at biannual frequency for the first year, and annually thereafter (i.e. 2021).
	I – RCM			
	D – MCM			
MB2	MCM		Current	Currently on monitoring. Pressure monitoring required twice daily until 31/10/2020, and 6-monthly water level measurement for remainder of CSG production. Online date is 16 February 2019 however data was lost between 30 October and 9 January 2020.
MB3	MCM		Current	Currently on monitoring. Pressure monitoring required twice daily until 31/10/2020, and 6-monthly water level measurement for remainder of CSG production. Online date is 16 February 2019 however data was lost between 30 October and 9 January 2020.
MB4	Unconfined alluvium		Contingent	Not currently required as criteria not yet triggered. Requirement for installation is based on (modelled) increased risk of depressurisation resulting from changes in the FDP, or MB1 pressure monitoring data indicate interconnectivity of MCM with overlying units.
MB5	Tertiary / Triassic	Mavis Downs	2022	Not currently required due to no development within 10km
MB6	Quaternary / Tertiary	BGP FDP (northern development area)	Contingent	Not currently required as criteria not yet triggered. Requirement for installation is based on (modelled) increased risk of depressurisation resulting from changes in the FDP, or monitoring of other sites in the northern development area indicate the potential or likelihood of preferential groundwater flow occurring across formations by way of geological faults
MB7	S – Tertiary		2029	Not currently required due to no development within 10km
	D – RCM			
MB8	Quaternary / Tertiary		2030	Not currently required due to no development within 10km
MB9	S – Quaternary / Tertiary		2029	Not currently required due to no development within 10km
	I – RCM			
	D – MCM / FCCM			
MB10	Tertiary		2030	Requires installation immediately prior to commencement of pumping from Wards Well pilot wells (currently scheduled for Jan 2022).
MB11	S – Quaternary / Tertiary or Rewan Formation		2029	Not currently required due to no development within 10km
	D – RCM			
MB12	Quaternary / Tertiary		2028	Existing Fitzroy Mining monitoring bore (EFGW5D) being utilised to obtain pressure monitoring data in place of MB12. EFGW5D is located approximately 345m from the proposed location for MB12. Monitoring commenced in July 2018. Pressure monitoring will include 6-monthly water level measurements for remainder of CSG production
MB13	S – Quaternary / Tertiary (if present)	BGP FDP (southern development area)	Contingent - 2028	MB13S not currently required due to no development within 10km Requirement for installation of MB13D is based on monitoring of MB13-S and/or other monitoring points in the southern development area indicates the potential or likelihood of preferential groundwater flow occurring across formations by way of geological faults, or ongoing modelling or revised development indicates a greater risk of depressurisation impact at this location
	D – Blackwater Group (RCM / FCCM / MCM)			
MB14	S – Quaternary / Tertiary		2029	Not currently required due to no development within 10km
	I – RCM			
	D – MCM / RCCM			
MB15	S – Unconfined alluvium		2029	Not currently required due to no development within 10km
	I – Tertiary / Triassic			
MB16	Tertiary		2029	Not currently required due to no development within 10km
MB17	S – Unconfined alluvium	ATP 1103 (in proximity to Lake Elphinstone)	Contingent	Not currently required as criteria not yet triggered Requirement for installation is based on if revised modelling indicates a risk of depressurisation impacts to Lake Elphinstone, or if impacts are detected at MB11-S
	I – Rewan Formation			
Supplementary monitoring bores				
AEN1214	Rangal Coal Measures	BGP FDP (northern development area)	Existing	Not currently required due to no development within 10km
AEN1036	Blackwater Group	BGP FDP (southern development area)	Existing	
AEN1050	Quaternary alluvium	Red Hill Central & Mavis Downs development area	Existing	
GW001	VWP 1 – alluvium	Red Hill Central & Mavis Downs development area	Existing	Annual data download from VWP logger
	VWP 2 – Fort Cooper Coal Measures			
GW007	Alluvium	Red Hill Central & Mavis Downs development area	Existing	Requires 6-monthly manual water level measurements
	Fort Cooper Coal Measures			

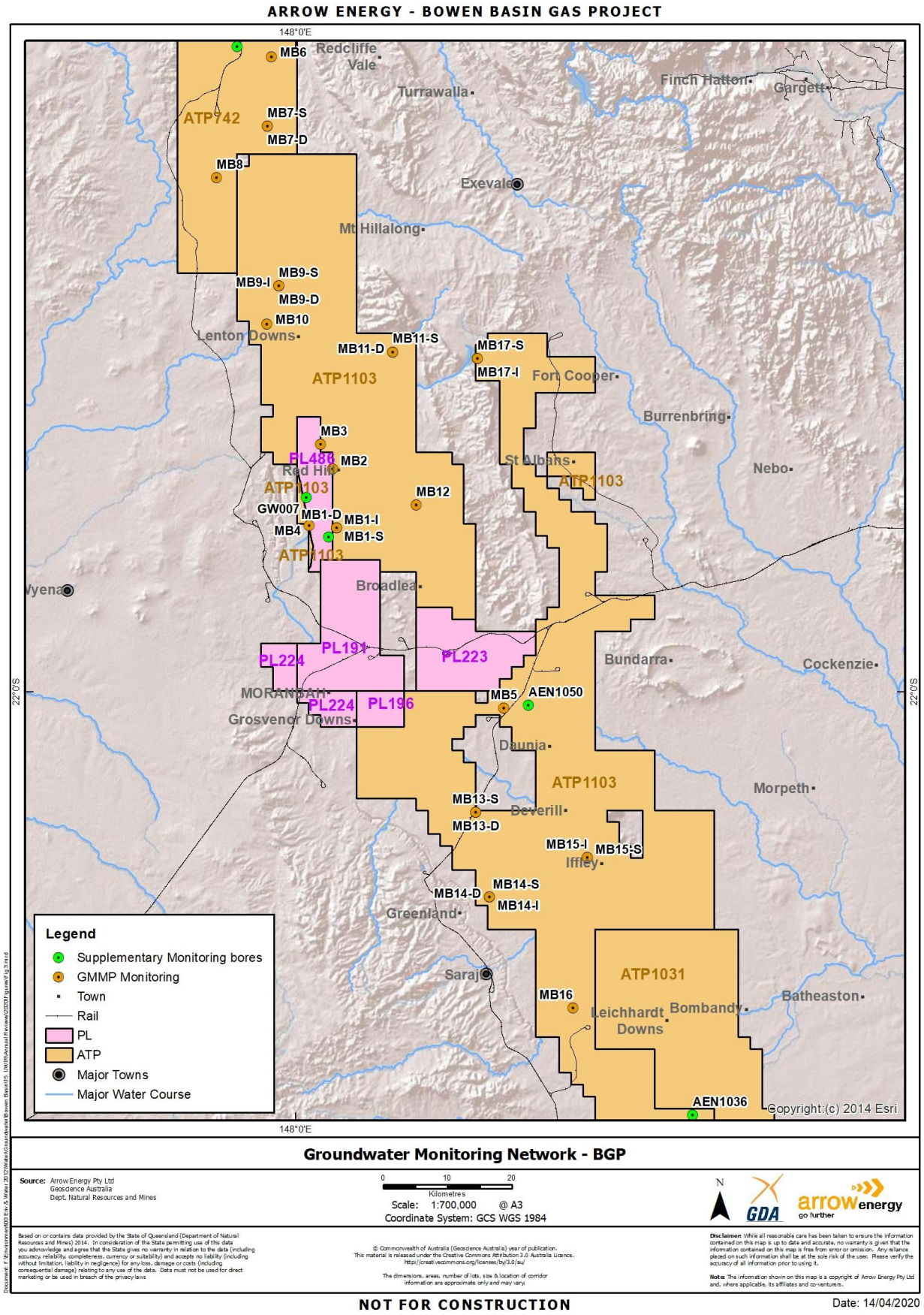


Figure 4: Groundwater Monitoring Network for BGP

4 GROUNDWATER ASSESSMENT UPDATE

4.1 Trigger Levels

Arrow's early warning system (EWS) is based on comparing modelled groundwater drawdowns derived from the GMMP groundwater model with early warning indicator levels (EWI), trigger threshold (TT), and drawdown limits, to inform escalating response actions.

The values of the EWI, TT and limits for the Quaternary age alluvium, Tertiary age sediments and basalts and Triassic age Clematis sandstone are presented below.

- EWI – Predicted drawdown by more than the applicable bore trigger threshold (BTT) (2 metres for unconsolidated aquifers and 5 metres for consolidated aquifers) for the Quaternary age alluvium, Tertiary age sediments and basalts and Triassic age Clematis sandstone.
- TT – Predicted drawdown by more than the BTT for the Quaternary age alluvium, Tertiary age sediments and basalts and Triassic age Clematis sandstone within three years.
- Limit – Predicted drawdown by more than double the applicable BTT for the Quaternary age alluvium, Tertiary age sediments and basalts and Triassic age Clematis sandstone within three years.
- The EWS values are not assigned to the coal measures (Moranbah Coal Measures and Rangal Coal Measures) per the GMMP.

The 2019 Bowen UWIR indicated that drawdown is not predicted in the unconsolidated aquifers and the Clematis sandstone.

Analysis of the current water supply bores dataset (6 April 2020) from the Department of Resources, Mines and Energy (DNRME) indicated that all bores were below the EWS values for their targeted formation.

There have been no exceedances of EWS values to date.

4.2 Groundwater Level Monitoring

In-depth analysis of the groundwater levels for the MGP is available in the 2020 Bowen UWIR Annual Review (Appendix A). Findings for the MGP groundwater levels are summarised in sections below.

4.2.1 Shallow Monitoring Bores

4.2.1.1 MGP

Groundwater levels ranged from:

- 200.4 to 209.2 m Australian Height Datum (AHD) in the weathered Tertiary Basalt aquifer,
- 233.2 to 242.3 m AHD in the Tertiary Sediment aquifer,
- 209.8 to 211.7 m AHD in the Quaternary Alluvium aquifer,
- 202.4 to 206.3 m AHD in the weathered Fort Cooper Coal Measures aquifer, and
- 237.2 to 238.6 m AHD in the Rewan Formation.

Groundwater level monitoring indicated:

- Actual groundwater levels monitored in bore M339W have remained steady over the monitoring period;
- The water levels in M222W and M225W have continued to steadily rise since monitoring began in 2012;
- Recharge to shallow aquifers due to above mean rainfall has continued to contribute to the rising trend in groundwater levels noted in M222W and M225W with a peak at the end of 2017. The water level in M230W has declined since this peak, likely due to the drop in the Cumulative Rainfall Departure (CRD);
- AN021F is installed in the Tertiary Sediment and has increased in water level since monitoring began. AN020F is installed in the Rewan Formation which is considered to be a regional aquitard. Groundwater levels monitored at AN020F has remained steady over the monitoring period;
- A decline in groundwater pressure was noted at bore M224W between November 2017 and November 2019. As discussed in the 2019 Bowen UWIR, the water levels in this bore indicate a possible hydraulic link to the river level fluctuations. This is in-line with the conceptual hydrogeological model report in the 2019 Bowen UWIR, where there

is linkage between rainfall events and river level flow periods to groundwater level. This decline is not considered to be due to the effects of CSG production; and

- A decline in groundwater pressure was noted at bore M230W between November 2017 and November 2019. The water levels observed in this bore is considered to have been influenced by nearby mining operations, similar to the decline seen in M340W (as discussed in the 2017 Annual Review of the 2016 Bowen UWIR) where a decline in groundwater levels has made this monitoring borehole dry.

The groundwater levels indicated that there is no apparent influence of CSG production to the Quaternary alluvium, weathered Tertiary basalt, Tertiary sediment, weathered Fort Cooper coal measures and Rewan Formation. This data supports the groundwater modelling predictions made in the 2019 Bowen UWIR.

4.2.1.2 BGP

Groundwater level monitoring has been undertaken in the following shallow groundwater monitoring bores which form part of the GMMP monitoring network. Table 3 provides a summary of these bores.

- Monitoring since January 2018 for bore MB12; and
- Monitoring since November 2019 for bores MB1-S, GW001A and GW007A.

Table 3: BGP Shallow Groundwater Monitoring Bores

Bore ID	Total Constructed Depth (m)	Screen Interval (mbgl)	Screened Formation
MB1-S	60	45 - 50	Fort Cooper Coal Measures – Girrah Seam
MB12	59.1	56 – 59	Rewan Formation
GW001A	6.5	6.5	Tertiary Sediment
GW007A	7.5	1.5 – 7.5	Tertiary Sediment

The groundwater level monitoring results are shown in Appendix A. Groundwater levels, as is shown in Figure 5, range from:

- 227.9 to 64.75 m Australian Height Datum (AHD) in the Tertiary Sediment aquifer;
- 209.5 m AHD in the weathered Fort Cooper Coal Measures aquifer, and
- 286.4 m AHD in the Rewan Formation.

Groundwater level monitoring, as reported in the annual review for the Bowen Basin UWIR, (Appendix A) indicates:

- Groundwater levels are stable in the shallow bores;
- GW007A was recorded as dry. An alternate location may be required if GW007A is shown to be continually dry; and
- Water level decline and recovery in MB12 is due to water quality sampling (pumping) being undertaken in the bore. The frequency of water quality sampling was decreased in H2 2019 where subsequent water level data show water level recovery between monitoring events.

Based on the presented monitoring data in Figure 5, there is no apparent influence of CSG production to the Tertiary Sediment, Fort Cooper Coal Measures and Rewan aquifers in which these bores are installed. This is expected given no water production has commenced in the BGP.

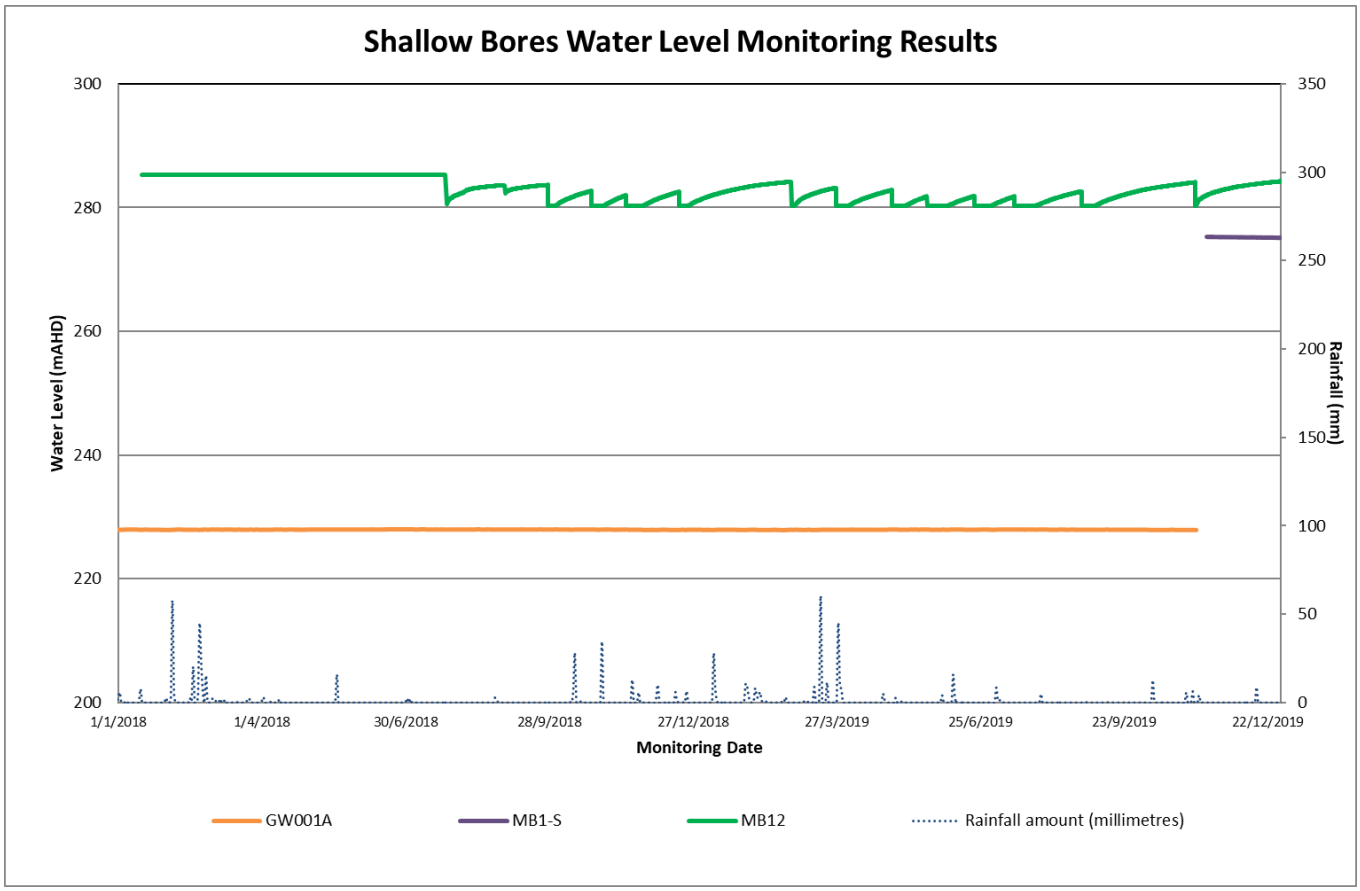


Figure 5: BGP Shallow Bores Water Level Monitoring Results

4.2.2 Deep Monitoring Bores

4.2.2.1 MGP

Observed groundwater pressures ranged from:

- 211.1 to 216.8 m AHD in the BCG;
- 49.5 to 207.7 m AHD in the FCCM; and
- -129.1 to 204.5 m AHD in the MCM.

Groundwater level monitoring, as reported in the annual review for the Bowen Basin UWIR (Appendix A), indicated:

- Modelled drawdown greater than the bore trigger threshold was not predicted to occur at bores M313W (BCG), M314W (BCG), AN019F (FCCM), M324W (FCCM), MB1 (FCCM and MCM), GW001 (FCCM) and GW007 (FCCM) which is confirmed by the monitoring data;
- Modelled drawdown greater than the bore trigger threshold was predicted to occur at bore M314W (MCM), however monitoring data shows that water levels in this bore is less than the bore trigger threshold;
- Monitoring data shows that drawdown greater than the bore trigger threshold was detected at monitoring bores M314W (MCM), M324W (MCM) and M162V (MCM). There are no existing or useable bores within a 2 km radius of these locations (M162V, M313W and M324W) in the IAA aquifer.
- Modelled drawdown at sites M313W and M324W predicted drawdown greater than the bore trigger threshold, which was confirmed in the monitoring data, however drawdown detected at M313W is significantly less than that predicted; and
- Modelled drawdown at site M162V did not predict drawdown greater than the bore trigger threshold whereas the monitoring data shows drawdown greater than the bore trigger threshold. Monitored drawdown is most likely due to localised drawdown influences from nearby production.

In comparison to the groundwater levels obtained in the deep monitoring bores, the groundwater model predictions are over-estimating the impacts to the Moranbah Coal Measures (MCM) in the MGP area, with slight under-estimation of impacts in the FCCM and Back Creek Group (BCG).

4.2.2.1 BGP

Groundwater pressure monitoring has been undertaken in the following deep groundwater monitoring bores which form part of the GMMP groundwater monitoring network. Table 4 provides details for these bores.

- Monitoring since November 2011 for bore MB1-D;
- Monitoring since September 2013 for bore MB3;
- Monitoring since September 2015 for bore MB2 (as detailed in Section 0); and
- Monitoring since November 2019 for bores GW001 and GW007 (as detailed in Section 0).

Table 4: Deep Groundwater Monitoring Bores

Bore ID	Total Constructed Depth (m)	Screen Interval (mbgl)	Screened Formation
MB1-I MB1-D	550	336 -340 423.9-506.6	Fort Cooper Coal Measures Moranbah Coal Measures
MB2	834	701.1-814.7	Moranbah Coal Measures
MB3	796.3	712.3 – 717.9	Moranbah Coal Measures
GW001B	250	-	Fort Cooper Coal Measures
GW007B	181.5	175.5 – 181.5	Fort Cooper Coal Measures

The groundwater pressure monitoring history is shown in Figure 6, with the 2019 data presented in Figure 7. Observed groundwater pressures ranged from:

- 202.4 to 269.1m AHD in the FCCM; and
- -416 to 323.0m AHD in the MCM.

The monitoring data collected to date indicated the following:

- Drawdown at MB1 in the MCM and FCCM aquifer indicated a decline of 4.6 m. This decline in groundwater level could be due to the following as there is no production occurring at present in the Red Hill Central Area:
    - Groundwater pressure equilibration after installation of the pressure monitoring equipment in October 2019; or
    - Natural variation.
- MB2 and MB3 display recovering water levels, as these wells were previous production wells.

Note that the water level data collected in GW001 is presented up to November 2019 due to manual downloading of data in November 2019. This location continues to log data after this date.

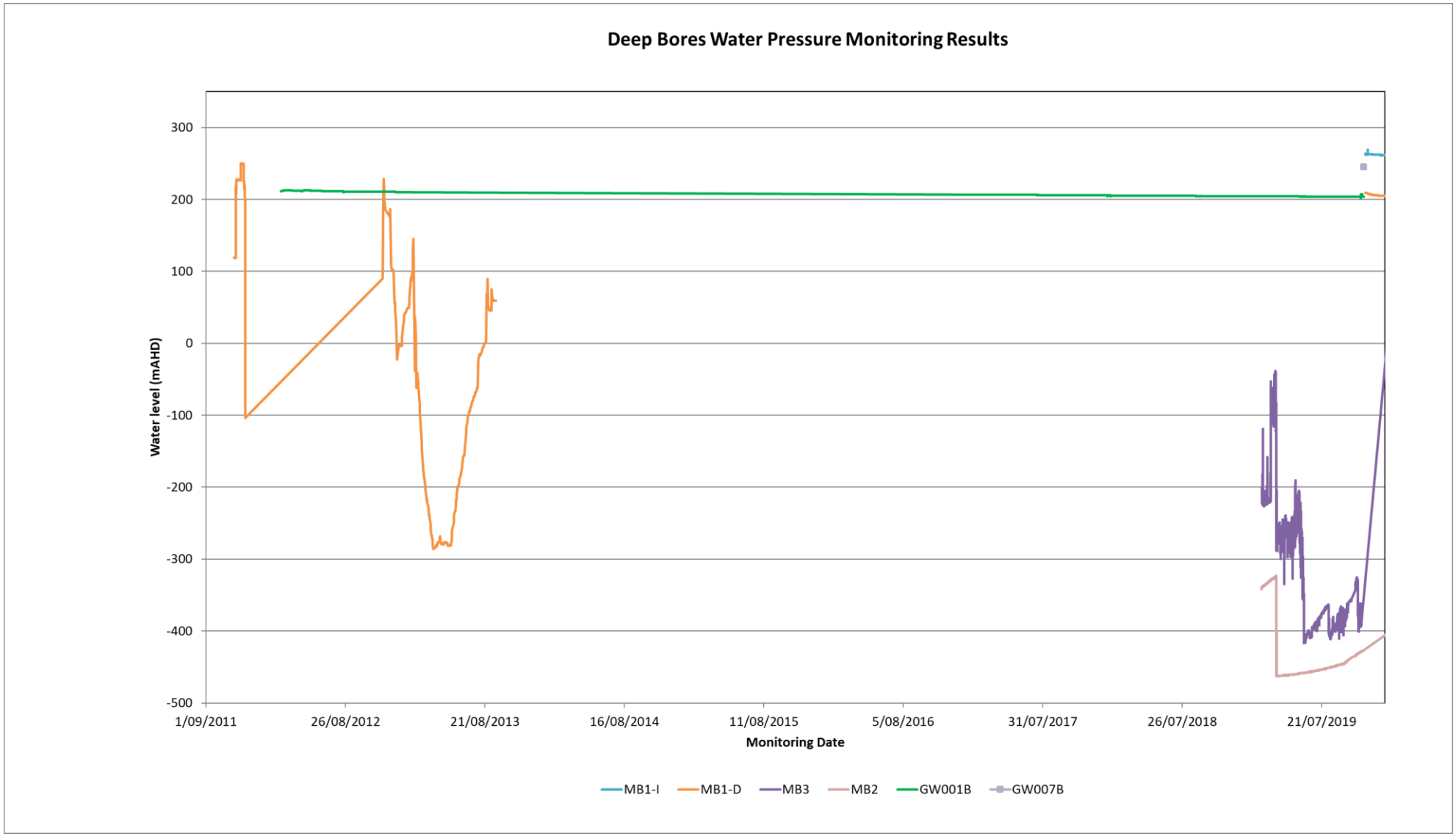


Figure 6: BGP Deep Bores Water Pressure Monitoring Results – 2012 to present

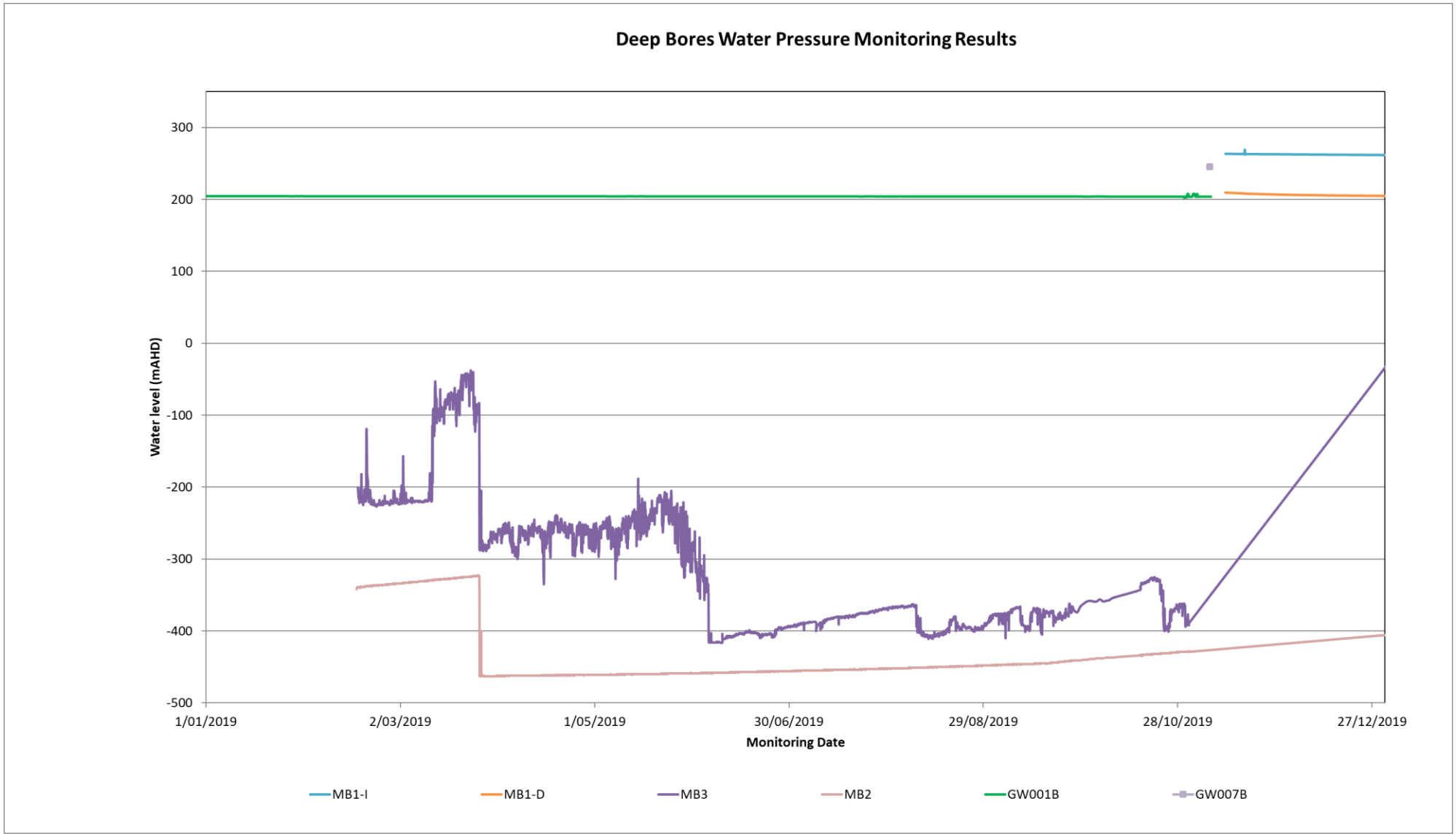


Figure 7: BGP Deep Bores Water Pressure Monitoring Results - 2019

4.2.3 Groundwater Flow

A review of vertical gradients was undertaken for two monitoring locations in the MGP Area and one monitoring location in the BGP area. The conclusions for Site 1 and Site 2 in the MGP Area as outlined in the 2020 Bowen UWIR Annual Review were:

- Site 1: The pressure trends between the MCM and shallow aquifer seem to indicate no vertical hydraulic links exist at this location.
- Site 2: The pressure trends suggest that impacts are contained within the MCM and FCCM and that no vertical hydraulic links exist at this location.

A review of vertical gradients was undertaken for one monitoring location in the BGP (MB1 – denoted Site 3). Figure 8 shows the graphically displayed vertical gradients for Site 3 and based on the presented data, a decrease in water levels in the Moranbah Coal Measures is visible, with a smaller decrease seen in the Fort Cooper Coal Measures. This decline in groundwater level could be due to the following as there is no production occurring at present in the Red Hill Central Area:

- Groundwater pressure equilibration after installation of the pressure monitoring equipment in October 2019; or
- Natural variation.

Currently, MB1 does not display groundwater level impacts in the Quaternary Alluvium. As per the GMMP, if modelling or analysis display the potential or likelihood of groundwater level impacts, monitoring location MB4 will be installed.

Ongoing monitoring at this site will provide further information on the interconnectivity of aquifers.

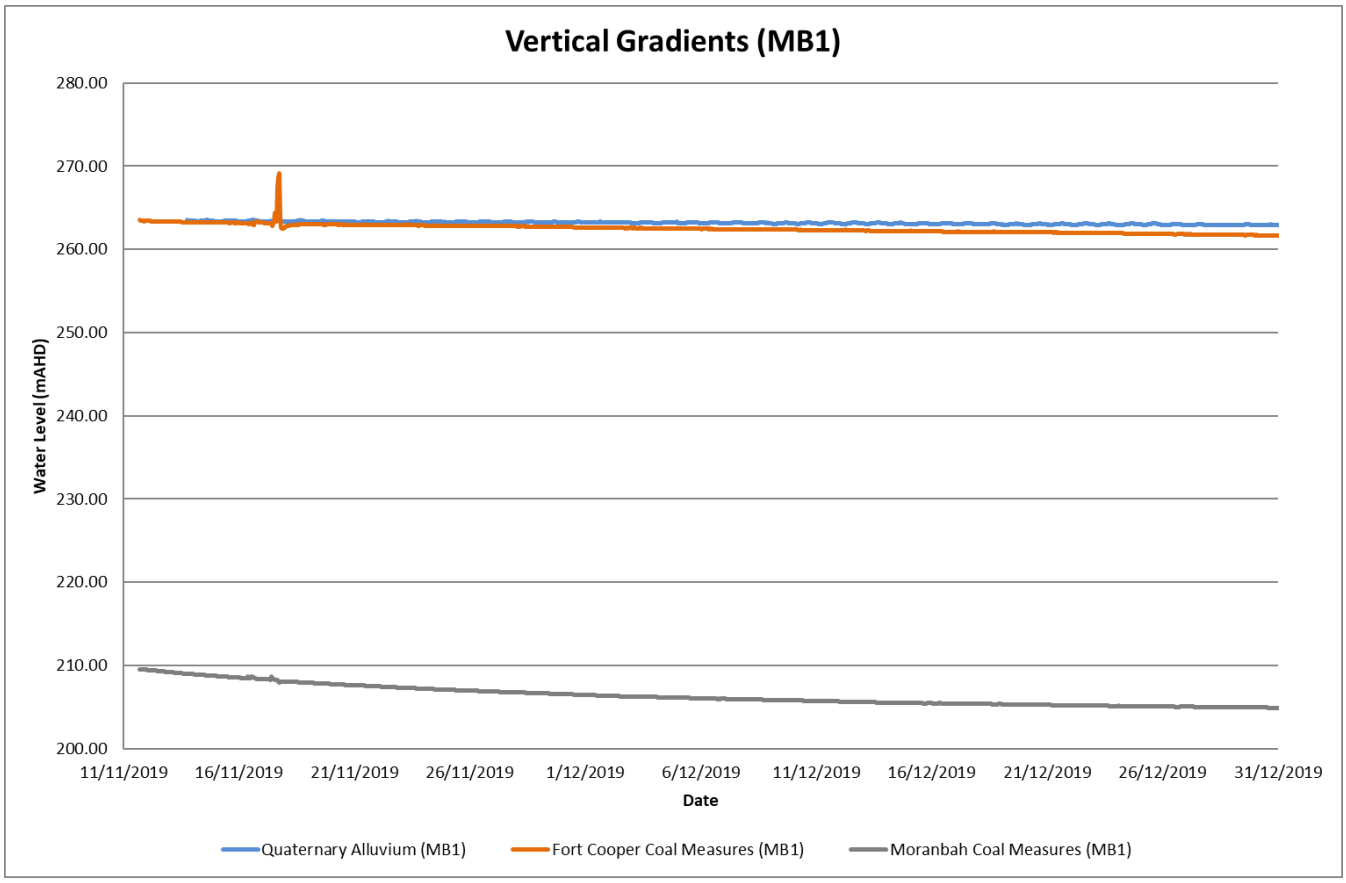


Figure 8: Site 3 - Review of Vertical Gradients (MB1)

4.3 Groundwater Quality Monitoring

The groundwater quality monitoring results are shown in Appendix B. A summary of these results are provided in the following sections.

In-depth analysis of the groundwater levels for the MGP is available in the 2020 Bowen UWIR Annual Review. Findings for the MGP groundwater levels are summarised below.

4.3.1 Shallow aquifer water quality

4.3.1.1 MGP

The groundwater quality data indicates that there are no notable trends. In general, the data showed chat

- Groundwater quality of the Quaternary Alluvium varies from brackish to saline
- Groundwater quality of the Tertiary Basalt aquifer varies from brackish to saline
- Groundwater quality of the Tertiary Sediment aquifer is fresh to brackish
- Groundwater quality of the Weathered Coal Measures is brackish
- Groundwater quality of the Rewan Formation is brackish

4.3.1.2 BGP

No groundwater quality data was obtained for the shallow aquifer. At present, no shallow groundwater quality data locations are required to be collected. As the project progresses, the following locations will require groundwater quality data to be collected:

- MB5;
- MB7-S;
- MB8;
- MB9-S;
- MB10;
- MB11-S;
- MB13-S (contingent);
- MB14-S;
- MB15-S & MB13-I (contingent);
- MB16; and
- MB17-S & MB17-I (contingent).

4.3.2 Deep aquifer background water quality

4.3.2.1 MGP

Results for some parameters between different monitoring locations show high degree of variation which is likely to be attributable to the spatial heterogeneity and low permeability of the hydrogeological system. In addition to this, as displayed by the groundwater pressure data, groundwater recovery for some sites is slow and this is likely to result in variations in some parameters at the same monitoring location. Overall, a review of this data indicates that there are no notable trends. In general, this data shows that:

- Groundwater quality of the FCCM aquifer is fresh to brackish; and
- Groundwater quality of the MCM aquifer is fresh to brackish.

4.3.2.2 BGP

At present, groundwater quality data is required to only be collected at MB1-D. One sample (November 2019 has been collected. Water quality sampling is required at MB1-D at biannual frequency for the first year, and annually thereafter. The next sample from MB1-D will be collected in May 2020.

A sample was collected from GW0007B at the same visit as a water level logger download from GW007B was undertaken in November 2019. Although it is not required by the GMMP, it is included here for analysis.

Deep groundwater quality data will be required to be collected at the following monitoring locations as the project progresses:

- MB1-D;
- MB7-D;
- MB9-I & MB9-D;
- MB11-D; and
- MB14-I & MB14-D.

Table 5 provides a summary of water quality results obtained from bores targeting the deep aquifers (MB1-D and GW007B). This provides an indication of water quality ranges for each parameter analysed based on aquifer type. With the limited data, the groundwater quality of both the FCCM and the MCM is brackish.

Table 5: Background Water Quality – Deep Monitoring Bores

Parameters	Units	Fort Cooper Coal Measures	Moranbah Coal Measures
		GW007B	MB1-D
Field pH		6.79	7.95
Electrical Conductivity	µS/cm	15700	8790
Total Dissolved Solids	mg/L	9910	5110
Hydroxide Alkalinity (OH-) as CaCO3	mg/L	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	1380	817
Total Alkalinity as CaCO3	mg/L	1380	817
Sulphate, SO4	mg/L	<1	<1
Chloride, Cl	mg/L	4920	2250
Calcium - Dissolved	mg/L	276	14
Magnesium - Dissolved	mg/L	256	12
Sodium - Dissolved	mg/L	2330	1900
Potassium - Dissolved	mg/L	64	16
Arsenic-Dissolved	mg/L	0.005	0.002
Beryllium-Dissolved	mg/L	<0.001	<0.001
Barium-Dissolved	mg/L	12.2	4.29
Chromium-Dissolved	mg/L	<0.001	<0.001
Cobalt-Dissolved	mg/L	0.001	0.001
Copper-Dissolved	mg/L	<0.001	0.005
Lead-Dissolved	mg/L	<0.001	0.008
Manganese-Dissolved	mg/L	0.12	0.049
Molybdenum	mg/L	0.006	0.018
Nickel-Dissolved	mg/L	0.02	0.036
Selenium	mg/L	<0.01	<0.01
Vanadium-Dissolved	mg/L	<0.01	<0.01
Zinc-Dissolved	mg/L	2.16	0.045
Boron	mg/L	0.24	1.04
Iron	mg/L	2.94	1.53
Fluoride, F	mg/L	0.2	2.2
Phosphate as P in water	mg/L	0.02	0.45

5 RESEARCH

A list of projects in this reporting period are described below:

- Bowen subsurface constraints mapping: Investigating and categorising structure and subsurface constraints across the Bowen with a view to developing a structure probability tool (or structure density predictive tool) across areas with lower data density. This will also assist with the assessment of reservoir connectivity across the basin. This project is currently in development.

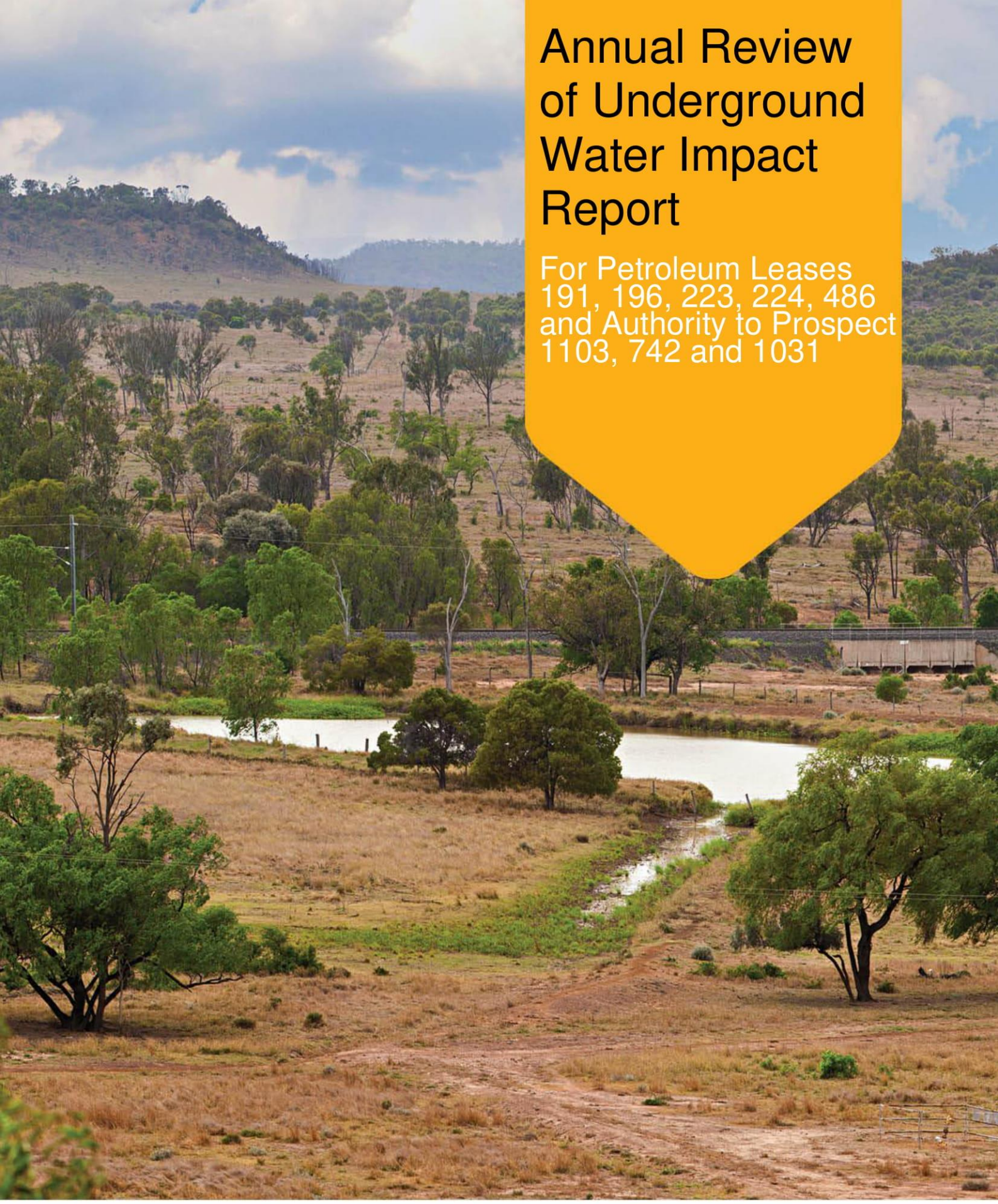
- Intrusion mapping using 3D seismic: Developed new methodologies using existing seismic attribute data to predict areas of intrusion/high likelihood of intrusion. The results of this will feed into the Bowen subsurface constraints mapping. This project is awaiting publication, with the finalised paper to be included in the 2021 GMMP annual report.

6 CONCLUSION

This report satisfies the following requirements for the annual report as outlined in Section 6.2.4 of the GMMP. Significant updates during the report period include:

- Seven (7) wells have been installed, below the 1408 authorised operational wells. The seven wells are non-operational at present, with production expected August 2020.
- Six (6) locations have been installed as a part of the BGP monitoring network to supplement the existing monitoring network established for Arrow's MGP network with the following summary:
    - There is no apparent influence of CSG production to the Quaternary alluvium, weathered Tertiary basalt, Tertiary sediment, weathered Fort Cooper Coal Measures (FCCM) and Rewan aquifers in the installed monitoring network for the BGP. This is expected given no water production has commenced;
    - In comparison to the groundwater levels obtained in the deep monitoring bores, the groundwater model predictions are over-estimating the impacts to the Moranbah Coal Measures (MCM) in the MGP area, with slight under-estimation of impacts in the FCCM and Back Creek Group (BCG).
    - A review of the groundwater quality data indicates that there are no notable trends for both the shallow and deep aquifers in the MGP.
- Red Hill Central Petroleum Lease (within PL486) was granted in 2019 with production expected to commence in August 2020;
- Mavis Downs (within ATP 1103) water production is expected to be delayed until at least 2022; and
- Ellensfield (within ATP1103) water production is expected to start in 2020 with no material water production.
- No non-compliances were recorded and therefore no remedial actions were undertaken.
- All monitoring obligations have been met, with no exceedances recorded across the monitoring network. Thus, no corrective actions were implemented.
- The project is has not advanced to the Lake Elphinstone area therefore MB11 is scheduled to be installed in 2029.
- Two research studies have been undertaken – Bowen subsurface constraints mapping and intrusion mapping using 3D seismic
- No out of cycle Underground Water Impact Report (UWIR) was submitted. The 2020 Annual Review of the Bowen UWIR concluded that there was no material change to water impacts as the water production forecast is significantly less than what was modelled in the 2019 UWIR. This report was submitted to Queensland's Department of Environment and Science (DES) on 22 April 2020.

APPENDIX A: 2020 Annual Review of the 2019 Bowen UWIR



Annual Review of Underground Water Impact Report

For Petroleum Leases 191, 196, 223, 224, 486 and Authority to Prospect 1103, 742 and 1031

arrow energy
go further

April 2020

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EXECUTIVE SUMMARY

The 2019 Bowen Underground Water Impact Report (2019 Bowen UWIR) for Authority to Prospect (ATP) 1103, 1031, 742 and Petroleum Leases (PL) 191, 196, 223, 224 and 486 was approved with conditions by the Department of Environment and Science (DES) on 9 July 2019. The 2019 Bowen UWIR included tenures for Arrow's domestic gas project in the Bowen Basin, referred to as the Moranbah Gas Project (MGP), and an expansion project referred to as the Bowen Gas Project (BGP). This review has been undertaken in line with the *Water Act (2000)* and conditions received in relation to the annual review. This review considers:

- Any new hydrogeological data that significantly alters the conceptual model;
- Whether the taking of water for production of Coal Seam gas (CSG) has varied significantly from that forecast in the 2019 UWIR;
- Whether new or additional production of CSG is planned;
- Whether new production testing has been undertaken or is planned;
- Whether predictions made in the 2019 UWIR have materially changed; and
- The implementation of the Water Monitoring Strategy (WMS) as was proposed in the 2019 Bowen UWIR.

Key findings of the 2020 annual review for the MGP tenures consisting of PLs 191, 196, 223 and 224 are:

- Water production for the 2020 annual review data capture period (1 January 2019 to 31 December 2019) is less than 1% greater than that modelled in the 2019 Bowen UWIR;
- The updated water production forecast for between 2020 to 2025 is 665.4 ML less than that modelled in the 2019 Bowen UWIR (48% decrease); and
- Given the water production forecast is significantly less than what was modelled in the 2019 UWIR, there is not expected to be an increase in potential impacts.

Key findings of the 2020 annual review for the BGP tenures consisting of ATPs 1103, 1031, 742 and PL 486 are:

- Water production is yet to commence as part of the Red Hill Central development on PL486.
- There is no update to the water production forecast for PL486 between 2020 to 2025;
- Three production testing wells in ATP 1103 were active in 2019 (RH098A, RH099A and RH100A), with a combined water production of 2.8 ML for the annual review period. This amount of water produced is below the Peak Downs reference pilot site. Therefore, any IAA arising from production testing wells in the 2020 annual review data capture period will be smaller than that associated with the reference pilot site. A 1-kilometre IAA radius consistent with the methodology outlined in the 2019 Bowen UWIR showed that no landholder bores are in proximity to the testing. No further investigation is required; and
- Actual impacts are expected to be less than modelled given actual water production was less than what was modelled in the 2019 UWIR.

Based on the above, there is no material increase in observed and predicted water production in the MGP and BGP, therefore the modelling conducted in the 2019 UWIR is a conservative estimate and groundwater impacts as a result will be less than previously predicted.

1 INTRODUCTION

This report forms the first annual review (2020 annual review) of the 2019 UWIR for Arrow Energy's MGP and BGP projects. The spatial distribution of these projects is shown in Figure 1.

The 2019 Bowen UWIR was approved with conditions by the Department of Environment and Science (DES), and took effect on the 9 July 2019 (Notice of Approval 101/0017990).

This report satisfies the requirements for the annual review outlined in the:

- *Water Act (2000)*;
- 2019 Bowen UWIR annual review commitments; and
- 2019 Bowen UWIR approval conditions.

In addressing the annual review requirements, Arrow has considered the following:

- Any new hydrogeological data that significantly alters the conceptual model;
- Whether the taking of water for production of CSG has varied significantly from that forecast;
- Whether new or additional production of CSG is planned;
- Whether new production testing has been undertaken or is planned;
- Whether predictions made in the 2019 Bowen UWIR have changed materially; and
- The implementation of the WMS; including any updates to the WMS.

Where practical, the results and analysis of the data contained in this report has been separated into each project (MGP and BGP).

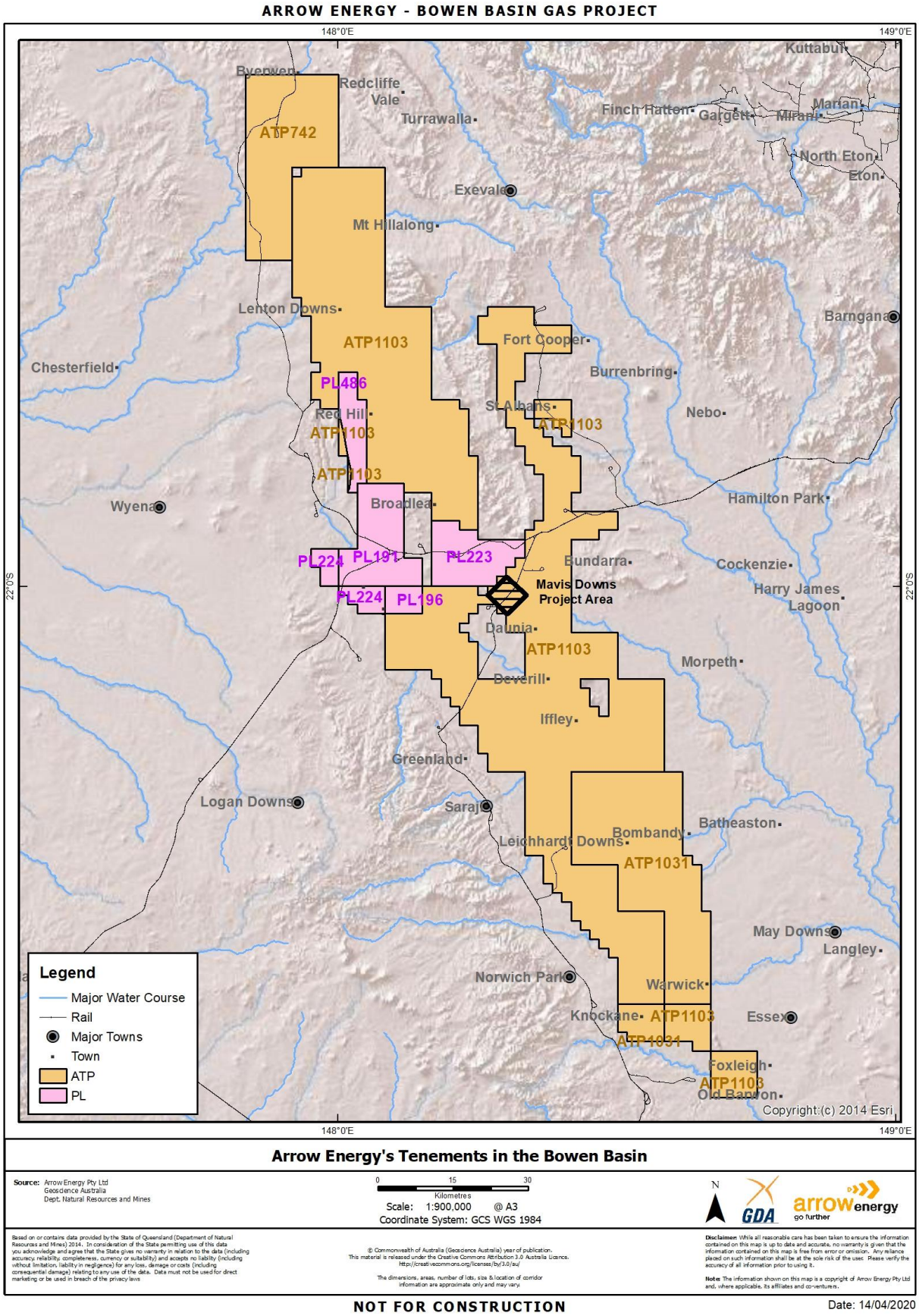

Figure 1: Location of ATP 1103, 1031, 742, 832 and PL 191, 196, 223, 224 and 486

2 WATER PRODUCTION REVIEW

A review of actual water production and forecast water production is presented in this section of this report for the MGP and BGP projects (as shown in Figure 2).

Review of water production from the ATP's and PL's is based on the following:

- 2019 Bowen UWIR data capture period from 1 January 2003 to 31 December 2018;
- 2019 Bowen UWIR water production forecast period from 1 January 2019 to 31 December 2025;
- 2020 Annual review data capture period from 1 January 2019 to 31 December 2019; and
- 2020 Annual review water production forecast period from 1 January 2020 to 31 December 2025.

Historical data from the Peak Downs (PD) production testing site on ATP 1103 (comprising production testing wells PD120V , PD122V, PD130V, and PD131V) was used as a reference pilot site to estimate the IAA for future production testing sites, specifically any which commenced during the annual review period. Arrow has done this because the BGP is a phased expansion of production and production testing on to tenures for which only limited production testing has previously occurred and therefore only limited hydrogeological data exists.

The annual review uses the following assessment approach outlined in the 2019 Bowen UWIR:

- Water produced at Peak Downs (part of ATP1103 production testing site between 2013 and 2015) was 26.7 ML which resulted in an Immediately Affected Area (PD IAA) in the 2019 Bowen UWIR which extended approximately 1 km from the wells. This is termed the reference pilot site.
- Actual water production from any subsequent production testing site in the annual review data capture period was compared to that produced at the reference pilot site
- If water produced at the production testing well in the annual review data capture period was equal to or less than the reference pilot site, then it was concluded that any resultant Immediately Affected Area (IAA) would be equal to or less than the reference pilot site.
- If water production in the production testing well in the annual review data capture period was greater than PD IAA site, then a review of the 1m drawdown contour was undertaken to identify any existing or abandoned but useable landholder water supply bores that may be at risk of impact.

2.1 Moranbah Gas Project

Table 1 and Table 2 below provide a comparison between observed water production and forecasted water production in the 2019 Bowen UWIR and the updated observed water production for the 2020 annual review data capture period. It should be noted that whilst PLs 191, 196, 223 and 224 make up the Moranbah Gas Project (MGP), production has only been undertaken on PLs 191, 196 and 224.Table 1 shows the observed water production for 1 January 2003 to 31 December 2019 and the comparison of observed to forecasted production for the 2019 annual review data capture period.

Based on the observed water produced for the annual review data capture period, there has been 36.9 ML more water produced than that forecast in the 2019 Bowen UWIR.

Table 1: MGP Water Production

Report	Water Production (ML) 1 Jan 2003 - 31 Dec 2018	Water Production (ML) 1 Jan 2019 - 31 Dec 2019	Total Water Production (ML) 1 Jan 2003 - 31 Dec 2019	Difference
2019 Bowen UWIR	4575.4	218.5*	4793.9	N/A -
2020 Annual Review	4575.4	255.4	4829.8	36.9 ML more (<1%)

* denotes forecast production

Table 2 below shows the updated water production forecast for 2020 to 2025. The forecast has been updated based on new data and a better understanding of the reservoir. The updated forecast is significantly less than that included in the 2019 Bowen UWIR.

Table 2: Forecast Water Production PL 191, 196, and 224

Year	2019 Bowen UWIR Forecast Water Production (ML)	2020 Annual Review Forecast Water Production (ML)	Difference
2020	211.5	145.7	65.8 ML less than the 2019 Bowen UWIR
2021	203.8	119.5	84.3 ML less than the 2019 Bowen UWIR
2022	197.2	128.4	68.8 ML less than the 2019 Bowen UWIR
2023	191.0	129.3	61.7 ML less than the 2019 Bowen UWIR
2024	185.7	106.8	78.9 ML less than the 2019 Bowen UWIR
2025	179.7	92.4	87.3 ML less than the 2019 Bowen UWIR
Total	1387.5	722.1	665.4 ML less than the 2019 Bowen UWIR (48.0% less)

2.1.1 Predicted Impacts

The impacts predicted in the 2019 Bowen UWIR define the IAA as occurring only in the Moranbah Coal Measures as shown in Figure 2 below. There was no predicted IAA in any other formations. The IAA is a prediction of impacts (i.e. drawdown exceeding the bore trigger threshold) of 5 metres drawdown for a 3-year period which commenced in January 2019. Based on this, the prediction of the IAA is influenced by the water production from 2003 to 2019. As indicated in Table 1, the actual water production for 2020 annual review data capture period is 36.9 ML more than the modelled water production in the 2019 Bowen UWIR. The updated water production forecast presented in Table 2 is 48% less that the forecast used to develop the 2019 Bowen UWIR. This reduction in water production is due to updated reservoir information and changes in the field development plan (FDP) of the MGP.

It is expected that the modelled IAA impact predictions made in the 2019 Bowen UWIR overestimate impacts likely to occur based on the updated water production forecast.

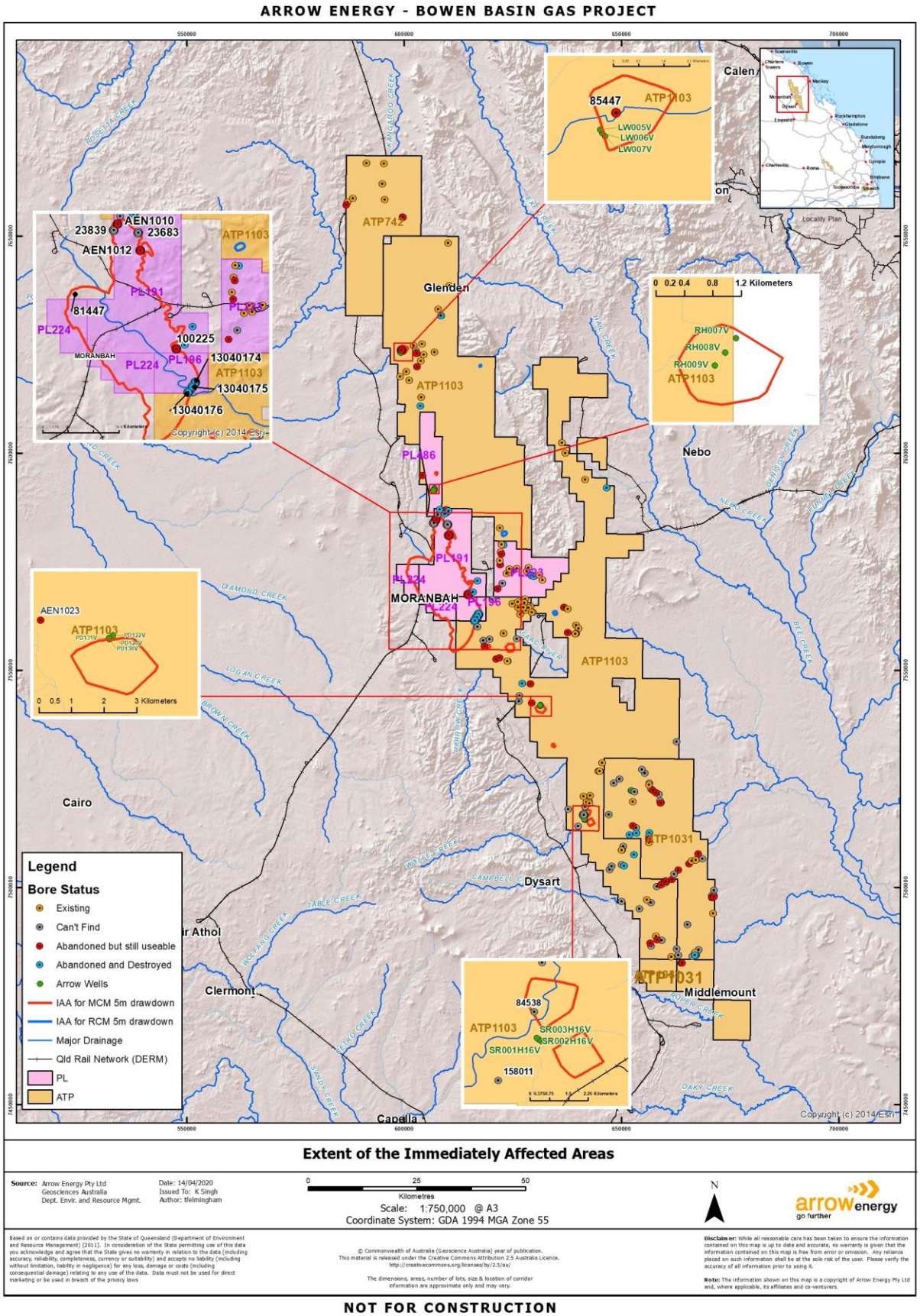

Figure 2: Extent of the IAA as per the 2019 UWIR

2.2 Bowen Gas Project

The Arrow Energy Bowen Gas Project (BGP) was approved by the Queensland Government on 8 September 2014 and the Commonwealth on 27 October 2014. Arrow's BGP involves a phased expansion of Arrow's Bowen Basin tenures. It comprises an update of development plans in the same general areas (i.e. within tenements ATP742, ATP1103, and ATP1031) from those presented in the Supplementary Report to the Environmental Impact Statement (SREIS) with the addition of development in Mavis Downs (also located within ATP1103).

The Field Development Plan (FDP) as outlined in the 2019 Bowen UWIR was as follows:

- Red Hill Central (within PL486 within ATP 1103) to commence in 2019;
- Mavis Downs (within ATP1103) to commence in 2021; and
- The remainder of field development (ATP1103, ATP742 and ATP1031) commencing 2030.

There have been a number of key changes from the 2019 Bowen UWIR this reporting period as follows:

- Red Hill Central Petroleum Lease (within PL486) was granted in 2019 with production expected to commence in 2020;
- Mavis Downs (within ATP 1103) water production is expected to be delayed until at least 2022; and
- Ellensfield (ATP1103) water production is expected to start in 2020 with no material water production.

2.2.1 ATP 1103

ATP 1103 is a large prospecting tenure located to the North, East and South of the MGP. A total of 2.8 ML of water was been produced as part of production testing on ATP 1103 since the 2019 annual review. Note that this water volume is from production testing wells (RH098A, RH099A and RH100A) on what was ATP 1103. This has now been converted to PL 486 (Red Hill Central).

A total of 2.8 ML of water was been produced as part of production testing on ATP 1103 since the 2019 annual review.

2.2.1.1 Predicted Impacts

In the 2019 Bowen UWIR, no IAA was predicted in ATP 1103. This is consistent with the methodology presented in the 2019 Bowen UWIR as no forecasts of IAA's are presented for production testing sites. The combined water volume for the production testing (RH098A, RH099A and RH100A) was 2.8 ML for the annual review period. This amount of water produced is below the volume produced from the reference pilot site. Therefore, any IAA arising from production testing wells in the 2020 annual review data capture period will be smaller than that associated with the reference pilot site. A 1-kilometre IAA radius consistent with the methodology outlined in the 2019 Bowen UWIR showed that no landholder bores are located in proximity to the testing as displayed in Figure 3.

Based on the limited production and impact, no change is proposed to the modelling undertaken for the 2019 Bowen UWIR.

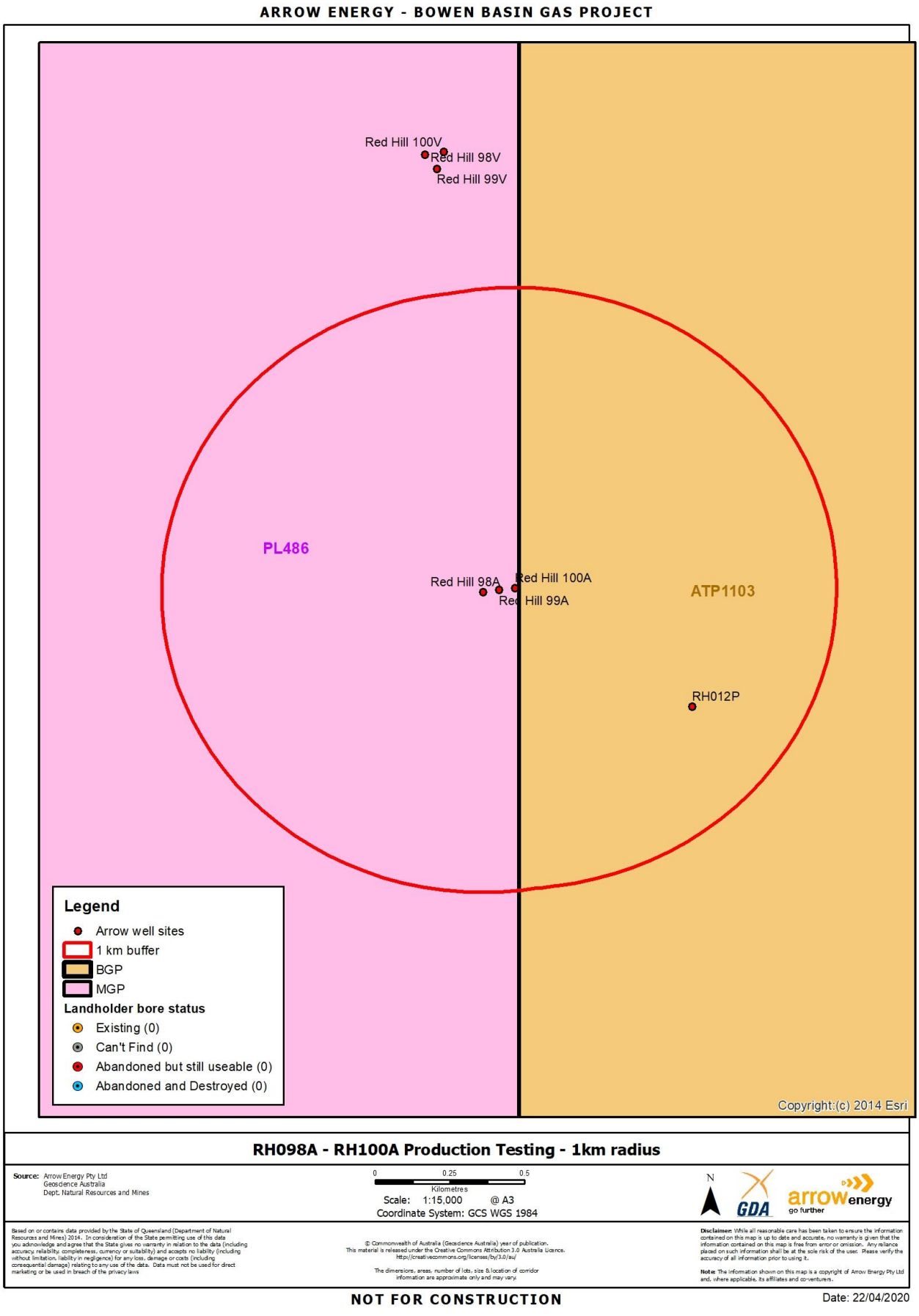

Figure 3: 1km buffer RH098A, RH099A and RH100A

2.2.2 Red Hill Central

The Red Hill Central (RHC) development is located approximately 30 km north of the township of Moranbah with the MGP area to its south. Water production from RHC is planned to occur from 2020 to 2025. The water production profile used in the 2019 Bowen UWIR indicated a total of 875 ML of water to be produced over that period. There was no update to this forecast at the time of writing of this report.

As noted in Section 2.2.1, production testing was commenced in ATP 1103 prior to PL 486 being granted. Therefore the water volumes for the production testing (from wells RH098A, RH099A and RH100A) are included in ATP 1103 water volumes. That production testing does not form part of the RHC development. Therefore, as production from the RHC development has not commenced, a total of 0 ML of water has been produced as part of production from RHC since the 2019 UWIR.

Table 3 below shows the current water production forecast for 2020 to 2025.

Table 3: Forecast Water Production PL 486

Year	2019 Bowen UWIR Forecast Water Production (ML)	2020 Annual Review Forecast Water Production (ML)	Difference
2020	125	125	Nil
2021	125	125	Nil
2022	125	125	Nil
2023	125	125	Nil
2024	125	125	Nil
2025	125	125	Nil
Total	875	875	Nil

2.2.2.1 Predicted Impacts

Water production for the 2020 annual review data capture period was 0 ML. As a result, there is no material change in the information or predictions made in the 2019 Bowen UWIR. Based on this, no change is proposed to the modelling undertaken for the 2019 Bowen UWIR.

2.2.3 Mavis Downs

The Mavis Downs development is located to the south of PL223 in ATP 1103, approximately 24 km east of the township of Moranbah. This development borders the MGP to the west. Mavis Downs production was forecast to occur from 2021 to 2030, with a total of 673 ML of water to be produced, however production has been delayed starting from 2022 at the earliest.

2.2.3.1 Predicted Impacts

Water production for the 2020 annual review data capture period was 0 ML. As a result, there is no potential for an increase to the impacts predicted in the 2019 Bowen UWIR. Based on this, no change is proposed to the modelling undertaken for the 2019 Bowen UWIR.

2.2.4 ATP 1031

ATP 1031 lies approximately 100 km to the south of the MGP. A total of 0 ML of water has been produced as part of production testing on ATP 1031 since the 2019 annual review.

2.2.4.1 Predicted Impacts

In the 2019 Bowen UWIR, no IAA was predicted in ATP 1031. This is consistent with the methodology presented in the 2019 Bowen UWIR as no forecasts of IAA's are presented for production testing sites. No further production testing has been undertaken on ATP 1031 since the UWIR and therefore there is no material change in the information or predictions made in the 2019 Bowen UWIR. Based on this, no change is proposed to the modelling undertaken for the 2019 Bowen UWIR.

2.2.5 ATP 742

ATP 742 is located approximately 50 kilometres north of the MGP. A total of 0 ML of water has been produced as part of production testing on ATP 1031 since the 2019 annual review.

2.2.5.1 Predicted Impacts

In the 2019 Bowen UWIR, no IAA was predicted in ATP 742. This is consistent with the methodology presented in the 2019 Bowen UWIR as no forecasts of IAA's are presented for production testing sites. No further production testing has been undertaken in any wells on ATP 1031 since the UWIR and therefore there is no material change in the information or predictions made in the 2019 Bowen UWIR. Based on this, no change is proposed to the modelling undertaken for the 2019 Bowen UWIR.

3 WATER MONITORING STRATEGY (WMS)

3.1 MGP Area Groundwater Monitoring Network

A total of 16 groundwater monitoring bores form the groundwater monitoring network for the MGP Area. Figure 4 provides an overview of the spatial distribution of the groundwater monitoring network. Groundwater monitoring is being undertaken in these bores in accordance with the WMS in the approved 2019 Bowen UWIR and approval conditions.

As discussed in Section 4.3, drawdown observed in monitoring bore M162V has resulted in water level dropping below the pump intake and as a result water sampling could not be undertaken. Sampling has undertaken at production bore M134GM since 2017, which is located approx. 480 m north of M16V. The bore has been completed to approximately the same depth as M162V and intersects the MCM seam. Water quality sampling will be undertaken in production bore M134GM until water levels recover sufficiently to allow sampling to be carried out again in M162V.

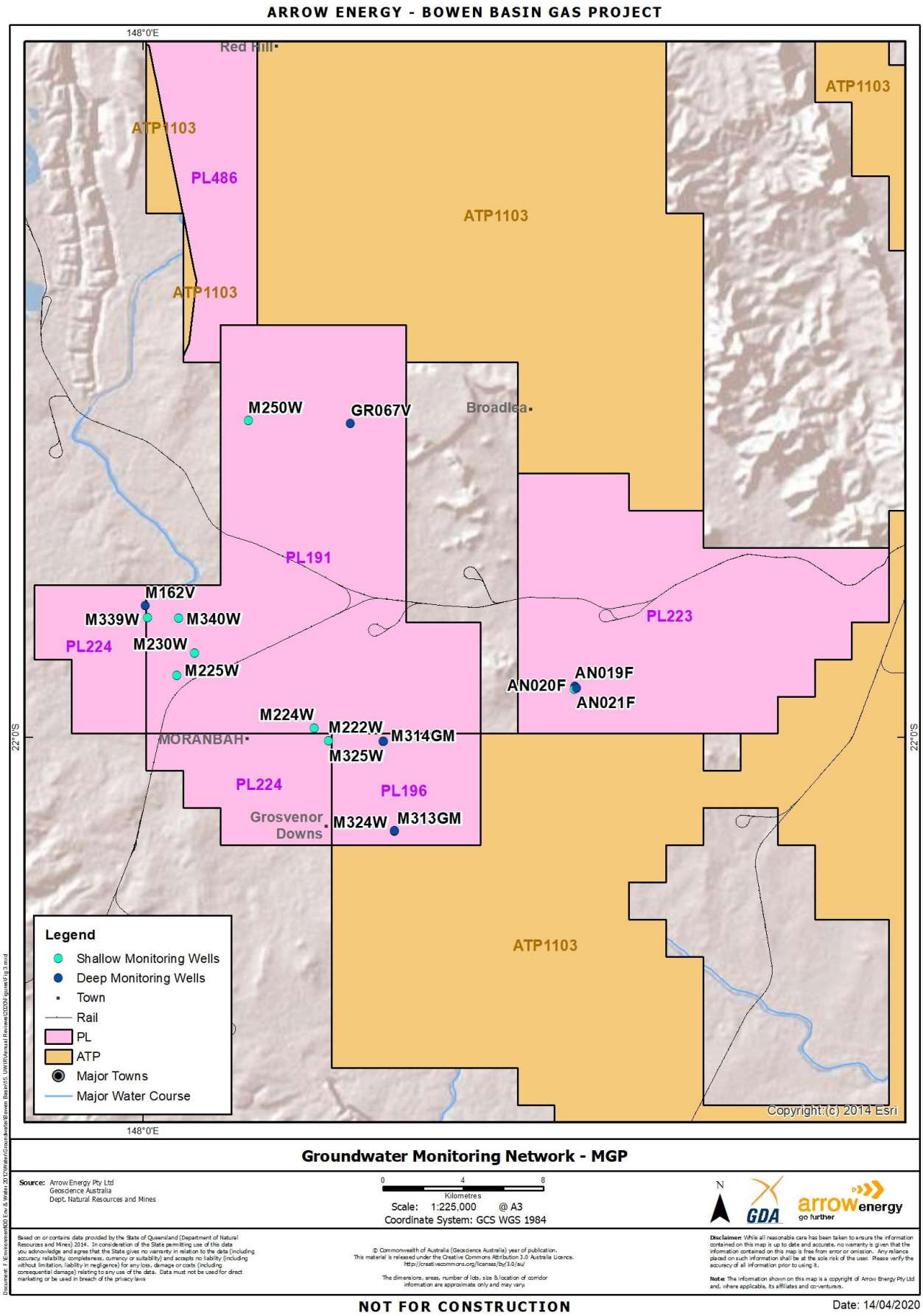

Figure 4: Groundwater Monitoring Network for MGP

3.2 BGP Area Groundwater Monitoring Network

The network is comprised of 35 monitoring intervals at 22 separate locations (comprising 12 single sites and 10 nested sites of 23 monitoring intervals) form the approved groundwater monitoring network for the BGP area. Figure 5 provides an overview of the spatial distribution of the groundwater monitoring network. Table 4 below displays the monitoring requirements of the BGP, along with the status of each location. Note that Table 4 displays the monitoring location name as per the 2019 Bowen Groundwater Monitoring and Management Plan (GMMP) which was submitted to the Commonwealth Department of the Environment and Energy to comply with Arrow Energy's approval for the BGP. All subsequent reporting is based off this nomenclature.

At present, six locations have been installed as a part of the monitoring network; MB1-S/I/D, MB2, MB3, MB12, GW001 and GW007 as detailed below.

MB1-S/I/D

MB1 was installed as an appraisal (pilot) production well (originally named Red Hill-30) in January 2010. Groundwater pressure observations were made from the Moranbah Coal Measures (i.e. the deep interval) using the well from November 2011 to December 2011. Pumping from the well (for the pilot) was also undertaken during this time.

Pilot operation (and monitoring) ceased between December 2011 and November 2012.

The well was again monitored from 30 November 2012. The water level in Red Hill-30 had recovered to within 92% of its original baseline level prior to pumping for the pilot recommencing in December 2012.

From December 2012 the pilot was again operated (including production from Red Hill-30). Production from Red Hill-30 and the other pilot well in the pilot ceased in May and April 2013 respectively. Monitoring in Red Hill-30 continued until it was suspended in September 2013.

In October 2019 MB1 was modified to enable additional monitoring from the intermediate and shallow intervals to take place. Groundwater pressure data has been collected from all three intervals in MB1 since 11 November 2019. Drilling information for MB1 identified sufficient Quaternary / Tertiary Sediment or Rangal Coal Measures were not encountered at this location, and, the shallow and intermediate monitoring points are instead located within the Fort Cooper Coal Measures.

MB2

MB2 was installed as an appraisal (pilot) production well (originally named Red Hill-60) in January 2011. Groundwater pressure observations were made from the Moranbah Coal Measures using the well from September to October 2015 (1.5 months), October 2017 to May 2018 (8 months), February 2019 to November 2019 (7 months) and, following a period of data loss between November 2019 to January 2020, from January 2020 until present. Pumping (intermittently) from the well (for the pilot) was undertaken between 2012 and 2018. The well was converted to a monitoring well using the existing downhole pressure gauge in February 2019.

MB3

MB3 was installed as an appraisal (pilot) production well (originally named Red Hill-51) in November 2011. Groundwater pressure observations were made from the Moranbah Coal Measures using the well from September 2013 to May 2014 (9 months), October 2017 to May 2018 (7 months), and February 2019 to November 2019 (7 months) before the downhole pressure gauge failed. The well was converted to a monitoring well using the existing downhole pressure gauge in February 2019.

An adjacent appraisal (pilot) production well (originally named Red Hill-50) will be converted to a monitoring well in May 2020 and which will then fulfil monitoring requirements for MB3.

MB12

MB12 was installed as a mine monitoring bore (originally named EFGW5D) by Fitzroy Mining in June 2008. Groundwater pressure observations were made from the Rewan Formation through both manual water level measurements and hourly data logger measurements since January and July (respectively) 2018. A data logger was installed in the monitoring bore in July 2018 which is still in operation.

GW001 and GW007

GW001 and GW007 were installed as mine monitoring bores by BHP Mitsubishi Alliance (BMA) in 2011. Arrow commenced monitoring these two bores in November 2019 however historical data for GW001 extends back to February 2017.

Table 4: BGP Monitoring network

Monitoring location	Monitoring interval and target formation	Development area	Installation by year (indicative)	Status
MB1	S – Quaternary / Tertiary	Red Hill Central	2019	Pressure monitoring required twice daily until 11/11/2020, and 6-monthly water level measurement for remainder of CSG production. Water quality sampling required from MB1-D at biannual frequency for the first year, and annually thereafter (i.e. 2021).
	I – RCM			
	D – MCM			
MB2	MCM		Current	Currently on monitoring. Pressure monitoring required twice daily until 31/10/2020, and 6-monthly water level measurement for remainder of CSG production. Online date is 16 February 2019 however data was lost between 30 October and 9 January 2020.
MB3	MCM		Current	Currently on monitoring. Pressure monitoring required twice daily until 31/10/2020, and 6-monthly water level measurement for remainder of CSG production. Online date is 16 February 2019 however data was lost between 30 October and 9 January 2020.
MB4	Unconfined alluvium		Contingent	Not currently required as criteria not yet triggered. Requirement for installation is based on (modelled) increased risk of depressurisation resulting from changes in the FDP, or MB1 pressure monitoring data indicate interconnectivity of MCM with overlying units.
MB5	Tertiary / Triassic	Mavis Downs	2020	Not currently required due to no development within 10km
MB6	Quaternary / Tertiary	BGP FDP (northern development area)	Contingent	Not currently required as criteria not yet triggered. Requirement for installation is based on (modelled) increased risk of depressurisation resulting from changes in the FDP, or monitoring of other sites in the northern development area indicate the potential or likelihood of preferential groundwater flow occurring across formations by way of geological faults
MB7	S – Tertiary		2029	Not currently required due to no development within 10km
	D – RCM			
MB8	Quaternary / Tertiary		2030	Not currently required due to no development within 10km
MB9	S – Quaternary / Tertiary		2029	Not currently required due to no development within 10km
	I – RCM			
	D – MCM / FCCM			
MB10	Tertiary		2030	Requires installation immediately prior to commencement of pumping from Wards Well pilot wells (currently scheduled for Jan 2022).
MB11	S – Quaternary / Tertiary or Rewan Formation		2029	Not currently required due to no development within 10km
	D – RCM			
MB12	Quaternary / Tertiary		2028	Existing Fitzroy Mining monitoring bore (EFGW5D) being utilised to obtain pressure monitoring data in place of MB12. EFGW5D is located approximately 345m from the proposed location for MB12. Monitoring commenced in July 2018. Pressure monitoring will include 6-monthly water level measurements for remainder of CSG production
MB13	S – Quaternary / Tertiary (if present)	BGP FDP (southern development area)	Contingent - 2028	MB13S not currently required due to no development within 10km Requirement for installation of MB13D is based on monitoring of MB13-S and/or other monitoring points in the southern development area indicates the potential or likelihood of preferential groundwater flow occurring across formations by way of geological faults, or ongoing modelling or revised development indicates a greater risk of depressurisation impact at this location
	D – Blackwater Group (RCM / FCCM / MCM)			
MB14	S – Quaternary / Tertiary		2029	Not currently required due to no development within 10km
	I – RCM			
	D – MCM / RCCM			
MB15	S – Unconfined alluvium		2029	Not currently required due to no development within 10km
	I – Tertiary / Triassic			
MB16	Tertiary		2029	Not currently required due to no development within 10km
MB17	S – Unconfined alluvium	ATP 1103 (in proximity to Lake Elphinstone)	Contingent	Not currently required as criteria not yet triggered Requirement for installation is based on if revised modelling indicates a risk of depressurisation impacts to Lake Elphinstone, or if impacts are detected at MB11-S
	I – Rewan Formation			
Supplementary monitoring bores				
AEN1214	Rangal Coal Measures	BGP FDP (northern development area)	Existing	
AEN1036	Blackwater Group	BGP FDP (southern development area)	Existing	
AEN1050	Quaternary alluvium	Red Hill Central & Mavis Downs development area	Existing	
GW001	VWP 1 – alluvium	Red Hill Central & Mavis Downs development area	Existing	Annual data download from VWP logger
	VWP 2 – Fort Cooper Coal Measures			
GW007	Alluvium	Red Hill Central & Mavis Downs development area	Existing	Requires 6-monthly manual water level measurements
	Fort Cooper Coal Measures			

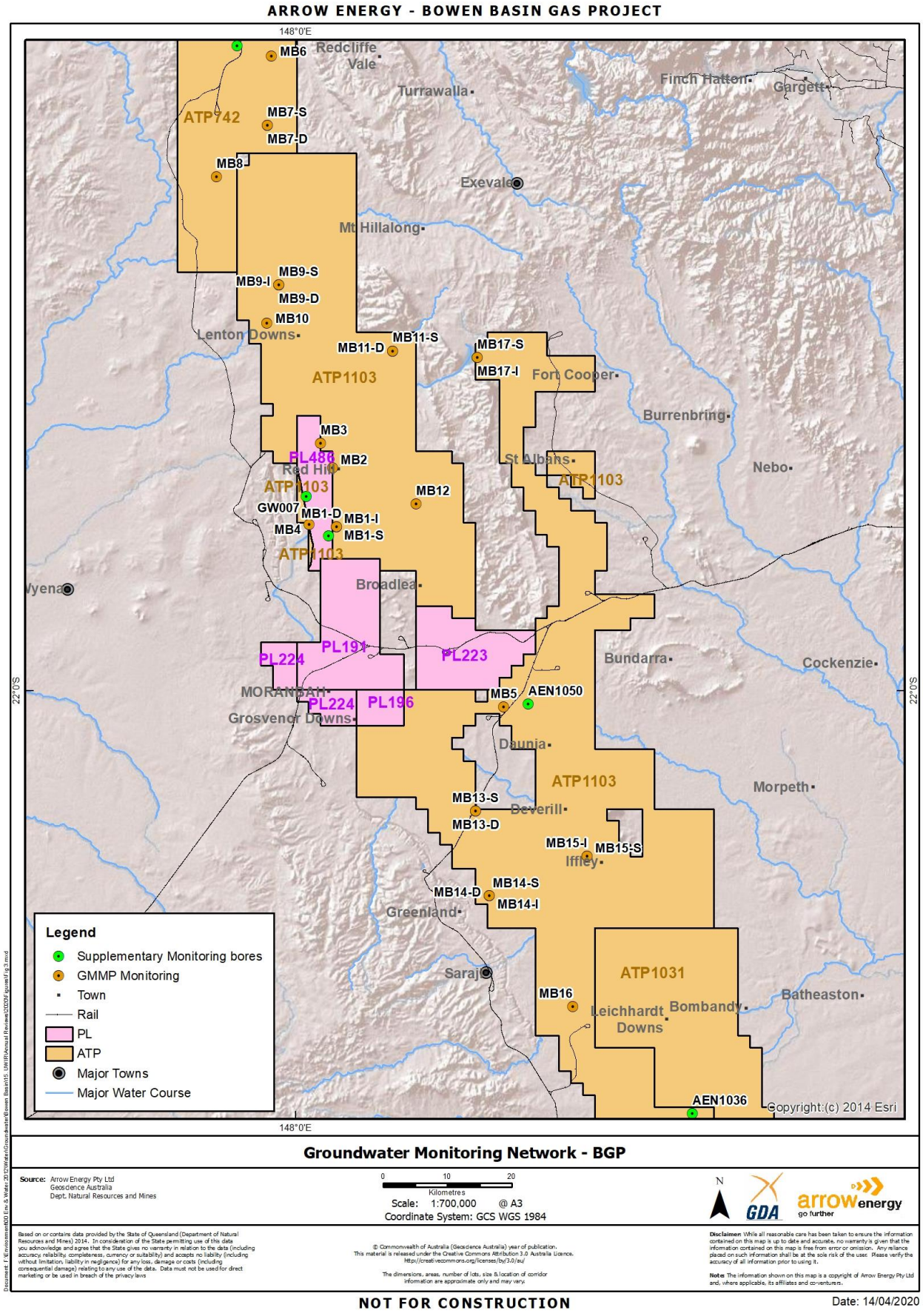

Figure 5: Groundwater Monitoring Network for BGP

4 GROUNDWATER ASSESSMENT UPDATE

4.1 Trigger Levels

The trigger levels associated with the 2019 Bowen UWIR are the bore trigger threshold as defined in the Water Act (2000). Bore trigger threshold, for an aquifer, means a decline in the water level in the aquifer that is –

a) If a regulation prescribes the bore trigger threshold for an area in which the aquifer is situated – the prescribed threshold for the area; or
b) Otherwise –
    i. For a consolidated aquifer – 5m; or
    ii. For an unconsolidated aquifer – 2m.

Based on this, the applicable bore trigger threshold for the MGP and BGP is 5 m for a consolidated aquifer and 2 m for an unconsolidated aquifer. Consistent with the Water Act, no trigger thresholds are proposed for water quality.

4.2 Groundwater Level Monitoring

4.2.1 Shallow Monitoring Bores

Groundwater level monitoring has been undertaken in the following shallow groundwater monitoring bores which form part of the 2019 Bowen UWIR groundwater monitoring network for the MGP and BGP Area (Table 5 provides a summary of these bores).

- Monitoring since June 2012 for bores M339W, M225W, M340W, M230W, M250W, M224W, M222W;
- Monitoring since March 2016 for bores AN020F and AN021F;
- Monitoring since January 2018 for bore MB12; and
- Monitoring since November 2019 for bores MB1-S, GW001 and GW007A.

Table 5: Shallow Groundwater Monitoring Bores

Bore ID	Total Constructed Depth (m)	Screen Interval (mbgl)	Screened Formation
M339W	41.0	35.0 – 41.0	Weathered Tertiary Basalt
M225W	34.0	23.0 – 34.0	Weathered Tertiary Basalt
M340W	27.3	19.3 – 27.3	Weathered Tertiary Basalt
M230W	32.0	29.0 – 32.0	Weathered Tertiary Basalt
M250W	56.5	44.5 – 56.5	Tertiary Sediment
M224W	32.5	26.5 – 32.5	Quaternary Alluvium
M222W	30.2	20.0 – 26.0	Weathered Fort Cooper Coal Measures
AN020F	77.0	70.0 – 72.0	Rewan Formation
AN021F	27.0	20.0 – 22.0	Tertiary Sediment
MB1-S	60	45 - 50	Fort Cooper Coal Measures – Girrah Seam
MB12	59.1	56 – 59	Rewan Formation
GW001	6.5	6.5	Tertiary Sediment
GW007A	7.5	1.5 – 7.5	Tertiary Sediment

The groundwater level monitoring results are shown in Appendix A. Groundwater levels, as is shown in Figure 6, range from:

- 200.4 to 209.2 m Australian Height Datum (AHD) in the weathered Tertiary Basalt aquifer,
- 233.2 to 242.3 m AHD in the Tertiary Sediment aquifer,
- 209.8 to 211.7 m AHD in the Quaternary Alluvium aquifer,
- 202.4 to 206.3 m AHD in the weathered Fort Cooper Coal Measures aquifer, and

- 237.2 to 238.6 m AHD in the Rewan Formation.

All bores located within close proximity to the Isaac River display similar depths to groundwater. This is shown in Figure 7.

The groundwater levels for bores M250W, AN021F and MB12 are higher due to the respective surface elevation in the areas being approximately 50 to 60m, 30 to 40m and 85 to 95m, respectively, above the other bores. As indicated in Table 5, M250W and AN021F are installed in the Tertiary Sediment and located approximately 10 km north and east of the other groundwater monitoring sites along the Isaac River, while MB12 is constructed within the Rewan Formation and located approximately 26km northeast of the other groundwater monitoring sites along the Isaac River.

A comparison of modelled drawdown predictions made in the 2019 Bowen UWIR with monitoring data to date has been undertaken. There is no predicted IAA for unconsolidated aquifers for the MGP and BGP; as modelled drawdown does not exceed the bore trigger threshold of 2 metres. The monitoring data to date supports this modelled prediction in the 2019 Bowen UWIR.

Groundwater monitoring further indicates:

- Actual groundwater levels monitored in bore M339W have remained steady over the monitoring period.
- The water levels in M222W and M225W have continued to steadily rise since monitoring began in 2012.
- Figure 7 displays cumulative rainfall departure and groundwater levels at groundwater monitoring bores M225W, M230W, M222W and M224W. Recharge to shallow aquifers due to above mean rainfall has continued to contribute to the rising trend in groundwater levels noted in M222W and M225W with a peak at the end of 2017. The water level in M230W has declined since this peak, likely due to the drop in the CRD.
- There is no predicted IAA for any aquifer underlying PL 223; hence modelled drawdown greater than the bore trigger threshold at the end of 2019 was not predicted in the 2019 Bowen UWIR to occur at the location of bores AN020F and AN021F. AN021F is installed in the Tertiary Sediment and has increased in water level since monitoring began. AN020F is installed in the Rewan Formation which is considered to be a regional aquitard. Groundwater levels monitored at AN020F has remained steady over the monitoring period.
- A decline in groundwater pressure by greater than the bore trigger threshold was noted at bore M224W between November 2017 and November 2019. As discussed in the 2019 Bowen UWIR, the water levels in this bore indicate a possible hydraulic link to the river level fluctuations. This is in-line with the conceptual hydrogeological model report in the 2019 Bowen UWIR, where there is linkage between rainfall events and river level flow periods to groundwater level. This decline is not considered to be due to the effects of CSG production.
- A decline in groundwater pressure by greater than the bore trigger threshold was noted at bore M230W between November 2017 and November 2019. The water levels observed in this bore is considered to have been influenced by nearby mining operations, similar to the decline seen in M340W (as discussed in the 2017 Annual Review of the 2016 Bowen UWIR) where a decline in groundwater levels has made this monitoring borehole dry. Both monitoring bores are in the same area, as shown in Figure 4.
- Water level decline and recovery in MB12 is due to water quality sampling (pumping) being undertaken in the bore. The frequency of water quality sampling was decreased in H2 2019 where subsequent water level data show water level recovery between monitoring events.

Based on the graphically presented monitoring data in Figure 6, it is clear that there is no apparent influence of CSG production to the Quaternary alluvium, weathered Tertiary basalt, Tertiary sediment, weathered Fort Cooper coal measures and Rewan aquifers in which these bores are installed. This data supports the groundwater modelling predictions in the 2019 Bowen UWIR and drawdown greater than the bore trigger threshold due to CSG production is not observed as predicted.

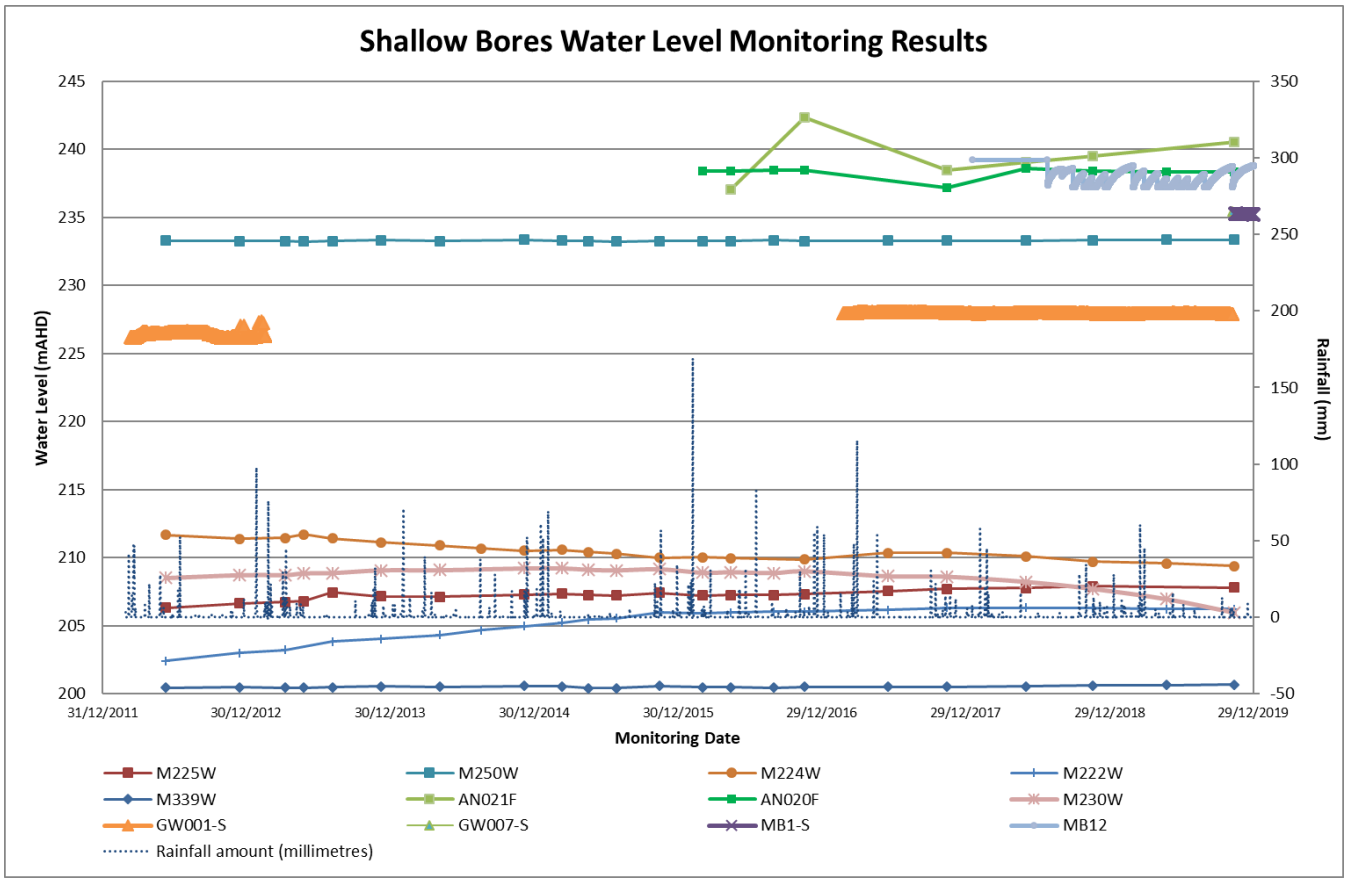

Figure 6: Shallow Bores Water Level Monitoring Results

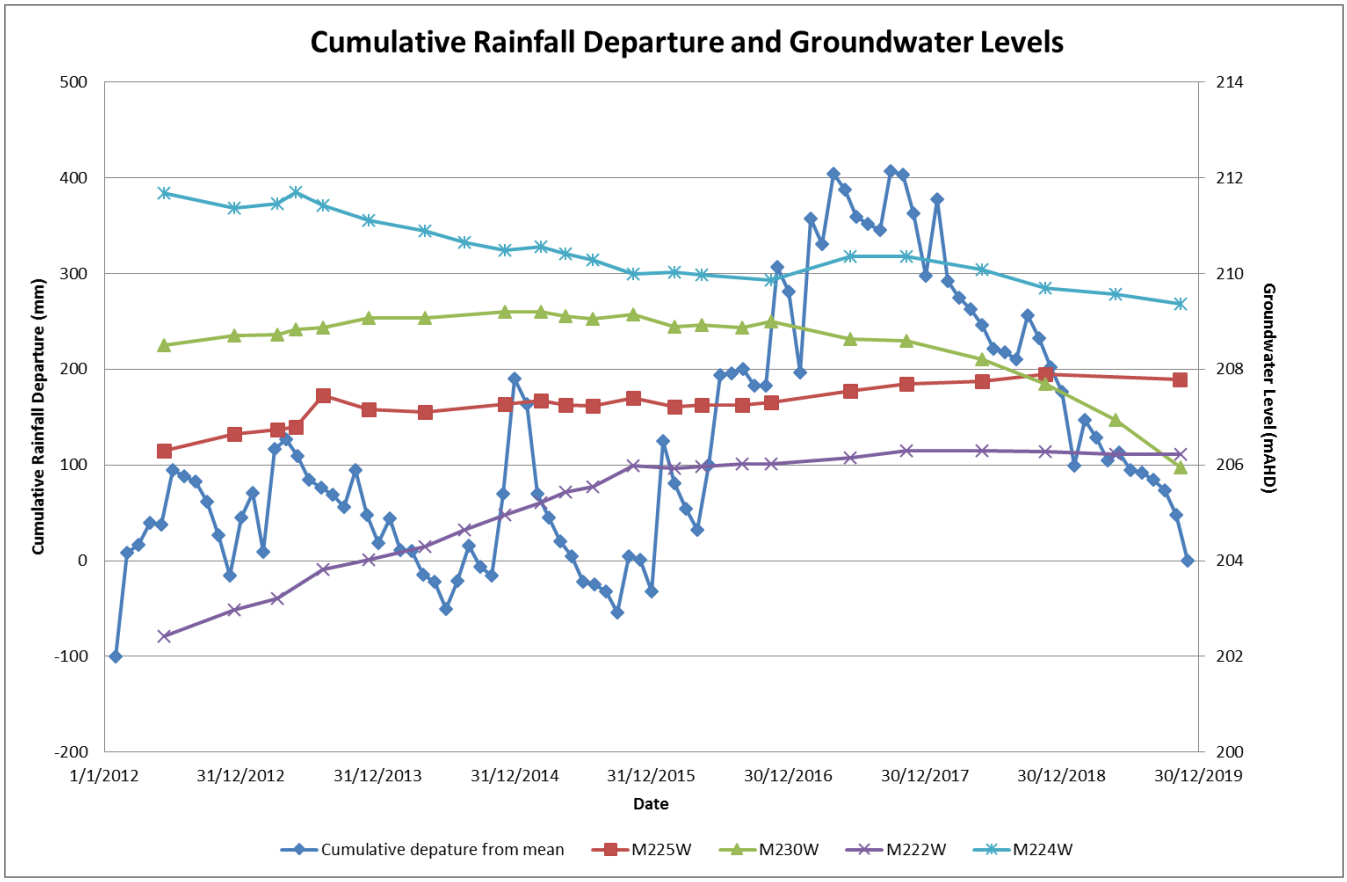

Figure 7: Cumulative Rainfall Departure and Groundwater Levels

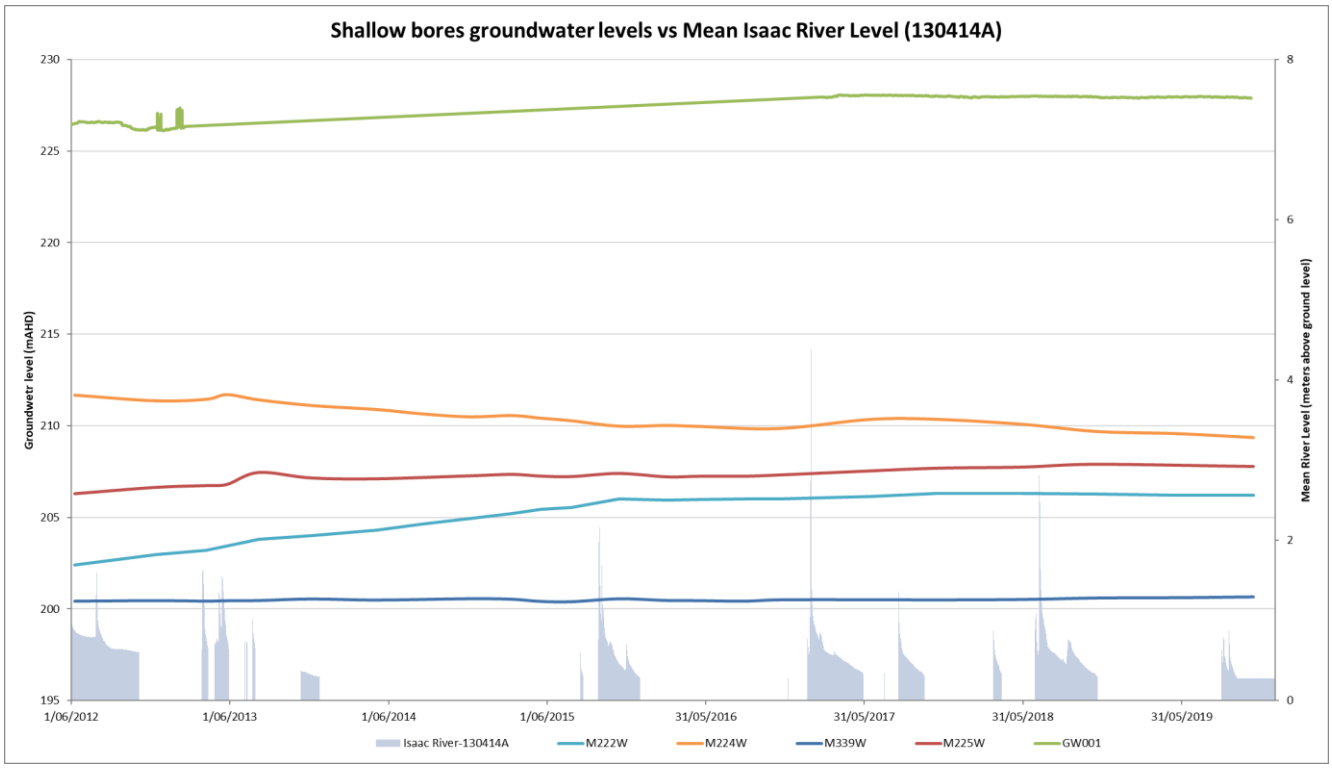

Figure 8: Shallow Groundwater levels vs mean Isaac River levels

4.2.2 Deep Monitoring Bores

Groundwater pressure monitoring has been undertaken in the following deep groundwater monitoring bores which form part of the 2019 Bowen UWIR groundwater monitoring network.

- Monitoring since November 2011 for bore MB1-D (as detailed in Section 3.2);
- Monitoring since September 2013 for bore MB3 (as detailed in Section 3.2);
- Monitoring since September 2014 for bores M313W, M314W, M324W;
- Monitoring since February 2015 for bore M325W;
- Monitoring since September 2015 for bore MB2 (as detailed in Section 3.2);
- Monitoring since November 2015 for bores AN019Fand M162V (December 2015);
- Monitoring since February 2016 for bore GR067V; and
- Monitoring since November 2019 for bores GW001 and GW007 (as detailed in Section 3.2).

Table 6 provides details for these bores. Pressure gauge data has been successfully obtained from bores M313W, M314W, M324W, AN019F, GR067V and M162V. As previously indicated in the 2018 Annual Review for the 2016 Bowen UWIR, available data suggested that the permeability of the formation that M325W is installed into is so low that recovery of groundwater pressures in the Fort Cooper Coal Measures would take a very long time. The updated water level data supports the previous statement in that over the last 18 months the water level recovery is 80% of the highest recorded water level since construction.

Declines in groundwater levels greater than the bore trigger threshold have been observed at bores M324W (MCM), M313W (MCM) and M162V (MCM). Monitoring data suggests that there is some apparent influence of CSG production to the MCM.

No decline in groundwater levels greater than the bore trigger threshold is observed at bores M314W (MCM), M325W (MCM), M324W (FCCM), M313W (BCG), M314W (BCG), AN019F (FCCM), and GR067V (MCM).

Table 6: Deep Groundwater Monitoring Bores

Bore ID	Total Constructed Depth (m)	Screen Interval (mbgl)	Screened Formation
M313W	532.4	313.0 – 316.5 507.0 – 510.0	Moranbah Coal Measures (QA Seam) Back Creek Group
M314W	560.5	210.5 – 213.5 551.5 – 553.5	Moranbah Coal Measures (QA Seam) Back Creek Group
M324W	240.0	163.0 – 166.0 187.0 – 190.0	Fort Cooper Coal Measures Moranbah Coal Measures (QA Seam)
M325W	202.3	180.5 – 182.0	Fort Cooper Coal Measures
AN019F	290.0	269.0 – 271.0	Fort Cooper Coal Measures
M162V	276.0	252.0 – 256.0	Moranbah Coal Measures
GR067V	610.9	543.2 – 610.9	Moranbah Coal Measures
MB1	550	336 -340 423.9-506.6	Fort Cooper Coal Measures Moranbah Coal Measures
MB2	834	701.1-814.7	Moranbah Coal Measures
MB3	796.3	712.3 – 717.9	Moranbah Coal Measures
GW001	250	-	Fort Cooper Coal Measures
GW007B	181.5	175.5 – 181.5	Fort Cooper Coal Measures

The groundwater pressure monitoring results are shown in Figure 9. Observed groundwater pressures ranged from:

- 211.1 to 216.8m AHD in the BCG;
- 49.5 to 207.7m AHD in the FCCM; and
- -129.1 to 204.5m AHD in the MCM.

A comparison of modelled drawdown predictions modelled in the 2019 Bowen UWIR with monitoring data to date has been undertaken and indicates:

- Modelled drawdown in the MCM aquifer at the end of 2019 at the location of M314W was predicted in the model to be approximately 215 m. Actual groundwater pressures monitored for the MCM at M314W indicates decline in pressures of approximately 3.2 m;
- Modelled drawdown in the MCM aquifer at the end of 2019 at the location of M313W and M324W was predicted in the model to be approximately 149 m.
- Actual groundwater pressures monitored at M324W shows a maximum decline in pressure by 6.63 m in March 2017. Since March 2017, the water level has recovered by 2.4 m which represents a 36% recovery of the water level prior to the drawdown as indicated in Figure 9;
- Actual groundwater pressure monitored for the MCM at M313W shows the maximum decline in the pressure of 74.5m, as measured in March 2017. Since March 2017 the water level has recovered by 48.55 m which represents approximately 65% recovery of the original water level prior to the drawdown and as indicated in Figure 9. The graphically displayed water level curve indicates the recovery will continue. These groundwater monitoring bores are located in the southern part of PL 196 and approximately 350 m from production well GM052V. The total amount of water actually produced from GM052V during this annual review data capture period was 0 ML. Since production ceased, the water level recovery commenced;
- Drawdown in the MCM aquifer at the end of 2019 at the location of M162V was predicted to be approximately 60 m. Actual groundwater pressures monitored at this site shows a steady groundwater pressure decrease of approximately 20 m;
- Drawdown in the MCM aquifer at the end of 2019 at the location of GR067V was predicted to be approximately 0.2. m. Decreases in pressures of up to 150 metres, noted in April and August 2016, are due to depressurisation activities in this bore associated with monitoring events. The recovery curve has subsequently stabilised and a standing water level of 202-203 mAHD is evident;
- Drawdown in the FCCM aquifer at the end of 2019 at the location of M324W was predicted to be 0.05 m. Actual groundwater pressures monitored for the FCCM at M324W shows a decline of approximately 1.4 m;

- Drawdown in the FCCM aquifer at the end of 2019 at the location of AN019F was predicted to be 0.3m. Actual groundwater pressures monitored indicates a small decline of approximately 0.89 m;
- Drawdown in the BCG aquifer at the end of 2019 at the location of M313W and M314W was not predicted to occur in the model. Actual groundwater pressures monitored for the BCG at M313W and M314W indicate a decline of approximately 1.4 m and 3.5 m respectively;
- Drawdown in the MCM aquifer at the end of 2019 at the location of MB1 was predicted to be 4m. Actual pressures monitored indicates a decline of 4.6 m;
- Drawdown in the FCCM aquifer at the end of 2019 at the location of MB1, GW001 and GW007 was predicted to be 0 m. Actual pressured monitored indicates a decline of 4.61; and
- MB2 and MB3 display recovering water levels, as these wells were previous production wells.

Based on this it is concluded that observations of drawdown were generally consistent with respect to predicted exceedances of the bore trigger threshold as follows:

- Modelled drawdown greater than the bore trigger threshold was not predicted to occur at bores M313W (BCG), M314W (BCG), AN019F (FCCM), M324W (FCCM), MB1 (FCCM and MCM), GW001 (FCCM) and GW007 (FCCM) which is confirmed by the monitoring data;
- Modelled drawdown greater than the bore trigger threshold was predicted to occur at bore M314W (MCM), however monitoring data shows that water levels in this bore is less than the bore trigger threshold;
- Monitoring data shows that drawdown greater than the bore trigger threshold was detected at monitoring bores M314W (MCM), M324W (MCM) and M162V (MCM). There are no existing or useable bores within a 2 km radius of these locations (M162V, M313W and M324W) in the IAA aquifer.
- Modelled drawdown at sites M313W and M324W predicted drawdown greater than the bore trigger threshold, which was confirmed in the monitoring data, however drawdown detected at M313W is significantly less than that predicted;
- Modelled drawdown at site M162V did not predict drawdown greater than the bore trigger threshold whereas the monitoring data shows drawdown greater than the bore trigger threshold. Monitored drawdown is most likely due to localised drawdown influences from nearby production; and
- MB2 and MB3 display recovering water levels and do not have a stable water level to reference drawdown.

In comparison to the groundwater levels obtained in the deep monitoring bores, the groundwater model predictions are over-estimating the impacts to the MCM, with slight under-estimation of impacts in the FCCM and BCG.

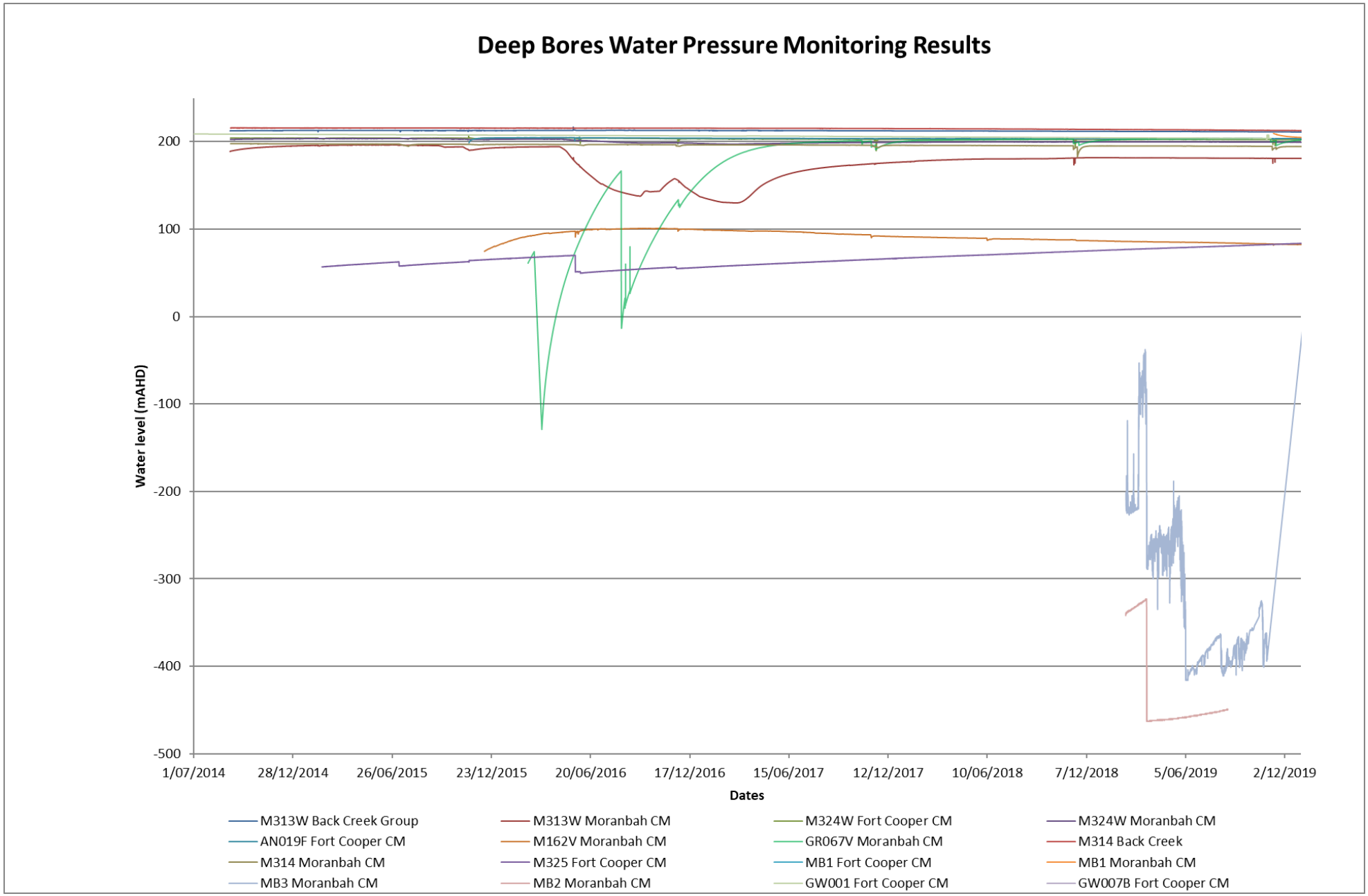

Figure 9: Deep Bores Water Pressure Monitoring Results

4.2.3 Groundwater Flow

A review of vertical gradients was undertaken for three monitoring locations in the MGP Area. Monitoring at each site included:

- Site 1: From deepest to shallowest; BCG (M314W), MCM (M314W), FCCM (M325W) as well as data from monitoring approximately 3 km north west in FCCM (M222W) and Quaternary Alluvium (M224W);
- Site 2: From deepest to shallowest; BCG (M313W), MCM (M313W), MCM (M324W), FCCM (M324W); and
- Site 3. From deepest to shallowest, MCM, FCCM and Quaternary alluvium, in MB2.

4.2.3.1 Site 1

Figure 10 below shows the vertical gradients for Site 1 and the latest data indicates the FCCM aquifer, at bore M325W, has the lowest pressure. The collected and graphically displayed data indicate a very steady and continued recovery of approximately 34m. With the exception of Site 1, there is an apparent gradient toward the MCM (the target coal seams for CSG production from the MGP) i.e. upward from the BCG and downward from the Quaternary Alluvium, to the FCCM and then to the MCM.

As discussed in Section 4.2.1, water levels in monitoring bore M222W which is constructed into the FCCM show a rising trend in response to above average rainfall recharge. Water levels in M224W constructed in the Quaternary Alluvium show that trends in water levels are linked to flows in the nearby Isaac River.

As discussed in Section 4.2.2 slight decline in pressures have been observed in M314W within MCM and the BCG. The pressure trends between the MCM and shallow aquifer seem to indicate no vertical hydraulic links exist at this location.

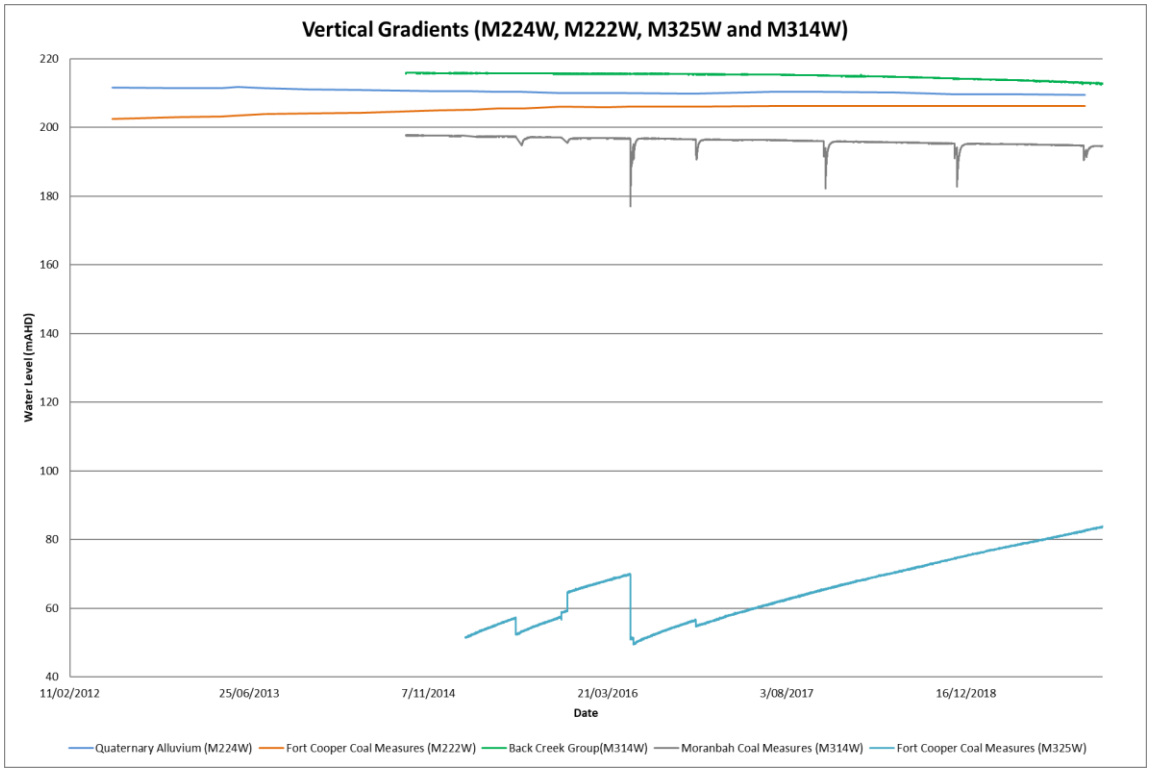

Figure 10: Site 1 - Review of Vertical Gradients (M224W, M222W, M325W and M314W)

4.2.3.1 Site 2

Figure 11 shows the graphically displayed vertical gradients for Site 2 and based on the presented data, the lower pressure in the MCM aquifer has reduced since production ceased in GM052V and recovery continues.

As discussed in Section 4.2.2, drawdown as a result of water production in CSG wells to the MCM aquifer is evident at site M313W and M324W but since the production ceased in April 2017, the water level recovery is evident in both monitoring boreholes. Monitoring data for the FCCM and BCG at this site indicates a slight decline in pressures. Decline in pressures noted for the FCCM are observed to correlate to the water production in CSG wells and consequential drawdown in the underlying MCM. This suggests that there is some transmission of impacts from the MCM to the shallower FCCM. Whilst

there is some decline in pressures in the deeper Back Creek Group aquifer, it is does not clearly correlate to the water production in the CSG wells and ongoing monitoring will confirm this. Based on this, monitoring data suggests that impacts are contained within the MCM and FCCM.

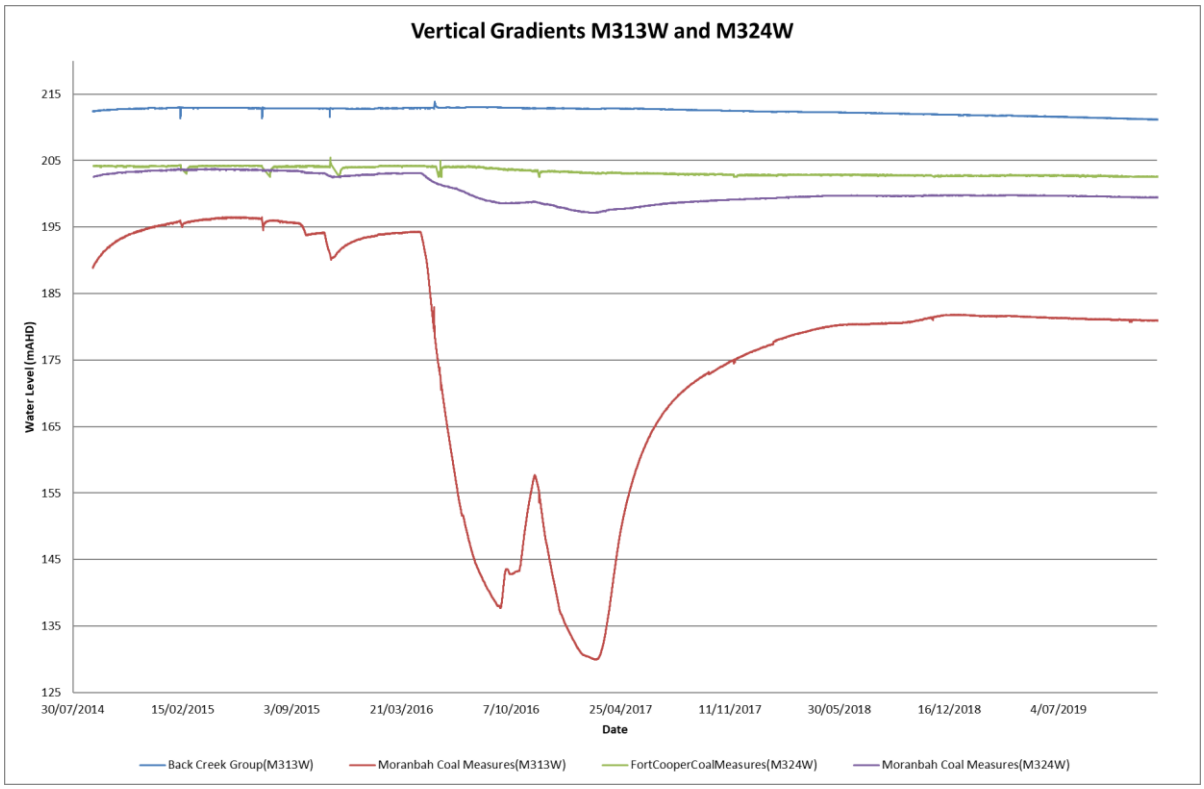

Figure 11: Site 2 - Review of Vertical Gradients (M324W and M313W)

4.2.3.1 Site 3

Figure 12 shows the graphically displayed vertical gradients for Site 3 and based on the presented data, a decrease in water levels in the Moranbah Coal Measures is visible, with a smaller decrease seen in the Fort Cooper Coal Measures. Prior to this decrease, the Fort Cooper Coal Measures displayed similar water levels to the Quaternary Alluvium.

Ongoing monitoring at this site will provide further information on the interconnectivity of aquifers at these sites.

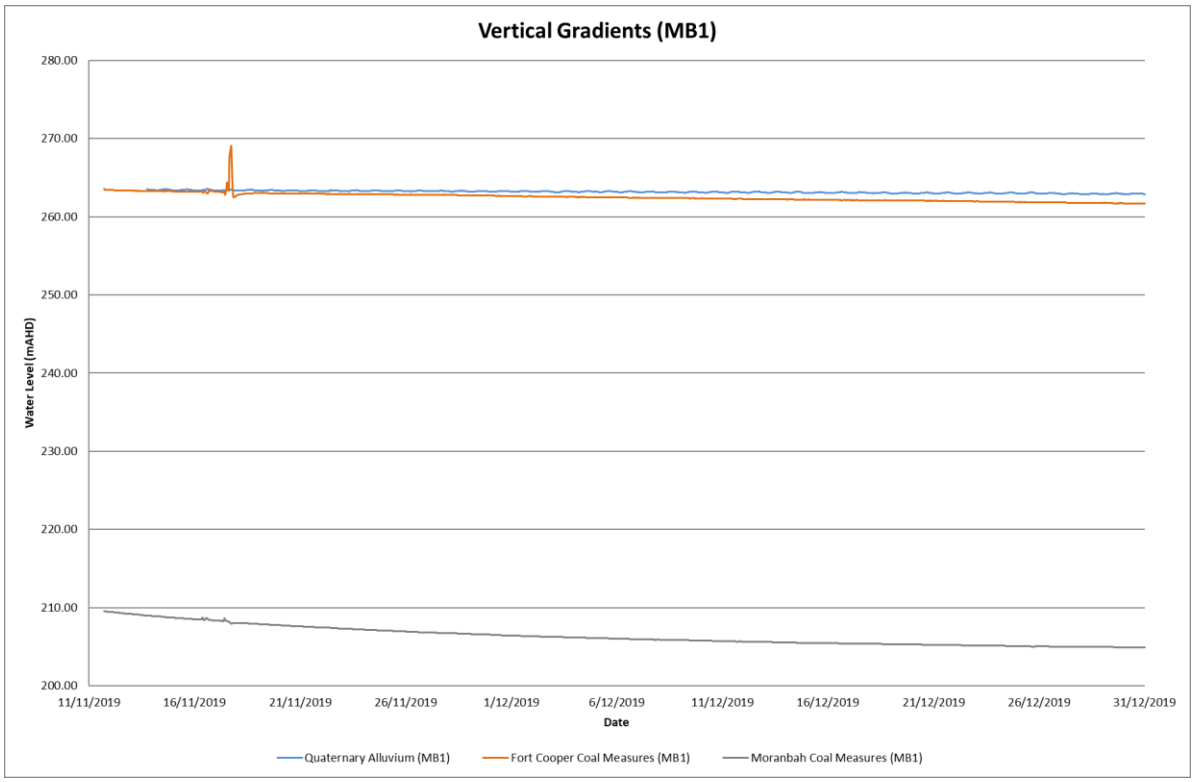

Figure 12: Site 3 - Review of Vertical Gradients (MB1)

5 GROUNDWATER QUALITY MONITORING

Groundwater quality monitoring has been undertaken since June 2012 in seven shallow groundwater monitoring bores and since May 2016 from one shallow groundwater monitoring bore which form part of the UWIR WMS. It should be noted that one additional shallow groundwater monitoring bore (AN021F) exists but has not been able to be sampled due to the low water volume in the bore casing. An adjacent bore, AN020F, drilled and completed into the Rewan Formation, has been sampled since 13 May 2016 as the replacement.

Groundwater quality monitoring was also undertaken in four deep groundwater monitoring bores that were completed in July 2014, two deep groundwater monitoring bores that were completed in November 2015, and one deep groundwater monitoring bore that was completed in August 2016 which also form part of the 2019 Bowen UWIR WMS groundwater monitoring network.

As a part of commencement of the BGP, additional monitoring sites have been incorporated in the monitoring network. These sites (MB1, MB2, MB3, GW001 and GW007) are located in PL 486.

As per the 2018 Bowen Annual Review, M134GM replaced M162V for the purpose of water quality monitoring from November 2017.

The groundwater quality monitoring results are shown in Appendix B. The primary purpose of groundwater quality monitoring is to identify changes in background water quality. A summary of these results (2012 to 2019) are provided in the following sections.

5.1 Shallow aquifer background water quality

Table 7 provides a summary of water quality results obtained from bores targeting the shallow aquifers (M339W, M225W, M340W, M230W, M250W, M224W, M222W and AN020F) with data updated from the 2019 annual review period. This provides an indication of water quality ranges for each parameter analysed based on aquifer type. Results for some parameters between different monitoring locations in the Tertiary Basalt show high degree of variation which is likely to be attributable to the spatial heterogeneity of that hydrogeological system. Review of this data indicates that there are no notable trends. As displayed by the groundwater level data in Section 4.2.1 , recharge by rainfall or streams occurs to shallow aquifers and is likely to result in variations in some parameters at the same monitoring location as shown in the table below. In general, this data shows that:

- Groundwater quality of the quaternary alluvium varies from brackish to saline
- Groundwater quality of the tertiary basalt aquifer varies from brackish to saline
- Groundwater quality of the tertiary sediment aquifer is fresh to brackish
- Groundwater quality of the weathered coal measures is brackish
- Groundwater quality of the Rewan Formation is brackish

Table 7: Background Water Quality - Shallow Monitoring Bores

Parameter	Quaternary Alluvium		Tertiary Basalt		Tertiary Sediment		Weathered Coal Measures		Rewan Formation	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
pH	5.73	7.48	6.28	8.49	5.42	7.76	6.09	8.16	6.2	7.58
EC uS/cm (laboratory)	4240	31600	5300	42769	2170	2650	9090	11000	10400	11200
TDS mg/L (laboratory)	2360	27000	3000	29000	1300	1620	5190	9600	6210	7310
Bicarbonate Alkalinity as $CaCO_3$ (mg/L)	<1	<5	<1	<5	<1	<5	<1	<5	<1	<1
Total Alkalinity as $CaCO_3$ (mg/L)	<1	<5	<1	94	<1	<5	<1	<5	<1	<1
Sulphate as SO_4 (mg/L)	101	360	380	827	53	116	261	457	20	126
Chloride (mg/L)	101	360	380	827	53	116	261	457	20	126
Calcium (mg/L)	541	6200	60	1140	54	106	78	177	<1	1
Magnesium (mg/L)	1020	14000	1490	17000	660	794	3140	4100	3750	4030
Sodium (mg/L)	172	1000	55	204	12	20	290	440	429	460

Parameter	Quaternary Alluvium		Tertiary Basalt		Tertiary Sediment		Weathered Coal Measures		Rewan Formation	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Potassium (mg/L)	107	1400	85	792	38	52	340	506	174	203
Arsenic (mg/L) (dissolved)	543	6200	891	13000	344	510	932	1400	1450	1650
Barium (mg/L) (dissolved)	5	17	12	150	9	13	9	14	24	29
Beryllium (mg/L) (dissolved)	<0.01	0.008	<0.01	3770	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium (mg/L) (dissolved)	<0.001	0.008	<0.001	0.002	<0.001	<0.01	<0.001	0.011	<0.001	<0.001
Cobalt (mg/L) (dissolved)	<0.00001	0.193	<0.0005	<0.005	<0.0005	<0.001	<0.000001	<0.001	<0.001	<0.001
Chromium (mg/L) (dissolved)	0.045	0.2	0.05	0.283	0.047	0.11	0.184	3.9	3.42	3.88
Copper (mg/L) (dissolved)	<0.0005	0.0002	<0.0001	0.0012	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese (mg/L) (dissolved)	<0.001	0.015	<0.001	0.01	0.001	0.076	<0.001	0.002	<0.001	<0.001
Molybdenum mg/L	<0.001	0.027	<0.001	0.005	<0.0001	0.005	<0.001	0.002	<0.001	0.001
Nickel (mg/L) (dissolved)	<0.005	0.017	<0.001	0.07	<0.001	0.005	<0.001	0.036	<0.001	0.005
Selenium (mg/L)	<0.001	<0.01	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strontium (mg/L)	0.834	8.1	<0.005	0.611	0.007	0.095	1.1	1.86	1.17	1.92
Lead mg/L (dissolved)	0.001	0.003	0.002	0.008	<0.001	0.002	0.002	0.004	<0.001	0.007
Vanadium (mg/L) (dissolved)	0.004	0.17	0.005	0.253	0.006	0.088	<0.001	0.125	<0.001	0.006
Zinc (mg/L) (dissolved)	<0.01	<0.05	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron (mg/L)	3.19	14	1.52	8.98	0.686	0.725	6.67	8.96	11	11.3
Iron (mg/L)	<0.001	0.002	<0.001	0.042	<0.001	<0.01	<0.001	<0.01	<0.01	<0.01
Mercury (mg/L) (dissolved)	0.008	0.302	<0.005	0.185	<0.005	0.131	<0.005	0.115	<0.005	<0.005
Fluoride (mg/L)	0.13	0.39	0.42	2.96	0.61	0.76	0.3	0.34	0.13	0.2
Phosphate as P (mg/L)	0.2	10.1	<0.05	0.43	<0.05	0.43	11	21.1	1.68	14.3

5.2 Deep aquifer background water quality

Table 8 provides a summary of water quality results obtained from bores targeting the deep aquifers (M313W, M314W, M324W, M325W, AN019F, GR067V, M162V and M134GM), with data updated from the 2019 annual review period. This provides an indication of water quality ranges for each parameter analysed based on aquifer type. Results for some parameters between different monitoring locations show high degree of variation which is likely to be attributable to the spatial heterogeneity and low permeability of the hydrogeological system. In addition to this, as displayed by the groundwater pressure data, groundwater recovery for some sites is slow and this is likely to result in variations in some parameters at the same monitoring location. Overall, a review of this data indicates that there are no notable trends. In general, this data shows that:

- Groundwater quality of the Fort Cooper Coal Measures aquifer is fresh to brackish; and
- Groundwater quality of the Moranbah Coal Measures is fresh to brackish.

Table 8: Background Water Quality – Deep Monitoring Bores

Parameter	Fort Cooper Coal Measures		Moranbah Coal Measures	
	Min	Max	Min	Max
pH	8.13	11.8	7.27	9.42
EC uS/cm (laboratory)	1170	11100	1710	16000
TDS mg/L (laboratory)	707	6140	1160	9810
Bicarbonate Alkalinity as $CaCO_3$ (mg/L)	<1	456	<1	<1
Total Alkalinity as $CaCO_3$ (mg/L)	<1	135	<1	456
Sulphate as SO_4 (mg/L)	<1	635	159	2310
Chloride (mg/L)	225	720	159	2420

Parameter	Fort Cooper Coal Measures		Moranbah Coal Measures	
	Min	Max	Min	Max
Calcium (mg/L)	<1	68	<1	134
Magnesium (mg/L)	188	3540	198	5770
Sodium (mg/L)	2	168	7	209
Potassium (mg/L)	<1	5	<1	62
Arsenic mg/L (dissolved)	199	2330	212	3490
Barium mg/L (dissolved)	12	73	9	1450
Beryllium mg/L (dissolved)	<0.001	0.005	<0.001	0.013
Cobalt mg/L (dissolved)	<0.001	<0.001	<0.001	<0.001
Chromium mg/L (dissolved)	0.005	3.25	0.236	23
Copper mg/L (dissolved)	<0.001	<0.001	<0.001	0.001
Manganese mg/L (dissolved)	<0.001	0.004	<0.001	0.018
Molybdenum mg/L	<0.001	0.004	<0.001	0.01
Nickel mg/L (dissolved)	<0.001	0.582	<0.001	7.08
Selenium mg/L	<0.001	0.459	<0.001	2.19
Lead mg/L (dissolved)	<0.001	0.304	0.008	0.446
Strontium mg/L	0.02	0.114	0.001	0.082
Vanadium mg/L (dissolved)	<0.001	0.009	<0.001	0.032
Zinc mg/L (dissolved)	<0.01	<0.01	<0.01	<0.01
Boron mg/L	0.639	8.18	1.18	10.8
Iron mg/L	<0.01	<0.01	<0.01	0.02
Fluoride (mg/L)	<0.005	0.427	<0.005	0.568
Phosphate as P (mg/L)	0.42	1.17	0.46	2.4

6 CONCLUSION

Key findings of the 2020 annual review for the water production are:

MGP:

- Water production for the 2020 annual review data capture period (1 January 2019 to 31 December 2019) is less than 1% more than that modelled in the 2019 Bowen UWIR;
- The updated water production forecast for between 2020 to 2025 is 665.4 ML less than that modelled in the 2019 Bowen UWIR (48% decrease); and
- Given the predicted forecast water production is significantly less than what was modelled in the 2019 UWIR, the predicted impacts are expected to be less than modelled and an update of the of the 2019 UWIR is not proposed.

BGP:

- Water production is yet to commence for PL486;
- Three production testing wells in ATP 1103 were active in 2019 (RH098A, RH099A and RH100A), with a combined water production of 2.8 ML for the annual review period. This amount of water produced is below the Peak Downs reference pilot site. Therefore, any IAA arising from production testing wells in the 2020 annual review data capture period will be smaller than that associated with the reference pilot site. A 1-kilometre IAA radius consistent with the methodology outlined in the 2019 Bowen UWIR showed that no landholder bores are in proximity to the testing. No further investigation is required; and
- Given the predicted forecast water production is significantly less than what was modelled in the 2019 UWIR, the predicted impacts are expected to be less than modelled and an update of the 2019 UWIR is not proposed.

As identified above, there is no material increase in observed and predicted water production for the MGP and BGP, therefore the modelling conducted in the 2019 UWIR overestimates groundwater impacts and an update of the 2019 UWIR is not proposed.

Key findings of the 2020 annual review for water levels monitoring are:

- There is no apparent influence of CSG production to the Quaternary alluvium, weathered Tertiary basalt, Tertiary sediment, weathered Fort Cooper coal measures and Rewan aquifers in which these bores are installed; and
- In comparison to the groundwater levels obtained in the deep monitoring bores, the groundwater model predictions are over-estimating the impacts to the MCM, with slight under-estimation of impacts in the FCCM and BCG.

Key findings of the 2020 annual review for water quality monitoring are:

- A review of this data indicates that there are no notable trends for both the shallow and deep aquifers.

APPENDIX A: WATER LEVEL RESULTS

SHALLOW BORES

Bore Name	SWL (mAHD)																						
	9/06/2012	13/12/2012	8/04/2013	25/05/2013	6/08/2013	6/12/2013	5/05/2014	19/08/2014	5/12/2014	11/03/2015	17/05/2015	27/07/2015	13/11/2015	2/03/2016	13/05/2016	29/08/2016	15/11/2016	15/06/2017	12/11/2017	1/06/2018	17/11/2018	24/05/2019	12/11/2019
M339W	200.426	200.456	200.43	200.451	200.462	200.546	200.49		200.56	200.533	200.416	200.398	200.556	200.466	200.456	200.426	200.500	200.507	200.498	200.520	200.600	200.620	200.660
M225W	206.298	206.641	206.737	206.8	207.455	207.152	207.11		207.27	207.349	207.257	207.23	207.402	207.215	207.245	207.248	207.316	207.54	207.685	207.75	207.9		207.78
M340W	207.621	208.973	208.118	208.216	208.261	208.507	208.6		208.7	208.771	208.753	208.805	208.918	208.869	208.9	208.761	205.946	203.032					
M230W	208.495	208.705	208.715	208.837	208.865	209.062	209.07		209.2	209.204	209.106	209.058	209.145	208.884	208.922	208.863	208.992	208.629	208.591	208.214	207.7	206.94	205.95
GW001																							227.894
GW007A																							264.752
M250W	233.288	233.248	233.238	233.232	233.248	233.308	233.26		233.33	233.289	233.25	233.221	233.25	233.243	233.258	233.328	233.237	233.283	233.273	233.29	233.32	233.34	233.34
AN021F															237.06		242.34		238.47	239.06	239.52		240.52
M224W	211.675	211.365	211.45	211.705	211.42	211.11	210.89	210.65	210.49	210.561	210.419	210.277	209.982	210.02	209.969		209.852	210.354	210.355	210.08	209.69	209.57	209.36
M222W	202.414	202.974	203.209		203.819	204.014	204.3	204.65	204.95	205.21	205.44	205.54	205.994	205.929	205.969	206.014	206.014	206.149	206.301	206.3	206.28	206.22	206.22
AN020F														238.37	238.366	238.48	238.44		237.18	238.61	238.39	238.36	238.36
MB12																			298.54	298.49	281.08	281.08	286.4463
MB1-S																							209.52

APPENDIX B: WATER QUALITY RESULTS

SHALLOW MONITORING

Monitoring Bore ID	Sample Date	Field pH	Electrical Conductivity µS/cm	Total Dissolved Solids (grav) mg/L	Hydroxide Alkalinity (OH-) as CaCO3 mg/L	Carbonate Alkalinity as CaCO3 mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Total Alkalinity as CaCO3 mg/L	Sulphate, SO4 mg/L	Chloride, Cl mg/L	Calcium - Dissolved mg/L	Magnesium - Dissolved mg/L	Sodium - Dissolved mg/L	Potassium - Dissolved mg/L
M339W	11/12/2012	6.46	38000	26000	<5	<5	680	680	980	15000	150	670	10000	110
M339W	4/04/2013	6.28	36000	22000	<5	<5	690	690	830	14000	160	700	9700	120
M339W	21/05/2013	8.09	37000	29000	<5	<5	680	680	1100	17000	150	710	10000	120
M339W	7/08/2013	6.42	37000	25000	<5	<5	660	660	990	15000	190	670	13000	150
M339W	5/12/2013	6.6	39000	28000	<5	<5	660	660	1100	16000	160	740	11000	110
M339W	11/05/2014	6.6	37900	24600	<1	<1	698	698	1020	13800	150	722	7740	100
M339W	9/12/2014	6.46	39300	25400	<1	<1	706	706	893	13700	158	780	8220	138
M339W	10/03/2015	6.53	39000	27100	<1	<1	644	644	932	13900	183	682	8360	98
M339W	16/05/2015	6.67	37500	24200	<1	<1	647	647	1140	12200	167	668	7770	82
M339W	27/07/2015	6.53	38200	25400	<1	<1	658	658	1020	13500	180	676	7600	90
M339W	16/11/2015	6.43	32300	21200	<1	<1	714	714	987	12700	147	669	7170	81
M339W	2/03/2016	7.56	39800	21200	<1	<1	712	712	1000	13400	160	747	8710	104
M339W	13/05/2016		39000	24400	<1	<1	681	681	1020	13000	178	712	7850	89
M339W	29/08/2016	8.37	41300	28200	<1	43	714	757	993	12600	170	688	7790	93
M339W	15/11/2016	7.13	37100	22900	<1	<1	652	652	1050	12600	171	743	8440	92
M339W	13/06/2017		38600	25100	<1	<1	726	726	964	13500	186	780	9040	105
M339W	12/11/2017	6.99	39800	27100	<1	<1	708	708	923	13700	204	792	9570	102
M339W	1/06/2018	6.58	39300		<1	<1	644	644	974	12900	181	772	8990	97
M339W	17/11/2018	6.51	42769	26800	<1	<1	661	661	916	11600	174	750	7800	96
M339W	27/05/2019	6.47	37398	26200	<1	<1	632	632	958	13600	174	769	8370	95
M339W	12/11/2019	6.69	38760	23400	<1	<1	669	669	936	13800	142	680	7860	88
M225W	3/04/2013	7.54	28000	17000	<5	<5	810	810	710	11000	150	510	7200	84
M225W	21/05/2013	6.53	28000	21000	<5	<5	790	790	660	10000	150	520	7500	82
M225W	8/08/2013	6.59	29000	20000	<5	<5	780	780	700	11000	160	480	7500	75
M225W	5/12/2013	6.84	30000	21000	<5	<5	780	780	780	11000	180	490	9500	95
M225W	6/05/2014	6.98	29900	19400	<1	<1	745	745	369	9940	142	495	5440	72
M225W	5/12/2014	6.73	30500	20100	<1	<1	808	808	617	9880	151	523	6450	76
M225W	11/03/2015	6.82	30100	20000	<1	<1	716	716	827	10200	163	508	6600	75
M225W	17/05/2015	6.89	30200	19800	<1	<1	780	780	884	9850	161	518	6430	64
M225W	28/07/2015	6.96	28700	19300	<1	<1	790	790	735	9660	157	478	5670	65
M225W	16/11/2015	6.38	23700	17400	<1	<1	826	826	738	9870	134	485	5460	59
M225W	2/03/2016	7.71	30500	19400	<1	<1	817	817	721	10300	153	541	6530	76
M225W	13/05/2016	7.57	29600	18400	<1	<1	779	779	752	9390	158	532	6570	66
M225W	29/08/2016	7.45	29600	17900	<1	<1	799	799	727	9750	158	532	6220	68
M225W	15/11/2016	7.31	30200	19800	<1	<1	778	778	711	9620	169	567	6560	72
M225W	13/06/2017		29900	18300	<1	<1	827	827	786	10800	150	492	6780	66
M225W	12/11/2017	7.15	30700	20100	<1	<1	814	814	691	10400	144	507	5930	64
M225W	31/05/2018	7.16	30100	19200	<1	<1	701	701	701	9900	169	578	6960	70
M225W	21/11/2018	6.74	29700	19000	<1	<1	748	748	723	10200	159	566	6470	68
M225W	25/05/2019	6.59	29500	19500	<1	<1	738	738	745	10700	159	541	6250	70
M225W	7/11/2019	6.91	30400	21800	<1	<1	733	733	715	10200	149	566	6670	71
M340W	11/12/2012	6.6	8600	5200	<5	<5	620	620	240	2900	57	110	2100	25
M340W	4/04/2013	6.3	8300	5200	<5	<5	620	620	230	2600	62	120	1900	32
M340W	22/05/2013	6.81	8400	5000	<5	<5	610	610	240	2700	59	120	1900	25
M340W	7/08/2013	6.63	8600	5000	<5	<5	620	620	230	2700	55	110	2000	26
M340W	5/12/2013	6.63	9100	5700	<5	<5	610	610	260	2800	56	110	2200	27
M340W	10/05/2014	6.74	10000	6500	<1	<1	661	661	246	3150	71	141	1920	25
M340W	8/12/2014	6.69	11100	6390	<1	<1	708	708	257	3400	85	172	2050	33
M340W	12/03/2015	6.81	11400	6500	<1	<1	689	689	269	3760	102	174	2240	32
M340W	17/05/2015	6.82	11700	6900	<1	<1	679	679	383	3740	96	179	2060	27
M340W	28/07/2015	6.68	11400	6280	<1	<1	668	668	319	3670	100	177	2120	29
M340W	16/11/2015	6.38	10700	7320	<1	<1	727	727	322	3850	89	193	2180	28
M340W	2/03/2016	8.43	12600	6400	<1	43	681	725	320	4060	101	203	2480	33
M340W	13/05/2016	7.67	12400	7140	<1	<1	693	693	342	3790	100	200	2310	30
M340W	29/08/2016	8.49	13000	7250	<1	94	636	730	345	3780	107	198	2340	30
M340W	15/11/2016	7.44	13100	7430	<1	<1	668	668	371	4310	109	216	2420	31
M340W	13/06/2017		11300	6590	<1	<1	651	651	353	3690	90	180	2180	27
M230W	11/12/2012	7.15	5600	3300	<5	<5	420	420	64	1600	55	93	1200	18
M230W	3/04/2013	6.66	5400	3200	<5	<5	420	420	66	1600	60	96	1000	19
M230W	21/05/2013	7.01	5300	3300	<5	<5	410	410	60	1700	60	96	1100	18
M230W	7/08/2013	7.05	5600	3000	<5	<5	400	400	77	1700	58	93	1100	16
M230W	7/12/2013	6.96	5900	3700	<5	<5	390	390	83	1700	56	85	1200	15
M230W	11/05/2014	6.99	6010	3910	<1	<1	426	426	82	1660	67	100	1040	14
M230W	5/12/2014	7.05	6100	3120	<1	<1	418	418	73	1490	70	103	970	17
M230W	12/03/2015	7	6080	3360	<1	<1	410	410	69	1730	74	100	1030	16
M230W	17/05/2015	7	6180	3580	<1	<1	407	407	97	1550	75	106	985	14
M230W	28/07/2015	7.05	6000	3210	<1	<1	404	404	87	1500	74	107	1050	16
M230W	15/11/2015	6.62	6260	3440	<1	<1	419	419	82	1840	69	101	891	12
M230W	2/03/2016	7.82	6350	3350	<1	<1	431	431	84	1760	68	104	995	17
M230W	13/05/2016	7.78	6120	3500	<1	<1	419	419	80	1760	72	110	1050	16
M230W	29/08/2016	7.48	6130	3450	<1	<1	417	417	79	1680	76	111	1050	18
M230W	15/11/2016	7.51	6220	3500	<1	<1	414	414	83	1750	68	117	1100	15
M230W	13/06/2017		6270	3470	<1	<1	442	442	78	1870	65	110	1100	15
M230W	12/11/2017	7.5	6400	3710	<1	<1	420	420	79	1820	70	114	1070	15
M230W	1/06/2018	6.95	6860	3960	<1	<1	380	380	99	1920	78	121	1170	17
M230W	21/11/2018	6.83	7260	4140	<1	<1	401	401	104	2140	98	158	1300	17
M230W	25/05/2019	6.74	7450	4410	<1	<1	397	397	117	2480	101	163	1350	18
M230W	10/11/2019	6.88	7420	4770	<1	<1	403	403	110	2330	93	150	1260	18
M250W	13/12/2012	5.42	2400	1400	<5	<5	61	61	54	700	14	39	380	11
M250W	6/04/2013	5.77	2400	1600	<5	<5	69	69	69	660	17	45	490	13
M250W	25/05/2013	5.86	2500	1600	<5	<5	67	67	83	730	18	46	510	13
M250W	6/08/2013	5.82	2300	1300	<5	<5	72	72	81	730	19	43	450	11
M250W	5/12/2013	5.92	2500	1600	<5	<5	60	60	84	710	14	39	480	12
M250W	9/05/2014	5.64	2440	1590	<1	<1	76	76	76	682	13	43	393	12
M250W	7/12/2014	5.65	2530	1380	<1	<1	58	58	76	717	13	45	432	11
M250W	10/03/2015	5.5	2540	1580	<1	<1	58	58	92	768	19	42	420	10
M250W	18/05/2015	5.75	2560	1420	<1	<1	55	55	92	763	17	44	398	10
M250W	29/07/2015	5.48	2430	1430	<1	<1	59	59	89	729	15	44	387	11
M250W	16/11/2015	5.72	2170	1300	<1	<1	72	72	76	664	12	38	344	9
M250W	2/03/2016	6.54	2650	1490	<1	<1	53	53	92	787	15	45	408	12
M250W	13/05/2016	6.74	2620	1530	<1	<1	116	116	95	774	18	52	461	11
M250W	29/08/2016	7.76	2600	1440	<1	<1	64	64	81	678	14	44	396	10
M250W	15/11/2016	6.36	2460	1400	<1	<1	60	60	86	715	12	46	411	10
M250W	18/06/2017		2450	1360			63	63	80	708	12	42	402	10
M250W	13/11/2017	7.23	2650	1620			55	55	106	794	20	50	465	11
M250W	2/06/2018	5.8	2530					55	77	708	15	48	440	10
M250W	22/11/2018	5.66	2510	1520	<1	<1	62	62	89	746	15	48	420	11
M250W	26/05/2019	5.45	2480	1400	<1	<1	58	58	88	790	16	48	407	11
M250W	7/11/2019	5.93	2510	1560	<1	<1	59	59	87	744	20	46	414	11
M222W	16/06/2012	6.43	9520	6690	<1	<1	457	457	85	3140	326	355	1120	14
M222W	14/12/2012	6.52	9300	6500	<5	<5	420	420	78	3500	290	340	1000	14
M222W	5/04/2013	6.22	9100	6500	<5	<5	300	300	140	4100	320	440	1100	14
M222W	26/05/2013	6.67	9400	7500	<5	<5	290	290	100	3200	350	450	1100	14
M222W	9/08/2013	6.17	9200	6200	<5	<5	310	310	110	3400	340	400	1100	11
M222W	6/12/2013	6.26	9700	9600	<5	<5	300	300	130	3300	440	380	1400	12
M222W	10/05/2014	6.16	9480	6160	<1	<1	316	316	129	3420	363	428	1010	10
M222W	19/08/2014	6.81	9090	8950	<1	<1	275	275	128	3450	365	448	1020	12
M222W	4/12/2014	6.25	10200	7520	<1	<1	303	303	116	3330	361	451	1080	12
M222W	11/03/2015	6.55	10000	6810	<1	<1	295	295	122	3450	395	395	999	10
M222W	17/05/2015	6.32	9890	7160	<1	<1	304	304	165	3480	374	426	943	9
M222W	27/07/2015	6.23	9670	6150	<1	<1	290	290	129	3420	385	434	956	10
M222W	17/11/2015	6.1	10200	6820	<1	<1	296	296	124	3560	352	376	932	10
M222W	2/03/2016	7.19	10700	5190	<1	<1	318	318	118	3560	342	434	1040	12
M222W	13/05/2016	7.22	9890	5740	<1	<1	282	282	177	3340	376	456	1040	10
M222W	29/08/2016	8.16	10400	7370	<1	<1	280	280	155	3170	414	474	1080	10
M222W	15/11/2016	6.62	10300	6300	<1	<1	292	292	140	3660	407	492	1170	11
M222W	13/06/2017		10600	6320			310	310	145	3920	379	448	1140	11
M222W	7/11/2017	6.82	10600	6800			271	271	126	3670	399	466	1080	10
M222W	29/05/2018	6.29	11000					286	131	4020	417	478	1170	12
M222W	18/11/2018	6.19	11000	6970	<1	<1	282	282	130	3630	406	494	1080	11
M222W	24/05/2019	6.09	10700	7230	<1	<1	261	261	159	4000	432	506	1180	10
M222W	10/11/2019	6.09	10700	8400	<1	<1	275	275	161	3780	404	470	1110	11
M224W	16/06/2012	6.22	29500	22300	<1	<1	355	355	1600	9560	831	1260	4170	11
M224W	15/12/2012	6.24	28000	22000	<5	<5	340	340	1500	14000	780	1100	4500	13
M224W	7/04/2013	5.73	25000	20000	<5	<5	360	360	1300	11000	740	1000	4300	16
M224W	25/05/2013	6.11	18000	14000	<5	<5	220	220	880	6200	610	680	2600	17
M224W	6/08/2013	6.07	23000	17000	<5	<5	240	240	1200	9100	840	980	4500	12
M224W	6/12/2013	6.15	28000	27000	<5	<5	280	280	6200	11000	1000	1400	6200	13
M224W	10/05/2014	6.24	27200	17700	<1	<1	253	253	1250	10200	779	1080	3690	11
M224W	19/08/2014	6.34	27600	21000	<1	<1	192	192	1060	10800	822	1300	4590	13
M224W	4/12/2014	6.14	31600	22900	<1	<1	186	186	842	9710	764	1320	4080	13
M224W	12/03/2015	6.46	22900	16500	<1	<1	174	174	710	8850	661	842	3240	10
M224W	17/05/2015	6.36	21000	16800	<1	<1	184	184	978	7200	640	768	2760	8
M224W	27/07/2015	6.13	24700	17100	<1	<1	188	188	948	8670	712	984	3390	9
M224W	17/11/2015	6.13	27700	17500	<1	<1	158	158	890	9930	613	870	3320	7
M224W	2/03/2016	7.38	10800	5950	<1	<1	128	128	656	3350	316	360	1600	6
M224W	13/05/2016	7.48	17900	11100	<1	<1	202	202	799	5860	512	664	2680	9
M224W	29/08/2016	7.21	4240	2360	<1	<1	101	101	541	1020	172	107	543	5
M224W	15/11/2016	6.77	17700	11700	<1	<1	192	192	802	6210	570	696	2650	8
M224W	13/06/2017		17600	11000	<1	<1	238	238	1070	6490	676	630	2400	9
M224W	07/11/2017	6.97	20400	14100	<1	<1	232	232	1000	7120	774	778	2650	10
M224W	29/05/2018	6.28	27200					304	1240	10100	870	1090	4100	10
M224W	18/11/2018	6.33	5490	3630	<1	<1	141	141	574	1270	264	137	669	5
M224W	24/05/2019	6.53	12800	8730	<1	<1	152	152	907	4490	448	440	1960	6
M224W	10/11/2019	6.12	18400	15200	<1	<1	141	141	644	6430	426	628	2760	6
AN020F	13/05/2016	6.2	10800	6210	<1	<1	22	22	<1	3750	429	178	1550	29
AN020F	15/11/2016	6.32	10600	7210	<1	<1	21	21	1	4030	439	174	1450	26
AN020F	15/11/2017	7.39	10900	7010	<1	<1	47	47	<1	3790	456	182	1650	29
AN020F	15/11/2018	7.05	11200	7280	<1	<1	126	126	<1	3800	460	203	1460	24
AN020F	11/11/2019	7.58	10400	7310	<1	<1	20	20	<1	3830	457	174	1580	29

Monitoring Bore ID	Sample Date	Arsenic-Dissolved mg/L	Beryllium-Dissolved mg/L	Barium-Dissolved mg/L	Cadmium-Dissolved mg/L	Chromium-Dissolved mg/L	Cobalt-Dissolved mg/L	Copper-Dissolved mg/L	Lead-Dissolved mg/L	Manganese-Dissolved mg/L	Molybdenum mg/L	Nickel-Dissolved mg/L	Selenium mg/L	Strontium mg/L	Vanadium-Dissolved mg/L	Zinc-Dissolved mg/L	Boron mg/L	Iron mg/L	Mercury-Dissolved mg/L	Fluoride, F mg/L	Phosphate as P in water mg/L
M339W	11/12/2012	<0.001	<0.0005	0.056	0.0004	0.006	<0.001	0.007	<0.001	0.016		0.018			0.003	0.05			0.00008	0.45	0.1
M339W	4/04/2013	<0.001	<0.0005	0.057	0.0003	0.007	<0.001	0.005	<0.001	0.013		0.027			0.003	0.039			<0.00005	0.44	0.11
M339W	21/05/2013	<0.001	<0.0005	0.067	0.0005	0.004	<0.001	0.059	<0.001	0.012		0.014			0.003	0.068			0.00009	0.33	0.026
M339W	7/08/2013	<0.002	<0.0005	0.061	0.0004	0.003	<0.001	0.004	<0.001	0.007		0.014			0.003	0.078			<0.00005	0.29	0.19
M339W	5/12/2013	<0.001	<0.0005	0.055	0.0005	0.006	<0.001	0.007	<0.001	0.007		0.015			0.003	0.06			<0.00005	0.37	0.085
M339W	11/05/2014							<0.05		<0.01						<0.05			<0.0001		0.26
M339W	9/12/2014							<0.005		<0.005						0.04			<0.0001	0.4	0.08
M339W	10/03/2015	<0.005	<0.005	0.058		<0.005	<0.005	<0.005	<0.005	0.009		0.026			<0.05	0.053				0.8	
M339W	16/05/2015	<0.001	<0.001	0.124	0.0007	0.002	<0.001	0.009	<0.001	0.009		0.012			<0.01	0.128			0.0008	0.4	
M339W	27/07/2015	<0.001	<0.001	0.051	0.0004	<0.001	<0.001	0.001	<0.001	0.003		0.012			<0.01	0.016			0.001	0.5	
M339W	16/11/2015	<0.005	<0.005	0.053	<0.0005	<0.005	<0.005	0.01	<0.005	<0.005		0.014			<0.05	0.149			0.0006	0.4	0.1
M339W	2/03/2016	<0.001	<0.001	0.050		0.007	<0.001	0.002	<0.001	0.002		0.014			<0.01	0.046				0.4	0.24
M339W	13/05/2016	0.001	<0.001	0.055		0.01	<0.001	0.008	<0.001	0.005	0.003	0.014	0.01	8.48	<0.01	0.051	2.58	<0.05	<0.0001	0.4	0.62
M339W	29/08/2016	<0.005	<0.005	0.058		0.01	<0.005	0.005	<0.005	<0.005	<0.005	0.014	<0.05	8.98	<0.05	0.027	2.66	<0.05		0.5	0.07
M339W	15/11/2016	<0.001	<0.001	0.055	0.0001	0.002	<0.001	<0.001	<0.001	0.006	0.003	0.014	<0.01	8.36	<0.01	0.021	2.42	<0.05	<0.0001	0.5	0.15
M339W	13/06/2017							0.006		<0.005						<0.025	2.74	<0.05	<0.0001	0.5	
M339W	12/11/2017	<0.005	<0.005	0.062		0.008	<0.005		<0.005	<0.005	<0.005	0.015	<0.05		<0.05	<0.025	2.96	0.06		0.4	0.07
M339W	1/06/2018							<0.005		<0.005						<0.025	2.66	<0.05	0.001	0.4	0.09
M339W	17/11/2018	<0.005	<0.005	0.057		0.01	<0.005	<0.005	<0.005	<0.005	<0.005	0.013	<0.05		<0.05	<0.025	2.36	<0.05		0.09	
M339W	27/05/2019							<0.005		<0.005						0.029	2.91	<0.05	0.0009	<0.05	
M339W	12/11/2019	<0.005	<0.005	0.052		0.009	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05		<0.05	0.047	2.81	<0.05		0.11	
M225W	3/04/2013	<0.001	<0.0005	0.063	0.0006	0.003	<0.001	0.01	<0.001	0.011		0.025			0.015	0.042			<0.00005	0.48	0.2
M225W	21/05/2013	0.001	<0.0005	0.140	0.0006	0.002	0.001	0.01	<0.001	0.21		0.034			0.009	0.053			<0.00005	0.37	0.11
M225W	8/08/2013	<0.001	<0.0005	0.120	0.001	0.002	0.001	0.03	<0.001	0.18		0.068			0.013	0.036			<0.00005	0.32	0.19
M225W	5/12/2013	<0.001	<0.0005	0.120	0.0007	0.002	0.002	0.009	<0.001	0.35		0.056			0.009	0.031			<0.00005	0.37	0.11
M225W	6/05/2014							<0.05		<0.01						0.059			<0.0001		0.1
M225W	5/12/2014							0.028		0.004						0.058			0.0001	0.5	0.27
M225W	11/03/2015	<0.005	<0.005	0.075		<0.005	<0.005	<0.005	<0.005	0.009		0.026			<0.05	0.096				0.8	
M225W	17/05/2015	0.001	<0.001	0.112	0.0012	0.001	<0.001	0.022	<0.001	0.161		0.048			0.01	0.029			<0.0001	0.4	
M225W	28/07/2015	0.001	<0.001	0.089	0.0006	<0.001	<0.001	0.011	<0.001	0.033		0.016			0.01	0.018			<0.0001	0.6	
M225W	16/11/2015	<0.005	<0.005	0.055	0.0006	<0.005	<0.005	0.012	<0.005	<0.005		0.022			<0.05	0.099			0.0001	0.6	0.18
M225W	2/03/2016	<0.001	<0.001	0.053		0.002	<0.001	0.02	<0.001	0.001		0.012			0.01	0.035				0.5	0.25
M225W	13/05/2016	<0.001	<0.001	0.062	0.0005	0.002	<0.001	0.006	<0.001	0.01	0.004	0.028	<0.01	4.25	0.01	0.036	2.48	<0.05	<0.0001	0.5	0.13
M225W	29/08/2016	<0.001	<0.001	0.065		0.002	<0.001	0.012	<0.001	0.006	0.004	0.022	<0.01	4.58	0.01	0.038	2.1	<0.05		0.6	0.22
M225W	15/11/2016	<0.001	<0.001	0.068	0.0006	0.002	<0.001	0.006	<0.001	0.008	0.006	0.058	<0.01	4.93	0.01	0.062	2.32	<0.05	0.0002	0.7	0.12
M225W	13/06/2017							0.013		0.005						0.018	1.92	<0.05	<0.0001	0.4	0.43
M225W	12/11/2017	<0.001	<0.001	0.060		0.003	<0.001		<0.001	0.008	0.004	0.253	<0.01		0.01	0.015	1.95	<0.05		0.5	0.17
M225W	31/05/2018							0.012		0.027						<0.025	2.07	<0.05	<0.0001	0.6	0.1
M225W	21/11/2018	<0.005	<0.005	0.103		<0.005	<0.005	0.07	<0.005	<0.005	<0.005	0.016	<0.05		<0.05	0.046	2.02	<0.05	0.0001	0.5	0.14
M225W	25/05/2019							0.041		0.022						0.031	1.98	0.08	0.0001	0.5	0.09
M225W	7/11/2019	<0.005	<0.005	0.067		<0.005	<0.005	<0.005	<0.005	0.008	<0.005	0.011	<0.05		<0.05	0.11	2.24	<0.05		0.5	0.09
M340W	11/12/2012	<0.001	<0.0005	0.056	0.0002	<0.001	0.0002	0.005	<0.001	0.1		0.012			0.003	0.035			<0.00005	0.45	0.1
M340W	4/04/2013	<0.001	<0.0005	0.056	<0.0001	<0.001	0.002	0.004	<0.001	0.085		0.014			0.002	0.028			<0.00005	1.6	0.077
M340W	22/05/2013	<0.001	<0.0005	0.057	<0.0001	<0.001	0.002	0.005	<0.001	0.086		0.007			0.002	0.036			<0.00005	1.4	0.055
M340W	7/08/2013	<0.001	<0.0005	0.061	<0.0001	<0.001	0.002	0.002	<0.001	0.095		0.006			0.001	0.037			<0.00005	1.3	0.1
M340W	5/12/2013	<0.001	<0.0005	0.058	<0.0001	<0.001	0.002	<0.001	<0.001	0.1		0.013			0.001	0.021			<0.00005	1.5	0.063
M340W	10/05/2014							0.007		0.075						0.041			<0.0001		0.12
M340W	8/12/2014							0.008		0.081						0.076			<0.0001	1.8	0.08
M340W	12/03/2015	<0.001	<0.001	0.068		<0.001	0.002	0.003	<0.001	0.058		0.022			<0.01	0.013				1.7	
M340W	17/05/2015	<0.001	<0.001	0.194	<0.0001	<0.001	0.001	0.024	<0.001	0.051		0.009			<0.01	0.185			<0.0001	1.6	
M340W	28/07/2015	<0.001	<0.001	0.113	<0.0001	<0.001	<0.001	0.011	<0.001	0.049		0.038			<0.01	0.06			<0.0001	1.9	
M340W	16/11/2015	<0.001	<0.001	0.057	<0.0001	0.001	0.001	0.018	<0.001	0.047		0.01			<0.01	0.098			<0.0001	1.6	0.04
M340W	2/03/2016	<0.001	<0.001	0.060		<0.001	0.002	0.002	<0.001	0.044		0.01				0.018				2.0	0.08
M340W	13/05/2016	<0.001	<0.001	0.070	<0.0001	<0.001	0.001	0.012	<0.001	0.034	0.004	0.005	<0.01	2.95	<0.01	0.132	2.26	<0.05	<0.0001	1.8	0.05
M340W	29/08/2016	<0.001	<0.001	0.073		0.001	0.003	0.002	<0.001	0.06	0.004	0.008	<0.01	3.32	<0.01	0.005	1.83	<0.05		2.0	0.05
M340W	15/11/2016	<0.001	<0.001	0.075	<0.0001	0.002	0.002	<0.001	<0.001	0.056		0.006	<0.01		<0.01	0.014	2.14		<0.0001	1.6	0.08
M340W	13/06/2017							<0.001		0.611						<0.005	1.75	<0.05	<0.0001	1.9	12.6
M230W	11/12/2012	0.002	<0.0005	0.150	<0.0001	<0.001	<0.001	0.001	<0.001	0.097		0.005			<0.001	0.014			<0.00005	0.79	0.67
M230W	3/04/2013	0.002	<0.0005	0.170	<0.0001	<0.001	0.002	0.002	<0.001	0.26		0.01			<0.001	0.027			<0.00005	0.76	0.16
M230W	21/05/2013	0.002	<0.0005	0.180	<0.0001	<0.001	0.002	0.004	<0.001	0.18		0.014			<0.001	0.021			<0.00005	0.54	0.094
M230W	7/08/2013	0.002	<0.0005	0.180	<0.0001	<0.001	<0.001	0.003	<0.001	0.091		0.01			<0.001	0.033			<0.00005	0.46	0.27
M230W	7/12/2013	0.002	<0.0005	0.180	<0.0001	<0.001	0.002	0.003	<0.001	0.16		0.008			<0.001	0.017			<0.00005	0.63	0.11
M230W	11/05/2014							0.003		0.212						0.037			<0.0001		0.17
M230W	5/12/2014							0.001		0.317						0.06			<0.0001	0.7	0.3
M230W	12/03/2015	0.002	<0.001	0.195		<0.001	0.003	0.001	<0.001	0.251		0.131			<0.01	0.013				0.8	
M230W	17/05/2015	0.002	<0.001	0.283	<0.0001	<0.001	0.003	0.002	<0.001	0.243		0.01			<0.01	0.024			<0.0001	0.6	
M230W	28/07/2015	0.002	<0.001	0.237	<0.0001	<0.001	0.001	0.004	<0.001	0.146		0.012			<0.01	0.049			<0.0001	0.7	
M230W	15/11/2015	0.002	<0.001	0.175	<0.0001	0.002	<0.001	0.002	<0.001	0.046		0.06			<0.01	0.068			<0.0001	0.8	0.17
M230W	2/03/2016	0.001	<0.001	0.164		<0.001	0.001	0.002	<0.001	0.035		0.006			0.042	<0.01				0.7	0.19
M230W	13/05/2016	0.001	<0.001	0.184	<0.0001	<0.001	<0.001	0.001	<0.001	0.04	0.006	0.021	<0.01	1.52	<0.01	0.024	0.6	<0.05	<0.0001	0.7	0.1
M230W	29/08/2016	0.001	<0.001	0.186		<0.001	<0.001	0.007	<0.001	0.027	0.008	0.039	<0.01	1.68	<0.01	0.026	0.42	<0.05		0.7	0.1
M230W	15/11/2016	0.002	<0.001	0.186	<0.0001	<0.001	<0.001	0.002	<0.001	0.097	0.008	0.026	<0.01	1.71	<0.01	0.036	0.47	<0.05	<0.0001	0.6	0.08
M230W	13/06/2017							0.001		0.451						0.014	0.45	0.36	<0.0001	0.8	0.18
M230W	12/11/2017	0.002	<0.001	0.206		<0.001	0.005		<0.001	0.203	0.005	0.014	<0.01		<0.01	0.065	0.47	<0.05		0.7	0.23
M230W	1/06/2018							0.001		0.188						0.012	0.44	0.43	<0.0001	0.7	0.17
M230W	21/11/2018	0.002	<0.001	0.207		<0.001	0.003	<0.001	<0.001	0.186	0.003	0.009	<0.01		<0.01	0.047	0.48	<0.05	<0.0001	0.7	0.12
M230W	25/05/2019							0.001		0.213						0.012	0.56	0.39	<0.0001	0.7	0.14
M230W	10/11/2019	0.002	<0.001	0.206		<0.001	0.004	<0.001	<0.001	0.186	0.002	0.015	<0.01		<0.01	0.016	0.52	0.29		0.7	0.13
M250W	13/12/2012	<0.001	<0.0005	0.1	<0.0001	0.002	<0.001	0.002	<0.001	0.027		0.008			<0.001	0.023			<0.00005	0.18	0.012
M250W	6/04/2013	<0.001	<0.0005	0.11	<0.0001	0.001	<0.001	0.002	<0.001	0.054		0.014			<0.001	0.02			<0.00005	0.14	0.01
M250W	25/05/2013	<0.001	<0.0005	0.1	<0.0001	0.003	<0.001	0.004	<0.001	0.015		0.007			<0.001	0.018			<0.00005	0.14	0.012
M250W	6/08/2013	<0.001	<0.0005	0.1	<0.0001	0.002	<0.001	0.002	<0.001	0.007		0.006			<0.001	0.016			<0.00005	0.13	0.079
M250W	5/12/2013	<0.001	<0.0005	0.083	<0.0001	0.002	<0.001	0.001	<0.001	0.019		0.01			<0.001	0.014			<0.00005	0.14	<0.005
M250W	9/05/2014							0.004		0.018						0.019			<0.0001		1.3
M250W	7/12/2014							<0.001		0.017						<0.005			<0.0001	0.2	0.08
M250W	10/03/2015	<0.001	<0.001	0.07		0.003	<0.001	<0.001	<0.001	0.013		0.01			<0.01	0.018				0.6	
M250W	18/05/2015	<0.001	<0.001	0.07	<0.0001	0.002	0.001	<0.001	<0.001	0.015		0.011			<0.01	0.019				0.2	
M250W	29/07/2015	<0.001	<0.001	0.078	<0.0001	0.003	0.001	<0.001	<0.001	0.028		0.01			<0.01	0.106			<0.0001	0.2	
M250W	16/11/2015	<0.001	<0.001	0.061	<0.0001	0.001	0.004	0.005	<0.001	0.076		0.048			<0.01	0.131			<0.0001	0.2	0.4
M250W	2/03/2016	<0.001	<0.001	0.047		0.002	<0.001	0.001	<0.001	0.014		0.01			<0.01	0.048				0.2	0.16
M250W	13/05/2016	<0.01	<0.001	<0.001		0.076	<0.0001	0.002	<0.001	0.011	<0.001	0.009	<0.01	0.725	<0.01	0.016	0.76	0.05	<0.0001	0.2	0.91
M250W	29/08/2016	<0.001	<0.001	0.055		0.002	0.001	0.001	<0.001	0.012	<0.001	0.01	<0.01	0.686	<0.01	0.008	0.61	<0.05		0.2	0.51
M250W	15/11/2016	<0.001	<0.001	0.05	<0.0001	0.002	0.001	<0.001	<0.001	0.012	<0.001	0.008	<0.01	0.698	<0.01	0.032	0.73	<0.05	<0.0001	0.2	0.47
M250W	18/06/2017							0.001		0.014						0.021	0.67	<0.05	<0.0001	0.2	0.44
M250W	13/11/2017	<0.001	<0.001	0.072		0.002	0.005	0.002	<0.001	0.095	0.002	0.043	<0.01		<0.01	0.111	0.7	<0.05		0.3	0.62
M250W	2/06/2018							<0.001		0.014						0.006	0.73	0.43	<0.0001	0.2	0.63
M250W	22/11/2018	<0.001	<0.001	0.057		0.002	0.001	0.001	<0.001	0.016	<0.001	0.01	<0.01		<0.01	0.072	0.68	<0.05	<0.0001	0.2	0.77
M250W	26/05/2019							0.001		0.021						0.031	0.74	<0.05	<0.0001	0.2	0.23
M250W	7/11/2019	<0.001	<0.001	0.059		0.002	0.004	<0.001	<0.001	0.043	0.001	0.088	<0.01		<0.01	0.035	0.74	<0.05		0.2	0.03
M222W	16/06/2012	0.003	<0.000001	3.9	<0.0001	0.002	0.002	0.002	<0.001	1.17		0.125			<0.01	0.041			<0.0001	0.6	
M222W	14/12/2012	<0.001	<0.0005	1.2	<0.0001	<0.001	0.002	0.003	<0.001	1.3		0.005			<0.001	0.043			<0.00005	0.48	<0.005
M222W	5/04/2013	<0.001	<0.0005	0.26	<0.0001	<0.001	<0.001	0.002	<0.001	1.1		0.019			<0.001	0.037			<0.00005	0.68	<0.005
M222W	26/05/2013	0.001	<0.0005	0.24	<0.0001	<0.001	<0.001	0.002	<0.001	1.3		0.004			<0.001	0.007			<0.00005	0.47	<0.005
M222W	9/08/2013	0.003	<0.0005	0.23	<0.0001	<0.001	<0.001	0.001	<0.001	1.2		<0.001			<0.001	0.011			<0.00005	0.44	<0.005
M222W	6/12/2013	0.006	<0.0005	0.24	<0.0001	<0.001	<0.001	0.002	<0.001	1.7		0.001			<0.001	0.018			<0.00005	0.59	<0.005
M222W	10/05/2014							0.004		1.35						0.019			<0.0001		2.09
M222W	19/08/2014							0.001		1.54						0.036			<0.0001	0.4	0.18
M222W	4/12/2014							<0.001		1.45						0.115			<0.0001	0.8	0.74
M222W	11/03/2015	0.003	<0.001	0.248		<0.001	<0.001	<0.001	<0.001	1.27		<0.001			<0.01	0.02				1	
M222W	17/05/2015	0.011	<0.001	0.202	<0.0001	<0.001	<0.001	<0.001	<0.001	1.57		0.002			<0.01	0.021			<0.0001	0.7	
M222W	27/07/2015	0.004	<0.001	0.226	<0.0001	<0.001	<0.001	<0.001	<0.001	1.28		0.007			<0.01	<0.005			<0.0001	0.8	
M222W	17/11/2015	0.004	<0.001	0.22	<0.0001	<0.001	<0.001	0.001	<0.001	1.37		<0.001			<0.01	0.074			<0.0001	0.9	0.53
M222W	2/03/2016	0.003	<0.001	0.219		0.002	<0.001	<0.001	<0.001	1.27		0.017			<0.01	0.043				0.8	0.11
M222W	13/05/2016	0.009	<0.001	0.201	<0.0001	<0.001	<0.001	<0.001	<0.001	1.59	0.004	<0.001	<0.01	6.67	<0.01	<0.005	0.33	17.6	<0.0001	0.7	0.43
M222W	29/08/2016	0.01	<0.001	0.184		<0.001	<0.001	<0.001	<0.001	1.86	0.004	0.003	<0.01	8.96	<0.01	<0.005	0.32	21.1		0.8	0.55
M222W	15/11/2016	0.005	<0.001	0.252	<0.0001	<0.001	<0.001	<0.001	<0.001	1.59	0.003	0.002	<0.01	8.73	<0.01	0.015	0.34	13.6	<0.0001	0.8	0.19
M222W	13/06/2017							<0.001		1.55						<0.005	0.33	11.4	<0.0001	0.7	0.32
M222W	7/11/2017	0.005	<0.001	0.288		<0.001	<0.001	<0.001	<0.001	1.63	0.002	0.001	<0.01		<0.01	<0.005	0.3	14.5		0.8	0.43
M222W	29/05/2018							0.002		1.63						<0.005	0.32	15.5	<0.0001	0.7	0.46
M222W	18/11/2018	0.004	<0.001	0.268		<0.001	<0.001	<0.001	<0.001	1.48	0.002	<0.001	<0.01		<0.01	<0.005	0.34	11		0.6	0.12
M222W	24/05/2019							0.036		1.65						0.069	0.32	18.6	<0.0001	0.7	0.39
M222W	10/11/2019	0.007	<0.001	0.248		<0.001	<0.001	0.014	<0.001	1.56	0.003	0.028	<0.01		<0.01	0.059	0.32	17.1		0.7	0.41
M224W	16/06/2012	<0.050	<0.00001	0.078	<0.0050	<0.010	0.011	<0.00005	<0.010	7.75		<0.00005			<0.10	0.06			<0.0001	0.9	
M224W	15/12/2012	0.003	<0.0005	0.11	<0.0001	<0.001	0.012	<0.001	<0.001	7.8		0.023			0.001	0.009			<0.00005	0.74	0.03
M224W	7/04/2013	0.002	<0.0005	0.2	0.0002	<0.001	0.015	<0.001	<0.001	8.1		0.04			<0.001	0.024			<0.00005	0.45	<0.005
M224W	25/05/2013	0.004	<0.0005	0.14	<0.0001	<0.001	0.007	<0.001	<0.001	4.8		0.083			0.002	0.008			<0.00005	0.23	<0.005
M224W	6/08/2013	0.005	<0.0005	0.13	<0.0001	<0.001	0.01	<0.001	<0.001	6.8		0.018			<0.001	0.027			<0.00005	0.37	0.052
M224W	6/12/2013	0.007	<0.0005	0.13	<0.0001	<0.001	0.012	<0.001	<0.001	8		0.015			<0.001	0.021			<0.00005	0.51	0.007
M224W	10/05/2014							<0.05		7.57						0.056			<0.0001		0.3
M224W	19/08/2014							<0.001		7.98						0.302			<0.0001	0.4	0.79
M224W	4/12/2014							<0.001		6.83						0.067			<0.0001	0.4	0.17
M224W	12/03/2015	0.004	<0.001	0.157		<0.001	0.016	0.006	<0.001	4.4		0.119			<0.01	0.044				0.6	
M224W	17/05/2015	0.006	<0.001	0.164	<0.0001	<0.001	0.021	0.001	<0.001	4.59		0.025			<0.01	0.05			<0.0001	0.3	
M224W	27/07/2015	0.008	<0.001	0.157	0.0001	<0.001	0.019	0.003	<0.001	4.51		0.17			<0.01	0.059			<0.0001	0.5	
M224W	17/11/2015	0.008	<0.001	0.163	<0.0001	<0.001	0.027	<0.001	<0.001	3.78		0.014			<0.01	0.101			<0.0001	0.4	0.11
M224W	2/03/2016	0.005	<0.001	0.065		<0.001	0.009	0.002	<0.001	1.36		0.021			<0.01	0.037				0.4	0.06
M224W	13/05/2016	0.008	<0.001	0.159	<0.0001	<0.001	0.011	0.005	<0.001	3.42	0.001	0.007	<0.01	11.4	<0.01	0.176	0.34	4.8	<0.0001	0.4	<0.05
M224W	29/08/2016	0.003	<0.001	0.06		<0.001	0.005	<0.001	<0.001	0.834	0.001	0.004	<0.01	3.19	<0.01	0.037	0.13	0.2		0.2	0.09
M224W	15/11/2016	0.008	<0.001	0.182	<0.0001	<0.001	0.017	<0.001	<0.001	3.75	0.002	0.02	<0.01	14	<0.01	0.21	0.24	5.39	<0.0001	0.4	0.07
M224W	13/06/2017							<0.001		4.04						0.052	0.22	7.91	<0.0001	0.3	0.08
M224W	07/11/2017	<0.001	0.193	<0.001		0.015	<0.001		<0.001	4.94	0.003	0.042	<0.01	<0.01	<0.01	0.044	0.22	10.1		0.4	0.3
M224W	29/05/2018							0.002		6.72						0.062	0.34	7.2	<0.0001	0.5	0.22
M224W	18/11/2018	<0.001	<0.001	0.045		<0.001	0.003	0.017	<0.001	0.313	<0.001	0.014	<0.01		<0.01	0.103	0.16	0.52		0.2	0.03
M224W	24/05/2019							0.001		1.68						0.032	0.29	1.12	<0.0001	0.4	0.13
M224W	10/11/2019	0.006	<0.001	0.126		<0.001	0.026	0.002	<0.001	1.58	0.001	0.045	<0.01		<0.01	0.059	0.39	4.43		0.3	<0.05
AN020F	13/05/2016	<0.001	<0.001	3.72	<0.0001	<0.001	0.001	<0.001	<0.001	1.92	<0.001	<0.001	<0.01	11.3	<0.01	<0.005	0.14	14.3	<0.0001	<0.1	<0.01
AN020F	15/11/2016	<0.001	<0.001	3.62		<0.001	<0.001	<0.001	<0.001	1.85	0.001	0.001	<0.01	11	<0.01	<0.005	0.19	8.25		<0.1	<0.05
AN020F	15/11/2017	<0.001	<0.001	3.42		<0.001	<0.001	<0.001	<0.001	1.17	0.005	0.006	<0.01		<0.01	<0.005	0.14	5.01		<0.1	0.11
AN020F	15/11/2018	<0.001	<0.001	3.88		<0.001	<0.001	0.001	<0.001	1.19	0.007	0.001	<0.01		<0.01	<0.005	0.2	5.36		<0.1	<0.01
AN020F	11/11/2019	<0.001	<0.001	3.66		<0.001	<0.001	0.005	<0.001	1.42	0.002	0.002	<0.01		<0.01	<0.005	0.13	1.68		<0.1	<0.01

DEEP MONITORING

Monitoring Bore ID	Sample Date	Field pH	Electrical Conductivity	Total Dissolved Solids	Hydroxide Alkalinity (OH-)	Carbonate Alkalinity as	Bicarbonate Alkalinity as	Total Alkalinity	Sulphate, SO4	Chloride, Cl	Calcium - Dissolved	Magnesium - Dissolved	Sodium - Dissolved	Potassium - Dissolved	Arsenic-Dissolved	Beryllium-Dissolved	Barium-Dissolved	Cadmium-Dissolved	Chromium-Dissolved	Cobalt-Dissolved	Copper-Dissolved	Lead-Dissolved	Manganese-Dissolved	Molybdenum	Nickel-Dissolved	Selenium	Strontium	Vanadium-Dissolved	Zinc-Dissolved	Boron	Iron	Mercury-Dissolved	Fluoride, F	Phosphate as P in water
			µS/cm	(grav) mg/L	as CaCO3 mg/L	CaCO3 mg/L	CaCO3 mg/L	as CaCO3 mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
M313W	25/07/2014	9.42	1710	1160	<1	51	283	334	12	252	7	<1	319	98	0.004	<0.001	0.843		0.018	0.01	2.12	2.19	0.429		0.032			0.02	0.568				0.6	2.28
M313W	13/02/2015	8.12	6940	4110	<1	<1	781	781	4	1810	26	5	1420	126	<0.001	<0.001	4.88		<0.001	<0.001	0.055	<0.001	0.139		0.004			<0.01	<0.005				2.4	2.32
M313W	11/11/2015	8.3	6890	3870	<1	<1	666	667	2	1910	22	4	1250	56	<0.001	<0.001	2.8		<0.001	<0.001	0.002	<0.001	0.099		0.002			<0.01	<0.005				2.4	0.87
M313W	30/05/2016	8.48	4570	2420	<1	41	443	484	2	1130	10	1	1000	60	<0.001	<0.001	1.23	<0.001	<0.001	<0.001	<0.001	<0.001	0.04	0.017	<0.001	<0.01	1.39	<0.01	0.008	0.5	0.28			0.16
M313W	15/11/2016	7.8	5620	2950	<1	<1	634	634	<1	1420	20	3	1170	62	0.002	<0.001	2.63	<0.001	<0.001	<0.001	0.002	<0.001	0.077	0.035	0.003	<0.01	3.02	<0.01	0.018	0.95	1.08		2.3	0.89
M313W	19/11/2017	8.59	6020	3320	<1	48	587	636	<1	1720	24	4	1370	60	0.003	<0.001	2.54		<0.001	<0.001	<0.001	<0.001	0.071	0.035	0.002	<0.01		<0.01	<0.005	0.92	0.57		2	0.83
M313W	16/11/2018	8.05	5840	3210	<1	4	621	625	<1	1350	24	4	1200	61	0.003	<0.001	2.25		<0.001	<0.001	0.002	<0.001	0.106	0.039	0.002	<0.01		<0.01	<0.005	0.81	1.07		1.9	
M313W	14/11/2019	7.99	6030	3360	<1	<1	621	621	2	1600	20	4	1260	55	0.003	<0.001	2.42		<0.001	<0.001	<0.001	<0.001	0.088	0.041	0.002	<0.01		<0.01	<0.005	0.88	0.45		2.1	
M314W	24/07/2014	8.57	5090	4790	<1	9	1210	1220	134	198	46	1	212	1450	0.013	<0.001	0.575		0.015	0.005	7.08	0.562	0.446		0.018			<0.01	0.472				0.4	65.6
M314W	13/02/2015	8.04	7150	5470	<1	<1	1180	1180	69	1370	29	6	1040	795	0.004	<0.001	1.37		<0.001	0.002	0.995	<0.001	0.141		0.01			<0.01	<0.005				0.9	20.6
M314W	13/11/2015	8.01	8210	5280	<1	<1	836	836	2	2190	17	5	1420	335	0.003	<0.001	1.31		<0.001	<0.001	0.031	<0.001	0.14		0.013			<0.01	0.011				1.1	17.4
M314W	30/05/2016	8.6	8500	4880	<1	49	767	817	<1	2370	22	6	1640	326	0.003	<0.001	5.21	<0.001		<0.001	0.022	<0.001	0.028	0.053	0.001	<0.01	5.5	<0.01	0.01	0.87	0.1	0.87		9.67
M314W	15/11/2016	8.88	8180	4810	<1	108	827	934	<1	2290	19	6	1500	404	0.004	<0.001	3.88	<0.001	<0.001	<0.001	0.03	<0.001	0.036	0.062	0.002	<0.01	3.67	<0.01	0.009	0.9	0.21		1.3	12.1
M314W	18/11/2017	8.9	8300	4860	<1	169	908	1080	<1	2190	17	5	1880	543	0.004	<0.001	2.91		<0.001	<0.001	0.024	<0.001	0.053	0.068	0.002	<0.01		<0.01	<0.005	0.76	0.18		1.2	14.2
M314W	20/11/2018	8.72	8010	4910	<1	142	892	1030	<1	2010	15	5	1530	459	0.005	<0.001	2.86		<0.001	<0.001	0.024	<0.001	0.057	0.078	0.002	<0.01		<0.01	<0.005	0.81	0.29		1.2	
M314W	16/11/2019	8.59	7910	4900	<1	86	991	1080	2	1860	8	4	1460	465	0.005	<0.001	2.43		<0.001	<0.001	0.024	<0.001	0.068	0.082	0.003	<0.01		<0.01	<0.005	0.77	0.33		1.3	
M324W	26/07/2014	9.17	1170	707	<1	48	177	225	24	188	26	5	199	31	0.005	<0.001	0.31		0.004	0.004	0.582	0.459	0.304		0.008			<0.01	0.427				1	2.01
M324W	13/02/2015	8.83	2660	1540	<1	105	615	720	1	505	7	2	627	29	<0.001	<0.001	0.482		<0.001	<0.001	<0.001	<0.001	0.018		0.002			<0.01	0.093				3.7	0.88
M324W	30/05/2016	8.57	2750	1390	<1	64	624	688	6	522	6	1	599	12	<0.001	<0.001	0.921	<0.001	<0.001	<0.001	<0.001	<0.001	0.025	0.02	<0.001	<0.01	0.889	<0.01	0.006	0.76	0.22			0.46
M324W	15/11/2016	8.58	2650	1540	<1	59	635	694	<1	503	5	1	612	12	0.001	<0.001	0.738	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	0.024	<0.001	<0.01	0.807	<0.01	0.01	0.78	0.13		4.5	0.44
M324W	19/11/2017	8.86	2740	1300	<1	104	568	672	<1	536	4	1	666	13	0.001	<0.001	0.572		<0.001	<0.001	<0.001	<0.001	0.006	0.027	<0.001	<0.01		<0.01	<0.005	0.72	<0.05		3.9	0.57
M324W	16/11/2018	8.66	2740	1520	<1	86	565	651	<1	507	3	1	579	13	0.001	<0.001	0.555		<0.001	<0.001	0.001	<0.001	0.006	0.031	<0.001	<0.01		<0.01	<0.005	0.74	0.12		3.8	
M324W	14/11/2019	8.7	2690	1530	<1	74	571	645	1	524	2	<1	595	12	0.001	<0.001	0.56		<0.001	<0.001	<0.001	0.001	0.005	0.03	<0.001	<0.01		<0.01	<0.005	0.72	0.2		4.3	
M325W	13/02/2015	8.55	3410	2260	<1	14	252	297	68	906	2	<1	709	73	0.002	<0.001	0.005		<0.001	0.003	0.016	<0.001	0.009		0.009			<0.01	0.024				0.7	0.56
M325W	13/11/2015	8.13	5000	2730	<1	<1	450	450	4	1400	8	1	919	40	0.001	<0.001	0.252		<0.001	0.002	<0.001	<0.001	0.086		<0.001			<0.01	<0.005				1.1	0.45
M325W	30/05/2016	8.74	6150	3310	<1	75	370	446	1	1600	6	<1	1250	39	0.002	<0.001	0.384	<0.001	<0.001	<0.001	0.008	<0.001	0.057	0.114	0.002	<0.01	0.639	<0.01	0.009	1.17	0.24			0.4
AN019F	10/11/2015	11.8	10200	5430	456	82	<1	539	33	2920	154	<1	1620	19	0.002	<0.001	2.79		<0.001	<0.001	0.006	<0.001	<0.001		0.007			<0.01	0.01				0.8	0.04
AN019F	30/05/2016	11.6	10800	5970	410	100	<1	510	38	3180	168	<1	1840	29	0.004	<0.001	3.25	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.056	0.008	<0.01	8.18	<0.01	<0.005	0.42	<0.05	0.42		0.05
AN019F	15/11/2016	11.8	11100	6140	428	125	<1	553	37	3400	162	<1	1970	28	0.004	<0.001	2.65	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.036	0.006	<0.01	5.92	<0.01	0.014	0.46	<0.05		0.7	<0.05
AN019F	15/11/2017	11.1	10700	5890	123	135	<1	258	35	3340	104	<1	2330	27	0.004	<0.001	2.4		<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.003	<0.01		<0.01	0.006	0.45	<0.05		0.7	0.13
AN019F	11/11/2019	11.41	10700	6550	195	125	<1	319	32	3540	82	<1	2280	23	0.004	<0.001	2.34		<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.002	<0.01		<0.01	<0.005	0.57	<0.05		0.8	
GR067V	30/08/2016	9.05	7020	4000	<1	407	1550	1960	19	1180	7	1	1580	14	0.003	<0.001	1.48	0.001	0.001	<0.001	0.002	<0.001	0.11	0.032	0.006	<0.01	1.18	<0.01	0.011	0.81	1.56			0.6
GR067V	15/11/2016	8.12	7850	4640	<1	<1	2310	2310	3	1260	15	3	1850	13	0.003	<0.001	4.94	0.001	0.001	<0.001	<0.001	<0.001	0.024	0.024	0.001	<0.01	3.72	<0.01	0.018	1.17	0.68		1.8	0.3
GR067V	19/11/2017	8.72	8210	4910	<1	238	2120	2360	4	1440	19	3	2190	12	0.003	<0.001	3.83		<0.001	<0.001	<0.001	<0.001	0.008	0.019	<0.001	<0.01		<0.01	0.008	1.03	0.16		1.7	0.3
GR067V	23/11/2018	8.46	8340	6020	<1	456	1950	2410	7	1460	18	3	2050	12	0.002	<0.001	4.44		<0.001	<0.001	<0.001	<0.001	0.008	0.023	<0.001	<0.01		<0.01	0.008	1.18	0.22		2	
GR067V	16/11/2019	8.19	7950	4950	<1	47	2380	2420	7	1350	7	3	2040	9	0.002	<0.001	3.23		<0.001	<0.001	<0.001	<0.001	0.009	0.019	<0.001	<0.01		<0.01	0.005	1.28	0.29		2	
M162V	14/11/2015	8.44	11500	6970	<1	38	1060	1090	3	3640	10	6	2370	12	<0.001	<0.001	0.236		<0.001	<0.001	<0.001	<0.001	0.092		<0.001			<0.01	<0.005				1.9	1.13
M162V	30/05/2016	7.91	12700	7250	<1	<1	1050	1050	2	4040	56	19	2590	12	<0.001	<0.001	11	<0.001	<0.001	<0.001	0.01	<0.001	0.063	0.002	0.001	<0.01	10.8	<0.01	0.16	2.4	3			<0.05
M162V	15/11/2016	7.7	12300	6660	<1	<1	1060	1060	<1	3870	69	18	2670	12	<0.001	<0.001	9.93	<0.001	<0.001	<0.001	<0.001	<0.001	0.034	0.001	<0.001	<0.01	9.77	<0.01	0.032	2.02	2.19		2.6	0.03
M134W	14/11/2017	8.1	15600	9810	<1	<1	168	168	<1	5770	209	62	3490	12	<0.001	<0.001	23		<0.001	<0.001	<0.001	<0.001	0.064	0.001	<0.001	<0.01		<0.01	0.009	0.46	0.40		0.5	0.04
M134W	215/11/2018	7.3	16000	9710	<1	<1	159	159	<1	5310	182	61	2990	12	<0.001	<0.001	20.3		<0.001	<0.001	0.002	<0.001	0.063	0.001	<0.001	<0.01		<0.01	0.011	0.48	0.3		0.5	
M134W	14/11/2019	7.27	15500	9670	<1	<1	162	162	1	5460	134	58	3200	12	0.002	<0.001	20.2		<0.001	0.005	<0.001	<0.001	0.098	0.007	0.02	<0.01		<0.01	0.02	0.47	1.18		0.5	0.04
MB1	17/11/2019	7.95	8790	5110	<1	<1	817	817	<1	2250	14	12	1900	16	0.002	<0.001	4.29		<0.001	0.001	0.005	0.008	0.049	0.018	0.036	<0.01		<0.01	0.045	1.04	1.53		2.2	0.45
GW007B	15/11/2019	6.79	15700	9910	<1	<1	1380	1380	<1	4920	276	256	2330	64	0.005	<0.001	12.2		<0.001	0.001	<0.001	<0.001	0.12	0.006	0.02	<0.01		<0.01	2.16	0.24	2.94		0.2	0.02

- **APPENDIX B: Water Level Results**

Shallow Bores

Bore Name	SWL (mAHD)				
	12/11/2017	1/06/2018	17/11/2018	24/05/2019	12/11/2019
GW001					227.894
GW007A					DRY
MB12	298.54	298.49	281.08	281.08	286.4463
MB1-S					209.52

APPENDIX C: Water Quality Results

Deep monitoring

Monitoring Bore ID	Sample Date	Field pH	Electrical Conductivity	Total Dissolved Solids	Hydroxide Alkalinity (OH-)	Carbonate Alkalinity as	Bicarbonate Alkalinity as	Total Alkalinity	Sulphate, SO4	Chloride, Cl	Calcium - Dissolved	Magnesium - Dissolved	Sodium - Dissolved	Potassium - Dissolved	Arsenic-Dissolved	Beryllium-Dissolved	Barium-Dissolved	Cadmium-Dissolved	Chromium-Dissolved	Cobalt-Dissolved	Copper-Dissolved	Lead-Dissolved	Manganese-Dissolved	Molybdenum	Nickel-Dissolved	Selenium	Strontium	Vanadium-Dissolved	Zinc-Dissolved	Boron	Iron	Mercury-Dissolved	Fluoride, F	Phosphate as P in water
			µS/cm	(grav) mg/L	as CaCO3 mg/L	CaCO3 mg/L	CaCO3 mg/L	as CaCO3 mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MB1-D	17/11/2019	7.95	8790	5110	<1	<1	817	817	<1	2250	14	12	1900	16	0.002	<0.001	4.29		<0.001	0.001	0.005	0.008	0.049	0.018	0.036	<0.01		<0.01	0.045	1.04	1.53		2.2	0.45
GW007B	15/11/2019	6.79	15700	9910	<1	<1	1380	1380	<1	4920	276	256	2330	64	0.005	<0.001	12.2		<0.001	0.001	<0.001	<0.001	0.12	0.006	0.02	<0.01		<0.01	2.16	0.24	2.94		0.2	0.02