WAMBO COAL PTY LIMITED

SOUTH BATES UNDERGROUND MINE

EXTRACTION PLAN
LONGWALLS 11 TO 16

REPORT 2
GROUNDWATER ASSESSMENT REVIEW

Peabody ENERGY

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DATE: 3 January 2017

TO: Steven Peart
Environment and Community Manager
Wambo Coal Pty Ltd
Peabody Energy Australia
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FROM: Dr Noel Merrick

RE: **South Bates Underground Mine Longwalls 11 to 16 Extraction Plan – Groundwater Assessment Review**

OUR REF: HS2016/64

This report responds to a request from Wambo Coal Pty Ltd (WCPL) for a groundwater assessment review in support of the Extraction Plan for Longwalls 11 to 16 of the South Bates Underground Mine (**Figure 1**). WCPL has approval for the extraction of three longwall panels in the Whybrow Seam (Longwalls 11 to 13) and three longwall panels in the Wambo Seam (Longwalls 14 to 16) (**Figure 2**).

WCPL is preparing an Extraction Plan for Longwalls 11 to 16. This Extraction Plan outlines the proposed management, mitigation, monitoring and reporting of potential subsidence impacts and environmental consequences from the secondary extraction of approved longwalls at the South Bates Underground Mine. Additional information on the Wambo Coal Mine and the South Bates Underground Mine is provided in the main text of the Extraction Plan.

An application to modify the Development Consent (DA 305-7-2003 MOD 15) was lodged in July 2015 to allow an extension to the South Bates Underground Mine to include three additional longwalls (Longwalls 14 to 16) in the Wambo Seam and was approved on 10 November 2015. HydroSimulations (HS) constructed and calibrated a numerical groundwater model that was applied as part of the South Bates (Wambo Seam) Underground Mine Modification Groundwater Assessment (HS, 2015).

This report presents a review of the predictions presented in the South Bates (Wambo Seam) Underground Mine Modification Groundwater Assessment (HS, 2015) in consideration of recent groundwater monitoring results, more recent numerical modelling and changes in the longwall layout that have occurred since the assessment.

Since the completion of the South Bates (Wambo Seam) Underground Mine Modification Groundwater Assessment, the mine layout has been revised to incorporate the following changes:

- The longwalls in the Wambo Seam are proposed to be extracted in reverse order, from the south-eastern most longwall to the north-western most longwall.
- The commencing (i.e. south-western) end of Longwall 11 has been shortened by 363 m.
- The commencing end of Longwall 12 has been shortened by 79 m.
- The commencing end of Longwall 13 has been shortened by 378 m.
- The commencing end of Longwall 14 has been shortened by 243 m.
- The finishing end of Longwall 14 has been slightly lengthened by 23 m.
- The commencing end of Longwall 16 has been slightly shortened by 13 m.

Scope of Work

In accordance with Condition 22D, Schedule 4 of the Development Consent, this report includes a summary of predicted impacts to groundwater resources from South Bates Underground Mine (Longwalls 11 to 16).

Documentation

The following documents have been relied upon as an aid to this groundwater assessment review:

1. HydroSimulations (HS), 2015, *South Bates (Wambo Seam) Underground Mine Modification – Groundwater Assessment*. Report HC2015/026 for Wambo Coal Pty Ltd. July 2015.
2. HydroSimulations (HS), 2016, *South Wambo Underground Mine Modification – Groundwater Assessment*. Report HS2016/01 for Wambo Coal Pty Ltd. March 2016.
3. Mine Subsidence Engineering Consultants (MSEC), 2017, *South Bates Underground Mine Subsidence Assessment - Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan for WYLW11 to WYLW13 in the Whybrow Seam and WMLW14 to WMLW16 in the Wambo Seam*. Report No. MSEC 855. Report prepared for Wambo Coal Pty Ltd, January 2017.
4. Operational Risk Mentoring, 2016, *South Bates Underground Mine – Longwalls 11 to 16 Subsidence Risk Assessment Report*. Document ORMJ1408/1622, December 2016.
5. WCPL, 2015, *Wambo Coal Groundwater Monitoring Program*. Version No. 10, October 2015.
6. WCPL, 2016, *South Bates Underground Mine Water Management Plan Longwalls 11-16*. Revision D, December 2016.
7. Australian Mining Engineering Consultants, 2000, *The Influence of Subsidence Cracking on Longwall Extraction beneath Water Courses, Aquifers, Open Cut Voids and Spoil Piles*. Australian Coal Association Research Program (ACARP) Report C5016, August 2000.
8. Coffey, 2000, *Hydrological Response to Mining Panels 9 and 9A in South Wambo Creek*. Report prepared for Wambo Mining Corporation Pty Ltd, January 2000.
9. Ditton, S. and Merrick, N, 2014, *A New Subsurface Fracture Height Prediction Model for Longwall Mines in the NSW Coalfields*. Geological Society of Australia, 2014 Australian Earth Sciences Convention (AESC), Sustainable Australia. Abstract No 03EGE-03 of the 22nd Australian Geological Convention, Newcastle City Hall and Civic Theatre, Newcastle, New South Wales. July 7 - 10. Page 136.

Previous Studies

Background

Substantial coal mining activity has occurred historically and is continuing currently in the vicinity of Wambo, by a number of companies, with development across several coal seams. Coal is extracted by means of both underground and open cut mining methods. Coal mines neighbouring Wambo include United Colliery to the north and east of Wambo, Mt Thorley Warkworth to the south-east, and a number of open cut and underground mines to the north and east within the Hunter Valley Operations (**Figure 2**).

Historical mining at Wambo has involved four seams in the open cuts - Whybrow, Redbank Creek, Wambo and Whynot. WCPL operates five open cut pits: Bates; Bates South; Wombat; Homestead and Montrose. Underground mining has involved recovery from the Wambo and Whybrow seams. The Whybrow seam was mined at the Homestead underground mine between 1979 and 1999, and in the Wollemi underground mine between 1997 and 2002. The North Wambo Underground Mine commenced production (with Longwall 1) in October 2007 and finished in January 2016.

Longwall mining in the Whybrow Seam at the South Bates Underground Mine commenced in February 2016. Longwall 11 was completed in July 2016. Longwall extraction from the Wambo Seam is planned to commence in mid-2017.

Hydrogeology

As part of the South Bates (Wambo Seam) Underground Mine Modification assessment, HS prepared a groundwater assessment for Wambo in 2015 (HS, 2015). This assessment showed that the hydrogeological regime of the Wambo Coal Mine area comprises two main systems:

- a Quaternary alluvial aquifer system of channel fill deposits associated with Wollombi Brook, North Wambo Creek, Wambo Creek and Stony Creek; and
- underlying Permian strata of low permeability and very low yielding to essentially dry sandstone and lesser siltstone and low to moderately permeable coal seams which are the prime water bearing strata within the Permian sequence.

The flow in North Wambo Creek has been altered by the historical and existing mining operations including the removal of alluvium across the full width of the channel with consequent desaturation of the adjacent upstream and downstream alluvium. A section of North Wambo Creek has been diverted around the open cut pits.

Historical and ongoing open cut and underground mining within the Wambo area (including adjoining mining operations) has created significant groundwater sinks and this has generated a regional zone of depressurisation within the Permian coal measures.

Subsidence

Potential subsidence impacts to the creeks and watercourses directly above and adjacent to Longwalls 11 to 16 have been assessed by MSEC (2017). The maximum predicted additional subsidence is 1.95 m from the Whybrow Seam and 4.15 m cumulatively from the Whybrow and Wambo Seams (MSEC, 2017).

The north-eastern ends of Longwalls 11 to 13 will pass beneath the North Wambo Creek diversion and Longwalls 14 to 16 will finish adjacent to the diversion. MSEC (2017) anticipates approximately 2 m of vertical subsidence, 80 millimetres per metre (mm/m) of tilt, curvatures greater than 3 km^{-1} and tensile and compressive strains greater than 30 mm/m along the North Wambo Creek diversion.

Stony Creek is approximately 65 m south-west of the longwalls under the revised layout. Only minor subsidence (approximately 150 mm vertical subsidence and <0.1 mm/m tensile and compressive strains) is expected along Stony Creek (MSEC, 2017).

Surface cracking along the North Wambo Creek diversion above Longwall 11 was observed to be about 25-50 mm in width, with a maximum in the order of 100 mm near a bend in the alignment of the diversion (MSEC, 2017).

Above Longwalls 11 to 13 in the Whybrow Seam, the depth of cover is 54 m to 470 m. MSEC (2017) concludes it "*is not expected that there would be a hydraulic connection between the surface and seam over the majority of the longwalls, as none was observed after the extraction of the first seven longwalls at the NWUM, which were mined directly beneath North Wambo Creek at a depth of cover of around 100 m. It is possible that hydraulic connection between the surface and seam could develop above the finishing (i.e. north-eastern) ends of the longwalls, where the depths of cover to the overlying Whybrow Seam are less than 100 m…*"

It follows that groundwater levels are likely to be lowered temporarily by strata dilation due to subsidence deformation.

The depth of cover above the Whybrow Seam at the North Wambo Creek diversion is approximately 64 m to 80 m and there would be an enhanced hydraulic connection between the seam and the surface in this location.

Australian Mining Engineering Consultants (2000) presented measured inflow rates at and adjacent to German Creek and Oaky Creek Longwall Mines in the period from 1986 to 1997. Measured inflow rates from surface water sources are summarised in **Table 1**.

Table 1 Measured Inflow Rates at German Creek and Oaky Creek Mines

MINE	DATE	OVERBURDEN THICKNESS (m)	MEASURED INFLOW RATES (L/s)	WATER SOURCE	COMMENTS
Central Colliery	1986	70	25	Tieri Sill Aquifer	Initial flow 25 L/s, Reducing to 9 L/s after 35 days.
Southern Colliery	December 1990	70	140	Pit E surface run-off in final void	Flow down tension cracks in pit floor.
Southern Colliery	September 1991	130 - 140	27	German Creek	Subsidence trough above 603 Panel prior to removal works.
Southern Colliery	December 1993	150 - 160	30	German Creek	Subsidence trough above 604 Panel prior to removal works. Permian rock exposed in creek bed.
Southern Colliery	January 1994	120	45	Cattle Creek	Subsidence trough above 604 Panel prior to remedial works. Eddies above tension cracks.
Oaky No. 1 Underground Mine	January 1996	100 - 168	190	Sandy Creek Diversion Channel Talagai Pit Talagai Spoil Piles	40 L/s 89 L/s 61 L/s
Oaky No. 1 Underground Mine	January 1997	150 - 168	17	Sandy Creek Diversion Channel	From three longwall troughs.

Source: Australian Mining Engineering Consultants (2000).

In addition to the work conducted by Australian Mining Engineering Consultants (2000), mining was conducted under Wambo Creek at similar depths of cover at the nearby Homestead Mine in Longwalls 9 and 9A in the Whybrow Seam. A large flow event in Wambo Creek occurred while mining was occurring in Longwall 9 immediately below the creek. Coffey (2000) reported "a maximum of about 200 L/s of surface flow was being transferred to the mine".

Subsequent flow monitoring was conducted during the period when Longwall 9A was undermining the creek. This involved pumping water from Wollombi Brook at a measured rate to an un-subsided area between Longwalls 9 and 9A. Outflow to Wollombi Brook, which was monitored by means of a weir, stabilised with a loss through subsidence cracks of 12.4 to 14.1 L/s (1.1 to 1.2 ML/day).

The potential enhanced vertical hydraulic conductivity (K) can be estimated based on reported inflows by Australian Mining Engineering Consultants (2000) and Coffey (2000). The highest inflow reported by Klenowski was approximately 16 ML/day (190 L/s), and the reported inflow to the Homestead Mine was approximately 17 ML/day (200 L/s). The portion of Wambo Creek above the Homestead Mine Longwalls 9 and 9A is approximately 500 m long. Assuming a channel width of approximately 5 m, the effective vertical K would have been approximately 7 m/day.

For the North Wambo Creek diversion above the South Bates Underground Mine, using a reach of 250 m (above one longwall), a channel width of 5 m, and a conservative K of 10 m/day, the estimated inflow would be approximately 12.5 ML/day.

It is noted that the vertical K would reduce as sediments flow into subsidence cracks and following remediation.

In addition, WCPL has reported that no increase in groundwater inflows to the workings following rainfall events has been observed as part of the experience from Longwall 11 to date.

Groundwater Modelling

The groundwater assessment by HS (2015) included numerical modelling (using MODFLOW-SURFACT software) to assess the potential cumulative impacts on regional and local groundwater resources of the proposed South Bates Longwalls 14 to 16, approved South Bates Longwalls 11 to 13, North Wambo Longwalls 1 to 10A and surrounding mining operations.

Since the modelling presented in HS (2015), the model has been converted to MODFLOW-USG Beta for improved mass balance when simulating longwall mining, as well as faster run-times. The existing rectilinear grid structure of the previous model was retained to enable direct comparison of results. The model was then re-calibrated using the latest data whilst ensuring consistency with previously reported model results. The results of the latest model are presented in HS (2016) for the South Wambo Underground Mine Modification.

The model domain is discretised into 320 rows, 380 columns and 16 layers. The dimensions of the model cells are uniformly 50 m in both lateral directions. The model extent is 16 kilometres (km) from west to east and 19 km from south to north, covering an area of approximately 300 square km (**Figure 3**).

The layer definition within the model has allowed the mined coal seams to be represented individually. A single layer of overburden separates each coal seam in the model. The target Whybrow and Wambo coal seams are layers 3 and 5 in the model, respectively. The HS (2015) model used a conservative estimate of about 170 m for the fractured zone height (0.67 times the panel width of 250 m). As the depth of cover for the Whybrow Seam across the entire South Bates Underground Mine varies from 54 m to 470 m, fracturing was modelled to reach ground surface over the north-eastern portion of the mine footprint. The HS (2016) model applied the Ditton and Merrick (2014) Geology Model algorithm to obtain a more rigorous estimation of the height of connective fracturing above the mine void. This algorithm includes a procedure for quantifying the effects of multi-seam mining. The reappraisal showed that the extent of previously adopted fracturing in the HS (2015) groundwater model was conservative. Fracturing still is expected to be often to land surface, at the northern ends of longwall panels for 25-40% of panel length. For multi-seam mining the interburden between coal seams is expected to be fully fractured, and is simulated accordingly.

Transient calibration against groundwater levels was carried out with the HS (2016) model for the period January 2003 to December 2014 which includes the period when North Wambo Underground Mine Longwalls 1 to 10 were mined (HS, 2016). The achieved calibration performance measure was 3.9% Scaled Root Mean Square (SRMS) for the calibration period (HS, 2016).

Risk Assessment

A risk assessment review, facilitated by Operational Risk Mentoring on 26 October 2016, included the participation of the author of this groundwater assessment review. The scope of the risk assessment workshop was (Operational Risk Mentoring, 2016):

> *To review the risk assessment for South Bates Underground Mine with an emphasis on identifying those subsidence impacts with high-risk levels and/or potentially severe consequences. To confirm that adequate risk treatment measures are applied such that the residual risk ranking is tolerable*.

Although several groundwater issues were identified, the only priority loss scenarios identified in the risk assessment were (Operational Risk Mentoring, 2016):

> *Failure of the monitoring program to detect and respond to an impact on the groundwater system.* (Rank D4 – Broadly Acceptable)
>
> *Boundary faults result in differences between modelled and observed groundwater drawdown (possibly conservative at a distance, but inaccurate locally).* (Rank D5 – Broadly Acceptable)

As a result of the previous risk assessment, the groundwater monitoring program in the vicinity of the South Bates Underground Mine was reviewed and new monitoring sites installed as an additional control measure. This report has reviewed the monitoring results from the groundwater monitoring program (see Data Analysis below). The nearby groundwater monitoring sites (GW21 and N2) are still operational following extraction of Longwall 11.

Lower priority issues of relevance identified and tabulated by Operational Risk Mentoring (2016) include:

1. Induced leakage from Stony Creek resulting from a lowering of the water table associated with the extraction of Longwalls 11 to 16. (Rank E5)
2. Reduced baseflow to North Wambo Creek (including diversion) resulting from a lowering of the water table associated with the extraction of Longwalls 11 to 16. (Rank D5)
3. Induced leakage from North Wambo Creek Diversion due to subsidence. (Rank D3)

No follow-up actions that were not already completed, relevant to groundwater, were identified.

Data Analysis

Groundwater Monitoring

Groundwater monitoring at Wambo is undertaken in accordance with the Groundwater Monitoring Program (GWMP) (WCPL, 2015). The objectives of the GWMP are to establish baseline groundwater quality and water level data and to implement a programme of data collection that can be utilised to assess potential impacts of mining activities on the groundwater resources of the area.

The Wambo groundwater monitoring network currently consists of approximately 40 monitoring sites (**Figure 4**). A network of monitoring bores has been established in the alluvial aquifers associated with the principal drainage pathways, as well as multi-level vibrating wire piezometers (VWPs) installed within the Permian groundwater system.

Consistent with the GWMP, groundwater quality sampling has been undertaken by WCPL in accordance with AS/NZS 5667.11:1998 – *Guidance on Sampling of Ground Waters*. Samples are measured in the field for acidity (pH), electrical conductivity (EC) and temperature (T).

Key Monitoring Bores

The key monitoring bores for this groundwater assessment are:

- GW16 – in alluvium on North Wambo Creek, about 2 km north;
- GW17 – in weathered rock beneath alluvium on North Wambo Creek, about 2 km north;
- N5 – a multi-level VWP array adjacent to North Wambo Creek, about 2 km north;
- GW19 – in alluvium over Longwall 11 (always dry);
- N3 – a multi-level VWP over Longwall 11 headings;
- GW21 – in interburden about 200 m from the centre of Longwall 13; and
- N2 – a multi-level VWP adjacent to GW21.

Two discontinued monitoring bores also provide useful baseline information:

- P5 – in alluvium over North Wambo Underground Mine Longwall 1; and
- P6 – in alluvium over North Wambo Underground Mine Longwall 2.

Figure 5 displays the groundwater level hydrographs at P5 and P6, and long-term trends by applying an 11-point smoothing window (approximately 1 year), compared with the rainfall residual mass curve (RMC) since 2005, and with the commencement dates for each North Wambo Underground longwall panel. The RMC is a filtered version of the monthly rainfall record which suppresses spiky rainfall events and enhances long-term trend information. During a wetter than normal period, the curve climbs. Conversely, the curve falls during a drier than normal period. If rainfall is the primary driver for groundwater level dynamics, the groundwater hydrographs can be expected to follow a similar trend. The water table at P5 and P6 responds rapidly and with high amplitude (2-4 m) to rainfall events. There is very good correlation between the two groundwater curves and the RMC until mid-2012, at which time a mining effect can be seen. This would not be due to extraction of Longwall 5 at that time, but would be due to open cut mining approaching from the north-west (**Figure 4**).

At January 2013, the open cut face was about 400 m from P5. Both hydrographs show a decline in water level during the passage of Longwall 1 and Longwall 2, when rainfall was close to average conditions. Following this decline these bores have recovered during wetter conditions. The early decline is indicative of a mining effect on water level due probably to enhanced leakage of water from the alluvium to the underlying Permian rocks and it is noted that this mechanism is consistent with the potential impacts described in the Wambo Development Project EIS and the North Wambo SEE. The alluvium still maintained sufficient water and had not been dewatered by mining.

Both P5 and P6 groundwaters freshened with time, as illustrated by the EC responses in **Figure 6**. The alluvial water moved into a better beneficial use category from 3,000-4,000 microsiemens per centimetre (µS/cm) at the commencement of Longwall 1 to less than 1,000 µS/cm at September 2012. For the full period of record, the groundwater EC has been less than 1,000 µS/cm at P5 for about 15% of the time and at P6 for about 40% of the time. The EC trends suggest replenishment by good quality water beyond what occurred pre-mining. The mechanism would be either increased rainfall recharge or reduced upflow of more saline groundwater into the alluvium in response to mining. The mechanism of increased rainfall recharge is consistent with the period of above average rainfall indicated by the RMC (**Figure 6**).

The pH condition of the groundwater at P5 and P6 was very stable before mining and during mining. There have been variations of up to 1 pH unit that bear some correlation with rainfall trends.

Figure 7 displays fluctuating and smoothed groundwater level hydrographs at GW16 and GW17, as well as the RMC and the commencement dates of North Wambo Underground and South Bates Underground longwall panels. Both GW16 and GW17 show strong correlation with the RMC until mid-2012, after which a pronounced decline in water levels occurred despite fairly average weather conditions. This is attributed to the northwards progression of nearby open cut mining. Since mid-2012 groundwater levels have increased in response to large rainfall events (March 2013, January-March 2015, January 2016), but the long decline in groundwater level from May 2013 to March 2015 is due to open cut mining. With sustained wetter conditions, groundwater levels recover to normal levels, as occurred during 2015. Strong declines in groundwater level during 2016 are likely due to the commencement of mining at South Bates Underground and the encroaching open cut, as water levels dropped despite wetter conditions.

Although bores GW16 and GW17 are only 250 m apart, and both are alongside North Wambo Creek, their salinities are quite different (**Figure 8**). The water at GW16 has always been less than 1,000 µS/cm while the water at GW17 is typically about 5,000 µS/cm. While both bores were previously classified as ‘alluvial’, analysis of the driller logs indicates that GW16 is likely screened in alluvium while GW17 is likely screened in Permian overburden.

Figure 9 shows groundwater levels at GW21 in the Permian coal measures, as well as the RMC and the commencement dates for North Wambo Underground and South Bates Underground longwall panels. A mild mining effect is likely at GW21, located between North Wambo Underground Longwall 1 and South Bates Underground Longwall 13. As this occurred at the time of North Wambo Underground Longwall 5 (1.5 km distant), the effect is more likely due to open cut mining (0.5 km away). Mining at South Bates Underground appears to have had no effect, suggestive of the mitigating effect of the fault between GW21 and South Bates Underground.

Although Bore GW21, being dry more often than not, has had limited sampling, initial values suggest very high groundwater salinity (about 16,000 µS/cm) (**Figure 10**). Overall, interburden salinities are quite variable in magnitude and temporal pattern.

VWP responses are shown in **Figure 11**, **Figure 12** and **Figure 13** for bores N2, N3 and N5, respectively. At N2 and N3, the Wambo Seam heads are similar (-10 to -20 mAHD) with substantial pressure heads (60 to 70 m). The Whybrow Seam heads also are similar at both locations (near 0 mAHD), again with substantial pressure heads (15 to 35 m). The sensor in the interburden between the two seams records a higher head at each location than observed in the Whybrow Seam (about 15 mAHD), whereas at N5 the head is very similar to that in the Whybrow Seam. This suggests mining-induced lateral depressurisation in the two seams, with less effect in the interburden. At N2 there is some drawdown due to South Bates Underground Longwall 11 in the upper three piezometers, with no clear effect in the lower three piezometers which all show positive pressure head. This could be due to protection provided by the fault between South Bates Underground Longwall 13 and North Wambo Underground Longwall 1. At N3, the four lowest piezometers were destroyed on 25 May 2016 as South Bates Underground Longwall 11 approached. The upper two piezometers, however, are still functioning, although both have heads at or near the respective sensor elevations. At N5, the three lowest piezometers show a continually declining head due primarily to adjacent open cut mining; at this stage, there is no clear effect from South Bates Underground Longwall 11.

Groundwater Modelling Results

The groundwater model developed using MODFLOW-SURFACT software (HS, 2015) has been used to predict responses to South Bates Underground Mine extraction of coal from the Whybrow Seam for Longwalls 11 to 13 and from the Wambo Seam for Longwalls 14 to 16. Since that assessment, the mine layout is proposed to be changed by shortening the commencing ends of Longwalls 11-14 and 16 (by 13 to 378 m), and lengthening the finishing end of Longwall 14 (by 23 m). In addition, the longwalls in the Wambo Seam are proposed to be extracted in reverse order. These changes to the mine layout have not been modelled explicitly. The effect of shortening or lengthening a panel is to reduce or increase the drawdown extent by a similar distance. The effect of a reversal in mining direction would be to alter the timing of drawdown effects without any change to drawdown magnitude. The drawdown maps produced in HS (2015) are, therefore, conservative assessments of the expected effects of the modified mine layout.

Of most relevance to this groundwater assessment are the predicted drawdowns in model layer 1 for the alluvium and the regolith at the end of Longwall 16. The predicted drawdowns are cumulative as they include the effects of concurrent open cut mining and the final stages of the United Underground Mine in a deeper coal seam.

Figure 14 shows the predicted cumulative drawdown in alluvium and regolith following completion of mining of the Whybrow Seam by Longwall 13. **Figure 15** shows the predicted incremental drawdown following completion of mining of the Whybrow Seam by Longwall 16. Due to the cumulative impacts of approved mining, shallow drawdowns in alluvium and regolith from the commencement of the South Bates Underground Mine are expected to reach about 10 m at the north-eastern end of the mine layout. This is partially due to fracturing to land surface but primarily due to adjacent open cut mining. Negligible drawdown is anticipated over the western half of the mine layout and in the vicinity of Stony Creek. Mining of the Wambo Seam contributes no more than 0.01 m to the predicted drawdown in alluvium and regolith. There are no private registered bores within the ambit of South Bates if it were to act alone. Therefore, there are no private bores likely to be affected by 2 m drawdown or more (a minimal harm consideration of the Aquifer Interference Policy).

HS (2015) presents a discussion of the changes in baseflow in North Wambo Creek predicted to occur during the mining of Longwalls 11 to 16. North Wambo Creek was shown to behave as a gaining stream on average with a fluctuation in baseflow of about 0.01 ML/day. This change in baseflow is considered to be negligible. In the vicinity of South Bates, there is an expectation of enhanced leakage from the diversion if the creek happens to flow at the same time or shortly after the passage of Longwalls 11 to 13 beneath the creek, or the approach of Longwalls 14 to 16 towards the diversion.

In the model, the diversion has been simulated as an ephemeral drain and the scenario of occasional high flows is not examined as part of the numerical model; however, this has been discussed further above. It would be inappropriate to model an ephemeral stream using a “river” algorithm as that would require specification of open water levels for the entire duration of a stress period (usually one year for prediction) with consequent exaggerated leakage. A drain mechanism is a conservative approach for impact assessment, as enhanced leakage through river cells would reduce any predicted shallow drawdowns on the water table.

There is a series of north-northeast to south-southwest trending faults within and adjacent to the South Bates Underground Mine area with throws between 0.5 m and 1 m (MSEC, 2017). Some larger faults have been identified to the north-west and to the south-east of the South Bates Underground Mine with throws ranging between 3 m and 12 m (MSEC, 2017). These faults may result in some confinement of groundwater drawdown, as has been observed at GW21 and N2, which would make the numerical model predictions somewhat conservative at a distance, with some potential for local differences directly above the longwall panels.

Conclusion

The key findings of this groundwater assessment review are:

1. It is not realistic to assess the drawdown caused by the South Bates Underground Mine acting alone, as the groundwater responses are affected significantly by adjacent open cut and longwall mining.

2. Shallow drawdowns in alluvium and regolith from the commencement to the completion of the South Bates Underground Mine are expected to reach about 10 m at the north-eastern end of the mine layout, in the vicinity of the North Wambo Creek diversion.

3. Negligible drawdown in shallow groundwater systems is anticipated over the western half of the South Bates Underground Mine layout and in the vicinity of Stony Creek.

4. Nearby monitoring bores P5 and P6 in the North Wambo Creek alluvium have experienced freshwater recharge at a rate higher than occurred pre-mining. This could be due to higher rainfall recharge through surficial cracking or reduced upflow of more saline groundwater. A similar response is likely where Longwalls pass beneath the North Wambo Creek diversion.

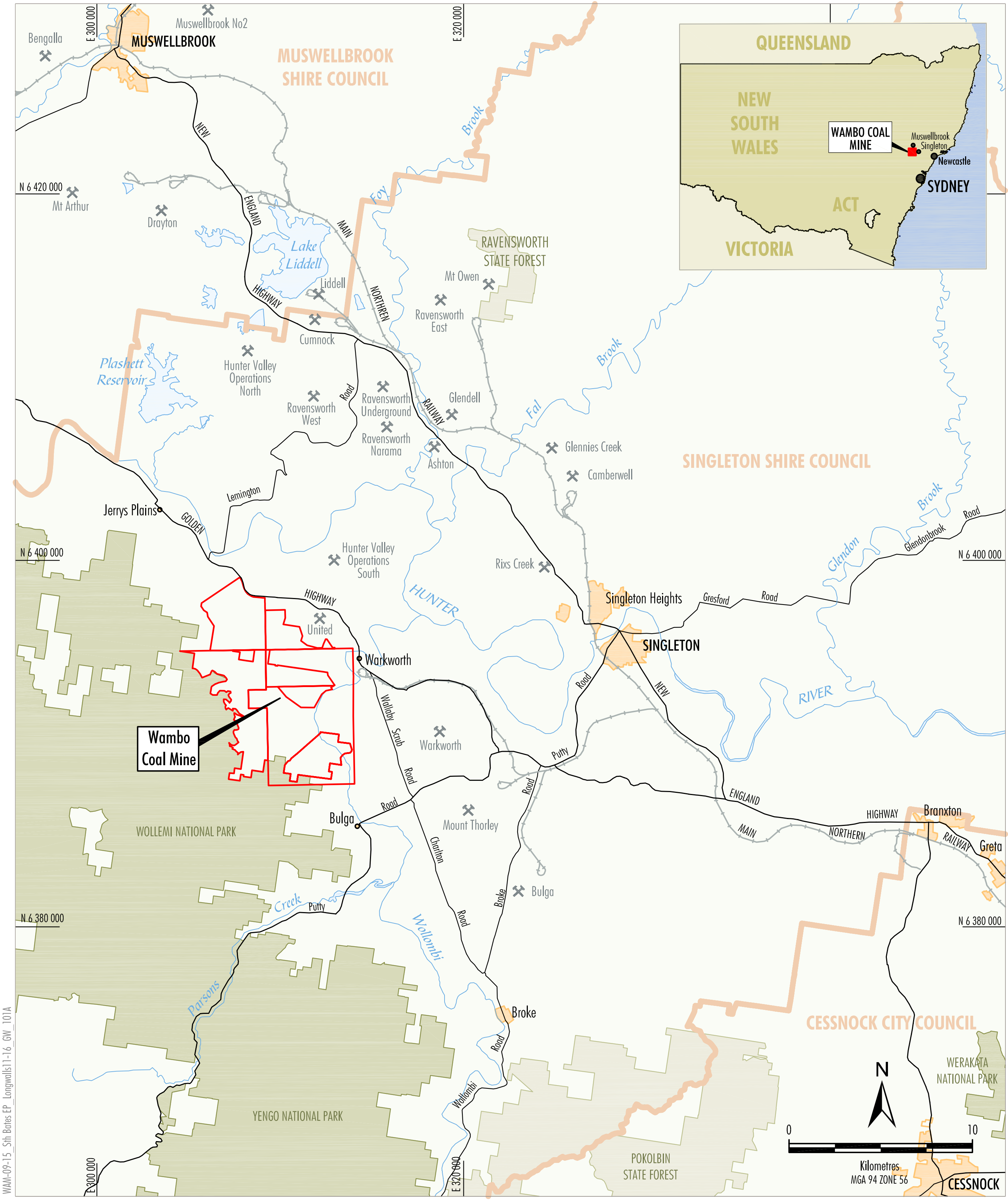
5. There is an expectation of enhanced leakage from the North Wambo Creek diversion if the creek happens to flow at the same time or shortly after the passage of Longwalls 11 to 13 beneath the creek or the completion of Longwalls 14 to 16 adjacent to the diversion.

6. There are no private registered bores within the ambit of the drawdown effects of South Bates if it were to act alone. Therefore, there are no private bores likely to be affected by 2 m drawdown or more (a minimal harm consideration of the Aquifer Interference Policy).

This data analysis, based on currently available records, has shown that there are no predicted material impacts from longwall mining beyond what was foreseen for the cumulative impacts described in the South Bates (Wambo Seam) Underground Mine Modification – Groundwater Assessment (HS, 2015). The recent proposed revision to the mine layout in terms of panel lengths and mining direction would lessen the predicted impacts, but the benefits would be marginal. Therefore, revision of the potential environmental consequences of Longwalls 11 to 16 is not required as the predictions in HS (2015) are expected to be conservative.

ENCLOSURE A

FIGURES



LEGEND

- Mining and Coal Lease Boundary
- Local Government Boundary
- Mining Operation

Source: Geoscience Australia (2009)

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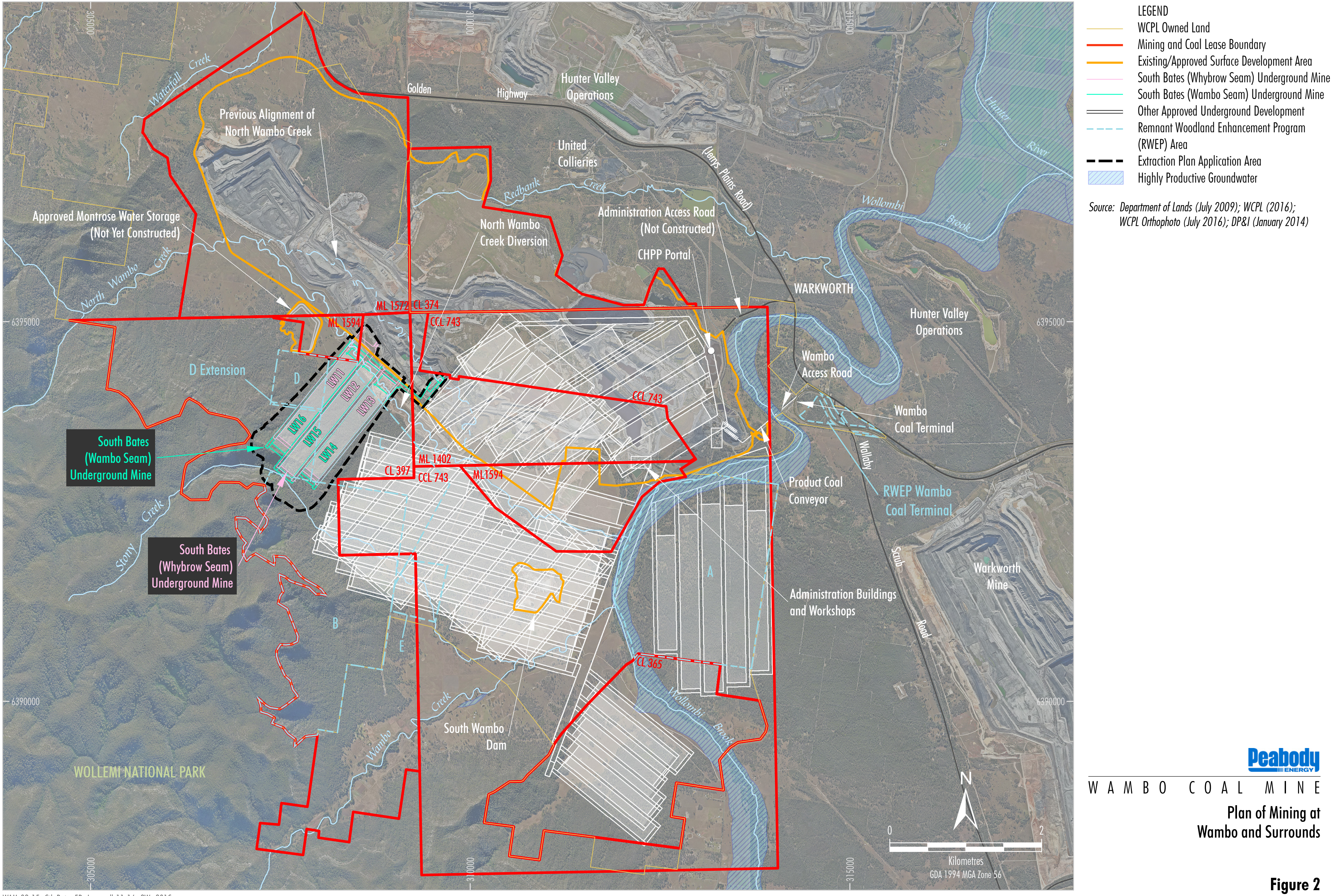
WAMBO COAL MINE

Regional Location

Figure 1



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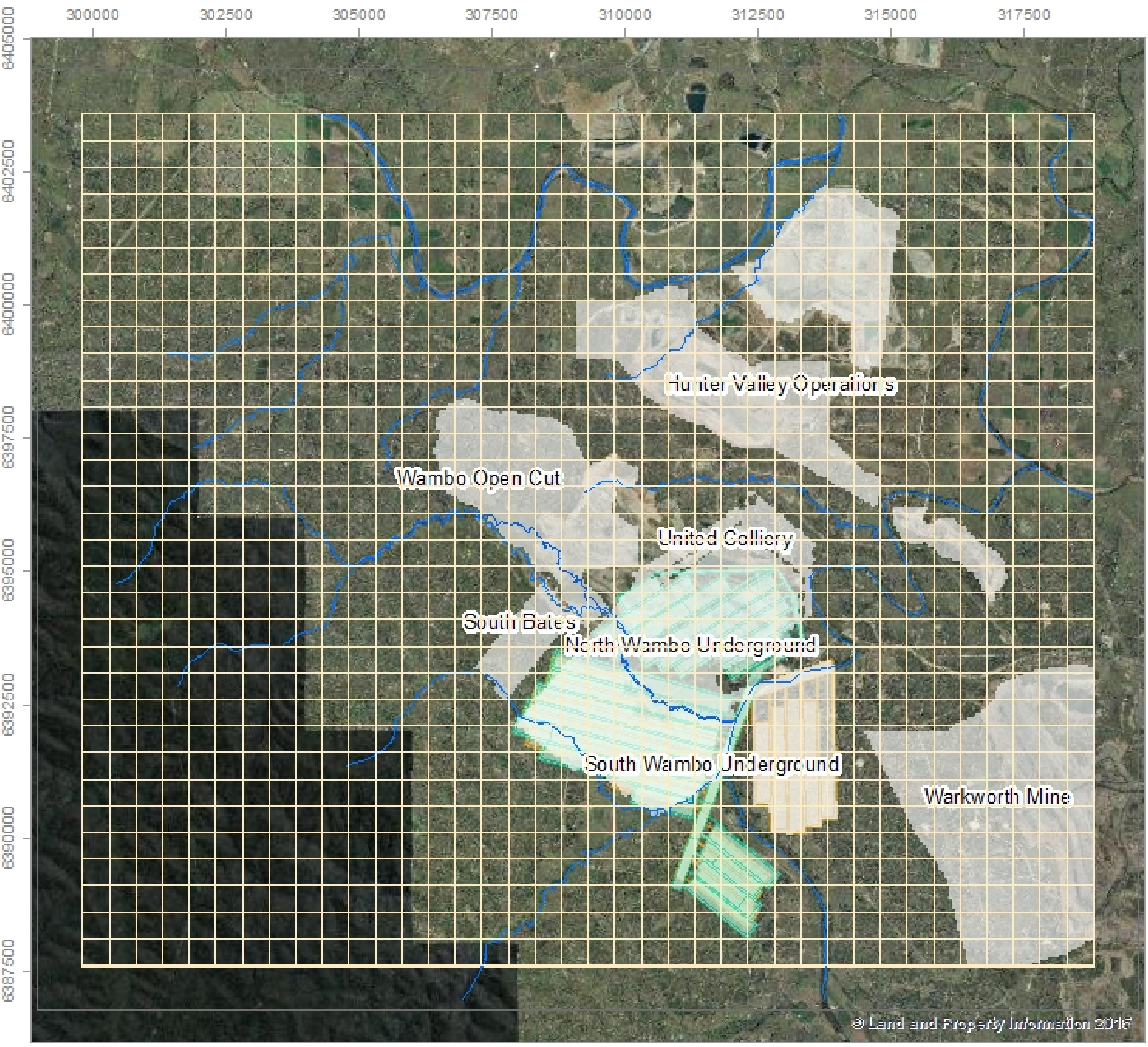
WAMBO COAL MINE

Plan of Mining at Wambo and Surrounds

Figure 2

WAM-09-15_Sth Bates EP_Longwalls11-16_GW_201C



Model Grid

1 square = 100 model cells

Rivers and Creeks

Woodlands Hill Layout

Arrowfield Layout

0 0.5 1 2 3 km

Scale: 0 @ A4
GDA 1994 MGA Zone 56

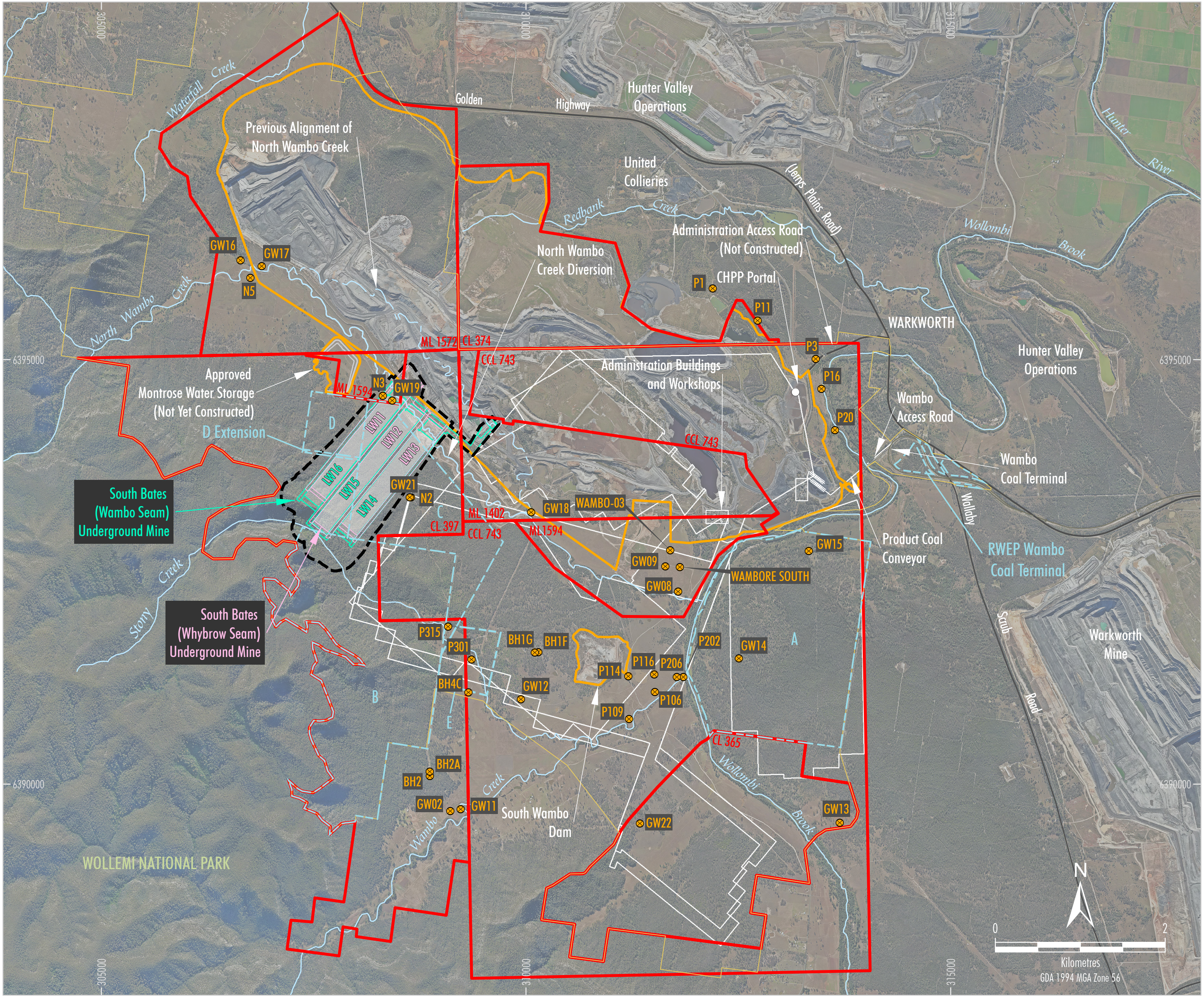
Wambo Coal Pty Ltd

Model Domain

DrawingNo: WAM003
Rev: A.
Created by: CTurvey
Date: 27/11/2015
X:\HYDROSIM\WAM003\GIS\Maps\Deliverable\Model_Domain.mxd

HYDROSIMULATIONS

Figure 3



LEGEND

- WCPL Owned Land
- Mining and Coal Lease Boundary
- Existing/Approved Surface Development Area
- South Bates (Whybrow Seam) Underground Mine
- South Bates (Wambo Seam) Underground Mine
- Other Approved Underground Development
- Remnant Woodland Enhancement Program (RWEP) Area
- Extraction Plan Application Area
- Groundwater Monitoring Site

Source: Department of Lands (July 2009); WCPL (2016); WCPL Orthophoto (July 2016)

Peabody ENERGY

WAMBO COAL MINE

Groundwater Monitoring Network

Figure 4

WAM-09-15_Sth Bates EP_Longwalls11-16_GW_202C

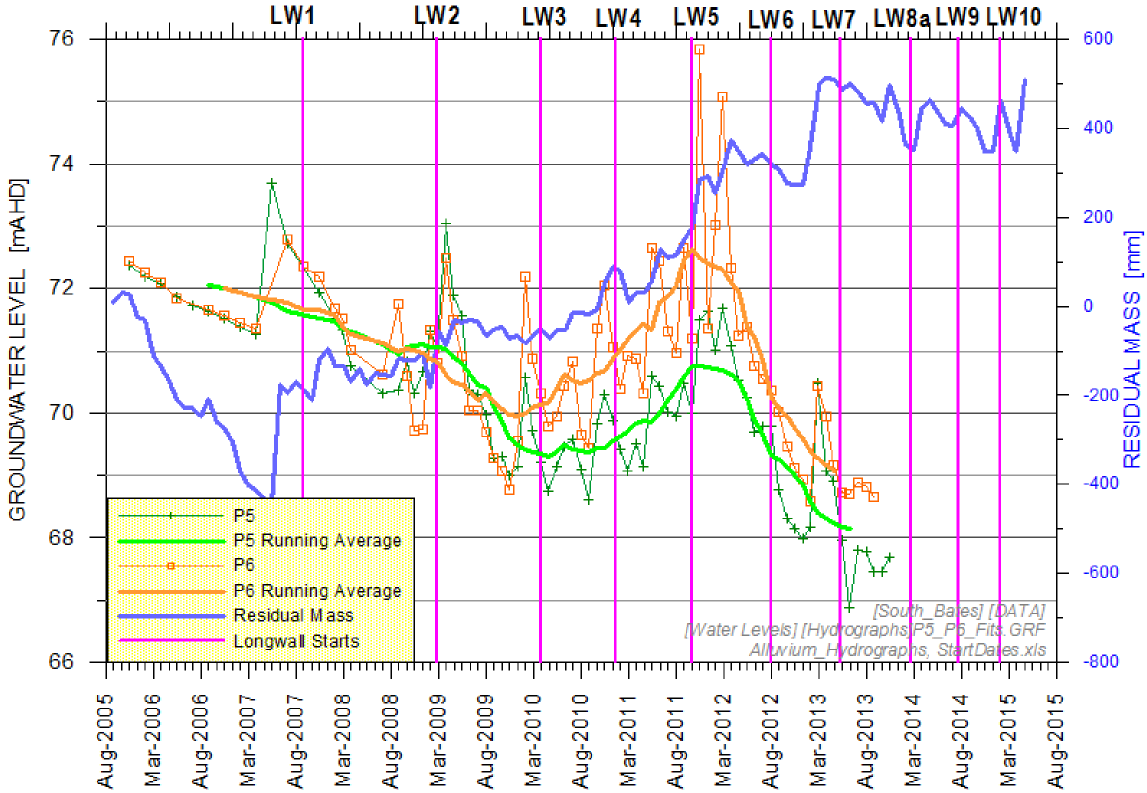


Figure 5. North Wambo Creek Observed and Smoothed Hydrographs at Monitoring Bores P5 and P6

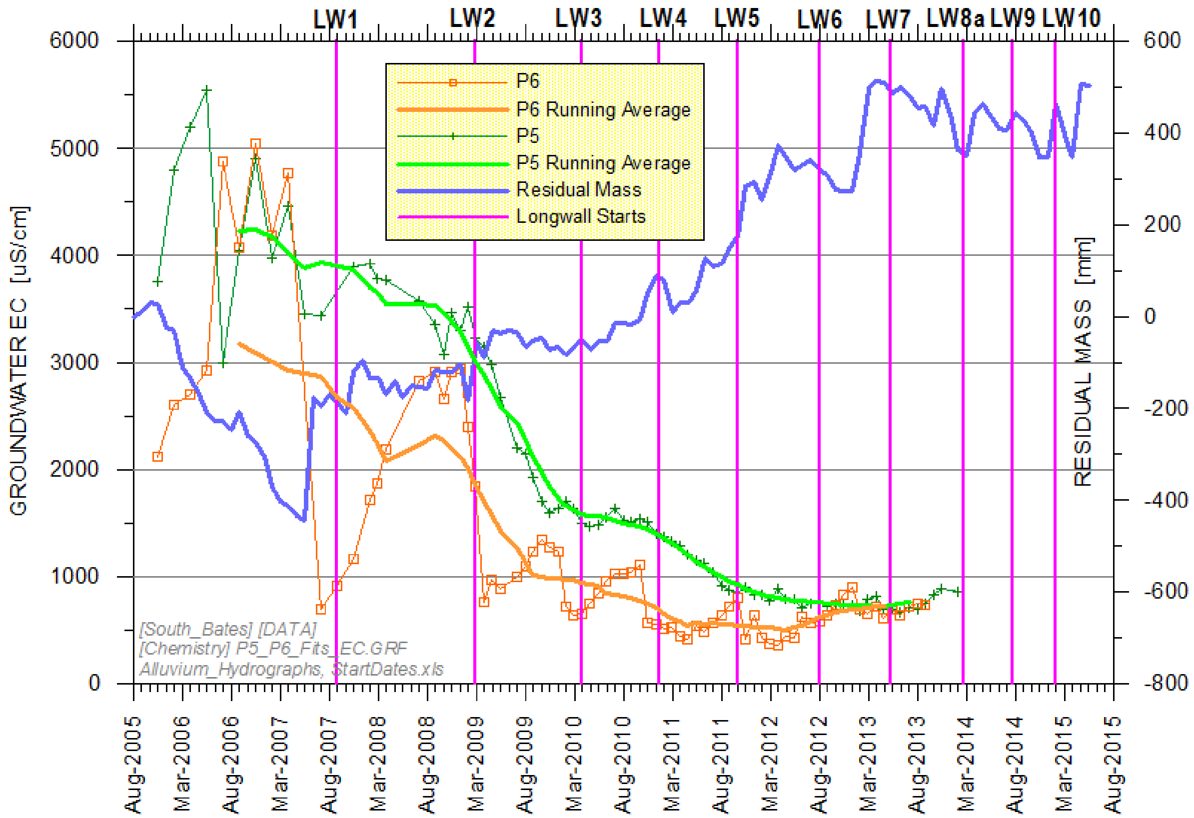


Figure 6. North Wambo Creek Smoothed EC Time-Series at Monitoring Bores P5 and P6

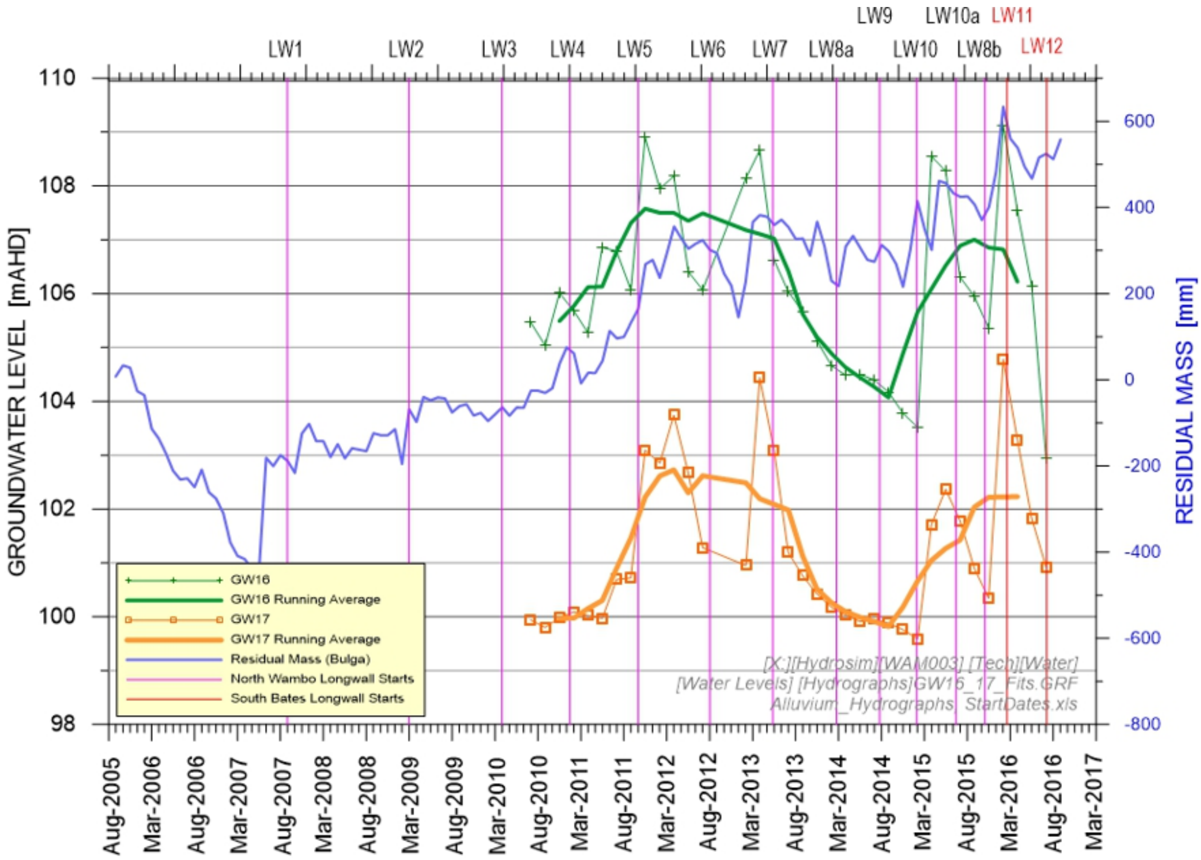


Figure 7. North Wambo Creek Observed and Smoothed Hydrographs at Monitoring Bores GW16 and GW17

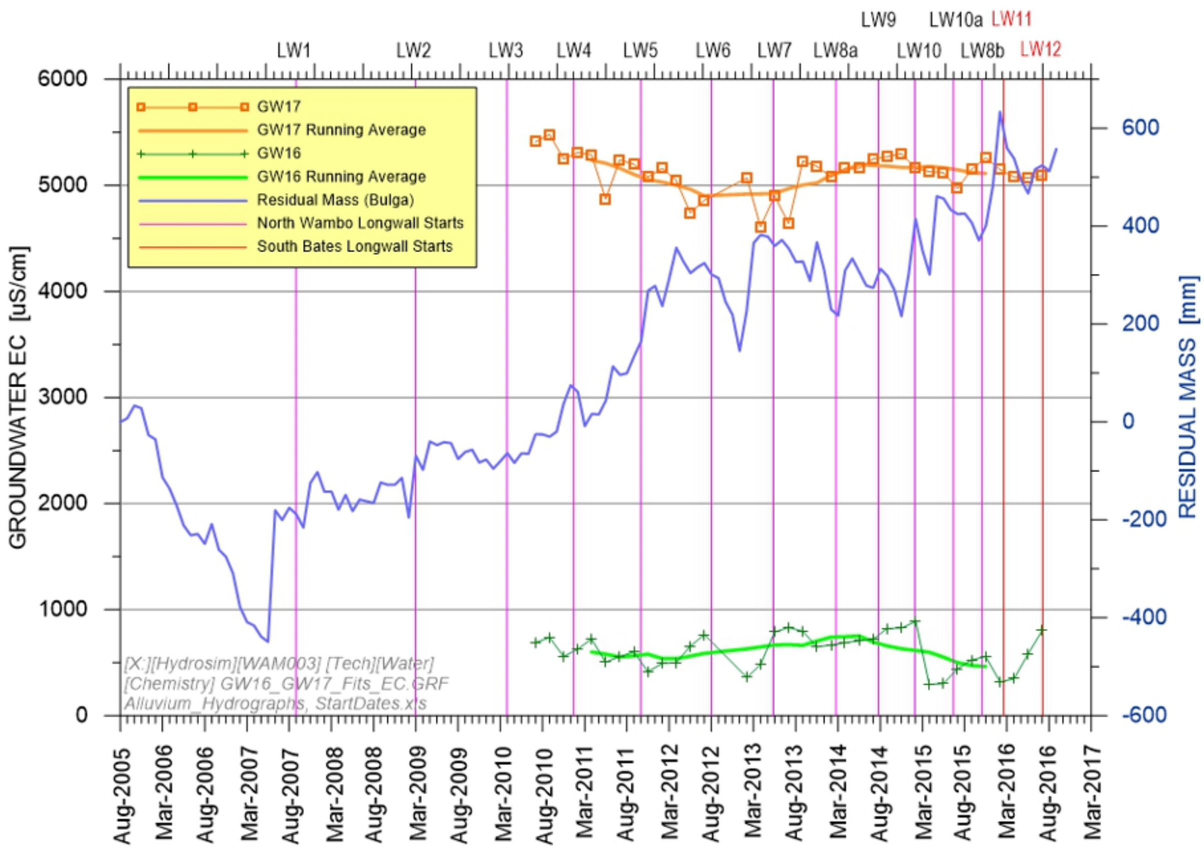


Figure 8. North Wambo Creek Smoothed EC Time-Series at Monitoring Bores GW16 and GW17

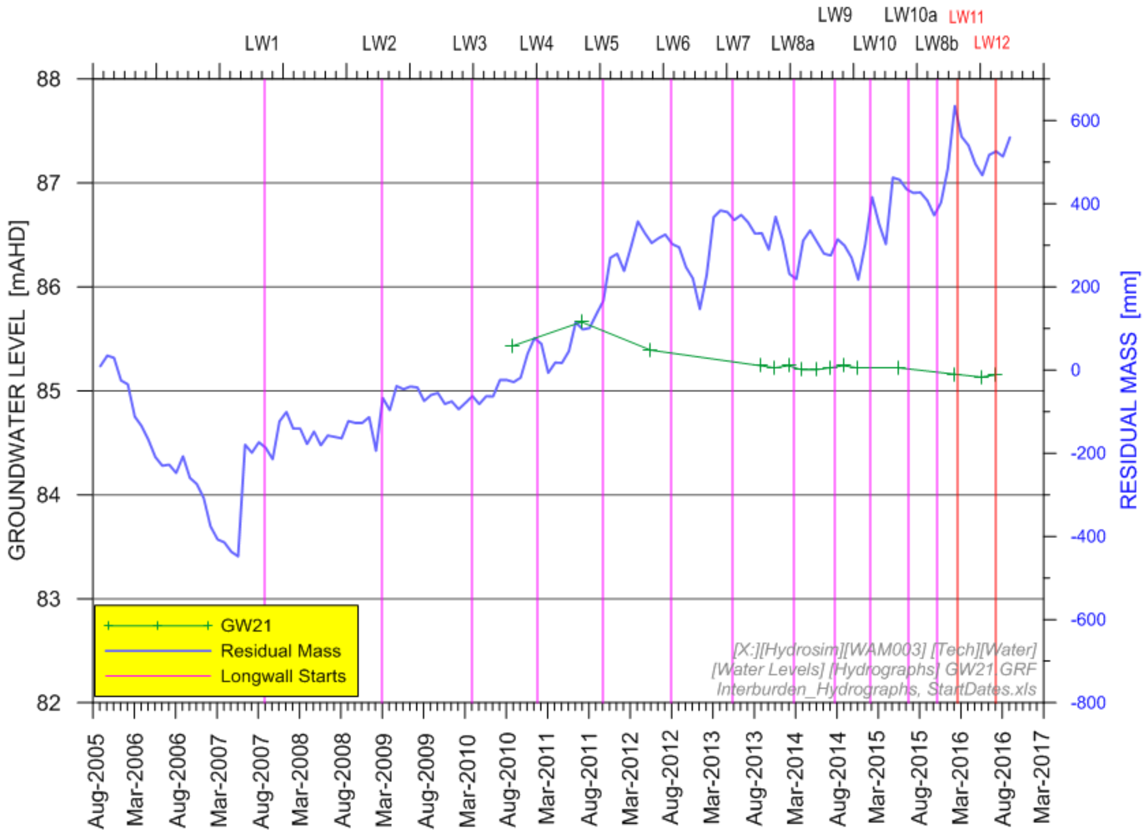


Figure 9. Interburden Observed Hydrograph at Monitoring Bore GW21

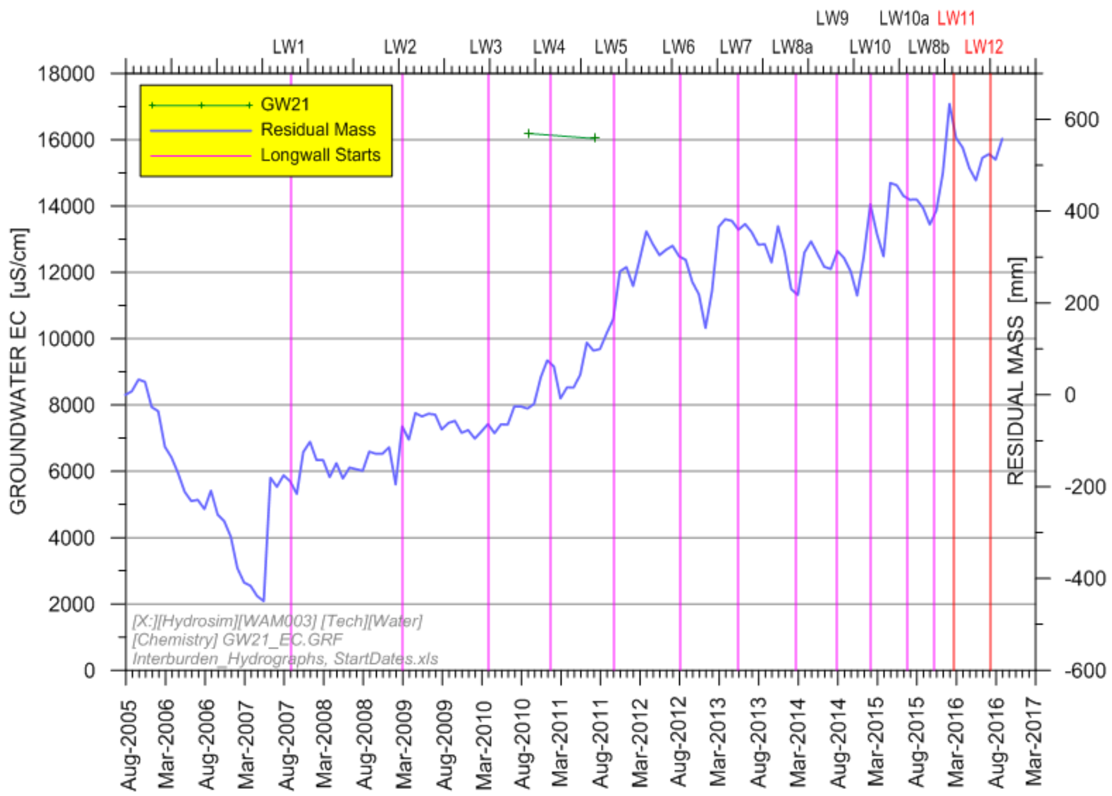


Figure 10. Interburden EC Time-Series at Monitoring Bore GW21

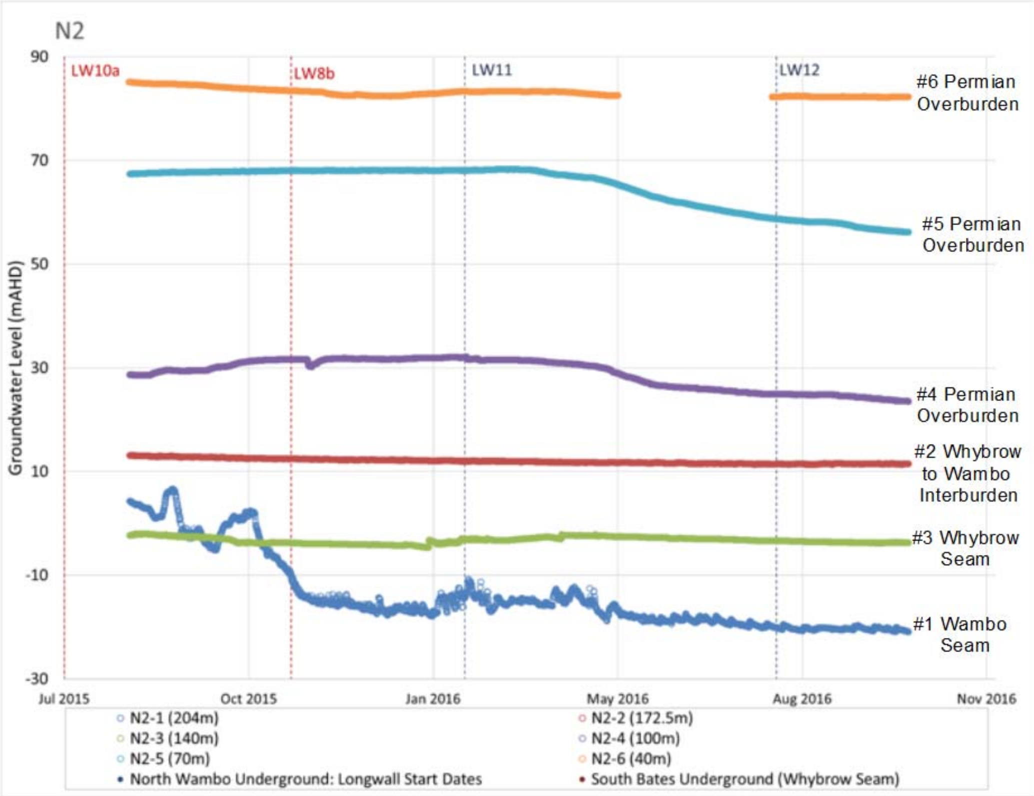


Figure 11. Observed Hydrographs at VWP Monitoring Bore N2

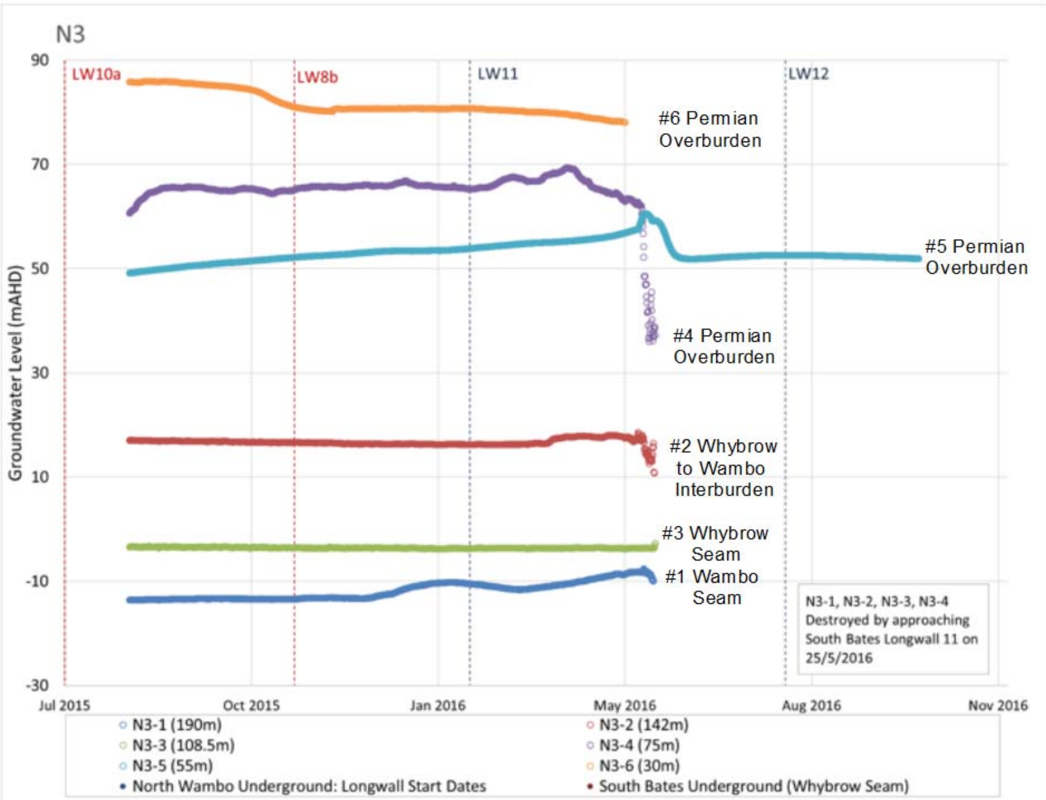


Figure 12. Observed Hydrographs at VWP Monitoring Bore N3

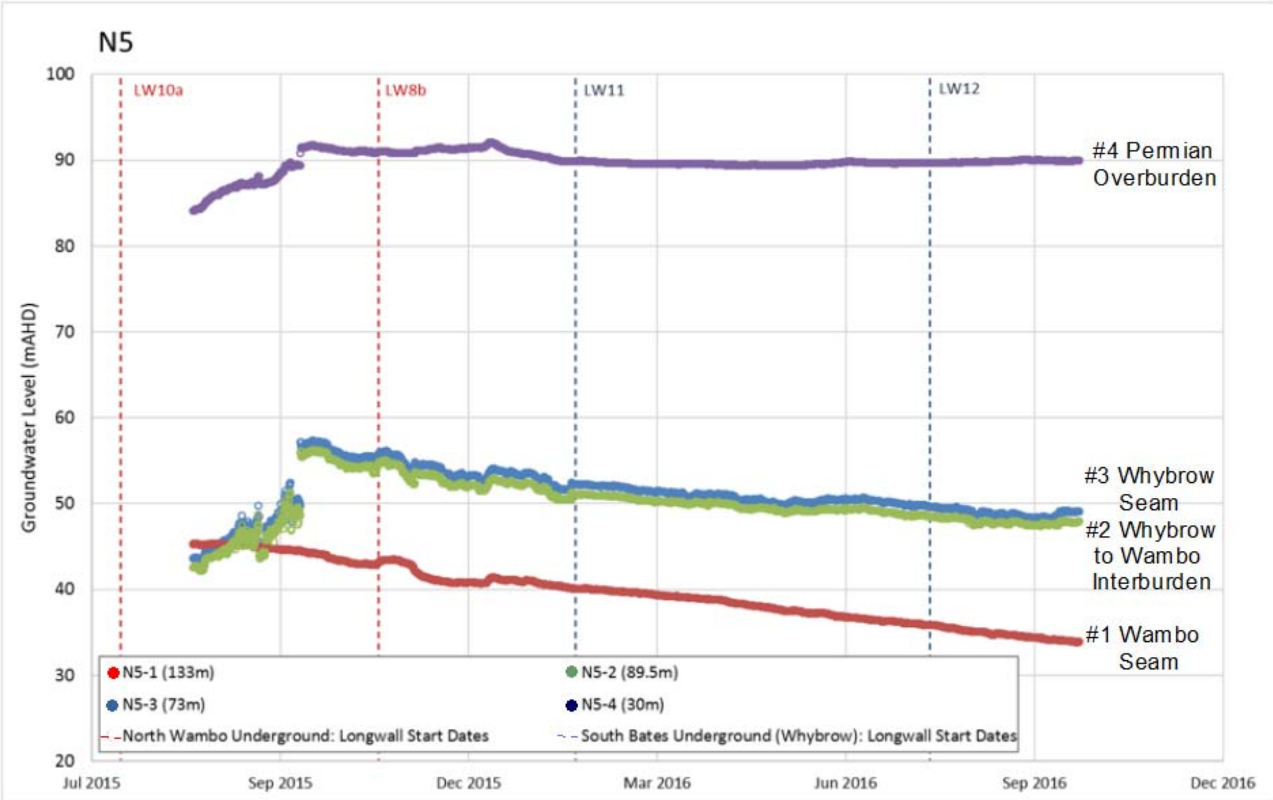


Figure 13. Observed Hydrographs at VWP Monitoring Bore N5

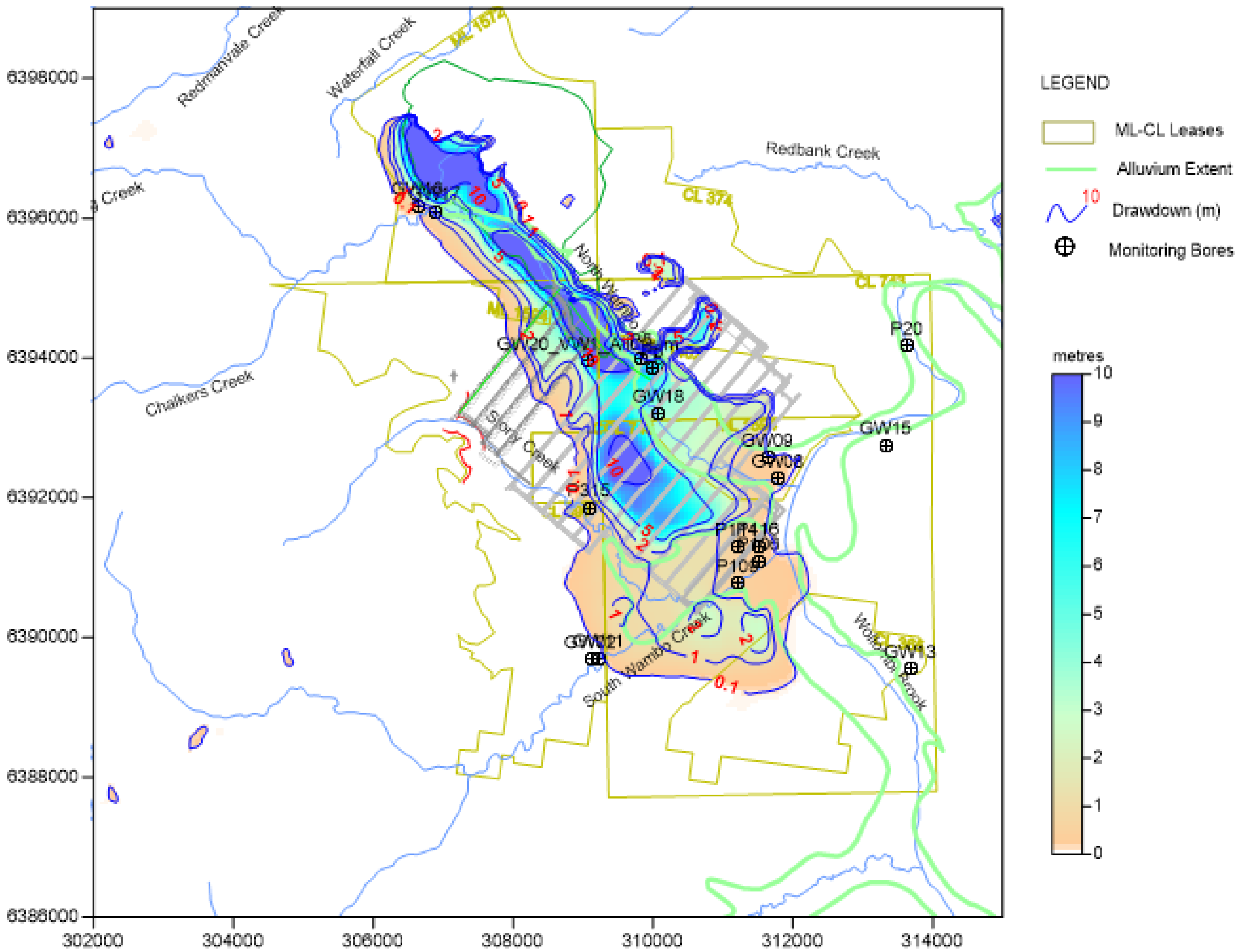


Figure 14. Cumulative Drawdown (m) in Alluvium / Regolith at the end of Whybrow Seam Mining

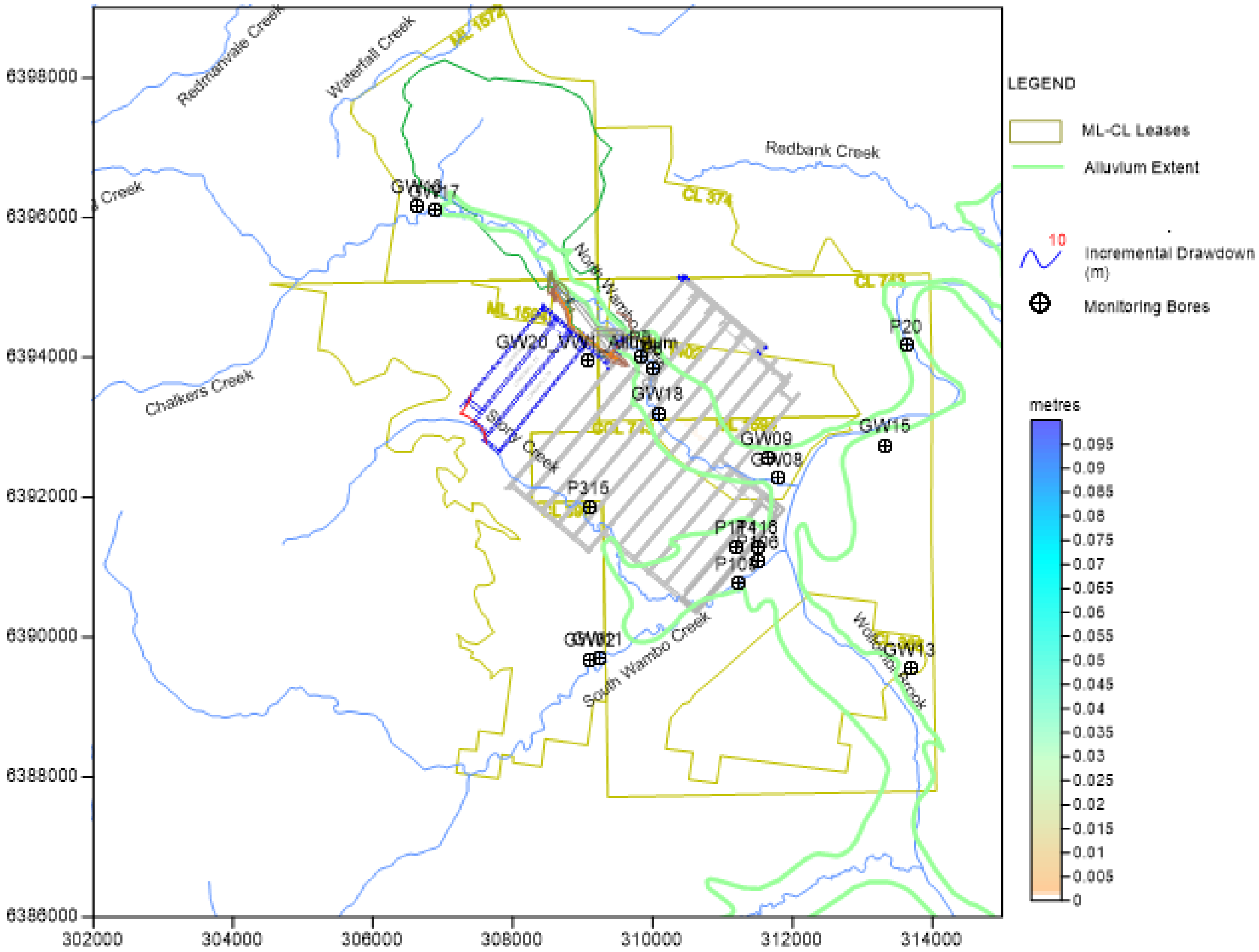


Figure 15. Incremental Drawdown (m) in Alluvium / Regolith at the end of Wambo Seam Mining