

MAC-ENC-PRO-062

GROUNDWATER MONITORING PROGRAM

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Version No	Date Published	Details
Version 1	20 August 2012	Approved by the Department of Planning & Infrastructure on 20/8/2012.
Version 2	23 January 2015	Revision to incorporate groundwater monitoring network changes, introduction of two-stage trigger methodology.
Version 3	10 March 2015	Revision incorporating DP&E and NOW comments
Final	28 April 2015	Approved by the Department of Planning & infrastructure on 28/4/2015.

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1. Scope

This monitoring program describes the environmental monitoring activities undertaken by Hunter Valley Energy Coal (HVEC) Pty Ltd in relation to groundwater resources at the Mt Arthur Coal Mine.

Groundwater monitoring is undertaken for the purpose of quantifying changes to the groundwater system as a result of operations, assessing the performance of the control measures used to limit these impacts, and to meet relevant legal and other requirements.

This monitoring program addresses a number of distinct elements of groundwater monitoring. For each element, the program sets out background information, the purpose of the monitoring and the deliverables which are produced as a result of the monitoring. The program also includes a detailed description of the monitoring methods. Reference (baseline) data relevant to the program are provided in Appendix 1.

A review has identified several opportunities for improvement associated with the groundwater monitoring network infrastructure and sampling methodology. A plan to remedy, replace and decommission several bores in the network and improve sampling procedures is currently being implemented. The network upgrade works are scheduled for completion by 31 December 2015. This monitoring program describes monitoring requirements for the new groundwater monitoring network as well as specific interim monitoring arrangements (described in Appendix 3) that will apply while the monitoring network upgrade works are being implemented and a sufficient reference dataset is being collected.

1.1 Responsibilities

The NSW Energy Coal Asset President is responsible for ensuring that all legal and other requirements described in this monitoring program are met.

HVEC employs environmental specialists and sufficient other staff with experience and qualifications acceptable to establish, maintain and fulfil the requirements of this monitoring program.

1.2 Review and modification

This monitoring program is reviewed annually as a minimum. Any required amendments identified during the review will be updated in a revision of the program and submitted to Department of Planning and Environment for approval.

Monitoring bores which will be mined through, are no longer accessible or are unable to be monitored will be progressively replaced as required.

1.3 Context

This monitoring program meets the requirement for a Groundwater Monitoring Program under Schedule 3 Conditions 29 and 33 of the Mt Arthur Coal Modification Project Approval (PA 09_0062 MOD1).

2. Detailed Procedure

2.1 Groundwater Levels

2.1.1 Background

The environmental values associated with the hydrogeological regime of the Mt Arthur Coal Mine area considered in the development of this monitoring program include primary industry use and recharge of alluvial aquifer systems.

Agricultural users in the region surrounding the mine area may rely on groundwater bores to provide water for irrigation, stock watering and domestic usage.

Depressurisation of the Permian coal measures associated with mining has resulted in localised changes to the groundwater gradient beneath the alluvium with discharge from the coal seams to the alluvium reversed to leakage from the alluvium to the coal seams in the vicinity of open cut mining.

A comprehensive description of the local and regional groundwater resources are provided in Section 4.4 and Appendix B of the Modification Project Environmental Assessment.

2.1.2 Purpose

Provide information that can be used to manage depressurisation due to mining of the coal measures and associated impacts on the alluvial aquifer systems to ensure no significant variation from predicted impacts detailed in the Environmental Assessment. The information also facilitates ongoing validation of the groundwater model and assessment of the effectiveness of groundwater management measures.

2.1.3 Deliverables

- Records of groundwater levels to assess performance against impact assessment criteria (trigger values) shown in Table 3, potential impacts on regional aquifers and impacts on the groundwater supply of potentially affected landowners.
- Records of groundwater levels to assess groundwater seepage into open cut pits, as well as associated seepage impacts on the Hunter River and Saddlers Creek alluvial aquifers.
- Records of riparian vegetation monitoring data to assess potential impacts on groundwater dependent riparian vegetation.
- Records of groundwater model verification.
- Continuous groundwater level monitoring instrumentation to be operational a minimum of 80 per cent of the time.
- Calibration and maintenance of sampling equipment and records maintained.

2.1.4 Method

Bore locations for automated and manual water level monitoring are shown in Figure 1 and a summary for each site, including geographic coordinates, is provided in Table 1. Monitoring of groundwater levels is undertaken at the bores/piezometers and in accordance with the schedule in Table 2.

Regional background monitoring is completed through sampling of bores GW25 (north of site), GW41 A and GW41 P (north west of site), BCGW10, BCGW11, and BCGW22 (west of site) and BCGW05 and BCGW15 (south west of site) (refer Figure 2).

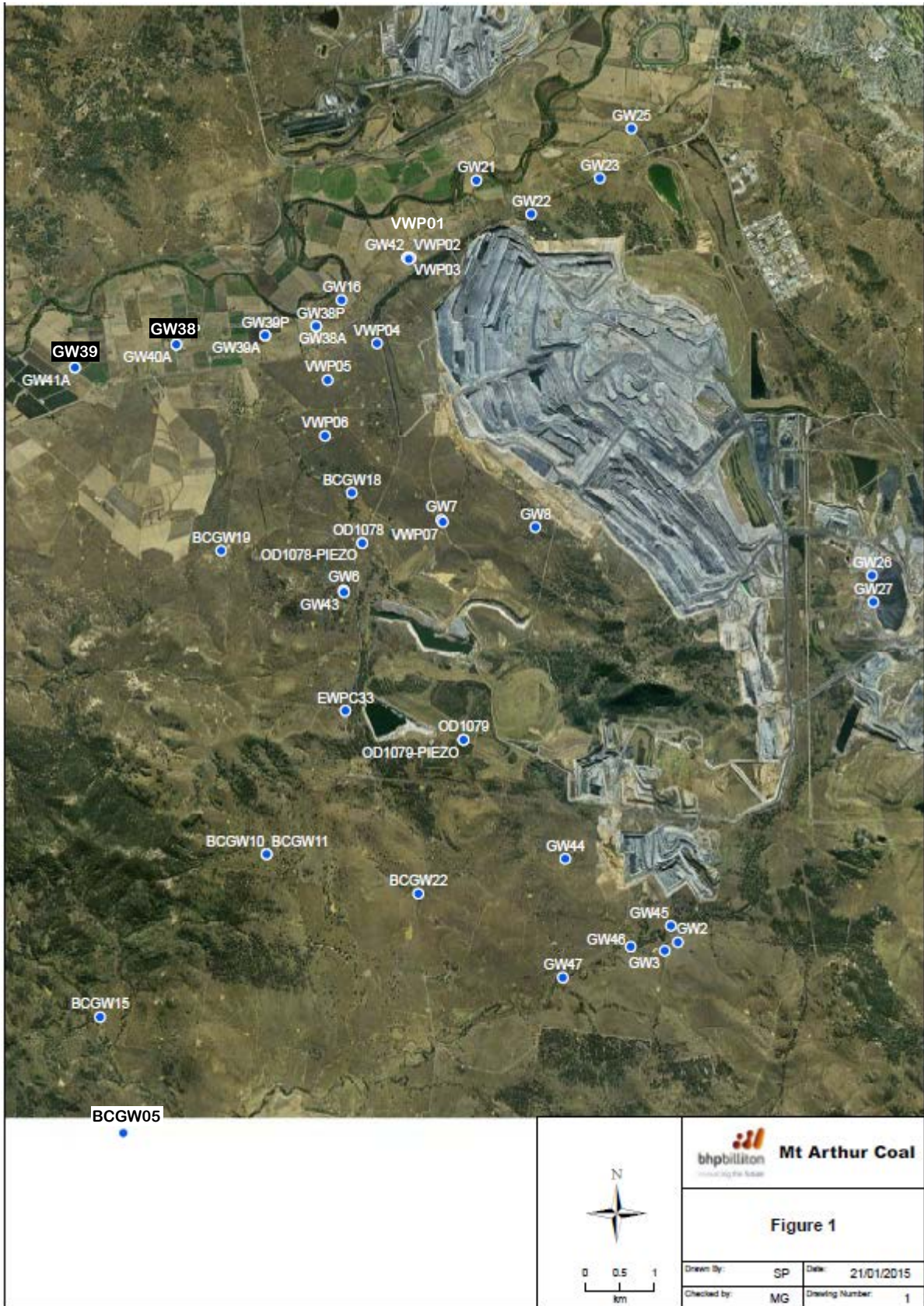


Figure 1: Groundwater Level Monitoring Locations

Table 1: Groundwater Level Monitoring Locations

Site No.	Location	Coordinates (GDA94 Zone 56)	Site No.	Location	Coordinates (GDA94 Zone 56)	Site No.	Location	Coordinates (GDA94 Zone 56)
Alluvial aquifer bores								
GW45 ¹	On site – upper Saddlers Creek	E. 298944 N. 6413748 *	GW21 ²	Off Denman Road – Edinglassie Homestead	E. 296141 N. 6424483	GW40A ²	Off Denman Road - 1212 Gind Holstiens	E. 291815 N. 6422119
GW46 ¹	On site – central Saddlers Creek	E. 298364 N. 6413447 *	GW25 ²	Off Bengalla Road – north of Mt Arthur North	E. 298376 N. 6425231	GW41A ²	Off Denman Road - Wellbrook	E. 290354 N. 6421789
GW47 ¹	On site – lower Saddlers Creek	E. 297387 N. 6413003 *	GW38A ²	Off Denman Road - gate no.968	E. 293831 N. 6422377	GW42 ²	Off Denman Road - west of Edinglassie Homestead	E. 295139 N. 6423369 *
GW16 ²	Off Denman Road – west of Mt Arthur North	E. 294197 N. 6422759	GW39A ²	Off Denman Road - Denman Road West	E. 293094 N. 6422248			
Permian coal seam aquifer bores								
GW2	On site – south of Saddlers Creek	E. 299045 N. 6413511	GW49	Off Denman Road – Wellbrook	E. 290354 N. 6421789	OD1079 – piezo	On site – south of Mt Arthur North	E. 295956 N. 6416427
GW3	On site – south of Saddlers Creek	E. 298856 N. 6413389	BCGW05 ^	Off Golden Highway	E. 291053 N. 6410764	GW43	Off Edderton Road – Roxburgh South	E. 294232 N. 6418551 *
GW6	Off Edderton Road – Roxburgh South	E. 294227 N. 6418579	BCGW10 ^	Off Edderton Road – west of Bayswater No.3	E. 293115 N. 6414779	GW44	On site – off McDonalds Lane	E. 297422 N. 6414715 *
GW7	On site– south west of Mt Arthur North	E. 295635 N. 6419595	BCGW11 ^	Off Edderton Road – west of Bayswater No.3	E. 293117 N. 6414779	VWP01	Off Denman Road – west of Edinglassie Homestead (Sensor 11-1676)	E. 295167 N. 6423381
GW8	On site – south of Mt Arthur North	E. 296991 N. 6419491	BCGW15 ^	Off Golden Highway	E. 290717 N. 6412432	VWP02	Off Denman Road – west of Edinglassie Homestead (Sensor 11-3848)	E. 295195 N. 6423364
GW22	On site – north of Mt Arthur North (off Denman Road)	E. 296930 N. 6423998	BCGW18	Off Edderton Road - opposite Calool	E. 294345 N. 6419985	VWP03P1 VWP03P2	Off Denman Road – west of Edinglassie Homestead (Sensors11-3849, 11-3850)	E. 295166 N. 6423349
GW23	On site – north of Mt Arthur North (off Denman Road)	E. 297919 N. 6424515	BCGW19	Off Edderton Road – Roxburgh South	E. 292462 N. 6419152	VWP04P1 VWP04P2 VWP04P3 VWP04P4	Off Edderton Road - opposite Windmill north	E. 294708 N. 6422137 *
GW26	On site –west cut tailings dam	E. 301841 N. 6418792	BCGW22	On site – south west of Bayswater No.3	E. 295304 N. 6414211	VWP05P1 VWP05P2 VWP05P3 VWP05P4	Off Edderton Road - opposite Windmill south	E. 293997 N. 6421606 *
GW27	On site – west cut tailings dam	E. 301863 N. 6418412	EWPC33	Off Edderton Road – west of Bayswater No.3	E. 294253 N. 6416847	VWP06P1 VWP06P2 VWP06P3 VWP06P4	Off Edderton Road - opposite Huon	E. 293958 N. 6420804 *
GW38P	Off Denman Road - gate no.968	E. 293832 N. 6422384	OD1078	On site – south west of Mt Arthur North	E. 294495 N. 6419259	VWP07P1 VWP07P2 VWP07P3 VWP07P4	On site - south west of Mt Arthur North	E. 295657 N. 6419563 *
GW39P	Off Denman Road - Denman Road West	E. 293095 N.6422251	OD1078 – piezo	On site – south west of Mt Arthur North	E. 294495 N. 6419259			

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Site No.	Location	Coordinates (GDA94 Zone 56)	Site No.	Location	Coordinates (GDA94 Zone 56)	Site No.	Location	Coordinates (GDA94 Zone 56)
GW48	Off Denman Road - 1212 Gia Gindi Holstiens	E. 291815 N. 6422119	OD1079	On site – south of Mt Arthur North	E. 295956 N. 6416427			

¹ Bore targeting Saddlers Creek alluvial aquifer

² Bore targeting Hunter River alluvial aquifer

^ Inclusion in monitoring program will be contingent on resolution of landowner access arrangements

* Coordinates for new monitoring locations are subject to change following final site selection for construction

Notes:

- Information regarding monitoring bore selection and location is included in 'Recommendations for changes to the Mt Arthur Coal groundwater monitoring network (AGE, 2014).
- Bore construction diagram records are maintained for each monitoring location. Where 'as-built' diagrams are not available, schematic diagrams have been developed from drill records, geological model and monitored groundwater levels.

Groundwater level monitoring is performed in accordance with AS/NZS 5667.1:1998 and relevant guidelines.

Table 2: Groundwater Level Monitoring Schedule

Bore ID	Frequency	Parameters
GW2, GW3, GW6, GW7, GW8, GW16, GW21, GW22, GW23, GW25, GW26, GW27, GW38A, GW38P, GW39A, GW39P, GW40A, GW48, GW41A, GW49, BCGW05, BCGW10, BCGW11, BCGW15, BCGW18, BCGW19, BCGW22, EWPC33, OD1078, OD1078-piezo, OD1079, OD1079-piezo, VWP01, VWP02, VWP03 (P1 & P2), GW42, GW43, GW44, GW45, GW46, GW47, VWP04 (P1 – P4), VWP05 (P1 – P4), VWP06 (P1 – P4), VWP07 (P1 – P4)	Continuous (every six hours)	Groundwater level elevation/depth to groundwater
GW2, GW3, GW6, GW7, GW8, GW16, GW21, GW22, GW23, GW25, GW26, GW27, GW38A, GW38P, GW39A, GW39P, GW40A, GW48, GW41A, GW49, BCGW05, BCGW10, BCGW11, BCGW15, BCGW18, BCGW19, BCGW22, EWPC33, OD1078, OD1078-piezo, OD1079, OD1079-piezo, VWP01, VWP02, VWP03 (P1 & P2), GW42, GW43, GW44, GW45, GW46, GW47, VWP04 (P1 – P4), VWP05 (P1 – P4), VWP06 (P1 – P4), VWP07 (P1 – P4)	Every two months	Data logger download and equipment checks. Manual groundwater level elevation/depth to groundwater (for validation and instrument drift correction).

As shown in Table 2, representative monitoring bores in the alluvial aquifers and Permian strata have been fitted with data loggers for continuous depth to water measurement via either a pressure transducer (with barometric pressure correction) or vibrating wire piezometer (VWP) apparatus. The monitoring schedule shown in Table 2 allows groundwater levels to be assessed in terms of impacts on regional aquifers, alluvial aquifers and private users. The impacts of the operation on water users and surrounding aquifers will be monitored, assessed and responded to in accordance with the Landholder Consultation and Investigation Process presented in Appendix 1 of the Surface and Groundwater Response Plan.

Impact Assessment Criteria

Groundwater level impact assessment criteria have been established as the larger of:

- a) 10 per cent greater than model drawdown prediction; or
- b) 1m greater than model drawdown prediction.

If,

- i. three or more alluvial bore water levels fall below the trigger values in Table 3 in one round of monitoring¹ OR water levels in any alluvial bore fall below the trigger values in Table 3 for three consecutive readings¹; or
- ii. water levels in any fractured rock bore fall below the trigger values in Table 3 for two consecutive readings.

¹ Where drawdown (as calculated from manual groundwater level measurement) is not proven to result from changes to the level in the Hunter River from reasons other than mine drawdown

Groundwater level impact assessment criteria trigger values as derived from reference data are presented in Table 3. Reference data is provided in Appendix 1.

Table 3: Groundwater Level Impact Assessment Criteria Trigger Values

Monitoring Location ^	Drawdown trigger (+ 10% or 1m greater than model drawdown prediction) (m)	Groundwater level trigger (mRL)
GW2	1	145.4
GW3	1	145.3
GW6	13.3	165.5
GW7	39.5	134.1*
GW8	71.2	118.4*
GW16	1.2	121.8
GW21	1	126.4
GW22	51	88.2
GW23	6.8	132.5
GW25	10.9	120*
GW38A	1	121.9
GW38P	1	121.0
GW39A	1	120.8
GW39P	1	120.9
GW40A	1	118.7
GW40P	1	118.5
GW41A	1	118.7
GW41P	1	118.4
BCGW18	12.2	142.7*
BCGW19	7.4	174.4*
BCGW22	12.2	128.8
EWPC33	19.9	176.2
OD1078	10.6	153.5
OD1078-piezo	10.6	142.3
OD1079-piezo	16.9	158.7
VWP01	15.8	96.1
VWP02	17.3	70.4
VWP03P1	17.1	88.5
VWP03P2	17.1	85.0

* Trigger level is below the base of the monitoring bore. ^ GW26 and GW 27 do not have a trigger value as their purpose is for operational tailings monitoring. BCGW05, BCGW10, BCGW11, BCGW15 do not have a trigger value as their purpose is for monitoring background conditions. OD1079 does not have a trigger values as no reliable reference data is available for this bore.

Where monitored groundwater level readings exceed impact assessment criteria, a response protocol will be followed as outlined in the Surface and Groundwater Response Plan.

Groundwater Inflows to Mining Operations

Monitoring of hydrogeological conditions is undertaken to assess groundwater seepage into open cut pits, especially from adjacent alluvial aquifers. Groundwater level monitoring being the key data set used to simulate inflows to mine areas through modelling. A large proportion, if not all, of the seepage to the open pit is lost through evaporation at the coalface or exported as moisture in run of mine activities. Currently, there is no quantitative method to measure the volume of groundwater inflows to mining operations. The groundwater model for the current mine approval is the most appropriate method to calculate water take.

Groundwater model predictions for the Environmental Assessment have open cut pit inflow increasing from 0.85ML/d, in 2009, to a peak of 2.61ML/d in 2016. The model predicts a slight decrease to 2.50ML/d at the end of open cut mining in 2026. Maximum loss of flow to the Hunter River alluvium due to mining is calculated to peak at 0.72 ML/day. These estimates are deemed as valid unless groundwater level trigger levels are exceeded.

Groundwater Yield

The Environmental Assessment predicted negligible effects on groundwater use at surrounding private bores. Notwithstanding this, potential impacts of the operation on water users will be monitored via the groundwater level monitoring network, assessed and responded to in accordance with the Landholder Consultation and Investigation Process presented in Appendix 1 of the Surface and Groundwater Response Plan. Monitoring to determine groundwater yield will be considered at privately owned bores upon landowner request.

Permeability testing is also undertaken during installation of new monitoring bores to determine local groundwater hydraulic parameters.

Groundwater Model Prediction Validation Process

Groundwater predictions (mine inflows and groundwater levels/drawdown) are calculated using a groundwater model developed to support the currently approved mining. In order to validate the model, predictions will be compared on an annual basis to the monitoring program groundwater level information.

The groundwater model will be reviewed every five years and, if required, updated and recalibrated to reflect operational or water management changes.

Groundwater Dependent Ecosystems and Riparian Vegetation

In addition to the monitoring schedule in Table 2 and Table 5, monitoring of riparian vegetation is undertaken quarterly as part of the Surface Water Monitoring Program and serves equally as a monitor of groundwater dependent riparian vegetation. Four photographs are to be taken at each of the surface water vegetation monitoring sites; looking upstream, looking downstream, looking at the left bank² and looking at the right bank³. These photographs are labelled with the location, direction and date.

2.2 Groundwater Quality

2.2.1 Background

The environmental values associated with the hydrogeological regime of the Mt Arthur Coal Mine area considered in the development of this monitoring program include primary industry use and water quality of alluvial aquifer systems.

Agricultural users in the region surrounding the mine area may rely on groundwater bores to provide water for irrigation, stock watering and domestic usage.

The numerical model predicts mining would result in an ongoing localised groundwater sink in the Permian coal measures. Due to this ongoing sink there is not expected to be significant migration or deterioration in groundwater quality resulting from mining.

A comprehensive description of the local and regional groundwater resources are provided in Section 4.4 and Appendix B of the Modification Project Environmental Assessment.

2.2.2 Purpose

Provide information that can be used to manage water quality impacts of mining of the coal measures and associated impacts on the alluvial aquifer systems to ensure no significant variation from modelled predictions detailed in the Environmental Assessment.

² Left bank refers to the bank to the left when looking in a downstream direction.

³ Right bank refers to the bank to the right when looking in a downstream direction.

2.2.3 Deliverables

- Records of groundwater quality to assess performance against impact assessment criteria (trigger values) shown in Table 6, potential impacts on regional aquifers (including the Hunter River and Saddlers Creek alluvial aquifers) and impacts on the groundwater supply of potentially affected landowners.
- Calibration of sampling equipment and records maintained.

2.2.4 Method

Bore locations for water quality monitoring are shown in Figure 2 and a summary for each site, including geographic coordinates, is provided in Table 4. Monitoring of groundwater quality is undertaken at the bores/piezometers and in accordance with the schedule in Table 5.

Regional background monitoring is completed through sampling of bores GW25 (north of site), GW41 A and GW41 P (north west of site), BCGW10, BCGW11, and BCGW22 (west of site) and BCGW05 and BCGW15 (south west of site) (refer Figure 2).

Groundwater quality monitoring is performed in accordance with AS/NZS 5667.1:1998 and relevant guidelines. Laboratory analysis will be undertaken by a laboratory which has relevant accreditation by the National Association of Testing Authorities (NATA), Australia.



Figure 2: Groundwater Quality Monitoring Locations

Table 4: Groundwater Quality Monitoring Locations

Site No.	Location	Coordinates (MGA)	Site No.	Location	Coordinates (MGA)	Site No.	Location	Coordinates (MGA)
Alluvial aquifer bores								
GW45 ¹	On site – upper Saddlers Creek	E. 298944 N. 6413748 *	GW21 ²	Off Denman Road – Edinglassie Homestead	E. 296141 N. 6424483	GW40A ²	Off Denman Road - 1212 Gia Gindi Holstiens	E. 291815 N. 6422119
GW46 ¹	On site – central Saddlers Creek	E. 298364 N. 6413447 *	GW25 ²	Off Bengalla Road – north of Mt Arthur North	E. 298376 N. 6425231	GW41A ²	Off Denman Road - Wellbrook	E. 290354 N. 6421789
GW47 ¹	On site – lower Saddlers Creek	E. 297387 N. 6413003 *	GW38A ²	Off Denman Road - gate no.968	E. 293831 N. 6422377	GW42 ²	Off Denman Road - west of Edinglassie Homestead	E. 295139 N. 6423369 *
GW16 ²	Off Denman Road – west of Mt Arthur North	E. 294197 N. 6422759	GW39A ²	Off Denman Road - Denman Road West	E. 293094 N. 6422248			
Permian coal seam aquifer bores								
GW2	On site – south of Saddlers Creek	E. 299045 N. 6413511	GW39P	Off Denman Road - Denman Road West	E. 293095 N.6422251	BCGW18	Off Edderton Road - opposite Calool	E. 294345 N. 6419985
GW6	Off Edderton Road – Roxburgh South	E. 294227 N. 6418579	GW48	Off Denman Road - 1212 Gia Gindi Holstiens	E. 291815 N. 6422119	BCGW22	On site – south west of Bayswater No.3	E. 295304 N. 6414211
GW7	On site– south west of Mt Arthur North	E. 295635 N. 6419595	GW49	Off Denman Road – Wellbrook	E. 290354 N. 6421789	EWPC33	Off Edderton Road – west of Bayswater No.3	E. 294253 N. 6416847
GW22	On site – north of Mt Arthur North (off Denman Road)	E. 296930 N. 6423998	BCGW05 ^	Off Golden Highway	E. 291053 N. 6410764	GW43	Off Edderton Road – Roxburgh South	E. 294232 N. 6418551 *
GW23	On site – north of Mt Arthur North (off Denman Road)	E. 297919 N. 6424515	BCGW10 ^	Off Edderton Road – west of Bayswater No.3	E. 293115 N. 6414779	GW44	On site – off McDonalds Lane	E. 297422 N. 6414715 *
GW26	On site –west cut tailings dam	E. 301841 N. 6418792	BCGW11 ^	Off Edderton Road – west of Bayswater No.3	E. 293117 N. 6414779			
GW38P	Off Denman Road - gate no.968	E. 293832 N. 6422384	BCGW15 ^	Off Golden Highway	E. 290717 N. 6412432			

¹ Bore targeting Saddlers Creek alluvial aquifer

² Bore targeting Hunter River alluvial aquifer

^ Inclusion in monitoring program will be contingent on resolution of landowner access arrangements

* Coordinates for new monitoring locations are subject to change following final site selection for construction

Notes:

- Information regarding monitoring bore selection and location is included in 'Recommendations for changes to the Mt Arthur Coal groundwater monitoring network (AGE, 2014).
- Bore construction diagram records are maintained for each monitoring location. Where 'as-built' diagrams are not available, schematic diagrams have been developed from drill records, geological model and monitored groundwater levels.

Table 5: Groundwater Quality Monitoring Schedule

Bore ID	Frequency	Parameters
GW2, GW6, GW7, GW16, GW21, GW22, GW23, GW25, GW26, GW38A, GW38P, GW39A, GW39P, GW40A, GW48, GW41A, BCGW05, BCGW10, BCGW11, BCGW15, GW41P, BCGW18, BCGW22, EWPC33, GW42, GW43, GW44, GW45, GW46, GW47	Every six months	Water temperature, pH, EC, TDS, TSS, iron, sulphate, chloride, calcium, magnesium, potassium, sodium, carbonate, bicarbonate, total phosphorus, aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, selenium and zinc.

The monitoring schedule shown in Table 5 allows groundwater quality to be assessed in terms of impacts on regional aquifers, alluvial aquifers and private users. The impacts of the operation on water users and surrounding aquifers will be monitored, assessed and responded to in accordance with the Landholder Consultation and Investigation Process presented in Appendix 1 of the Surface and Groundwater Response Plan.

Impact Assessment Criteria

Groundwater quality impact assessment criteria have been established as:

- a) recorded pH value is outside the range of 6.5 – 9.0 for three consecutive readings.
- b) Stage 1 electrical conductivity (EC): measured values that have a 95 per cent probability of being different from those already measured (95 per cent confidence level).
- c) Stage 2 electrical conductivity (EC): measured values that have a 99 per cent probability of being different from those already measured (99 per cent confidence level).

Groundwater quality impact assessment criteria trigger values as derived from reference data are presented in Table 6. Reference data is provided in Appendix 1.

Table 6: Groundwater Quality Impact Assessment Criteria Trigger Values

ID	pH Trigger		EC 1 st Stage Trigger (µS/cm)	EC 2 nd Stage Trigger (µS/cm)
	Lower	High		
GW2	6.5	9.0	4,266	4,440
GW6			5,251	5,510
GW7			5,393	5,532
GW16			5,666	6,048
GW21			4,469	5,244
GW22			7,022	7,353
GW23			6,827	7,401
GW25			9,401	10,120
GW26			7,953	8,538
GW38A			4,806	5,024
GW38P			3,224	3,512
GW39A			6,531	6,817
GW39P			8,405	9,825
GW40A			4,477	4,587
GW40P			4,790	5,267
GW41A			4,970	5,134
GW41P			5,956	6,626
BCGW05			14,882	16,233
BCGW10			2,938	3,053
BCGW11			5,698	6,828
BCGW15			10,857	11,937
BCGW18			7,212	7,885
BCGW22			15,526	16,212
EWPC33	4,592	5,562		

Where monitored groundwater quality readings exceed impact assessment criteria, a response protocol will be followed as outlined in the Surface and Groundwater Response Plan (the response protocol for pH will be according to the process equivalent for a stage 2 groundwater trigger).

2.3 Reporting

A detailed review of monitoring results will be undertaken annually and the results, together with a discussion of the findings, will be presented in the Annual Environmental Management Report as outlined in the Environmental Management Strategy. The annual review of monitoring results will include calculation of charge balance error to assess data quality assurance, including issues with sampling technique, laboratory analysis or parameters tested.

3. References

3.1 External Documents

Resource Strategies (2013), Mt Arthur Coal Open Cut Modification – Environmental Assessment. Prepared for Hunter Valley Energy Coal Pty Ltd.

Australasian Groundwater and Environmental (AGE) Consultants (2013), “Mt Arthur Coal – Appendix B Groundwater Impact Assessment”. Report prepared for Resource Strategies January 2013.

Standards Australia (1998), “Water quality - Sampling - Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples” Australian/New Zealand Standard AS/NZS 5667.1:1998, Sydney.

3.2 Internal Documents

MAC-ENC-MTP-034 Site Water Management Plan
MAC-ENC-PRO-061 Surface Water Monitoring Program
MAC-ENC-PRO-063 Surface and Groundwater Response Plan
MAC-ENC-MTP-041 Environmental Management Strategy

Australasian Groundwater and Environmental (AGE) Consultants (2014), “Recommendations for changes to the Mt Arthur Coal groundwater monitoring network”. Letter to Mt Arthur Coal – G1602J/1 February 2015.

Appendix 1: Groundwater Reference Data

Groundwater Levels and Quality

Groundwater levels and quality parameters (pH and electrical conductivity - EC) have been measured routinely at a number of both paired and stand-alone bores within and external to the site since 1997. Groundwater level and quality data collected at the bores are summarised in Table A1.1. This data was collected between February 1996 and September 2010 and serves as the available reference conditions prior to the current mining approval.

Baseline groundwater conditions are described in detail in the Mt Arthur Coal Open Cut Modification Environmental Assessment.

Table A1.1: Reference (Baseline) Groundwater Monitoring Data

ID	Water Level (mRL)		Number of data points	pH		Number of data points	EC (µS/cm)		Number of data points	Comment
	Min	Max		Min	Max		Min	Max		
GW2	143.2	146.5	53	6.5	8.0	53	3180	4770	53	
GW3	141.6	146.3	52	7.1	8.8	51	3460	8000	52	
GW6	173.5	178.7	57	6.2	7.6	56	2820	6000	56	
GW7	173.3	175.0	52	6.4	7.6	51	4160	5630	52	
GW8	129.3	193.3	54	6.1	8.1	53	389	6070	54	
GW16	121.5	124.2	69	5.9	8.0	65	2510	6150	65	
GW21	126.0	129.7	68	6.8	7.8	63	850	5440	63	
GW22	113.6	139.9	52	6.4	7.7	52	551	6870	52	
GW23	130.6	140.0	66	6.5	7.4	65	662	8080	65	
GW25	130.1	131.4	69	6.4	7.8	65	4120	9600	65	
GW26	165.8	193.2	58	4.5	7.1	60	3170	8500	59	
GW27	164.7	195.5	56	5.4	7.1	56	5430	9100	56	
GW38P	121.4	122.1	16	7.2	8.1	13	1960	3830	13	
GW38A	122.1	122.9	17	7.0	7.6	13	3330	4580	13	
GW39P	120.3	121.9	18	7.0	7.8	13	500	6000	13	
GW39A	121.3	121.8	18	6.8	7.5	13	4750	6530	13	
GW40A	119.0	119.7	18	6.9	7.6	13	3830	4330	13	
GW40P	118.8	119.5	18	7.5	8.1	13	1080	3840	13	
GW41P	118.7	119.4	18	7.3	7.6	13	750	4500	13	
GW41A	119.2	119.7	18	6.7	7.6	13	3790	4760	13	
BCGW05	126.2	127.9	17	6.7	7.7	11	7060	13240	12	Inclusion in interim monitoring program will be contingent on resolution of landowner access arrangements
BCGW10	176.4	178.3	18	7.0	8.4	12	2240	2830	13	Inclusion in interim monitoring program will be contingent on resolution of landowner access arrangements
BCGW11	176.4	178.5	18	6.8	8.3	12	70	4910	13	Inclusion in interim monitoring program will be contingent on resolution of landowner access arrangements

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ID	Water Level (mRL)		Number of data points	pH		Number of data points	EC (µS/cm)		Number of data points	Comment
	Min	Max		Min	Max		Min	Max		
BCGW12	170.4	174.6	18	6.7	7.4	12	4330	5600	13	Remove from the network
BCGW15	145.3	147.3	13	6.1	7.2	7	3190	8510	8	Inclusion in interim monitoring program will be contingent on resolution of landowner access arrangements
BCGW18	152.9	154.9	18	5.5	8.6	13	3100	7860	13	
BCGW19	180.2	181.9	18	7.0	8.3	13	2930	4700	13	
BCGW22	138.5	140.0	18	5.9	7.5	12	10700	14710	13	
EWPC33	195.4	196.4	18	6.5	7.5	12	290	6280	13	
OD1046	174.4	175.4	18	5.7	7.4	12	4370	5850	13	Remove from the network
OD1046-PIEZO	138.9	157.4	17	9.3	11.4	12	2090	3490	13	Remove from the network
OD1049-SURFACE	130.0	130.7	18	6.8	7.3	12	9990	13500	13	Remove from the network
OD1049-WH	130.7	132.1	18	8.7	12.3	12	2110	3310	13	Remove from the network
OD1073	197.8	199.4	18	6.6	7.3	13	2137	4520	13	Remove from the network
OD1073-PIEZO	150.7	198.5	18	6.9	11.9	13	2420	5030	13	Remove from the network
OD1074	207.3	210.1	18	5.8	7.2	12	6430	8450	13	Remove from the network
OD1074-PIEZO	164.4	170.3	17	6.7	7.5	11	6340	8500	12	Remove from the network
OD1078	163.1	164.1	18	6.4	8.1	12	1810	8120	13	
OD1078-PIEZO	149.9	153.9	18	6.4	7.6	12	1470	4770	13	
OD1079-PIEZO	172.3	177.4	18	8.6	12.2	12	1250	5450	13	
OD1082-PIEZO	158.9	175.5	18	6.4	8.5	12	980	1990	13	Remove from the network
OR2051	215.4	217.6	18	6.5	7.4	12	3320	4030	13	Remove from the network
OR2051-PIEZO	169.1	174.0	16	6.5	7.7	9	1140	5970	9	Remove from the network

Groundwater Yield

Alluvial bore yields are generally low, due to the thin saturated thickness of the alluvium; the higher yielding bores are those with the greatest saturated thickness. A basal gravel layer in the Hunter River alluvium is generally regarded as the target for higher yield production bores. Pumping tests on five monitoring bores (GW16, GW17, GW21, GW24 and GW25) indicated rates of around 0.25 L/s, with the drawdown in individual bores varying between 0.01 m and 0.97 m.

A number of hydraulic tests on various coal seams within the EA Boundary have reported yields ranging from 1.0 – 3.3 L/s. A long-term (28 days) pumping test undertaken in bore GW9 adjacent the Ramrod Creek was reported to provide a continuous yield of about 1.7L/s.

Privately-Owned Groundwater Bores

In addition to the Mt Arthur Coal monitoring bores presented in Table 5, numerical modelling predicts privately owned bores that could be affected by Mt Arthur Coal mining operations are listed in Table A1.2.

Table A1.2: Privately-owned Groundwater Bores

Bore Number	Licence No.	Coordinates		Owner
		Easting	Northing	
GW011295	20WA212203	290536	6425144	Private Owned Land
GW018298	20CA208185	294391	6423498	HVEC Owned Land
GW019116	20CA212202	295459	6425029	Mine Owned Land
GW024700	NA	295573	6423275	HVEC Owned Land
GW027311	20CA207877	292056	6422787	Private Owned Land
GW029644	20BL023940	289048	6411215	Private Owned Land
GW029645	20BL023939	289066	6414082	Private Owned Land
GW029646	20BL023938	292841	6414900	Private Owned Land
GW029647	20BL023417	291005	6413906	Private Owned Land
GW029648	20BL023418	290875	6413873	Private Owned Land
GW029649	20BL023419	291321	6413790	Private Owned Land
GW029654	20BL023411	289250	6412822	Private Owned Land
GW029655	20BL023405	290702	6412144	Private Owned Land
GW029658	20BL023408	289462	6413936	Private Owned Land
GW029659	20BL023407	289121	6411494	Private Owned Land
GW029660	20BL023412	290211	6413089	Private Owned Land
GW029661	20BL023406	293054	6414688	Private Owned Land
GW030745	NA	296052	6422854	HVEC Owned Land
GW031622	20BL024276	294440	6415949	HVEC Owned Land
GW031623	20BL023652	294122	6417453	HVEC Owned Land
GW031859	20BL024674	294633	6415460	HVEC Owned Land
GW032077	20BL024716	294266	6416778	HVEC Owned Land
GW032512	20BL024338	294386	6418629	HVEC Owned Land
GW033193	20BL026154	293686	6417043	HVEC Owned Land

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Bore Number	Licence No.	Coordinates		Owner
		Easting	Northing	
GW033547	40BL026898	296176	6415461	HVEC Owned Land
GW033915	20BL024261	294185	6419509	HVEC Owned Land
GW038607	20BL029567	290205	6420916	Private Owned Land
GW045469	20BL103870	295550	6420532	HVEC Owned Land
GW049223	20BL106334	298120	6413682	HVEC Owned Land
GW053233	20CA208013	291336	6423158	Private Owned Land
GW053299	20WA207634	291127	6423123	Private Owned Land
GW053572	20CA207877	291651	6423266	Private Owned Land
GW053700	20BL120419	291465	6423253	Private Owned Land
GW053701	20WA207640	291492	6423192	Private Owned Land
GW057807	20CA207901	294895	6424463	Mine Owned Land
GW059131	20BL119201	294964	6424927	Mine Owned Land
GW060282	20BL119795	292578	6422598	Private Owned Land
GW061636	20BL133914	291981	6426129	Mine Owned Land
GW073576	20BL166372	291596	6424675	Private Owned Land
GW078026	NA	294351	6419981	HVEC Owned Land
GW078707	20BL167441	289548	6413537	Private Owned Land
GW078708	20BL167442	290888	6413226	Private Owned Land
GW078709	20BL167443	290749	6412391	Private Owned Land
GW079731	20WA207724	289989	6422513	HVEC Owned Land
GW200003	20BL166521	291033	6425814	Private Owned Land
GW200837	20BL172265	291518	6421752	Private Owned Land
GW201144	20BL170860	288730	6419900	Private Owned Land
GW201183	20BL172665	295165	6423349	HVEC Owned Land
GW201520	20BL172816	293375	6425866	Mine Owned Land
GW270001	20WA212203	291815	6422117	Private Owned Land

Appendix 2: Correspondence Records

EPA Consultation

From: Gale, Michael (NSWEC)
Sent: Friday, 23 January 2015 3:47 PM
To: hunter.region@epa.nsw.gov.au
Cc: kurt.sorensen@epa.nsw.gov.au; Withell, Sarah (NSWEC)
Subject: Groundwater and Surface Water Plans | Mt Arthur Coal
Attachments: 150123 Groundwater Monitoring Program Draft.docx; Groundwater Monitoring Program current.pdf; 150123 Surface Water Monitoring Program Draft.docx; Surface Water Monitoring Program current.pdf; 150123 Surface and Ground Water Response Plan Draft.docx; Surface and Groundwater Response Plan current.pdf; Additional Information.docx

Dear Kurt,

In accordance with the requirements of Schedule 3 Condition 29 of the Mt Arthur Coal Modification Project Approval (PA 09_0062 MOD1), I would like to invite comment and input from the EPA on the following draft programs/plans:

- **Groundwater Monitoring Program** – revised to incorporate holistic groundwater network review and two-stage trigger procedure.
- **Surface Water Monitoring Program** – revised to incorporate two-stage trigger procedure.
- **Surface and Groundwater Response Plan** – revised to incorporate groundwater and surface water exceedance protocol and alluvial cut-off wall management measures according to Schedule 3 Condition 28 of the Modification Project Approval (PA 09_0062 MOD1).

The attached document 'Additional Information.doc' provides an overview of the proposed two-stage trigger procedure as it relates to surface water for your background to the revisions. This methodology has also been incorporated into the newly revised groundwater monitoring program. I have also attached the previously approved document versions for your reference.

Regards,

Mike.



bhpbilliton
resourcing the future
Michael Gale
Superintendent Environment Analysis & Improvement
Mt Arthur Coal

NOW Consultation and Endorsement



BHP Billiton Mt Arthur Coal
By Email
Michael.Gale@bhpbilliton.com

ATTN: Mr Michael Gale

Contact Alison Collaros
Phone (02) 4904 2527
Fax (02) 4904 2501
Email Alison.collaros@dpi.nsw.gov.au

Our ref ER20491
Your ref PA09_0062_MOD1

Dear Mr Gale

Mt Arthur Coal Mine – Hunter Valley Energy Coal Pty Ltd – Response to Submissions in relation to Revised Surface Water and Groundwater Monitoring Programs and Response Plan

NSW Office of Water has reviewed the Supplementary Report and the additional information supplied by BHP Billiton Mt Arthur Coal in response to the recommendations issued by NSW Office of Water in the letter dated 24 February 2015. It is considered that the proponent has provided a satisfactory response to each of the issues raised. Office of Water considers that appropriate information has been provided in relation to the water quality monitoring program and time variant plots and that suitable work is underway to allow the re-assessment of trigger levels within a timeframe of 12-30 months.

If you require further information regarding Office of Water's comments, please contact Alison Collaros, Senior Water Regulation Officer on Alison.collaros@dpi.nsw.gov.au or (02) 4904 2527.

Yours sincerely



Mitchell Isaacs
Manager, Strategic Stakeholder Liaison
1 April 2015

Approval from DP&E



Michael Gale
Superintendent Environment Analysis & Improvement
Mt Arthur Coal
PMB 8
MUSWELLBROOK NSW 2333

Contact: Scott Brooks
Phone: 6575 3401
Fax: 6575 3415
Email: scott.brooks@planning.nsw.gov.au
Our ref: 09-0062

Dear Mike,

Mt Arthur Coal Groundwater Monitoring Program and Surface and Groundwater Response Plan.

Thank you for providing the most recent versions of the Mt Arthur Coal Groundwater Monitoring Program and the Surface and Groundwater Response plans on the 1st April for review. These are required by Condition 33 & 34 Schedule 3 of Approval 09-0062.

I can advise that the Department has reviewed these plans and can advise that the Secretary has approved both plans.

Could you please ensure that the finalised management plans are forwarded to the Department by the 15th May 2015 and that the plan is uploaded onto the company's website as soon as possible.

If you require further information or clarification in this matter please contact Scott Brooks on 6575 3401 or by email to scott.brooks@planning.nsw.gov.au.

Yours sincerely



Scott Brooks
Investigations (lead) Compliance
Singleton
As Nominee of the Secretary, Dept of Planning & Environment.

Appendix 3: Interim Monitoring Program

An ongoing work program is in place to improve the current groundwater monitoring network. The intent of the work is to improve bore integrity at existing monitoring locations and install new monitoring locations.

The interim monitoring schedule, including the proposed suite of parameters for specific locations is summarised in Table A3.1. Due to the monitoring network upgrades and improvements to sampling procedures, monthly groundwater quality sampling is proposed for a period of twelve months following completion of the upgrade works. If consistent results are noted for the initial twelve month period (year one), it is proposed that the monitoring frequency be reduced to every two months for the following twelve month period (year two) reverting ultimately to the monitoring frequency as described in Section 2.

This interim monitoring program will apply while the monitoring network upgrade works are being implemented and a sufficient reference dataset is being collected. This interim monitoring program proposes in the immediate term to use the existing reference values for ongoing reference.

Bore locations are shown in Figure A3.1 and a summary for each site, including geographic coordinates, is provided in Tables A3.2 and A3.3.

Table A3.1: Interim Groundwater Monitoring Schedule

Bore ID	Frequency	Parameters
During upgrade works		
GW8, GW16, GW21, GW25, GW38A, GW38P, GW40A, BCGW05, BCGW10, BCGW22, VWP01, VWP02, VWP03 (P1 & P2)	Continuous (every six hours)	Groundwater level elevation/ depth to groundwater
GW8, GW16, GW21, GW25, GW38A, GW38P, GW40A, BCGW05, BCGW10, BCGW22, VWP01, VWP02, VWP03 (P1 & P2)	Every two months	Data logger download and equipment checks. Manual groundwater level elevation/depth to groundwater (for validation and instrument drift correction).
GW2, GW3, GW6, GW7, GW22, GW23, GW26, GW27, GW39A, GW39P, GW41A, BCGW11, BCGW15, BCGW18, BCGW19, EWPC33, OD1078, OD1078-piezo, OD1079, OD1079-piezo	Every two months	Groundwater level elevation / depth to groundwater
GW2, GW6, GW7, GW16, GW21, GW22, GW23, GW25, GW26, GW38A, GW38P, GW39A, GW39P, GW40A, GW41A, BCGW05, BCGW10, BCGW11, BCGW15, BCGW18, BCGW22, EWPC33	Every two months ^	Water temperature, pH, EC, TDS, TSS, iron.
GW2, GW6, GW7, GW16, GW21, GW22, GW23, GW25, GW26, GW38A, GW38P, GW39A, GW39P, GW40A, GW41A, BCGW05, BCGW10, BCGW11, BCGW15, BCGW18, BCGW22, EWPC33	Every six months ^	Sulphate, chloride, calcium, magnesium, potassium, sodium, carbonate bicarbonate, total phosphorus, aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, selenium and zinc.

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Bore ID	Frequency	Parameters
Following completion of upgrade works		
GW2, GW3, GW6, GW7, GW8, GW16, GW21, GW22, GW23, GW25, GW26, GW27, GW38A, GW38P, GW39A, GW39P, GW40A, GW48, GW41A, GW49, BCGW05, BCGW10, BCGW11, BCGW15, BCGW18, BCGW19, BCGW22, EWPC33, OD1078, OD1078-piezo, OD1079, OD1079-piezo, VWP01, VWP02, VWP03 (P1 & P2), VWP04 (P1 – P4), VWP05 (P1 – P4), VWP06 (P1 – P4), VWP07 (P1 – P4), GW42, GW43, GW44, GW45, GW46, GW47	Continuous (every six hours)	Groundwater level elevation/ depth to groundwater
GW2, GW3, GW6, GW7, GW8, GW16, GW21, GW22, GW23, GW25, GW26, GW27, GW38A, GW38P, GW39A, GW39P, GW40A, GW48, GW41A, GW49, BCGW05, BCGW10, BCGW11, BCGW15, BCGW18, BCGW19, BCGW22, EWPC33, OD1078, OD1078-piezo, OD1079, OD1079-piezo, VWP01, VWP02, VWP03 (P1 & P2), VWP04 (P1 – P4), VWP05 (P1 – P4), VWP06 (P1 – P4), VWP07 (P1 – P4), GW42, GW43, GW44, GW45, GW46, GW47	Every two months	Data logger download and equipment checks. Manual groundwater level elevation/depth to groundwater (for validation and instrument drift correction).
GW2, GW6, GW7, GW16, GW21, GW22, GW23, GW25, GW26, GW38A, GW38P, GW39A, GW39P, GW40A, GW48, GW41A, GW49, BCGW05, BCGW10, BCGW11, BCGW15, BCGW18, BCGW22, EWPC33, GW42, GW43, GW44, GW45, GW46, GW47	Monthly for months 0-12 (year one of interim program)	Water temperature, pH, EC, TDS, TSS, iron, sulphate, chloride, calcium, magnesium, potassium, sodium, carbonate, bicarbonate, total phosphorus, aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, selenium and zinc.
GW2, GW6, GW7, GW16, GW21, GW22, GW23, GW25, GW26, GW38A, GW38P, GW39A, GW39P, GW40A, GW48, GW41A, GW49, BCGW05, BCGW10, BCGW11, BCGW15, BCGW18, BCGW22, EWPC33, GW42, GW43, GW44, GW45, GW46, GW47	Every two months for months 12-24 (year two of interim program)	Water temperature, pH, EC, TDS, TSS, iron, sulphate, chloride, calcium, magnesium, potassium, sodium, carbonate, bicarbonate, total phosphorus, aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, selenium and zinc.

* The following monitoring bores are planned to be decommissioned for water level monitoring and will not be monitored for water level during the upgrade works: GW37 (mined through), GW40P, GW41P, BCGW12, OD1046, OD1046-piezo, OD1049-surface, OD1049-WH, OD1073, OD1073-piezo, OD1074, OD1074-piezo, OD1082, OD1082-piezo, OR2051, OR2051-piezo.

^ The following monitoring bores are planned to be decommissioned for water quality monitoring and will not be monitored for water quality during the upgrade works: GW3, GW8, GW27, GW37 (mined through), GW40P, GW41P, BCGW12, BCGW19, OD1046, OD1046-piezo, OD1049-surface, OD1049-WH, OD1073, OD1073-piezo, OD1074, OD1074-piezo, OD1078, OD1078-piezo, OD1079, OD1079-piezo, OD1082, OD1082-piezo, OR2051, OR2051-piezo.



Figure A3.1: Interim Groundwater Monitoring Locations (also shows monitoring bores to be decommissioned as red points)

Table A3.2: Interim Groundwater Level Monitoring Locations

Site No.	Location	Coordinates (GDA94 Zone 56)	Site No.	Location	Coordinates (GDA94 Zone 56)	Site No.	Location	Coordinates (GDA94 Zone 56)
Alluvial aquifer bores								
GW45 ¹	On site – upper Saddlers Creek	E. 298944 N. 6413748 *	GW21 ²	Off Denman Road – Edinglassie Homestead	E. 296141 N. 6424483	GW40A ²	Off Denman Road - 1212 Ginda Holstiens	E. 291815 N. 6422119
GW46 ¹	On site – central Saddlers Creek	E. 298364 N. 6413447 *	GW25 ²	Off Bengalla Road – north of Mt Arthur North	E. 298376 N. 6425231	GW41A ²	Off Denman Road - Wellbrook	E. 290354 N. 6421789
GW47 ¹	On site – lower Saddlers Creek	E. 297387 N. 6413003 *	GW38A ²	Off Denman Road - gate no.968	E. 293831 N. 6422377	GW42 ²	Off Denman Road - west of Edinglassie Homestead	E. 295139 N. 6423369 *
GW16 ²	Off Denman Road – west of Mt Arthur North	E. 294197 N. 6422759	GW39A ²	Off Denman Road - Denman Road West	E. 293094 N. 6422248			
Permian coal seam aquifer bores								
GW2	On site – south of Saddlers Creek	E. 299045 N. 6413511	GW49	Off Denman Road – Wellbrook	E. 290354 N. 6421789	OD1079 – piezo	On site – south of Mt Arthur North	E. 295956 N. 6416427
GW3	On site – south of Saddlers Creek	E. 298856 N. 6413389	BCGW05 ^	Off Golden Highway	E. 291053 N. 6410764	GW43	Off Edderton Road – Roxburgh South	E. 294232 N. 6418551 *
GW6	Off Edderton Road – Roxburgh South	E. 294227 N. 6418579	BCGW10 ^	Off Edderton Road – west of Bayswater No.3	E. 293115 N. 6414779	GW44	On site – off McDonalds Lane	E. 297422 N. 6414715 *
GW7	On site– south west of Mt Arthur North	E. 295635 N. 6419595	BCGW11 ^	Off Edderton Road – west of Bayswater No.3	E. 293117 N. 6414779	VWP01	Off Denman Road – west of Edinglassie Homestead (Sensor 11-1676)	E. 295167 N. 6423381
GW8	On site – south of Mt Arthur North	E. 296991 N. 6419491	BCGW15 ^	Off Golden Highway	E. 290717 N. 6412432	VWP02	Off Denman Road – west of Edinglassie Homestead (Sensor 11-3848)	E. 295195 N. 6423364
GW22	On site – north of Mt Arthur North (off Denman Road)	E. 296930 N. 6423998	BCGW18	Off Edderton Road - opposite Calool	E. 294345 N. 6419985	VWP03P1 VWP03P2	Off Denman Road – west of Edinglassie Homestead (Sensors11-3849, 11-3850)	E. 295166 N. 6423349
GW23	On site – north of Mt Arthur North (off Denman Road)	E. 297919 N. 6424515	BCGW19	Off Edderton Road – Roxburgh South	E. 292462 N. 6419152	VWP04P1 VWP04P2 VWP04P3 VWP04P4	Off Edderton Road - opposite Windmill north	E. 294708 N. 6422137 *
GW26	On site –west cut tailings dam	E. 301841 N. 6418792	BCGW22	On site – south west of Bayswater No.3	E. 295304 N. 6414211	VWP05P1 VWP05P2 VWP05P3 VWP05P4	Off Edderton Road - opposite Windmill south	E. 293997 N. 6421606 *
GW27	On site – west cut tailings dam	E. 301863 N. 6418412	EWPC33	Off Edderton Road – west of Bayswater No.3	E. 294253 N. 6416847	VWP06P1 VWP06P2 VWP06P3 VWP06P4	Off Edderton Road - opposite Huon	E. 293958 N. 6420804 *

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Site No.	Location	Coordinates (GDA94 Zone 56)	Site No.	Location	Coordinates (GDA94 Zone 56)	Site No.	Location	Coordinates (GDA94 Zone 56)
GW38P	Off Denman Road - gate no.968	E. 293832 N. 6422384	OD1078	On site – south west of Mt Arthur North	E. 294495 N. 6419259	VWP07P1 VWP07P2 VWP07P3 VWP07P4	On site - south west of Mt Arthur North	E. 295657 N. 6419563 *
GW39P	Off Denman Road - Denman Road West	E. 293095 N.6422251	OD1078 – piezo	On site – south west of Mt Arthur North	E. 294495 N. 6419259			
GW48	Off Denman Road - 1212 Gia Gindi Holstiens	E. 291815 N. 6422119	OD1079	On site – south of Mt Arthur North	E. 295956 N. 6416427			

¹ Bore targeting Saddlers Creek alluvial aquifer

² Bore targeting Hunter River alluvial aquifer

^ Inclusion in interim monitoring program will be contingent on resolution of landowner access arrangements

* Coordinates for new monitoring locations are subject to change following final site selection for construction

Table A3.3: Interim Groundwater Quality Monitoring Locations

Site No.	Location	Coordinates (MGA)	Site No.	Location	Coordinates (MGA)	Site No.	Location	Coordinates (MGA)
Alluvial aquifer bores								
GW45 ¹	On site – upper Saddlers Creek	E. 298944 N. 6413748 *	GW21 ²	Off Denman Road – Edinglassie Homestead	E. 296141 N. 6424483	GW40A ²	Off Denman Road - 1212 Ginda Holstiens	E. 291815 N. 6422119
GW46 ¹	On site – central Saddlers Creek	E. 298364 N. 6413447 *	GW25 ²	Off Bengalla Road – north of Mt Arthur North	E. 298376 N. 6425231	GW41A ²	Off Denman Road - Wellbrook	E. 290354 N. 6421789
GW47 ¹	On site – lower Saddlers Creek	E. 297387 N. 6413003 *	GW38A ²	Off Denman Road - gate no.968	E. 293831 N. 6422377	GW42 ²	Off Denman Road - west of Edinglassie Homestead	E. 295139 N. 6423369 *
GW16 ²	Off Denman Road – west of Mt Arthur North	E. 294197 N. 6422759	GW39A ²	Off Denman Road - Denman Road West	E. 293094 N. 6422248			
Permian coal seam aquifer bores								
GW2	On site – south of Saddlers Creek	E. 299045 N. 6413511	GW39P	Off Denman Road - Denman Road West	E. 293095 N.6422251	BCGW18	Off Edderton Road - opposite Calool	E. 294345 N. 6419985
GW6	Off Edderton Road – Roxburgh South	E. 294227 N. 6418579	GW48	Off Denman Road - 1212 Ginda Holstiens	E. 291815 N. 6422119	BCGW22	On site – south west of Bayswater No.3	E. 295304 N. 6414211
GW7	On site– south west of Mt Arthur North	E. 295635 N. 6419595	GW49	Off Denman Road – Wellbrook	E. 290354 N. 6421789	EWPC33	Off Edderton Road – west of Bayswater No.3	E. 294253 N. 6416847
GW22	On site – north of Mt Arthur North (off Denman Road)	E. 296930 N. 6423998	BCGW05 ^	Off Golden Highway	E. 291053 N. 6410764	GW43	Off Edderton Road – Roxburgh South	E. 294232 N. 6418551 *
GW23	On site – north of Mt Arthur North (off Denman Road)	E. 297919 N. 6424515	BCGW10 ^	Off Edderton Road – west of Bayswater No.3	E. 293115 N. 6414779	GW44	On site – off McDonalds Lane	E. 297422 N. 6414715 *
GW26	On site –west cut tailings dam	E. 301841 N. 6418792	BCGW11 ^	Off Edderton Road – west of Bayswater No.3	E. 293117 N. 6414779			
GW38P	Off Denman Road - gate no.968	E. 293832 N. 6422384	BCGW15 ^	Off Golden Highway	E. 290717 N. 6412432			

¹ Bore targeting Saddlers Creek alluvial aquifer

² Bore targeting Hunter River alluvial aquifer

^ Inclusion in interim monitoring program will be contingent on resolution of landowner access arrangements

* Coordinates for new monitoring locations are subject to change following final site selection for construction